TABLE OF CONTENTS

Note: This Table of Contents has been prepared for the convenience of those using this contract with the sole express purpose of locating quickly the information contained herein; and no claims shall arise due to omissions, additions, deletions, etc., as this Table of Contents shall not be considered part of the contract.

DATE
FEDERAL AID PROJECT NO. XXXX(XXX)
STATE PROJECT NO. 015-384

FLOOD RISK REDUCTION PROGRAM

Town of Bridgeport
Federal Aid Project No. XXXX(XXX)

The State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, Facilities and Incidental Construction, Form 818, 2020, is hereby made part of this contract, as modified by the Special Provisions contained herein. Form 818 is available at the following DOT website link http://www.ct.gov/dot/cwp/view.asp?a=3609&q=430362. The current edition of the State of Connecticut Department of Transportation's "Construction Contract Bidding and Award Manual" ("Manual"), is hereby made part of this contract. If the provisions of this Manual conflict with provisions of other Department documents (not including statutes or regulations), the provisions of the Manual will govern. The Manual is available at the following DOT website link http://www.ct.gov/dot/cwp/view.asp?a=2288&q=259258. The Special Provisions relate in particular to the State Project No. 015-384 in the City of Bridgeport.

CONTRACT TIME AND LIQUIDATED DAMAGES

_____ ( ) calendar days will be allowed for completion of the work on this Contract and the liquidated damages charge to apply will be Dollars ($) per calendar day.

NOTICE TO CONTRACTOR – REFERENCE TO STATE OF CONNECTICUT DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS

Reference is made in this Contract to Sections or Articles of Connecticut Department of Transportation Standard Specifications for Roads, Bridges, Facilities and Incidental Construction, Form 818, dated 2020 and the subsequent Supplemental Specifications to the Standard Specifications dated July 2020. Reference is designated by the abbreviation "CTDOT – Form 818." The referenced Section, Article or Subarticle along with title may follow the abbreviation CTDOT – Form 818. Modifications may include additions, deletions, corrections and changes. Copies of CTDOT Form 818 may be purchased from:

Connecticut Department of Transportation, Manager of Contracts, P.O. Box 317546, 2800 Berlin Turnpike, Newington, CT 06131-7546 or Online with Supplements at:
http://www.ct.gov/dot/cwp/view.asp?a=3609&q=430362

Within the CTDOT – Form 818 Standard Specifications and wherever the following terms are used they shall mean, respectively:

CTDOT – Form 818 or Contract Documents term	Meaning Herein
State, Department, Commissioner, Owner	State of Connecticut Department of Housing (DOH)
Engineer or Architect	Representative of DOH
Inspector	Representative of Owner, Local Public Agency or other duly authorized representative
Laboratory	Laboratory designated by the Engineer or Owner

All work under this contract shall follow and be constructed in conformance with CTDOT – Form 818 except as amended herein.

Local Public Agency(ies): Local Regulatory Agency(ies) shall be defined as the governing body or authority having jurisdiction over or responsibility for a particular activity within the scope of this Contract. They may be specifically defined within the Special Conditions, otherwise, the Contractor shall be responsible to determine same in the local area of the Contract.

Further, it is provided that whenever anything is indicated to be "contemplated, required, determined, directed, specified, authorized, ordered, given, designated, indicated, considered necessary, deemed necessary, permitted, reserved, suspended, established, approval, approved, disapproved, acceptable, unacceptable, suitable, accepted, satisfactory, unsatisfactory, sufficient,

insufficient, rejected, or condemned," it shall be understood as if the expression were followed by the words "by the Owner" or "to the Owner."

NOTICE TO CONTRACTOR - INCREASED REQUIREMENTS FOR CONSTRUCTION FIELD OFFICE

This Notice is to alert the Contractor of the increased size and other requirements for the Contract item "Construction Field Office, (Size)" due to Covid-19 and other considerations.

The revisions to special provisions:

ITEM #0969060A - CONSTRUCTION FIELD OFFICE, SMALL
ITEM #0969062A - CONSTRUCTION FIELD OFFICE, MEDIUM
ITEM #0969064A - CONSTRUCTION FIELD OFFICE, LARGE
ITEM #0969066A - CONSTRUCTION FIELD OFFICE, EXTRA LARGE

include but not limited to, increased field office size, increased ventilation requirements, increase cleaning requirements, and additional field office supply requirements.

All costs for these requirements shall be included in the Construction Field Office item included in the Contract.

NOTICE TO CONTRACTOR - PORTLAND CEMENT CONCRETE (PCC) MIX CLASSIFICATIONS

SECTIONS 6.01 and M.03 MIX CLASSIFICATION EQUIVALENCY

Sections 6.01 *Concrete for Structures* and M.03 *Portland Cement Concrete* have been revised to reflect changes to item names and nomenclature for standard Portland cement concrete (PCC) mix classifications. Special Provisions, plan sheets and select pay items in this Contract may not reflect this change. Refer to the Concrete Mix Classification Equivalency Table below to associate the Concrete Mix Classifications with Former Mix Classifications that may be present elsewhere in the Contract.

Concrete Mix Classification Equivalency Table

New Mix Classification (Class PCCXXXYZ[1])	Former Mix Classification
Class PCC03340	Class "A"
Class PCC03360	Class "C"
Class PCC04460[2]	Class "F"
Class PCC04462[2]	High Performance Concrete
Class PCC04481, PCC05581	Class "S"

Table Notes:

1. See Table M.03.02-1, Standard Portland Cement Concrete Mixes, for the new Mix Classification naming convention.
2. Class PCC04462 (formerly Class "HP1" Concrete; also called low permeability concrete) is to be used for the following cast-in-place bridge components: decks, bridge sidewalks, and bridge parapets.

Where called for in the Contract, **Low Permeability Concrete** shall be used, as specified in Sections 6.01 and M.03. Please pay special attention to the requirements for Class PCC04462, including:

- Submittal of a mix design developed by the Contractor and a concrete supplier **at least 90 days prior to placing the concrete**
- Testing and trial placement of the concrete mix is to be developed and discussed with the Department

The Department will not consider any requests for change to eliminate the use of Low Permeability Concrete on this Project.

NOTICE TO CONTRACTOR – UTILITY CONTACTS

Listed below are utility contacts for this Project.

Cable TV

Cablevision dba Altice USA
Mr. Kevin Robinson, Construction Manager
Phone: (914) 326-1071
Mobile: (732) 803-0616
E-Mail: Kevin.robinson1@alticeusa.com

Communication

Lightower Fiber Networks I, LLC
dba Crown Castle Fiber
Mr. Eric Clark, Manager Fiber Construction
Phone: (203) 649-3904
Mobile: (860) 863-8311
Email: Eric.Clark@crowncastle.com

The Southern New England Telephone Company
dba Frontier Communications of Connecticut
Ms. Lynne DeLucia, Engineering
Phone: (203) 238-5000
Mobile: (860) 967-4389
Email: lynne.m.delucia@ftr.com

MCImetro Access Transmission Services Corp.
dba Verizon Enterprise Solutions
Mr. Eric C Johnson, Engr Iv Spec-Ntwk Eng & Ops
Phone: (401) 727-9558
Mobile: (401)729-0630
Email: eric.c.johnson@verizon.com

Mobilitie, LLC Attn: Asset Management
Ms. Jacki Rhodes, Manager, Lease Administration - Small Cells
Mobile: (949) 531-3134
Email: jacki@mobilitie.com; AssetMgmt@mobilitie.com

Electric Distribution

The United Illuminating Company
Mr. Fred Arnold, Project Management Engineer
Phone: (203) 499-3922

Mobile: (203) 361-7513
Email: Fred.Arnold@uinet.com

Electric Transmission

The Connecticut Light & Power Company
dba Eversource Energy – Electric Distribution
Mr. Thomas Woronik, Supervisor - Field Engineering Design
Phone: (860) 447-5713
Email: Thomas.Woronik@eversource.com

Fire Hydrant

Bridgeport Fire Department
Len Bonaventura, Senior Fire Inspector – Fire Marshal Division
Phone: (203) 383-3452
Email: leonard.bonaventura@bridgeportct.gov

Gas

The Southern Connecticut Gas Company
Mr. Dwight Edwards, Lead Engineer
Phone: (203) 795-7868
Email: dedwards@soconngas.com

Kinder Morgan, Inc. (Tennessee Gas Pipeline L.L.C.)
Mr. David Wood, Project Manager – Ops
Phone: (860) 763-6005
Mobile: (413) 530-7117
Email: David_Wood@kindermorgan.com

Railroad

Metro-North Commuter Railroad Company
Mr. David B. Willard, P.E., Assistant Director
Phone: (203) 337-3606
Email: willard@mnr.org

Sewer

City of Bridgeport Water Pollution Control Authority
Laura McBennett Mappa, General Manager
Email: lauren.mcbennettmappa@bridgeportct.gov

Water

Aquarion Water Company of Connecticut
Mr. Carlos Vizcarrondo, Relocations Coordinator
Phone: (203) 337-5950
Mobile: (203) 395-3097
Email: cvizcarrondo@aquarionwater.com

NOTICE TO CONTRACTOR – PROTECTION OF EXISTING UTILITIES

Existing utilities shall be maintained during construction except as specifically stated herein and/or noted on the plans and as coordinated with the utilities. The Contractor shall verify the location of underground, structure mounted and overhead utilities. Construction work within the vicinity of utilities shall be performed in accordance with current safety regulations.

The Contractor shall notify "Call Before You Dig," telephone 1-800-922-4455 for the location of public utility, in accordance with Sections 16-345 through 16-359 of the Regulations of the Public Utilities Regulatory Agency.

Representatives of the various utility companies shall be provided access to the work, by the Contractor.

Contractors are cautioned that it is their responsibility to verify locations, conditions, and field dimensions of all existing features, as actual conditions may differ from the information shown on the plans or contained elsewhere in the specifications.

The Contractor shall notify the Engineer prior to the start of work and shall be responsible for all coordination with the Owner. The Contractor shall allow the Engineer complete access to the work.

The Contractor shall be liable for all damages or claims received or sustained by any persons, corporations or property in consequence of damage to the existing utilities, their appurtenances, or other facilities caused directly or indirectly by the operations of the Contractor.

Any damage to any existing private and public utility, as a result of the Contractors operations, shall be repaired to the utilities and Engineer's satisfaction at no cost to the Owner or the Utilities, including all materials, labor, etc., required to complete the repairs.

The Contractor's attention is directed to the requirements of Article 1.07.13 – "Contractor's Responsibilities for Adjacent Property, Facilities and Services."

Prior to opening an excavation, effort shall be made to determine whether underground installations, e.g., water, sanitary, gas, electric ducts, communication ducts, etc., will be encountered and, if so, where such underground installations are located. When the construction approaches the estimated location of such an installation, the exact location shall be determined by careful probing or hand digging, and when it is uncovered, proper supports shall be provided for the existing installation. Utility companies shall be contacted and advised of proposed work prior to the start of actual excavation, as noted above.

NOTICE TO CONTRACTOR - UTILITY SPECIFICATIONS

The contractor is hereby notified that all utility specifications contained elsewhere herein shall be made a part of this contract, and that the contractor shall be bound to comply with all requirements of such specifications. The requirements and conditions set forth in the subject specifications shall be binding on the contractor just as any other specification would be.

NOTICE TO CONTRACTOR – VERIFICATION OF EXISTING CONDITIONS, PLAN DIMENSIONS, AND FIELD MEASUREMENTS

Included in this Contract is the modification, alteration and/or addition to existing structures. Contractors are cautioned that it is their responsibility to verify locations, conditions, and field dimensions of all existing features, as actual conditions may differ from information shown on the plans or contained elsewhere in the specifications.

The Contractor is responsible for verifying all dimensions before any work is begun. Dimensions of the existing structures shown on the plans are for general reference only; they are not guaranteed. The Contractor shall take all field measurements necessary to assure proper fit of the finished work and shall assume full responsibility for their accuracy. When shop drawings and/or working drawings based on field measurements are submitted for approval and/or review, the field measurements shall also be submitted for reference by the reviewer.

In the field, the Contractor shall examine and verify all existing and given conditions and dimensions with those shown on the plans. If field conditions and dimensions differ from those shown on the plans, the Contractor shall use the field conditions and dimensions and make the appropriate changes to those shown on the plans as approved by the Engineer. All field conditions and dimensions shall be so noted on the drawings submitted for approval.

There shall be no claim made against the OWNER by the Contractor for work pertaining to modifications required by any difference between actual field conditions and those shown by the details and dimensions on the contract plans. The Contractor will be paid at the unit price bid for the actual quantities of materials used or for the work performed, as indicated by the various items in the contract.

NOTICE TO CONTRACTOR – CONTRACTOR PARKING

The Contractor is hereby advised that there are limited areas available for employee parking adjacent to the various construction locations within and adjacent to the project limits. At no time shall parked or stored vehicles used for and by construction personnel impinge on roadway traffic operations, pedestrian access and/or access and egress to local businesses and other adjacent properties. The Contractor's parking arrangements are subject to all local parking regulations. The Contractor must also conform to the requirements of the Special Provision "Article 1.07.07 – Safety and Public Convenience."

The Contractor must submit to the Engineer for review and approval any areas they intend to use for parking. The Contractor must submit verification of approval to the Engineer prior to use.

The Contractor may be required to shuttle employees to the project site from an off-site/remote parking facility, if required, at their expense. There will be no direct payment for employee parking under the contract.

NOTICE TO CONTRACTOR - ENVIRONMENTAL INVESTIGATIONS

Environmental site investigations have been conducted that involved the sampling and laboratory analysis of soil, sediment, concrete, timbers and groundwater collected from various locations and depths within the project limits. The results of these investigations indicated the presence of detectable concentrations of total petroleum hydrocarbons (TPH), volatile organic compounds (VOC), polynuclear aromatic hydrocarbons (PAH) and RCRA 8 metals in the soils within proposed construction areas. The DEP groundwater classification beneath the site is GA. Based on these findings, three (3) AOEC's exist(s) within the proposed project limits. In addition, "Low Level" AOEC's exist within the proposed project limits, where the compounds detected at concentrations below the numeric criteria. The presence of the compounds at these concentrations will not require material-handling measures beyond those required for normal construction operations. The presence of these compounds at these concentrations will require the disposition of soils excavated from these areas to be restricted as described herein. Material excavated from within the "Low Level" AOEC's that cannot be reused within the Project limits will require disposal at an approved treatment/disposal facility in accordance with Item No. 0202315A - Disposal of Controlled Materials.

The Contractor is hereby notified that controlled materials requiring special management or disposal procedures will be encountered during various construction activities conducted within the project limits. Therefore, the Contractor will be required to implement appropriate health and safety measures for all construction activities to be performed within the AOEC(s). These measures shall include, but are not limited to, air monitoring, engineering controls, personal protective equipment and decontamination, equipment decontamination and personnel training. WORKER HEALTH AND SAFETY PROTOCOLS WHICH ADDRESS POTENTIAL AND/OR ACTUAL RISK OF EXPOSURE TO SITE SPECIFIC HAZARDS IS SOLELY THE RESPONSIBILITY OF THE CONTRACTOR.

The City/Town of XXXX, as Generator, will provide an authorized representative to sign all manifests and waste profile documentation required by disposal facilities for disposal of contaminated sediments, timbers, concrete water, and controlled and hazardous materials.

All suitable material excavated within the "Low Level" AOEC(s) shall be utilized as fill/backfill within the project limits, in accordance with the following conditions: (1) such soil is deemed to be structurally suitable for use as fill by the Engineer; (2) such soil is not placed below the water table; 3) the DEP groundwater classification of the area where the soil is to be reused as fill does not preclude said reuse; and (4) such soil is not placed in an area subject to erosion. Soils within the "Low Level" AOEC(s) are to be reused on-site prior to the use of other soils and/or fill such that no excess soils requiring off-site disposal are generated from the "Low Level" AOEC(s).

The Sections which shall be reviewed by the Contractor include, but are not limited to, the following:

- Item No. 0101000A - Environmental Health and Safety
- Item No. 0101109A – Hazardous Materials Excavation
- Item No. 0101128A - Securing, Construction and Dismantling of a Waste Stockpile and Treatment Area
- Item No. 0101126A – Disposal of Hazardous Waste
- Item No. 0101130A – Environmental Work – Solidification
- Item No. 0101133A – Disposal of Contaminated Railroad Ties
- Item No. 0101117A - Controlled Materials Handling
- Item No. 0101140A – Disposal of Contaminated Timber Piles
- Item No. 0202315A - Disposal of Controlled Materials
- Item No. 0202318A - Management of Reusable Controlled Material
- Item No. 0202642A – Abandonment of Wells
- Item No. 0202761A – Handling and Disposal of Contaminated Concrete
- Item No. 0204213A – Handling Contaminated Groundwater

The Contractor is alerted to the fact that a Department environmental consultant will be on site for excavation and dewatering activities within the AOEC(s), to collect soil and groundwater samples (if necessary), and to observe site conditions for the State. **The WSA on the plans is to be used exclusively for temporary stockpiling of excavated materials from within project AOEC(s) for determination of disposal classification. Access to the WSA may be limited. The Contractor shall co-ordinate with [insert name and phone # here] for WSA access.**

Information pertaining to the results of the environmental investigations discussed can be found in the documents listed below. The results contained in the environmental investigation reports listed below show levels of various contaminants that the Contractor may encounter during construction. Actual levels found during construction may vary and such variations will not be considered a change in condition provided the material can still be disposed as non-hazardous at one or more of the disposal facilities listed in Item No. 0202315A - Disposal of Controlled Materials. These documents shall be available for review at the Office of Contracts, 2800 Berlin Turnpike, Newington, Connecticut.

· Task 110 - Corridor Land Use Evaluation. Interchange Modications: Interstate 84 at Route 72, Plainville, Connecticut. Maguire Group Connecticut, Inc. October 28, 1998.

Task 210 - Surficial Site Investigation. New Entrance & Exit Ramps Route 72 Westbound to Route 372. Plainville, Connecticut. Maguire Group Inc., April 4, 2000.

NOTICE TO CONTRACTOR – WORK ON ADJACENT PROJECT

The Contractor is responsible for coordinating with the Owner for any projects being constructed concurrently within the area of this project. The Contractor is responsible for coordinating with the Owner to minimize disruption to traffic operations within the area. Detour operations on the project will require approval by the Owner.

NOTICE TO CONTRACTOR - 1.05 CONTROL OF THE WORK

1.05.03 – CONFORMITY WITH PLANS AND SPECIFICATIONS (INCLUDING QUALITY CONTROL)

The Contractor is hereby notified that a Quality Management Plan will be required for this Project in accordance with CTDOT – Form 818, Article 1.05.03 – Conformity with Plans and Specifications (including Quality Control).

NOTICE TO CONTRACTOR – EARLY SUBMITTALS

The Contractor is hereby advised that the Owner has identified the potential need to order certain materials and equipment, and thereby submit certain submittals for approval early in the construction process to ensure the Project is completed within the allowable Contract Time. Submittals shall be in accordance with Form 818 Article 1.05.02 and shall be submitted to the Engineer within 15 calendar days of award. The following items have been identified as requiring early submission of shop drawings and product data:

- XXXX
- XXXX
- XXXX

The list above is not intended to be all-inclusive and does not relieve the Contractor from coordinating the activities of its subcontractors and suppliers. The Contractor will not be permitted to perform any physical work on the Project without the approval of the required submittals. Failure to properly plan for long lead items within the Contract schedule will not be justification for additional construction time.

It is recommended that the Contractor identify early in the construction sequencing process the subcontractors and suppliers associated with long lead-time items and submit the appropriate shop drawings and supporting data, for review upon Notice to Proceed.

NOTICE TO CONTRACTOR – CONTRACTOR OBLIGATIONS

The Contractor shall repair at its own expense any and all damage caused by construction operations to existing buildings and utilities, unless said damage is scheduled as part of the Project Work.

During all times that the Project Site is occupied by the City or Private Property Owners, the Contractor shall maintain the following utilities and services to the extent described to permit City operations:

1. Electrical Services: The Contractor shall be responsible for paying all monthly electrical usage utility costs related to all construction field offices.

2. Telephone Services: The Contractor shall be responsible for paying all monthly telephone usage utility costs related to all construction field offices.

3. Sanitary Facilities: The Contractor is responsible for emptying the sanitary facilities at its expense.

4. Water: The Contractor is responsible for paying all expenses for water usage.

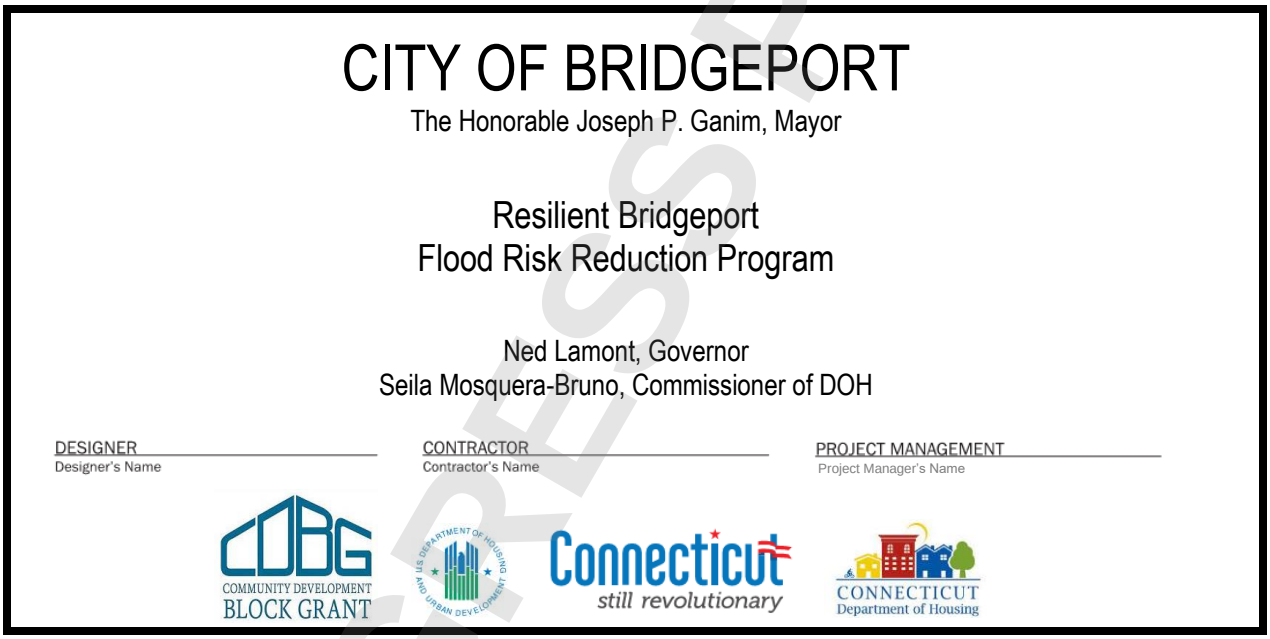
The Contractor shall bid the project accordingly.

NOTICE TO CONTRACTOR – COLD WEATHER CONCRETE ACTIVITIES

The Contractor can expect that it will be required that temperature sensitive work will be performed during the winter months. Therefore, preparations must be made by the Contractor to protect this work from the cold and adverse conditions that the winter months may bring. The Contractor shall strictly adhere to all required cold weather concrete procedures as specified within the Contract and conduct its activities accordingly. The Contractor is specifically referred to CTDOT – Form 818, Subarticle 6.01.03-II-2(c), Cold Weather Protection. There will be no additional compensation paid to the Contractor for this work but it shall be included in the general cost of the work.

NOTICE TO CONTRACTOR – DOH CONSTRUCTION SIGN

The Contractor is hereby advised that they shall be required to provide a Department of Housing (DOH) construction sign. Base sign is shown on below, Contractor shall submit sign shop drawing in accordance with Section 1.05 to the Engineer for the DOH's review and approval prior to procurement. The cost of providing this sign shall be considered to be included in the general cost of the contract and will not be measured for payment.



NOTICE TO CONTRACTOR – FOR REFERENCE ONLY DRAWINGS

The Contractor is hereby advised that drawings are included within the Contract Documents that are "For Reference Only." These are for his information only and shall not be included in his bid and will not be measured for payment.

NOTICE TO CONTRACTOR – SALVAGE

The Contractor is hereby notified that the following items from this project are salvageable. Only those items in good condition, as determined by the Engineer, shall be salvaged as noted below.

City of Bridgeport:

- covers, frames and grates from drainage structures;
- bluestone curbing
- metal beam rail sections, posts and hardware;
- sign posts, sheeting and hardware;
- aluminum street light poles with luminaires;

Article 1.04.06 – Removal and Disposal of Structures on the Work Site is supplemented as follows:

Prior to construction, the Engineer and the Contractor shall take an inventory of all items identified above, or elsewhere in the Special Provisions, for salvage to determine which items shall be salvaged for the City. If inspection of an item is not possible prior to construction, it shall be performed at a later date so that a salvage determination can be made.

All sheet aluminum signs designated for removal from City Roadways are to be salvaged. The Contractor shall sort all sheet aluminum signs by size and shall stack ten signs to a bundle. Each bundle shall be bound by tape or metal strap. The bundles shall be stacked on pallets and delivered to the City.

The Contractor shall load and deliver those salvageable materials identified herein and elsewhere in the Special Provisions, as approved by the Engineer, to the City of Bridgeport and unload those salvageable materials where and as directed. Delivery hours are between 7:00 A.M. and 3:00 P.M., Monday through Friday. The Contractor shall confirm intended delivery of materials to the City at least two days in advance. All items shall be protected from damage, delivered to the City's Public Works Garage at the address noted below, and stockpiled in a manner acceptable to the City. The contact person for this facility is Mr. XXXX (203) xxx-xxxx and the delivery address is as follows:

City of Bridgeport
Bridgeport Public Works Garage
475 Asylum Street
Bridgeport, Connecticut 06610

The costs to salvage and deliver these components shall be considered to be included in the unit prices of the applicable items and will not be measured separately for payment.

NOTICE TO CONTRACTOR – APPLICABLE DOCUMENTS, STANDARDS AND CODES

The installed transmission media, electronics equipment and materials, and installation procedures shall conform to or otherwise be in compliance with all applicable laws and requirements of industry and public agency standards, codes, ordinances and documents.

Installation procedures and the materials provided shall also comply with all legal requirements, applicable laws, and applicable codes, standards, regulations, recommendations, and authorities including but not limited to those of the following entities:

- Connecticut Department of Transportation (CTDOT) Standard Specifications for Roads, Bridges, Facilities and Incidental ConstructionCity of Bridgeport, Department of Engineering, Engineering Standard Details
- Federal Highway Administration (FHWA)
- Federal Communications Commission (FCC)
- American National Standards Institute (ANSI)
- Electronic Industries Association (EIA)
- Institute of Electrical & Electronics Engineers (IEEE)
- National Television Standards Committee (NTSC)
- Telecommunications Industries Association (TIA)
- Underwriters Laboratories (UL)
- National Electrical Code (NEC)
- Insulated Cable Engineers Association (ICEA)
- National Electrical Manufacturers Association (NEMA)
- Public Utilities Regulatory Agency (PURA)
- American Society for Testing and Materials (ASTM)
- National Fire Protection Association (NFPA)
- Occupational Safety and Health Administration (OSHA)

In the event that a City of Bridgeport construction detail is in conflict with a standard CTDOT detail, then the City of Bridgeport detail shall take precedence. In the event of any conflict between any of the other aforesaid laws, regulations, standards, codes, ordinances and documents, and the government's specifications, the Contractor shall immediately bring the conflict to the attention of the Engineer.

NOTICE TO CONTRACTOR – GENERAL PROCEDURE FOR ACCESS TO RAILROAD PROPERTY

All outside parties who need to perform construction or maintenance on or adjacent to Metro-North Railroad property must comply with the following:

1) **Permit Application**: Parties requiring an entry permit shall submit a written request to the Chief Maintenance of Way Officer defining the location, scope of work and duration of activities on or adjacent to Railroad facilities. Address the letter to:

   Chief Maintenance of Way Officer
   Metro-North Railroad
   Attention: Rick Webster, AD
   420 Lexington Avenue, 10th Floor
   New York, NY 10017
   Tel: 212-499-4533

2) **Insurance**: Furnish proof of insurance in a form acceptable to an approved by the Director of MTA Risk and Insurance Management no less than 20 working days prior to the intended start of work to:

   MTA/Metro-North Railroad
   Attn: Risk & Insurance Management
   Standards, Enforcement and Claims Unit
   2 Broadway, 21st Floor
   New York, NY 10004
   Tel: (646) 252-1430

   Applicant shall obtain confirmation of receipt and approval of the insurance certificate from the Director of MTA Risk and Insurance Management.

3) **Payment**: Upon review of the scope of work provided with the permit application, Metro-North will prepare an estimate of the cost of providing Railroad Protective Personnel and all other expenses related to the project. Supply payment, in full, of Metro-North's estimated cost of Railroad Force Account Services no less than 20 working days prior to the intended start of work. Obtain confirmation or receipt by the Chief Maintenance of Way Officer. Since the payment is based on an estimated cost, unexpended funds if any, will be subject to

reimbursement. On the contrary, should the actual work exceed the estimated cost, an additional payment shall be submitted to continue Railroad Force Account Services.

4) **Technical Submittals**: Supply copies of construction shop drawings, calculations and supporting documentation to:

Mr. David B. Willard, P.E.
Assistant Director, Structural Engineering
Metro-North Railroad Capital Engineering
Bridgeport, Connecticut Office
525 Water Street, 3rd Floor
Bridgeport, CT 06601
Tel: (203) 337-3606/Fax: (203) 337-3609

Ms. Julie Thomas
Connecticut Department of Transportation
Property Management
50 Union Ave, 4th Floor West
New Haven, CT 06519
Tel: 203-497-3383
Fax: 203-789-6956

Upon receipt of the submittals, allow 15 working days from date of receipt for Metro-North's review of the submittals prior to requesting a conference to schedule that activity.

Once the above requirements have been satisfied, contact the Assistant Director, Structural Engineer no less than 15 working days prior to the start of work to schedule a pre-construction conference at (203) 337-3606.

When all is in order, the Bridgeport Office Department will schedule Railroad coordination and support services. No work will commence until the applicant receives permission from the designated Railroad Representative at the site to proceed with the work.

NOTICE TO CONTRACTOR – PRE-BID CONFERENCE

A mandatory Pre-Bid Conference will be held at:

Bridgeport City Hall
Meeting Room X
45 Lyon Terrace
Bridgeport, CT

The pre-bid conference will include an overview of State Project No. 015-384 (Flood Risk Reduction Program) and the interrelationship and anticipated scheduling of the projects involved.

Also covered at the Pre-bid Meeting will be:

- Project Revisions
- Contract Time and Liquidated Damages
- Review Construction Schedule/Critical Path/Contract Deadlines

No questions will be taken at the pre-bid conference. All questions or comments must be submitted in writing and received no later than 4:00 p.m. of the second business day following the pre-bid conference. Questions may be emailed to the XXXXXX at XXXXXX. In the subject of your email please indicate "Pre-Bid Question(s) Project No. 015-384".

Registration will be from 9:30 to 10:00 a.m. the morning of the pre-bid conference. Bidders are requested to register early.

Any bids received from a Contractor who is found to have not attended the mandatory pre-bid conference will be rejected as nonresponsive.

NOTICE TO CONTRACTOR - FEDERAL RAIL SAFETY REGULATIONS (49 C.F.R. PART 219) CONCERNING ALCOHOL AND DRUG TESTING

On October 16, 2008, the United States Congress enacted the Rail Safety Improvement Act of 2008 (RSIA). RSIA directs the Federal Railroad Administration (FRA) to promulgate new safety regulations related to railroad safety. The purpose of this NTC is to notify you of certain requirements recently promulgated by the FRA that may be applicable to work you are currently performing, or may in the future perform, for the Connecticut Department of Transportation (Department).

On June 10, 2016, the FRA published a final rule expanding the scope of its drug and alcohol testing regulations (FRA Regulations) to provide that "[e]ach railroad must ensure that a regulated employee is subject to being selected for random testing... whenever the employee performs regulated service on the railroad's behalf." 49 C.F.R. § 219.601. A "regulated employee" includes a contractor to a railroad or any individual who is performing activities for a railroad and includes those contractors, consultants or individuals who are deemed "maintenance-of-way" employees under 49 C.F.R. Part 219 (See 49 C.F.R. §219.5).

The term maintenance-of-way (MOW) employee, as used in 49 C.F.R. Part 219, is defined in 49 C.F.R. § 214.7 as "any employee…of a contractor to a railroad, whose duties include inspection, construction, maintenance or repair of railroad track, bridges, roadway, signal and communications systems, electric traction systems, roadway facilities or roadway maintenance machinery on or near track or with the potential of fouling a track, and flagmen and watchmen/lookouts." (collectively, MOW Activities).

The final rule, which is effective **June 12, 2017,** requires contractors and consultants employing MOW employees to submit a Part 219 Compliance Plan to FRA **prior** to the effective date. Please consult the following link to the model drug and alcohol plan prepared by the FRA for guidance.

https://www.fra.dot.gov/eLib/details/L02814

The final rule mandates, among other things, the establishment of a random testing pool to ensure a testing rate of 50% of MOW employees for drugs and 25% of MOW employees for alcohol on an annual basis. For more information related to the requirements, please refer to:

http://www.ecfr.gov/cgi-bin/text-idx?rgn=div5&node=49:4.1.1.1.14

Every contractor or consultant that is performing MOW Activities must comply with its obligations under 49 C.F.R. Part 219 to ensure that all MOW employees are being randomly tested for drugs and alcohol. Failure of a contractor or consultant to timely comply with the FRA Regulations may subject that firm to civil penalties. In addition, MetroNorth Railroad (MNR) has stated that contractors or consultants who do not comply with the FRA regulations will not be able to work on MNR property.

The Department strongly urges all contractors and consultants to consult with their attorneys and/or to conduct their own independent due diligence regarding the requirements imposed by the new FRA Regulations to determine what steps are necessary to assure compliance. The information provided herein is advisory in nature and is offered without warranty of any kind. The Department does not accept any responsibility or liability for the accuracy, content, completeness, legality, or reliability of the information contained herein.

Any questions regarding the FRA Regulations concerning drug and alcohol testing should be directed to: Mr. Gerald Powers, Drug and Alcohol Program Manager, Office of Safety Enforcement, Federal Railroad Administration, 1200 New Jersey Avenue SE, Mail Stop 25, Washington, DC 20590 or via telephone (202) 493-6313.

NOTICE TO CONTRACTOR – PERMITS/PERMIT APPLICATIONS

The Contractor is hereby notified that all permit and permit applications contained herein shall be made a part of this Contract, and that the Contractor shall be bound to comply with all requirements of such permits and permit applications as though the Contractor were the permittee. If at the time the permit is received its contents differ from that which is outlined in the application, the permit shall govern.

Should the permit be received just after the receipt of bids and the permit requirements significantly change the character of the work, adjustment will be made to the contract in accordance with the appropriate articles in Section 1.04. The requirements and conditions set forth in the permit and permit application shall be binding on the Contractor just as any other specification would be. In the case of a conflict between a provision of the environmental permit or permit application and another provision in the Contract documents, the former shall govern.

NOTICE TO CONTRACTOR – LOCATING TRAILERS ON THE PROJECT SITE

The Contractor is hereby advised that the Contractor may be limited to locating Contractor office trailers and portable bathroom facilities within the limits of the Project work areas. If the Contractor's requirement for trailer space cannot be accommodated within the designated areas, the Contractor shall be responsible for locating Contractor office trailers off site at no expense to the Department.

The Contractor shall locate the Construction Field Office(s) in the area indicated in the Contract Documents or as directed by the Engineer.

The Contractor shall bid the project accordingly.

NOTICE TO CONTRACTOR - PROPRIETARY ITEMS

The Contractor is hereby notified that the following items shall be furnished by the specific manufacturer.

Item	Item Description	Manufacturer
XXXXXXXA	Xxxxxxxxxx	Xxxxxxxxxx

Table to be completed for next submission

D.B.E. SUBCONTRACTORS AND MATERIAL SUPPLIERS OR MANUFACTURERS

January 2013

I. ABBREVIATIONS AND DEFINITIONS AS USED IN THIS SPECIAL PROVISION

A. *CTDOT* means the Connecticut Department of Transportation.

B. *USDOT* means the U.S. Department of Transportation, including the Office of the Secretary, the Federal Highway Administration ("FHWA"), the Federal Transit Administration ("FTA"), and the Federal Aviation Administration ("FAA").

C. *Broker* means a party acting as an agent for others in negotiating Contracts, Agreements, purchases, sales, etc., in return for a fee or commission.

D. *Contract, Agreement or Subcontract* means a legally binding relationship obligating a seller to furnish supplies or services (including but not limited to, construction and professional services) and the buyer to pay for them. For the purposes of this provision, a lease for equipment or products is also considered to be a Contract.

E. *Contractor* means a consultant, second party or any other entity under Contract to do business with CTDOT or, as the context may require, with another Contractor.

F. *Disadvantaged Business Enterprise ("DBE")* means a for profit small business concern:

1. That is at least 51 percent owned by one or more individuals who are both socially and economically disadvantaged or, in the case of a corporation, in which 51 percent of the stock is owned by one or more such individuals; and

2. Whose management and daily business operations are controlled by one or more of the socially and economically disadvantaged individuals who own it; and

3. Certified by CTDOT under Title 49 of the Code of Federal Regulations, Part 26, (Title 49 CFR Part 23 of the Code of Federal Regulations for Participation of Disadvantaged Business Enterprise in Airport Concessions).

G. *USDOT-assisted Contract* means any Contract between CTDOT and a Contractor (at any tier) funded in whole or in part with USDOT financial assistance.

H. *Good Faith Efforts ("GFE")* means all necessary and reasonable steps to achieve a DBE goal or other requirement which by their scope, intensity, and appropriateness to the objective, can reasonably be expected to fulfill the program requirement.

I. *Small Business Concern* means, with respect to firms seeking to participate as DBEs in USDOT-assisted Contracts, a small business concern as defined pursuant to Section 3 of the Small Business Act and Small Business Administration ("SBA") regulations implementing it (13 CFR Part 121) that also does not exceed the cap on average annual gross receipts in 49 CFR Part 26, Section 26.65(b).

J. *Socially and Economically Disadvantaged Individual* means any individual who is a citizen (or lawfully admitted permanent resident) of the United States and who is:

1. Any individual who CTDOT finds, on a case-by-case basis, to be a socially and economically disadvantaged individual.

2. Any individuals in the following groups, members of which are rebuttably presumed to be socially and economically disadvantaged:

    - "Black Americans", which includes persons having origins in any of the Black racial groups of Africa;
    - "Hispanic Americans", which includes persons of Mexican, Puerto Rican, Cuban, Dominican, Central or South American, or other Spanish or Portuguese culture or origin, regardless of race;
    - "Native Americans", which includes persons who are American Indians, Eskimos, Aleuts, or Native Hawaiians.
    - "Asian-Pacific Americans", which includes persons whose origins are from Japan, China, Taiwan, Korea, Burma (Myanmar), Vietnam, Laos, Cambodia (Kampuchea), Thailand, Malaysia, Indonesia, the Philippines, Brunei, Samoa, Guam, the U.S. Trust Territories of the Pacific Islands (Republic of Palau), the Commonwealth of the Northern Marianas Islands, Macao, Fiji, Tonga, Kiribati, Juvalu, Nauru, or Federated States of Micronesia;
    - "Subcontinent Asian Americans", which includes persons whose origins are from India, Pakistan, Bangladesh, Bhutan, the Maldives Islands, Nepal or Sri Lanka;
    - Women;
    - Any additional groups whose members are designated as socially and economically disadvantaged by the SBA, at such time as the SBA designation becomes effective.

K. *Commercially Useful Function ("CUF")* means the DBE is responsible for the execution of the work of the contract and is carrying out its responsibilities by actually performing, managing, and supervising the work involved with its own forces and equipment. The DBE must be responsible for procuring, determining quantity, negotiating price, determining quality and paying for all materials (where applicable) associated with their work. The DBE must also perform at least 30% of the total cost of its contract with its own workforce.

II. ADMINISTRATIVE REQUIREMENTS

A. General Requirements

A DBE goal percentage equaling () percent (%) of the Contract value has been established for this Contract. This DBE goal percentage will be applied to the final Contract value to ultimately determine the required DBE goal. If additional work is required, DBE firms should be provided the appropriate opportunities to achieve the required DBE goal.

In order to receive credit toward the Contract DBE goal, the firms utilized as DBE subcontractors or suppliers must be certified as DBEs in the type of work to be counted for credit by CTDOT's Office of Contract Compliance prior to the date of the execution of the subcontract. Neither CTDOT nor the State of Connecticut's Unified Certification Program (UCP) makes any representation as to any DBE's technical or financial ability to perform the work. Prime contractors are solely responsible for performing due diligence in hiring DBE subcontractors.

All DBEs shall perform a CUF for the work that is assigned to them. The Contractor shall monitor and ensure that the DBE is in compliance with this requirement. The Connecticut DBE UPC Directory of certified firms can be found on the CTDOT website http://www.ct.gov/dot. The directory lists certified DBE firms with a description of services that they are certified to perform. Only work identified in this listing may be counted towards the project's DBE goal. A DBE firm may request to have services added at any time by contacting CTDOT's Office of Contract Compliance. No credit shall be counted for any DBE firm found not to be performing a CUF.

Once a Contract is awarded, all DBEs that were listed on the pre-award DBE commitment document must be utilized. The Contractor is obligated to provide the value and items of the work originally established in the pre-award documentation to the DBE firms listed in the pre-award documentation. Any modifications to the pre-award commitment must follow the procedure established in Section II-C.

The Contractor shall designate a liaison officer who will administer the Contractor's DBE program. Upon execution of this Contract, the name of the liaison officer shall be furnished in writing to CTDOT's unit administering the Contract, CTDOT's Office of Contract Compliance and CTDOT's Office of Construction ("OOC"). Contact information for the designated liaison officer shall be furnished no later than the scheduled date for the pre-construction meeting.

The Contractor shall submit a bi-monthly report to the appropriate CTDOT unit administering the Contract. This report shall indicate what work has been performed to date, with the dollars paid and percentage of DBE goal completed.

Verified payments made to DBEs shall be included in this bi-monthly report. A sample form is included on the CTDOT website.

In addition, the report shall include:

1. A projected time frame of when the remaining work is to be completed for each DBE.

2. A statement by the Contractor either confirming that the approved DBEs are on schedule to meet the Contract goal, or that the Contractor is actively pursuing a GFE.

3. If retainage is specified in the Contract specifications, then a statement of certification that the subcontractors' retainage is being released in accordance with 1.08.01 (Revised or supplemented).

Failure by the Contractor to provide the required reports may result in CTDOT withholding an amount equal to one percent (1%) of the monthly estimate until the required documentation is received.

The Contractor shall receive DBE credit when a DBE, or any combination of DBEs, perform work under the Contract in accordance with this specification.

Only work actually performed by and/or services provided by DBEs which are certified for such work and/or services, as verified by CTDOT, can be counted toward the DBE goal. Supplies and equipment a DBE purchases or leases from the Contractor or its affiliate cannot be counted toward the goal.

Monitoring of the CUF will occur by CTDOT throughout the life of the project. If it is unclear that the DBE is performing the work specified in its subcontract with the prime Contractor, further review may be required. If it is determined that the DBE is not performing a CUF, then the work performed by that DBE will not be counted towards the DBE goal percentage.

B. Subcontract Requirements

The Contractor shall submit to CTDOT's OOC all requests for subcontractor approvals on the standard CLA-12 forms provided by CTDOT. The dollar amount and items of work identified on the CLA-12 form must, at minimum, equal the dollar value submitted in the pre-award commitment. CLA-12 forms can be found at http://www.ct.gov/dot/construction under the "Subcontractor Approval" section. All DBE subcontractors must be identified on the CLA-12 form, regardless of whether they are being utilized to meet a Contract goal percentage. A copy of the legal Contract between the Contractor and the DBE subcontractor/supplier, a copy of the Title VI Contractor Assurances and a copy of the Required Contract Provision for Federal Aid Construction Contracts (Form FHWA-1273) (Federal Highway Administration projects only) must be submitted along with a request for subcontractor approval. These attachments cannot be substituted by reference.

If retainage is specified in the Contract specifications, then the subcontract agreement must contain a prompt payment mechanism that acts in accordance with Article 1.08.01 (Revised or supplemented).

If the Contract specifications do not contain a retainage clause, the Contractor shall not include a retainage clause in any subcontract agreement, and in this case, if a Contractor does include a retainage clause, it shall be deemed unenforceable.

In addition, the following documents are to be included with the CLA-12, if applicable:

- An explanation indicating who will purchase material.
- A statement explaining any method or arrangement for utilization of the Contractor's equipment.

The subcontract must show items of work to be performed, unit prices and, if a partial item, the work involved by all parties. If the subcontract items of work or unit prices are modified, the procedure established in Section II-C must be followed.

Should a DBE subcontractor further sublet items of work assigned to it, only lower tier subcontractors who are certified as a DBE firm will be counted toward the DBE goal. If the lower tier subcontractor is a non-DBE firm, the value of the work performed by that firm will not be counted as credit toward the DBE goal.

The use of joint checks between a DBE firm and the Contractor is acceptable, provided that written approval is received from the OOC prior to the issuance of any joint check. Should it become necessary to issue a joint check between the DBE firm and the Contractor to purchase materials, the DBE firm must be responsible for negotiating the cost, determining the quality and quantity, ordering the material and installing (where applicable), and administering the payment to the supplier. The Contractor should not make payment directly to suppliers.

Each subcontract the Contractor signs with a subcontractor must contain the following assurance:

"The subcontractor/supplier/manufacturer shall not discriminate on the basis of race, color, national origin, or sex in the performance of this contract. The contractor shall carry out applicable requirements of 49 CFR Part 26 in the award and administration of DOT-assisted contracts. Failure by the contractor/subcontractor/supplier/manufacturer to carry out these requirements is a material breach of this contract, which may result in the termination of this contract or such other remedy as the recipient deems appropriate."

C. Modification to Pre-Award Commitment

Contractors may not terminate for convenience any DBE subcontractor or supplier that was listed on the pre-award DBE commitment without prior written approval of the OOC. This includes, but is not limited to, instances in which a Contractor seeks to perform work originally designated for a DBE subcontractor with its own forces or those of an affiliate, a non-DBE firm, or with another DBE firm. Prior to approval, the Contractor must demonstrate to the satisfaction of the OOC, that it has good cause, as found in 49CFR Part 26.53 (f)(3), for termination of the DBE firm.

Before transmitting its request for approval to terminate pre-award DBE firms to the OOC, the Contractor must give written notice to the DBE subcontractor and include a copy to the OOC of its notice to terminate and/or substitute, and the reason for the notice.

The Contractor must provide five (5) days for the affected DBE firm to respond. This affords the DBE firm the opportunity to advise the OOC and the Contractor of any reasons why it objects to the termination of its subcontract and why the OOC should not approve the Contractor's action.

Once the Contract is awarded, should there be any amendments or modifications of the approved pre-award DBE submission other than termination of a DBE firm, the Contractor shall follow the procedure below that best meets the criteria associated with the reason for modification:

1. If the change is due to a scope of work revision or non-routine quantity revision by CTDOT, the Contractor must notify CTDOT's OOC in writing or via electronic mail that their DBE participation on the project may be impacted as soon as they are aware of the change. In this case, a release of work from the DBE firm may not be required; however the Contractor must concurrently notify the DBE firm in writing, and copy the OOC for inclusion in the project DBE file. This does not relieve the Contractor of its obligation to meet the Contract specified DBE goal, or of any other responsibility found in this specification.

2. If the change is due to a factor other than a CTDOT directive, a request for approval in writing or via electronic mail of the modification from the OOC must be submitted, along with an explanation of the change(s), prior to the commencement of work. The Contractor must also obtain a letter of release from the originally named DBE indicating their concurrence with the change, and the reason(s) for their inability to perform the work. In the event a release cannot be obtained, the Contractor must document all efforts made to obtain it.

3. In the event a DBE firm that was listed in the pre-award documents is **unable** or **unwilling** to perform the work assigned, the Contractor shall:

    - Notify the OOC Division Chief immediately and make efforts to obtain a release of work from the firm.
    - Submit documentation that will provide a basis for the change to the OOC for review and approval prior to the implementation of the change.
    - Use the DBE Directory to identify and contact firms certified to perform the type of work that was assigned to the unable or unwilling DBE firm. The Contractor should also contact CTDOT's Office of Contract Compliance for assistance in locating additional DBE firms to the extent needed to meet the contract goal.

Should a DBE subcontractor be terminated or fail to complete work on the Contract for any reason, the Contractor must make a GFE to find another DBE subcontractor to substitute for the original DBE. The DBE replacement

shall be given every opportunity to perform at least the same amount of work under the Contract as the original DBE subcontractor.

If the Contractor is unable to find a DBE replacement:

- The Contractor should identify other contracting opportunities and solicit DBE firms in an effort to meet the Contract DBE goal requirement, if necessary, and provide documentation to support a GFE. (Refer to GFE in Section III.)
- The Contractor must demonstrate that the originally named DBE, who is unable or unwilling to perform the work assigned, is in default of its subcontract, or identify other issues that affected the DBE firm's ability to perform the assigned work. **The Contractor's ability to negotiate a more advantageous agreement with another subcontractor is not a valid basis for change.**

III. GOOD FAITH EFFORTS

The DBE goal is **NOT** reduced or waived for projects where the Contractor receives a Pre-Award GFE determination from the Office of Contract Compliance prior to the award of the Contract. It remains the responsibility of the Contractor to make a continuing GFE to achieve the specified Contract DBE goal. The Contractor shall pursue every available opportunity to obtain additional DBE firms and document all efforts made in such attempts.

At the completion of all Contract work, the Contractor shall submit a final report to CTDOT`s unit administering the Contract indicating the work done by and the dollars paid to DBEs. Only verified payments made to DBEs performing a CUF will be counted towards the Contract goal.

Goal attainment is based on the total Contract value, which includes all construction orders created during the Contract. If the Contractor does not achieve the specified Contract goal for DBE participation or has not provided the value of work to the DBE firms originally committed to in the pre-award submission, the Contractor shall submit documentation to CTDOT`s unit administering the Contract detailing the GFE made during the performance of the Contract to satisfy the goal.

A GFE should consist of the following, where applicable (CTDOT reserves the right to request additional information):

1. A detailed statement of the efforts made to replace an unable or unwilling DBE firm, and a description of any additional subcontracting opportunities that were identified and offered to DBE firms in order to increase the likelihood of achieving the stated goal.

2. A detailed statement, including documentation of the efforts made to contact and solicit bids from certified DBEs, including the names, addresses, and telephone numbers of each DBE firm contacted; the date of contact and a description of the information provided to each DBE regarding the scope of services and anticipated time schedule of work items proposed to be subcontracted and the response from firms contacted.

3. Provide a detailed explanation for each DBE that submitted a subcontract proposal which the Contractor considered to be unacceptable stating the reason(s) for this conclusion.

4. Provide documentation, if any, to support contacts made with CTDOT requesting assistance in satisfying the specified Contract goal.

5. Provide documentation of all other efforts undertaken by the Contractor to meet the defined goal. Additional documentation of efforts made to obtain DBE firms may include but will not be limited to:
   - Negotiations held in good faith with interested DBE firms, not rejecting them without sound reasons.
   - Written notice provided to a reasonable number of specific DBE firms in sufficient time to allow effective participation.
   - Those portions of work that could be performed by readily available DBE firms.

In instances where the Contractor can adequately document or substantiate its GFE and compliance with other DBE Program requirements, the Contractor will have satisfied the DBE requirement and no administrative remedies will be imposed.

IV. PROJECT COMPLETION

At the completion of all Contract work, the Contractor shall:

1. Submit a final report to CTDOT`s unit administering the Contract indicating the work done by, and the dollars paid to DBEs.

2. Submit verified payments made to all DBE subcontractors for the work that was completed.

3. Submit documentation detailing any changes to the DBE pre-award subcontractors that have not met the original DBE pre-award commitment, including copies of the Department's approvals of those changes.

4. Retain all records for a period of three (3) years following acceptance by CTDOT of the Contract and those records shall be available at reasonable times and places for inspection by authorized representatives of CTDOT and Federal agencies. If any litigation, claim, or audit is started before the expiration of the three (3) year period, the records shall be retained until all litigation, claims, or audit findings involving the records are resolved.

If the Contractor does not achieve the specified Contract goal for DBE participation in addition to meeting the dollar value committed to the DBE subcontractors identified in the pre-award commitment, the Contractor shall submit documentation to CTDOT`s unit administering the Contract detailing the GFE made during the performance of the Contract to satisfy the goal.

V. SHORTFALLS

A. Failure to meet DBE goals

As specified in (II-A) above, attainment of the Contract DBE goal is based on the final Contract value. The Contractor is expected to achieve the amount of DBE participation originally committed to at the time of award; however, additional efforts must be made to provide opportunities to DBE firms in the event a Contract's original value is increased during the life of the Contract.

The Contractor is expected to utilize the DBE subcontractors originally committed in the DBE pre-award documentation for the work and dollar value that was originally assigned.

If a DBE is terminated or is unable or unwilling to complete its work on a Contract, the Contractor shall make a GFE to replace that DBE with another certified DBE to meet the Contract goal.

The Contractor shall immediately notify the OOC of the DBE's inability or unwillingness to perform, and provide reasonable documentation and make efforts to obtain a release of work from the firm.

If the Contractor is unable to find a DBE replacement, then the Contractor should identify other contracting opportunities and solicit DBE firms in an effort to meet the Contract DBE goal requirement, if necessary, and provide documentation to support a GFE.

When a DBE is unable or unwilling to perform, or is terminated for just cause, the Contractor shall make a GFE to find other DBE opportunities to increase DBE participation to the extent necessary to at least satisfy the Contract goal.

For any DBE pre-award subcontractor that has been released appropriately from the project, no remedy will be assessed, provided that the Contractor has met the criteria described in Section II-C.

B. Administrative Remedies for Non-Compliance:

In cases where the Contractor has failed to meet the Contract specified DBE goal or the DBE pre-award commitment, and where no GFE has been demonstrated, then one or more of the following administrative remedies will be applied:

1. A reduction in Contract payments to the Contractor as determined by CTDOT, not to exceed the shortfall amount of the **DBE goal**. The maximum shortfall will be calculated by multiplying the Contract DBE goal (adjusted by any applicable GFE) by the final Contract value, and subtracting any verified final payments made to DBE firms by the Contractor.

2. A reduction in Contract payments to the Contractor determined by CTDOT, not to exceed the shortfall amount of the **pre-award commitment**. The maximum shortfall will be calculated by subtracting any verified final payments made by the Contractor to each DBE subcontractor from the amount originally committed to that subcontractor in the pre-award commitment.

3. A reduction in Contract payments to the Contractor determined by CTDOT for any pre-award DBE subcontractor who has not obtained the dollar value of work identified in the DBE pre-award commitment and has not followed the requirements of Section II-C or for any DBE firm submitted for DBE credit that has not performed a CUF.

4. The Contractor being required to submit a written DBE Program Corrective Action Plan to CTDOT for review and approval, which is aimed at ensuring compliance on future projects.

5. The Contractor being required to attend a Non-Responsibility Meeting on the next contract where it is the apparent low bidder.

6. The Contractor being suspended from bidding on contracts for a period not to exceed six (6) months.

VI. CLASSIFICATIONS OTHER THAN SUBCONTRACTORS

A. Material Manufacturers

Credit for DBE manufacturers is 100% of the value of the manufactured product. A manufacturer is a firm that operates or maintains a factory or establishment that produces on the premises the materials or supplies obtained by the Contractor.

If the Contractor elects to utilize a DBE manufacturer to satisfy a portion of, or the entire specified DBE goal, the Contractor must provide the OOC with:

- Subcontractor Approval Form (CLA-12) indicating the firm designation,
- An executed "Affidavit for the Utilization of Material Suppliers or Manufacturers" (sample attached), and
- Substantiation of payments made to the supplier or manufacturer for materials used on the project.

B. Material Suppliers (Dealers)

Credit for DBE dealers/suppliers is limited to 60% of the value of the material to be supplied, provided such material is obtained from an approved DBE dealer/supplier.

In order for a firm to be considered a regular dealer, the firm must own, operate, or maintain a store, warehouse, or other establishment in which the materials, supplies, articles or equipment of the general character described by the specifications and required under the contract are bought, kept in stock, and regularly sold or leased to the public in the usual course of business. At least one of the following criteria must apply:

- To be a regular dealer, the firm must be an established, regular business that engages, as its principal business and under its own name, in the purchase and sale or lease of the products in question.
- A person may be a regular dealer in such bulk items as petroleum products, steel, cement, gravel, stone, or asphalt without owning, operating or maintaining a place of business if the person both owns and operates distribution equipment for the products. Any supplementing of the regular dealers' own distribution equipment shall be by long term lease agreement, and not on an ad hoc or contract to contract basis.
- Packagers, brokers, manufacturers' representatives, or other persons who arrange or expedite transactions are not regular dealers within the meaning of this paragraph.

If the Contractor elects to utilize a DBE supplier to satisfy a portion or the entire specified DBE goal, the Contractor must provide the OOC with:

- Subcontractor Approval Form (CLA-12) indicating the firm designation,
- An executed "Affidavit for the Utilization of Material Suppliers or Manufacturers" (sample attached), and
- Substantiation of payments made to the supplier or manufacturer for materials used on the project.

C. Brokering

- Brokering of work for DBE firms who have been listed by the Department as certified brokers is allowed. Credit for those firms shall be applied following the procedures in Section VI-D.
- Brokering of work by DBEs who have been approved to perform subcontract work with their own workforce and equipment is not allowed, and is a Contract violation.
- Firms involved in the brokering of work, whether they are DBEs and/or majority firms who engage in willful falsification, distortion or misrepresentation with respect to any facts related to the project shall be

referred to the U.S. DOT, Office of the Inspector General for prosecution under Title 18, U.S. Code, Part I, Chapter 47, Section 1020.

D. Non-Manufacturing or Non-Supplier DBE Credit

Contractors may count towards their DBE goals the following expenditures with DBEs that are not manufacturers or suppliers:

- Reasonable fees or commissions charged for providing a bona fide service such as professional, technical, consultant or managerial services and assistance in the procurement of essential personnel, facilities, equipment materials or supplies necessary for the performance of the Contract, provided that the fee or commission is determined by the OOC to be reasonable and consistent with fees customarily allowed for similar services.
- The fees charged only for delivery of materials and supplies required on a job site when the hauler, trucker, or delivery service is a DBE, and not the manufacturer, or regular dealer of the materials and supplies, and provided that the fees are determined by the OOC to be reasonable and not excessive as compared with fees customarily allowed for similar services.
- The fees or commissions charged for providing bonds or insurance specifically required for the performance of the Contract, provided that the fees or commissions are determined by CTDOT to be reasonable and not excessive as compared with fees customarily allowed for similar services.

E. Trucking

While technically still considered a subcontractor, the rules for counting credit for DBE trucking firms are as follows:

- The DBE must own and operate at least one fully licensed, insured, and operational truck used on the Contract.
- The DBE receives credit for the total value of the transportation services it provides on the Contract using trucks it owns, insures and operates using drivers it employs.
- The DBE may lease trucks from another DBE firm, including an owner-operator who is certified as a DBE. The DBE who leases trucks from another DBE receives credit for the total value of the transportation services the lessee DBE provides on the Contract.
- The DBE may lease trucks from a non-DBE firm; however the DBE may only receive credit for any fees or commissions received for arranging transportation services provided by the non-DBE firms. Additionally, the DBE firm must demonstrate that they are in full control of the trucking operation for which they are seeking credit.

VII. Suspected DBE Fraud

In appropriate cases, CTDOT will bring to the attention of the USDOT any appearance of false, fraudulent, or dishonest conduct in connection with the DBE program, so that USDOT can take the steps, e.g. referral to the Department of Justice for criminal prosecution, referral to USDOT Inspector General, action under suspension and debarment or Program Fraud and Civil Penalties rules provided in 49 CFR Part 31.

CONNECTICUT DEPARTMENT OF TRANSPORTATION
(OFFICE OF CONSTRUCTION)
BUREAU OF ENGINEERING AND CONSTRUCTION

This affidavit must be completed by the State Contractor's DBE notarized and attached to the contractor's request to utilize a DBE supplier or manufacturer as a credit towards its DBE contract requirements; failure to do so will result in not receiving credit towards the contract DBE requirement.

State Contract No.

Federal Aid Project No.

Description of Project

I, _____, acting in behalf of _____,
(Name of person signing Affidavit) (DBE person, firm, association or corporation)
of which I am the _____ certify and affirm that _____
(Title of Person) (DBE person, firm, association or corporation)
is a certified Connecticut Department of Transportation DBE. I further certify and affirm that I have read and understand 49 CFR, Sec. 26.55(e)(2), as the same may be revised.

I further certify and affirm that _____ will assume the actual and
(DBE person, firm, association or Corporation)
for the provision of the materials and/or supplies sought by _____ .

If a manufacturer, I operate or maintain a factory or establishment that produces, on the premises, the materials, supplies, articles or equipment required under the contract an of the general character described by the specifications.

If a supplier, I perform a commercially useful function in the supply process. As a regular dealer, I, at a minimum, own and operate the distribution equipment for bulk items. Any supplementing of my distribution equipment shall be by long-term lease agreement, and not on an ad hoc or contract-by-contract basis.

I understand that false statements made herein are punishable by Law (Sec. 53a-157), CGS, as revised).

(Name of Corporation or Firm)

(Signature & Title of Official making the Affidavit)

Subscribed and sworn to before me, this _____ day of _____ 20 _____.

Notary Public (Commissioner of the Superior Court)

My Commission Expires_____

CERTIFICATE OF CORPORATION

I, _____, certify that I am the _____
(Official) (President)
of the Corporation named in the foregoing instrument; that I have been duly authorized to affix the seal of the Corporation to such papers as require the seal; that _____, who signed said instrument on behalf of the Corporation, was then _____ of said corporation; that said instrument was duly signed for and in behalf of said Corporation by authority of its governing body and is within the scope of its corporation powers.

_____ _____
(Signature of Person Certifying) (Date)

SECTION 1.02 - PROPOSAL REQUIREMENTS AND CONDITIONS

1.02.01—Contract Bidding and Award:

After the first sentence of the third paragraph, add the Following:

In accordance with the provisions of the Construction Contract Bidding and Award Manual, bidders must be prequalified for **(2 Utility Work & 6 Road Construction and Rehabilitation: Local Roads & Streets and non-freeways)**, to be eligible to bid on this project. Bidders that are not prequalified for this work classification will not be approved to bid on this project.

SECTION 1.03 - AWARD AND EXECUTION OF CONTRACT

Article 1.03.02 - Award and Execution of Contract:

After the second sentence of the only paragraph add the following:

The successful bidder is hereby notified of the Department's intent to award this contract within __ days of the bid opening.

Article 1.03.08 - Notice to Proceed and Commencement of Work:

Change the first paragraph to read as follows:

The Contractor shall commence and proceed with the Contract work on the date specified in a written Notice to Proceed issued by the Engineer to the Contractor. The date specified will be no later than 45 calendar days after the date of the execution of the Contract by the Department, however, the contractor is hereby put on notice that it is the Department's intent to issue the Notice to Proceed no later than 24 calendar days after the date of the execution of the Contract by the Department.

SECTION 1.05 - CONTROL OF THE WORK

Replace Article 1.05.02 *with the following:*

1.05.02—Plans, Working Drawings, Shop Drawings, Product Data, Submittal Preparation and Processing - Review Timeframes, Department's Action:

1. Plans: The plans prepared by the Department show the details necessary to give a comprehensive idea of the construction contemplated under the Contract. The plans will generally show location, character, dimensions, and details necessary to complete the Project. If the plans do not show complete details, they will show the necessary dimensions and details, which when used along with the other Contract documents, will enable the Contractor to prepare Working Drawings, Shop Drawings or Product Data necessary to complete the Project.

2. Working Drawings: When required by the Contract or when ordered to do so by the Engineer, the Contractor shall prepare and submit the Working Drawings, signed, sealed and dated by a qualified Professional Engineer licensed to practice in the State of Connecticut, for review. The Working Drawings shall be submitted sufficiently in advance of the work detailed, to allow for their review in accordance with the requirements specified in 1.05.02-5 (including any necessary revisions, resubmittal, and final review). There will be no direct payment for furnishing any Working Drawings, procedures or supporting calculations, but the cost thereof shall be considered as included in the general cost of the work.

The Contractor is only required to deliver paper copies that have been stamped with "No Exceptions Noted" or "Exceptions as Noted." Guidance to the Contractor for the number of properly sized paper copies will be provided by the Department.

All Working Drawing submission documents shall conform to the following requirements:

A. Drawings:
   i. Delivered in a single multi-page PDF file.
   ii. Shall be sized ANSI D (34 inches × 22 inches).
   iii. Contain a border, title block and a rectangular box, 2.25 inches wide × 1.75 inches high, in the lower right hand corner for the Department's stamp.
   iv. Text height and width shall be 0.125 inch.
   v. All letter characters shall be uppercase.
   vi. Shall be searchable.
   vii. Shall be black and white.
   viii. Cover Page - shall be digitally signed by the Contractor's Professional Engineer.
   ix. All pages shall include a watermark of the Professional Engineer's stamp in a common area.

B. Calculations:
   i. Delivered in a single PDF file
   ii. Shall be sized ANSI A (8.5 inches × 11 inches).

iii. Cover Page shall be digitally signed by the Contractor's Professional Engineer.

C. Supporting Documentation:
   i. Delivered as an independent single PDF file
   ii. Shall be sized ANSI A (8.5 inches × 11 inches).

a. Working Drawings for Permanent Construction: The Contractor shall supply to the Department a certificate of insurance in accordance with 1.03.07 at the time that the Working Drawings for the Project are submitted.

The Contractor's designer, who prepares the working drawings, shall secure and maintain at no direct cost to the State a Professional Liability Insurance Policy for errors and omissions in the minimum amount of $2,000,000 per error or omission. The Contractor's designer may elect to obtain a policy containing a maximum $250,000 deductible clause, but if the Contractor's designer should obtain a policy containing such a clause, they shall be liable to the extent of at least the deductible amount. The Contractor's designer shall obtain the appropriate and proper endorsement of its Professional Liability Policy to cover the indemnification clause in this Contract, as the same relates to negligent acts, errors or omissions in the Project work performed by them. The Contractor's designer shall continue this liability insurance coverage for a period of

(i) 3 years from the date of acceptance of the work by the Engineer, as evidenced by a State of Connecticut, Department of Transportation form entitled "Certificate of Acceptance of Work," issued to the Contractor; or

(ii) 3 years after the termination of the Contract, whichever is earlier, subject to the continued commercial availability of such insurance.

b. Working Drawings for Temporary Construction: The Contractor shall submit drawings, calculations, procedures and other supporting data to the Department in accordance with this Specification, with the exception of requirements defined under a. Working Drawings for Permanent Construction.

3. Shop Drawings: When required by the Contract, or when ordered to do so by the Engineer, the Contractor shall prepare and deliver Shop Drawings to the Department for review.

Shop Drawings shall be submitted sufficiently in advance of the work detailed, to allow for their review in accordance with the requirements specified in 1.05.02-5 (including any necessary revisions, resubmittal, and final review). There will be no direct payment for furnishing any Shop Drawings but the cost thereof shall be considered as included in the general cost of the work.

The Contractor is only required to deliver paper copies that have been stamped with "No Exceptions Noted" or "Exceptions as Noted." Guidance to the Contractor for the number of properly sized paper copies will be provided by the Department.

Shop Drawing submission documents shall conform to the following requirements:

A. Delivered in a single multi-page PDF file.

B. Shall be sized ANSI D (34 inches × 22 inches).
C. Contain a border, title block and a rectangular box, 2.25 inches wide × 1.75 inches high, in the lower right hand corner for the Department's stamp.
D. Text height and width shall be 0.125 inch.
E. All letter characters shall be uppercase.
F. Shall be searchable.
G. Shall be black and white.

4. Product Data: When required by the Contract, or when ordered to do so by the Engineer, the Contractor shall prepare and deliver Product Data to the Department for review.

Product Data shall be submitted sufficiently in advance of the work detailed, to allow for their review in accordance with the requirements specified in 1.05.02-5 (including any necessary revisions, resubmittal, and final review). There will be no direct payment for furnishing any Product Data but the cost thereof shall be considered as included in the general cost of the work.

The Contractor shall submit the Product Data in a single submittal for each element of construction.

The Contractor shall mark each copy of the Product Data submittal to show applicable choices and options. Where Product Data includes information on several products that are not required, copies shall be marked to indicate the applicable information. Product Data shall include the following information and confirmation of conformance with the Contract to the extent applicable: manufacturer's printed recommendations, compliance with recognized trade association standards, compliance with recognized testing agency standards, application of testing agency labels and seals, notation of coordination requirements, Contract item number, and any other information required by the individual Contract provisions.

The Contractor is only required to deliver paper copies that have been stamped with "No Exceptions Noted" or "Exceptions as Noted." Guidance to the Contractor for the number of properly sized paper copies will be provided by the Department.

Product Data submission documents shall conform to the following requirements:

A. Delivered in a single PDF file
B. Shall be sized ANSI A (8.5 inches × 11 inches).
C. Marked to indicate applicable choices and options.
D. Where non-applicable information and products are included, notations shall be made to clearly delineate applicable from non-applicable information.

5. Submittal Preparation and Processing – Review Timeframes: If the Department deems a submittal incomplete or unacceptable because not all the required documents were attached, documents are incomplete, or are in the incorrect format, the Department will send the submittal back to the Contractor before reviewing. When a submittal is sent back as incomplete, the

associated documents have not been reviewed and the review process and any associated timeframe requirements have not begun.

The Contractor shall allow 30 calendar days for submittal review by the Department, from the date receipt is acknowledged by the Department. For any submittals stamped with "Revise and Resubmit" or "Rejected," the Department is allowed an additional 20 calendar days for review of any resubmissions.

An extension of Contract time will not be authorized due to the Contractor's failure to transmit submittals sufficiently in advance of the work to permit processing.

The furnishing of Shop Drawings, Working Drawings or Product Data, or any comments or suggestions by the Designer or Engineer concerning Shop Drawings, Working Drawings or Product Data, shall not relieve the Contractor of any of its responsibility for claims by the State or by third parties, as per 1.07.10.

The furnishing of the Shop Drawings, Working Drawings and Product Data shall not serve to relieve the Contractor of any part of its responsibility for the safety or the successful completion of the Project construction.

6. Department's Action: The Department will review each submittal, mark each with a self-explanatory action stamp, and return the stamped submittal promptly to the Contractor. The Contractor shall not proceed with the part of the Project covered by the submittal until the submittal is marked "No Exceptions Noted" or "Exceptions as Noted" by the Department. The Contractor shall retain sole responsibility for compliance with all Contract requirements. The stamp will be marked as follows to indicate the action taken:

b. If submittals are marked "No Exceptions Noted," the Designer or Engineer has not observed any statement or feature that appears to deviate from the Contract requirements. This disposition is contingent on being able to execute any manufacturer's written warranty in compliance with the Contract provisions.
c. If submittals are marked "Exceptions as Noted," the considerations or changes noted by the Department's Action are necessary for the submittal to comply with Contract requirements. The Contractor shall review the required changes and inform the Department if they feel the changes violate a provision of the Contract or would lessen the warranty coverage.
d. If submittals are marked "Revise and Resubmit," the Contractor shall revise the submittals to address the deficiencies or provide additional information as noted by the Department. The Contractor shall allow an additional review period as specified in 1.05.02-5.
e. If submittals are marked "Rejected," the Contractor shall prepare and submit a new submittal in accordance with the Department's notations. The resubmissions require an additional review and determination by the Department. The Contractor shall allow an additional review period as specified in 1.05.02-5.

SECTION 1.06 CONTROL OF MATERIALS

Article 1.06.01 - Source of Supply and Quality:

Add the following:

Traffic Signal Items:

For the following traffic signal items the contractor shall submit a complete description of the item, shop drawings, product data sheets and other descriptive literature which completely illustrates such items presented for formal review. Such review shall not change the requirements for a certified test report and materials certificate as may be called for. All documents shall be grouped into one separate file for each group of items as indicated by the Roman numerals below (for example, one pdf file for all of the pedestal items). The documents for all of the traffic signal items shall be submitted at one time, unless otherwise allowed by the engineer.

I. 1003206 – Light Standard (15' Bracket, 30' Mounting Height)

SECTION 1.08 - PROSECUTION AND PROGRESS

Article 1.08.04 - Limitation of Operations - Add the following:

In order to provide for traffic operations as outlined in the Special Provision "Maintenance and Protection of Traffic," the Contractor will not be permitted to perform any work which will interfere with the described traffic operations on all project roadways as follows:

The Contractor shall not perform any work that will interfere with traffic operations during the below State observed Legal Holidays and Legal Holiday Periods.

A. On the following State observed Legal Holidays:

New Year's Day	Labor Day
Martin Luther King Jr. Day	Veterans Day
Presidents' Day	Thanksgiving Day
Good Friday	Day After Thanksgiving
Memorial Day	Christmas Day
Independence Day	

Additional Restrictions

A. The Contractor shall not be allowed to perform any work between 6:00 p.m. and 6:00 a.m each day.

Additional Lane Closure Restrictions

It is anticipated that work on adjacent projects will be ongoing simultaneously with this project. The Contractor shall be aware of those projects and anticipate that coordination will be required to maintain proper traffic flow at all times on all project roadways, in a manner consistent with these specifications and acceptable to the Engineer.

The Contractor will not be allowed to perform any work that will interfere with traffic operations on a roadway when traffic operations are being restricted on that same roadway, unless there is at least a one mile clear area length where the entire roadway is open to traffic or the closures have been coordinated and are acceptable to the Engineer. The one mile clear area length shall be measured from the end of the first work area to the beginning of the signing pattern for the next work area.

SECTION 1.10 – ENVIRONMENTAL COMPLIANCE

Article 1.10.5 – Noise Pollution

Delete the second paragraph and replace it with the following:

All methods and devices employed to minimize noise shall be subject to the continuing approval of the Engineer. The Contractor shall schedule and conduct operations in a manner that will minimize, to the greatest extent feasible, the disturbance to the public and to occupants of buildings in the vicinity of and adjacent to the project. In addition, in no case shall the restrictions identified in this Article limit the Contractor's responsibility for compliance with all Federal, state, and local safety ordinances and regulations.

Noise Reduction Methods

A. The Contractor shall use all reasonable efforts to implement noise reduction methods listed below to minimize construction noise emission levels. Noise reduction methods shall include, but not be limited to:

1. Use of: 1) concrete crushers, shears, processors, wire or pavement saws for concrete deck removal, demolitions, or similar construction activity; 2) pre-auguring equipment to reduce the duration of impact or vibratory pile driving; 3) local power grid to reduce the use of generators; 4) noise barriers and noise control curtains.

2. Attaching: 1) intake and exhaust mufflers, shields, or shrouds; 2) noise-deadening material to inside of hoppers, conveyor transfer points, or chutes.

3. Maintaining: 1) equipment mufflers and lubrication; 2) precast decking or plates; 3) surface irregularities on construction sites to prevent unnecessary noise.

4. Limiting: 1) the number and duration of equipment idling on the site; 2) the use of annunciators or public address systems; 3) the use of air or gasoline-driven hand tools.

5. Configuring, to the extent feasible: 1) the construction site in a manner that keeps loud equipment and activities as far as possible from noise-sensitive locations; 2) barrels or signage to detour traffic away from plated trenches.

6. Scheduling of construction events and limiting usage times to minimize noise, especially during nighttime hours and near sensitive abutters.

7. Minimizing noise from the use of backup alarms using measures that meet OSHA regulations. This includes use of self-adjusting ambient-sensitive backup alarms,

manually-adjustable alarms on low setting, use of observers, and scheduling of activities so that alarm noise is minimized.

9. Where practical and feasible, configuring construction sites to minimize backup alarm noise. For example, construction site access should be designed such that delivery and dump trucks move through the site in a forward manner without the need to back up.

10. Preventing nuisance noise conditions using methods such as those described in this Article.

11. Using only variable message and sign boards that are solar powered or connected to the local power grid.

Definitions

Noise is any audible sound which has the potential to annoy or disturb humans, or to cause an adverse psychological or physiological effect on humans.

Daytime refers to the period from 7 AM to 6 PM local time daily, except Sundays and Federal holidays.

Evening refers to the period from 6 PM to 10 PM local time daily, except Sundays and Federal holidays.

Nighttime refers to the period from 10 PM to 7 AM local time daily, as well as all day Sunday and Federal holidays.

Noise-Sensitive Locations shall mean locations where particular sensitivities to noise exist, such as residential areas, institutions, hospitals, and parks.

Nuisance Noise refers to sound levels that annoy or disturb a reasonable person of normal sensitivities, but do not exceed the noise limits specified herein.

Lot-line refers to the line separating a parcel of land from another parcel or from the street.

Background Noise shall be defined as the measured ambient noise level associated with all existing environmental, transportation, and community noise sources in the absence of any audible construction activity.

dBA shall be defined as the sound level (in decibels referenced to 20 micro-pascals) as measured using the A-weighting network on a sound level meter, in accordance with ANSI S1.4 Standards.

Lmax shall be defined as the maximum measured sound level at any instant in time.

L10 shall be defined as the sound level exceeded 10 percent of the time for a specified monitoring period.

Slow specifies a time constant or 1 second for the root-mean-square (RMS) detector used by a sound level meter, in accordance with ANSI S1.4 Standards.

Impact noise is noise produced from impact or devices with discernible separation in sound pressure maxima. Examples for impact equipment include, but are not limited to; blasting, clam shovel or chisel drops, pavement breakers, jackhammers, hoe rams, mounted impact hammers, and impact pile drivers (but not vibratory pile drivers). Table 2 specifies types of equipment which are considered to emit impact or continuous noise.

Construction Limitations

A. Noise Levels

1. Daytime, evening, and nighttime construction noise levels at noise-sensitive locations and other noise monitoring locations shall not exceed the lot-line noise limits specified in Table 1. The lot-line criteria shall apply to all points on a given lot-line of an affected receptor.

2. Equipment and associated equipment operating under full load shall not exceed the Lmax noise limits specified in Table 2. The 50-feet noise emission limits specified in Table 2 shall apply to the entire operation in which the equipment is engaged. Table 2 also provides distinction as to which equipment is considered to emit impact or continuous noise.

3. Work shall be performed in a manner to prevent nuisance conditions such as noise which exhibits a specific audible frequency or tone (e.g., backup alarms, unmaintained equipment, brake squeal, etc.) or impact noise (e.g., jackhammers, hoe rams, etc.). The Engineer will make any final interpretation concerning whether or not nuisance noise conditions exist. The Engineer has the authority to stop the Work until nuisance noise conditions are resolved, without additional time or compensation for the Contractor.

B. Equipment Operations

1. Contractors shall use approved haul routes to minimize noise at residential and other sensitive noise receptor sites.

2. All equipment with backup alarms operated at night from 10 PM to 7 AM by the Contractor, vendors, suppliers, and subcontractors on or near the construction site shall be equipped with either audible self-adjusting ambient-sensitive or manually-

adjustable backup alarms. The ambient-sensitive alarms shall automatically adjust to a maximum of 5 dBA over the surrounding background noise levels. The manually-adjustable alarms shall be set at the lowest setting required to be audible above the surrounding noise. Installation and use of the alarms shall be consistent with the performance requirements of the current revisions of Society of Automotive Engineering (SAE) J994, J1446, and OSHA regulations.

3. Per State regulations, engine idling for trucks is limited to 3 minutes maximum.

Noise Reduction Materials and Equipment

A. Noise reduction materials for noise barriers and noise control curtains may be new or used. Used materials shall be of a quality and condition to perform their designed function. Noise control barriers and noise control curtains shall have a Sound Transmission Class of STC-30 or greater, based on certified sound transmission loss data taken according to ASTM Test Method E90. They shall also have a Noise Reduction Coefficient rating of NRC-0.85 or greater, based on certified sound absorption coefficient data taken according to ASTM Test Method C423.

B. Noise reduction equipment and materials may include, but not be limited to:

1. Shields, shrouds, or intake and exhaust mufflers.
2. Noise-deadening material to line hoppers, conveyor transfer points, storage bins, or chutes.

C. All equipment used on the construction site, including jackhammers and pavement breakers, shall have exhaust systems and mufflers that have been recommended by the manufacturer as having the lowest associated noise.

D. The local power grid shall be used wherever feasible to limit generator noise. No generators larger than 25 KVA shall be used and, where a generator is necessary, it shall have maximum noise muffling capability and meet the noise emission limits specified in Table 2.

Complaint Procedure

A. The objective of the complaint procedure is to ensure that public and agency complaints are addressed and resolved consistently and expeditiously.

B. If the Contractor receives a complaint regarding construction noise, the Contractor shall immediately notify the Engineer.

C. In the event that a measured noise level exceed allowable limits, or is resulting in nuisance conditions, the Contractor shall immediately use noise reduction materials and methods

such as, but not limited to, those described herein to reduce noise levels or to alleviate the nuisance conditions.

D. In the event that a measured noise level at a lot line exceeds allowable limits and the source noise level is below its Lmax limit as described in Table 2 and the Contractor has implemented all noise reduction materials and methods as described herein and approved by the Engineer, the Engineer will direct the Contractor to implement the use of **additional** noise barriers, noise control curtain systems or other methods to reduce the noise levels or to alleviate the nuisance conditions. The costs associated with the implementation of these **additional** noise barriers, noise control curtain systems or other methods are included under the contract item "Noise Mitigation" or in the absence thereof as extra work.

Except for extra work associated with "Noise Mitigation," as defined above, any costs associated with this Article shall be included in the general cost of the contract. In addition, there shall be no time granted to the Contractor for compliance with this notice. The Contractor's compliance with this notice and any associated regulations shall not be grounds for claims as outlined in Section 1.11 – "Claims."

TABLE 1. CONSTRUCTION NOISE LOT- LINE LIMITS (b), (c), (d)

Noise Receptor Location Land Use	L10 Level (dBA, slow) (whichever is greater)	Lmax Level (dBA, slow)
DAYTIME (7 AM to 6 PM)		
Residential Areas	75 or Background+5 (a)	85 (a) 90 (impact equipment)
Commercial Areas	80 or Background+5 (a)	90
Industrial Areas	85 or Background+5 (a)	90
EVENING (6 PM to 10 PM)		
Residential Areas	Background+5	85
Commercial Areas	None	90
Industrial Areas	None	90
NIGHTTIME (10 PM to 7 AM)		
Residential Areas		
If Background < 70 dBA	Background+5	80
If Background > 70 dBA	Background+3	80
Commercial Areas	None	90
Industrial Areas	None	90

NOTES:

(a) Noise from impact equipment is exempt from the L10 requirement, however is still subject to a lot-line Lmax limit of 90 dBA.

(b) All measurements shall be taken at the affected lot-line. In situations where the work site is within 50 feet of a lot-line, the measurement shall be taken from a point along the lot-line such that a distance of 50 feet is maintained between the sound level meter and the construction activity being monitored.

(c) Lot-line noise limits shall apply to all points along the receptor's lot-line.

(d) L10 noise readings are averaged over 20 minute intervals. Lmax noise readings occur instantaneously.

TABLE 2. CONSTRUCTION EQUIPMENT 50-FEET NOISE EMISSION LIMITS (a), (b)

Equipment Category	Lmax Noise Limit at 50 ft, dBA, slow	Is Equipment an Impact Device? (c)	Acoustic Usage Factor (d)
All other equipment > 5 HP	85	No	50 %
Auger Drill Rig	84	No	20 %
Backhoe	78	No	40 %
Bar Bender	80	No	20 %
Blasting	94	Yes	1 %
Boring Jack Power Unit	80	No	50 %
Chain Saw	84	No	20 %
Clam Shovel	87	Yes	20 %
Compactor (ground)	80	No	20 %
Compressor (air)	78	No	40 %
Concrete Batch Plant	83	No	15 %
Concrete Mixer Truck	79	No	40 %
Concrete Pump Truck	81	No	20 %
Concrete Saw	90	No	20 %
Crane (mobile or stationary)	81	No	20 %
Dozer	82	No	40 %
Drill Rig Truck	79	No	20 %
Drum Mixer	80	No	50 %
Dump Truck	76	No	40 %
Excavator	81	No	40 %
Flat Bed Truck	74	No	40 %
Front End Loader	79	No	40 %
Generator (25 KVA or less)	73	No	50 %
Generator (more than 25 KVA)	81	No	50 %
Gradall	83	No	40 %
Grader	85	No	40 %
Grapple (on backhoe)	85	No	40 %
Horizontal Boring Hydraulic Jack	80	No	25 %
Hydra Break Ram	90	Yes	20 %
Impact Pile Driver (diesel or drop)	95	Yes	20 %
Insitu Soil Sampling Rig	84	No	20 %
Jackhammer	85	Yes	20 %
Man Lift	75	No	20 %
Mounted Impact Hammer (hoe ram)	90	Yes	20 %
Paver	77	No	50 %
Pavement Scarifier	85	No	20 %
Pickup Truck	75	No	40 %
Pneumatic Tools	85	No	50 %
Pumps	77	No	50 %
Refrigerator Unit	73	No	100 %
Rivet Buster / Chipping Gun	79	Yes	20 %
Rock Drill	81	No	20 %
Roller	80	No	20 %
Sand Blasting	90	No	20 %
Scraper	84	No	40 %
Shears (on backhoe)	90	No	40 %
Slurry Plant	78	No	100 %
Soil Mix Drill Rig	80	No	50 %
Tractor	84	No	40 %
Vacuum Excavator (vac-truck)	85	No	40 %
Vacuum Street Sweeper	80	No	10 %
Ventilation Fan	79	No	100 %
Vibrating Hopper	85	No	50 %
Vibratory Concrete Mixer	80	No	20 %
Vibratory Pile Driver	95	No	20 %
Warning Horn	83	No	5 %
Welder / Torch	73	No	40 %

NOTES:

(a) Measured at 50 feet from the construction equipment, with a Aslow≅ (1 sec.) time constant.

(b) Noise limits apply to total noise emitted from equipment and associated components operating at full power while engaged in its intended operation.

(c) AImpact≅ equipment is assumed to produce separate discernable sound pressure maxima.

(d) AAcoustic Usage Factor≅ represents the percent of time that equipment is assumed to be running at full power while working on site.

SECTION 10.00 - GENERAL CLAUSES FOR HIGHWAY ILLUMINATION AND TRAFFIC SIGNAL PROJECTS

Article 10.00.03 – Plans:
In the first paragraph, replace the 2nd, 3rd, and 4th sentences with the following:

The Contractor shall digitally mark, in red, any changes on the plan(s) using a pdf program. Markups shall also include field-obtained GPS coordinates for installed span pole, mast arm assembly, controller, and light standard locations.

- The GPS technology used should be able to provide coordinates that are within 12" of accuracy.
- Coordinates provided are to be as accurate as possible for locations where satellite coverage is compromised by tree canopies, buildings, etc.

The Contractor shall submit the digital pdf file(s) to the Engineer and to DOT.TrafficElectrical@ct.gov, for Traffic Signals, prior to requesting the Functional Inspection.

Also prior to requesting the Functional Inspection, the Contractor shall deliver to the Engineer the following:

In item no. 1, replace "Four (4)" with "Digital PDF Files and Five (5)" [paper prints of schematics and wiring diagrams…].

After item no. 3, add an item no. 4 as the following:

4. Digital field pictures, in .JPG format and labeled appropriately, of the following constructed items:
   a. Signals heads facing each approach. The pictures are to be taken along each intersection approach in order to observe the relation between the signal faces and the approach centerline, lane line(s), and edge line.
   b. Inside of hand holes
   c. Inside of the controller cabinet
   d. Traffic foundations (Span poles, MAA, Controller Cabinet, Light Standards, Pedestals)
   e. Video detector locations and mountings
   f. Utility Clearances from span wire and MAAs
   g. Screen shots of detection zones

Article 10.00.10 Section 2. Subsection a) After Part 3, add the following:

4. 360-Degree Video Detection System Tests: The following tests shall be performed on all traffic signals with 360-Degree Video Detection Systems. The test results shall be recorded

and submitted to the Engineer prior to the functional inspection of the traffic signal. Refer to the "Quality Best Practices" attachment to the special provision for Item # 1112286A - 360 DEGREE VIDEO DETECTION PROCESSOR:

a) Cabinet Grounding Test: The cabinet ground shall be tested with a clamp-on ground meter in accordance with the detection system manufacturer's recommendations to ensure a ground reading of a maximum of 25 Ohms. The results of this test shall be recorded.

b) AC Power Test: The AC outlet for the processor shall be checked with a digital voltmeter according to the detection system manufacturer's recommendations to ensure that all three connections for the outlet are properly connected and to verify that the AC voltage from the line to neutral and the line to ground is 120VAC. The results of this test shall be recorded.

c) Ethernet Cable Test: Each Ethernet cable shall be tested with a digital Ethernet cable tester in accordance with the detection system manufacturer's recommendations to ensure the cable length does not exceed 300-ft and ensure a Real World Certification of at least 100 MB. The results of this test shall be recorded.

d) Drain Wire Resistance Test: Each Ethernet cable drain wire shall be checked with a digital voltmeter in accordance with detection system manufacturer's recommendations to ensure that the resistance between the drain wire grounding post and the cabinet ground rod equals 0 Ohms. The results of this test shall be recorded.

Article 10.00.10 Section 2. Subsection b) Part 3. Functional Inspection:
In the first paragraph, after the 2nd sentence, add the following:

Prior to the Functional Inspection, the Contractor shall verify with the CTDOT Traffic Signal Lab that each detection camera is operating properly. In instances where the existing traffic control equipment is being revised or replaced, the verification with the CTDOT Traffic Signal Lab shall be prior to the required Preliminary Functional Test. The Contractor shall have a bucket truck with crew on site during the Functional Inspection to make any necessary aerial signal and detection equipment adjustments as directed by the Engineer.

After the fourth paragraph, add the following:

Upon the successful completion of the Functional Inspection and once all corrections and adjustments resulting from the Functional Inspection are completed, the Contractor shall update as-built plans and pictures to reflect any changes made and submit as required in Section 10.00.03 within 7 days of the completion of the 30-day test.

Article 10.00.12 - Negotiations with utility company: Add the following:

The Contractor shall give notice to utility companies a minimum of 30 days prior to required work or services to the utility company. Refer to Section 1.07 – Legal Relations and Responsibilities for the list of utility companies and representatives the contractor shall use.

The Contractor shall perform all work in conformance with Rules and Regulations of Public Utility Regulatory Authority (PURA) concerning Traffic Signals attached to Public Service Company

Poles. The Contractor is cautioned that there may be energized wires in the vicinity of the specified installations. In addition to ensuring compliance with NESC and OSHA regulations, the Contractor and/or its Sub-Contractors shall coordinate with the appropriate utility company for securing/protecting the site during the installation of traffic signal mast arms, span poles or illumination poles.

When a span is attached to a utility pole, the Contractor shall ensure the anchor is in line with the proposed traffic signal span wire. More than 5 degree deviation will lower the holding strength and is not allowed. The Contractor shall provide any necessary assistance required by the utility company, and ensure the anchor and guy have been installed and properly tensioned prior to attaching the span wire to the utility pole.

ITEM NO. 0101000A - ENVIRONMENTAL HEALTH AND SAFETY

Description:

Under this item, the Contractor shall establish protocols and provide procedures to protect the health and safety of its employees and subcontractors as related to the proposed construction activities performed within the Project AOEC(s). Work under this Item consists of the development and implementation of a written HASP that addresses the relative risk of exposure to documented hazards present within Project limits. The HASP shall establish health and safety protocols that address the relative risk of exposure to regulated substances in accordance with 29 CFR 1910.120 and 29 CFR 1926.65. Such protocols shall only address those concerns directly related to site conditions.

Note: The Engineer will prepare a site-specific health and safety plan which is compatible with the Contractor's plan and will be responsible for the health and safety of all Project Inspectors, Department employees and consulting engineers.

Materials:

The Contractor must provide chemical protective clothing (CPC) and personal protective equipment (PPE) as stipulated in the Contractor's HASP during the performance of work in areas identified as potentially posing a risk to worker health and safety for workers employed by the Contractor and all subcontractors.

Construction Methods:

1-Existing Information: The Contractor shall utilize all available information and existing records and data pertaining to chemical and physical hazards associated with any of the regulated substances identified in the environmental site investigations to develop the HASP. A list of documents containing this data is found in "Notice to Contractor – Environmental Investigations".

2-General: The requirements set forth herein pertain to the provision of workers' health and safety as it relates to proposed Project activities when performed in the presence of hazardous or regulated materials or otherwise environmentally sensitive conditions. THE PROVISION OF WORKER HEALTH AND SAFETY PROTOCOLS WHICH ADDRESS POTENTIAL AND/OR ACTUAL RISK OF EXPOSURE TO SITE SPECIFIC HAZARDS POSED TO CONTRACTOR EMPLOYEES IS SOLELY THE RESPONSIBILITY OF THE CONTRACTOR.

The Contractor shall be responsible for the development, implementation and oversight of the HASP throughout the performance of work within the limits of the AOEC(s), as identified in the Contract Documents, and in other areas identified by the Engineer or by the HASP where site conditions may pose a risk to worker health and safety and/or the environment. **No physical**

aspects of the work within the AOEC shall begin until the HASP is reviewed by the Engineer and is determined to meet the requirements of the specifications. However, the Contract time, in accordance with Article 1.03.08, will begin on the date stipulated in the Notice to Proceed.

3-Regulatory Requirements: All construction related activities performed by the Contractor within the limits of the AOEC(s) or in other areas where site conditions may pose a risk to worker health and safety and/or the environment shall be performed in conformance with 29 CFR 1926, Safety and Health Regulations for Construction and 29 CFR 1910, Safety and Health Regulations for General Industry. Conformance to 29 CFR 1910.120, Hazardous Waste Site Operations and Emergency Response (HAZWOPER) may also be required, where appropriate.

4-Submittals: Three copies of the HASP shall be submitted to the Engineer within four (4) weeks after the Award of Contract or four (4) weeks prior to the start of any work in the AOEC, whichever is first, but not before the Award of the Contract.

The HASP shall be developed by a qualified person designated by the Contractor. This qualified person shall be a Certified Industrial Hygienist (CIH), Certified Hazardous Material Manager (CHMM), or a Certified Safety Professional (CSP). He/she shall have review and approval authority over the HASP and be identified as the Health and Safety Manager (HSM). The HASP shall bear the signature of said HSM indicating that the HASP meets the minimum requirements of 29 CFR 1910.120 and 29 CFR 1926.65.

The Engineer will review the HASP(s) within four (4) weeks of submittal and provide written comments as to deficiencies in and/or exceptions to the plan(s), if any, to assure consistency with the specifications, applicable standards, policies and practices and appropriateness given potential or known site conditions. Items identified in the HASP which do not conform to the specifications will be brought to the attention of the Contractor, and the Contractor shall revise the HASP to correct the deficiencies and resubmit it to the Engineer for determination of compliance with this item. The Contractor shall not be allowed to commence work activities in the AOEC(s), as shown on the Plans, or where site conditions exist which may pose a risk to worker health and safety and/or the environment, until the HASP has been reviewed and accepted by the Engineer. No claim for delay in the progress of work will be considered for the Contractor's failure to submit a HASP that conforms to the requirements of the Contract.

5-HASP Provisions:

(a) General Requirements: The Contractor shall prepare a HASP covering all Project site work regulated by 29 CFR 1910.120(b)/ 1926.65(b) to be performed by the Contractor and all subcontractors under this Contract. The HASP shall establish in detail, the protocols necessary for the recognition, evaluation, and control of all hazards associated with each task performed under this Contract. The HASP shall address site-specific safety and health hazards of each phase of site operation and include the requirements and procedures for employee protection. The level of detail provided in the HASP shall be tailored to the type of work, complexity of operations to be performed, and hazards

anticipated. Details about some activities may not be available when the initial HASP is prepared and submitted. Therefore, the HASP shall address, in as much detail as possible, all anticipated tasks, their related hazards and anticipated control measures.

The HASP shall interface with the Contractor's Safety and Health Program. Any portions of the Safety and Health Program that are referenced in the HASP shall be included as appendices to the HASP. All topics regulated by the 29 CFR 1910.120(b)(4) and those listed below shall be addressed in the HASP. Where the use of a specific topic is not applicable to the Project, the HASP shall include a statement to justify its omission or reduced level of detail and establish that adequate consideration was given the topic.

(b) Elements:

(i) Site Description and Contamination Characterization: The Contractor shall provide a site description and contaminant characterization in the HASP that meets the requirements of 29 CFR 1910.120/1926.65.

(ii) Safety and Health Risk Analysis/Activity Hazard Analysis: The HASP shall address the safety and health hazards on this site for every operation to be performed. The Contractor shall review existing records and data to identify potential chemical and physical hazards associated with the site and shall evaluate their impact on field operations. Sources, concentrations (if known), potential exposure pathways, and other factors as noted in CFR 1910.120/126.65, paragraph (c)(7) employed to assess risk shall be described. The Contractor shall develop and justify action levels for implementation of engineering controls and personal protective equipment upgrades and downgrades for controlling worker exposure to the identified hazards. If there is no permissible exposure limit (PEL) or published exposure level for an identified hazard, available information from other published studies may be used as guidance. Any modification of an established PEL must be fully documented.

The HASP shall include a comprehensive section that discusses the tasks and objectives of the site operations and logistics and resources required to complete each task. The hazards associated with each task shall be identified. Hazard prevention techniques, procedures and/or equipment shall be identified to mitigate each of the hazards identified.

(iii) Staff Organization, Qualifications and Responsibilities: The HASP shall include a list of personnel expected to be engaged in site activities and certify that said personnel have completed the educational requirements stipulated in 29 CFR 1910.120 and 29 CFR 1926.65, are currently monitored under a medical surveillance program in compliance with those regulations, and that they are fit for work under "level C" conditions.

The Contractor shall assign responsibilities for safety activities and procedures. An outline or flow chart of the safety chain of command shall be provided in the HASP. Qualifications, including education, experience, certifications, and training in safety and health for all personnel engaged in safety and health functions shall be documented in the

HASP. Specific duties of each on-site team member should be identified. Typical team members include but are not limited to Team Leader, Scientific Advisor, Site Safety Officer, Public Information Officer, Security Officer, Record Keeper, Financial Officer, Field Team Leader, and Field Team members.

The HASP shall also include the name and qualifications of the individual proposed to serve as Health and Safety Officer (HSO). The HSO shall have full authority to carry out and ensure compliance with the HASP. The Contractor shall provide a competent HSO on-site who is capable of identifying existing and potential hazards in the surroundings or working conditions which are unsanitary, hazardous or dangerous to employees and who has authorization to take prompt corrective measures to eliminate or control them. The qualifications of the HSO shall include completion of OSHA 40-hour HAZWOPER training and 8-hour HAZWOPER supervisory training; a minimum of one year of working experience with the regulated compounds that have been documented to exist within Project limits; a working knowledge of Federal and State safety regulations; specialized training or documented experience (one year minimum) in personal and respiratory protective equipment program implementation; the proper use of air monitoring instruments, air sampling methods and procedures; and certification training in first aid and CPR by a recognized, approved organization such as the American Red Cross.

The primary duties of the HSO shall be those associated with worker health and safety. The Contractor's HSO responsibilities shall be detailed in the written HASP and shall include, but not be limited to the following:

(A) Directing and implementing the HASP.

(B) Ensuring that all Project personnel have been adequately trained in the recognition and avoidance of unsafe conditions and the regulations applicable to the work environment to control or eliminate any hazards or other exposure to illness or injury (29 CFR 1926.21). All personnel shall be adequately trained in procedures outlined in the Contractor's written HASP.

(C) Authorizing Stop Work Orders, which shall be executed upon the determination of an imminent health and safety concern.

(D) Contacting the Contractor's HSM and the Engineer immediately upon the issuance of a Stop Work order when the HSO has made the determination of an imminent health and safety concern.

(E) Authorizing work to resume, upon approval from the Contractor's HSM.

(F) Directing activities, as defined in the Contractor's written HASP, during emergency situations; and

(G) Providing personal monitoring where applicable, and as identified in the HASP.

(iv) Employee Training Assignments: The Contractor shall develop a training program to inform employees, supplier's representatives, and official visitors of the special hazards and procedures (including PPE, its uses and inspections) to control these hazards during field operations. Official visitors include but are not limited to Federal Agency Representatives, State Agency Representatives, Municipal Agency Representatives, Contractors, subcontractors, etc. This program shall be consistent with the requirements of 29 CFR 1910.120 and 29 CFR 1926.65.

(v) Personal Protective Equipment: The plan shall include the requirements and procedures for employee protection and should include a detailed section on respiratory protection. The Contractor shall describe in detail and provide appropriate personal protective equipment (PPE) to insure that workers are not exposed to levels greater than the action level for identified hazards for each operation stated for each work zone. The level of protection shall be specific for each operation and shall be in compliance with all requirements of 29 CFR 1910 and 29 CFR 1926. The Contractor shall provide, maintain, and properly dispose of all PPE.

(vi) Medical Surveillance Program: All on-site Contractor personnel engaged in 29 CFR 1910.120/1926.65 operations shall have medical examinations meeting the requirements of 29 CFR 1910.120(f) prior to commencement of work.

The HASP shall include certification of medical evaluation and clearance by the physician for each employee engaged in 29 CFR 1910.120/1926.65 operations at the site.

(vii) Exposure Monitoring/Air Sampling Program: The Contractor shall submit an Air Monitoring Plan as part of the HASP which is consistent with 29 CFR 1910.120, paragraphs (b)(4)(ii)(E), (c)(6), and (h). The Contractor shall identify specific air sampling equipment, locations, and frequencies in the air-monitoring plan. Air and exposure monitoring requirements shall be specified in the Contractor's HASP. The Contractor's CIH shall specify exposure monitoring/air sampling requirements after a careful review of the contaminants of concern and planned site activities.

(viii) Site Layout and Control: The HASP shall include a map, work zone delineation (support, contamination, reduction and exclusion), on/off-site communications, site access controls, and security (physical and procedural).

(ix) Communications: Written procedures for routine and emergency communications procedures shall be included in the Contractor's HASP.

(x) Personal Hygiene, Personal Decontamination and Equipment Decontamination: Decontamination facilities and procedures for personnel protective equipment, sampling equipment, and heavy equipment shall be discussed in detail in the HASP.

(xi) Emergency Equipment and First Aid Requirements: The Contractor shall provide appropriate emergency first aid kits and equipment suitable to treat exposure to the hazards identified, including chemical agents. The Contractor will provide personnel that have certified first aid/CPR training on-site at all times during site operations.

(xii) Emergency Response Plan and Spill Containment Program: The Contractor shall establish procedures in order to take emergency action in the event of immediate hazards (i.e., a chemical agent leak or spill, fire or personal injury). Personnel and facilities supplying support in emergency procedures will be identified. The emergency equipment to be present on-site and the Emergency Response Plan procedures, as required 29 CFR 1910.120, paragraph (1)(1)(ii) shall be specified in the Emergency Response Plan. The Emergency Response Plan shall be included as part of the HASP. This Emergency Response Plan shall include written directions to the closest hospital as well as a map showing the route to the hospital.

(xiii) Logs, Reports and Record Keeping: The Contractor shall maintain safety inspections, logs, and reports, accident/incident reports, medical certifications, training logs, monitoring results, etc. All exposure and medical monitoring records are to be maintained according to 29 CFR 1910 and 29 CFR 1926. The format of these logs and reports shall be developed by the Contractor to include training logs, daily logs, weekly reports, safety meetings, medical surveillance records, and a phase-out report. These logs, records, and reports shall be maintained by the Contractor and be made available to the Engineer.

The Contractor shall immediately notify the Engineer of any accident/ incident. Within two working days of any reportable accident, the Contractor shall complete and submit to the Engineer an accident report.

(xiv) Confined space entry procedures: Confined space entry procedures, both permit required and non permit required, shall be discussed in detail.

(xv) Pre-entry briefings: The HASP shall provide for pre-entry briefings to be held prior to initiating any site activity and at such other times as necessary to ensure that employees are apprised of the HASP and that this plan in being followed.

(xvi) Inspections/audits: The HSM or HSO shall conduct Inspections or audits to determine the effectiveness of the HASP. The Contractor shall correct any deficiencies in the effectiveness of the HASP.

6-HASP Implementation: The Contractor shall implement and maintain the HASP throughout the performance of work. In areas identified as having a potential risk to worker health and safety, and in any other areas deemed appropriate by the HSO, the Contractor shall be prepared to immediately implement the appropriate health and safety measures, including but not limited to the use of personal protective equipment (PPE), and engineering and administrative controls.

If the Engineer observes deficiencies in the Contractor's operations with respect to the HASP, they shall be assembled in a written field directive and given to the Contractor. The Contractor shall immediately correct the deficiencies and respond, in writing, as to how each was corrected. Failure to bring the work area(s) and implementation procedures into compliance will result in a Stop Work Order and a written directive to discuss an appropriate resolution(s) to the matter. When the Contractor demonstrates compliance, the Engineer shall remove the Stop Work Order. If a Stop Work Order has been issued for cause, no delay claims on the part of the Contractor will be honored.

Disposable CPC/PPE, i.e. disposable coveralls, gloves, etc., which come in direct contact with hazardous or potentially hazardous material shall be placed into 55 gallon USDOT 17-H drums and disposed of in accordance with Federal, State, and local regulations. The drums shall be temporarily staged and secured within the WSA until the material is appropriately disposed.

7-HASP Revisions: The HASP shall be maintained on-site by the Contractor and shall be kept current with construction activities and site conditions under this Contract. The HASP shall be recognized as a flexible document which shall be subject to revisions and amendments, as required, in response to actual site conditions, changes in work methods and/or alterations in the relative risk present. All changes and modifications shall be signed by the Contractor's HSM and shall require the review and acceptance by the Engineer prior to the implementation of such changes.

Should any unforeseen hazard become evident during the performance of the work, the HSO shall bring such hazard to the attention of the Contractor and the Engineer as soon as possible. In the interim, the Contractor shall take action, including Stop Work Orders and/or upgrading PPE as necessary to re-establish and maintain safe working conditions and to safeguard on-site personnel, visitors, the public and the environment. The HASP shall then be revised/amended to reflect the changed condition.

Method of Measurement:

1-Within thirty (30) calendar days of the award of the Contract, the Contractor shall submit to the Engineer for acceptance a breakdown of its lump sum bid price for this item detailing:

(a) The development costs associated with preparing the HASP in accordance with these Specifications.
(b) The cost per month for the duration of the Project to implement the HASP and provide the services of the HSM and the HSO.

2-If the lump sum bid price breakdown is unacceptable to the Engineer; substantiation showing that the submitted costs are reasonable shall be required.

3-Upon acceptance of the payment schedule by the Engineer, payments for work performed will be made as follows:

(a) The lump sum development cost will be certified for payment.

(b) The Contractor shall demonstrate to the Engineer monthly that the HASP has been kept current and is being implemented and the monthly cost will be certified for payment.

(c) Any month where the HASP is found not to be current or is not being implemented, the monthly payment for the Environmental Health and Safety Item shall be deferred to the next monthly payment estimate. If the HASP is not current or being implemented for more than thirty calendar days, there will be no monthly payment.

(d) Failure of the Contractor to implement the HASP in accordance with this Specification shall result in the withholding of all Contract payments.

Basis of Payment:

This work will be paid for at the Contract lump sum price for "Environmental Health and Safety" which price shall include all materials, tools, equipment and labor incidental to the completion of this item for the duration of the Project to maintain, revise, monitor and implement the HASP. Such costs include providing the services of the HSM and HSO, Contractor employee training, chemical protective clothing (CPC), personal protective equipment (PPE), disposal of PPE and CPC, medical surveillance, decontamination facilities, engineering controls, monitoring and all other HASP protocols and procedures established to protect the Health and Safety for all on-site workers.

Pay Item	Pay Unit
Environmental Health and Safety	L.S.

ITEM #0101117A - CONTROLLED MATERIALS HANDLING

Description:

Work under this Item is intended to provide specific procedural requirements to be followed by the Contractor during the excavation of Controlled Materials from within any AOEC, as shown on the Project Plans. This supplements Specification Sections 2.02, 2.03, 2.06, and 2.86, and Contract Special Provisions for excavation wherever contaminated materials are encountered. Work under this item shall include transporting and stockpiling materials at the WSA; and covering, securing, and maintaining the stockpiled materials throughout the duration of the Project. All materials, excluding the existing pavement structure (asphalt and subbase), rock, ledge, and concrete, excavated within AOEC(s) are to be considered Controlled Materials.

Controlled Materials consisting of non-hazardous levels of regulated substances have been documented to exist within the Project. Such contamination is documented in the reports listed in the "Notice to Contractor – Environmental Investigations." Where contaminated soils are excavated, such soil will not be reusable as backfill, unless authorized by the Engineer in writing, and will require special handling, disposal and documentation procedures.

Materials:

The required materials are detailed on the Project Plans. All materials shall conform to the requirements of the Contract.

Plastic Sheet: Polyethylene plastic sheeting for underlayment shall be at least 30 mil thick. Polyethylene plastic sheeting for covering excavated material shall be a thickness of 10 mil. Both shall be at least 10 feet wide.

Covers for roll-off/storage containers shall be made of polyethylene plastic, or similar water-tight material, that is of sufficient size to completely cover top opening and can be securely fastened to the container.

Sand Bags: Sandbags used to secure polyethylene covers shall be at least 30 pounds.

Sorbent Boom: Shall be 8 inches in diameter and 10 feet long and possess petrophilic and hydrophobic properties. Sorbent booms shall also have devices (i.e. clips, clasps, etc.) for connection to additional lengths of boom.

Construction Methods:

A. General

When Controlled Materials are encountered during the course of the work, health and safety provisions shall conform to the appropriate sections of the Contract. Provisions may include

implementation of engineering controls, air and personal monitoring, the use of chemical protective clothing (CPC), personal protective equipment (PPE), implementation of engineering controls, air and personal monitoring, and decontamination procedures.

Unless otherwise directed by the Engineer, materials removed from any excavation within an AOEC shall be transported directly from their point of origin on the Project to the WSA. The stockpiles of excavated Controlled Materials shall be maintained as shown on the Project Plans. The Contractor shall plan excavation activities within AOEC(s) in consideration of the capacity of WSA, and the material testing and disposal requirements of the applicable Contract item. **No claims for delay shall be considered based on the Contractor's failure to coordinate excavation activities as specified herein.**

The Engineer will sample the stockpiled Controlled Materials at a frequency and for the constituents to meet the acceptance criteria of the treatment/recycling/disposal facilities submitted by the Contractor. The Contractor is hereby notified that laboratory turnaround time is expected to be fifteen (15) working days. Turnaround time is the period of time beginning when the Contractor notifies the Engineer which facility it intends to use and that the stockpile is ready for sampling and ending with the Contractor's receipt of the laboratory analytical results. Any change of intended treatment/recycling/disposal facility may prompt the need to resample and will therefore restart the time required for laboratory turnaround. The laboratory will furnish such results to the Engineer. Upon receipt, the Engineer will make available to the Contractor the results of the final waste characterization determinations. **No delay claim will be considered based upon the Contractor's failure to accommodate the laboratory turnaround time as identified above.**

B. Transportation and Stockpiling

In addition to following all pertinent Federal, State and local laws or regulatory agency policies, the Contractor shall adhere to the following precautions during transport of non-hazardous materials:

- Transported Controlled Materials are to be covered prior to leaving the point of generation and are to remain covered until the arrival at the WSA;

- All vehicles departing the site are properly logged to show the vehicle identification, driver's name, time of departure, destination, and approximate volume and content of materials carried;

- All vehicles shall have secure, watertight containers free of defects for material transportation;

- No material shall leave the site until there is adequate lay down area prepared in the WSA; and,

- Documentation must be maintained indicating that all applicable laws have been satisfied and

that the materials have been successfully transported and received at the WSA.

Construction of the WSA shall be completed prior to the initiation of construction activities generating Controlled Materials. Plastic polyethylene sheeting shall underlay all excavated Controlled Materials. Measures shall be implemented to divert rainfall away from the WSA.

No Controlled Materials shall be excavated or transported to the WSA until registration under the "General Permit for Contaminated Soil and/or Sediment Management (Staging and Transfer)" has been obtained by ConnDOT.

Placement of sorbent boom along the perimeter of the WSA shall be conducted when soil is saturated with petroleum product.

Excavated materials shall be staged as shown on the Project Plans or as directed by the Engineer.

C. WSA Maintenance

The Contractor shall provide all necessary materials, equipment, tools and labor for anticipated activities within the WSA. Such activities include, but are not limited to, handling and management of stockpiles and drummed CPC/PPE; uncovering and recovering stockpiles; maintenance of WSA; replacement of damaged components (i.e. sand bags, plastic polyethylene sheeting, etc.); and waste inventory record management. The Contractor shall manage all materials in the WSA in such a way as to minimize tracking of potential contaminated materials across the site and off-site, and minimize dust generation.

Each stockpile shall be securely covered when not in active use with a cover of sufficient size to prevent generation of dust and infiltration of precipitation. The cover shall be to prevent wind erosion.

The staged stockpiles shall be inspected at least daily by the Contractor to ensure that the cover and containment have not been damaged and that there is no apparent leakage from the pile. If the cover has been damaged, or there is evidence of leakage from the piles, the Contractor shall immediately replace the cover or containment as needed to prevent the release of materials to the environment from the piles.

An inventory of stockpiled materials and drummed CPC/PPE shall be conducted on a daily basis. Inventory records shall indicate the approximate volume of material/drums stockpiled per day; the approximate volume of material/drums stockpiled to date; material/drums loaded and transported off-site for disposal; any materials loaded and transported for on-site reuse; and identification of stockpiles relative to their points of generation.

Following the removal of all stockpiled Controlled Materials, residuals shall be removed from surfaces of the WSA as directed by the Engineer. This operation shall be accomplished using dry methods such as shovels, brooms, mechanical sweepers or a combination thereof. Residuals shall be disposed of as Controlled Materials.

D. Dewatering

Dewatering activities shall conform to Items in pertinent articles of the Contract.

E. Decontamination

All equipment shall be provided to the work site free of contamination. The Engineer may prohibit from the site any equipment that in his opinion has not been thoroughly decontaminated prior to arrival. Any decontamination of the Contractor's equipment prior to arrival at the site shall be at the expense of the Contractor. The Contractor is prohibited from decontaminating equipment on the Project that has not been thoroughly decontaminated prior to arrival.

The Contractor shall furnish labor, materials, tools and equipment for decontamination of all equipment and supplies that are used to handle Controlled Materials. Decontamination shall be conducted at an area designated by the Engineer and may be required prior to equipment and supplies leaving the Project, between stages of the work, or between work in different AOEC's.

Dry decontamination procedures are recommended. Residuals from dry decontamination activities shall be collected and managed as Controlled Materials. If dry methods are unsatisfactory as determined by the Engineer, the Contractor shall modify decontamination procedures as required subject to the Engineer's approval.

F. Dust Control

The Contractor shall implement a fugitive dust suppression program in accordance with the Contract to prevent the off-site migration of particulate matter and/or dust resulting from excavation, loading and operations associated with Controlled Materials. It shall be the Contractor's responsibility to supervise fugitive dust control measures and to monitor airborne particulate matter. The Contractor shall:

1. Employ reasonable fugitive dust suppression techniques.
2. Visually observe the amounts of particulate and/or fugitive dust generated during the handling of Controlled Materials. If the apparent amount of fugitive dust and/or particulate matter is not acceptable to the Engineer, the Engineer may direct the Contractor to implement corrective measures at his discretion, including, but not limited to, the following:

    (a) apply water to pavement surfaces
    (b) apply water to equipment and excavation faces; and
    (c) apply water during excavation, loading and dumping.

G. Permit Compliance

The Contractor shall comply with the terms and conditions of the CTDEEP "General Permit for Contaminated Soil and/or Sediment Management (Staging and Transfer)," including the General Operating Conditions and the Specific Operating Conditions, except that the Engineer will conduct all soil/sediment characterization and perform all record keeping. In particular, the Contractor shall:

1. Operate, maintain and repair the WSA in conformance with the requirements of the General Permit.
2. Maintain a communications system capable of summoning fire, police, and/or other emergency service personnel.
3. Prevent unauthorized entry onto the stockpiles by the use of fences, gates, or other natural or artificial barriers.
4. Separate incidental excavation waste to the satisfaction of the receiving facility or to an extent that renders the contaminated soil and/or sediment suitable for its intended reuse.
5. Isolate and temporarily store incidental waste in a safe manner prior to off-site transport to a facility lawfully authorized to accept such waste.
6. Not store more that 100 cubic yards of incidental waste at any one time.
7. Sort, separate and isolate all hazardous waste from contaminated soil and/or sediment.
8. Prevent or minimize the transfer or infiltration of contaminants from the stockpiles to the ground as detailed in "B. Transportation and Stockpiling" above.
9. Securely cover each stockpile of soil as detailed in "C. WSA Maintenance" above.
10. Minimize wind erosion and dust transport as detailed in "F. Dust Control" above.
11. Use anti-tracking measures at the WSA to ensure the vehicles do not track soil from the WSA onto a public roadway at any time.
12. Instruct the transporters of contaminated soil and/or sediment of best management practices for the transportation of such soil (properly covered loads, removing loose material from dump body, etc.).
13. Control all traffic related to the operation of the facility in such a way as to mitigate the queuing of vehicles off-site and excessive or unsafe traffic impact in the area where the facility is located.
14. Ensure that except as allowed in section 22a-174-18(b)(3)(C) of the Regulations of Connecticut State Agencies, trucks are not left idling for more than three (3) consecutive minutes.

Method of Measurement:

The work of Controlled Material Handling will be measured for payment by the number of cubic yards of controlled material excavated within the AOEC(s) and taken to the WSA. This measurement shall be in accordance with and in addition to the quantity measured for payment of the applicable excavation item in Specification Sections 2.02, 2.03, 2.06, and 2.86, or the Contract Special Provisions, as applicable. Excess excavations made by the Contractor beyond the payment limits specified in the Contract will not be measured for payment and the Contractor assumes all costs associated with the appropriate handling, management and disposal of this material.

Equipment decontamination, the collection of residuals, and the collection and disposal of liquids generated during equipment decontamination activities will not be measured separately for payment.

Basis of Payment:

This work shall be paid for at the Contract unit price, which shall include all transportation from the excavation site to the final WSA, including any intermediate handling steps; stockpiling Controlled Materials at the WSA; covering, securing, and maintaining the individual stockpiles within the WSA throughout the duration of the Project; and all tools, equipment, material and labor incidental to this work.

This price shall also include equipment decontamination; the collection of residuals generated during decontamination and placement of such material in the WSA; and the collection and disposal of liquids generated during equipment decontamination activities.

All materials, labor and equipment associated with compliance with the General Permit for Contaminated Soil and/or Sediment Management (Staging and Transfer) will not be measured separately, but will be considered incidental to the item "Controlled Materials Handling."

Securing, construction and dismantling of the WSA shall be paid for under Item 101128A. Handling and disposal of contaminated groundwater will be paid for under Item 0204210A. Payment for dust control activities shall be made under the appropriate Contract items.

Pay Item	Pay Unit
Controlled Materials Handling	CY

ITEM #0101128A – SECURING, CONSTRUCTION AND DISMANTLING OF A WASTE STOCKPILE AND TREATMENT AREA

Description:

Work under this Item shall consist of the securing, construction and dismantling of the temporary Waste Stockpile Area at the location designated on the Project Plans and in accordance with the Contract. All controlled and hazardous materials excavated during construction activities shall be stockpiled in the WSA. The WSA shown on the Plans is to be used exclusively for temporary stockpiling of excavated materials from within Project AOEC(s) and Hazardous AOEC(s) for determination of disposal classification.

Materials:

The required materials are detailed on the Project Plans. All materials shall conform to the requirements of the Contract.

Construction blocks shall be solid precast rectangular concrete six feet in length, three in height, and two feet in depth.

Polyethylene plastic sheeting for underlayment shall be a thickness of 30 mil and minimum width of ten feet.

Sand bags used to secure polyethylene sheeting soil covers shall have a minimum weight of thirty pounds.

Bedding sand shall conform to Section 6.51.02 of the Specifications.

Processed Aggregate Base shall conform to Section 3.04 of the Specifications.

Hay bales shall conform to the requirements of Section 2.18 of the Specifications.

Bituminous Concrete shall conform to Section 4.06 of the Specifications.

Roll-off/Storage Containers shall be of watertight, steel-body construction, of the size specified and able to handle the storage and subsequent transportation of material to the disposal facility.

Precast Concrete Barrier Curb shall conform to Section 8.22 of the Specifications.

Construction Methods:

The WSA shall be constructed in accordance with the Contract at the location shown on the Project Plans.

Construction of the WSA shall be completed prior to the initiation of construction activities generating Controlled or Hazardous Materials. The Contractor is responsible for the maintenance and protection of all utilities potentially affected during WSA construction. The Contractor shall locate and mark all existing utilities potentially affected prior to initiating WSA construction.

The proposed location of the WSA shall be cleared of any debris and vegetation as directed by the Engineer. Any objectionable materials, which may result in damage to the polyethylene sheeting underlayment, shall be removed prior to stockpiling excavated controlled or hazardous materials.

The Contractor shall comply with the terms and conditions of the DEP "General Permit for Contaminated Soil and/or Sediment Management (Staging and Transfer)", including the General Operating Conditions and the Specific Operating Conditions, except that the Engineer will conduct all soil/sediment characterization and perform all record keeping. In particular, the Contractor shall:

1. Construct and repair the WSA in conformance with the requirements of the General Permit.
2. Prevent unauthorized entry onto the stockpiles by the use of fences, gates, or other natural or artificial barriers.
3. Install anti-tracking measures at the WSA to ensure the vehicles do not track soil from the WSA onto a public roadway at any time.
4. Post and maintain a sign that is visible from a distance of at least 25' at the WSA identifying the name of the permittee (State of CT, Department of Transportation), the DOT field office phone number, the hours of operation for the WSA, and the phrase, "Temporary Soil Staging Area". Lettering shall be at least one inch (1") high with a minimum overall sign dimension of four (4) feet wide by two (2) feet high. Such sign is only required if the capacity of the WSA is equal to or greater than 1,000 cubic yards. If initially the WSA capacity is less than 1,000 c.y. and the WSA capacity is subsequently increased, the Contractor shall post and maintain the required sign at no additional cost to the State, prior to stockpiling the additional material.

Following the removal of all stockpiled material, the Contractor shall use dry decontamination procedures for all surfaces of the WSA as directed by the Engineer. Residual materials shall be disposed of as Controlled or Hazardous Materials. If the results from dry methods are unsatisfactory to the Engineer, the Contractor shall modify decontamination procedures as required.

The Contractor shall be responsible for the collection and treatment/recycling/disposal of any liquid wastes that may be generated by its decontamination activities in accordance with applicable regulations.

Upon completion of the Project and following removal of all residual Controlled or Hazardous Materials, the Contractor shall dismantle the WSA and return the area to original condition. During dismantling, the Contractor shall remove all materials such as polyethylene sheeting and

sand bags. Materials shall be disposed of by the Contractor as solid waste in accordance with the Contract and all Federal, State and local regulations.

Operation and maintenance of the WSA shall be included under Item 101117A "Controlled Material Handling" and/or Item 101109A "Hazardous Materials Excavation".

Method of Measurement:

This work will be measured for payment at the Lump Sum cost for securing, construction, and dismantling of a WSA.

Basis of Payment:

This work will be paid for at the Contract Lump Sum, which shall include all materials, tools, labor, equipment, permits, and work needed to secure, construct, decontaminate and dismantle the WSA, including all clearing, grubbing, grading, clean up, site restoration and seeding.

All materials, labor and equipment associated with compliance with the General Permit for Contaminated Soil and/or Sediment Management (Staging and Transfer) will not be measured separately, but will be considered incidental to the item "Securing, Construction and Dismantling of a Waste Stockpile and Treatment Area".

Pay Item	Pay Unit
Securing, Construction and Dismantling Of a Waste Stockpile and Treatment Area	L.S.

ITEM #0101130A - ENVIRONMENTAL WORK - SOLIDIFICATION

Description:

Under this item, the Contractor shall be responsible for the solidification of controlled and hazardous materials containing free draining liquids, as may be necessary during the performance of work operations prior to off-site disposal. Materials shall be dewatered prior to the addition of solidification material.

The Contractor shall submit within seven (7) days of the Notice to Proceed, for the Engineer's review, a detailed methodology and plan of operation for the solidification of materials.

Materials:

The materials used for solidification shall be a naturally occurring material such as diatomaceous earth or other material as approved by the Engineer. Said material shall be in a dry state prior to use in solidification operations. No polymers or other synthetic materials shall be allowed.

Construction Methods:

Submittals:
The Contractor shall submit for the Engineer's review, a plan showing the location of solidification material storage and proposed mixing location as well as a detailed narrative describing the equipment, materials and methodology to be used. The Contractor shall also include its planned methods to remove or drain away free water prior to the addition of any solidification materials to controlled or hazardous materials. The methodology shall completely describe the Contractor's proposed plan for removal of free liquids (as determined by ASTM) from the excavated materials. Should solidification fail to eliminate free liquids as proposed, the Contractor will be required to revise the solidification plan at no additional cost to the State.

Upon visual examination, if controlled or hazardous materials have free liquids present, the Contractor may, with concurrence of the Engineer, add dry materials to absorb free-standing liquids, utilizing a methodology accepted by the Engineer. The Contractor shall dewater controlled and hazardous materials prior to the addition of solidification materials to the satisfaction of the Engineer. All dewatering fluids shall be handled in accordance with the Contract. Solidification procedures shall be subject to monitoring by the Engineer.

The maximum quantity of solidification material that may be used by the Contractor shall be limited to twenty (20) percent, by volume, of the material being solidified. Should this procedure be demonstrated as not effective in the elimination of the presence of free-standing liquids, the Contractor shall submit methods for the removal of free-standing water. The Contractor shall also submit the additional costs of the proposed alternative to the Engineer for review. No alternative methods of solidification shall be initiated until reviewed and accepted by the Engineer.

Method of Measurement:

This work will be measured for payment as the actual weight of solidification material used by the Contractor. The Contractor shall demonstrate the amount of solidification material used by the original weight tickets from a certified scale. The weight tickets shall show the weight of the material brought to the site and subsequently used in solidification operations.

If no certified scale is available, the Engineer may allow for the calculation of the weight by a summation of sealed, pre-measured bags.

Basis of Payment:

This work will be paid for at the Contract unit price for solidification material used and accepted by the Engineer. Such price shall include all labor, materials, tools, and equipment incidental to the work including transportation of the materials to the Project and the addition of solidification material to excavated materials.

Pay Item	Pay Unit
Environmental Work - Solidification	Ton

ITEM #0202315A - DISPOSAL OF CONTROLLED MATERIALS

Description:

Work under this item shall consist of the loading, transportation and final off-site disposal/ recycling/treatment of controlled materials (excluding dewatering fluids) that have been generated from various excavations within the AOEC(s), brought to the WSA and determined to be contaminated with regulated substances at non-hazardous levels. This contamination is documented in the reports listed in the "Notice to Contractor – Environmental Investigations." The results contained in the environmental investigation reports listed in the "Notice to Contractor – Environmental Investigations" show levels of various contaminants that the Contractor may encounter during construction. Actual levels found during construction may vary and such variations will not be considered a change in condition provided the material can still be disposed as non-hazardous at one or more of the disposal facilities listed herein. The controlled materials, after proper characterization by the Engineer, shall be taken from the WSA, loaded, transported to and treated/recycled/disposed of at a permitted treatment/recycle/disposal facility listed herein.

The Contractor must use one or more of the following Department-approved treatment/recycle/ disposal facilities for the disposal of non-hazardous materials:

Phoenix Soil, LLC 58 North Washington Street Plainville, CT 06062 (860) 747-8888: Sandra Zac	ESMI of New Hampshire 67 International Drive Loudon, NH 03307 (603) 783-0228: Steve Bennitt
ESMI of New York 304 Towpath Road Fort Edward, New York 12828 (800) 511-3764: Peter Hanson	Allied Waste Niagara Fall Landfill, LLC 5600 Niagra Falls Blvd. Niagara, NY 14304 (716) 285-3344: David Hanson
Ted Ondrick Company, LLC 58 Industrial Road Chicopee, MA 01020 (413) 592-2566: David Costanzo	Clean Earth of Carteret 24 Middlesex Avenue Carteret, NJ 07008 (732) 541-8909: Cheryl Coffee
Clean Earth of Philadelphia 3201 S. 61 Street Philadelphia, PA 19153 (215) 724-5520: Mike Kelly	Cumberland County Landfill 135 Vaughn Road Shippensburg, PA 17257 (717) 729-2060: Don Demkovitz

The Southbridge Recycling and Disposal Park 165 Barefoot Road Southbridge, MA 01550 (603) 235-3597: Scott Sampson	Hazelton Creek Properties, LLC * 280 South Church Street Hazelton, PA 18201 (570) 501-5050: Allen Swantek
Colonie Landfill 1319 Louden Road Cohoes, NY 12047 (518) 951-0794: Eric Morales	

* Note: each bin will require an additional 10 days (or more) for PADEP to review analytical data and approve material for disposal prior to facility acceptance of material. This is in addition to all other restrictions and wait periods defined below.

The above list contains treatment/recycle/disposal facilities which can accept the waste stream generated by the project in quantities that may be limited by their permits and their operations restrictions. It is the responsibility of the contractor to verify that a facility will be available and capable of handling the volume as well as the chemical and physical characteristics of material generated by the project.

Construction Methods:

A. Material Disposal

The Engineer will sample materials stored at the WSAs at a frequency established by the selected treatment/recycling/disposal facilities. The Contractor shall designate to the Engineer which facility it intends to use, as well as the facility acceptance criteria and sampling frequency, prior to samples being taken. The Contractor is hereby notified that laboratory turnaround time is expected to be fifteen (15) working days. Turnaround time is the period of time beginning when the Contractor notifies the Engineer which facility it intends to use and that the bin within the WSA is full and ready for sampling and ending with the Contractor's receipt of the laboratory analytical results. Any change of intended treatment/recycling/disposal facility may prompt the need to resample and will therefore restart the time required for laboratory turnaround. The laboratory will furnish such results to the Engineer. Upon receipt, the Engineer will make available to the Contractor the results of the final waste characterization determinations. **No delay claim will be considered based upon the Contractor's failure to accommodate the laboratory turnaround time as identified above.**

The Contractor shall obtain and complete all paperwork necessary to arrange for material disposal (such as disposal facility waste profile sheets). It is solely the Contractor's responsibility to co-ordinate the disposal of controlled materials with its selected treatment/recycling/disposal facility(s). Upon receipt of the final approval from the facility, the Contractor shall arrange for the loading, transport and treatment/recycling/disposal of the materials in accordance with all Federal and State regulations. **No claim will be considered**

based on the failure of the Contractor's selected disposal facility(s) to meet the Contractor's production rate or for the Contractor's failure to select sufficient facilities to meet its production rate.

Any material processing (including but not limited to the removal of woody debris, scrap metal, pressure-treated and untreated wood timber, large stone, concrete, polyethylene sheeting or similar material) required by the Contractor's selected facility will be completed by the Contractor prior to the material leaving the site. It is solely the Contractor's responsibility to meet any such requirements of its facility. Any materials removed shall be disposed of or recycled in a manner acceptable to the Engineer at no additional cost. If creosote treated timbers are removed, they will be disposed of under the item "Disposal of Contaminated Timber Piles", "Disposal of Contaminated Railroad Ties" or in accordance with Article 1.04.05 in the absence of such items.

All manifests or bills of lading utilized to accompany the transportation of the material shall be prepared by the Contractor and signed by an authorized Department representative, as Generator, for each truck load of material that leaves the site. The Contractor shall forward the appropriate original copies of all manifests or bills of lading to the Engineer the same day the material leaves the Project.

A load-specific certificate of treatment/recycling/disposal, signed by the authorized agent representing the disposal facility, shall be obtained by the Contractor and promptly delivered to the Engineer for each load.

B. Material Transportation

In addition to all pertinent Federal, State and local laws or regulatory agency polices, the Contractor shall adhere to the following precautions during the transport of controlled materials off-site:

- Transported controlled materials are to be covered sufficiently to preclude the loss of material during transport prior to leaving the site and are to remain covered until the arrival at the selected treatment/recycling/disposal facility.

- All vehicles departing the site are to be properly logged to show the vehicle identification, driver's name, time of departure, destination, and approximate volume, and contents of materials carried.

- No materials shall leave the site unless a treatment/recycling/disposal facility willing to accept all of the material being transported has agreed to accept the type and quantity of waste.

C. Equipment Decontamination

All equipment shall be provided to the work site free of gross contamination. The Engineer may prohibit from the site any equipment that in his opinion has not been thoroughly decontaminated prior to arrival. Any decontamination of the Contractor's equipment prior to arrival at the site shall be at the expense of the Contractor. The Contractor is prohibited from decontaminating equipment on the Project that has not been thoroughly decontaminated prior to arrival.

The Contractor shall furnish labor, materials, tools and equipment for decontamination of all equipment and supplies that are used to handle Controlled Materials. Decontamination shall be conducted at an area designated by the Engineer and shall be required prior to equipment and supplies leaving the Project, between stages of the work, and between work in different AOEC's.

The Contractor shall use dry decontamination procedures. Residuals from dry decontamination activities shall be collected and managed as Controlled Materials. If the results from dry methods are unsatisfactory to the Engineer, the Contractor shall modify decontamination procedures as required.

The Contractor shall be responsible for the collection and treatment/recycling/disposal of any liquid wastes that may be generated by its decontamination activities in accordance with applicable regulations.

Method of Measurement:

The work of "DISPOSAL OF CONTROLLED MATERIALS" will be measured for payment as the actual net weight in tons of material delivered to the treatment/recycling/disposal facility. Such determinations shall be made by measuring each hauling vehicle on the certified permanent scales at the treatment/recycling/disposal facility. Total weight will be the summation of weight bills issued by the facility specific to this Project. Excess excavations made by the Contractor beyond the payment limits specified in Specification Sections 2.02, 2.03, 2.06, and 2.86, or the Contract Special Provisions (as appropriate) will not be measured for payment and the Contractor assumes responsibility for all costs associated with the appropriate handling, management and disposal of this material.

The disposal of excavated materials, originally anticipated to be controlled materials, but determined by characterization sampling not to contain concentrations of regulated chemicals (non-polluted or "clean" materials) will not be measured for payment under this item but will be considered as surplus excavated materials and will be paid in accordance with Article 1.04.05.

Any materials stored in the WSAs, and which are reused within Project limits, will not be measured for payment under this item. This material will be paid for under Item 0202318A – Management of Reusable Controlled Material or in accordance with Article 1.04.05 in the item's absence.

Equipment decontamination, the collection of residuals, and the collection and disposal of liquids generated during equipment decontamination activities will not be measured separately for payment.

Any material processing required by the Contractor-selected disposal facility, including the proper disposal of all removed materials other than creosote treated wood, will not be measured for payment.

Basis of Payment:

This work will be paid for at the Contract unit price, which shall include the loading and transportation of controlled materials from the WSAs to the treatment/recycling/disposal facility; the fees paid to the facility for treatment/recycling/disposal; the preparation of all related paperwork; and all equipment, materials, tools, and labor incidental to this work. **This unit price will be applicable to all of the listed disposal facilities and will not change for the duration of the Project.**

This price shall also include equipment decontamination; the collection of residuals generated during decontamination and placement of such material in the WSA; and the collection and disposal of liquids generated during equipment decontamination activities.

Pay Item	Pay Unit
Disposal of Controlled Materials	Ton

ITEM #0202318A MANAGEMENT OF REUSABLE CONTROLLED MATERIAL

Description:

Work under this item shall include all materials, equipment, tools and labor required to load, transport from the WSA, place, and compact reusable controlled materials in fill areas located within the Project limits. "Reusable controlled material" is soil that contains contaminant concentrations above analytical detection limits, but below the applicable regulatory criteria.

Construction Methods:

Controlled material stored within the WSA which is determined to be reusable following analytical testing shall be loaded, transported, placed and compacted at fill areas located within the Project limits in accordance with the following conditions: (1) such soil is deemed to be structurally suitable for use as fill by the Engineer; (2) such soil is not placed below the water table; 3) the DEP groundwater classification of the area where the soil is to be reused as fill does not preclude said reuse; and (4) such soil is not placed in an area subject to erosion.

Method of Measurement:

"Management of Reusable Controlled Material" will be measured for payment by the number of cubic yards of material loaded and transported from the WSA and placed at fill areas located within the Project limits in accordance with the Contract.

Basis of Payment:

"Management of Reusable Controlled Material" will be paid for at the Contract unit price, which shall include all materials, equipment, tools and labor necessary to load and transport reusable controlled materials from the WSA to fill areas located within the Project limits and to place and compact the reusable material. This price shall include any decontamination of soil handling equipment, and the treatment/recycling/disposal of wastes generated in conjunction with such decontamination.

No separate payment will be made for consolidating previously tested individual stockpiles that have been deemed reusable, but shall be considered incidental to the work.

The disposal of any reusable controlled material that fails to meet material testing requirements for the intended use in accordance with the Contract requirements, as well as any excess reusable material, will be paid under Item 202315A, "Disposal of Controlled Material".

Pay Item	Pay Unit
Management of Reusable Controlled Materials	C.Y.

ITEM #0202452A – TEST PIT

Description:

Test pits shall be performed for determining the location of underground utilities. This work shall consist of the removal and satisfactory disposal of all materials, the removal of which is necessary for the proper completion of the work, at the locations shown on the plans or as ordered, and backfilling, all in accordance with these specifications.

The purpose of the test pits is for locating and examining soils, groundwater, drains, pipes, rocks, utilities, structure foundations, or any other obstacles. Utility facilities to be located shall include pipes, conduits, service connections, structures, tanks, utility appurtenances, and any miscellaneous items directed by the Engineer such as telltales/markers on the existing pipes, etc.

Materials:

Materials used for restoration of surfaces shall be as approved by the Engineer.

Construction Methods:

Test pits shall be made in conformity with the requirements of the plans or as ordered by the Engineer. The Contractor shall furnish and employ such shores, braces, pumps, etc., as may be necessary for the protection of property, proper completion of the work and the safety of the public and employees of the Contractor and the Department. All bracing, etc., shall be removed when no longer required for the construction or safety of the work.

Wherever portions of existing full-depth bituminous concrete pavement are to be removed in conjunction with test pits, they shall be removed to neat lines. Where the limits of the areas in which such bituminous pavement is to be removed are adjacent to existing bituminous concrete pavement that is to remain in place, the limits shall be cut by a method approved by the Engineer. Test pit excavations shall have neat, clean-cut, and vertical sides; hand-digging shall be employed when required by the Engineer. Sawcut shall be performed where necessary and as directed by the Engineer.

Dig test pits so as to ensure that underground utilities or structures are not damaged. It shall be the Contractor's sole responsibility for any damages incurred during excavation operations. Any damages shall be repaired or replaced by the Contractor to the satisfaction as directed by the Engineer at the Contractor's own expense.

The Contractor shall perform field surveys to establish the horizontal and vertical location and to document the type and size of the utilities at each test pit. The work shall be performed in accordance with the requirements of Section 9.80, Construction Staking. The Contractor shall furnish the Engineer copies of all test pit data.

After the test pit is completed, the Contractor shall notify the Engineer. The test pit shall not be backfilled until directed by the Engineer. Protect each pit with steel plates, other coverings, fences, barriers, or other appropriate materials as deemed necessary. Compact backfill materials 95% to the sub-grade elevation or as otherwise directed.

When backfilling is required, the material used shall be of a quality satisfactory to the Engineer and shall be free from large or frozen lumps, wood and other extraneous material. All backfill placed below subgrade shall be placed in layers of not more than 6 inches in depth after compaction and shall be thoroughly compacted by means of mechanical rammers or vibrators or by pneumatic tampers. Hand tampers shall be used only upon written permission of the Engineer. Unless otherwise ordered by the Engineer, the backfill shall be brought to the surface of the surrounding ground or subgrade and neatly graded.

The surface of test pit areas shall be restored to a condition equal or better than original as approved by the Engineer. Test pits throughout the project area are to be completed prior to beginning actual construction activities.

All suitable material removed in making the excavation shall be used for backfill if required. All surplus or unsuitable material shall be removed and disposed of as directed. Should additional material be required for backfilling, it may be obtained from the Project excavation or from borrow pits, gravel pits, or elsewhere as the Engineer may direct.

Method of Measurement:

Test pits will be measured as each excavated, backfilled, surveyed, documented and accepted. There will be no separate measurement for mobilization and demobilization associated with this item.

Basis of Payment:

Test Pits will be paid for at the contract unit price each complete in place and accepted, which price shall include all materials, equipment, tools, surveys, and labor incidental thereto.

The price shall also include backfilling, patching roadways and sidewalks in kind, restoration of the ground where required and the disposal of surplus material. No additional payment will be made for shoring, bracing, pumping, and bailing or for material or equipment necessary for the satisfactory completion of the work.

Pay Item	Pay Unit
Test Pit	EA.

ITEM #0204151A – HANDLING WATER

Description: Work under this item shall consist of designing, furnishing, installing, maintaining, removing and disposing of a temporary water handling system. This may include water-handling-cofferdams (temporary barriers), bypass pipes, bypass pumps/hoses, temporary energy dissipation, sumps, drainage channels, and equipment and work necessary for dewatering.

A temporary water handling system redirects surface water beyond, through, or around the limits of construction to allow work to be done in the dry.

Materials: The materials required for this work shall be as shown on the plans, on the accepted working drawings, or as ordered by the Engineer.

Construction Methods: The Contractor shall prepare and submit written procedures for handling water. Working drawings, in accordance with Article 1.05.02, shall also be prepared and submitted.

The Contractor shall consider stream conditions and water elevations associated with the Site to determine the type of temporary water handling system required to redirect water away from work being performed. The system shall be designed to be compatible with the stage construction and Maintenance and Protection of Traffic, as indicated in the Contract, and shall conform to Section 1.10.

The Contractor shall be responsible for maintenance of the water handling system. If the system becomes damaged or displaced during construction, the system shall be corrected as required.

Unless otherwise provided or directed, all temporary water handling system components shall be removed and disposed of in an acceptable manner when no longer required.

Method of Measurement: The work under this item, being paid on a lump sum basis, will not be measured for payment.

Basis of Payment: This work will be paid for at the Contract lump sum price for "Handling Water" complete and accepted, which price shall include designing (including submittals and working drawings), furnishing, installing, maintaining, removing, and disposing of all temporary water handling system components as are necessary for completion of the work. This price shall include all materials, equipment, tools, labor and work incidental thereto.

A schedule of values for payment shall be submitted to the Engineer for review and comment.

Pay Item	Pay Unit
Handling Water	L.S.

ITEM #0204213A - HANDLING CONTAMINATED GROUNDWATER

Description:

Under this Item, the Contractor shall collect, manage, treat, and dispose of contaminated groundwater generated during dewatering operations within the designated Groundwater Areas of Environmental Concern (GW AOECs) within the project limits.

Contaminated groundwater is defined as "groundwater which has been generated from excavations within the designated GW AOECs containing substances at concentrations that exceed the effluent limits for the DEEP General Permit for the Discharge of Groundwater Remediation Wastewater Directly to Surface Water". The presence of contaminants removable through control of settleable solids does not constitute contaminated groundwater. Groundwater contamination caused by the Contractor's activities or work practices is also not considered contaminated groundwater.

The contamination and groundwater depth at the time of the investigation is documented in the reports listed in the "Notice to Contractor – Environmental Investigations". Contaminants and depth to groundwater is provided for the Contractor's information and may be influenced by factors such as seasonal groundwater table changes, tidal changes, drought or flooding conditions, local withdrawals from the aquifer, local construction, etc. Additional information with regard to soil descriptions and groundwater observations may also be available if geotechnical investigations were conducted for the project. The Contractor shall contain contaminated groundwater and 1) treat it on-site prior to discharge to sanitary sewer; 2) treat it on-site prior to discharge to surface water; or 3) transport water to an off-site treatment/disposal facility.

This Item does not apply to the possible diversion of existing storm water flow around the construction site during Project activities. Diversion of existing storm water or surface flows shall be completed in accordance with the Contract and all applicable permits. This item also does not include process water or wastewater generated by the Contractor's work activities.

Construction Methods:

A. General

It is the Contractor's responsibility to determine the expected groundwater generation rate from construction activities, select the appropriate groundwater management method, and size its system capacity to meet those dewatering needs.

All equipment required as a part of this Item shall be installed in a location and manner acceptable to the Engineer and in accordance with the manufacturer's recommendations. Equipment shall be decontaminated prior to arrival at the Project, decontaminated prior to

being moved to another area of the project, and then decontaminated before it leaves the Project, at no additional cost to the State. Solids (soil or sediment) generated by on-site dewatering activities shall be brought to the Waste Stockpile Area (WSA) for testing and characterization by the Engineer.

The Contractor is responsible for operating and maintaining the equipment at all times when dewatering in the GW AOEC(s) occurs. This includes providing appropriate supervision during evenings, weekends, and holidays. If the system is intended to operate unattended, a remote alarm system acceptable to the Engineer shall be installed to monitor critical system operating parameters and the Contractor shall be responsible for providing rapid emergency response during non-working hours in the event a system malfunction occurs. A list of names and phone numbers shall be displayed in the immediate vicinity of the system for emergency contacts.

The Contractor shall report releases from the groundwater treatment system due to overfilling or equipment/piping failure to the DEEP Spill Response Unit in accordance with RCSA 22a-450 and provide the Engineer with all information, including the DEEP case number. All costs related to spill response associated with the Contractor's on-site containment or treatment system will be the responsibility of the Contractor.

The Contractor shall collect all samples related to permit compliance in the presence of the Engineer. The Contractor shall provide informational copies of all groundwater analytical results and discharge monitoring reports to the Engineer as they are generated.

The Contractor shall operate the dewatering equipment at a rate that removes the groundwater that naturally infiltrates the excavation. The Contractor shall not cause a hydraulic gradient that draws groundwater into the excavation at an excessive rate. Additional treatment required due to the mobilization of off-site contaminants caused by the Contractor dewatering at an excessive rate will be the responsibility of the Contractor.

Additional treatment related to the Contractor's work activities (i.e. treatment or increased charges due to changes in pH or introduction of different contaminants into the groundwater) and management and disposal of excess water related to the Contractor's process water or waste water will not be included under this item but will be considered a part of the Contractor's cost for the item under which the work is being performed.

B. Groundwater Management Methods

The Contractor shall use one or more of the following methods for the management and disposal of contaminated groundwater. Based on project specifics and site constraints, the Contractor may choose to use more than one of the following methods on a single project. All methods may not be possible at the site due to sanitary sewer or permitting restrictions.

1. On-Site Treatment System with Discharge to Sanitary Sewer

a. Contractor Submittals

At least 14 days prior to any submittal to the Publicly Owned Treatment Works (POTW) or DEEP, the Contractor shall submit the treatment system design, which has been sealed by a Professional Engineer licensed in the State of Connecticut to the Engineer for review and comment. Equipment shall prevent sediments and solids, as well as contaminants in excess of the permit allowable effluent concentrations, from entering the sanitary sewer. This submittal shall include a schematic or diagram that shows all treatment system equipment, well point locations, pump set-ups in excavations, sedimentation control methods, system location, method of conveyance, flow rates, pipe sizes, valve locations, sampling ports, discharge locations, electrical power connection, etc.

The Contractor shall submit the manufacturer's data sheets, assembly details and performance data on all treatment equipment. If dewatering equipment is to remain on site between October 15 and April 15, the Contractor shall include its method to prevent the treatment system equipment from freezing (heat tape, immersion heaters, etc.).

The Contractor shall detail its method to collect and contain water in its excavations. The Contractor shall also describe in detail its methods for limiting the quantity of water entering the excavation, including shoring, location of well points, limiting excavation size, preventing entry of surface water into the excavation, etc. The Contractor shall also include its assumptions and flow rate calculations related to the sizing of the system.

It is the Contractor's responsibility to design and properly size the system to accommodate the anticipated contaminants and dewatering rates based on its construction activities, POTW limitations, and permit requirements. The Contractor is alerted that construction activities may be limited based on permit restrictions or POTW limitations.

No claim for delay or request for additional time will be considered based upon the Contractor's failure to accommodate the review process.

b. Permits

Groundwater generated by construction activities within a GW AOEC shall be appropriately treated and discharged to the sanitary sewer system within Project limits. Management and discharge of contaminated groundwater shall be accomplished in accordance with a DEEP General Permit and POTW requirements. The Contractor shall be responsible for registering under the General Permit, any other necessary State or local permits, and all associated fees.

The DEEP General Permit for the Discharge of Groundwater Remediation Wastewater to Sanitary Sewer is available at www.ct.gov/deep. The Contractor shall submit the most current permit registration form to the DEEP. A minimum lead-time of six (6) weeks can

be expected to process and submit the registration, in addition to coordination time with the POTW. **No claim for delay or request for additional time will be considered based upon the Contractor's failure to accommodate the permitting process.** The Contractor shall not submit the permit registration to the DEEP prior to the Engineer's review of and comment on the treatment system.

The Contractor shall submit a copy of the DEEP permit certificate of registration to the Engineer prior to initiating any discharge.

All testing required by the general permit shall be conducted by a laboratory certified by the Connecticut Department of Public Health (DPH) for the method specified in the permit. The Contractor shall submit copies of the analytical results to the all parties specified in the permit terms and conditions and to the Engineer.

No claim for delay or request for additional time will be considered based upon the Contractor's failure to design a system to meet this performance specification. It is the Contractor's responsibility to properly size the treatment system and temporary containment tanks based on its anticipated flow rates from construction activities and to determine the level of treatment required to meet permit discharge limits.

c. Treatment System Operation

The Contractor shall ensure that all personnel involved in the groundwater treatment operations understand the terms of the General Permit. In the event of a conflict between the requirements of the Contract and the permit, the more stringent will apply.

The Contractor shall not commence work activities within any GW AOEC until such time as:

i. the temporary groundwater treatment system design is reviewed by the Engineer and comments are adequately addressed,

ii. the system is installed in accordance with the accepted design and is completely operational, and

iii. a copy of the Contractor's permit certificate of registration has been submitted to the Engineer.

The Contractor shall make any sanitary sewer tie-in modifications necessary to accommodate the treatment unit only after obtaining approval from the Engineer and the POTW.

The Contractor shall take all meter readings required by the permit and forward them to the appropriate parties.

The Contractor shall collect all samples related to permit compliance in the presence of the Engineer and shall submit copies of the analytical results and discharge monitoring reports to the appropriate agency(ies) as required by the General Permit terms and conditions. The Contractor shall provide informational copies of all analytical results and discharge monitoring reports to the Engineer as they are generated. In the event of an exceedance, the Contractor shall immediately comply with the "***Duty to Correct, Record, and Report Violations***" section of the General Permit. The Contractor shall provide the Engineer a copy of the required DEEP reporting and then document its review of the treatment system and all actions taken to correct the exceedance in writing to the Engineer within 48 hours of receiving laboratory data documenting the exceedance.

If the discharge must be suspended due to an effluent violation, the Contractor shall only restart the discharge after obtaining all necessary approvals from the DEEP/POTW and in full compliance with the General Permit and any amendments imposed thereto.

No claim for delay, request for additional time, or request for additional design/redesign costs for the system will be considered based upon the Contractor's failure to design/redesign a system to meet this performance specification.

2. On-Site Treatment System with Discharge to Surface Water

   a. Contractor Submittals

At least 14 days prior to <u>any</u> submittal to the DEEP, the Contractor shall submit the treatment system design, which has been sealed by a Professional Engineer licensed in the State of Connecticut, to the Engineer for review and comment. Equipment shall prevent sediments and solids, as well as contaminants in excess of the permit allowable effluent concentrations, from discharging. This submittal shall include a schematic or diagram that shows all treatment system equipment, well point locations, pump set-ups in excavations, sedimentation control methods, system location, method of conveyance, flow rates, pipe sizes, valve locations, sampling ports, discharge locations, electrical power connection, etc.

The Contractor shall submit the manufacturer's data sheets, assembly details and performance data on all treatment equipment. If dewatering equipment is to remain on site between October 15 and April 15, the Contractor shall include its method to prevent the treatment system equipment from freezing (heat tape, immersion heaters, etc.).

The Contractor shall detail its method to collect and contain water in its excavations. The Contractor shall also describe in detail its methods for limiting the quantity of water entering the excavation, including shoring, location of well points, limiting excavation size, preventing entry of surface water into the excavation, etc. The Contractor shall also include its assumptions and flow rate calculations related to the sizing of the system.

It is the Contractor's responsibility to design and properly size the system to accommodate the anticipated contaminants and dewatering rates based on its construction activities and permit requirements. The Contractor is alerted that construction activities may be limited based on permit restrictions.

No claim for delay or request for additional time will be considered based upon the Contractor's failure to accommodate the review process.

b. Permits

Groundwater generated by construction activities within a GW AOEC shall be appropriately treated and discharged to surface water within Project limits. Management and discharge of contaminated groundwater shall be accomplished in accordance with a DEEP General Permit. The Contractor shall be responsible for registering under the General Permit and all associated fees.

The DEEP General Permit for the Discharge of Groundwater Remediation Wastewater Directly to Surface Water is available at www.ct.gov/deep. The Contractor shall submit the most current permit registration form to the DEEP. A minimum lead-time of six (6) weeks can be expected to process and submit the registration. **No claim for delay or request for additional time will be considered based upon the Contractor's failure to accommodate the permitting process.** The Contractor shall not submit the permit registration to the DEEP prior to review of and comment on the treatment system by the Engineer.

The Contractor shall submit a copy of the DEEP permit certificate of registration to the Engineer prior to initiating any discharge.

All testing required by the General Permit shall be conducted by a laboratory certified by the Connecticut Department of Public Health (DPH) for the method specified in the permit. The Contractor shall submit copies of the analytical results to the all parties specified in the permit terms and conditions and to the Engineer.

No claim for delay or request for additional time will be considered based upon the Contractor's failure to design a system to meet this performance specification. It is the Contractor's responsibility to properly size the treatment system and temporary containment tanks based on its anticipated flow rates from construction activities and to determine the level of treatment required to meet permit discharge limits.

For sites where the receiving water body does not qualify the site for registration under the DEEP General Permit for the Discharge of Groundwater Remediation Wastewater Directly to Surface Water and the discharge is anticipated to continue for 30 days or less, the Contractor may qualify for a DEEP Temporary Authorization (TA) to discharge to surface water. The Contractor will be bound to the terms and conditions of the TA the same as if it were a permit. If the Contractor applies for, and receives, a TA from the

DEEP, all other requirements of this specification will apply, except that where the specification refers to a permit, the TA will be substituted.

c. Treatment System Operation

The Contractor shall ensure that all personnel involved in the groundwater treatment operations understand the terms of the General Permit. In the event of a conflict between the requirements of this Item and the permit, the more stringent will apply.

The Contractor shall not commence work activities within any GW AOEC until such time as:

i. the temporary groundwater treatment system design is reviewed by the Engineer and comments are adequately addressed,

ii. the system is installed in accordance with the accepted design and is completely operational, and

iii. a copy of the Contractor's permit certificate of registration has been submitted to the Engineer.

The Contractor shall take all meter readings required by the permit and forward them to the appropriate parties.

The Contractor shall submit copies of the analytical results and discharge monitoring reports to the appropriate agency(ies) as required by the General Permit terms and conditions. The Contractor shall provide informational copies of all analytical results and discharge monitoring reports to the Engineer as they are generated. In the event of an exceedance, the Contractor shall immediately comply with the "***Duty to Correct, Record, and Report Violations***" section of the General Permit. The Contractor shall provide the Engineer a copy of the required DEEP reporting and then document its review of the treatment system and all actions taken to correct the exceedance in writing to the Engineer within 48 hours of receiving laboratory data documenting the exceedance.

If the discharge must be suspended due to an effluent violation, the Contractor shall only restart the discharge after obtaining all necessary approvals from the DEEP and in full compliance with the General Permit and any amendments imposed thereto.

No claim for delay, request for additional time, or request for additional design/redesign costs for the system will be considered based upon the Contractor's failure to design/redesign a system to meet this performance specification.

3. Off-Site Treatment and Disposal

At least 14 days prior to any work involving the dewatering of contaminated groundwater, the Contractor shall submit for the Engineer's review and comment its proposed system to collect and contain the contaminated groundwater. This submittal shall include schematics of proposed pump set-ups in excavations; sedimentation control measures; probable location of temporary containment tanks; schematics of proposed method to transfer liquids from temporary containment tanks to transport vehicles; schematic of proposed method to off-load liquids at the off-site permitted treatment/disposal facility; documentation that transport vehicles hold a "Waste Transportation Permit" for contaminated liquids per CGS 22a-454; and the name of the disposal facility from the following list of Department-approved and DEEP-permitted treatment facilities for State-regulated liquid disposal:

Clean Harbors of CT
51 Broderick Rd.
Bristol, CT 06010
(860)224-7600

United Oil Recycling
Gracey Ave.
Meriden, CT 06450
(203)238-6754

Bridgeport United Recycling
50 Cross St.
Bridgeport, CT 06610
(203)238-6754

All testing required to meet facility acceptance parameters shall be conducted by the Contractor in the presence of the Engineer. The Contractor is hereby notified that laboratory turnaround time is expected to be fifteen (15) working days. The Contractor shall provide informational copies of the laboratory results to the Engineer. **No delay claim will be considered based upon the Contractor's failure to accommodate the laboratory turnaround time as identified above or to design its system with sufficient holding capacity to accommodate this requirement.**

The Contractor shall obtain and complete all paperwork necessary to arrange for disposal of the contaminated groundwater (such as disposal facility waste profile sheets). It is solely the Contractor's responsibility to coordinate the disposal with its selected facility. Upon receipt of the final approval from the facility, the Contractor shall arrange for the loading, transport and disposal in accordance with all Federal and State regulations. **No claim will be considered based on the failure of the Contractor's selected disposal facility(s) to meet the Contractor's production rate or for the Contractor's failure to select sufficient facilities to meet its production rate.**

The Contractor will be responsible for disposal of the entire shipment as the Hazardous Waste Generator for water that undergoes a change in waste classification due to the Contractor's work activities or processes (i.e. contaminated groundwater being classified characteristically hazardous for pH due to grouting operations).

Method of Measurement:

Within fourteen (14) calendar days after addressing the Engineer's comments on the proposed system(s) for Handling Contaminated Groundwater, the Contractor shall submit to the Engineer for approval a cost breakdown of its lump sum bid price. The submission must include substantiation showing that the cost breakdown submitted is reasonable based on the Contractor's lump sum bid. The cost breakdown shall be in accordance with the following payment schedule:

a. The cost to prepare the design for proposed system(s) for Handling Contaminated Groundwater, including preparation and submittal of all permit registration applications, in accordance with these specifications. Design costs shall not exceed 10% of the total cost of the item.

b. The procurement and installation cost for the proposed system(s) for Handling Contaminated Groundwater in accordance with these specifications. Procurement and installation costs shall not exceed 20% of the total cost of the item.

c. Equipment decontamination and demobilization and restoration of site. Decontamination and demobilization costs shall not exceed 10% of the total cost of the item.

d. The remaining costs for operation, monitoring, permit compliance, sampling and analysis, disposal costs, and maintenance of the proposed system(s), including cleaning of the temporary containment tanks of settled solids, transporting of solids to the WSA, and transportation of the contaminated dewatering wastewater to an off-site permitted treatment/disposal facility in accordance with these specifications shall be divided evenly throughout the duration of the project work involving contaminated groundwater at the discretion of the Engineer.

Increased costs directly related to the Contractor's operation (i.e. treatment or increased charges due to changes in pH or additional contaminants, treatment and disposal of excess water related to process or waste water, etc.) will not be paid under this item but will be considered a part of the Contractor's cost for the item under which the work is being performed.

Basis of Payment:

This work will be paid for at the Contract lump sum price for "Handling Contaminated Groundwater" which price shall include: all work and materials involved with handling contaminated groundwater from within GW AOECs and shall include all equipment, materials, tools and labor incidental to removal of the contaminated groundwater from the excavation; conveying contaminated groundwater from the dewatering point to the temporary containment tanks and groundwater treatment facility; treatment; conveying discharge of contaminated wastewater to a sanitary sewer, surface water or off-site disposal at a permitted treatment/disposal facility (including transportation); disposal or recycling of used treatment media (i.e. bag filters and spent carbon); permit applications; disposal and permit fees; POTW fees; electrical costs; sampling and documentation costs; laboratory costs; design and

monitoring; mobilization, operation, and maintenance of the system; site work; all required equipment decontamination; transportation of solids to the WSA; and equipment demobilization.

Sedimentation control associated with work under this Item will be paid under the appropriate items of the Contract.

Pay Item	Pay Unit
Handling Contaminated Groundwater	LS

ITEM #0216012A - CONTROLLED LOW STRENGTH MATERIAL

Description:
Controlled Low Strength Material (CLSM) is a self consolidating, rigid setting material to be used in backfills, fills, structural fills and elsewhere as indicated on the plans, or as directed by the Engineer. The flow and set time characteristics of CLSM shall be designed to meet the specific job conditions. All CLSM material covered by this specification shall be designed to be hand excavatable at any time after placement. It shall be composed of a mixture of portland cement, aggregate, and water with the option of using fly ash, slag cement, air-entraining agents, and other approved admixtures.

Materials:
All materials utilized in the CLSM mix design shall be in accordance with the applicable requirements of Article M.03.01

Composition:
The composition of the CLSM shall be in accordance with the requirements set forth in Article M.03.01-Component Materials, as well as the applicable sections of ACI 229R. The Contractor shall submit each proposed mix design, with all supporting data, to the Engineer for review and approval at least two weeks prior to its use.

The setting time of CLSM materials shall be designed so as to achieve the strength necessary to comply with the time constraints called for under the Maintenance and Protection of Traffic requirements of the project specifications. The use of chloride accelerators is not permitted.

The minimum compressive strength of the CLSM material shall be 30 pounds per square inch (psi) and the maximum compressive strength of the CLSM shall be 150 pounds per square inch (psi) when tested in accordance with ASTM D4832 after 56 days.

The CLSM mix design shall utilize a nominal maximum size of No. 8 aggregate as specified in M.01.02.

CLSM mixes shall have a minimum of 20% entrained air when tested in accordance with AASHTO T152.

Construction Methods:
CLSM shall only be placed when the ambient temperature is at least 32° F and rising. CLSM material shall be deposited within 2 hours of initial mixing.

CLSM may be placed by chutes, conveyors, buckets or pumps depending upon the application and accessibility of the site. Should voids or cavities remain after the placement of the CLSM, the Contractor shall modify the placement method or flow characteristics of the CLSM. Voids or cavities which have not been filled properly shall be corrected as directed by the Engineer and at the Contractor's expense.

Method of Measurement:
This work will be measured for payment by the actual number of cubic yards of "Controlled Low Strength Material installed and accepted within the pay limits shown on the contract plans or as directed by the Engineer.

Basis of Payment:
This work will be paid at the contract unit price per cubic yard "Controlled Low Strength Material," which price shall include all materials, equipment, tools and labor incidental thereto.

Pay Item	Pay Unit
Controlled Low Strength Material	C.Y.

ITEM #0219011A – SEDIMENT CONTROL SYSTEM AT CATCH BASIN

Description:
This work shall consist of furnishing, installing, cleaning, maintaining, replacing, and removing sediment control system at catch basins at the locations and as shown on plans and as directed by the engineer.

Materials
Sack shall be manufactured from a specially designed woven polypropylene geotextile sewn by a double needle machine, using a high strength nylon thread. Sack shall be manufactured by one of the following or an approved equal:

Siltsack®
Terrafix Geosynthetics Inc.:
Website: www.terrafixgeo.com

Dandy Sack™
Dandy Products Inc.
P.O. Box 1980
Westerville, Ohio 43086
Phone: 800-591-2284
Fax: 740-881-2791
Email: dlc@dandyproducts.com
Website: www.dandyproducts.com

FLeXstorm Inlet Filters
Inlet & Pipe Protection
24137 W. 111th St - Unit A
Naperville, IL 60564
Telephone: (866) 287-8655
Fax: (630) 355-3477

The sack will be manufactured to fit the opening of the catch basin or drop inlet. Sack will have the following features: two dump straps attached at the bottom to facilitate the emptying of sack and lifting loops as an integral part of the system to be used to lift sack from the basin. The sack shall have a restraint cord approximately halfway up the sack to keep the sides away from the catch basin walls, this cord is also a visual means of indicating when the sack should be emptied. Once the strap is covered with sediment, the sack should be emptied, cleaned and placed back into the basin.

Construction Methods:
Installation, removal, and maintenance shall be per manufacturer instructions and recommendations.

Method of Measurement:
Sediment Control System at Catch Basin will be measured as each installed, maintained, accepted, and removed. There will be no separate measurement for maintenance or replacement associated with this item.

Basis of Payment:
Sediment Control System at Catch Basin will be paid for at the contract unit price each complete in place and accepted, which price shall include all maintenance throughout construction, materials, equipment, tools, and labor incidental thereto.

Pay Item	Pay Unit
Sediment Control System at Catch Basin	EA.

ITEM #0406999A – ASPHALT ADJUSTMENT COST

Description: The Asphalt Adjustment Cost will be based on the variance in price for the performance-graded binder component of hot mix asphalt (HMA), Polymer Modified Asphalt (PMA), and Ultra-Thin Bonded Hot-Mix Asphalt mixtures completed and accepted during the Contract.

The Asphalt Price is available on the Department of Transportation website at:

http://www.ct.gov/dot/asphaltadjustment

Construction Methods:

An asphalt adjustment will be applied only if all of the following conditions are met:

I. For HMA and PMA mixtures:
   a. The HMA or PMA mixture for which the adjustment would be applied is listed as a Contract item with a pay unit of tons.
   b. ***The total quantity for all HMA and PMA mixtures in the Contract or individual purchase order (Department of Administrative Service contract awards) exceeds 1000 tons or the Project duration is greater than 6 months.***
   c. The difference between the posted *Asphalt Base Price* and *Asphalt Period Price* varies by more than $5.00 per ton.

II. For Ultra-Thin Bonded HMA mixtures:
   a. The Ultra-Thin Bonded HMA mixture for which the adjustment would be applied is listed as a Contract item.
   b. The total quantity for Ultra-Thin Bonded HMA mixture in the Contract exceeds:
      i. 800 tons if the Ultra-Thin Bonded HMA item has a pay unit of tons.
      ii. 30,000 square yards if the Ultra-Thin Bonded HMA item has a pay unit of square yards.

      Note: The quantity of Ultra-Thin Bonded HMA measured in tons shall be determined from the material documentation requirements set forth in the Ultra-Thin Bonded HMA item Special Provision.
   c. The difference between the posted *Asphalt Base Price* and *Asphalt Period Price* varies by more than $5.00 per ton.
   d. No Asphalt Adjustment Cost will be applied to the liquid emulsion that is specified as part of the Ultra-Thin Bonded HMA mixture system.

III. Regardless of the binder used in all HMA or PMA mixtures, the Asphalt Adjustment Cost will be based on PG 64-22.

The Connecticut Department of Transportation (CTDOT) will post on its website, the average per ton selling price (asphalt price) of the performance-graded binder. The average is based on the high and low selling price published in the most recent available issue of the **Asphalt Weekly Monitor®** furnished by Poten & Partners, Inc. under the "East Coast Market – New England, New Haven, Connecticut area," F.O.B. manufacturer's terminal.

The selling price furnished from the Asphalt Weekly Monitor ® is based on United States dollars per standard ton (US$/ST).

Method of Measurement:

Formula: **HMA x [PG%/100] x [(*Period Price - Base Price*)] = $ ____**

where

- **HMA:**
  1. For HMA, PMA, and Ultra-Thin Bonded HMA mixtures with pay units of tons: The quantity in tons of accepted HMA, PMA, or Ultra-Thin Bonded HMA mixture measured and accepted for payment.
  2. For Ultra-Thin Bonded HMA mixtures with pay units of square yards: The quantity of Ultra-Thin Bonded HMA mixture delivered, placed, and accepted for payment, calculated in tons as documented according to the Material Documentation provision (Construction Methods, paragraph G) of the Ultra-Thin Bonded HMA Special Provision.
- ***Asphalt Base Price***: The asphalt price posted on the CTDOT website 28 days before the actual bid opening posted.
- ***Asphalt Period Price***: The asphalt price posted on the CTDOT website during the period the HMA or PMA mixture was placed.
- **PG%:** Performance-Graded Binder percentage
  1. For HMA or PMA mixes:
     - PG% = 4.5 for HMA S1 and PMA S1
     - PG% = 5.0 for HMA S0.5 and PMA S0.5
     - PG% = 6.0 for HMA S0.375, PMA S0.375, HMA S0.25 and PMA S0.25
  2. For Ultra-Thin Bonded HMA mixes: PG% = Design % PGB (Performance Graded Binder) in the approved job mix formula, expressed as a percentage to the tenth place (e.g. 5.1%)

The asphalt adjustment cost shall not be considered as a changed condition in the Contract as result of this provision since all bidders are notified before submission of bids.

Basis of Payment: The "Asphalt Adjustment Cost" will be calculated using the formula indicated above. A payment will be made for an increase in costs. A deduction from monies due the Contractor will be made for a decrease in costs.

The sum of money shown on the Estimate and in the itemized proposal as "Estimated Cost" for this item will be considered the bid price although the adjustment will be made as described above. The estimated cost figure is not to be altered in any manner by the bidder. If the bidder should alter the amount shown, the altered figure will be disregarded and the original cost figure will be used to determine the amount of the bid for the Contract.

Pay Item	Pay Unit
Asphalt Adjustment Cost	est.

ITEM #050719XA - PRECAST CONCRETE CISTERN

Description:

This work shall consist of designing, furnishing, preparing, and installing a precast concrete cistern structure as shown on the plans and as ordered by the Engineer. This item also includes all hardware, inserts, dowels for connections, reinforcing steel and joint materials as shown on the plans.

Materials:

The materials for this work shall meet the following requirements, if applicable:

- The precast concrete cistern structure shall meet the requirements of M.08.02 and shall utilize concrete with a 28-day minimum compressive strength of 4000 psi.

- All reinforcing steel, including dowel bar mechanical connectors, shall be galvanized and shall meet the requirements of M.06.01.

- All threaded concrete inserts, lifting fixtures, and miscellaneous hardware cast into precast concrete components shall be galvanized in accordance with ASTM A153 or ASTM B695 Grade 50. All portions of the lifting and seating devices shall be recessed from the finished concrete surface.

- Non-shrink grout shall meet the requirements of M.03.05 and be suitable for submerged applications.

Construction Methods:

1. **Design:**

   (a) Design calculations for the precast concrete cistern structure shall be submitted in accordance with the requirements of Article 1.05.02. The design calculations shall be prepared, signed, sealed, and dated by a qualified Professional Engineer licensed to practice in the state of Connecticut. The furnishing of such design calculations shall not serve to relieve the Contractor of any part of the responsibility for the safety of the work or for the successful completion of the Project.

   (b) The precast concrete cistern structure shall be designed to accommodate ASCE 7 pedestrian loading as well as HS-20 AASHTO vehicle loading.

2. **Submittals:** All submittals shall include a title sheet with the following:

   - Project number, town, and location.

- Structure number, when shown on the plans.
- Design code, as applicable.
- Contact information for fabricator – contact information shall include name and address of the fabricator and the name of contact person with phone number and email address.

(a) Shop Drawings - Precast Concrete Cistern Structure: Prior to fabrication, the Contractor shall submit an individually packaged set of shop drawings for the precast concrete cistern structure to the Engineer for review, in accordance with the plans and Article 1.05.02. The shop drawing package shall include details necessary for fabrication of the structure, handling, and installation of the structure, supporting documents for all materials incorporated into the precast concrete components, and for other materials provided by the fabricator.

(b) Working Drawings - Lifting and Seating Devices: Prior to fabrication, the Contractor shall submit working drawings and supporting computations for the embedded lifting and seating devices required for the handling and installation of the precast concrete cistern structure to the Engineer for review in accordance with Article 1.05.02. Prior to applying load to the embedded devices, the concrete shall attain the minimum concrete compressive strength associated with the safe working load of the device.

(c) Working Drawings - Installation of Precast Concrete Cistern Structure: Prior to installation of the precast concrete cistern structure, the Contractor shall submit working drawings and supporting computations for the lifting and placement of the precast concrete components to the Engineer for review in accordance with Article 1.05.02. Cranes shall be operated in accordance with the Connecticut Department of Public Safety regulations. The Contractor shall be responsible for verifying the weights of the lifts. The working drawing submittal shall include, but not be limited to the following:

- Plans of the work area showing all structures, roads, railroad tracks, Federal and State regulated areas as depicted on the plans, overhead and subsurface utilities, property lines, or any other information relative to erection. No picks shall be allowed over vehicular, pedestrian, railway, or vessel traffic.
- A detailed narrative describing the lifting and installation sequences.
- Manufacture's data sheet for the crane(s) including the load/capacity chart. The capacity of the crane(s) shall be adequate for the total lift/pick loads including rigging, spreaders, and other materials. In the area of railroads and navigable waterways, the capacity shall be as required by the regulatory authorities.
- Manufacturer's data sheets and product data sheets for all rigging (slings, spreader bars, blocks, etc.), lifting devices, and other connecting equipment and hardware listing the number, type, size, arrangement, and capacity of each.
- Location of each crane for each pick.
- Crane support measures, including any support beneath the outriggers such as bearing pads, crane mats, planking or special decking, or other means to transfer the crane's total weight (including the lifted load) into the earth or structure beneath it.
- Delivery locations of each component.

- Boom length and the lift and setting radius for each pick (or maximum lift radius).
- Pick point location(s) on each component.
- Lifting weight of each component, including rigging (clamps, spreader beams, etc.).

(d) Product Data – Field Installed Materials: Prior to installation of the precast concrete components, the Contractor shall submit product data for field installed materials, such as non-shrink grout, geotextile, etc., not addressed in other submissions to the Engineer, for review in accordance with Article 1.05.02.

3. Fabrication and Manufacture: The fabrication and manufacture of the precast concrete components shall meet the requirements of Article M.08.02-4 as supplemented by the following:

(a) Reinforcing Steel: Reinforcing steel shall be fabricated and installed in accordance with Articles 6.02.03-2 through 6.02.03-5. The welding of reinforcement is not permitted.

(b) Test Cylinders: During the casting of the components, the Contractor shall cast a minimum of four 4-inch × 6-inch test cylinders in accordance with AASHTO T23 during each production run. Cylinders shall be cured under the requirements of ASTM C31 and shall be used to confirm that the concrete meets the requirements of Article M.03.02.

(c) Placing Concrete: Concrete shall not be deposited in the forms until the Contractor has inspected the reinforcing steel, including all other embedded components, and has documented such inspection.

Concrete shall not be deposited into the forms when the ambient temperature is below 40°F or above 100°F, unless adequate heating or cooling procedures have been previously approved by the Engineer. The concrete temperature shall be 60°F to 90°F at the time of placement.

Truck-mixed or transit-mixed concrete will not be allowed.

Production during the winter season, from November 15 to March 15 inclusive, will be permitted only on beds located in a completely enclosed structure of suitable size and dimension that provides a controlled atmosphere for the protection of the casting operation and the product.

Outside concreting operations will not be permitted during rainfall unless the operation is completely under cover.

The concrete shall be vibrated internally, or externally, or both, as needed to provide adequate flow and consolidation of the concrete. The vibration shall be provided in such a manner as to avoid displacement of reinforcing steel, forms, or other components. There shall be no interruption in the placement of concrete. Concrete shall be placed and vibrated

sufficiently to produce a surface free from imperfections such as honeycombing, segregation, cracking, or checking.

Any deficiencies noted in the components may be cause for rejection.

(d) Finishing: All fins, runs, or mortar shall be removed from the concrete surfaces which will remain exposed. Form marks on exposed surfaces shall be smoothed by grinding. All exposed, outside concrete surfaces shall be given a grout clean-down finish in accordance with Article 6.01.03-10.

(e) Handling and Storage: Any precast concrete components damaged during storage, transportation, or handling shall be repaired or replaced by the Contractor, at its own expense, as directed by the Engineer.

(f) Repairs: The Contractor shall submit to the Engineer, for review, any proposed methods or materials to be used in the repair of precast concrete components or defective surfaces. Precast concrete components with defective area greater than 10% as determined by the Engineer will be rejected.

4. Fabrication Tolerances: Tolerances of forming precast concrete cistern box sections shall be as follows:

(a) Internal Dimensions: The internal dimensions shall be within 1% of the design dimensions or within 1-1/2 inches, whichever is less.

(b) Roof, Floor and Wall Thickness: The roof, floor and wall thickness shall be within 1/4-inch of the thicknesses shown in the design.

(c) Laying Length of Opposite Surfaces: Variations in laying lengths of two opposite surfaces of the box section shall be less than 1/8-inch/foot of internal span up to 3/4-inch maximum.

(d) Length of Section: The length of a section shall not vary from the designed length by more than 1/2-inch in any box section.

5. Pre-assembly of Cistern Box Sections: Cistern box sections shall conform to all dimensions within tolerances specified herein. Adjacent sections shall be assembled without a gasket at the manufacturing plant to ensure that all tolerances are met prior to shipping. All sections that will be joined with mechanical connectors shall be pre-assembled, complete with fasteners, to confirm alignment. The Department shall be given at least 2 working days' notice to inspect and evaluate the sections prior to shipping.

6. Pre-Installation Site Work:

(a) Structure excavation for the precast concrete cistern shall be performed to the required depth shown on the plans.

(b) The granular fill base shall be placed on geotextile as indicated on the plans and graded to the elevation of the bottom of the proposed precast cistern, to ensure uniform foundations for the structures. Geotextile shall be the ”Separation – Medium Survivability” type and shall be selected from the Department’s Qualified Product List.

(c) Where a firm foundation is not encountered at the grades established due to unsuitable material -- such as soft, spongy, or unstable soil -- the unsuitable material shall be removed and replaced with approved granular fill, thoroughly compacted in lifts not to exceed 6 inches. The Engineer shall be notified prior to removal of the unsuitable material to determine the depth of removal necessary.

7. Installation: The installation of the precast concrete cistern box sections shall be in accordance with the plans and the following:

(a) The installation of the precast concrete cistern box sections shall proceed as required by the stage construction plans, and the special provisions entitled “Prosecution and Progress” and “Maintenance and Protection of Traffic.”

(b) All cistern box section lap joints shall be sealed with rubber gaskets and must provide a silt-tight fit. A positive means, through the use of seating devices, shall be used for pulling each section against the adjacent section to assure a silt-tight joint. The gasket shall be uniformly compressed to a minimum of 1/2 of its uncompressed width. The joint opening between adjacent seated sections on all interior surfaces of the cistern shall be uniform and match the width shown on the plans. The interior surfaces on either side of the lap joints of the adjacent seated sections shall form a smooth and continuous plane, free from irregularities.

(c) After its installation, any cistern box section, as determined by the Engineer, not acceptable in vertical or horizontal alignment for any reason, including but not limited to settlement, displacement, excess camber, or misfit, shall be removed by the Contractor and correctly installed, as directed by the Engineer and at the Contractor’s expense.

(d) The lap joints on the exterior of the roof and the interior of the floor and the lap joints on the interior and exterior of the walls shall be filled with non-shrink grout after seating the sections. The exposed portions of the lap joints within the haunches or fillets on the interior of the cistern sections shall also be filled with non-shrink grout. The non-shrink grout shall be finished smooth and flush with the adjacent concrete surface.

All portions of the lifting and seating devices that extend to or beyond the finished concrete surface shall be removed. All fixtures or holes cast into the sections for lifting or seating shall be completely filled with non-shrink grout and finished smooth and flush with the adjacent concrete surface.

The surface preparation, mixing, placing, curing, and finishing of the non-shrink grout shall follow the written instructions provided by the manufacturer of the grout. The Contractor shall furnish the Engineer with copies of the instructions.

Prior to the introduction of water over non-shrink grout, the non-shrink grout shall attain a minimum compressive strength of 3,000 psi.

(e) Geotextile shall be placed on the exterior surface of the roof and walls of the precast concrete cistern and shall be attached to the structure with silicone caulk. The geotextile shall be the "Separation – High Survivability" type and shall be selected from the Department's Qualified Product List.

(f) All inlet pipes shall be set flush with the inside face of the wall of the cistern structure as shown on the plans. The pipes shall extend through the walls for a sufficient distance beyond the outside surface to allow for satisfactory connections, and the concrete or masonry shall be constructed around them neatly to prevent leakage along their outer surfaces.

8. Erection Tolerances: The Contractor shall be responsible for ensuring the overall length of the precast cistern meets the layout requirements on the plans within all acceptable tolerances as specified in the contract.

Method of Measurement:

The work for designing, furnishing, preparing, and installing a precast concrete cistern structure as shown on the plans and as ordered by the Engineer, shall be paid on a lump sum basis and will not be measured.

The quantities of the various other Contract items entering into the completed work shall be determined in accordance with the provisions of the plans and specifications for the several items involved – structure excavation, granular fill, pervious structure backfill, temporary earth retaining structure, geotextiles, and metal grating. Only accepted work shall be included, and the dimensions used shall be those shown on the plans, except as modified by the written orders of the Engineer.

Measurement for payment for work and materials involved with installing inlet pipes to connect to the precast cistern will be as provided for under the applicable Contract drainage items in accordance with Article 6.86.04.

Basis of Payment:

Prior to beginning work, the Contractor shall submit a proposed schedule of values for review and concurrence by the Engineer.

This work will be paid for at the Contract lump sum price for "Precast Concrete Cistern", completed in place and accepted, at the location designated, which price shall include all materials -- concrete, reinforcing steel, dowel bar mechanical splicers, threaded concrete inserts, lifting fixtures, miscellaneous hardware, non-shrink grout, and geotextiles -- equipment, tools, and labor incidental for designing, furnishing, preparing, and installing a precast concrete cistern structure as shown on the plans and as ordered by the Engineer.

Structure excavation shall be paid for under the item "Structure Excavation – Earth".

Granular fill shall be paid for under the item "Granular Fill".

Pervious structure backfill shall be paid for under the item "Pervious Structure Backfill".

Geotextiles shall be paid for under the items "Geotextile (Separation – High Survivability)" and "Geotextile (Separation – Medium Survivability)".

Temporary earth retaining structure and metal grating shall be paid for under separate items.

Pay Item	**Pay Unit**
Precast Concrete Cistern	l.s.

ITEM #0601086A – 7' X 3' PRECAST CONCRETE BOX CULVERT

Description: Work under this item consists of designing, furnishing and installing a precast concrete box culvert as shown on the plans and as ordered by the Engineer. This item also includes all hardware, inserts, dowels for connections, reinforcing steel and joint materials as shown on the plans.

Materials:

- The concrete mix design shall meet the requirements of M.03.02, Class PCC05562, and shall be submitted to the Engineer.

- All reinforcing steel, including dowel bar mechanical connectors, shall be galvanized and shall meet the requirements of M.06.01.

- All threaded concrete inserts, lifting fixtures, and miscellaneous hardware cast into precast concrete components shall be galvanized in accordance with ASTM A153 or ASTM B695 Grade 50. All portions of the lifting and seating devices shall be recessed from the finished concrete surface.

- Non-shrink grout shall meet the requirements of M.03.05 and be suitable for submerged applications.

- Gaskets shall meet the requirements of ASTM D1056, C1677 or C990.

Construction Methods:

1. Design:

(a) Design calculations for the precast concrete box culvert shall be submitted in accordance with the requirements of Article 1.05.02. The design calculations shall be prepared, signed, sealed, and dated by a qualified Professional Engineer licensed to practice in the state of Connecticut. The furnishing of such design calculations shall not serve to relieve the Contractor of any part of the responsibility for the safety of the work or for the successful completion of the Project.

(b) The precast concrete box culvert shall be designed to accommodate ASCE 7 pedestrian loading as well as HS-20 AASHTO vehicle loading.

2. Submittals: All submittals shall include a title sheet with the following:

- Project number, town and crossing.
- Bridge number, when shown on the plans.
- Design code, as applicable.

- Contact information for fabricator – contact information shall include name and address of the fabricator and the name of contact person with phone number and email address.

(a) Shop Drawings - Precast Concrete Components: Prior to fabrication, the Contractor shall submit an individually packaged set of shop drawings for the precast concrete components for each precast box culvert location to the Engineer for review, in accordance with the plans and Article 1.05.02. Each shop drawing package shall include details necessary for fabrication of each unique component, handling, and installation of the precast concrete components, supporting documents for all materials incorporated into the precast concrete components and for other materials provided by the fabricator.

(b) Working Drawings - Lifting and Seating Devices: Prior to fabrication, the Contractor shall submit working drawings and supporting computations for the embedded lifting and seating devices required for the handling and installation of the precast concrete components at each box culvert location to the Engineer for review in accordance with Article 1.05.02. Prior to applying load to the embedded devices, the concrete shall attain the minimum concrete compressive strength associated with the safe working load of the device.

(c) Working Drawings - Installation of Precast Concrete Components: Prior to installation of the precast concrete components, the Contractor shall submit working drawings and supporting computations for the lifting and placement of the precast concrete components, to the Engineer for review in accordance with Article 1.05.02. Cranes shall be operated in accordance with the Connecticut Department of Public Safety regulations. The Contractor shall be responsible for verifying the weight of each lift. The working drawing submittal shall include, but not be limited to the following:

- Plan of the work area showing all structures, roads, railroad tracks, Federal and State regulated areas as depicted on the plans, overhead and subsurface utilities, property lines, or any other information relative to erection. No picks shall be allowed over vehicular, pedestrian, railway or vessel traffic.
- A detailed narrative describing the lifting and installation sequence.
- Manufacture's data sheet for the crane(s) including the load/capacity chart. The capacity of the crane shall be adequate for the total lift/pick load including rigging, spreaders and other materials. In the area of railroads and navigable waterways, the capacity shall be as required by the regulatory authorities.
- Manufacturer's data sheets and product data sheets for all rigging (slings, spreader bars, blocks, etc.), lifting devices, and other connecting equipment and hardware listing the number, type, size, arrangement and capacity of each.
- Location of each crane for each pick.
- Crane support measures, including any support beneath the outriggers such as bearing pads, crane mats, planking or special decking, or other means to transfer the crane's total weight (including the lifted load) into the earth or structure beneath it.
- Delivery location of each component.
- Boom length and the lift and setting radius for each pick (or maximum lift radius).

- Pick point location(s) on each component.
- Lifting weight of each component including rigging (clamps, spreader beams, etc.)

(d) Product Data – Field Installed Materials: Prior to installation of the precast concrete components, the Contractor shall submit product data for field installed materials, such as non-shrink grout, geotextile, etc., not addressed in other submissions to the Engineer for review in accordance with Article 1.05.02.

3. Fabrication and Manufacture: The fabrication and manufacture of the precast concrete components shall meet the requirements of Article M.08.02-4 as supplemented by the following:

(a) Reinforcing Steel: Reinforcing steel shall be fabricated and installed in accordance with Articles 6.02.03-2 through 6.02.03-5. The welding of reinforcement is not permitted.

(b) Test Cylinders: During the casting of the components, the Contractor shall cast a minimum of four 4-inch × 6-inch test cylinders in accordance with AASHTO T23 during each production run. Cylinders shall be cured under the requirements of ASTM C31 and shall be used to confirm that the concrete meets the requirements of Article M.03.02.

(c) Placing Concrete: Concrete shall not be deposited in the forms until the Contractor has inspected the reinforcing steel, including all other embedded components, and has documented such inspection.

Concrete shall not be deposited into the forms when the ambient temperature is below 40°F or above 100°F, unless adequate heating or cooling procedures have been previously approved by the Engineer. The concrete temperature shall be 60°F to 90°F at the time of placement.

Truck-mixed or transit-mixed concrete will not be allowed.

Production during the winter season, from November 15 to March 15 inclusive, will be permitted only on beds located in a completely enclosed structure of suitable size and dimension that provides a controlled atmosphere for the protection of the casting operation and the product.

Outside concreting operations will not be permitted during rainfall unless the operation is completely under cover.

The concrete shall be vibrated internally, or externally, or both, as needed to provide adequate flow and consolidation of the concrete. The vibration shall be provided in such a manner as to avoid displacement of reinforcing steel, forms, or other components. There shall be no interruption in the placement of concrete. Concrete shall be placed and vibrated sufficiently to produce a surface free from imperfections such as honeycombing, segregation, cracking, or checking.

Any deficiencies noted in the components may be cause for rejection.

(d) Finishing: All fins, runs, or mortar shall be removed from the concrete surfaces which will remain exposed. Form marks on exposed surfaces shall be smoothed by grinding. All exposed, outside concrete surfaces shall be given a grout clean-down finish in accordance with Article 6.01.03-10.

(e) Handling and Storage: Any precast concrete components damaged during storage, transportation or handling shall be repaired or replaced by the Contractor, at its own expense, as directed by the Engineer.

(f) Repairs: The Contractor shall submit to the Engineer, for review, any proposed methods or materials to be used in the repair of precast concrete components or defective surfaces. Precast concrete components with defective area greater than 10% as determined by the Engineer will be rejected.

4. Fabrication Tolerances: Tolerances of forming precast concrete box sections shall be as follows:

(a) Internal Dimensions: The internal dimensions shall be within 1% of the design dimensions or within 1-1/2 inches, whichever is less.

(b) Roof, Floor and Wall Thickness: The roof, floor and wall thickness shall be within 1/4-inch of the thicknesses shown in the design.

(c) Laying Length of Opposite Surfaces: Variations in laying lengths of two opposite surfaces of the box section shall be less than 1/8-inch/foot of internal span up to 3/4-inch maximum.

(d) Length of Section: The length of a section shall not vary from the designed length by more than 1/2-inch in any box section.

5. Pre-assembly of Box Sections: Box sections shall conform to all dimensions within tolerances specified herein. Adjacent sections shall be assembled without a gasket at the manufacturing plant to ensure that all tolerances are met prior to shipping. All sections that will be joined with mechanical connectors shall be pre-assembled, complete with fasteners, to confirm alignment. The Department shall be given at least 2 working days' notice to inspect and evaluate the sections prior to shipping.

6. Pre-Installation Site Work:

(a) Structure excavation for the precast concrete culvert shall be performed to the required depth shown on the plans.

(b) The granular fill base shall be placed on geotextile as indicated on the plans and graded to the elevation of the bottom of the proposed culvert, to ensure uniform foundations for the structure. Geotextile shall be the "Separation – Medium Survivability" type and shall be selected from the Department's Qualified Product List.

(c) Where a firm foundation is not encountered at the grades established due to unsuitable material -- such as soft, spongy, or unstable soil -- the unsuitable material shall be removed and replaced with approved granular fill, thoroughly compacted in lifts not to exceed 6 inches. The Engineer shall be notified prior to removal of the unsuitable material to determine the depth of removal necessary.

7. Installation: The installation of the precast concrete box sections and components shall be in accordance with the plans and the following:

(a) The installation of the precast concrete box sections shall proceed as required by the sequence of construction, stage construction plans, and the special provisions entitled "Prosecution and Progress" and "Maintenance and Protection of Traffic."

(b) Prior to installing the inlet and outlet end box culvert sections, a bed of non-shrink grout shall be placed on the cut-off walls. The end box culvert sections shall be connected to the cut-off wall using galvanized dowels installed in cast or drilled holes and bonded with non-shrink grout.

(c) All box culvert lap joints shall be sealed with rubber gaskets and must provide a silt-tight fit. A positive means, through the use of seating devices, shall be used for pulling each section against the adjacent section to assure a silt-tight joint. The gasket shall be uniformly compressed to a minimum of 1/2 of its uncompressed width. The joint opening between adjacent seated sections on all interior surfaces of the culvert shall be uniform and match the width shown on the plans. The interior surfaces on either side of the lap joints of the adjacent seated sections shall form a smooth and continuous plane, free from irregularities.

(d) After its installation, any box section, as determined by the Engineer, not acceptable in vertical or horizontal alignment for any reason, including but not limited to settlement, displacement, excess camber, or misfit, shall be removed by the Contractor and correctly installed, as directed by the Engineer and at the Contractor's expense.

(e) The lap joints on the exterior of the roof and the interior of the floor and the lap joints on the interior and exterior of the walls (full height on each side) shall be filled with non-shrink grout after seating the sections. The exposed portions of the lap joints within the haunches or fillets on the interior of the culvert sections shall also be filled with non-shrink grout. The non-shrink grout shall be finished smooth and flush with the adjacent concrete surface.

All portions of the lifting and seating devices that extend to or beyond the finished concrete surface shall be removed. All fixtures or holes cast into the sections for lifting or seating shall be completely filled with non-shrink grout and finished smooth and flush with the adjacent concrete surface.

The surface preparation, mixing, placing, curing, and finishing of the non-shrink grout shall follow the written instructions provided by the manufacturer of the grout. The Contractor shall furnish the Engineer with copies of the instructions.

Prior to the passage of flowing water over the with non-shrink grout, the non-shrink grout shall attain a minimum compressive strength of 3,000 psi.

(f) "Membrane Waterproofing (Cold Liquid Elastomeric)" shall be placed on the entire exterior surface of the roof, over the lap joints between the culvert sections, and extend 12 inches down the sidewalls. The membrane shall extend 12 inches to each side of the lap joint.

8. Erection Tolerances: The Contractor shall be responsible for ensuring the overall length of the box culvert meets the layout requirements on the plans within all acceptable tolerances as specified in the contract.

Method of Measurement: The work for designing, furnishing, preparing, and installing the precast concrete box culvert, as shown on the plans and as ordered by the Engineer, will not be measured for payment but will be paid for by the linear foot of precast concrete box culvert as dimensioned on the plans along each box culvert cell, completed and accepted.

The quantities of the various other Contract items entering into the completed work shall be determined in accordance with the provisions of the plans and specifications for the several items involved – structure excavation, granular fill, pervious structure backfill, temporary earth retaining structure, concrete cutoff walls, headwalls, return walls, riprap, geotextile (separation – medium survivability), and membrane waterproofing (cold liquid elastomeric). Only accepted work shall be included, and the dimensions used shall be those shown on the plans, except as modified by the written orders of the Engineer.

Basis of Payment: The work for the precast concrete box culvert will be paid for at the Contract unit price per linear foot for "7' x 3' Precast Concrete Box Culvert," completed in place and accepted, at the location designated, which price shall include all equipment, materials, tools and labor incidental to the manufacture, shipping, repair, and installation of the precast concrete box culvert of the specified size at the location shown on the plans.

Structure excavation shall be paid for under the item "Structure Excavation – Earth".

Granular fill shall be paid for under the item "Granular Fill".

Pervious structure backfill shall be paid for under the item "Pervious Structure Backfill".

Membrane waterproofing shall be paid for under the item "Membrane Waterproofing (Cold Liquid Elastomeric)".

Geotextile shall be paid for under the item "Geotextile (Separation – Medium Survivability)".

Temporary earth retaining structure, concrete cutoff walls, headwalls, return walls, and riprap shall be paid for under separate items.

Pay Item	**Pay Unit**
7' x 3' Precast Concrete Box Culvert	l.f.

ITEM #0601780A – GRAFFITI CONTROL

Description:

This item shall consist of the surface preparation and application of an anti-graffiti coating to the areas and within the limits shown on the Plans or as directed by the Engineer, and in accordance with these Specifications.

Materials:

Clear, Anti-Graffiti Sacrificial Coating:

Provide as follows:

1. At Porous and Textured Surfaces: At concrete, provide products that meet the following specifications:
    a. Form: Water-thin for spray application; white, semi-opaque liquid
    b. Specific Gravity: 0.976
    c. Weight per Gallon: 8.12 lbs.
    d. Viscosity at 77°F.: 300 cps
    e. Flash Point: > 200°F
    f. VOC: 0g/l

2. At Smooth, Dense Surfaces: At metal, provide products that meet the following specifications:
    a. Form: Thickened white Thixotropic liquid for roller or brush application
    b. Specific Gravity: 0.977
    c. Weight per Gallon: 8.13 lbs.
    d. Viscosity at 77°F.: 300 cps
    e. Flash Point: > 200°F
    f. VOC: 0g/l

Construction Methods:

Quality Control

1. Applicator: Applicator shall be certified in writing as an approved applicator by the manufacturer of the materials to be used.

2. Materials and application thereof shall meet the public health, safety, and environmental requirements of all local, state, or federal codes, regulations, and ordinances having jurisdiction.

3. Source: For each material type required for work of this Section, provide primary materials that are products of one manufacturer. Provide secondary or accessory materials that are acceptable to manufacturers of primary materials.

4. Provide materials that comply with all Federal and State requirements for Volatile Organic Compound (VOC) content.

Submittals

1. Product Data: Submit manufacturer's printed product data, specifications, application instructions, use limitations and recommendations for each material used. Provide certifications that materials and systems comply with specified requirements.

2. Submit evidence the product has been successfully tested for anti-graffiti paint protection with the paint having aged on the surface a minimum of three months prior to stripping. Verify that the test procedures were as directed and observed by the Engineer.

3. Test Reports: Provide certified reports for all specified tests.

4. Quality Assurance Submittals:

    a. Materials Certificates: For each project, signed by manufacturers.
    b. Manufacturer Certification Letter in accordance with NOTICE TO CONTRACTOR - POTENTIAL FOR ASBESTOS CONTAINING MATERIALS

Project Conditions

1. Weather: Perform work of this Section only when existing or forecasted weather conditions are within the limits established by manufacturers of the materials and products used.

    a. Materials shall be applied only when substrate surface temperature and ambient temperature is 50°F and rising. Keep materials stored between 65°F and 85°F during application. Do not apply to substrate if materials exceed 85°F in temperature.

    b. Avoid wind drift to adjacent surfaces.

    c. Divert and protect pedestrian and auto traffic adjacent to application. Remove spills and overspray immediately.

2. Substrates: Proceed with work only when substrate construction and penetration work is complete.

3. Safety: Take all precautions for applicators recommended by product manufacturer.

    a. Refer to manufacturer's product literature for complete cautionary and emergency data. Do not use near fire or extreme heat and provide proper ventilation. Applicators shall wear NIOSH/MSHA approved respirators, eye protection, and protective clothing to avoid splash to skin and eyes. Read material safety data sheets for additional safety information.

Delivery, Storage and Handling

1. Deliver materials and products in unopened, factory labeled packages. Store and handle in strict compliance with manufacturer's instructions and recommendations. Store under cover and protect from weather damage.

2. Sequence deliveries to avoid delays but minimize on-site storage.

Spare Parts

1. Furnish to the Engineer spare parts described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

    a. 1 gallon of anti-graffiti coating.

Inspection

1. Examine substrates and conditions detrimental to the proper completion of the work.

2. Do not proceed with work until unsatisfactory conditions are corrected.

Application

1. General Application Requirements: Strictly comply with manufacturer's instructions and recommendations, except where more restrictive requirements are specified in this Section.

2. Protection: Protect adjacent non-coated surfaces from coming in contact with solutions by using a strippable masking agent, plastic sheeting and waterproof tape, or another effective isolator approved by the Engineer and penetrating sealer manufacturer.

3. Surface Preparation: All caulking, patching, and joint sealants shall be installed prior to application of penetrating sacrificial coating. Masonry surfaces shall be cleaned free of dust, surface dirt, efflorescence, contaminants, and membrane curing compounds.

a. New work normally does not require cleaning; however, areas that have become heavily contaminated with surface dirt, oil, etc., during construction, shall require thorough cleaning for best performance of the sacrificial coating. Masonry surfaces shall be power washed with high pressure water and appropriate chemical cleaners to remove contaminants that may have built up. Surfaces to be treated shall be dry and absorbent to assure good penetration of the sacrificial coating.

4. Test Application: Prior to beginning primary work of this Section, provide test application mock-ups for each type of substrate material and condition to be coated at locations acceptable to Engineer and obtain Engineer's acceptance. Protect and maintain acceptable mock-ups throughout the work of this Section to serve as criteria for acceptance of this work.

    a. Provide sacrificial coating test mock-ups prior to beginning exterior production graffiti-proofing. Test various techniques and solutions to determine the best methods for the conditions encountered. Provide one 25 s.f. test application for each different method tested and for each different material that must be graffiti-proofed. Demonstrate Contractor's quality control system to ensure uniform final appearance. Test adjacent non-graffiti-proofed surfaces for possible adverse reactions to graffiti-proofing methods. Use all tested products in strict compliance with the manufacturer's instructions and recommendations. Keep accurate, detailed records of concentrations, solutions, and techniques used to assist in replicating satisfactory results.

5. Application: Penetrating graffiti-proofing shall be applied as packaged; do not dilute or alter material unless otherwise approved by manufacturer. Follow manufacturer's strict recommendations and instructions for different substrates, and for coverage rates.

Field Quality Control

1. The Contractor shall establish and maintain throughout the work of this Section an effective quality control program to ensure that work is performed as required by the Contract Documents. Establish specific procedures to prevent chemical damage of adjacent surfaces.

Method of Measurement:
This work shall be measured for payment by the number of square yards covered within the limits shown on the Plans or as ordered and accepted by the Engineer.

Basis of Payment:
This work will be paid for at the contract unit price per square yard for "Graffiti Control," complete in place, which price shall include surface preparation, application of anti-graffiti coating and all materials, equipment, tools, and labor incidental thereto.

Payment will be made under:

Pay Item	Pay Unit
Graffiti Control	S.Y.

ITEM #0601XXXA – ARCHITECTURAL CONCRETE FINISHES

Description:

This work shall consist of all labor, materials, and equipment to complete the Architectural Concrete Textured Finishes as shown on the Drawings with designated patterns and textures. Work in this section is supplementary to project cast-in-place concrete. All work shall be in accordance with the contract documents.

Materials:

A. Formliner Panels

Shall be custom manufactured 100% pure urethane form liners mold bonded to ACX plywood. Urethane form liner thicknesses as required to obtain pattern indicated. Ensure support systems required to carry all loads while maintaining all finish requirements, alignment of joints and seams, thickness of materials, location of surface in space, true to line and plane, and designed to provide for leak-proof seams between panels.

Liner types shall be a "Varied Weave Pattern" with multiple modules as shown on Drawings.

1. Formliner/facing modules shall be sized to minimize seams or joints in the finish surface and follow module variations as shown on Drawings.
2. Mating edge surfaces of form liner shall be accurately formed and fabricated so that individual alignment of panels is accurate and remains tight resulting in monolithic appearance of finish surface.
3. Anchors for fastening formliner/facing system to backup form shall be concealed, providing secure positive anchorage, use screw type fasteners of size and shape required to firmly anchor formliner to form system facing. Formliner shall be back-fastened to backup form system so that no fasteners appear in the finish concrete surface.
4. Integrate plywood or other suitable reinforcing into formliners for anchorage, back-fastening, and proper support of formliner, to prevent distortion of surfaces under loads encountered preparing and placing concrete, and to maintain shape, size, and stability of formliner.
5. Right angle edges of forms where surface to be exposed in finish concrete shall be without radius, arris or bevel, unless otherwise indicated in the Drawings. Fabricate flanges to provide accurate alignment between units, to provide uniform compressive pressure between forms, to prevent loss of fluid during concrete placement, and dimensional support for formliner.

The Contractor shall use one of the following form liner manufacturers or an approved equivalent:

- Architectural Polymers, Inc., 1220 Little Gap Road, Palmerton, PA 18071, PH: 610.824.3322, W: www.apformliner.com

- Scott System, 10777 E. 45th Avenue, Denver, CO 80239, PH: 303.373.2500, W: www.scottsystem.com
- Fitzgerald Formliners, 1500 East Chestnut Avenue, Santa Ana, CA 92701, PH: 714.245.9715, W: www.formliners.com

B. Smooth Surface Panels

Flat form surfaces shall be plastic coated material as follows:

1. Panels shall be ¾" thick, in sizes to minimize joint lines and produce required straight, uniform, square edge, level seams, construction joints and edges.
2. Pine plywood, minimum 7 plies per inch thickness. Panels shall be faced with a high-density plastic overlay (HDO).
3. Birch plywood, minimum 14 plies per inch thickness, with heavy duty plastic overlay surface on both sides. Edges shall be sealed in manufacture.

All smooth surface formwork panels shall have sealed, square edges, and have square corners. Butted edges of panels, when multiple panels are assembled together, shall not vary more than 1/16 inch in 10 ft. in any butted joint

C. Release Agents

For all formwork surfaces shall be colorless, non-staining and have no deleterious effects on the finished concrete, manufactured specifically for non-absorbent surfaces and for reducing surface voids. Formwork for custom formliners shall also be treated as directed by the custom form liner manufacturer.

D. Form Ties

Shall be manufactured specifically for use as concrete ties and shall be designed to seal tightly to the form face material without fluid loss. Ties shall be of sufficient strength to resist fluid concrete placing pressures and formwork elongation at the longest span of support used in the project. Ties shall be one of the following as approved by the Engineer:

1. Fiberglass rod tie system with screw tie clamp grippers - Gripper shall have a screw adjustable device between the rod gripper and the form contact surface. Rod size shall be minimum 3/8 in. and maximum 3/4 in. diameter as approved after use on the mockup.
2. Cone/Tube/Rod or Cone/Coil/Rod tie system with screw tie clamps - Cone size shall be maximum 1-1/2 in. diameter for coil spreader and 2 in. for tube spreader. Depth of cone shall be minimum 1-1/2 in.

All ties proposed for the work shall be used in the mockup structure for review and selection by the Engineer.

E. Joint Sealer

Seal formwork abutting edge conditions against fluid loss utilizing the following:

1. Foam gaskets for sealing field erected corner form joints shall be highly compressible foam rubber or neoprene tape, paper backed, with pressure sensitive adhesive on one side, and shall be of sufficient width and thickness for specific use.
2. Sealant for sealing permanent shop or bench fabricated unrevealed joints shall be non-staining, silicone caulking.

Large field joint gaps use aerosol applied expanding foam; type suitable for use intended. Use where form units abutting irregular materials and foam tape not sufficiently compressed or strong enough to stop fluid concrete leakage from formwork. Do not allow foam to expand into surface contact area of exposed concrete.

F. Patching Material

The patching material, technique, and match with adjacent surfaces shall be approved by the Engineer prior to any patching. Plastering and skim coating of surfaces will not be allowed.

Construction Methods:

A. General

Responsibility for the design of architectural concrete textured finishes to be in conformance with requirements of the contract documents, and as approved by the Engineer. All work shall be performed using the highest standards of quality for visual and durable concrete and shall rest with the contractor.

B. Performance Criteria

The completed formed concrete surfaces shall match the color and texture of the approved sample panels. All textured finish work shall be performed so that no evidence of the following will be evident when the formwork is removed:

1. Damage of any kind.
2. Formwork fastening penetrations or formwork anchoring devices or projections other than approved embedded items.
3. Out of alignment or incorrect profiles.
4. Discoloration caused from form liner staining.

5. If any of the above-mentioned deficiencies occur, the Engineer may order the affected concrete replaced or repaired with acceptable results. Repair only when directed by the Engineer. Corrected deficiencies must meet with the Engineer's approval. All remedial work shall be performed at a location approved by the Engineer and shall be submitted as tests prior to any repair work being accomplished.

C. Quality Assurance

The work of this section shall be performed by a concrete contractor who specializes in the type of finish work required for this project, with a minimum of five years documented successful experience and shall be performed by skilled workers thoroughly trained in the necessary trades to perform the work. Prior to commencing with the work, the contractor shall submit resumes, references, and photographs/locations of prior work examples of textured finish concrete surfaces for approval by the Engineer.

The concrete contractor shall assign a quality control person to oversee the architectural concrete textured finish work. The primary duty is to be responsible for the required execution of the work. The Concrete Quality Control Technician shall develop a check list for execution of the work and for sign off by the concrete superintendent and be submitted to the Engineer. The Quality Control Technician shall understand and be familiar with the requirements of this section.

After approval of products and samples and as early as possible, but not less than 30 days prior to the fabrication of the formwork, a pre-installation meeting shall be scheduled with the manufacturer's representative, contractor, and Engineer to discuss the materials, methods of forming, coordinating and quality control procedures involved in the Architectural Concrete Textured Finish work and the interface with related work.

The success of this Project depends greatly upon visual elements of construction that require review, selection and acceptance of samples and mockups at an early stage. Items of primary visual concern – concrete mix materials, urethane liner facing materials, concrete samples, and mockups shall be submitted as soon as possible. Verify list of priority items with the Engineer, notify Engineer of any impediments to providing priority samples.

D. Submittals

Do not proceed with the construction of the architectural concrete textured finish in the project, including fabrication of the formwork, until all samples, product data, mock-up and shop drawings have been approved by the Engineer. Contractor shall submit for approval:

1. Product Data / Qualifications for the materials specified herein, including but not limited to:

- Custom urethane form liner manufacturer; liner tolerances, anchoring methods, backing requirements
- Smooth surface panel
- Form release agent
- Form tie solution
- Joint sealers
- Concrete patching material

2. List – project names and locations of three similar past projects of the manufacturer and installer.
3. Item Samples – custom urethane form liner, joint seal material, and form ties.
4. Shop Drawings – plans, elevations, and sections to show detailed layout of all textured finish concrete work and interfacing adjacent concrete work, including the mockups. Show all flood walls and retaining walls. Include relevant liner panels, ties, depressions, openings, recesses, reveals, control joints, and construction joints. Shop drawings shall include detailed numbering and/or identification system used to positively identify urethane liner modules.
5. Construction Procedure Documents – develop and submit written procedures for the execution and sequencing of the work. These procedures shall be used by the contractor and incorporated into a Quality Control Checklist.

E. Formwork

General Requirements: Use only form units that are in like new condition and replace panels with defects with new panels. Use screw type fastening and clamping devices to maintain alignment, and to tightly close joints at corners, end forms, and at bulkheads. Apply pressure at joint to resist concrete placing pressure as close to the joint as possible. Vertical and horizontal construction joints shall be at locations approved by the Engineer and before the erection of formwork begins and shall be formed so the joint is straight, in plane and flush with the adjacent surface. Construction joints shall be at a panel joint seam and shall not interrupt the pattern of the formliner. Gaskets shall be installed in formwork corner joints and bulkheads assembled and disassembled in field. Place the gasket within the form joint. Install gasket away from contact edge 1/16 in. to 1/8 in. Clean all formwork contact surfaces prior to use. Take care in cleaning to not damage the surface. Prior to first use, all urethane liners shall be cleaned per manufacturer's recommendations.

Fabrication: Design formwork to permit easy removal. Prying against the concrete will not be permitted. Care shall be taken so as not to damage the finished concrete surface in cutting or removal of the forms. The forms shall be completely rigid and strong enough to withstand without deflection or elongation, movement or fluid loss at the high hydraulic pressures that result from the rapid filling and vibration required for architectural concrete placing. Forms

shall be fabricated so the concrete can be adequately placed, vibrated and finished to achieve the specified finishes.

Layout form ties, form joints, reveals and exposed embedments as shown on the Drawings.

1. Ties: Locate ties to fall at centers of individual weaves in the textured concrete. No ties shall fall on weave edge or liner butting seams.
2. Embedments: Numbers, wayfinding signage, and similar items are to be cast as part of the architectural concrete textured finish as shown on the Contract Drawings. Coordinate as required. Securely and accurately locate and anchor embedment's with correct orientation. Anchor using screw type fasteners to provide compression connection to prevent loss of concrete fluid or movement of embedment. Seal or gasket at interface with urethane formliner.

Smooth surfaces shall be square and flat. Protect all cut edges to avoid swelling. Install joint sealer in all fabricated butt joints of smooth surface panels to prevent fluid loss. At butting plywood panel edges place a bead of sealant 1/8" max at back edge (away from contact face) of one panel prior to butting interface edge surfaces. Take care not to allow sealant to come in contact with form surface.

Prior to use, all form surfaces shall be coated with form release agent. Only manufacturer recommended and CT DOT approved form release agents shall be utilized. Release agents shall be applied in strict accordance with release agent manufacturer recommendations. Hand-charged sprayers will only be allowed if a thin uniform coating of release agent is obtained on the form.

Wherever forms are to be refurbished and reused adjacent to or in combination with new forms or forms in like-new condition, locate the older forms so that any variation in texture or finish that might appear will be inconspicuous. Locate transition only at corners or other changes of plane.

Transitions between adjacent planes of surfaces shall be without the use of chamfers or radiused forms, unless otherwise specifically shown on the Architectural Drawings.

F. Formwork Erection Tolerances

Fabricate and position formwork surfaces to maintain hardened concrete finish lines within the following allowable variations:

- From designed edge elevation in 10 ft: +/- ¼"
- From designed vertical plane in 10 ft: +/- ¼"
- Cross-sectional dimensions: +/- ¼"
- In-place concrete finish surface to new formed finish surface: +/- ¼"

- Liner form surface to surface at butt joint: Maximum variation of urethane liner thickness – Fabricate so that liner plywood backing is tight to back-up form system.
- It is the intent of this specification that the formwork will be erected in such a manner that lines and surfaces are visually presentable without obvious defects. Where lines and planes require adjusting from one placement to another, adjust the forms to realign in a visually acceptable manner.

G. Finishes and Patching

All exposed work shall be finished with the approved finishes determined from sample tests executed in the mock-ups. Finishes shall be as specified herein where indicated on the drawings. Minor defects may require fins to be removed (i.e. top edges) or minor patching performed, however, it is the intent of this specification that the work will be performed in such a manner that only the cleaning treatments and sealer/anti-graffiti applications will be required after stripping.

Prior to treating, all surfaces shall receive the following preparation and cleanup: All surfaces to receive treatment shall be a minimum of 21 days old, or as recommended by the manufacturer. All surfaces can be treated at end of project.

- Remove all stains using an appropriate non-abrasive stain remover for each type.
- Protect all adjacent work during operations. At completion of day's work leave area clean. At completion of work, remove all equipment, waste and excess material and leave area clean.
- All treatments shall be applied to the mock-up surfaces as directed by the Engineer. Finish treatments shall be applied to the building concrete surfaces only when and as directed by the Engineer.

Treat the formed concrete surfaces with cleaning applications as determined from tests:

- "Non-acid" Treatment for concrete surfaces: After stripping, the surface shall be treated for stain removal and cleaning when directed by the Engineer.

Sealer treatment for all architectural concrete surfaces: Treat all exposed vertical wall surfaces with CT DOT approved Penetrating Type Protective Sealer per the manufacturers written instruction.

- All surfaces receiving treatment shall be dry.
- All surfaces receiving treatment shall be clean and free of stains and laitance.
- Any curing agents used to be completely dissipated prior to application of sealer so that sealer will be absorbed into the concrete. Test sealer in small area in inconspicuous

location to determine if concrete curing material has sufficiently dissipated for proper application of sealer.

Formed Square Corner Edge Treatment: After concrete is hard use a fine masons stone or fine grit sanding block on the edge to achieve an eased edge with a 1/16-inch radius. Take care not to damage the adjacent surface. This applies to two adjacent vertically formed corner surfaces and to a formed surface adjacent to a trowel finished top surface. This treatment to be done only to edges as directed by the Engineer.

Tie Hole Treatment: Finish holes for approved ties as follows:

- At cone tie holes, plug the hole with either a field cast plug using same concrete as used in the wall, or by the following method.
    - Fill the hole void with a color matching mortar and tool the hole to recess the mortar surface in the hole, depth as directed by the Engineer. Take care not to allow mortar to be in contact with the finished wall surfaces.
    - Fill the cone hole by tamping in the mortar to a dense filling and finish with a dowel type tool with limiting collar to the recess required. Smooth the recessed mortar. After finishing remove excess mortar on tape and remove the tape.
    - Where through-the-wall-tie holes occur, plug the holes with backer rod material and leave 2-inch void at end. Fill void with patching mortar as indicated above.

Patching: Only areas designated by the Engineer shall be patched. Where minor patching is required, as approved by the Engineer as a means of rendering the surface acceptable, it shall consist of patching with a texture matching technique and color matching mortar mix. Test patches shall be placed on the mock-up or other approved surface and be approved by the Engineer prior to commencing any patching of the work.

Apply all treatments in a manner that conforms to applicable environmental regulations. Provide protective materials, neutralizing materials, and supports to guide any run-off, overspray, or application to a collection point for proper removal. Protect adjacent water and ground surfaces from contamination from any deleterious substances, contaminants, liquids, or powders. Render any spills benign; remove from site and dispose of in environmentally friendly manner.

H. Protection

Protect all Architectural Concrete Textured Surfaces from damage of any kind. Pay special attention to surfaces near work of other trades. All surfaces shall be free of damage at time of acceptance. Allowing damage and patching or cleaning at end of project is not acceptable. Locate material staging areas where operations will not damage textured surfaces. Protection shall assure protection from paint, oils, rust, stains, impact, or any other kind.

Method of Measurement:

The quantity of Architectural Concrete Textured Finishes shall be measured in SQUARE FEET constructed in accordance with the plans and specifications and as directed by the Engineer.

Basis of Payment:

Payment will be made under:

Pay Item	Pay Unit
Architectural Concrete Textured Finishes (Floodwalls)	S.F.

ITEM #0601XXXA – CONCRETE FOR STRUCTURES, CLASS A-40

ITEM #0601XXXA – LIGHTWEIGHT CONCRETE IN STRUCTURES, CLASS A-40

ITEM #0601XXXA – CONCRETE FOR STRUCTURES, CLASS A

ITEM #0601XXXA – CONCRETE FOR FLOODWALL AND GATES

ITEM #0601XXXA – CONCRETE FOR UTILITY CROSSINGS AND GATE SEEPAGE WALL POURS

Description:

This section describes Concrete in Structures to be used in the floodwall, floodgate foundations, and other miscellaneous features. Concrete in Structures under this section shall refer to all concrete in structures other than concrete curb, concrete sidewalk, concrete base for pavement, and concrete pavement. Finish, color, and design shall be as specified.

Materials:

A. Concrete for deposit as a concrete structure shall comply with the requirements of Section 0601XXXA, Concrete, and be of the class, type and method of mixing specified. Coarse aggregate shall be of the type, grade, size number and nominal size specified. Rubble aggregate shall be used when specified or shown on the Contract Drawings.

   Where concrete is specified to be lightweight, the aggregate shall be in conformance with the requirements of ASTM designation C 330, Lightweight Aggregates for Structural Concrete, and the Contractor shall design the mix for a unit weight of one hundred and twenty (120) pounds per cubic foot.

B. The following concrete classes, as described in Section 0601XXXA, Concrete shall be used unless otherwise noted on the plans and details:

Element	Concrete Class
Floodwall and flood gate column/foundations	Flood protection system
Utility crossings, gate seepage wall closure pours, stabilization slabs, and other misc. features	B-32

C. Concrete reinforcement shall comply with the requirements of Section 6.02 Reinforcing Steel.

Kind of reinforcement, size and placement shall be as specified and as shown on Contract Drawings. Reinforcement shall be installed in accordance with the requirements of Section 0602XXXA Steel Reinforcement in Concrete.

D. Elastic Type Concrete Expansion Joint Sealer and Preformed Expansion Joint Filler shall comply with the requirements of Section 5.2, type as specified.

Construction Methods:

A. Submittals

(a) Concrete Mix Design

1. Concrete mix design with product and test data demonstrating compliance with Section 0601XXXA, Concrete.

2. Re-qualifications of materials or mix proportions required as a result of changes, test failures, or failure to gain initial approval for any reason.

3. Concrete mix design shall indicate strength and type of concrete; materials, type, brand and amounts of material constituents, including but not limited to cement, pozzolans, admixtures and applicable reference specifications.

(b) Certificates

1. Cement – supplier's certified mill reports for cement produced within 30 days of the project start date and every other mill report thereafter throughout the project.
2. Fly Ash – supplier's certified mill reports for fly ash produced within 60 days of the project start date and every other mill report thereafter through the project finish date.
3. Slag – supplier's mill reports for fly ash produced within 60 days of the project start date and every other mill report thereafter through the project finish date.
4. Admixtures – manufacturer's letter of certification, signed by a duly authorized manufacturer's representative, dated not less than 30 days from the project start date, and manufacturer's product data.
5. Aggregate – supplier's test reports generated within one year of the project start date showing evaluation and compliance of product in accordance with the specification requirements of ASTM C33.
6. Water – supplier's test reports generated within three months of the project start date showing evaluation and compliance of product in accordance with the specification requirements of ASTM 1602.
7. Certified test reports for field cured cylinders, as required for removal of forms.
8. Certified test reports for cores and/or load tests.
9. Manufacturers' certification of compliance with specified materials and products.

10. Mill Test Certificates for steel reinforcement.
11. Certified Test Data and reports for materials and compressive strengths of mix designs.

(c) Concrete Placement Plan

Concrete placement plan, including procedure for bending or straightening reinforcement in the field, plan for mixing, transporting, conveying, placing, finishing, and curing concrete, procedure for placement of concrete underwater, procedure for repair of defects, and mechanical splicing procedures.

(d) Shop Drawings

1. Shop Drawings and required structural computations for formwork as applicable.
2. Plans and procedures for reshoring.
3. Shop Drawings for Steel Reinforcement.
4. Locations of Construction Joints, expansion joints, and waterstops.

6. Engineer's approval of Shop Drawings shall not relieve the Contractor of the responsibility for any errors, or for furnishing materials of the proper size, quality and quantity.
7. Locations of conduit runs, pipes, and all other inserts or openings in concrete elements.
8. Record Drawings

(e) Test and Sampling Data

Provide all test and sampling data as specified herein

B. Design and Construction of Forms

(a) Forms shall accurately conform to the shape, lines and dimensions of the structure for which they are required, be substantial and sufficiently tight to prevent leakage of mortar, and have, unless otherwise specified by the Engineer, moldings or chamfer strips at angles. They shall be of adequate strength and be braced or tied together with approved ties and spacers, so as to maintain position and shape, and to ensure the safety of workmen and passersby, be clean and free from sawdust, chips, dirt, ice and other objectionable materials. Forms shall present smooth, true surfaces to the concrete placed against them, having temporary openings where necessary, to facilitate cleaning and inspection immediately before concrete is deposited. Forms shall be coated with non-staining oil before the reinforcement is placed, or be wetted except in freezing weather.

(b) Except in cases of curved, special, and exposed surfaces, the lumber for concrete forms, after being planed, shall be not less than one and one-sixteenth (1-1/16") inches in actual

thickness, shall be dressed on both surfaces, shall be tongued and grooved and shall be constructed so as to produce mortar tight joints. Plywood or other approved material shall be used on all exposed concrete surfaces, and lumber used in conjunction with it may be less than one and one-sixteenth (1-1/16") inches, if approved by the Engineer.

(c) The metal used for forms shall be of such thickness that the forms shall remain true to shape. All bolt and rivet heads shall be countersunk. Clamps, pins, or other connecting devices shall be designed to hold the forms rigidly together and to allow removal without injury to the concrete. Metal forms which do not present a smooth surface or line up properly shall not be used. Special care shall be exercised to keep metal forms free from rust, grease, or foreign matter, such as will tend to discolor the concrete.

(d) If required, the Contractor shall submit details of the forms the Contractor proposes to use to the Engineer for approval before the Contractor starts their construction.

(e) Any metal ties or anchorages which are required within the forms to hold them to correct alignment and location shall be so constructed that the metal work can be removed to a depth of at least one (1") inch from the face surface of the concrete without injury to such surface by spalling or otherwise. Wire ties shall not be used unless permitted by the Engineer. All cavities produced by the removal of metal ties shall be filled carefully with a mortar of fine aggregate and cement in the proportion that has been employed for the particular class of concrete treated and the surface left smooth and even and uniform in color.

C. Expansion Joints and Waterstops

Expansion and construction joints shall be provided of the shape, in the manner, and at the intervals required as shown on the Contract Drawings.

When concrete is to be placed against a joint filler, holes or joints in the filler shall be suitably filled with mastic to prevent mortar or concrete from entering the joint and restricting its movement. The face edges of all joints shall be carefully finished or formed true to line and elevation for a minimum distance of 2 in. back from all exposed surfaces.

When caulking compound is used to seal a joint containing premolded bituminous joint fillers, a layer of an approved type of pressure-sensitive release tape shall be placed between these materials due to incompatibility.

Waterstops shall be installed in the joints of floodwalls and esplanade walls to provide for expansion and contraction movements at joints. Place waterstop at all joints exposed to view, as shown on the Contract Drawings, or as directed by the Engineer. Waterstop shall be polyvinyl chloride or other approved flexible material, or the type indicated on the Contract

Drawings. The waterstop shall extend at least 3 inches into the concrete on each side of the joint, shall be joined continuous and watertight, and shall be carefully protected from damage until covered by concrete or backfill.

D. Conveying

(a) Loss of Ingredients
Concrete shall be conveyed rapidly from the job-mixer or transporting vehicles to the place of final deposit by approved methods which will prevent loss of ingredients.

(b) Conveyors
Concrete shall be conveyed by chutes, pipes, buckets, tremies, buggies, wheelbarrows, or other approved conveyors.

(c) Cleaning
When required, all conveyors shall be thoroughly cleaned and flushed with water which shall not fall on concrete in place.

(d) Chutes
Chutes shall be of metal or metal-lined. They shall have a slope not flatter than one vertical to two horizontal and shall deliver concrete in a practically continuous flow. Concrete shall be discharged into hoppers when the depositing is intermittent.

(e) Long Chutes
The use of long chutes is prohibited (a) generally, unless permitted under circumstances and in accordance with conditions prescribed by the Engineer, and (b) specifically, when the concrete is incorporated in structures which will be subject to saltwater action.

(f) Pipes
When concrete is conveyed through pipes, the pipes shall be kept full of concrete and have discharge ends kept buried in the fresh concrete, unless otherwise permitted.

(g) Bottom Dump Buckets
When concrete is placed by means of a bottom dump bucket, the buckets shall have a capacity of not less than one-half (1/2) cubic yard. In depositing concrete from such a bucket, the bucket shall be lowered gradually and carefully until it rests upon the concrete already placed. It shall then be raised very slowly during the discharge travel.

E. Depositing

(a) Depositing On Surfaces

Concrete shall be deposited on surfaces free from standing water, dirt, shavings, sawdust, ice or other undesirable matter. Where necessary to deposit on set concrete, the set concrete shall be roughened, cleaned, washed and freshly coated with neat cement grout. Concrete shall be deposited at points and by methods which will minimize rehandling, prevent flowing, and obviate the necessity of working along forms. In sections confined by temporary vertical bulkheads, the concrete shall be deposited in a continuous operation until the section is completed. No drop shall exceed five (5') feet. It shall be deposited by methods which will release entrapped air and produce a dense, compact mass. Concrete shall not be deposited on ground which is in a muddy or frozen condition.

(b) Depositing Under Water

For concrete to be deposited under water, the cement content shall be increased by ten (10) percent over that indicated for the class and type of concrete specified.

Concrete shall not be deposited in water if it is practicable to deposit in air. No concrete shall be deposited in water having a temperature below thirty-five (35) degrees Fahrenheit, unless permitted by the Engineer.

Concrete for deposit under water shall be conveyed by means of tremies or other approved methods.

When deposited by tremie method, the tremie shall be water-tight and sufficiently large to permit free flow of concrete. The discharge end shall be kept continuously submerged in the concrete and the shaft kept full of concrete.

(c) Depositing in Forms

Unless specifically authorized to place concrete under water, there shall be no water in the forms at any time any concrete is deposited therein, and the work of depositing shall be kept well above the level of any rising water so that there will be no danger of entrance of water into the forms until the concrete is in place.

Concrete shall be deposited in continuous horizontal layers, each of which shall be placed before the one below has set and from which laitance and excess water shall be removed in such a manner that successive layers will be thoroughly bonded together to eliminate planes of separation between layers and prevent seepage of water.

Special care shall be taken to fill each part of the forms by depositing concrete directly as near final position as possible, to work the coarser aggregates back from the face and to force the concrete under and around the reinforcement bars without displacing them.

After the concrete has taken its initial set, care shall be exercised to avoid jarring the forms or placing any strain on the ends of projecting reinforcement.

(d) Depositing in Forms for Floodwall

Concrete for the floodwall monoliths shall be placed in one continuous pour, unless shown to be staged or otherwise noted on the Contract Drawings. Vertical and horizontal construction joints shall not be permitted in the floodwall monoliths, unless approved by the Engineer. Where construction joints cannot be avoided, a waterstop shall be installed in the joint and as approved by the Engineer.

(e) Compacting Concrete

Unless otherwise permitted by the Engineer, all concrete, during and immediately after depositing, shall be compacted thoroughly by means of internal vibrators, supplemented by spades, slicing rods, forks or treading. The concrete shall be worked thoroughly around the reinforcement and around embedded fixtures and in the corners of the forms. The operation of compacting the concrete shall be conducted so as to form a compact, dense, impervious, artificial stone which shall show a smooth face on exposed surfaces. Porous, plastered, or defective concrete shall be removed and replaced as directed by the Engineer, entirely at the Contractor's expense.

Vibrators shall be of sturdy construction, adequately powered and capable of transmitting to the concrete not less than 3,000 nor more than 5,000 vibrations per minute when operating under load. The vibration shall be sufficiently intense to cause the concrete to flow or settle rapidly into place and visibly affect the concrete over a radius of at least eighteen (18") inches when used in a concrete having a one (1") inch slump.

Either electric or mechanical internal vibrators approved by the Engineer may be used. When vibrators are used, at least one vibrator for every ten (10) cubic yards of concrete placed per hour shall be in use at all times. In addition to these, at least one extra vibrator shall be at hand for emergency use.

The vibration shall be of sufficient duration to accomplish thorough compaction but shall not be prolonged to a point where segregation occurs. Internal vibrators shall be applied close enough to the forms to vibrate the surface concrete effectively, but care shall be taken to avoid hitting the forms sufficiently to damage them. In the use of the vibrators care shall be taken not to cause vibration of concrete in which initial set has taken place.

F. Concreting During Rainfall

During periods of rainfall, concrete may be placed only if permitted by the Engineer, and under conditions where the required water-cement ratio can be maintained.

The placing of concrete during wet weather will not relieve the Contractor of any responsibilities under this contract.

G. Care of Concrete During Cold Weather

Obtain approval prior to placing concrete when the ambient temperature is below 40° F or when concrete is likely to be subjected to freezing temperatures within 24 hours. During air temperatures below 38° F. in the shade, concrete in structures shall, where required, be maintained in an atmosphere of not less than 50° F., for at least five (5) days after placing or until the concrete has thoroughly hardened, and sufficient protective coverings, fuel and heating equipment shall be furnished, installed, operated and maintained to secure the required temperature conditions without injury to the concrete. Limit the rate of cooling to 37° F. in any 1 hour and 50° F. per 24 hours after heat application.

H. Surface Curing and Protection

All surfaces of concrete shall be protected from injury and horizontal surfaces shall be cured in compliance with the requirements of Section 6.01.03.

From the moneys due to the Contractor, under this item, the sum of ten (10) dollars will be deducted for each square foot of horizontal surface which the Contractor does not cure, as herein required.

I. Removal of Forms

Forms shall not be removed until the concrete has hardened sufficiently, and the removal shall be carried out in such a manner as to ensure the complete safety of the structure. In no event however shall forms be removed in less than three (3) days, unless approved by the Engineer. The Contractor shall be responsible for all damage or injury resulting from the removal of forms.

J. Surface Finish

(a) Sample Slabs

The Contractor shall, where required, submit for approval sample concrete slabs of desired sizes, exhibiting the surface finishes required that the Contractor proposes to furnish. Exposed surfaces of structures shall be finished, as required, to present appearances equal to those of samples on file in the office of the Engineer.

(b) Voids
The work of finishing shall not be started until all voids are filled with mortar of the same ingredients and proportions as used in the concrete.

(c) Float, Rubbed, and Scrubbed Finishes
Forms shall be removed as early as possible to expose concrete while it is green (set but not hardened).

Float finish surfaces shall be finished smooth and true by means of wooden or steel floats and have edges, including those of joints, rounded or chamfered.

Rubbed finished surfaces shall be thoroughly wetted, be finished smooth and true by means of carborundum or other abrasive blocks, and have lather working up on the surface removed by brushing and washing. Only water shall be used in finishing. Scrubbed finished surfaces shall have the coarse aggregate uniformly exposed by scrubbing with wire brushes and water. Muriatic acid shall, where required, be added to the water in proportion of one to five (1:5) and be entirely removed with clean water when the desired finish is obtained.

(d) Pointed and Bush-Hammered Finishes
Thoroughly cured concrete surfaces shall be dressed with tools to a uniform texture of an even face. The tools ordinarily used are electric, air, or hand tools, giving various textured surfaces such as hand-tooled, rough or fine pointed, crandalled or bush-hammered as specified.

(e) Floodwall Finish
Finish for exposed faces of the floodwall shall be as specified on the Contract Drawings.

K. Repairs

(a) General
Surface defects and tie holes shall be repaired, as specified hereinafter, within 24 hours after removal of forms, unless otherwise approved by the Engineer. Ambient air temperature, and temperature of the concrete and repair mortar shall not be lower than 50 degrees F nor higher than 90 degrees F during repair and curing.

Defects determined by Engineer to exceed surface defects (e.g., defects that extend to a depth such that reinforcing steel is exposed) shall be repaired in accordance with procedures approved by Engineer. Contractor shall submit relevant defect repair procedures.

(b) Repair of Defective Areas

All honeycombed and other defective concrete in surface defects shall be removed down to sound concrete. As required, edges shall be chipped perpendicular to the surface, or slightly undercut; no feather-edges will be permitted. The area to be patched, and an area at least six inches wide surrounding it, shall be dampened to prevent absorption of water from the patching mortar. Bonding grout, consisting of one part cement to one part fine sand (passing a No. 30 sieve) mixed to a consistency of thick cream, shall be well brushed into the surface to be patched after surface water has evaporated from the area.

Patching mixture shall be made from the same materials as the concrete; mix shall be not more than one part cement to two and one-half parts sand by damp loose volume. White portland cement shall be substituted for a part of the gray portland cement on exposed surfaces to match the surrounding concrete; color match shall be determined by a trial patch. Mixing water, for patching mixture shall be no more than necessary for handling and placing. Patching mixture shall be at the stiffest consistency that will permit placing.

Patching mixture shall be applied when the bond coat begins to lose its water sheen. Mixture shall be thoroughly consolidated into place and struck off so as to leave the patch slightly higher than the surrounding surface. Patch shall be left undisturbed for at least one hour, to permit initial shrinkage, before final finishing. Patched area shall be kept damp for seven days. Metal tools shall not be used to finish a patch in a formed surface that will be exposed.

Other materials for adhesion or patching, including latex-modified portland cement mortar and epoxy mortars and compounds, shall be subject to prior approval by Engineer and shall be used in accordance with manufacturer's recommendations.

(c) Tie Holes

Unless stainless steel, noncorrosive, or Engineer-approved coated ties are used, tie holes in surfaces not to be exposed in the finished Work shall be cleaned, thoroughly dampened, and filled solid with patching mortar. Procedures and materials for plugging tie holes in surfaces to be exposed in the finished Work shall be as approved by Engineer.

(d) Removal of Stains and Surface Deposits

Stains, rust, efflorescence, and surface deposits considered objectionable by the Engineer, shall be removed as approved by the Engineer.

Method of Measurement:

In determining the volume of concrete to be paid for, deductions will be made for the spaces occupied by drains. Deductions will not be made for the spaces occupied by steel reinforcement, structural steel or water-proofing. Other deductions will or will not be made, as specified.

Basis of Payment:

The contract price per cubic yard for Concrete for Structures, Class A-40, Lightweight Concrete in Structures, Class A-40, Concrete for Structures, Class A, Concrete for Floodwall and Gates, and Class B-32, Concrete for Utility Crossings and Gate Seepage Wall Closure Pours, measured in place, except such concrete as otherwise paid for, shall cover the cost of all labor, materials, equipment, insurance, and incidentals required to furnish and construct the concrete structure complete in full compliance with the requirements of the specifications, exclusive of steel reinforcement, and to furnish such samples for testing and to provide such testing equipment, laboratory space and facilities as may be required. All joints, waterstops, and sealants shall be included in the contract price.

The contract price per cubic yard for concrete placed underwater shall include the cost of the additional ten (10) percent of cement used for such concrete.

Payment will be made under:

Pay Item	Pay Unit
Concrete for Structures, Class A-40	C.Y.
Lightweight Concrete in Structures, Class A-40	C.Y.
Concrete for Structures, Class A	C.Y.
Concrete for Floodwall and Gates	C.Y.
Concrete for Utility Crossings and Gate Seepage Wall Pours	C.Y.

ITEM #0601XXXA – CONCRETE

Description:

This section describes Concrete for use in the floodwall, floodgate foundations, and other miscellaneous structures.

A. Concrete shall be of the classes and types shown in Table I.

Note: Based on dry-rodded volumetric measurement of ingredient materials:

High Early Strength Concrete is approximately equal to a 1 : 1-1/4 : 2-1/4 mix.

Class A-40 Concrete is approximately equal to a 1 : 1-3/4 : 2-3/4 mix.

Class B-32 Concrete is approximately equal to a 1 : 2 : 3-1/4 mix.

TABLE I

Class		Concrete Type	Type of Portland Cement Concrete
Designation	Nominal Mix		
Flood Protection System	-	Type IA Type IIA	Normal Air-entrained Moderate Sulphate Resistant Air-entrained
High-Early	7-1/2 Bag Mix	Type IIIA	Moderate Sulphate Strength Resistant Air-entrained
Class A-40	7-Bag Mix	Type IA Type IIA	Normal Air-entrained Moderate Sulphate Resistant Air-entrained
Class B-32	6-Bag Mix	Type IA Type IIA	Normal Air-entrained Moderate Sulphate Resistant Air-entrained

Note: The above proportions shown for non-High-Early mixes shall be modified by pozzolan substitutes as per Subsection below on Contractors Formula.

B. Concrete shall be mixed by the following methods:

Method A -- Central Plant Mix

Method B -- Transit Mix

Method C -- Truck Mix

Method D -- Mixed by hand or in job mixers not exceeding one-half (1/2) cubic yard capacity when permitted by the Engineer.

Central Plant Mix Concrete is concrete produced at an approved plant, ready for use prior to discharge into a transporting vehicle.

Transit Mix Concrete is concrete whose constituent materials are proportioned at a central plant and mixed with water in transit to or at the point of deposition in a transporting vehicle.

Truck Mix Concrete is concrete whose constituent materials are proportioned at a central plant and transported to the point of deposition where water is added and mixed in a transporting vehicle.

Unless otherwise specified, concrete may be mixed by Method A, Method B or Method C.

C. Class, type and method of mixing concrete shall be as specified.

Type, grade, size number and corresponding nominal size of coarse aggregate shall be as specified. Concrete shall be pigmented when specified

Materials:

Concrete shall be a homogeneous mixture consisting of cement, fine aggregate, coarse aggregate, water, and admixtures and pozzolan (when used). It shall be proportion-strength concrete whose constituent materials are proportioned in accordance with specification requirements to produce a required strength. Air-entrained concrete shall be concrete which in addition to the above shall have a specified air content resulting from the use of an admixture in the concrete.

A. Cement

Cement shall be dry, free from lumps and have a temperature less than 170 degrees Fahrenheit when used.

For concrete exposed to view, the Contractor shall not use more than one (1) brand, unless otherwise permitted.

Cement shall be measured by weight or in full bags of 94 pounds each for Portland cement.

When cement is measured by weight, it shall be weighed on a scale separate from those used for the other materials. After weighing, the entire contents of the hopper shall be completely discharged.

When the cement is measured in bags, no fractions of bags shall be used unless weighed. Bags of cement shall be taken from the place of storage and placed adjacent to the mixer, in separate piles containing the exact number of bags for each mixer charge. Each pile shall be emptied into the mixer for each charge.

B. Aggregates

Aggregates shall be measured by weight. Batch weights shall be based on saturated surface-dry materials and shall be corrected to take into account the weight of surface moisture contained in the aggregate.

When volumetric measurements are permitted, the Engineer shall require such increase in the volumes of fine and coarse aggregates as will compensate for the bulking. Only approved measuring devices shall be used.

NOTE: When aggregates are measured in the damp-loose condition (for use in Mixing Method D), they will occupy greater volume than when dry-rodded and the percentage bulking shall be determined by test. Approximate average bulking value for sand is twenty-five (25) percent and for coarse aggregate six (6) percent. Volumes may also be determined from the Contractor's approved weight formula by dividing by the damp-loose weight of aggregates per cubic foot. Average weight of damp-loose sand is 85 pounds per cubic foot and average weight of damp-loose coarse aggregate is 95 pounds per cubic foot.

C. Water

Water shall be measured by volume or by weight. The device for the measurement of the water shall be readily adjustable and, under all operating conditions, shall be accurate within one (1.0%) percent of its maximum capacity.

Water shall be potable and drawn from municipal water mains.

D. Pigmented Admixture

When pigmented concrete is specified, the concrete shall be colored with an approved pigment. The final color of the concrete shall be as approved by the Engineer. Pigments used shall not vary the air content of the concrete by more than +0.5%. The concrete mix shall be adjusted to provide that the air content of the concrete remains within the specified tolerances.

Pigmented admixture shall be measured by weight. Water present in pigment shall be taken into account in measuring the quantity of water required for each batch.

E. Pozzolans

Fly ash shall conform to the chemical and physical requirements for Mineral Admixture, Class F listed in AASHTO M 295 and shall meet the requirements of the CT Department of Transportation, Standard Specifications, Section M.03.01.3(c), Replacement Material. Any fly ash hardened by moisture will be rejected. Fly ash stored over the winter at the concrete producing plant will be retested for specification compliance by the Department or its agent.

Ground granulated blast-furnace slag (GGBFS) shall conform to the chemical and physical requirements for Grade 100 or 120 slag, as classified in AASHTO M 302, and shall meet the requirements of CT Department of Transportation, Standard Specifications, Section M.03.01.3(c), Replacement Material. Any GGBFS hardened by moisture will be rejected. GGBFS stored over the winter at the concrete producing plant will be re-tested for specification compliance by the Department or its agent.

Microsilica (Silica fume) shall conform to the standard and optional physical and chemical requirements of AASHTO M 307. Microsilica shall be used wherever increased early compressive strength, reduced permeability and increased abrasion resistance is required.

Maximum pozzolan limits shall be based on ACI 318-14, Exposure Class F3.

F. Admixtures

All admixtures shall conform to ASTM C 494. They shall contain not more than 0.05% chloride ions, and shall be used in accordance with the manufacturer's recommendations. Submit dosage charts, including the effects of concrete temperatures from 50 deg F to 90 deg F, to the Engineer.

A corrosion inhibitor admixture shall be included in the mix design for the flood protection system and marine concretes. The concentration of calcium nitrite shall be 30% +/- 2% by weight of solids per gallon. Corrosion inhibitor admixture shall not accelerate the setting time of the concrete mixture. Use a retarder and/or other admixtures to ensure that acceleration of setting time does not occur, while maintaining the applicable performance criteria.

G. Contractors Formula

All concrete mix designs shall be subject to approval by the Engineer. Before the Contractor begins to manufacture concrete, the Contractor shall secure approval of the mix design the Contractor proposes to use. The Contractor shall submit for this purpose a statement, in writing, of the sources of all ingredient materials, the type and brand of the cement, pozzolans and the number of pounds of each of the materials in a saturated surface-dry condition making up one (1) cubic yard of concrete. The calculated yield of the mix shall be within + 2% of the Theoretical one (1) cubic yard. The range of water-cement (W/C) ratios within which the concrete will be manufactured and the method of mixing to be employed shall also be stated. The mix design submittal shall include gradation of aggregates, specific gravities of ingredients, unit weight, mix proportion for each batch (a minimum of 4 batches except in case of precast plants where one specific mix may be proposed), compressive strength test results for each mix at 7 days, 28 days (high early strength mixes may require 6 hrs, 24 hrs, 3 days and shrinkage test as per the requirements), and graphical representation of strength vs. W/C projected in hours/days.

With the exception of high-early strength concrete, the Contractor shall be required to substitute Portland cement with pozzolans (Fly Ash and/or GGBFS) such that the maximum amount of Portland cement per cubic yard of concrete does not exceed 400 pounds, and with the use of an approved non-corrosive, non- chloride admixture as required to obtain a minimum compressive strength of 3,000 psi in seven (7) days. For high-early strength concrete the Contractor may substitute Portland cement with pozzolans (Fly Ash and/or GGBFS), pound for pound, up to 20% (or up to 25% for tidal/sea water spray areas) of the weight of cement specified for any concrete mixture provided the Contractor can obtain a

minimum compressive strength of 3,000 p.s.i. in three (3) days. The Contractor, immediately following but not later than eight weeks after the date of the Contractor's Notice to Proceed, shall file with the Engineer, Age-Strength data of the job mix the Contractor proposes to use for the various ambient temperatures anticipated during the period of concrete placement. This data shall be presented in both tabular and graphical form for those various ambient temperatures with a maximum setting period of seven (7) days for Class B-32 concrete or seventy-two (72) hours for High-Early Strength Concrete.

Also, for high-early strength concrete, at no additional cost, the Contractor may be allowed to use a water reducing admixture to achieve an additional one (1") inch slump, for a maximum slump of four (4") inches, to enhance workability and to help in surface finishing of the concrete. If such an admixture is used the concrete shall have a minimum compressive strength of 3,200 psi at three (3) days as determined by the average compressive strength of one set of three (3) concrete cylinders for each day's work. The Contractor shall submit the mix design for approval by the Engineer; however, such approval by the Engineer shall not relieve the Contractor of their responsibility for meeting the minimum three (3) day strength requirements specified herein, when admixtures for slump and enhanced workability have been used.

The approved mix design shall not be changed without the written permission of the Engineer.

The approval of materials shall not preclude subsequent withdrawal of such approval in case of development of qualities objectionable to the Engineer.

On receipt of new deliveries of materials during the period of the contract, the Contractor shall inform the Engineer and the Contractor shall modify the mix design as directed by the Engineer. The order to modify the mix design shall be confirmed in writing.

The relative amounts of fine and coarse aggregates in any class of concrete may be changed within the limits given in Table II by the Engineer at any time to secure maximum density and to promote workability, provided the sum of the absolute volumes of the aggregates is unchanged. Such changes shall be made when required without extra compensation, regardless of the quantity of concrete affected thereby.

H. Mix Design

(a) Unless otherwise specified elsewhere herein, concrete shall comply with the applicable requirements of Tables II through VI.

(b) Concrete of Type IA, IIA and IIIA shall have an air-entrainment of 4 to 7 percent when the coarse aggregate is 1-1/2" stone and 5 to 7 percent when the coarse aggregate is 3/4" stone, with 6.5 percent desired in either case, except for the Flood Protection System classes of concrete, which shall meet the requirements in Paragraph (f).

(c) When an air-entraining admixture is added to the concrete it shall comply with the requirements of ASTM Designation C260.

(d) Maximum water-cement ratio for concrete used in the Flood Protection System class of concrete shall be 0.40.

(e) Chloride Ion Concentration by Weight of Cementitious Material (ASTM C 1152, ASTM C 1218, ASTM C 114, ACI 222R): The acid soluble chloride ions by weight of cementitious material in the concrete mix shall be less than or equal to 0.10% for reinforced concrete and 0.08% for prestressed concrete, as per ASTM C1202. The water-soluble chloride ions by weight of cementitious material in the concrete mix shall be less than or equal to 0.08% for reinforced concrete and 0.06% for prestressed concrete, as per ASTM C1218.

(f) Air entrainment in the Flood Protection System class of concrete shall meet the requirements in Table 19.3.3.1 in ACI 318-14 for Exposure Class F3, as reproduced below.

Table 19.3.3.1—Total air content for concrete exposed to cycles of freezing and thawing

Nominal maximum aggregate size, in.	Target air content, percent	
	F1	F2 and F3
3/8	6	7.5
1/2	5.5	7
3/4	5	6
1	4.5	6
1-1/2	4.5	5.5
2	4	5
3	3.5	4.5

(g) The Upper Quality Limit, UQL, of concrete permeability for the Flood Protection class of concrete shall be 1,700 Coulombs when tested in accordance with ASTM C1202. Performance testing shall be performed at 28 days.

TABLE II – PROPORTIONS

Class of Concrete	Nominal Size of Coarse Aggregate Used (in.)	Fine Aggregate Percentage by Weight of Total Aggregate (See Note 1)
Flood Protection System	5/8 or 3/4	Note 2
High-Early Strength	5/8 or 3/4 1-1/2	29 to 37 26 to 34

Class A-40	5/8 or 3/4 1-1/2	29 to 37 26 to 34
Class B-32	3/4	32 to 40

Note 1 – Quantity of fine aggregate may be varied within the limits indicated according to the type of coarse aggregate used, to obtain a smooth, dense, homogeneous and plastic mixture.

Note 2 – Fine aggregate shall conform to ASTM C33. Percentage by weight shall be selected by the Contractor to produce a workable and durable mix design.

TABLE III - INGREDIENT MATERIALS

Applicable Sections							
Type of Concrete	Portland Cement	Pozzolans	Sand Fine Aggregates	Coarse Aggregate	Air-entraining Admixture	Pigment	Retarder
IA	2.10 Type I*	Subsection (E)	2.21 Type IA	2.02**	2.09	2.19	2.09
IIA	2.10 Type II*	Subsection (E)	2.21 Type IA	2.02**	2.09	2.19	2.09
IIIA	2.10 Type II* or III* Type IA	Subsection (E)	2.21	2.02**	2.09	2.19	2.09

* To be used with an approved air-entraining admixture, which shall be added at the time concrete ingredients are mixed with water.

** Coarse aggregate shall be Type 1, Grade A or Grade B, or Type 2, Size No. 357, Size No. 57 or Size No. 67 of ASTM Designation C 33, as specified.

TABLE IV
COMPRESSIVE STRENGTH IN LBS. PER SQ. INCH, MIN. AVERAGE OF NOT LESS THAN THREE CYLINDERS OR CORES

Concrete – Type IA, Type IIA & Type IIIA at 28 Days

Class of Concrete	Cylinders or Cores
Flood Protection System	5,000
High-Early Strength	5,000***
Class A-40	4,000
Class B-32	3,200

***Concrete shall be required to obtain a minimum of 3,200 psi compressive strength at 3 days as determined by one set (3 cylinders) of concrete cylinders for each days work.
The above date limitations concerning cores refer to the date on which the concrete represented by the cores was deposited.
No reduction in minimum compressive strength will be allowed for concrete colored with pigment or any other additives.

TABLE V
TIME STRENGTH TABLE PORTLAND CEMENT CONCRETE

When compressive strength tests are made after the standard 28-day period following placing of the concrete, the strength at 28 days shall be determined from the actual compressive strength in accordance with the following table:

Tested at Days	Divide by	Tested at Days	Divide by	Tested at Days	Divide by	Tested at Days	Divide by
28	1.000	44	1.071	60	1.120	76	1.157
29	1.005	45	1.075	61	1.122	77	1.159
30	1.010	46	1.078	62	1.125	78	1.161
31	1.014	47	1.081	63	1.127	79	1.163
32	1.019	48	1.084	64	1.129	80	1.165
33	1.023	49	1.087	65	1.132	81	1.167
34	1.027	50	1.090	66	1.134	82	1.169
35	1.032	51	1.093	67	1.136	83	1.171
36	1.036	52	1.096	68	1.139	84	1.173

Tested at Days	Divide by	Tested at Days	Divide by	Tested at Days	Divide by	Tested at Days	Divide by
37	1.040	53	1.099	69	1.141	85	1.175
38	1.045	54	1.102	70	1.143	86	1.177
39	1.049	55	1.105	71	1.146	87	1.179
40	1.053	56	1.108	72	1.148	88	1.181
41	1.058	57	1.111	73	1.150	89	1.183
42	1.062	58	1.114	74	1.152	90	1.185
43	1.066	59	1.117	75	1.155	Over 90	1.185

TABLE VI - SLUMP VALUES

Concrete Placement	Design Slump Range, Inches	Maximum Slump, Inches
Sidewalks	1-1/2 to 3-1/2	3-1/2
Pavement		
Slipform Paving	1-1/2 to 2-1/2	2-1/2
Form Paving	1-1/2 to 2-1/2	3
Pavement bases	1-1/2 to 4	4
Structural Slabs	3 to 4	4
Piers, Pedestals, Rigid Frames or Arches Box Culverts throughout, Footing and Headwalls, general purpose structural.	2-1/2 to 3-1/2	4
Cast-in-Place Piles	2-1/2 to 3-1/2	5
Stabilization slabs	6 to 7	8
High early strength pavement slabs or structural sections	2 to 3	3
Structural placement 3 inches thick or less	2-1/2 to 3-1/2	3-1/2
Slip formed median barriers, parapet walls, curbs	1/2 to 1-1/2	1-1/2
Floodwall and flood gate foundations	2-1/2 to 4	4
Esplanade and cut-off wall pile cap (Marine Structures)	2-1/2 to 4	4
Concrete Seawall Cap (Marine Structures)	2-1/2 to 4	4

NOTE: Maximum slump for pumping applications shall be 4 inches. When a slump test is conducted on concrete produced by a mobile mixing unit, the slump shall be measured 3 to 5 minutes after discharge from the unit.

The above slump requirements shall apply at the point of discharge.
The Contractor shall supply at each point of concrete delivery a slump cone and rod conforming to the requirements of ASTM Designation C143 for use by the Engineer.

Construction Methods:

A. Concrete Batching Plant Requirements

The batching plant shall be so designed, operated and coordinated as to produce a sufficient quantity of concrete for the construction specified.

(a) Acceptance

Each Portland cement concrete batching plant shall be subject to approval by the Engineer. The minimum requirement for approval is that the proposed Portland cement concrete batching plant must be on the Connecticut Department of Transportation (CTDOT) approved list for the current construction season.

The minimum requirement for approval of a pre-cast concrete plant is that the proposed plant must be on the CTDOT approved list. A waiver for this requirement may be granted for special products that no CTDOT approved plant can produce.

Each Portland cement concrete batching plant shall also be subject to auditing and approval of the Engineer which may at any time discontinue the use of any previously approved equipment if non-conformance with the specifications result during the progress of the work. When the Engineer discontinues the use of the plant, production will not be acceptable for Project work until corrective measures satisfactory to the Engineer are carried out.

(b) Bins

The plant shall contain enough aggregate storage or holding bins to produce the class of concrete specified. The bins shall have adequate separations for fine aggregate and for the various sizes of coarse aggregates.

Separate storage or holding bins shall be provided for cement of different types except that Type I or Type II may be combined in common storage. The bins shall protect the cement from rain and moisture.

Pozzolan shall be stored at the batch plant in a separate storage or holding bin and it shall be protected from rain and moisture.

(c) Weight Hoppers and Discharge Chutes

The batching plant shall include separate weight hoppers for aggregate and cement. The cement weight hopper shall be enclosed to protect the cement against moisture and to reduce escaping dust.

All discharge chutes shall be arranged so that materials will not lodge or be lost on discharge. The chutes shall not be suspended from any part of the weighing system.

Vibrators arranged so that no significant vibrations are transmitted to the scales or other plant control equipment during the weighting process.

(d) Scales

Each facility requires:

- Scales installed on or after January 2, 2003 for weighing materials shall be load cell type and shall indicate the load at all stages of the weighing operation from zero to full capacity.

- Scales shall meet the requirements of the National Institute of Standards and Technology, Handbook 44, with no less than 500 nor greater than 2000 scale divisions.
- Digital displays shall match the primary scale within one (1) division.
- The minimum resolution of digital displays shall be equivalent to or less than the minimum graduations on the primary scale.
- Digital displays shall be easily readable and located in direct sight from the operator's normal workstation.

All plant scales shall be tested at the Contractor's expense by a competent scales technician as follows:

1. Annually, prior to use for Project work.
2. At intervals of not more than 90 calendar days.
3. Whenever a plant changes location.
4. At any time ordered by the Engineer.

A cradle or test platform, approved by the Engineer, for each scale and at least 20 standard 25 pound test weights shall be provided for testing. The use of a set of tests weights for two or more plants will be permitted only when they can be made readily available within one (1) hour.
If directed by the Engineer, provisions shall be made for locking scales against tampering.

(e) Proportioning Control Equipment

The materials, including admixtures, shall be proportioned by automatic proportioning devices, approved by the Engineer unless otherwise indicated on the plans or in the proposal. The automatic proportioning equipment shall be installed in an area enclosed for protection against dust and inclement weather.

(f) Inspection Facilities

Each Portland cement concrete plant site supplying concrete for Project work shall have a building or room available for use as an office and testing facility. The facility shall be located such that the testing and inspection can be performed in a reasonable manner. The building or room shall be ventilated, lighted, and adequate heating and cooling equipment shall be provided to maintain an ambient air temperature of 70^0 F $\pm 5^0$. The facility shall contain tables, benches, shelves, running water and the necessary equipment required for testing concrete aggregates according to written instructions. A telephone or other approved means of communication shall be provided at the plant site for use. A toilet and a lavatory shall also be available at the plant site.

The following equipment is the required minimum and shall be properly installed and maintained in good operating condition:

1. A power driven coarse aggregate sieve shaker with a minimum clear sieve area of 324 Square inches and equipped with an automatic shut-off timing device. A dust cover shall be provided when the shaker is installed inside the facility. The shaker shall be anchored to a firm base.
2. A fine aggregate sieve shaker, power driven independently of the coarse aggregate shaker, for eight-inch diameter sieves and equipped with an automatic shut-off timing device.
3. An aggregate sample splitter adjustable for splitting samples ranging in maximum aggregate size from one-half inch to two inches.
4. A scale, fifty pounds minimum capacity, with maximum 0.02-pound graduations.
5. A scale, one thousand gram minimum capacity, with maximum 0.5 gram graduations.
6. A stove or hotplate suitable for sample drying.
7. A two drawer, legal size, file cabinet with lock and two keys for the exclusive use of the inspector.
8. Necessary accessory test equipment including sieves suitable for all types of aggregates to be used and sample containers.

The plant facilities for inspection personnel are the property of the Contractor or their supplier and they shall be provided and maintained in clean condition by the Contractor or their supplier during the work.

B. Handling, Measuring, and Batching

The batch plant site, layout and equipment shall be such as to assure a continuous supply of material to the work.

The aggregates shall be batched at the batch plant site according to these specifications. When approved, bagged cement may be incorporated into the mixture. The batch size shall be adjusted to use whole bags of cement.

(a) Stockpiles

Stockpiles shall be formed on bases approved by the Engineer. The bases shall have adequate drainage and may consist of prepared aggregate bases, concrete, metal or wood surfaces, or barge floors. The stockpiles shall be built by methods which do not cause particle segregation. Aggregates from different sources and of different sizes shall be stockpiled separately in a manner such that the aggregates will not be contaminated by other sizes or aggregates from other sources. Approved aggregates shall be stockpiled separately from the non-approved aggregates.

Aggregates shall be handled throughout the batching process in a manner such as to maintain uniform grading of the material. In case the aggregates contain a high or non-uniform moisture content, the aggregates shall be stockpiled a sufficient length of time to stabilize the moisture content.

Each plant shall be equipped with an approved moisture sensing device that will indicate on a readily visible scale or chart the moisture content of the fine aggregate as it is batched. The free moisture content of the fine aggregate at the time of batching shall not exceed 8 percent of its saturated-surface dry weight.

(b) Heating Materials for Cold Weather Concreting

The aggregates and/or water shall be heated prior to batching to obtain a plastic concrete temperature not less than 50^0F or more than 70^0F, at the time the mixture is placed in the forms. When the air temperature is 32^0F or above, and when the aggregates are free of ice and frozen lumps, the desired temperature of the plastic concrete may be obtained by heating the mixing water only, unless otherwise ordered by the Engineer or the Engineer's representative. When the air temperature is below 32^0F, or whenever ordered, both mixing water and aggregates shall be heated as herein specified.

All water used for mixing concrete shall be heated to a temperature of at least 70^0 Fahrenheit but not over 180^0 Fahrenheit. Aggregates shall be heated either by steam or by dry heat to a temperature of at least 40^0 Fahrenheit but not over 100^0 Fahrenheit. To avoid the possibility of flash set, when water is heated to a temperature in excess of 100^0 Fahrenheit, water and aggregate shall be mixed together in the mixer in such a way that the high temperature of the water is reduced before cement is added. The heating equipment shall be such as to heat the mass uniformly and preclude the possibility of the occurrence of hot spots which will overheat the material.

(c) Batching

All plants shall be equipped with an approved automatic weighing, cycling and monitoring system installed as part of the batching equipment, unless otherwise indicated in the specifications, on the plans or in the proposal. The system shall include equipment for accurately proportioning the various components of the mixture by weight, or by volume for admixtures and water, in the proper order and shall include equipment for controlling the cycle sequence. In addition, timing of the mixing operations for central mix plants shall be required. The automatic proportioning system shall be capable of consistently delivering each constituent within the tolerances indicated in Table VII, Batching Tolerances. The system shall be designed so that the only manual operation(s) required to produce a preprogrammed

batch within these specifications shall be a switch or button to initiate the batching sequence and discharge the completed batch.

There shall be auxiliary interlock cutoff circuits to interrupt and stop the automatic batching operations whenever an error exceeding the acceptable tolerance occurs in proportioning for all material components except water. The Engineer may require the locking or sealing of any automated proportioning equipment that may be manually manipulated.

When the aggregate sizes are weighed cumulatively, the tolerance for each bin draw weight shall be based on the total aggregate batch weight. If aggregate sizes are weighed separately, the percentage shall apply to each scale weight. When a pozzolan is weighed cumulatively with the cement, the pozzolan shall be last in the weighing sequence and the tolerance for each material draw weight shall be based upon the total weight of cement plus pozzolan. The electrical circuits used to check delivery tolerances may be set at any span within the full allowable tolerance for any approved batch size. For plants not equipped to automatically adjust tolerances, the tolerance span shall be set for the minimum approved batch size wherever varying batch sizes are being produced.

The system shall be interlocked during the batching of cement and aggregates so that:

1. No inlet gate can be opened while the weigh hopper discharge gate is open.
2. No weigh hopper discharge gate can be opened:
   (a) While the hopper is being filled.
   (b) Until the full batch weight is within the delivery tolerance.
3. No new batch can be weighed until the hopper is entirely empty of the previous batch and the scale has returned to zero.

When manual batching is permitted, the constituents shall be batched within the indicated delivery tolerances for the automatic proportioning system.

TABLE VII
BATCHING TOLERANCES

Cement & Pozzolan Aggregate	± 1% (by weight)
Water (Note 1) Admixtures	± 2% (by weight) ± 1% (by weight or volume) ± 3% (by weight or volume or ± 1 oz.(Note 3), whichever is greater)
Zero Return (Aggregate)(Note 2)	± 2%
Zero Return (Cement & Pozzolan) (Note 2)	± 1%
Zero Return (Water)(Note 1, 2)	± 1%

NOTES: 1: Tolerance applies to water added at central mix plants only.
2: Zero Tolerance is based on the minimum allowable batch size.
3: Based on the preprogrammed target quantity.

(d) Admixture Dispensing Systems

Plants shall be equipped with the number of dispensing systems necessary to incorporate the required admixtures into the concrete. At least two admixture dispensing systems shall be required for plants supplying structural concrete. These systems shall be capable of accurate measurement within the tolerance limits specified in Table VII, Batching Tolerances. The measuring devices shall be equipped with a bypass valve suitable for obtaining a calibrated sample of admixture. Admixtures shall be dispensed in a manner that shall insure uniform distribution of the material throughout the mixture within the specified mixing period. When multiple admixtures are added to the concrete, they shall not come in direct contact with each other prior to mixing. Plants equipped with automatic proportioning systems shall include an approved automatic mechanical admixture dispensing system. The dispensing system shall consist of a volumetric measuring device, interlocked with the plant automated proportioning equipment in such a manner that will positively ensure that the quantity of admixture preset into the system has been actually measured and completely discharged. The admixture system shall be interlocked with the automated system so that:

1. Aggregate and/or cement weigh hopper discharge gates cannot be opened until the preset quantity of admixture has been satisfactorily batched or discharged.
2. The recordation of the presence of admixture shall be dependent upon the completion of the admixture discharge.

All plants shall provide at the operator's normal workstation readable indication of the actual quantity of admixture batched.

(e) Recording of Batching

All concrete batching plants equipped with automatic proportion systems shall have digital recording instruments and shall be so located as to be readily accessible and readable to the operator from their normal workstation. The recording instruments shall be designed to record the quantities of each aggregate component, cement, pozzolan (when used), water (at central mix plants) and the presence of admixture for each batch of concrete produced. All records of batches shall show the batch number, the day, the month, year, and time of day to the nearest minute for each batch and they shall be imprinted on the record so that each batch may be permanently identified. The Department shall be provided with a clear and legible copy of all batch records.

Cement, pozzolan and aggregate component weights quantities shall be recorded separately. Water at central mix plants may be recorded by weight or volume.

Weights and/or volumes shall be recorded as indicated on the batching scale or meter within an accuracy of ±1 scale or meter gradation. The minimum recorder resolution shall be equivalent to or less than the minimum gradation on the scale or meter, unless otherwise approved.

When the automation system is capable of producing other than standard size batches (full, half or quarter cubic yard increments), the recordation requirements shall be in accordance with written directives from the Director of QA.

On automation systems installed on or after January 2, 1987, a clear and identifiable indication shall appear on the recordation, whenever a batch is initiated without all conditions being satisfied for fully automated production under these specifications or a system is taken out of the fully automated mode during the batching sequence.

Each plant site shall be equipped with an approved instrument capable of automatically applying a time-date stamp to each delivery ticket as the delivery vehicle departs from the plant site.

(f) Failure of Automatic Batching, Admixture Dispensing and Recording Equipment

If at any time the automatic proportioning, admixture dispensing or recording instruments become inoperative, the plant may be allowed, with the approval of the Engineer to batch and mix concrete mixtures for a period not exceeding 48 hours from the time of breakdown. Written permission of the Engineer will be required to operate without these instruments for periods longer than 48 hours.

C. Concrete Mixing, Transporting, and Discharging

(a) General

Concrete may be mixed at a central plant, in truck mixers or at the site as described in these specifications. When mixed at a central plant, the concrete shall be transported in vehicles acceptable to the CTDOT. All concrete shall be discharged from the discharge openings directly into the forms or into approved conveyance equipment while fresh and before there is evidence of initial set. No retempering of the concrete will be permitted. Retempering is defined as the addition of water after the mix has attained its desired initial slump. Temperature of the concrete mixture upon discharge shall not exceed 90° Fahrenheit.

The Contractor shall supply concrete at a rate consistent with placement operations as determined by the Engineer. The Engineer, or its representative, may discontinue the use of any type of concrete mixing or transporting units when unsatisfactory results are obtained. The requirements of this section shall apply unless otherwise stated in the specific item.

A summary of time limitations for the various types of Portland Cement concrete mixing equipment from the beginning of batching to the completion of discharge is given to Table X, Summary of Concrete Batching, Mixing, Hauling and Discharging.

(b) Concrete Uniformity

Mixing shall be performed in an approved mixer capable of combining aggregates, cement, water, and admixtures into a thoroughly mixed and uniform mass within the specified mixing period and discharging the mixture without segregation. Each mixer shall display, in a clearly visible location, a manufacturer's supplied plate(s) stating the capacity of the mixer and the recommended drum speeds for each operation.

All concrete produced shall meet the uniformity requirements in Table VIII, Concrete Uniformity. Tests shall be performed by the Department when required by the specifications or requested by the Engineer. It will not be necessary to verify that mixing equipment meets the uniformity requirement unless evidence of non-uniform concrete is found or unless the Contractor requests a reduced mixing time for central mixers. In order to obtain uniformity, the Contractor may reduce the batch size below the rated mixer capacity or reduce the mixing speed tolerance limit.

(c) Central Mixed Concrete

Central mixed concrete is defined as concrete mixed in a stationary mixer and transported in approved agitating or non-agitating units to the point of deposition. Central mixed concrete may be used for mixing all concrete mixtures unless otherwise specified on the plans or in the proposal. Batch sizes for any mixer shall be no larger than the rated capacity of the drum indicated on the manufacturer's plate.

Mixing units shall be equipped with an acceptable timing device that will not permit a batch of concrete to be discharged until the specified mixing time has elapsed. Mixing units and control devices will be disapproved if at any time they are found unfit to function properly. When the blades inside the drum have become loose, broken, bent, scalloped, or worn away 20 percent in any dimension, they shall be properly repaired or replaced.

The minimum mixing time after all materials are in the drum shall be 90 seconds, unless it can be demonstrated through tests that uniformity of the concrete meeting the requirements of Table VIII, Concrete Uniformity, can consistently be obtained at lesser time. Central mixers shall discharge the entire batch in an unrestricted manner into a hopper or directly into a delivery unit. The delivery unit shall transport the thoroughly mixed concrete to the point of use without loss of uniformity. Each delivery unit must be approved prior to use and subjected to frequent inspections during its use. If found unfit, it will be disapproved until the

proper operating condition has been restored. Both the agitating and non-agitating delivery units shall be completely emptied, clean and free from concrete and wash water before receiving the next load of concrete.

Delivery agitating units shall rotate at a drum speed of 2 to 6 revolutions per minute unless otherwise approved. Agitating units shall conform to the requirements for truck mixers under subsection (e), Truck Mixed Concrete, as they pertain to operating condition and condition of the drum. When central mixed concrete is transported in units approved for truck mixing, a minimum of 90 percent of the design water shall be added to the mix by the batch plant water system. The addition of water to obtain initial slump will be permitted at the work site in not more than two additions. After each addition, the concrete shall be mixed at least 30 revolutions in accordance with truck mix requirements before discharging.

The haul road used by non-agitating concrete delivery units shall be free from holes washboarding or any other features that would cause segregation in the mix. In addition, non-agitating concrete delivery units shall have cover, when ordered by the Engineer, to protect the concrete from adverse drying conditions and precipitation.

TABLE VIII
CONCRETE UNIFORMITY

Test	Permissible Variation concrete samples taken at two locations in the batch
1. Weight per cubic foot calculated to an Air-Free Basis	2.0 lbs. per C.F.
2. Air Content, % by volume of concrete	1.0 percent
3. Slump:	
Average slump 4 inches or less	1.0 inches
Average slump greater than 4 inches	1.5 inches
4. Coarse aggregate content, portion by weight of each sample retained on a No. 4 sieve	6.0 percent
	1.6 percent
5. Unit weight of air-free mortars based on average for all comparative samples tested	10.0 percent
6. Average compressive strength of 7 days for each sample based on average strength of all comparative test specimens	

NOTE: Samples shall be taken at the point of discharge of the concrete mixer. Sampling and testing procedures shall be as approved by the DDC's Director of Quality Assurance.

The time interval between completion of mixing at the central mix plant and completion of discharge shall be as noted in Table IX, Time Limits for Delivery of Central Mixed Concrete.

TABLE IX
TIME LIMITS FOR DELIVERY OF CENTRAL MIXED CONCRETE

Delivery Unit	Type of Placement	Maximum Time Minutes	Notes
Non-agitating including all open top units	All	30	
Agitating – rotating drum	Structural	90	1
Agitating – rotating drum	Pavement	60	1 & 2

NOTE 1. The concrete will be rejected if there is evidence of setting up in the mixer. The Engineer may reduce the total time limit in hot weather or under unusual conditions if unsatisfactory results are obtained.
NOTE 2. The Engineer may increase the allowable time to 90 minutes maximum for small or irregular sections of pavements where placing and finishing operations can be completed rapidly.

(d) Transit Mixed Concrete

Transit mixed concrete is defined as concrete mixed completely in a truck mixer; mixing may occur at the following locations or combinations thereof: at the plant, while in transit, or at the point of deposition. Transit Mix may be used for all concrete items unless otherwise specified on the plans or in the proposal.

The truck mixer shall be the inclined axis rotating drum type equipped with a water tank(s) and water system having a measuring a device to measure water (U.S. gallons) introduced into the drum within an accuracy of two percent. In addition, each truck mixer shall be equipped with a hatch in the periphery of the drum shell of such design as to permit access to the inside of the drum for inspection.

Each truck mixer used for transit mixed concrete shall be equipped with an approved electrical revolution-counting device mounted in a clearly visible position.

The device shall show on separate counters (1) the number of drum revolutions at speeds within the mixing range and (2) the total number of drum revolutions. Both counters shall be legible to one revolution and shall be designed to accept a non-standard electric plug for resetting each counter to read zero at the time of loading at the batch plant. The revolution counting device shall be tamperproof such that if tampering occurs the counters will become inoperative or the device will otherwise indicate tampering including the interruption of electric power.

The revolution counting device shall be installed to count the number of revolutions of the drum in the direction of mixing. The device shall be adjusted so that it counts the number of revolutions specified for the mixing and agitating drum speed within the tolerances indicated on the manufacturers rating plate, but not to exceed the following requirements for truck mixers:
Mixing - 6 RPM minimum to 18 RPM maximum
Agitating - 2 RPM minimum to 6 RPM maximum

These limits may be adjusted for individual mixing units upon approval of the Engineer.

Each truck mixer unit shall be inspected and approved annually. During its use, additional inspections will be made to determine the operating condition of the equipment. Whenever improper conditions exist, the truck mixer unit shall be satisfactorily repaired or replaced. This will include blades inside the drum which have become heavily caked with mortar, loose, broken, bent, scalloped, worn 20 percent in any dimension or otherwise damaged.

Truck mixers will not be permitted to mix concrete batches having volumes greater than the maximum cubic yard capacity indicated on the manufacture's rating plate(s). The drum shall be drained of wash water before charging with the constituents of the concrete mixture, and the drum shall be revolving during loading.

Approximately 90% of the design water shall be added to the mix in a manner approved by either a batch plant water system or from the water supply carried on the truck.

Mixing shall begin not more than 5 minutes after cement has made contact with the aggregates. The load shall be mixed from 70 to 100 drum revolutions and then checked for consistency. If the truck is in transit to the project, the mixer speed shall be changed to agitating speed after 70 to 100 mixing revolutions. Under no circumstances shall the mixer drum be stopped.

Water may be added to the mixture in not more than two additions at the point of deposition before discharge to obtain initial slump. After each such addition the concrete shall be mixed at least 30 revolutions in the mixing speed range. The total number of revolutions in the mixing range shall not be less than 100 nor more than 160.

After completion of mixing, discharging may begin immediately, otherwise the mixer shall be revolved at agitating speed. Once discharge has commenced, the entire load shall be discharged in not more than 50 minutes.

Concrete shall be discharged through a completely opened discharge gate providing unrestricted flow. The discharge area or gate shall remain fully open throughout the discharge period and the rate of discharge shall be controlled by the speed of the drum.

The total time interval from the moment the cement makes contact with the aggregates to the completion of discharge shall not exceed 90 minutes for structural concrete placements and 60 minutes for pavement concrete placements. The Engineer may increase the allowable time for pavement placements to 90 minutes maximum for small or irregular sections where placing and finishing operations can be completed rapidly. The Assistant Commissioner, Construction or their representative may reduce the total time limit in hot weather or under unusual conditions, if unsatisfactory results are obtained.

(e) Truck Mixed Concrete

Truck mixed concrete is defined as concrete mixed completely in a truck mixer following the addition of mixing water at the point of deposition. The requirements of Subsection (d), Transit Mixed Concrete, apply except as modified:

1. Each truck mixer shall have an approved revolution counter located in a position readily visible to the Engineer. The electrical revolution counting device will not be required but it may be used to count the number of revolutions of the drum in the direction of mixing.
2. The loading of the mixers shall be performed in the following manner:
    a. Regular Truck Mix (cement in contact with moist aggregates). The drum many be rocked or revolved during the charging of coarse and/or fine aggregates with admixtures. Cement shall be charged last and the drum shall be stationary until mixing begins. Mixing shall begin no longer than 30 minutes after cement comes in contact with the aggregate.
    b. Layered Truck Mix (cement in contact with saturated surface dry or drier coarse aggregate). Fine aggregate with admixtures, coarse aggregate and cement that have been separately batched shall be charged through a hatch in the side of the drum in the following sequence: fine aggregate with admixtures, coarse aggregate and then cement. The drum may be rocked after the addition of each aggregate size and shall remain stationary while charging the cement and until mixing begins. Mixing shall begin no longer than 90 minutes after cement comes in contact with the coarse aggregate.
3. Mixing shall begin at the point of deposition after the addition of water. The water shall be introduced into the drum either from the head section or by dual injection from both the head and discharge section. The mixing shall continue for a minimum of 100 revolutions or until uniform concrete of the required consistency is produced whichever is longer. The mixing period shall not exceed 15 minutes.
4. The entire load shall be discharged within 30 minutes after mixing has been completed.

TABLE X
SUMMARY OF CONCRETE BATCHING, MIXING, HAULING AND DISCHARGING

Central Mixed Concrete	Transit Mixed Concrete	Truck Mixing Concrete	
	Requires electric revolution counting device		
Begin Batching Charge mixer in an approved manner	Begin Batching Materials batch loaded or ribbon loaded thru back	Regular Truck Mix Begin Batching Drum can be rocked or revolved for aggregates	Layered Truck Mix Begin Batching Fine agg. and SSD coarse agg. is loaded thru hatch. Can rock after each fraction
	Add approximately 90% of design water	Drum cannot be moved while cement is added	Drum cannot be moved while cement is added
End of Batching & Begin Mixing 90 Seconds Minimum After all material are in the mixer	Cement In Contact W/Aggs. 5 Minutes Maximum	Cement In Contact W/Aggs. 30 Minutes Maximum	Cement In Contact W/Aggs. 90 Minutes Maximum
	Beginning of Mixing At plant or in transit 100 revs Minimum 160 revs Maximum Mix: 6-18 rpm	Beginning of Mixing At project, after the addition of water 100 revs Minimum 15 Minutes Maximum Mix: 6-18 rpm	Beginning of Mixing At project, after the addition of water 100 revs Minimum 15 Minutes Maximum Mix: 6-18 rpm
End of Mixing Open Haul Units Rotating Drum Agitators 2-6 rpm 30 Minutes Maximum (Pav't) 60 Mins. Max. 90 Mins. Max. (Struct.)	End of Mixing Agitate 2-6 rpm Beginning of Discharge 50 Minutes Maximum	End of Mixing 30 Minutes Agitate 2-6 rpm Maximum	End of Mixing 30 Minutes Agitate 2-6 rpm Maximum
Completion of Discharge When concrete is transported in units approved for mixing, the remainder of the design water may be added at the work site to attain initial slump.	Completion of Discharge The remainder of the design water may be added at the work site to attain initial slump.	Completion of Discharge	Completion of Discharge

(f) Mobile Concrete Mixing Units

A mobile concrete mixing unit, as approved by the Engineer, may be used in miscellaneous work defined as curb, gutter, headwalls, catch basins, manholes, drop inlets, field inlets, sign foundations, lighting structure foundations, anchor units, pullboxes, leveling footings and similar placements.

Each mobile mixing unit shall be self-contained and of the continuous mixing type, capable of carrying sufficient unmixed dry bulk cement, fine and coarse aggregate, water and admixtures to produce on site no less than six (6) cubic yards of concrete.

The mobile mixing unit shall be equipped with proportioning devices which shall deliver the materials within the following tolerances by weight:

Cement	0 to + 4%
Fine Aggregate	± 2%
Coarse Aggregate	± 2%
Water	± 1%
Admixtures	± 3%

The amount of cement being introduced into the mix shall be measured by a meter which is clearly visible and kept clean at all times. The quantity of cement shall be recorded by a ticket printer which shall, as a minimum, record the number of revolution counts of the cement feeder.

The mixers shall provide positive control of the flow of water into the mixing chamber. Water flow shall be indicated by a flow meter and be readily adjustable to provide for minor variations in aggregate moisture. The system shall be equipped with a bypass valve or hose suitable to determine batching accuracy.

The mixers shall be equipped with at least one admixture delivery system. Each system shall provide positive control of the flow of admixture into the unit's mix water system. Flowmeters shall be used to control the amount of admixture added to the mix. Admixtures shall be dispensed in a manner that shall ensure uniform distribution of the material throughout the concrete. The system shall be capable of adding admixture in the amounts necessary to achieve the required air content. The system shall be equipped with a bypass valve suitable for obtaining a calibrated sample of admixture to determine batching accuracy. The mixers shall be capable of combining aggregates, cement, water and admixture into a thoroughly mixed and uniform mass. Discharge of the mixture shall be accomplished without segregation.

When mobile mixing units are permitted, no specific mixing time will be required except that the concrete shall be properly and uniformly mixed as determined by the Engineer. All the constituents of concrete manufactured by a mobile mixing unit shall be stockpiled at the project site unless otherwise approved by the Engineer.

The Contractor shall calibrate the mobile mixing unit and shall provide a record of the calibration of the unit to the Engineer for the mix design to be used. The Engineer will furnish the mix design information and the written calibration procedure to the Contractor. The Department reserves the right to witness the calibration of the mixing unit.

Prior to actual use, the Contractor shall demonstrate, to the Engineer, that the concrete meets the specification requirements for slump, air content and proportioning.

If, in the opinion of the Engineer, improper conditions exist, the conditions shall be corrected as approved by the Engineer. Improper conditions shall include, but not be limited to, hydrated cement deposits and mixing blades which are loose, broken, bent, scalloped, worn 20 percent in any dimension, or heavily caked with mortar.

If the Engineer determines that the mixer unit is not performing satisfactorily, the Engineer may discontinue use of the unit. The Contractor shall provide the necessary scales, containers and personnel approved by the Engineer to perform calibration of the unit.

(g) Small Construction Mixers

In work involving small quantities of concrete, the Engineer may permit a small construction mixer. The mixer shall be capable of producing concrete having the specified slump and air content. Any concrete placed under such conditions shall be mixed no less than 90 seconds after all the materials are in the mixer drum.

The use of a small construction mixer shall not be permitted for the flood protection system and marine structures.

D. Temperature of Concrete

The concrete at the time of pouring shall be maintained at a temperature of not less than 50^{o} F nor more than 90^{o} F.

When the air temperature exceeds 85^{o} F, the concrete subsequent to initial set shall be protected for three (3) days after pouring so as to prevent it from going above 90^{o} F.

When the air temperature is less than 38^{o} F in the shade the Contractor may submit, to the Engineer for approval, proposed methods for placing and protecting concrete in the cold. At

such temperatures concrete shall be poured only with the approval of the Engineer and shall be adequately protected.

If the air temperature falls below 50^{o} F, an accelerator may be used. If the air temperature exceeds 85^{o} F, a retarder may be used. Accelerators and retarders must be approved by the Engineer before use.

Method of Measurement:

No separate or additional payment will be made for compliance with the requirements of this Section.

Basis of Payment:

No separate or additional payment will be made for compliance with the requirements of this Section.

ITEM #0601XXXA – SLEEVED UTILITY CROSSING

Description:

This section describes the furnishing, delivering, and installing of utility crossing penetration seals including PVC sleeves and anchor/water stop plates for small utility conduits.

Materials:

All utility crossing penetration seals including PVC sleeves and anchor/water stop plates shall be in accordance with [to be determined].

Construction Methods:

All utility crossing penetration seals including PVC sleeves and anchor/water stop plates shall be installed in accordance with [to be determined].

Method of Measurement:

The quantity of utility crossing penetration seals including PVC sleeves and anchor/water stop plates measured for payment shall be the number of each size utility crossing penetration seal including PVC sleeve and anchor/water stop plate furnished, delivered, and installed by the Contractor.

Basis of Payment:

The contract price for sleeves and sealing of utilities and utility conduits shall be the unit price bid per each utility crossing penetration seal including PVC sleeve and anchor/water stop plate furnished, delivered, and installed. The unit cost shall cover the cost of all labor, equipment, materials, plant, samples, tests, and insurance required and necessary to furnish, deliver and install the penetration seals including PVC sleeves and anchor/water stop plates in the manner specified herein and as directed by the Engineer.

Payment will be made under:

Pay Item	Pay Unit
Sleeved Utility Crossing	Each

ITEM #0601XXXA – WATERSTOP

Description:

This section describes non-metallic waterstops embedded in concrete for spanning control, expansion, and/or construction joints. Waterstops may be subjected to chlorinated water, seawater, and many waterborne chemicals.

Materials:

The waterstop shall be flexible PVC (polyvinyl chloride) unless otherwise approved by the Engineer. The PVC waterstop shall be extruded from an elastomeric plastic material of which the basic resin is prime virgin polyvinyl chloride. The PVC compound shall not contain any scrapped or reclaimed material or pigment.

Submit manufacturer's data sheet on waterstop materials and splices.

Performance requirements as follows:

Property	Test Method	Required Limits
Water absorption	ASTM D570	0.15% max
Tear resistance	ASTM D624	300 lb/in (52.5 kN/m) min.
Ultimate Elongation	ASTM D638	350% min.
Tensile Strength	ASTM D638	2000 psi (13.78 Mpa) min.
Low Temperature	ASTM D746	No Failure @ -35°F (-37°C)
Stiffness in Flexure	ASTM D747	1000 psi (4.82 Mpa) min.
Specific Gravity	ASTM D792	1.38 max.
Hardness, Shore A	ASTM D2240	79 ± 3
Tensile Strength after accelerated extraction	CRD-C 572*	1600 psi (9.54 Mpa) min.
Elongation after accelerated extraction	CRD-C 572*	300% min.

Property	Test Method	Required Limits
Effect of Alkalies after 7 days: Weight Change, Hardness Change	CRD-C 572*	Between -0.10% / +0.25% ± 5 points

*Corps of Engineers: CRD-C 572-74

Accessories shall include:

- Factory-made fabrications for changes of direction, intersections, and transitions leaving only straight butt joint splices for the field.
- Teflon coated thermostatically controlled waterstop welding irons for field butt splices.

Waterstop shall have grommets, pre-punched holes, or hog rings (installed by others) spaced at 12 inches on center along length of waterstop.

Construction Methods:

A. Storage

Waterstops shall be stored under tarps to protect from oil, dirt, and sunlight.

B. Installation

Provide waterstops in construction joints as indicated on drawings.

Install formwork to accommodate waterstop materials. Locate waterstops in joints where indicated in Contract Documents. Minimize number of splices in waterstop. Splice waterstops in accordance with manufacturer's written instructions. Install factory-manufactured premolded mitered corners and compound joints that requires fusing of different waterstop types (U type and three bulb waterstops).

Install waterstops to form a continuous diaphragm in each joint. Make adequate provisions to support and protect waterstops during progress of work. Protect waterstops protruding from joints from damage.

Field butt splices shall be heat fused welded using a Teflon coated thermostatically controlled waterstop welding iron at approximately 380 degrees F. Reform waterstops at splices with a remolding iron with ribs or corrugations to match the pattern of the waterstop. The spliced area, when cooled, must show no signs of separation, holes, or other imperfections when bent by hand in as sharp an angle as possible. Follow approved

waterstop manufacturer recommendations. Lapping of waterstop, use of adhesives, or solvents shall not be allowed.

Center waterstop in joint and secure waterstop in correct position using grommets, pre-punched holes, or hog rings (installed by others) spaced at 12 inches on center along the length of the waterstop and wire tie to adjacent reinforcing steel.

C. Field Quality Control

Waterstop splicing defects which are unacceptable include, but are not limited to the following:

- Tensile strength less than 80 percent of parent section.
- Misalignment of centerbulb greater than 1/16 inch.
- Bond failure at joint deeper than 1/16 inch or 15 percent of material thickness.
- Misalignment that reduces waterstop cross section more than 15 percent.
- Visible porosity in the weld.
- Bubbles or inadequate bonding.
- Visible signs of splice separation when cooled splice is bent by hand at a sharp angle.
- Charred or burnt material.

Method of Measurement:

The quantity of Waterstop to be measured for payment shall be the number of linear feet computed between the limits shown on the Contract Drawings or within the limits established in writing by the Engineer prior to performing the work. No quantity will be included for material used for repair of defects.

Basis of Payment:

The unit price bid per linear foot for this item shall include the cost of furnishing all labor, materials, plant, equipment, insurance, samples, and incidentals necessary to complete the work in accordance with the Contract Drawings, the specifications, and the directions of the Engineer.

Payment will be made under:

Pay Item	Pay Unit
Waterstop	L.F.

ITEM #0602XXXA – STEEL REINFORCEMENT IN CONCRETE

Description:

This section describes installation of Steel Reinforcement in Concrete. Steel Reinforcement for Concrete shall be of steel bars or welded steel wire fabric used in the floodwall, floodgate foundations, and associated structures as specified and shown on the Contract Drawings.

Materials:

A. Steel reinforcement shall comply with the requirements of CTDOT Standard Specification Section 6.02, Reinforcing Steel.

(a) Reinforcing bars must be deformed, except spirals, load-transfer dowels, and welded wire reinforcement, which may be plain.
(b) ASTM A615/A615M with the bars marked S, Grade 60.
(c) Submit mill certificates for reinforcing bars.

B. Steel reinforcement shall be epoxy-coated in accordance with ASTM A775 for steel bars and ASTM A884 for welded wire fabric, unless otherwise noted.

C. Size and placement shall be as specified and as shown on the Contract Drawings.

D. Dowel and anchor bars, if required, shall be of a type, size and placement as specified and as shown on the Contract Drawings. The type of filler material used for anchoring shall be as specified on the Contract Drawings.

E. Shop drawings of reinforcing steel showing the location and type of supports and tie wires shall be submitted to the Engineer for approval before any work covered by these drawings is undertaken.

F. Taper threaded terminators must be positive-locking taper threaded type anchors meeting ASTM A615 Grade 60, and ASTM A970 Class HA. Threading must be done using equipment approved by the terminator manufacturer. Terminators must be installed per the manufacturer's written requirements.

Construction Methods:

A. Fabrication and Protection

Steel reinforcement bars shall be delivered in bundles or fabricated mats and shall have the manufacturer and size of steel identified by attached metal tags when one-quarter (1/4") inch or less in size and by rolled raised symbols or letters when greater than one-quarter (1/4")

inch, or by other means acceptable to the Engineer. Where reinforcement bars are delivered in bundles, they shall be securely wired. Bars shall be identified with heat number marked on attached tag.

Bar mats shall have bars of the size and spacing required and be made up in sections of the length and width required. They shall be fastened together in an approved manner at each intersection.

Reinforcement bars shall be protected at all times from mechanical injuries and from the weather and, when placed in the work, shall be free from injurious dirt, defects, paint and oil, and have a workmanlike finish. Bars which will remain exposed for some time after being placed in the work shall, if directed, be immediately coated with thin grout composed of equal parts of cement and sand.

Steel wire fabric shall be protected from moisture, and, when placed in the work, shall be free from grease, injurious rust, dirt, or other foreign substances.

B. Bending Bars

Reinforcement bars shall be bent cold to the exact shapes shown on the Contract Drawings and, if required, in conformity with approved templates. Bars having kinks or bends not shown on the plan will be rejected.

C. Splices and Laps

Reinforcement bars under flexural stress shall be of the full lengths required, or if permitted, be spliced with approved clamps or other approved devices which will transfer the full working stress of the bar. Reinforcement bars under temperature and shrinkage stresses shall be as long as can be conveniently used. Where necessary, laps shall be as directed. Laps shall be not less than forty (40) times the nominal diameter of the bars. Splices and laps shall be staggered. The distance between splices and laps and adjacent bars, and the distance between a splice or lap and the exposed surface of concrete shall be not less than two (2”) inches, or as shown on the plan.

Welded steel wire fabric shall have transverse or longitudinal end members overlapping each other by not less than a full mesh length or width, respectively. Overlapping sheets shall be securely and properly fastened together.

D. Supports

Steel reinforcement shall be supported at the specified depth in such a manner that no displacement will occur during concreting operations. It shall be supported either on approved devices or upon a layer of concrete which has been evenly struck off. The method of supporting the steel at the proper elevation shall be as approved by the Engineer. Bar supports shall be non-conductive material or plastic bar supports.

E. Placing

Submit placing drawings showing fabrication dimensions and placement locations of reinforcement and reinforcement supports. Placing drawings must indicate locations of splices, lengths of lap splices, and details of mechanical and welded splices.

Reinforcement bars shall be placed, spaced, securely fastened together, and held in their positions in an approved manner until the concrete is placed around them.

Steel wire fabric shall be laid in sheets which shall be straight and true to form and shall be securely held in position by approved methods so that they will be in their prescribed position after the concrete has been thoroughly compacted.

No concrete shall be deposited until the Engineer has inspected the placing of the reinforcing steel and has given permission to place the concrete. All concrete placed in violation of this provision will be rejected and removed at the Contractor's own expense.

F. Epoxy Coating Repairs

Repair sheared and cut ends and damaged coating with an epoxy patching material conforming to ASTM A775 (AASHTO M284) in accordance with the patching material manufacturer's recommendations.

G. Mechanical Anchors

Reinforcing bar anchorage in the form of taper-threaded terminators shall be provided for pile plugs at the locations indicated on the Contract Drawings, and as directed by the Engineer. The terminators shall be installed on-site, prior to placement of the cast-in-place concrete pile plugs. The taper-threaded terminators shall be of the size indicated on the Contract Drawings.

Method of Measurement:

The weight of steel reinforcement bars to be paid for will be that of all reinforcement bars incorporated in the work, as required, which shall be computed from theoretical lengths and weights of bars.

The weight of steel wire fabric to be paid for will be that of all material incorporated in the work, as required, which shall be computed from the theoretical lengths, widths, and weights.

The number of epoxy-coated anchor rods to be paid for will be inclusive of all drilling, specified length of reinforcement bars, and filler material incorporated into the work as required.

Basis of Payment:

The contract price per pound for Epoxy-Coated Steel Reinforcement shall cover the cost of all labor, materials, equipment, insurance, and incidentals required to furnish and install coated reinforcement complete in place in full compliance with the requirements of the specifications, and to furnish such samples for test as may be required.

The contract price per Epoxy-Coated Anchor Rod shall cover the cost of all labor, materials, equipment, insurance, and incidentals required to furnish and install the anchor rod, along with any filler materials, in place and in full compliance with the requirements of the specifications.

Payment will be made under:

Pay Item	Pay Unit
Epoxy-Coated Steel Reinforcement	LBS.
Epoxy-Coated Anchor Rod	Each

ITEM #0603XXXA – FABRICATED STEEL FLOODGATES

Description:

This specification covers the requirements for furnishing all plant, equipment, labor, and materials for fabricating, assembling, delivering, and installing closure gates in accordance with these specifications and applicable drawings.

(1) Swing Gate

This type of closure gate for flood protection constitutes a fabricated metal panel which sits on a concrete slab mounted hinge on one end and is connected with a hinge at the top on the same end. The other cantilevered end is free to move as the gates pivot around the axis through the hinges. During non-flood condition, the gate is usually kept swung open. The free end of the gate is usually supported with a hydraulic jack and is latched to a storage monolith (wall), usually featuring a vertical concrete column. At the wake of the flood, the hydraulic jack or screw is taken off; the gate is swung closed and is latched with the gate monolith, preventing any movement. The gate is pressed against the monolith. This causes a continuous rubber seal, running along two vertical edges and also horizontally along the bottom of the gate, to be engaged producing a watertight seal that blocks any water intrusion through the gate.

(2) Roller Gate

Roller type flood gate consists of a fabricated metal panel that sits on two rows of wheels running on tracks. The gate is pushed on one side during normal operating conditions opening up the monolith for access. In the wake of a flooding event, the roller gate panel is pushed towards the opening using winches. Once in place, the gate panel is latched to the concrete column on either end. A continuously running rubber seal, located on two vertical edges and along the horizontal bottom part of the gate, is pressed on the concrete monolith forming a watertight barrier.

A. References

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International

- ASTM A 1 Standard Specification for Carbon Steel Tee Rails
- ASTM A 27 Standard Specification for Steel Castings, Carbon, for General Application
- ASTM A 36 Specification for Carbon Structural Steel
- ASTM A 123 Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- ASTM A 123 Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- ASTM A 148 Standard Specification for Steel Castings, High Strength, for Structural Purposes
- ASTM A 153 Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

- ASTM A 240 Standard Specification for Chromium and Chromium – Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and General Applications
- ASTM A 276 Specification for Stainless Steel Bars and Shapes
- ASTM A 320 Standard Specification for Alloy-Steel and Stainless-Steel Bolting for Low-Temperature Service
- ASTM A 325 Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
- ASTM A 380 Standard Practice for Cleaning and Descaling Stainless Steel Parts, Equipment, and Systems
- ASTM A 489 Standard Specification for Carbon Steel Lifting Eyes
- ASTM A 490 Heat-Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength
- ASTM A 501 Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
- ASTM A 514/A 514M Standard Specification for High-Yield-Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding
- ASTM A 563 Standard Specification for Carbon and Alloy Steel Nuts
- ASTM A 564 Standard Specification for Hot – Rolled and Cold – Finished Age – Hardening Stainless Steel Bars and Shapes
- ASTM A 572 Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
- ASTM A 709 Standard Specification for Carbon and High-Strength Low-Alloy Structural Steel Shapes, Plates, and Bars and Quenched-and-Tempered Alloy Structural Steel Plates for Bridges
- ASTM A 992 Standard Specification for Structural Steel Shapes
- ASTM A 780 Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
- ASTM B 22 Standard Specification for Bronze Castings for Bridges and Turntables
- ASTM B 177 Standard Guide for Engineering Chromium Electroplating
- ASTM B 766 Standard Specification for Electrodeposited Coatings of Cadmium
- ASTM B 823 Standard Specification for Materials for Copper Base Powder Metallurgy (PM) Structural Parts
- ASTM D 395 Standard Test Methods for Rubber Property—Compression Set
- ASTM D 412 Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension
- ASTM D 471 Standard Test Method for Rubber Property—Effect of Liquids
- ASTM D 572 Standard Test Method for Rubber—Deterioration by Heat and Oxygen
- ASTM D 2240 Standard Test Method for Rubber Property—Durometer Hardness
- ASTM E 165 Standard Practice for Liquid Penetrant Testing for General Industry
- ASTM E 709 Standard guide for Magnetic Particle Examination
- ASTM F 436 Standard Specification for Hardened Steel Washers
- ASTM F 593 Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
- ASTM F 594 Standard Specification for Stainless Steel Nuts
- ASTM F 1145 Standard Specification for Turnbuckles, Swaged, Welded, Forged

- ASTM F 1554 Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
- ASTM F 3125 Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

American Society of Mechanical Engineers (ASME)

- ASME B4.1 Preferred Limits and Fits for Cylindrical Parts
- ASME B46.1 Surface Texture (Surface Roughness, Waviness, and Lay)
- ASME BPV IX Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications

American Welding Society (AWS)

- AWS D1.1 Structural Welding Code - Steel
- AWS D1.2 Structural Welding Code – Aluminum
- AWS D1.5 Bridge Welding Code

Federal Specification

- FF-S-200A Setscrews: Hexagon Socket and Spline Socket, Headless
- FS RR-W-410 Wire Rope and Strand

Connecticut State Department of Transportation

- Standard Specifications – Construction and Materials

Materials:

A. Metals

Structural steel, steel forgings, steel castings, stainless steel, bronze, aluminum alloy, and other metal materials used for fabrication shall conform to the requirements shown and specified herein.

B. Structural Steel

Structural steel shapes shall conform to ASTM A572/A572M, Grade 50. Structural steel plates shall conform to ASTM A36/A36M.

C. Self-Lubricating Bearings

Self-lubricating bearings shall conform to ASTM B823, Type II. The bearings shall be impregnated with a turbine grade lubricant containing oxidation and rust inhibitors and a polar anti-wear additive.

D. Bronze Castings

Bronze castings shall conform to ASTM B22/B22M, Copper Alloy UNS No. C91300.

E. Stainless Steel Plate, Sheet, Strip, Bars, and Shapes

Stainless steel plate, sheet, and strip shall conform to ASTM A240/A240M, UNS S 30400. Plate finish shall be hot-rolled, annealed or heat-treated, and blast-cleaned or pickled. Sheet and strip finish shall be No. 1.

Stainless Steel Bars and Shapes shall conform to ASTM A564 TYPE 630 Condition H100, and ASTM A276/A276M as shown in the drawings.

F. Rubber Seals

Rubber seals shall be fluorocarbon (Teflon) clad rubber seals of the mold type only and shall be compounded of natural rubber, synthetic polyisoprene, or a blend of both, and shall contain reinforcing carbon black, zinc oxide, accelerators, antioxidants, vulcanizing agents, and plasticizers. Physical characteristics of the seals shall meet the following requirements:

Physical Test	**Test Value**	**Test Method Specification**
Tensile Strength	2500 psi (min.)	ASTM D412
Elongation at Break	450 percent (min.)	ASTM D412
300 percent Modulus	900 psi (min.)	ASTM D412
Durometer Hardness (Shore Type A)	60 to 70	ASTM D2240
Water Absorption	5 percent by weight (max.)	ASTM D471
Compression Set	30 percent (max.)	ASTM D395
Tensile Strength (after aging 48 hrs.)	80 percent of tensile strength (min.)	ASTM D572

The "Water Absorption" test shall be performed with distilled water. The washed specimen shall be blotted dry with filter paper or other absorbent material and suspended by means of small glass rods in the oven at a temperature of 70 degrees C plus or minus 2 degrees C for 22 plus or minus 1/4 hours. The specimen shall be removed, allowed to cool to room temperature in air, and weighed. The weight shall be recorded to the nearest 1 mg as M1 (M1 is defined in ASTM D471). The immersion temperature shall be 70 degrees C plus or minus 1 degree C and the duration of immersion shall be 166 hours.

Rubber seals shall have a fluorocarbon film vulcanized and bonded to the sealing surface of the bulb. The film shall be 0.060 inch thick Huntington Abrasion Resistant Fluorocarbon Film No. 4508, or equal, and shall have the following minimum physical properties:

Tensile strength	2,000 psi
Elongation	250 percent

The outside surface of the bonded film shall be flush with the surface of the rubber seal and shall be free of adhering or bonded rubber. Strips and corner seals shall be molded in lengths suitable for obtaining the finish lengths shown and with sufficient excess length to provide test specimens for testing the adequacy of the adhesion bond between the film and bulb of the seal. At one end of each strip or corner seal to be tested, the fluorocarbon film shall be masked during bonding to prevent a bond for a length sufficient to hold the film securely during testing.

G. Bolts, Nuts and Washers

All bolts shall be high-strength bolts unless noted otherwise on the Drawings. High-strength bolts, nuts, and washers shall conform to ASTM F3125/F3125M, Grade A325, Type 1, hot-dip galvanized or ASTM A490, Type 1. Bolts 1/2 inch and larger shall have heavy hexagon heads. The finished shank of bolts shall be long enough to provide full bearing. Washers for use with bolts shall conform to the requirements specified in the applicable specification for bolts. Nuts shall be ASTM A563, type to match bolt type and finish. Hardened steel flat and beveled washers shall be ASTM F436, type to match bolt finish.

H. Screws

Screws shall be of the type indicated.

I. Shackles and Turnbuckles

Shackles and turnbuckles shall be of forged steel conforming to ASTM A668/A668M, zinc coated. Turnbuckles shall be end-threaded right and left hand and shall be of the size shown.

J. Screw Jacks

Screw jacks shall have a 30,000 lb rated capacity and shall conform to the details shown.

K. Winches

Winches shall be 15,000 lb marine winches with 4.0-inch drum as specified in plans. Each winch shall be equipped with 75 foot of 1/2 inch diameter wire cable suitable for exterior exposure.

L. Rails

Rail segments shall conform to 100 lb/yd American Railway Engineering Association (A.R.E.A) rails. Rail stops shall be as recommended by rail manufacturer for 100 lb/yd rails and for the wheel diameters indicated.

M. Wire Ropes

Wire rope shall conform to FS RR-W-410, Type III, Class 1, Construction 6 by 6 desk lashing ropes, improved plow steel, fiber core, as shown.

N. Wheels

Wheels shall be short hub or long hub, rigid type, heavy duty steel casters fabricated from steel castings conforming to ASTM A148/A148M. Wheel shall be of the size and load capacity shown and shall be provided with lubrication fittings, roller bearings and removable axle. Wheel treads shall be machined-finished to conform with the indicated rail. Unless otherwise specified or shown, axles for wheels shall be of stainless-steel bars conforming to ASTM A276/A276M, UNS S30400.

O. Padlocks and Hasps

Padlocks for gates shall be Master Lock, Co. No. 517KA or an approved equal. Padlocks shall be keyed alike and provided with two keys. Hasps shall be of wrought steel and sized to accommodate padlocks.

P. Elastomeric Bearing Pads

Elastomeric bearing pads shall conform to the requirements of CTDOT Specification Section 5.21, ELASTOMERIC BEARING PADS.

Construction Methods:

A. Quality Assurance

Qualification of welders and welding operators – Prior to welding, submit certification for each welder stating the type of welding and positions qualified for, the code and procedure qualified under, date qualified, and the firm and individual certifying the qualification tests. If the qualification date of the welder or welding operator is more than 6 months old, accompany the welding operator's qualification certificate with a current certificate by the welder attesting to the fact that the welder has been engaged in welding since the date of certification, with no break in welding service greater than 6 months. Conform to all requirements specified in AWS D1.1/D1.1M or BPVC SEC IX.

B. Delivery, Storage, and Handling

Perform delivery, handling, and storage of materials and fabricated items conforming to the requirements specified herein. Unload materials and equipment delivered to the site in the presence of the Engineer. Verify the condition and quantity of the items delivered by the Engineer and acknowledge receipt and condition thereof in writing. If delivered items are damaged or a shortage is determined, notify the Engineer of such in writing within 24 hours after delivery.

Rubber Seals – Store rubber seals in a place which permits free circulation of air, maintains a temperature of 70 degrees F or less, and prevents the rubber from being exposed to the direct rays of the sun. Keep rubber seals free of oils, grease, and other materials which would deteriorate the rubber. Rubber seals shall not be distorted during handling.

C. Sequencing and Scheduling

Submit a sequencing and scheduling plan, approved before the work is commenced, which illustrates that work affecting roadways has been coordinated with CT DOT. Include in the plan schedules, lists of labor or materials to be provided the affected agency, and any other aspects of the work that may impact on the operations of these entities as specified in the Contract requirements. The protection plan shall clearly demonstrate how all public or private roads, streets, or highways will be kept open to traffic at all times during the construction period, except as required to complete the Work and as shown on the CT DOT traffic stipulations. The sequencing and scheduling plan must comply with all other Contract requirements such as warning signs, flagmen, permits, and debris removal.

D. Fabrication

(a) Detail Drawings – Prior to performing any fabrication submit detailed shop drawings to the Engineer for approval. Submit detail drawings for metalwork and machine work, prior to fabrication, include within the detail drawings catalog cuts, templates, fabrication and assembly details and type, grade and class of material as appropriate. All temporary and tack welds shall be identified on the shop drawings. Each member shall be identified following the numbering scheme shown on the drawings. A table shall be provided containing a list of all members and a reference to each material certificate and test report that applies to that member. Shop drawings shall identify weld procedures and NDT required for each weld. Any and all splices shall be included in the shop drawings and clouded for approval. Indicate methods of protecting the work during shipping, storage, field assembly, and installation. Submit detail drawings of closure gates and appurtenant items, including fabrication drawings, etched pattern layout drawings, shop assembly drawings, delivery drawings, and field installation drawings.

(1) Fabrication Drawings – Fabrication drawings shall show complete details of materials, tolerances, connections, and proposed welding sequences which clearly differentiate shop welds and field welds.

(2) Etched Pattern Layout Drawings – Layout drawings shall show complete layout of etched pattern and graphics. Drawings to include etching profile and dimensions. Layouts to be coordinated with skin plate sizes and pattern offsets at seams, welds, latches, seals, and related elements as shown on the drawings.

(3) Shop Assembly Drawings – Shop assembly drawings shall provide details for connecting the adjoining fabricated components in the shop to assure satisfactory field installation.

(4) Delivery Drawings – Delivery drawings shall provide descriptions of methods of delivering components to the site, including details for supporting fabricated components during shipping to prevent distortion or other damages.

(5) Field Installation Drawings – Field installation drawings shall provide a detailed description of the field installation procedures. The description shall include the location and method of support of installation and handling equipment; provisions to be taken to protect concrete and other work during installation; method of maintaining components in correct alignment; plan for prestressing gate leaf diagonals, which shall

include descriptions of connections, riggings, anchorages, and measuring equipment; and methods for installing other appurtenant items.

(b) Structural Fabrication – Components shall be shop-fabricated of the materials specified and shown. Dimensional tolerances shall be as specified and shown. Splices shall occur only where shown. Pin holes shall be bored in components after welding, straightening, stress-relieving, and threading operations are completed. Brackets, eye bar sections, and other components requiring straightening shall be straightened by methods which will not damage the material. Bronze bushings shall be press-fitted with supporting components. Bolt connections, lugs, clips, or other pick-up assembly devices shall be provided for components as shown and required for proper assembly and installation.

Material must be straight before being laid off or worked. Perform straightening, if necessary, by methods that will not impair the metal. Sharp kinks or bends are cause for rejection of the material. Material with welds will not be accepted except where welding is definitely specified, indicated or otherwise approved. Make bends using approved dies, press brakes or bending rolls. Where heating is required, take precautions to avoid overheating the metal and allow it to cool in a manner that will not impair the original properties of the metal. Proposed flame cutting of material is subject to approval and must be indicated on detail drawings. Shearing must be accurate, and all portions of the work neatly finished. Make corners square and true unless otherwise shown. Fillet re-entrant cuts to a minimum radius of 3/4 inch unless otherwise approved. Provide finished members free of twists, bends and open joints. Tighten bolts, nuts and screws.

(1) Dimensional Tolerances for Structural Work – Measure dimensions using an approved calibrated steel tape of approximately the same temperature as the material being measured. The overall dimensions of an assembled structural unit must be within the tolerances indicated on the drawings or as specified in the particular section of these specifications for the item of work. Where tolerances are not specified in other sections of these specifications or shown, an allowable variation of 1/32 inch is permissible in the overall length of component members with both ends milled; component members without milled ends must not deviate from the dimensions shown by more than 1/16 inch for members 30 feet or less in length, and by more than 1/8 inch for members over 30 feet in length.

(2) Structural Steel Fabrication – Structural steel may be cut by mechanically guided or hand-guided torches when approved by the Engineer, provided an accurate profile with a surface that is smooth and free from cracks and notches is obtained. Prepare surfaces and edges in accordance with AWS D1.1/D1.1M,

(3) Prequalification of WPSs Clause - Where structural steel is not to be welded, chipping or grinding will not be required except as necessary to remove slag and sharp edges of mechanically guided or hand-guided cuts not exposed to view. Chip, grind or machine to sound metal hand-guided cuts which are to be exposed or visible.

(c) Welding – Welds shall be in accordance with AWS D1.1/D1.1M, and of the type shown and approved detail drawings. Components shall be stress-relief heat treated after welding

where shown. Stress-relieving of components shall be performed prior to the attachment of miscellaneous appurtenances.

(1) Welding Procedures for Structural Steel – Use prequalified welding procedures for structural steel as described in AWS D1.1/D1.1M, Prequalification of WPSs Clause or qualify by tests as prescribed in AWS D1.1/D1.1M, Qualification Clause. For welding procedures qualified by tests, the coupon welding and specimen testing will be witnessed and the test report document signed by the Engineer. Approval of any welding procedure does not relieve the Contractor of the responsibility for producing a finished structure meeting all requirements of these specifications. The Contractor will be directed or authorized to make any changes in previously approved welding procedures that are deemed necessary or desirable by the Engineer. Submit a complete schedule of welding procedures for each steel structure to be welded prior to commencing fabrication. Provide the schedule in conformance with the requirements specified in the provisions of AWS D1.1/D1.1M. Provide within the schedule detailed procedure specifications and tables or diagrams showing the procedures to be used for each required joint. Include in the welding procedures filler metal, preheat, interpass temperature and stress-relief heat treatment requirements. Clearly identify each welding procedure as being prequalified or required to be qualified by tests. Show types and locations of welds designated or in the specifications to receive nondestructive testing in the welding procedures.

(2) Welding Process – Perform welding of structural steel by an electric arc welding process using a method which conforms to the applicable provisions of AWS D1.1/D1.1M. Minimize residual stresses, distortion and shrinkage from welding.

(3) Filler Metal – Provide the electrode, electrode-flux combination and grade of filler metal conforming to the appropriate AWS specification for the base metal and welding process being used or be as shown where a specific choice of AWS specification allowable is required. Submit filler metal product data. Include the AWS designation of the electrodes to be used in the schedule of welding procedures. Use only low hydrogen electrodes for manual shielded metal-arc welding regardless of the thickness of the steel. Use a controlled temperature storage oven at the job site as prescribed by AWS D1.1/D1.1M, Fabrication Clause No 5 to maintain low moisture of low hydrogen electrodes.

(4) Preheat and Interpass Temperature – Perform preheating as required by AWS D1.1/D1.1M, Fabrication Clause or as otherwise specified except that the temperature of the base metal must be at least 70 degrees F. Slowly and uniformly preheat the joint area by approved means to the prescribed temperature, held at that temperature until the welding is completed and then permitted to cool slowly in still air.

(5) Stress-Relief Heat Treatment – Where stress relief heat treatment is specified or shown, perform in accordance with the requirements of AWS D1.1/D1.1M, Fabrication Clause unless otherwise authorized or directed.

(6) Workmanship – Perform welding workmanship in accordance with AWS D1.1/D1.1M, Fabrication Clause and other applicable requirements of these specifications.

(7) Preparation of Base Metal – Prior to welding inspect surfaces to be welded to ensure compliance with AWS D1.1/D1.1M, Fabrication Clause.

(8) Temporary Welds – Make temporary welds, required for fabrication and erection, under the controlled conditions prescribed for permanent work. Make temporary welds using low-hydrogen welding electrodes and by welders qualified for permanent work as specified in these specifications. Conduct preheating for temporary welds as required by AWS D1.1/D1.1M for permanent welds except that the minimum temperature must be 120 degrees F in any case. In making temporary welds, do not strike arcs in other than weld locations. Remove each temporary weld and grind flush with adjacent surfaces after serving its purpose.

(9) Tack Welds – Tack welds that are to be incorporated into the permanent work are to exhibit the same quality requirements as the permanent welds; clean and thoroughly fuse them with permanent welds. Perform preheating as specified above for temporary welds. Provide cascaded ends on multiple-pass tack welds. Remove defective tack welds before permanent welding.

(10) Weld Access Holes. Weld access holes (corner copes to prevent intersecting welds) shall be provided as shown on the shop drawings. If intersecting out-of-plane welds is encountered, the fabricator shall notify the Engineer for the approval of additional weld access hole additions in such locations. Payment for the addition of weld access holes not shown on plans will be the Contractor's responsibility. Unless shown on the drawings, welds will be required to wrap the ends of weld access holes.

(11) Weld Backing Removal. Unless otherwise indicated, all weld backing material shall be removed from welded joints prior to testing. All weld backing material that cannot be removed shall be identified on the shop drawings.

(12) Weld Backing Material Other Than Steel. All weld backing material, other than steel, shall be qualified by testing and shall be included in submitted PQR/WPS. Variation from approved weld backing material will not be permitted and will require the development and testing a new weld procedure which addresses the change in backing material.

(13) Welding of Steel Studs – Welding of steel studs must conform to the requirements of AWS D1.1/D1.1M, Stud Welding Clause, except as otherwise specified for the procedures for welding steel studs to structural steel, including mechanical, workmanship, technique, stud application qualification, production quality control and fabrication and verification inspection procedures.

(14) Application Qualification for Steel Studs – As a condition of approval of the stud application process, submit certified test reports and certification that the studs conform to the requirements of AWS D1.1/D1.1M, Stud Welding Clause, certified results of the stud manufacturer's stud base qualification test, and certified results of the stud application qualification test as required by AWS D1.1/D1.1M, Stud Welding Clause, prior to commencing fabrication, except as otherwise specified.

(15) Production Control – Production control of stud welding must conform to the requirements of AWS D1.1/D1.1M, Stud Welding Clause, except as otherwise

specified for quality control for production welding of studs. Weld studs on which pre-production testing is to be performed must be in the same general position as required on production studs (flat, vertical, overhead or sloping). If the reduction of the length of studs becomes less than normal as they are welded, stop welding immediately and do not resume until the cause has been corrected.

(16) Weldments – Portions of the structure include thick weldments where locked in thermal stresses may make final dimensions unstable. The Contractor is required to sequence the work and thermally stress relieve subassemblies of thick weldments such that final machining achieves stable specified dimensions and tolerances.

(17) Seal Welds – Seal welds are required as shown to maintain water tightness of weld joints and to prevent corrosion. All welds shall be seal welds unless noted otherwise. All seal welds shall be shown and made as indicated on the shop drawings. Seal welds, without a specific size shown, shall be made the minimum size fillet weld as required in AWS D1.1/D1.1M. In addition, seal welds may require weld wrapping around reentrant corners that is specifically prohibited in AWS D1.1/D1.1M.

(d) Bolted Connections – Provide bolts, nuts and washers of the type specified or indicated. Equip all nuts with washers except for high strength bolts. Use beveled washers where bearing faces have a slope of more than 1:20 with respect to a plane normal to the bolt axis. Where the use of high strength bolts is specified or indicated, conform the materials, workmanship and installation to the applicable provisions of ASTM F3125/F3125M. Install High Strength Bolts ASTM F3125/F3125M Grade A325 or Grade A490 in accordance with the requirements of RCSC S348. All High Strength Bolted Connections are fully pretensioned to the minimum pretension as specified in RCSC S348. Follow the pre-installation verification procedures outlined in RCSC S348. All other bolted connections are snug tight in accordance with RCSC S348.

(1) Accurately locate bolt holes, smooth, perpendicular to the member and cylindrical.

(2) Drill or subdrill holes for regular bolts and ream in the shop and not more than 1/16 inch larger than the diameter of the bolt.

(3) Match-ream or drill holes for fitted bolts in the shop. Remove burrs resulting from reaming. Keep bolt threads entirely outside of the holes. The body diameter of bolts must have tolerances as recommended by ASME B4.1 for the class of fit specified. Place fitted bolts in reamed holes by selective assembly to provide an LN-2 fit.

(4) Holes for high strength bolts must not have diameters more than 1/16 inch larger than bolt diameters. If the thickness of the material is not greater than the diameter of the bolts, the holes may be punched. If the thickness of the material is greater than the diameter of the bolts the holes may be drilled full size or subpunched or subdrilled at least 1/8 inch smaller than the diameter of the bolts and then reamed to full size. Poor matching of holes will be cause for rejection. Drifting occurring during assembly cannot distort the metal or enlarge the holes. Reaming to a larger diameter of the next standard size bolt will be allowed for slight mismatching.

(e) Machine Work – Tolerances, allowances and gauges for metal fits between plain, non-threaded, cylindrical parts conform to ASME B4.1 for the class of fit shown or required unless otherwise shown on approved detail drawings. Tolerances for machine-finished surfaces designated by non-decimal dimensions must be within 1/64 inch. Sufficient machining stock must be provided on placing pads to ensure true surfaces of solid material. Provide finished contact or bearing surfaces true and exact to secure full contact. Polish journal surfaces and finish all surfaces with sufficient smoothness and accuracy to ensure proper operation when assembled. Accurately machine parts entering any machine and all like parts be interchangeable except that parts assembled together for drilling or reaming of holes or machining will not be required to be interchangeable with like parts. Accurately locate all drilled bolt holes.

(1) Unfinished Surfaces – Lay out all work to secure proper matching of adjoining unfinished surfaces unless otherwise directed. Where there is a large discrepancy between adjoining unfinished surfaces chip and grind smooth or machine to secure proper alignment. Unfinished surfaces must be true to the lines and dimensions shown and be chipped or ground free of all projections and rough spots. Fill in depressions or holes not affecting the strength or usefulness of the parts in an approved manner.

(2) Pin Holes – Pin holes are to be bored true to gauges, smooth, straight and at right angles to the axis of the member. Do the boring after the member is securely fastened in position.

(3) Shafting – Turn or grind shafting with hot-rolled or cold-rolled steel, as required, unless otherwise specified or authorized. Provide fillets where changes in section occur. Cold-finished shafting may be used where keyseating is the only machine work required.

(4) Bearings – Bearings may be lined with bronze unless otherwise specified or shown. Where the bearing pressure is in excess of 200 psi, line bearings with bronze. Pressures on lined bearings must not exceed psi of projected area unless otherwise required or authorized. Anti-friction bearings of approved types and of sizes not less than those recommended by the bearing manufacturer for the duty intended will be permitted subject to approval. Properly align all bearings provided with a suitable means of lubrication. Install anti-friction bearings as required to provide for retention of the lubricant and to exclude dirt and grit.

(f) Etched Pattern – Exposed faces of gate skin plates to receive custom etched pattern as shown on the approved detail drawings. Etching to produce a smooth and continuous profile; gaps or skips in profile to be limited to 1/8” maximum. Profile to be at the width and depth indicated on the drawings; however, no etching to be more than 1/16” deep maximum.

(g) Miscellaneous Provisions – Apply zinc coatings in a manner and of a thickness and quality conforming to ASTM A123/A123M. Where zinc coatings are destroyed by cutting, welding or other causes regalvanize the affected areas. Regalvanize coatings 2 ounces or heavier with a suitable low-melting zinc base alloy similar to the recommendations of the American Hot-Dip Galvanizers Association to the thickness and quality specified for the original zinc coating. Repair coatings less than 2 ounces with cold galvanizing in accordance with ASTM A780/A780M.

(h) Drain holes – Locate drain holes as shown on the drawings, unless otherwise noted. Drain holes shall be drilled. Flame cutting of holes will not be permitted.

(i) Fabrications – Submit samples approved prior to use of the represented materials or items in the work. Samples of standard and shop fabricated items shall be full size and complete as required for installation in the work. Approved samples may be installed in the work provided each sample is clearly identified and its location recorded. Fabrications shall conform to the following requirements.

(1) Gate Leaf – Gate leaf shall be of welded structural steel fabrication. Gate leaf shall be provided complete with hinge assemblies, pintle assembly, wheel assemblies, gate hooks, seal assemblies, and other appurtenant components as specified and shown. Proposed shop-fabrication of gate leaf in separate segments to facilitate handling and shipping must be approved and shall be as shown on approved detail drawings. Such segments shall permit easy field-assembly and shall be as few as practicable to minimize the number of joints to be field-welded. The overall height of gate leaf shall not vary from the nominal dimension by more than 1/4 inch. The surfaces of framing elements to skin plates are to be welded shall not vary from a true plane by more than 1/4 inch. The diagonal dimensions across the corners of both faces of the gate leaf shall not differ from the calculated dimensions based on gate dimensions shown in the drawings by more than 1/2 inch. Splices in skin plates shall be located only where shown. Etched pattern on skin plates to be appear continuous across plate spices; individual etched profiles of the pattern to be aligned within 1/8" across skin plate splices. In addition to welds specifically indicated for nondestructive testing, other welds as chosen by the Engineer in the girders, verticals and skin plate of the gate leaf shall receive nondestructive testing at the Contractor's expense following the guidelines specified in Section 50.5.5(d)(8).

(2) Hinge Assembly –Materials for the hinge assembly shall follow the schedule shown in the plan. In addition to welds specifically indicated for nondestructive testing, 50 percent of the welds in the hinge assembly and the welds connecting the hinge assembly to the gate framing shall receive nondestructive testing utilizing Ultrasonic Testing. After all welding is completed, the hinge assembly shall be stress-relieved by heat-treating. Stress-relieving shall be performed prior to machining.

(3) Rolling Gate Wheel Assembly – Rolling gate wheel assembly shall be provided complete with cast steel wheels as specified herein and fittings, couplings and hoses for lubrication of wheels. Fittings shall be 1/4 inch threaded-pipe fitting. Couplings shall be 1/4-inch stainless steel half coupling. Hoses shall be 1/4 inch inside diameter, double-braided stainless steel flexible hoses. Couplings and hoses shall have a pressure rating of 3,000 psi.

(4) Seal Assembly – Seal assembly shall consist of rubber seals, steel retainer and spacer bars, retractable plate, and fasteners. Rubber seals shall be continuous over the full length. Seals shall be accurately fitted and drilled for proper installation. Bolt holes shall be drilled in the rubber seals by using prepared templates or the retainer bars as templates. Splices in seals shall be fully molded, develop a minimum tensile strength of 50 percent of the unspliced seal, and occur only at locations shown. All vulcanizing

of splices shall be done in the shop. The vulcanized splices between molded corners and straight lengths shall be located as close to the corners as practicable. Splices shall be on a 45-degree bevel related to the "thickness" of the seal. The surfaces of finished splices shall be smooth and free of irregularities. Steel retainer bars shall be field-spliced only where shown. Field welding of the steel retainer bar shall be ground flush.

(5) Miscellaneous Embedded Metals – Wall armor, shear anchors, protection and seal plates and shapes, and other miscellaneous embedded metals shall be of structural steel or corrosion-resisting steel conforming with the details specified herein and shown.

(j) Shop Assembly – Gates and appurtenant items shall be assembled completely in the shop, unless otherwise approved, to assure satisfactory field installation. Adjoining components shall be fitted and bolted together to facilitate field connections. The matchmarking of unassembled items shall be carefully preserved until the items are assembled. Mating surfaces and machined surfaces shall be covered with a rust preventive until assembly. Assembled components shall be shop-welded in their final positions as much as delivery and field installation conditions will permit. Rubber seals shall be fitted and drilled to match the seal retainers, match-marked, and removed for shipment. Shop assembly and disassembly work shall be performed in the presence of the Engineer unless waived in writing. The presence of the Engineer will not relieve the Contractor of any responsibility under this contract.

E. Tests, Inspection, and Verifications

Submit certified test reports for material tests with all materials delivered to the site.

(a) General – Perform material tests and analyses certified by an approved laboratory to demonstrate that materials are in conformity with the specifications. These tests and analyses must be performed and certified at the Contractor's expense and are in addition to the standard manufacturer's material test reports. Perform tests, inspections, and verifications conforming to the requirements of the particular sections of these specifications for the respective items of work unless otherwise specified or authorized. Conduct tests in the presence of the Engineer if so required. Furnish specimens and samples for additional independent tests and analyses upon request by the Engineer. Properly label specimens and samples and prepare for shipment. Submit certified test reports for material tests performed by the Contractor as well as manufacturers' material test reports with all materials delivered to the site.

(b) Nondestructive Testing – When doubt exists as to the soundness of any material part, such part may be subjected to any form of nondestructive testing determined by the Engineer. This may include Ultrasonic (UT), Magnetic Particle Testing (MT), Radiographic Testing (RT) or any other test that will thoroughly investigate the part in question. The cost of such investigation will be borne by the Department if the part is found to be sound and by the Contractor if the part is found to be defective. Any defects will be cause for rejection; replace and retest rejected parts at the Contractor's expense.

(c) Tests of Machinery and Structural Units – The details for tests of machinery and structural units must conform to the requirements of the particular sections of these specifications covering these items. Assemble each complete machinery and structural unit and test them in the shop, in the presence of the Engineer, unless otherwise directed. Waiving of tests does not relieve the Contractor of responsibility for any fault in operation, workmanship or material that occurs before the completion of the contract or guarantee. After being installed at the site, operate each complete machinery or structural unit through a sufficient number of complete cycles to demonstrate to the satisfaction of the Engineer that it meets the specified operational requirements in all respects.

(d) Inspection of Structural Steel Welding – Nondestructive testing of designated welds will be required. Supplemental examination of any joint or coupon cut from any location in any joint may also be required. Selection of welds to be tested shall be as agreed upon between the Engineer and Contractor. The Contractor's Certified Welding Inspector (CWI) shall be present whenever welding is performed. The CWI shall perform inspection, as necessary, prior to assembly, during assembly, during welding, and after welding. CWI shall perform inspection as required in AWS D1.1/D1.1M.

(6) Visual Examination – All visual inspection shall be conducted in accordance with AWS D1.1/D1.1M, by a CWI. Document this inspection in the Visual Weld Inspection Log. Submit certificates indicating that CWI meet the requirements of AWS QC1.

(7) Nondestructive Testing – Perform as designated or described in the sections of these specifications, the nondestructive testing of shop and field welds covering the particular items of work. Record final nondestructive testing results in the Weld Inspection Log which identifies final NDT inspection of all welds requiring inspection and submit the log.

(8) Testing Agency – The nondestructive testing of welds and the evaluation of tests as to the acceptability of the welds must be performed by a testing agency adequately equipped and competent to perform such services or by the Contractor using suitable equipment and qualified personnel. All personnel performing nondestructive testing shall be certified Level I or II in the method of NDT being utilized in accordance with AWS D1.1/D1.1M. Level I inspectors must have direct supervision of a Level II inspector. Submit certification for nondestructive testing personnel prior to all testing. In either case, written approval of the examination procedures is required, and performance of the examination tests must be done in the presence of the Engineer. The evaluation of tests is subject to the approval and all records become the property of the Department.

(9) Radiographic Testing (RT) – Radiographic examination is required on the major shop and field welds as per AWS D1.5/D1.5M. See Section 50.5.5(d)(8) for items that shall be subjected to RT. Welds which have been designated to receive radiographic examination and are found to be inaccessible to a radiation source or film or are

otherwise so situated that radiographic examination is not feasible may be examined, with written approval, by dye penetrant, magnetic particle tests, or ultrasonic tests.

(10) Ultrasonic Testing (UT) – Examine, evaluate and report ultrasonic testing of welds in conformance to the requirements of AWS D1.1/D1.1M, Inspection Clause, for statically loaded connections. Provide ultrasonic equipment capable of making a permanent record of the test indications. Make a record of each weld tested.

(11) Magnetic Particle Inspection Conform magnetic particle inspection of welds to the applicable provisions of ASTM E709.

(12) Dye Penetrant Inspection – Perform dye penetrant inspection of welds conforming to the applicable provisions of ASTM E165/E165M.

(13) Welds to be Subject to Nondestructive Testing – 100% of all welds shall be subjected to visual inspection. All welds connecting the Fracture Critical Member (FCM), including all girders, shall be considered Fracture Critical Weld (FCW) and shall be subjected to Radiographic Testing (RT). 50% of the welds including FCW on the hinge assembly shall be subjected to UT. In addition, test 25% of all other Complete Joint Penetration (CJP) welds using RT. Randomly test 50% of all PJP and fillet welds other than FCW using UT as per Table 6.2 of AWS D1.1/D1.1M.

(14) Test Coupons – The Department reserves the right to require the Contractor to remove coupons from completed work when doubt as to soundness cannot be resolved by nondestructive testing. When coupons are removed from any part of a structure, repair the members cut in a neat manner with joints of the proper type to develop the full strength of the members. Peen repaired joints as approved or directed to relieve residual stress. The expense for removing and testing coupons, repairing cut members and the nondestructive testing of repairs is borne by the Department if the work is not found to be defective or the Contractor if the work is found to be defective.

(15) Supplemental Examination – When the soundness of any weld is suspected of being deficient due to faulty welding or stresses that might occur during shipment or erection, the Department reserves the right to perform nondestructive supplemental examinations before final acceptance. The cost of such inspection will be borne by the Department. If welds are found to be defective, the Contractor shall repair the defective work and bear the cost of the inspection.

(16) Welding Repair Plan – Repair defective welds in accordance with AWS D1.1/D1.1M, Fabrication Clause. Remove defective weld metal to sound metal by use of grinding, air carbon-arc or oxygen gouging. Thoroughly clean surfaces before welding. Retest welds that have been repaired by the same methods used in the original inspection. Except for the repair of members cut to remove test coupons and found to have acceptable welds costs of repairs and retesting will be borne by the Contractor. Submit welding repair plans for steel, prior to making repairs.

(17) Inspection and Testing of Steel Stud Welding – Perform fabrication and verification inspection and testing of steel stud welding conforming to the requirements of AWS D1.1/D1.1M, Welding Clause except as otherwise specified. The Engineer will serve as the verification inspector. Bend or torque test one stud in every 100, including studs that do not show a full 360 degree weld flash, have been repaired by welding or whose reduction in length due to welding is less than normal as required by AWS D1.1/D1.1M, Stud Welding Clause. If any of these studs fail, bend or torque test two additional studs. If either of the two additional studs fails, all of the studs represented by the tests will be rejected. Studs that crack under testing in the weld, base metal or shank will be rejected and replaced by the Contractor at no additional cost.

(e) Testing of Rubber Seals – The fluorocarbon film of rubber seals shall be tested for adhesion bond in accordance with ASTM D413 using either the machine method or the deadweight method. A 1-inch long piece of seal shall be cut from the end of the seal which has been masked and subjected to tension at an angle approximately 90 degrees to the rubber surface. There shall be no separation between the fluorocarbon film and the rubber when subjected to the following loads:

Thickness of Fluorocarbon	**Machine Method at 50 mm2 inches per minute**	**Deadweight Method**
0.060 inch	30 pounds per inch width	30 pounds per inch width
0.030 inch	30 pounds per inch width	30 pounds per inch width

F. Installation

Gates and appurtenant items shall be assembled for installation in strict accordance with the contract drawings, approved installation drawings, and shop match-markings. Before assembly and installation, all bearing surfaces requiring lubrication shall be thoroughly cleaned and lubricated with an approved lubricant. All components to be field-welded shall be in correct alignment before welding is commenced.

(a) General – Thoroughly clean all parts to be installed. Remove packing compounds, rust, dirt, grit and other foreign matter. Clean holes and grooves for lubrication. Examine enclosed chambers or passages to make sure that they are free from damaging materials. Where units or items are shipped as assemblies they will be inspected prior to installation. Disassembly, cleaning and lubrication will not be required except where necessary to place the assembly in a clean and properly lubricated condition. Do not use pipe wrenches, cold chisels or other tools likely to cause damage to the surfaces of rods, nuts or other parts used for assembling and tightening parts. Tighten bolts and screws firmly and uniformly but take care not to overstress the threads. When a half nut is used for locking a full nut place the half nut first followed by the full nut. Apply the half nut snug tight before applying full torque on the full nut. Lubricate threads of all bolts except

high strength bolts, nuts and screws with an appropriate lubricant before assembly. Coat threads of corrosion-resisting steel bolts and nuts with an approved antigalling compound. Driving bolts or keys will not be permitted.

(b)

(1) Alignment and Setting – Accurately align each machinery or structural unit by the use of steel shims or other approved methods so that no binding in any moving parts or distortion of any member occurs before it is fastened in place. The alignment of all parts with respect to each other must be true within the respective tolerances required. Set true machines to the elevations shown.

(2) Blocking and Wedges – Remove all blocking and wedges used during installation for the support of parts to be grouted in foundations before final grouting unless otherwise directed. Blocking and wedges left in the foundations with approval must be of steel or iron.

(c) Embedded Metals – Corner protection angles, sill angles, seal plates, frames, pedestals, bases and other embedded metal items required for proper and complete installation shall be accurately installed to the alignment and grade required to ensure accurate fitting and matching of components. Embedded metals shall be given a primer coat of the required paint on all surfaces prior to installation in concrete forms. Anchors for embedded metals shall be installed as shown. Items requiring two concrete pours for installation shall be attached to the embedded anchors after the initial pour, adjusted to the proper alignment, and concreted in place with the second pour. Welded field splices in sealing surfaces of embedded items shall be ground smooth.

(d) Lower Hinge Assembly – Base anchors for the lower hinge assembly shall be embedded in the first pour concrete. Base plate shall be attached to base anchors, set to the final position, and epoxy fill shall be placed in the void behind the base plates and allowed to reach the strength as shown and the approved field installation drawings. After the gate leaf is set in place, the hinge assembly shall be adjusted to provide for continuous contact between the sealing surfaces over the full height and length of the gate leaf. Allowances shall be made for the seals which shall not be attached until painting operations are completed. Second pour concrete shall be placed after final adjustments are completed.

(e) Gate Leaf – Gate leaf components not assembled in the shop shall be assembled in the field as required for installation. Lower hinge assembly bearings shall be coated with grease prior to setting the gate leaf in place. All necessary precautions shall be taken to avoid distortion of the gate leaf or any component parts. Special care shall be exercised during installation to prevent any sag of the ends of the gate leaf due to compression of blocking or other causes. After the gate leaf has been set in place and the top hinge assembly installed, the gate leaf shall be plumbed and brought into correct position.

(f) Diagonals – Gate leaf diagonals shall be attached to the gate leaf after the leaf is set in place. Submit diagonal prestressing records immediately after completion of the prestressing operations. Diagonals shall be prestressed before the final adjustment of the hinge assemblies are made. Diagonal prestressing shall be as specified herein and as

shown and the prestressing plan developed by the Contractor. The prestressing plan shall be submitted to the Engineer for approval. The plan for prestressing the diagonals shall describe the method of prestressing including the materials, connections, rigging, anchorages, and measuring equipment including strain gauges. The strain gauges shall be removed after the prestressing operation and touch up painting shall be applied. Compile a record of the prestressing operations consisting of the information indicated in the following table:

Stress Data Table

Gate Leaf Location:				Date:	
	1	2	3	4	5
Diagonal	Strain Gauge Initial	Strain Gauge Final	E (in.)	D (in.)	d(in.)

1. Initial strain gauge readings shall be made after slack is removed.
2. Final strain gauge readings shall be made after prestressing is complete.
3. E is the total elongation over the full length of the diagonal, computed from the strain gauge readings.
4. D is the initial deflection (sag) of the leaf prior to prestressing.
5. d is the final deflection (sag) of the leaf measured after completion of the prestress operation; it is the deflection at the bottom of the cantilever end when final strain gauge readings are taken.

(g) Top Hinge Assembly – After the gate leaf has been set in place, the top hinge assembly shall be installed and adjusted so that the center of the hinge pin is in vertical alignment with the center of the pintle. When the top hinge pin is inserted, the gate leaf shall swing horizontally throughout its range of movement. Any required final adjustments to the top hinge assembly shall be made after the gate leaf diagonals have been prestressed. The second pour concrete shall be made after final adjustments are completed.

(h) Painting – Painting of the gates shall follow CTDOT Standard Specification Section 6.03, Structural Steel. Exposed parts of gates and appurtenances except machined surfaces, corrosion-resistant surfaces, surfaces of anchorages embedded in concrete, and other specified surfaces shall be painted as specified below

(1) Blast to near white metal (SSPC-SP 10).

(2) Prime with one coat of three component, metallic, zinc rich, epoxy primer.

(3) Coat with two (2) coats of low VOC, high solids, high build epoxy intermediate coat.

(4) Finish with one coat of low VOC, high build, semi-gloss urethane finish.

(i) Seal Assemblies – Rubber seal assemblies shall be installed after the embedded metal components have been concreted in place and the gate installation, including painting, completed. Rubber seals shall be fastened securely to metal retainers. Before operating the gates, a suitable lubricant as prescribed by the seal manufacturer shall be applied to the rubber seal rubbing plates to protect the rubber.

(j) Final Adjustment of Swing Gates – Swing gates have been designed with multiple degrees of adjustment. The pintle assembly has been designed to allow additional thrust washers to allow vertical adjustment. Shim packs have been specified to allow adjustment normal to the concrete abutment surface. Slotted holes have been provided in all seal angles to facilitate minor adjustments normal to the seal surfaces. The bearing blocks of each gate, attached to the horizontal girders, shall be in contact with the vertical face of the concrete abutment or embedded plates. If not in contact, the bearing blocks shall have a gap no larger than 1/32" measured by a feeler gauge between the bearing block and mating surface. Should the gap between the bearing blocks and mating surface exceed 1/32", the Contractor shall notify the Engineer. After all adjustments have been made, the seals of each gate shall be leak tested as specified herein.

(k) Testing of Seal – There shall be no inadvertent leakage paths around the seals. The intent of this specification is that the bulb of the J-bulb seal shall be in contact with the seal plate over the entire length when the gate is in the closed position. With the gate in the closed position, the spray from a hose shall be directed along every horizontal and vertical inch of the seal at the contact point between seal bulb and seal plate. The nozzle of the hose may be directed toward either side of the seal but shall be no more than 12 inches from the contact point between seal and seal plate. The spray shall be as nearly perpendicular to the seal as access permits. The flow of water from the hose shall be no less than 8 gallons per minute and the water pressure in the hose just upstream of the nozzle shall be no less than 40 psi, as measured by a calibrated gauge. If leakage occurs at any point along the seal, the gap between the rubber seal and seal plate shall be measured by means of feeler gauges while the water is not running. A maximum gap of 1/16 inch over not more than 12 inches will be accepted.

G. Protection of Finished Work

(a) Machined Surfaces – Thoroughly clean foreign matter off machined surfaces. Protect all finished surfaces. Oil and wrap unassembled pins and bolts with moisture resistant paper or protect them by other approved means. After applying primer wash finished surfaces of ferrous metals to be in bolted contact, with an approved rust inhibitor and coat them with an approved rust resisting compound for temporary protection during fabrication, shipping and storage periods. Paint finished surfaces of metals which will be exposed after installation, except corrosion resisting steel or nonferrous metals.

(b) Lubrication After Assembly – After assembly fill all lubricating systems with the appropriate lubricant and apply additional lubricant at intervals as required to maintain the equipment in satisfactory condition until acceptance of the work.

H. Acceptance Trial Operation

After completion of the gate installation, the Engineer will examine the gates for conformance with the contract requirements. The gates will be examined first to determine whether or not the workmanship conforms to the specification requirements and the standard of Painting and corrosion protection. The Contractor will then be required to operate the gates from the fully-opened to the fully-closed position to demonstrate that all parts are functioning properly. The number of error-free gate opening-closing operations, acceptable to the Engineer's satisfaction, shall follow the guidelines below.

(a) Swing Gates – Operate at least once using normal gate operating sequence and at least once using the alternative operating procedure. Refer to gate Operation & Maintenance (O&M) manual for details of operating procedures.

(b) Roller Gates – Operate at least once using normal gate operating sequence and at least once utilizing each of the two alternative operating procedures. Refer to gate O&M manual for details of operating procedures.

The workmanship in the fabrication and installation of gates shall be such that the gates in the closed position will form a watertight barrier across the opening, which shall be verified using a spray test. Required repairs or replacements to correct defects, shall be made at no additional cost to the Department. Repeat the trial operation after defects are corrected. Prior to final acceptance of the gates, provide temporary restraints to prevent unauthorized operation of the gates.

Method of Measurement:

Payment will be made at the lump sum price bid for each fabricated steel floodgate.

Basis of Payment:

Payment will constitute full compensation for furnishing all plant, labor, materials and equipment and performing all operations necessary for the installation of fabricated steel floodgates as specified and as shown in the drawings.

Pay Item	Pay Unit
Furnish and Install Fabricated Steel Floodgate	L.S.

ITEM #0603XXXA – STOPLOGS

Description:

This specification covers the requirements for fabricating, assembling, delivering, and installing stoplogs as part of a post and panel demountable floodgate system.

References

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International

- ASTM A153-16a Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
- ASTM A276-17 Standard Specification for Stainless Steel Bars and Shapes
- ASTM A572-18 Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
- ASTM B303-10R20 Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles
- ASTM D395-16E17 Standard Test Methods for Rubber Property - Compression Set
- ASTM D412-16 Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
- ASTM D471-16a Standard Test Method for Rubber Property - Effect of Liquids
- ASTM D572-04R19 Rubber Deterioration by Heat and Oxygen
- ASTM D2240-15E17 Standard Test Method for Rubber Property - Durometer Hardness

A. Submittals

(a) General – Submittals shall be transmitted by the Contractor in accordance with the requirements herein. The Contractor Quality Control (CQC) System Manager shall be responsible for certifying that all submittals are in compliance with the Contract requirements.

(a) Product Data

a. The Contractor shall submit schedules of welding procedures for structural steel and welding processes for aluminum.

b. The Contractor shall submit materials orders, materials lists and materials shipping bills.

c. The Contractor shall submit an Identification System which shows the disposition of specific lots of approved materials and fabricated items in the work, before completion of the contract.

d. The Contractor shall submit the approved sequencing and scheduling plan.

(b) Shop Drawings – The Contractor shall submit detail drawings of stoplogs and appurtenant shop fabricated items, including fabrication drawings, shop assembly drawings, delivery drawings, and field installation drawings for compliance confirmation. Include plans, elevations, and details of sections and connections as required. Show type and location of all fasteners

(c) Test Reports – The Contractor shall submit certified test reports for material tests, with all materials delivered to the site.

Materials:

A. Metals
Structural steel, structural aluminum, steel castings, stainless steel, aluminum alloy, and other metal materials used for fabrication shall conform to the requirements shown and specified herein.

B. Structural Steel
Structural steel shapes shall conform to ASTM A572/A572M, Grade 50. Structural steel plates shall conform to ASTM A36/A36M.

C. Structural Aluminum
Structural aluminum shall conform to Alloy 6061, Temper T6.

D. Stainless Steel Plate, Sheet, Strip, Bars, and Shapes
Stainless steel plate, sheet, and strip shall conform to ASTM A240/A240M, UNS S 30400. Plate finish shall be hot-rolled, annealed or heat-treated, and blast-cleaned or pickled. Sheet and strip finish shall be No. 1.

Stainless Steel Bars and Shapes shall conform to ASTM A564 TYPE 630 Condition H100, and ASTM A276/A276M as shown in the drawings.

E. Rubber Seals
Rubber seals for stop logs shall be compounded of natural rubber, synthetic polyisoprene, or a blend of both, and shall contain reinforcing carbon black, zinc oxide, accelerators, antioxidants, vulcanizing agents, and plasticizers. Physical characteristics of the seals shall meet the following requirements:

Physical Test	**Test Value**	**Test Method Specification**
Tensile Strength	2500 psi (min.)	ASTM D412
Elongation at Break	450 percent (min.)	ASTM D412
300 percent Modulus	900 psi (min.)	ASTM D412

Physical Test	Test Value	Test Method Specification
Durometer Hardness (Shore Type A)	60 to 70	ASTM D2240
Water Absorption	5 percent by weight (max.)	ASTM D471
Compression Set	30 percent (max.)	ASTM D395
Tensile Strength (after aging 48 hrs.)	80 percent of tensile strength (min.)	ASTM D572

The "Water Absorption" test shall be performed with distilled water. The washed specimen shall be blotted dry with filter paper or other absorbent material and suspended by means of small glass rods in the oven at a temperature of 70 degrees C plus or minus 2 degrees C for 22 plus or minus 1/4 hours. The specimen shall be removed, allowed to cool to room temperature in air, and weighed. The weight shall be recorded to the nearest 1 mg as M1 (M1 is defined in ASTM D471). The immersion temperature shall be 70 degrees C plus or minus 1 degree C and the duration of immersion shall be 166 hours.

Rubber seals shall have a fluorocarbon film vulcanized and bonded to the sealing surface of the bulb. The film shall be 0.060-inch-thick Huntington Abrasion Resistant Fluorocarbon Film No. 4508, or equal, and shall have the following minimum physical properties:

Tensile strength	2,000 psi
Elongation	250 percent

The outside surface of the bonded film shall be flush with the surface of the rubber seal and shall be free of adhering or bonded rubber. Strips and corner seals shall be molded in lengths suitable for obtaining the finish lengths shown and with sufficient excess length to provide test specimens for testing the adequacy of the adhesion bond between the film and bulb of the seal. At one end of each strip or corner seal to be tested, the fluorocarbon film shall be masked during bonding to prevent a bond for a length sufficient to hold the film securely during testing.

F. Bolts, Nuts and Washers

High-strength bolts, nuts, and washers shall conform to F3125 Type A325 Grade 3 zinc/aluminum coated or Grade A490 Grade 3 zinc/aluminum coated. Bolts, nuts, studs, stud bolts and bolting materials other than high-strength shall conform to ASTM A276, Type 316. Bolts 1/2 inch and larger shall have hexagon heads. The finished shank of bolts shall be long enough to provide full bearing. Washers for use with bolts shall conform to the requirements specified in the applicable specification for bolts.

G. Screws

Screws shall be of the type indicated.

H. Clips and Clip Bolts for Aluminum Panels
Clips and clip bolts for aluminum panels shall be approved standard manufactured stock items.

Construction Methods:

A. Quality Assurance

Qualification of welders and welding operators – Prior to welding, submit certification for each welder stating the type of welding and positions qualified for, the code and procedure qualified under, date qualified, and the firm and individual certifying the qualification tests. If the qualification date of the welder or welding operator is more than 6 months old, accompany the welding operator's qualification certificate with a current certificate by the welder attesting to the fact that the welder has been engaged in welding since the date of certification, with no break in welding service greater than 6 months. Conform to all requirements specified in AWS D1.1/D1.1M or BPVC SEC IX.

B. Delivery, Storage, and Handling
Perform delivery, handling, and storage of materials and fabricated items conforming to the requirements specified herein. Unload materials and equipment delivered to the site in the presence of the Engineer. Verify the condition and quantity of the items delivered by the Engineer and acknowledge receipt and condition thereof in writing. If delivered items are damaged or a shortage is determined, notify the Engineer of such in writing within 24 hours after delivery. Submit an Identification System which shows the disposition of specific lots of approved materials and fabricated items in the work, before completion of the contract

Rubber Seals – Store rubber seals in a place which permits free circulation of air, maintains a temperature of 70 degrees F or less, and prevents the rubber from being exposed to the direct rays of the sun. Keep rubber seals free of oils, grease, and other materials which would deteriorate the rubber. Rubber seals shall not be distorted during handling.

C. Sequencing and Scheduling
Submit a sequencing and scheduling plan, approved before the work is commenced, which illustrates that work affecting roadways has been coordinated with CT DOT. Include in the plan schedules, lists of labor or materials to be provided the affected agency, and any other aspects of the work that may impact on the operations of these entities as specified in the Contract requirements. The protection plan shall clearly demonstrate how all public or private roads, streets, or highways will be kept open to traffic at all times during the construction period, except as required to complete the Work and as shown on the CT DOT traffic stipulations. The sequencing and scheduling plan must comply with all other Contract requirements such as warning signs, signalers, permits, and debris removal.

D. Fabrication

(a) Detail Drawings – Detail drawings of stoplogs and appurtenant shop fabricated items, including fabrication drawings, shop assembly drawings, delivery drawings, and field installation drawings, shall conform to the requirements specified herein. Prior to performing any fabrication submit detailed shop drawings to the Engineer for approval. Submit detail drawings for metalwork and machine work, prior to fabrication, include within the detail drawings catalog cuts, templates, fabrication and assembly details and type, grade and class of material as appropriate. Each member shall be identified following the numbering scheme shown on the drawings. Submit detail drawings of closure gates and appurtenant items, including fabrication drawings, etched pattern layout drawings, shop assembly drawings, delivery drawings, and field installation drawings.

(1) Fabrication Drawings – Show on the fabrication drawings complete details of materials, tolerances, connections, and proposed welding sequences which clearly differentiate shop welds and field welds.

(1) Shop Assembly Drawings – Shop assembly drawings shall provide details for connecting the adjoining fabricated components in the shop to assure satisfactory field installation.

(2) Delivery Drawings – Delivery drawings shall provide descriptions of methods of delivering components to the site, including details for supporting fabricated components during shipping to prevent distortion or other damages.

(3) Field Installation Drawings – Show on the field installation drawings a detailed description of the field installation procedures. The description shall include the location and method of support of installation and handling equipment; provisions to be taken to protect concrete and other work during installation; method of maintaining components in correct alignment; and methods for installing appurtenant items.

(b) Structural Fabrication – Structural fabrication shall conform to the requirements specified and in CTDOT Standard Specifications Section M.06. Components shall be shop-fabricated of the materials specified and shown. Dimensional tolerances shall be as specified and shown. Splices shall occur only where shown. Bolt connections, lugs, clips, or other pick-up assembly devices shall be provided for components as shown and required for proper assembly and installation.

(1) Dimensional Tolerances for Structural Work – Measure dimensions using an approved calibrated steel tape of approximately the same temperature as the material being measured. The overall dimensions of an assembled structural unit must be within the tolerances indicated on the drawings or as specified in the particular section of these specifications for the item of work.

(c) Welding – Submit schedules of welding procedures for structural steel and welding processes for aluminum. Welding shall conform to the requirements specified in CTDOT Standard Specifications Section M.06. Welds shall be in accordance with AWS D1.1/D1.1M, and of the type shown and approved detail drawings. Components shall be stress-relief heat treated after welding where shown. Stress-relieving of components shall be performed prior to the attachment of miscellaneous appurtenances.

(d) Bolted Connections – Bolted connections shall conform to the requirements specified in CTDOT Standard Specifications Section M.06. Provide bolts, nuts and washers of the type specified or indicated. Equip all nuts with washers except for high strength bolts. Use beveled washers where bearing faces have a slope of more than 1:20 with respect to a plane normal to the bolt axis. Where the use of high strength bolts is specified or indicated, conform the materials, workmanship, and installation to the applicable provisions of ASTM F3125/F3125M. Install High Strength Bolts ASTM F3125/F3125M Grade A325 or Grade A490 in accordance with the requirements of RCSC S348. All High Strength Bolted Connections are fully pretensioned to the minimum pretension as specified in RCSC S348. Follow the pre-installation verification procedures outlined in RCSC S348. All other bolted connections are snug tight in accordance with RCSC S348.

(1) Accurately locate bolt holes, smooth, perpendicular to the member and cylindrical.

(2) Drill or subdrill holes for regular bolts and ream in the shop and not more than 1/16 inch larger than the diameter of the bolt.

(3) Match-ream or drill holes for fitted bolts in the shop. Remove burrs resulting from reaming. Keep bolt threads entirely outside of the holes. The body diameter of bolts must have tolerances as recommended by ASME B4.1 for the class of fit specified. Place fitted bolts in reamed holes by selective assembly to provide an LN-2 fit.

(4) Holes for high strength bolts must not have diameters more than 1/16 inch larger than bolt diameters. If the thickness of the material is not greater than the diameter of the bolts, the holes may be punched. If the thickness of the material is greater than the diameter of the bolts the holes may be drilled full size or subpunched or subdrilled at least 1/8 inch smaller than the diameter of the bolts and then reamed to full size. Poor matching of holes will be cause for rejection. Drifting occurring during assembly cannot distort the metal or enlarge the holes. Reaming to a larger diameter of the next standard size bolt will be allowed for slight mismatching.

(e) Machine Work – Machine work shall conform to the requirements specified in Section M.06. Tolerances, allowances and gauges for metal fits between plain, non-threaded, cylindrical parts conform to ASME B4.1 for the class of fit shown or required unless otherwise shown on approved detail drawings. Tolerances for machine-finished surfaces designated by non-decimal dimensions must be within 1/64 inch. Sufficient machining stock must be provided on placing pads to ensure true surfaces of solid material. Provide finished contact or bearing surfaces true and exact to secure full contact. Polish journal surfaces and finish all surfaces with sufficient smoothness and accuracy to ensure proper operation when assembled. Accurately machine parts entering any machine and all like parts be interchangeable except that parts assembled together for drilling or reaming of holes or machining will not be required to be interchangeable with like parts. Accurately locate all drilled bolt holes.

(1) Unfinished Surfaces – Lay out all work to secure proper matching of adjoining unfinished surfaces unless otherwise directed. Where there is a large discrepancy between adjoining unfinished surfaces chip and grind smooth or machine to secure proper alignment. Unfinished surfaces must be true to the lines and dimensions shown

and be chipped or ground free of all projections and rough spots. Fill in depressions or holes not affecting the strength or usefulness of the parts in an approved manner.

(2) Pin Holes – Pin holes are to be bored true to gauges, smooth, straight and at right angles to the axis of the member. Do the boring after the member is securely fastened in position.

(f) Etched Pattern – Exposed faces of gate skin plates to receive custom etched pattern as shown on the approved detail drawings. Etching to produce a smooth and continuous profile; gaps or skips in profile to be limited to 1/8" maximum. Profile to be at the width and depth indicated on the drawings; however, no etching to be more than 1/16" deep maximum.

(g) Miscellaneous Provisions – Miscellaneous provisions for fabrication shall conform to the requirements specified and in Section M.06. Apply zinc coatings in a manner and of a thickness and quality conforming to ASTM A123/A123M. Where zinc coatings are destroyed by cutting, welding or other causes regalvanize the affected areas. Regalvanize coatings 2 ounces or heavier with a suitable low-melting zinc base alloy similar to the recommendations of the American Hot-Dip Galvanizers Association to the thickness and quality specified for the original zinc coating. Repair coatings less than 2 ounces with cold galvanizing in accordance with ASTM A780/A780M.

(h) Drain holes – Locate drain holes as shown on the drawings, unless otherwise noted. Drain holes shall be drilled. Flame cutting of holes will not be permitted.

(i) Fabrications – Submit samples approved prior to use of the represented materials or items in the work. Samples of standard and shop fabricated items shall be full size and complete as required for installation in the work. Approved samples may be installed in the work provided each sample is clearly identified and its location recorded. Fabrications shall conform to the following requirements.

(1) Stoplogs and Posts – Stoplogs and posts shall be fabricated of extruded aluminum conforming to Alloy 6061, Temper T6. Steel items shall be galvanized where indicated.

(2) Stoplog Guides – Stoplog guides shall be fabricated of structural steel conforming to ASTM A572/A572M, Grade 50.

(3) Miscellaneous Embedded Metals – Corner protection angles, frames, base plates, and other embedded metal items required for complete installation shall conform to the details shown on plans.

(4) Seal Assembly – Seal assembly shall consist of rubber seals, steel retainer and spacer bars, retractable plate, and fasteners. Rubber seals shall be continuous over the full length. Seals shall be accurately fitted and drilled for proper installation. Bolt holes shall be drilled in the rubber seals by using prepared templates or the retainer bars as templates. Splices in seals shall be fully molded, develop a minimum tensile strength of 50 percent of the unspliced seal, and occur only at locations shown. All vulcanizing of splices shall be done in the shop. The vulcanized splices between molded corners and straight lengths shall be located as close to the corners as practicable. Splices shall

be on a 45-degree bevel related to the "thickness" of the seal. The surfaces of finished splices shall be smooth and free of irregularities. Steel retainer bars shall be field-spliced only where shown. Field welding of the steel retainer bar shall be ground flush.

(5) Miscellaneous Embedded Metals – Wall armor, shear anchors, protection and seal plates and shapes, and other miscellaneous embedded metals shall be of structural steel or corrosion-resisting steel conforming with the details specified herein and shown.

E. Tests, Inspection, and Verifications

Submit certified test reports for material tests with all materials delivered to the site.

(j) General – Perform material tests and analyses certified by an approved laboratory to demonstrate that materials are in conformity with the specifications. These tests and analyses must be performed and certified at the Contractor's expense and are in addition to the standard manufacturer's material test reports. Perform tests, inspections, and verifications conforming to the requirements of the particular sections of these specifications for the respective items of work unless otherwise specified or authorized. Conduct tests in the presence of the Engineer if so required. Furnish specimens and samples for additional independent tests and analyses upon request by the Engineer. Properly label specimens and samples and prepare for shipment. Submit certified test reports for material tests performed by the Contractor as well as manufacturers' material test reports with all materials delivered to the site.

F. Installation

Contractor shall install items at locations indicated in accordance with manufacturer's instructions. Verify all field dimensions prior to fabrication. Include materials and parts necessary to complete each assembly, whether indicated or not. Miss-alignment and miss-sizing of holes for fasteners is cause for rejection. Conceal fastenings where practicable. Joints exposed to weather must be watertight.

(a) Embedded Metals – Corner protection angles, frames, base plates, and other embedded metal items required for complete installation shall be accurately installed to the alignment and grade required to ensure accurate fitting and matching of components. Embedded metals shall be given a primer coat of the required paint on all surfaces prior to installation in concrete forms. Anchors for embedded metals shall be installed as shown. Items requiring two concrete pours for installation shall be attached to the embedded anchors after the initial pour, adjusted to the proper alignment, and concreted in place with the second pour.

(b) Seal Assemblies – Rubber seal assemblies shall be installed after the embedded metal components have been concreted in place and the gate installation, including painting, completed. Rubber seals shall be fastened securely to metal retainers. Before operating the gates, a suitable lubricant as prescribed by the seal manufacturer shall be applied to the rubber seal rubbing plates to protect the rubber.

G. Protection of Finished Work

After acceptance of trial operation of the stop logs and posts as described in subsequent section, all stop log panels, posts, bolts, and accessories are to be protected in a storage container located on-site and specified I pan. The storage container shall not exceed more than five feet in height. Contractor shall use separate storage containers for stop logs and posts, if needed. The storage containers shall be bolted to a slab on grade as shown on the plans and will have locks to protect against vandalism. The storage container shall be such that stop logs and posts can be taken out of storage without any special equipment.

H. Acceptance Trial Operation

After completion of installation, the Contracting Officer will examine the stoplog installation for final acceptance. The individual components of the stoplog installation will be examined first to determine whether the workmanship conforms to the specification requirements. The Contractor will be required to place the stoplogs and posts in the guides at least three times to demonstrate that the stoplogs fit properly and seat uniformly. Required repairs or replacements to correct defects, shall be made at no cost to IBWC. The trial operation shall be repeated after defects are corrected.

Method of Measurement:

Payment will be made at the lump sum price bid for each stoplog post and panel system that acts as a single floodgate.

Basis of Payment:

Payment shall constitute full compensation for furnishing all plant, labor, materials, and equipment and performing all operations necessary for installing the stoplogs as specified.

Pay Item	**Pay Unit**
Furnish and Install Fabricated Steel Floodgate	L.S.

ITEM #0603XXXA – STRUCTURAL STEEL

Description:

This section describes structural steel for use in the esplanade cut-off wall and flood protection systems. Structural steel, under this section, shall refer to all permanent structural steel members and hardware used in the flood protection systems, including utility crossings.

Materials:

A. Structural steel shall comply with the requirements of Section 6.03, Structural Steel, unless otherwise noted.

B. Structural steel shapes and plates shall be ASTM A36, unless otherwise shown on the Contract Drawings.

C. Bolts, nuts and washers shall conform to the provisions of ASTM F3125, A563, & F436, respectively.

D. Structural steel and hardware shall be coated in accordance with specification Section ESCR-559 – Protective Coating for Waterfront Structures.

Construction Methods:

A. Submittals

(a) Product Data

1. Materials list of items proposed to be provided under this Section.
2. Manufacturer's specifications, recommended installation procedures and equipment and other pertinent data needed to prove compliance with the specified requirements.
3. Manufacturers' catalogs indicating pull-out and shear strengths of all inserts.

(b) Shop Drawings

1. Fabrication and erection drawings, including welds. Drawings shall be executed in conformance with recommendations and requirements contained in the AISC Publication: DETAILING FOR STEEL CONSTRUCTION.

(c) Certificates

1. Submit certificate stating that all materials and procedures meet or exceed the specified requirements of this Section.
2. Mill certificates certifying chemical and physical properties of all steel furnished.

(d) Reports and Records

1. Inspection and Test Reports

2. Welding Qualification Records
3. Welding Procedures

B. All structural steel work, including, but not limited to fabrication inspection, transportation, and erection shall be performed in accordance with the provisions of the AISC Manual of Steel Construction and Code of Standard Practice For Steel Buildings and Bridges.

C. Inspection of Bolted Connections and Welds

The Contractor shall provide all labor and equipment necessary for the performance of inspection of bolt tightness during structural steel fabrication and erection.

Welds shall be inspected in accordance with AWS D1.1.

D. Qualification Test for Welders, Welding Procedures, and Electrode and Flux Combinations. The Contractor shall provide tests and certifications required to qualify welders, welding procedures and electrode and flux combinations in accordance with AWS D1.1.

E. Radiographic Inspection

Where shown on the Contract Drawings, the Contractor shall provide radiographic inspection and of preparation for radiography, together with the cost of providing access and of furnishing adequate facilities for the review of radiographs in the shop or field.

F. Ultrasonic Inspection

Ultrasonic inspection (UT) shall be performed on all full penetration welds in accordance with AWS D1.1. Any UT inspection work to be done on the job site will be performed by the City's designated representative. The Contractor shall perform any required preparation and furnish access to the weld joints to be inspected.

G. Magnetic Particle Inspection

The Contractor shall provide magnetic particle inspection when specified or required by the inspector to verify limits of defects discovered during visual inspection.

H. Repair of Defects in Welds and Base Metal

The Contractor shall repair defects found by visual inspection or nondestructive tests at no additional cost.

I. Straightening Bent Material and Correcting Camber Deficiencies

The Contractor shall perform all corrective work required to straighten bent material and correct camber deficiencies, when permitted, at no additional cost.

J. Field Repair, Reaming, and Drifting of Holes

Oversize reaming beyond the hole size shown on the shop drawings is not acceptable. The use of reamers to make up connections instead of drifting will not be allowed. Flame enlarging of holes will not be allowed. The Contractor shall provide all work permitted for the correction of unacceptable holes, including the installation of larger bolts, at no additional cost.

K. Field Splices

Field splice locations and details are shown in the Contract Drawings. If the Contractor wishes to change the location of the splice(s), the Contractor shall submit a request to the Engineer for approval.

Method of Measurement:

The quantity of structural steel to be measured for payment shall be the weight of steel, measured to the nearest pound, installed to the satisfaction of the Engineer. Steel density used to compute the weight of steel for payment shall be 490 lbs/cubic feet.

The weight of steel as shown on the approved shop drawings, shall include permanent bolts and welds in the structure as erected. The weight of all required bolts, nuts, washers, and all required welds will be estimated be adding 3% to the steel weight estimate, making no allowance for waste, and included in the weight for which payment will be made.

The weight of all erection materials including but not limited to bolts, pilot and driving nuts, temporary protective coatings, and all boxes, crates or other containers used for packing, together with sills, struts, and rods used for supporting members during transportation, will be excluded from the measurement for payment.

Basis of Payment:

The contract unit price for structural steel shall cover the cost of all labor, materials, plant, equipment, insurance, samples, and incidentals required to furnish, and install in full compliance with the requirements of the specifications and drawings.

Payment will be made under:

Pay Item	Pay Unit
Structural Steel (Uncoated)	LBS.
Structural Steel (Coated)	LBS.

ITEM #06043XXA – PREFABRICATED PEDESTRIAN BRIDGE

Description: Prefabricated bridge shall be "Timber Panel-Lam Recreation Bridge" as designed by Wheeler (Bridge Manufacturer), or approved equal.

Wheeler
9531 W 78th St, Ste 100
Minneapolis, MN 55344
(952) 929-7854
email: info@wheeler1892.com

Wheeler shall be responsible for designing, detailing, fabrication, delivery, construction and erection of the Timber Panel-Lam Recreation Bridge superstructure. Substructures shall be constructed in accordance with the plans and specifications.

1. References:

- AASHTO LRFD Bridge Design Specifications, current edition and interims
- AASHTO LRFD Guide Specifications for the Design of Pedestrian Bridges, current edition
- American Wood Protection Association (AWPA) Standards, current edition
- American Wood Council (AWC) National Design Specifications (NDS) for Wood Construction
- American Institute for Timber Construction (AITC), Timber Construction Manual

Design:

1. Timber Panel-Lam Recreation Bridge

- Bridge superstructure shall be designed using longitudinal dowel-laminated timber deck panels.
- Design shall be in accordance with AASHTO specification, all current interims and the following criteria:
    1. Bridge dimensions:
        a. Three span = 18'/34'/18' As measured from end to end of deck.
        b. Clear width = 6' As measured between inside faces of railing.
        c. Total rail height shall measure at least 42" above deck surface.
    2. All dead loads, applied dead loads, live loads, and wind loads as specified in the AASHTO specification.
    3. Live loads:
        a. 90 psf pedestrian load.
        b. Point Load = 1000 lbs plus 33% impact, applied at a single point.
        c. Lateral Wind Load = 35 psf on the full height of the bridge as if enclosed.
        d. Uplift Wind Load = 20 psf applied at the windward quarter point of the bridge width.
    4. Deflection requirements according to AASHTO.
- Railing shall be of all steel construction following the layout shown on the plans.
- Railing shall connect directly to side of the panelized deck.

- The orientation of the safety rail elements shall be horizontal.
- Horizontal safety rails shall contain a 4” sphere.
- Railing shall include a 4" minimum toe rail located no more than 2" clear above the deck. Toe rails shall be designed per AASHTO as horizontal rails.
- Design and materials for connection of superstructure to substructure shall be included with the superstructure and compatible with substructure design.
- Bearing elevations, structure depth, clearance and profile grade must conform to site conditions.

Materials:

1. Structural Timber

- This section shall include only such lumber and timber, as is part of the completed work. It shall not include falsework, forms, bracing, sheeting or other lumber and timber used for erection purposes.
- Lumber and timber shall meet the requirements of AASHTO M168. Glue laminated timber shall be manufactured using wet use adhesives.
- Knotholes and holes from causes other than knots shall be measured and limited as provided for knots. All visible pieces of lumber and timber having knots that are unsightly in appearance shall be rejected. Cluster knots and knots in groups are not permitted.
- Only pieces consisting of sound wood free from any form of decay shall be accepted. No piece of exceptionally light weight shall be accepted.
- Lumber and timber shall conform to the dimensions specified for either rough or surfaced stock.
- Lumber and timber to be graded as per WWPA Western Lumber Grading Rules or SPIB Standard Grading Rules as applicable.

2. Structural Steel

- All structural steel shall be A500 and hot dipped galvanized.

3. Preservative Treatment

- This section covers the wood preservatives and the preservative treatment of lumber, timber, and posts conforming to the Specifications as referenced or otherwise specified in the plans or special provisions. Temporary bracing shall not require preservative treatment.
- Preservative treatment of lumber and timber shall be by the pressure process, and unless otherwise provided in the contract special provisions, be in accordance AWPA Standards and AASHTO Designation M 133.
- Lumber and timber used for deck panels, spreader beams and rail posts shall be pressure treated with Copper Naphthenate in Type A Hydrocarbon Solvent in accordance with AWPA P-36 and HSA-14 with retentions to meet AWPA UC4B.
- Lumber used for safety railing and cap rail shall be treated with a waterborne preservative meeting the requirements of AWPA UC3B.

- Unless otherwise directed by the Engineer the material shall be graded prior to treatment. Material shall be accepted after treatment on the basis of its condition prior to treatment, on the basis of inspection of the treatment procedure substantiated by plant records, on the condition of the material after treatment and on absorption, penetration and visual inspection.
- So far as practicable all adzing, boring, chamfering, framing, gaining, mortising, surfacing and general framing, etc., shall be done prior to treatment. If cut after treatment, coat cut surfaces according to AWPA M4.
- All Douglas fir and other species that are difficult to penetrate shall be incised prior to treatment.

4. Hardware

- All hardware (machine bolts, carriage bolts, drift pins, lag screws, dowels, rods, nails, spikes, washers, connectors, etc.) shall conform to ASTM 307-97.
- Unless a Dome Head Bolt or approved equal is used, all bolt heads or tightening nuts in contact with Structural Timber and lumber shall have a washer of sufficient thickness and bearing area to ensure a minimum deformation of the contacted surface when tightened to develop not more than the maximum allowable tensile stress of that bolt
- Bolt heads or tightening nuts in contact with metal surfaces shall have a cut washer or approved equal placed between the bolt head or nut and the metal surface.
- All hardware shall be hot-dipped galvanized in accordance with AASHTO M111-91.

Construction Methods:

1. Submittals: All submittals shall include a title sheet with the following:

- Project number, town and crossing.
- Bridge number, when shown on the plans.
- Design code, as applicable.
- Contact information for fabricator – contact information shall include name and address of the fabricator and the name of contact person with phone number and email address.

(a) Sealed Plan

- A detailed bridge plan and supporting calculations sealed by a Professional Engineer registered in the State of Connecticut and experienced in timber bridge design shall be submitted to the Owner after award of contract.
- The bridge plan shall be unique and include all design details and all details necessary for the fabrication and installation of the bridge superstructure. Details of individual fabricated pieces are not required.
- Structural calculations for the design of the bridge superstructure shall include complete design, analysis and code checks.

(b) Timber Certification

- Solid sawn timber members shall conform to the requirements of the grading rules agency for the species, type, and grade specified in the plans or special provisions. Glued-Laminated members shall conform to the American Institute of Timber

Construction 117-201 for the combination, species, use, and appearance as specified in the plans or special provisions. A Grading Agency Certification is required on all timber material.

- The manufacture shall be regularly engaged in the production of the specified product or item and be able to furnish independent records or references of competence and satisfaction of this fact upon the request of the Owner.

Quality Assurance

1. Manufacture

- All material shall be well manufactured. All lumber and timber shall be straight, well sawed, sawed squared at ends and have opposite surfaces parallel unless otherwise required by the plans and specifications.
- Deck panels shall be assembled with 3/8" diameter ring shank dowels. All dowels are to be simultaneously driven with equal force using a mechanical press the full length of the deck, ensuring all heads are flush with the surface of the timber plank. Multiple impact tools are not to be used to set dowels because of potential for wood fiber rupture.
- Deck panels to be delivered to jobsite after being fully assembled at fabrication plant.
- All plank for deck panels shall be precision end trimmed to length with ¼" underlength and no overlength tolerance permitted.

2. Workmanship

- Workmanship shall be first class throughout. Nails and spikes shall be driven with sufficient force to set the heads flush with the surface of the wood, thus ensuring the surface shall be free from deep or frequent hammer marks.
- Proper pre-drilling of holes for screws, nails, spikes, lags or bolts where necessary to avoid splitting of timber will be required.

3. Handling

- Lumber and timber shall be handled with sufficient care to avoid breaking through portions penetrated by treatment, and thereby exposing untreated wood. Chains, peavies, cant hooks, pickaroons, timber dogs, pike poles and other pointed tools that would burr, blemish, penetrate or permanently deform the contacted member shall not be used. Rope, rubber or fabric slings only shall be used.

Basis of Payment: Payment for "Timber Panel-Lam Recreation Bridge" shall be compensation in full for all costs of design, supply, fabricating, and installation for recreation bridge superstructure.

Pay Item	Pay Unit
Timber Panel-Lam Recreation Bridge	N/A

ITEM #0605020A – DIMENSION STONE MASONRY (STONE WEIR)

Stone Weir, All Dimension Stone Masonry shall be constructed in accordance with CTDOT – Form 818, Article 6.05, Supplemented as follows:

Description:
Dimensional Stone shall be set on the pre-existing, cast-in-place Belvedere's concrete walls and surfaces as indicated in the plans and details. Dimensional stone shall also be placed in dedicated/specific locations at top-of-walls, and end-walls, lintels, and sills in the weir. Sills and lintels shall be coordinated between the adjacent, pre-fabricated, buried cistern, and the curvilinear weir.

Materials:
Add the Following:

Stone Source:

Inlet and Outlet Stone Weirs :

A. Basis-of-Design Product: Subject to compliance with requirements, provide Moonlit Rose® from Williams Stone Company or comparable stones by one of the following:
   a. Cold Spring Granite Company.
   b. Stony Creek Quarry.
   c. Williams Stone Company.
   d. Or, Approved Equal.

B. Each color of granite shall come from a single quarry, with sufficient reserves to satisfy the requirements of the project. The granite supplier shall have the capabilities to cut and finish the stone without delaying the project.

Stone:

A. Granite Building Stone Standard: ASTM C 615.

B. Special Shapes: Provide units of shape and dimensions that will produce weirs of dimensions and profiles to follow radius as shown on Drawings and as follows:

C. Stones must be of appropriate size and shape for the type or cap called for in the design.

D. Color and Texture: To closely match Architect's sample.

E. Finish: All exposed surfaces should be 'natural look' (not rectilinear sawn surfaces and edges)

Miscellaneous:

A. Anchors and Pins: Stainless Steel Pins as recommended by stone supplier for use with stone.

Installation Materials:

A. Pins: Stainless steel pins as recommended by stone supplier for use with stone.
B. Epoxy Grout
C. Granite granules from same Quarry as weir dimensional stones

Construction Methods:

Examination:

A. Prepare substrates using the methods recommended by the manufacturer for achieving best result for the substrates under project conditions.

B. Surfaces and Conditions: Prior to installing stone, examine the existing surfaces and conditions to receive the cut stone and verify surfaces and conditions are in accordance with the requirements and as shown on Drawings. Do not proceed until defective surfaces are brought into compliance.
    a. Examine surfaces and conditions with Installer present.

Preparation:

Prior to setting cut stone, clean all surfaces to remove accumulated dirt and stains. Clean thoroughly by scrubbing with non-metallic brushes followed by a drenching with clean water. Use only mild detergents that do not contain caustic fillers.

Placed Stone:

A. Set stone on radius to comply with requirements shown on Drawings. Set stone accurately in locations shown with edges and faces aligned according to established relationships.

B. Construction Tolerances: To be determined at subsequent phase of design with Weir Engineers.

C. Fill all joints at Water course with epoxy grout and add granite granules at exposed epoxy surfaces.

Adjusting:

A. Remove and replace stone not complying with requirements.

B. Replace non-complying stone to match final samples and mockups, comply with specified requirements. Replacement stone shall show no evidence of replacement.

C. Patching: Minor patching in small areas may be acceptable if the repair does not distract from the overall appearance of the finished project.

Protection:

A. At the end of each day's work, cover top of weirs with a non-staining waterproof covering. Protect partially finished work when not being worked on.

Cleaning:

A. Clean stone as work progresses.

B. Final Cleaning: Clean stone as recommended by fabricator or stone producer.
   a. Clean all finished stonework with a mild detergent using a fiber brush.
   b. After cleaning, rinse with clean water.
   c. Do not use acid or other caustic materials.

C. When cleaning is completed, remove temporary protection.

Stone Fabrication:

A. Fabricate stone in accordance with requirements, including Drawings and Shop Drawings.
   1. Granite: NBGQA's "Specifications for Architectural Granite."

B. Cut stone to produce pieces of stone shown on Drawings and recommended by stone source, for faces, edges, beds, and backs.

C. Thickness of Stone: Provide thickness shown, but not less than the following:
   1. Thickness: 8 inches
   2. Tolerance: Plus or minus 1/4 inch.

D. Dress joints (bed and vertical) straight and follow radius from face.

E. Finish exposed faces and edges of stone to comply with requirements shown for finish and to match approved samples and mockups.
   1. Finish:
      a. Face- Natural Cleft.
      b. Top of Weir Thermaled

F. Carefully inspect stone at fabrication plant for compliance with requirements for appearance, material, and fabrication. Replace defective units before shipment.

Submittals:

A. Product Data: For each stone type and each manufactured product shown on Drawings or specified.
    1. For each stone variety used on Project, include physical property data.

B. Shop Drawings: For the following:
    1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
    2. Detail components embedded in masonry.

C. Samples: Submit samples for each stone type required, exhibiting the full range of color characteristics expected.
    1. Submit a minimum of 2 each, 8 inches x 8 inches and 2 inches x 10 inches in size, in each color and finish specified.
    2. In the case of more variegated stones, color photos shall be submitted in addition to the number of samples to show the full range of color and markings to be expected.
    3. Accessories embedded in masonry.

D. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used.
    1. Submittal is for information only. Neither receipt of list nor approval of mockup constitutes approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Architect and approved in writing.

Quality Assurance:

A. Source Limitations for Stone: Obtain each stone variety from a single quarry.

B. Fabricator Qualifications: Engage experienced fabricator that has completed stone fabrication similar in material, design, and extent to that indicated for the project.

C. Installer Qualifications: Engage experienced installer that has completed stone installation similar in material, design, and extent to that indicated for the project.

D. Visual Mockup: Provide full mock-up of the approved stone or stones in the approved finishes, erected at a site agreed to by the Architect, Contractor, and the Fabricator. The approved mock-up shall become the standard for the project.
    a. Build mockup of areas as shown on Drawings.

b. Color consistency: demonstrate color consistency with mockup; color range shall not exceed range of color established by samples.
c. Included typical components.
d. Mockup may become part of the completed Work if approved at time of Substantial Completion.

Delivery, Storage and Handling:

A. Store and handle materials to prevent deterioration or damage.

B. Stone shall be carefully packed and loaded for shipment using reasonable care and customary precautions against damage in transit. Material, which may cause staining or discoloration shall not be used for blocking or packing.

C. The stone shall be stacked on timber or platforms at least 4 inches above the ground. Care shall be taken to prevent staining or discoloration during storage.

D. If storage is to be for a prolonged period, polyethylene or other suitable plastic film shall be placed between wood and finished surfaces of completely dry stone.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

F. Remove Soil to prevent staining face of stone.

Method of Measurement:

This work will be measured for payment by the number of square feet of completed and accepted.

Basis of Payment:

This work will be paid for at the Contract unit price per square foot for "Dimension Stone Masonry," complete in place, which price shall include materials, equipment, tools, labor and work incidental thereto; also all necessary excavation, refilling and disposal of surplus material.

Pay Item:	Pay Unit
Dimension Stone Masonry	S.F.

ITEM #06050XXA – STILLING BASIN WEIR
ITEM #06050XXA – STONE VENEER PARAPET
ITEM #06050XXA – PEDESTRIAN CROSSING VENEER STONE

Stilling Basin Weir, pedestrian crossing veneer stone and parapet shall be constructed in accordance with CTDOT – Form 818, article 6.05, Supplemented as follows:

Materials:

Add the Following:

Stilling Basin Stone shall be "Stony Creek Granite", supplied by Stony Creek Quarry, 99 Quarry Rd., Branford, CT 06405 or approved equal.

—Pavers shall have the bottom and the sides sawn. Top shall be thermal with no projection or depression exceeding 1/4 in.

—Color, texture, and finish shall match the sample at the office of the Landscape Architect, and shall be as approved by the Landscape Architect from samples submitted by the Contractor prior to delivery. Brick shall be uniform in color, size, appearance, and dimensions, and shall have smooth regular edges where they are closely butted.

Stone Veneer Parapet shall be "Stony Creek Granite", supplied by Stony Creek Quarry, 99 Quarry Rd., Branford, CT 06405 or approved equal.

—Pavers shall have the bottom and the sides sawn. Top shall be thermal with no projection or depression exceeding 1/4 in.

—Color, texture, and finish shall match the sample at the office of the Landscape Architect, and shall be as approved by the Landscape Architect from samples submitted by the Contractor prior to delivery. Brick shall be uniform in color, size, appearance, and dimensions, and shall have smooth regular edges where they are closely butted.

Basis of Payment:

Add the Following:

Pay Item:	Pay Unit
Stilling Basin Weir	ssf
Stone Veneer Parapet	ssf
Pedestrian Crossing Veneer Stone	ssf

ITEM #0702XXXA – MONITORING AND POST-CONSTRUCTION REPORT

Description:

The intent of this section is to monitor and summarize the effects of construction activities on structures located within the influence line of work to be performed under the contract to ensure that the Contractor's proposed means and methods of construction do not create or aggravate any potentially dangerous conditions.

The Contractor will be required to adhere to all criteria, requirements and recommendations of the Engineer approved preconstruction report; if not, the Contractor must cease work until corrective actions are taken.

Materials:

The Contractor shall submit to the Engineer qualifications of the firm it proposes to provide the engineering services described in this section. The proposed firm must, within the last three (3) consecutive years, have successfully provided engineering services similar to the services described in this section on a minimum of two (2) comparable projects. Such firm must carry professional liability insurance.

Compliance with such special experience requirements will be determined solely by the Engineer. Once a firm is approved, no substitution will be permitted, unless the Engineer has approved the qualifications of the proposed replacement in writing in advance. If the qualifications of the proposed firm are not acceptable, the Contractor shall submit the qualifications of another proposed firm within fifteen (15) days of notice to do so.

The firm approved for the preparation of the preconstruction report may also be submitted for approval to perform the monitoring and post- construction report work.

Construction Methods:

A. Monitoring Reports

The firm will be required to perform the monitoring during construction activity, including installation of sheet piles, piles, and ground improvement, and submit reports to the Engineer on a weekly basis. These reports shall include sketches noting the location of all monitoring points. The minimum monitoring points required are shown on the Contract Drawings; however, the Contractor and the consulting firm hired by the Contractor may add monitoring points as they see fit. Should any of the criteria set forth in the preconstruction report(s) be exceeded, the Engineer shall be notified immediately. Monitoring shall include but not be limited to the following:

(a) Settlement Monitoring

For existing structures and buildings:

1. A series of reference points shall be established outside of the "radius of influence" for monitoring structural settlements. All initial and subsequent readings shall be taken to the nearest one-hundredth (0.01) of a foot.

2. Structures and/or buildings shall be monitored daily for vertical and horizontal movement with respect to when work is being performed within the radius of influence. Upon completion of work within the radius of influence, buildings and/or structures shall be monitored weekly for the first month then monthly for the next five (5) months. In the event of an unusual or unexpected event, monitoring shall be performed within twenty-four (24) hours of the event.

3. Should the limit of horizontal and/or vertical movement, as set forth in the preconstruction report, of any building and/or structure be exceeded, the Contractor shall immediately and concurrently notify the Engineer and, at the Contractor's own expense, follow the steps included in the preconstruction report to rectify the situation and prevent any further settlement of such building and/or structure. The Contractor shall be fully responsible for any damages to any foundations, walls or other portions of buildings and/or structures that may result during the courses of this construction. Any damage done by the Contractor, whether it is accidental or due to negligence or carelessness in performing the work included in this contract shall be made good by the Contractor at the Contractor's own expense.

4. Permissible settlement for structures may be established by the Contractor's consulting firm but shall not exceed 1/2-inch.

5. All survey readings shall be done by or under the immediate supervision of a Licensed Land Surveyor, currently registered in the State of Connecticut. All survey readings shall include the imprint of the Surveyor's seal and signature.

6. The Contractor shall transmit a copy of all readings to the Engineer on the same day they are taken.

(b) Vibration Monitoring

For existing structures and buildings:

1. Should the Contractor employ means and methods of construction that will result in vibrations being imparted to the surrounding soil and/or buildings

and/or structures, the Contractor shall monitor and record particle velocity. Locations of the monitoring points shall be placed in such a manner so as to ensure recordings that reveal any possibility of damage to existing structures and/or buildings. Location of the monitoring points shall be subject to the Engineer's approval.

2. These points shall be monitored at all times when means and methods of construction resulting in vibrations are employed. The maximum permissible peak particle velocity shall be that noted in the preconstruction report. Should particle velocities be exceeded the Contractor shall immediately cease operations and resort to another method which will eliminate or minimize the effect of vibrations.

3. It shall be the Contractor's responsibility to restore any buildings or structures damaged as a result of the Contractor's operations to its original condition or better.

4. The maximum permissible peak particle velocity may be established by the Contractor's consulting firm but shall not exceed 1.0-inch per second (in particle velocity) above the ambient vibration level. Stop pile driving if the vibration exceeds 1.0- inch per second above ambient.

5. The results of the vibration monitoring shall be submitted to the Engineer on the same day of monitoring

B. Post-Construction Report

Within thirty (30) days of the completion of all work that necessitated monitoring, the chosen firm shall prepare and submit a report detailing the results of the monitoring program. The report shall include a comparison of all assumptions and field-measured values. Should there be excessive discrepancies between the assumptions and field-measured values, an explanation shall be presented within the report. The report shall include sketches of all monitoring points. The reports shall include the location and length of all piles and sheet piles driven superimposed on the geological profile. The location and lengths of piles and sheet piles to be installed are shown on the Contract Drawings. The post- construction report(s) shall be prepared by or under the immediate direction of a Connecticut State Licensed Professional Engineer as evidenced by the imprint of the Professional Engineer's seal and signature on the document.

Method of Measurement:

The contract unit price shall be the lump sum price bid and shall include the cost of all labor, materials, plant, equipment and insurance necessary or required to prepare weekly reports, examine buildings and structures, perform the construction monitoring, prepare the post-

construction report and do all other work incidental thereto all in accordance with the specifications, and as directed by the Engineer.

Basis of Payment:

No separate or additional payment will be made for compliance with the requirements of the preconstruction report including, but not limited to, any modification to the Contractor's means and methods of construction.

Payment for this work shall be made proportional to the work completed as follows:

Completion of Field Monitoring	60%
Acceptance of Post-Construction Report	40%

Payment will be made under:

Pay Item	Pay Unit
Monitoring and Post-construction Report	L.S.

ITEM #0702XXXA – PRECONSTRUCTION REPORT

Description:

The intent of this section is to prepare preconstruction reports for work to be performed under the contract to ensure that the Contractor's proposed means and methods of construction do not create or aggravate any potentially dangerous conditions. In order to ascertain the effects of construction on structures, the Contractor will be required to retain the services of a qualified firm with experience in structural engineering, soil mechanics, foundations, installation of piles, evaluation of the effect of construction on buildings and structures, and the effect of vibrations upon structures. All floodwall system construction work is subject to the preconstruction report.

Materials:

The Contractor shall submit to the Engineer qualifications of the firm it proposes to provide the engineering services described in this section. The proposed firm must, within the last three (3) consecutive years, have successfully provided engineering services similar to the services described in this section on a minimum of two (2) comparable projects. Such firm must carry professional liability insurance.

Compliance with such special experience requirements will be determined solely by the Engineer. Once a firm is approved, no substitution will be permitted, unless the Engineer has approved the qualifications of the proposed replacement in writing in advance. If the qualifications of the proposed firm are not acceptable, the Contractor shall submit the qualifications of another proposed firm within fifteen (15) days of notice to do so.

Construction Methods:

Upon approval and prior to construction, the chosen firm shall submit a report incorporating their findings and recommendations. The report shall be prepared by or under the immediate direction of a Connecticut State Licensed Professional Engineer as evidenced by the imprint of the Professional Engineer's seal and signature on the document. The report shall include but not be limited to the following:

A. A detailed description of the Contractor's proposed means and methods of construction including the installation of the floodwalls, pile system, and ground improvement.

B. An inspection of the interior and exterior (including photographs and digital audio-visual recordings as required) of all buildings and structures that may be affected by the proposed means and methods of construction.

C. A definition of the "radius of influence" that the proposed floodwall installation, pile installation, ground improvement, and other construction activity that will impart on the surrounding soil.

D. A definition of the limits of horizontal and vertical movement each building and/or structure within the "radius of influence" can tolerate without damage to the structural integrity of that building and/or structure; however, these limits shall be subject to the approval of the Engineer. Movements which shall be considered include, but are not limited to, vibration-related settlements, differential settlements, and building movement and/or rotation due to excavation or construction-related work.

E. A complete study of the vibrations that each building/structure can tolerate along with the anticipated vibrations promulgated by the means and methods of construction, taking into account the age and condition of the buildings.

F. A statement that the limits of movement and vibrations as defined in (D) and (E) above will not be exceeded as a result of the proposed means and methods of construction, as well as means and methods the Contractor, at the Contractor's own expense, will employ should any limits be exceeded. Limits of movement and vibrations shall be proposed by the Contractor and the firm hired by the Contractor; however, these limits shall be subject to the approval of the Engineer.

G. A geological profile of the soils in the area. This profile shall be based upon the boring logs taken for this project. The Contractor, at own discretion, may make additional borings to supplement the boring logs taken for the project. Supplemental borings made by the Contractor shall be at no additional cost, the cost for these borings shall be deemed included in the price bid for this preconstruction report.

H. A geotechnical data summary including assumed values for the physical and strength characteristics of the soils shown on the Record(s) of Borings, developed from, but not limited to available soil and/or rock descriptions, blow counts, and available geotechnical laboratory testing. Such physical and strength characteristics include, but are not limited to, a soil's unit weight, friction angle, cohesion, consolidation properties, and permeability/drainage properties.

I. Engineering computations to substantiate any values stated, recommended, or defined in (C), (D) and (E), using the appropriate data from (G) and (H).

The report(s) shall include all field notes, measurements and photographs and digital audio-visual recordings, as required, of existing conditions which may be aggravated by the proposed construction work and shall include a visual inspection of the interior and exterior of all buildings and structures within the radius of influence of construction activity and dewatering. A view of each exterior face of the building and/or structure is required. Additional interior photographs shall be taken to show any existing cosmetic or structural damage on buildings.

Applications for consents to enter buildings and/or structures for the purpose of inspection shall state that the inspection is necessary to ensure the structural integrity of the building. One counterpart of each consent, duly signed and acknowledged by the owner or one of the owners, executors or administrators for the owner and for the owner's agents, lessee and any other persons who shall have a vested or contingent interest in the building, or notice of refusal if consent is not obtained shall be filed with the Engineer at least ten (10) days before the commencement of work which affect the building or structure.

The report shall also include recommendations or comments regarding any potentially dangerous and/or unsafe conditions uncovered along with all other additional information required pursuant to other sections of the specifications.

All results of the building or structure examinations shall be incorporated into the preconstruction report.

No work may begin until the Department of Transportation has accepted the preconstruction report. This pertains to all contract work and no exceptions will be allowed unless otherwise stated in these specifications.

Prior to bidding, the Contractor shall examine the site and available subsurface inspection information and formulate means and methods of construction that will not result in any damage to existing structures. Should the Contractor lack the expertise in evaluating the effects of the Contractor's means and methods of construction, the Contractor should prepare its bid in consultation with an experienced firm or authority. In any event, the Contractor will be held liable for any damage to any existing structures due to the Contractor's means and methods of construction.

In addition, should the results of the preconstruction report(s) indicate that damage will result from the Contractor's proposed means and methods of construction, the Contractor will be required to amend the Contractor's means and methods of construction in accordance with the preconstruction report.

Method of Measurement:

The contract price shall be a lump sum price and shall include the cost of all labor, materials, plant, equipment and insurance necessary or required to prepare the preconstruction report, including building examinations and do all other work incidental thereto all in accordance with the specifications and as directed by the Engineer.

Basis of Payment:

No payment for the preconstruction report will be made until after the Department of Transportation has accepted the preconstruction report.

Payment will be made under:

Pay Item	Pay Unit
Preconstruction Report	L.S.

ITEM #0713XXXA – PROTECTIVE COATING FOR WATERFRONT STRUCTURES

Description:

Protective coating for use on the floodwall and floodgate foundation sheet piles and piles.

Protective coating for use on the flood protection system shall be a two-part coal tar epoxy polyamide coating system suitable for the waterfront environment. Where applicable, CTDOT Standard Specification Section M.07.02 – Coating Systems for Structural Steel, shall also apply.

Materials:

A. Coating
Coal Tar Epoxy Polyamide coating system shall comply with SSPC-PAINT16 and shall be a two-part 4:1 system conforming to SSPC-PS11.01

Construction Methods:

A. Submittals

(a) Materials list of items proposed to be provided under this Section.

(b) Manufacturer's specifications, recommended installation procedures and equipment, Materials Safety Data Sheets (MSDS) and other pertinent data needed to prove compliance with the specified requirements.

(c) Tools for mixing and application, as approved by the manufacturer of the coating system supplier.

(d) Manufacturer's instruction for field touch-up of damaged coating.

(e) Certificates - Field Test Results

B. General

Coating work shall only commence when ambient and curing temperatures are within limits of the coating manufacturer's recommendations and at least 5 degrees F above dew point temperature.
Ensure proper identification after packages are opened and all manufacturer safety recommendations are followed.

At time of delivery all products shall be dry, sealed in their original packages and containers, free of mud, oil, and any other materials or contaminants that may adversely affect quality.

C. Surface Preparation

Prepare steel surfaces for coating applications in accordance with SSPC-SP10/NACE No. 2, or as otherwise recommended by manufacturer.

D. Proportioning of coal tar epoxy-polyamide system

Coal tar epoxy-polyamide consists of a two-component system. Component A contains a refined coal tar pitch, polyamide resin, and a polyamine promoter to accelerate curing rate. Component B is an epoxy resin. Mix both components in a ratio of 4 parts of Component A to 1 part of Component B by volume. When thinning is allowed and is necessary for proper application, use xylene or the coating manufacturer's recommended thinner, to a maximum of 1/2 gallon to a 5-gallon batch.

Power-stir components to a smooth, uniform consistency. Stir coating periodically during induction period. Follow coating manufacturer's requirements for induction time and pot life of mixed batches.

E. Coating Application

Coatings shall be shop applied. Apply primer coating to dry surfaces not more than 4 hours after near-white blast cleaning. Apply coats so that finished surfaces are free from runs, sags, brush marks and variations in color.

Unless otherwise specified by manufacturer's recommendations, do not allow drying time between coats to exceed 72 hours. Under conditions of direct sunlight or elevated ambient temperatures of 90 degrees F or greater, limit intercoat drying period to a maximum of 24 hours.

Repair detected coating holidays, thin areas, exposed areas, and areas damaged during welding procedures prior to or during installation by surface treatment and application of additional coating or by manufacturer's recommendations. Allow a period of at least 72 hours to pass following final coat before placing in immersion service.

Apply the first coat to yield a dry film thickness of 8 to 10 mils. Apply the second coat so that the total dry film thickness of the two coats is between 16 and 20 mils. Measure using a magnetic thickness gage.

Coating shall be applied to the following steel elements to the extents described below, unless otherwise noted:

Floodwall and Floodgate Foundations

- Coat full length of H-piles and sheet piles
- For steel sheet piles, both faces shall be coated.

F. Field Touch-Up

Touch-up areas of coating damage for all sheet piles and H-piles with coal tar epoxy. Use same color as original coating. Follow manufacturer's instructions.

G. Field Tests

Conduct testing in the presence of the Engineer.

Holiday Testing

1. Prior to installation, test for holidays in total coating system.
2. Use a low-voltage holiday detector of less than 90 volts in accordance with manufacturer's recommendations.
3. After repair of holidays of surface treatment and application of additional coating or by manufacturer's recommendation, retest with low voltage holiday detector.

Dry Film Thickness

1. After repair of holidays, measure dry film thickness using a magnetic dry film thickness gage in accordance with ASTM D1186 and ASTM E376.
2. Re-measure after an additional coat is applied.
3. Continue to apply additional coats until minimum thickness requirements are met.

Method of Measurement:

No separate payment will be made for complying with the requirements of this Section.

Basis of Payment:

No separate payment will be made for complying with the requirements of this Section.

ITEM #0713XXXA – STEEL SHEET PILING

Description:

This section describes steel sheet piling for use in the flood protection structures. Steel sheet piling, under this section, shall refer to all permanent steel sheet piling used for the floodwall, floodgate foundations, and cut-off wall. All steel sheet piling described under this section shall also comply with CTDOT Standard Specification Section 7.13, Permanent Steel Sheet Piling, and Section M.09, Sheet Piling and Piles

Materials:

A. All sheet piles and king piles shall be delivered in single pieces. The interlocks of sheet piling and king piles shall be free-sliding, provide a swing angle suitable for the intended installation, but not more than 5 degrees when interlocked, and maintain continuous interlocking when installed. Sheet piling and king piles shall be sections of the dimensions shown on the Contract documents. Sheet piling and king piles shall be provided with standard pulling holes. The outboard face of sheet piling and king piles shall be fully coated in the shop per requirements of these Specification, and touched up in the field as required prior to, during and after driving.

   The Contract Documents refer to AZ steel sheet pile sections manufactured by Nucor Skyline. Use of equivalents shall be approved by the Engineer and shall not change other elements of the design that incur additional cost.

B. Steel sheet piling for the buried inland floodwall and deadman shall be ASTM A572, Grade 60.

C. Steel sheet piling for the floodwall shall be ASTM A572, Grade 60.

D. Steel sheet piling for the cut-off wall shall be ASTM A572, Grade 60.

E. Combi-wall for the cut-off wall shall be ASTM A572, Grade 60.

F. Tie rods for the cut-off wall anchoring system shall be ASTM 615, 75 ksi threaded bar hot-dip galvanized in accordance with ASTM A153.

G. Steel bearing plate, articulating couplers, and turnbuckles for the tie rods shall be galvanized and provided by the same manufacturer as the tie rod.

H. Coating for the steel sheet piling must be in accordance with specification #0713XXXA Protective Coating for Waterfront Structures.

I. Interlock sealant, where specified on the drawings, shall be a coal-tar resistant sealant suitable for sealing against water and applied in the factory. Interlock sealant shall be approved by the Engineer and the CT DEEP.

Construction Methods:

A. Submittals

(a) Equipment Descriptions – Complete descriptions of sheet piling driving equipment including hammers, extractors, protection caps, and other installation appurtenances shall be submitted for approval prior to commencement of work.

(b) Protective Coating Systems – Manufacturer's specifications, recommended installation procedures and equipment, Materials Safety Data Sheets (MSDS) and other pertinent data needed to prove compliance with the specified requirements. Tools for mixing and application, as approved by the manufacturer of the coating system supplier. Manufacturer's instruction for field touch-up of damaged coating.

(c) Interlock Sealant – Manufacturer's specifications, recommended installation procedures and equipment, Materials Safety Data Sheets (MSDS) and other pertinent data needed to prove compliance with the specified requirements.

(d) Shop Drawings – Drawings for sheet piling shall show complete piling dimensions and details, driving sequence, and location of installed piling. Detail drawings shall include details and dimensions of templates and other temporary guide structures for installing piling, as well as all appurtenances and temporary supports for the tie rods. Detail drawings shall provide details of the method of handling piling to prevent permanent deformation, overstress, and damage to coatings and piling interlocks.

(e) Design Data – Submit welding procedures (PQR / WPS) for approval.

(f) Certificates

- Welder's Qualifications (WPQ): Certificate stating that all coating materials and procedures meet or exceed the specified requirements of this Section.
- Field Test Results for Coating
- Material Mill Certificates

(g) Driving Records - Records of the sheet piling driving operations shall be submitted no later than 7 days after driving is completed. These records shall provide a system of identification which shows the disposition of approved piling in the work, driving equipment performance data, piling penetration rate data, piling dimensions, and top and bottom elevations of installed piling.

(h) Record Drawings - Provide in AutoCAD format with location and tip elevations.

(i) Pulling and Redriving - Provide records of all sheet piles that have been pulled or redriven.

(j) Contractor's Work Plan - Contractor shall submit a detailed work plan for driving all piles to Engineer for approval. It shall include procedures, equipment and personnel to be used, schedule and sequencing, and a general narrative of the proposed work and plan.

(k) Daily Reports – The Contractor shall submit the proposed driving hammer(s) and a report prepared by a State of Connecticut licensed Professional Engineer, including WEAP analysis, that shows the hammer is adequate to install the piles and will not damage the piles during driving.

B. Site Preparation

Protect existing structures, including overhead and buried utility lines, during installation of sheet piles. Contractor shall perform exploratory test pits in the area of the proposed sheet pile installation to first expose any buried utilities prior to any sheet pile installation.

C. Pile Driving Equipment (non-press-in method)

Where a press-in method of installation is not specified, the sheet piles shall be installed using an approved driving head designed to properly fit a pair of piles. Avoid damage to the top of the piles during driving.

Use an approved impact or vibratory pile hammer of sufficient size to drive the sheet piles to the tip elevation(s) shown on the Contract Drawings without causing stresses due to driving in excess of 90 percent of the yield strength (Fy) of the pile material, verified based on Wave Equation Analyses (WEAP Analyses) performed by the Contractor.

D. Pile Driving Equipment (press-in method)

Where specified on the drawings, the steel sheet piles shall be hydraulically pressed-in and extracted utilizing a non-vibratory, non-percussive hydraulic press-in methodology.

The hydraulic press-in equipment shall not produce more than 70dB of noise at a distance of 25 feet from the equipment while in operation. During pile installation, the hydraulic press-in equipment shall not produce any measurable vibration at the ground surface at a distance of 15 feet.

E. Welding and Splicing

Perform welding in accordance with requirements of AWS D1.1. Reinforce pile tips if and as shown on the Contract Drawings. Splicing of sheet piles is only permitted where there is limited headroom for the pile-installation equipment, such as under the FDR Drive viaduct, or as directed by the Engineer.

Have all welds visually inspected by an AWS Certified Welding Inspector (CWI). Nondestructively test all full penetration welds for 100 percent of the weld length by ultrasonic methods, as approved by the Engineer. Coordinate the Work and timely notify the Engineer to ensure that all testing and inspection procedures required by the Engineer are properly provided.

F. Welding of Headed Shear Studs on Sheet Piles

Headed shear studs shall be welded to the sheet piles at the locations indicated on the Contract Drawings, and as directed by the Engineer. The studs shall be installed on site, following sheet pile installation. The sheet piles shall not be coated in the immediate area surrounding the shear studs, or the coating shall be removed prior to stud installation. The headed shear studs shall be of the size indicated on the Contract Drawings. They shall not be coated. They shall be Nelson Type H4L or S3L, or approved equal, flux filled, welded as shown on the Drawings. Studs shall be from cold drawn steel Grades C-1010 through C-1020, per ASTM A108, and shall be welded per the manufacturer's recommendations. The minimum ultimate tensile strength shall be 60 ksi, and the minimum yield strength shall be 50 ksi.

G. Coating of Piles

Piles shall be coated in accordance with and to the extents specified on the Contract Drawings.

H. Alignment of Piling

Contractor shall furnish necessary surveying services for establishing sheet piling locations. Any sheet piles driven more than 2 in. from the location indicated on the Contract Drawings will not be acceptable. Sheet piling shall be driven plumb. For permanent work, deviation from the plumb position of more than one-eighth inch per foot shall be cause for rejection. Contractor shall provide suitable guide structures to ensure that piles and driving equipment are properly aligned during driving. Guide structures shall be equipped with suitable devices to avoid damaging protecting coatings of pilings. If, at any time, the piling is found to be out of plumb in the plane of the wall, the Contractor shall provide tapered piles or take other corrective measures to ensure plumbness of the succeeding.

I. Pile Driving

Use an approved guide frame or template to set sheet piles in proper position and alignment and to provide adequate lateral support to maintain vertical alignment during driving. Where field conditions require, use two levels of guide wales to maintain vertical alignment during driving.

Properly set and "shake out" steel sheet piles prior to driving. Place a pair of sheets within their interlocks; then lower them as far as possible. If the sheets bind or hang up in their interlocks before bearing on the ground, pick up adjacent sheets in pairs and shake out as required, until the sheets ride smoothly within their interlocks and simultaneously bear on the ground.

Top of sheet pile shall be normal to the driving force.

Drive sheet piles to the tip elevation(s) shown on the Contract Drawings. Drive sheet piles in segments to assure final sheet pile location are installed in the intended locations.

Drive sheet piles in such a manner as to prevent piles from leaning in the direction of driving and to provide a continuous closure of sheet piles, where closure is required. Where possible, drive sheet piling with the ball end leading. If an open socket is leading, provide a bolt or similar object in the bottom of the interlock to keep interlock free of soil material.

At the completion of the driving operation on a pile, verify that the pile is undamaged, free of defects and in compliance with the requirements of this Section.

Cut piles off at cut-off elevation as shown on the Contract Drawings as soon as practical after driving.
Obstructions encountered during driving shall be removed or the Contractor may penetrate the obstruction by spudding or other means at no additional cost to the City. Measures to be taken shall be as approved by the Engineer. Contractor is advised of the fact that remnants of abandoned timber piles, concrete debris, and rip rap and timber can be expected to be encountered. If a sheet pile strikes an obstruction, adjacent sheets shall be driven below the elevation of the obstruction before driving through, spudding, or removing the obstruction.

No jetting will be permitted without specific approval of the Engineer.

J. Correction of Deficiencies

Notify the Engineer immediately in writing of the failure of any sheet pile to meet any requirement of this Section. Such written notification shall include all information required for the evaluation of remedial measures.

Perform remedial work at Contractor's expense or in accordance with both the applicable Unit Price provisions, if any, and the modified design and details, if any, all as approved by the Engineer, except for sheet piles which do not comply with the requirements of this Section due to encountering during driving any underground obstruction consisting of a boulder or piece of manufactured or construction material as shown by the Contractor, and as determined by the Engineer on the basis of all field information.

K. Pre-drilling

Pre-drilling for installation of pipe piles shall be performed to clear obstructions and remove portions of existing historic structures to allow for installation of sheet piles and combi-walls to the specified tip elevation as shown on the Contract Drawings.

Method of Measurement:

The quantity of steel sheet piling to be measured for payment shall be the number of square feet, measured to the nearest square foot, installed to the satisfaction of the Engineer. The horizontal length will be measured along a projection of the sheeting on a plane parallel to and midway between the front and rear face of the sheeting wall. No payment or allowance will be made for steel sheet piling installed beyond the limits specified.

The quantity of combi-wall to be measured for payment shall be the number of square feet, measured to the nearest square foot, installed to the satisfaction of the Engineer. The horizontal length will be measured along a projection of the sheeting on a plane parallel to and midway between the front and rear face of the combi-wall. No payment or allowance will be made for steel sheet piling installed beyond the limits specified.

The quantity of tie rod to be measured for payment shall be the number of linear feet, measured to the nearest tenth of a foot, installed to the satisfaction of the Engineer. The quantity of tie rod shall include any articulated couplers, nuts, bearing plates, turnbuckles, temporary supports, and other hardware required to install the tie rods. No payment of allowance will be made for steel sheet piling installed placed beyond the limits specified.

The quantity of rock socket to be measured for payment shall be the number of rock sockets installed to the satisfaction of the Engineer. The rock socket shall include all drilling, removal of materials within the pile, cleaning, installation of anchors, temporary supports, concrete/grout fill, and other hardware required to install the rock sockets. No payment of allowance will be made for steel sheet piling installed placed beyond the limits specified.

Basis of Payment:

The contract unit price for steel sheet piling shall cover the cost of all labor, materials, plant, equipment, insurance, samples, and incidentals required to furnish, coatings (where specified), and install in full compliance with the requirements of the specifications and drawings. The cost to perform exploratory test pits to locate buried utilities prior to sheet pile installation and remove

any obstructions that may interfere with the installation of the sheet piling to the specified elevations will be included in the unit price.

The contract unit price for tie rods shall cover the cost of all labor, materials, articulating couplers, turnbuckles, plant, equipment, insurance, samples, and incidentals required to furnish, galvanize, touch-up, and install in full compliance with the requirements of the specifications and drawings. The unit price for tie rods shall include any articulated couplers, nuts, bearing plates, turnbuckles, temporary supports, and other hardware required to install the tie rods.

The contract unit price for combi-wall shall cover the cost of all labor, materials, plant, equipment, insurance, samples, and incidentals required to furnish, coatings (where specified), and install in full compliance with the requirements of the specifications and drawings. The cost to perform any investigations to locate buried utilities or potential obstructions prior to combi-wall installation and the removal of any obstructions that may interfere with the installation of the combi-wall to the specified elevations will be included in the unit price.

The contract unit price for rock sockets shall cover the cost of all labor, materials, plant, equipment, insurance, samples, and incidentals required to furnish and install in full compliance with the requirements of the specifications and drawings.

Pay Item	**Pay Unit**
Steel Sheet Pile Installed Using Non-Press-In Methods	S.F.
Steel Sheet Pile Installed Using the Press-In Method	S.F.
3.0 in. Diameter Hot-Dip Galvanized Tie Rod and All Appurtenances	L.F.

ITEM #0755XXXA – GEOTEXTILE FILTER FABRIC

Description:

This section describes the geotextile for use under the floodwall articulated concrete block revetment. Under this section, the Contractor shall furnish and install geotextile filter fabric in the manner shown on the Contract Drawings. The purpose of the geotextile filter fabric is to provide a permeable layer which allows water but not soil particles to pass through. The geotextile filter fabric shall be installed in accordance with the Contract Drawings, the specifications, and the directions of the Engineer.

Provide all labor, material, and equipment and perform all operations necessary for the complete and satisfactory installation of the geotextile. The work shall include, but not be limited to, placement of geotextile, material and associated equipment and operation used in laps or extra length; and associated material, equipment, and operations; and material and associated equipment and operations used to provide cushioning layer of sand or gravel or both to permit increase in allowable drop height of stone.

Contractor performing the Work of this section shall have at least five years minimum experience in similar projects.

Unless otherwise noted, all Geotextile Filter Fabric shall conform to Section 7.55 Geotextile.

Materials:

The filter fabric for the revetment shall consist of non-woven geotextile matching or exceeding the minimum average roll values listed in Table 1. Strength values indicated in the table are for the weaker principal direction.

Table 1: Minimum Physical Requirements for Geotextile

Property	Unit	Acceptable Values	Test Method
Tensile strength	Lbf	300 (Min)	ASTM D 4632
Puncture resistance	Lbf	180 (Min)	ASTM D 4833
Trapezoidal tear	Lbf	115 (Min)	ASTM D 4533
Burst strength	psi	580 (Min)	ASTM D 3786/D 3786M
Flow rate	gpm / ft^2	65 (Min)	ASTM D 4491
Permittivity	sec^{-1}	0.8 (Min)	ASTM D 4491
Apparent opening size	US Sieve	100	ASTM D 4751
Ultraviolet degradation	%	70% at 500 hrs (Min)	ASTM D 4355

Fibers used in the manufacturing of the geotextile shall consist of a long-chain synthetic polymer composed of at least 85 percent by weight of polyolefins, polyesters, or polyamides. If necessary, add stabilizers and/or inhibitors to the base polymer to make the filaments resistant to deterioration caused by ultraviolet light and heat exposure. Reclaimed or recycled fibers or polymer shall not be added to the formulation. Geotextile shall be formed into a network such that the filaments or yarns retain dimensional stability relative to each other, including the edges. Finish the edges of the geotextile to prevent the outer fiber from pulling away from the geotextile.

Seams are not permitted.

Geotextiles and factory seams shall meet the requirements specified in Table 1. Randomly sample geotextiles in accordance with ASTM D 4354 (Procedure Method A). Sample factory seams at the frequency specified in ASTM D 4884.

Provide all samples from the same production lot as will be supplied for the contract, of the full manufactured width of the geotextile by at least 10 feet long, except that samples for seam strength may be a full width sample folded over and the edges stitched for a length of at least 5 feet. Samples submitted for testing shall be identified by manufacturer's lot designation. For needle punched geotextile, the manufacturer shall certify that the geotextile has been inspected using permanent on-line metal detectors and does not contain any needles.

Collect samples at approved locations upon delivery to the site in accordance with ASTM D 4354 (Procedure Method B). Test samples to verify that the geotextile meets the requirements specified in Table 1. Identify samples by manufacturer's name, type of geotextile, lot number, roll number, and machine direction. Perform testing at an approved laboratory. Submit test results from the lot under review for approval prior to deployment of that lot of geotextile. Rolls which are sampled shall be immediately rewrapped in their protective covering.

The fabric shall be free of any treatment which might significantly alter its physical properties. During all periods of shipment and storage, the fabric shall be wrapped in a heavy-duty protective covering to protect it from direct sunlight, mud, dirt, dust, and other debris.

The manufacturer shall submit certified test data to cover each shipment of material.

Construction Methods:

A. Submittals

(a) Samples
Submit geotextile samples for testing to determine compliance with the requirements in this specification, a minimum of 60 days prior to the beginning of installation of the same textile.

(b) Certificates

Upon delivery of the geotextile, submit duplicate copies of the written certificate of compliance signed by a legally authorized official of the manufacturer. The certificate shall state that the geotextile shipped to the site meets the chemical requirements and exceeds the minimum average roll value listed in Table 1. Upon request, supply quality control and quality assurance tests for the geotextile.

B. Delivery and Storage

Deliver only approved geotextile rolls to the project site. All geotextile shall be labeled, shipped, stored, and handled in accordance with ASTM D4873. No hooks, tongs, or other sharp instruments shall be used for handling geotextile. Geotextiles shall be protected at all times against physical or chemical damage. Geotextiles shall be kept in the wrappings provided by the manufacturer until required for use in the works. The rolls of geotextile shall be stored on level ground and stacked not more than five rolls high and no other materials shall be stacked on top of the geotextile. Geotextile shall not be exposed to direct sunlight for longer than thirty days.

Geotextile filter fabrics which are subject to deterioration by ultraviolet rays shall be protected from sunlight during transport and storage. For those fabrics which are subject to damage from sunlight, the information on the packaging material shall warn against exposing the filter fabric to sunlight.

Prepare surface, on which the geotextile will be placed, to a relatively smooth surface condition in accordance with the applicable portion of this specification and shall be free from obstruction, debris, depressions, erosion feature, or vegetation. Remove any irregularities so as to ensure continuous, intimate contact of the geotextile with all the surface. Any loose material, soft or low-density pockets of material, shall be removed; erosion features such as rills, gullies etc. shall be graded out of the surface before geotextile placement.

C. Installation

The filter fabric shall be spread on a prepared surface as described above and called for on the Contract Drawings or as directed by the Engineer. The fabric shall be laid loosely, so that placement of overlaying materials will not stretch or tear it. Stone placement shall be done in a manner that will not prove injurious to the fabric. Should the fabric become torn or otherwise damaged by any cause, it shall be patched by placing an additional section of geotextile filter fabric over the tear with a three-foot overlap on all sides.

Place the geotextile in the manner and at the locations shown on the Contract Drawings. At the time of installation, the geotextile shall be rejected if it has defects, rips, holes, flaws,

deterioration or damage incurred during manufacture, transportation or storage. Any additional costs incurred by this rejection shall be borne by the Contractor.

The overlaying material shall be placed within a period of two (2) weeks whether the fabric is subject to damage from sunlight or not. Fabric shall be anchored in an approved manner that will hold it in position. Place the geotextile with the long dimension perpendicular to the shoreline and laid smooth and free of tension, stress, folds, wrinkles, or creases. Place the strips to provide a minimum width of 3 feet of overlap for each joint. The placement procedure requires that the length of the geotextile be approximately 10 percent greater than the slope length. Adjust the actual length of the geotextile used based on initial installation experience.

Adjacent sheets shall be overlapped by at least thirty-six (36") inches. Appropriate measures shall be taken to ensure required overlap exists after cushion placement. No traffic or Contractor's equipment will be permitted to travel directly on the geotextile filter fabric.

Protect the geotextile at all times during construction from contamination by surface runoff; remove any geotextile so contaminated and replaced with uncontaminated geotextile. Replace any geotextile damaged during its installation or during placement of stone or other materials: cost of replacement shall be borne by the Contractor. Schedule the work so that the covering of the geotextile with a layer of the specified material is accomplished within 7 calendar days after placement of the geotextile. Failure to comply shall require replacement of geotextile at no additional cost to the City. Protect the geotextile from damage prior to and during the placement of stone or other materials. Before placement of stone or other materials, demonstrate that the placement technique will not cause damage to the geotextile. In no case shall any type of equipment be allowed on the unprotected geotextile.

Method of Measurement:

The quantity of Geotextile Filter Fabric to be measured for payment shall be the number of square yards computed between the limits shown on the Contract Drawings or within the limits established in writing by the Engineer prior to performing the work. No quantity will be included for material used for repair of tears or for material used to provide the overlaps.

Basis of Payment:

The unit price bid per square yard for this item shall include the cost of furnishing all labor, materials, plant, equipment, insurance, samples, and incidentals necessary to complete the work including the cost of preparing the surface upon which the geotextile filter fabric is placed, all in accordance with the Contract Drawings, the specifications, and the directions of the Engineer.

Payment will be made under:

Pay Item	Pay Unit
Geotextile Filter Fabric	S.Y.

ITEM #0814002A – RESET GRANITE STONE CURBING

Work under this item shall conform to the applicable provisions of Section 8.14 of CTDOT – Form 818, supplemented and amended as follows:

Article 8.14.01 – Description:
Replace with the following:

This work shall consist of removing and resetting or adjusting existing Granite Stone Curbing and Granite Curved Stone Curbing disturbed during construction in the existing locations or as ordered by the Engineer.

Article 8.14.02 – Materials:
Replace with the following:

All existing Granite Stone Curbing and Granite Curved Stone Curbing removed during construction shall be reset in the original location or as directed by the engineer. Mortar, if required, shall be as specified in M.11.04. Class PCC03360 concrete shall be as specified in M.03.

Article 8.14.03 – Construction Methods:
Add the following:

Construction methods used for resetting the Granite Stone Curbing and Granite Curved Stone Curbing shall conform to the City of Bridgeport Standards and Specifications.

Article 8.14.05—Basis of Payment:
Replace second paragraph with the following:

There will be no direct payment for furnishing, placing and compacting granular base, beveling or rounding the ends of the curbing, sealing the joints with mortar, Class PCC03360 concrete, removing the curbing and hauling it to any location on or adjacent to the Project as directed by the Engineer; but the cost of this work shall be considered as included in the general cost of the work.

Pay Item	Unit
Reset Granite Stone Curbing	L.F.

ITEM #0803XXXA – ARTICULATING CONCRETE BLOCKS

Description:

This Section specifies requirements for furnishing and installing articulating concrete block mats for erosion protection.

Articulating Concrete Block (ACB) mats consist of a matrix of interconnected concrete block units for scour protection and erosion control. Units are connected by geometric interlock and/or cables, geotextiles, or geogrids, and may include a geotextile underlayment for subsoil segregation and retainment.

Any ACB mat underlayment shall conform to Section 0755XXXA, Geotextile Filter Fabric.

The following is a listing of the publications referenced in this Section:

ASTM International (ASTM)

ASTM C39/C39M	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
ASTM C42/C42M	Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
ASTM C140/C140M	Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
ASTM D6684	Standard Specification for Materials and Manufacture of Articulating Concrete Block (ACB) Revetment Systems.
ASTM D7276	Standard Guide for Analysis and Interpretation of Test Data for Articulating Concrete Block (ACB) Revetment Systems

National Concrete Masonry Association

TEK 11-12A	Articulating Concrete Block Revetment Design—Factor of Safety Method.
TR 220A	Design Manual for Articulating Concrete Block.

Materials:

A. All ACB mats shall be prefabricated as an assembly of concrete blocks, with specific hydraulic capacities, laced with revetment cables in accordance with ASTM D6684 Standard Specification for Materials and Manufacture of Articulating Concrete Block (ACB) Revetment Systems which can be produced as dry-cast (in a block machine) or wet-cast (with concrete and molds).

   (a) Sampling and testing of dry-cast ACB units shall be performed in accordance with ASTM C140, Standard Test Method for Sampling and Testing Concrete Masonry Units and Related Units.

(b) Sampling and testing of wet-cast units shall be performed in accordance with ASTM C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens and ASTM C42, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.

B. Each block may incorporate interlocking surfaces that minimize lateral displacement of the blocks within the mats when they are lifted. The interlocking surfaces must not protrude beyond the perimeter of the blocks to such an extent that they reduce the flexibility or articulation capability of the ACB mats or become damaged or broken when the mats are lifted during shipment or placement. Once the mats are in place, the interlocking surfaces shall minimize the lateral displacement of the blocks even if the cables should become damaged or removed.

C. ACB Cables and Fittings

a. The cables inserted into the mats shall form lifting loops at one end of the mat with the corresponding cable ends spliced together to form a lifting loop at the other end of the mat.

b. ACB mats shall be secured by either stainless steel cable, galvanized aircraft cable, or polyester cable as specified in ASTM 6884-04. Cable size will be determined by block and mat size and shall provide for a 5.0 or greater factor of safety when lifting and include appropriate reduction factors for mechanically crimped cable, and other fasteners. Loading conditions shall include the use of a spreader bar for placing the mats.

c. Polyester Cable Specific Details

1. Revetment cable shall be constructed of high tenacity, low elongating, and continuous filament polyester fibers. Cable shall consist of a core construction comprised of parallel fibers contained within an outer jacket or cover.

2. The revetment cable shall exhibit resistance to most concentrated acids, alkalis, and solvents. Cable shall be impervious to rot, mildew, and degradation associated with marine organisms. The materials used in the construction of the cable shall not be affected by continuous immersion in fresh or salt water.

3. Selection of cable and fittings shall be made in a manner that ensures a safe design factor for mats being lifted from both ends, thereby forming a catenary. Consideration shall be taken for the bending of the cables around hooks or pins during lifting. Revetment cable splicing fittings shall be selected so that the resultant splice shall provide a minimum of 60% of the minimum rated cable

strength. Fittings such as sleeves and stops shall be aluminum and washers shall be galvanized steel unless otherwise shown on the Contract Drawings.

d. Galvanized or Stainless Steel Cable

1. Revetment cable shall be constructed of preformed galvanized aircraft cable or stainless steel cable. The cables shall be made from individual wires and strands that have been formed during the manufacture into the shape they have in finished cable.

2. The revetment cable shall exhibit resistance to mild concentrations of acids, alkalis, and solvents. Fittings such as sleeves and stops shall be aluminum, and the washers shall be galvanized steel. Furthermore, depending on material availability, the cable type can be interchanged while always ensuring the required factor of safety for the cable.

3. Selection of cable and fittings shall be made in a manner that ensures a safe design factor for mats being lifted from both ends, thereby forming a catenary. Consideration shall be taken for the bending of the cables around hooks or pins during lifting. Revetment cable splicing fittings shall be selected so that the resultant splice shall provide a minimum of 75% of the minimum rated cable strength.

D. Blocks shall be sound and free of defects that would interfere with proper placement or that would impair the strength or longevity of the installation. Minor cracks, incidental to the usual method of manufacture, or chipping that results from customary methods of handling in shipping, delivery and placement will not be deemed grounds for rejection. Store blocks and preassembled ACB mats in a suitable location away from mud, paint, wet cement, and other contamination or disturbance. Discard blocks with the following defects:

- Broken appendages.
- Chips larger than 2 inches in any dimension.
- Cracks wider than 0.02 inches and longer than 33 percent of the nominal height

E. Articulating concrete block (ACB) mats shall be one of the following or approved equal:

- Armorflex, manufactured by Contech Engineered Solutions – 800-338-1122
- Shoreblock, manufactured by Shoretec, LLC – 225-304-3985
- Cable Concrete, manufactured by International Erosion Control Systems – 800-821-7462

Construction Methods:

A. Subgrade Preparation

a. Place the ACB revetment on undisturbed native soils or compacted fill. Do not place the ACB on surfaces that contain liquified or unstable soils, frost, ice, or debris.

b. All vegetation shall be completely removed. Remaining roots from vegetation shall be removed to a depth of 1 foot below the subgrade surface. Loose organic matter, stones larger than 1/2-inch diameter, and other debris shall be raked and removed from the final surface.

c. Grading shall be finished to a smooth surface, typical of that obtainable with a dozer and blade. A rough surface typically obtained with a backhoe or dragline will not be acceptable, except when ACB placement below mean high water is shown on the drawings or approved by the Engineer.

d. Fill soils shall be compacted. Incidental grading shall be compacted by heavy equipment or by tamping with a bucket to a density characteristic of the surrounding soils. The final surfaces accessible by compaction equipment shall be compacted with a smooth drum roller or vibratory plate tamper until there is no further evidence of consolidation. Where slopes limit operation of compaction equipment, the final surface shall be back-dragged to a dense smooth surface with bladed equipment. Localized loose or soft zones shall be corrected.

e. The grading tolerance shall be within 2 inches from the prescribed elevations, with no abrupt variations that would cause unacceptable projections of individual blocks.

f. The subgrade shall be maintained in a smooth condition between installation of the geotextile and the blocks. Deviations shall be corrected prior to installation of blocks.

B. Geotextile Installation

a. Label each geotextile roll with the manufacturer's name, product identification, roll dimensions, lot number, and date manufactured.

b. Geotextile rolls shall be handled and unloaded by hand, or with load carrying straps, a forklift with a stinger bar, or an axial bar assembly. Rolls shall not be dragged, lifted by one end, lifted by cables or chains, or dropped to the ground.

c. Store geotextiles to protect from cement, paint, excessive mud, chemicals, sparks and flames, temperatures more than 160 degrees F, and any other environmental condition

that may degrade the physical properties. If stored outdoors, the rolls shall be elevated from the ground surface and protected with an opaque waterproof cover. Geotextiles shall be delivered to the site in a dry and undamaged condition.

d. Geotextile shall be installed as described in Section 0755XXXA, Geotextile Filter Fabric. The geotextile shall be laid flat and smooth so that it is in direct contact with the subgrade. The geotextile shall be free of tension, folds, and wrinkles. The number of seams and overlaps shall be minimized by selective orientation of geotextile panels, within the limitations of maintaining a consistent pattern. Geotextile shall be placed immediately prior to block installation, if necessary, to limit damage. Seams shall be overlapped a minimum 18 inches.

e. To limit ultraviolet light exposure of the geotextile, place the blocks within 7 days after placing the geotextile, and any void filler within 14 days after placing the geotextile.

C. ACB Mat Installation

a. Placement of the pre-assembled ACB mats shall be in accordance with ASTM 6884-03 unless otherwise noted.

b. Placement of pre-assembled mats shall be done with a spreader bar to aid in lifting, aligning, and placing the mats. The ACB mats shall be placed directly into position, with a maximum space or gap between mattresses of 3 inches more than the nominal joint spacing of blocks within the mats. ACB mats out of alignment shall be lifted and reset. Mats shall not be pushed or pulled laterally after they are in contact with the geotextile or graded soils. No overlapping of mats will be accepted, and no blocks shall project vertically more than 1 inch beyond the adjacent blocks. As adjacent mats are placed, they shall be secured to each other by fastening the protruding horizontal and vertical cable connections and end cable loops together along each side of the mats.

c. Termination trenches shall be backfilled with a material specifically called out by the design engineer. Gaps in the system, whether end to end, side to side, or around a radius greater than 2” shall be filled with 4000 psi non-shrink grout. Use of cast in place concrete joints shall be minimized to the extent practicable.

d. Where the ACB abuts other structures including bulkheads, pipe outlets, or flood walls, head walls, voids shall be filled with approved aggregate and gaps shall be filled with cast-in-place concrete. The concrete shall be installed flush with the surface of the blocks.

e. Voids in the blocks, acceptable defects, or ACB mat interfaces not previously described shall be filled with an approved aggregate or grout.

D. Protection of Work

Work shall be protected against damage from subsequent operations. Displaced or broken blocks shall be removed and replaced to conform to all requirements of this section. Damaged material shall not be incorporated. Equipment shall not be allowed on the ACB that could crack, cause abrasion, or otherwise damage the blocks. Vehicles shall not operate directly on geotextile, except that rubber-tired vehicles may operate directly on short reaches of geotextile that meets or exceeds AASHTO M 288 survivability requirements for Class 1 geotextile. Vehicles shall not operate on the ACB until (during or after) placement of void filler. Vehicle traffic on the ACB shall be restricted to light weight rubber-tired vehicles, and where intermittent access is necessary to accomplish the work. Routine haul routes shall not be established on the ACB.

E. Submittals

a. All manufacturers' hydraulic testing and calculations in support of the proposed ACB mat system and geotextile shall be submitted to the Engineer. Selection and design of the appropriate ACB product shall be in accordance with TR 220A Design Manual for Articulating Concrete Block and TEK 11-12A Articulating Concrete Block Revetment Design—Factor of Safety Method. The minimum design safety factor shall be 1.5. The analysis shall be performed based upon the stability of the mat due to gravity forces alone, neglecting conservative forces added by cabling, mechanical anchorage, contact with adjacent blocks, or other restraints not attributable to gravity-based forces.

b. The manufacturer's certificates of compliance for ACB mats, cabling, and any cable fittings and connectors as specified in this document shall be furnished. The manufacturer's specifications, literature, shop drawings for the layout of the mats, and any recommendations, if applicable, that are specifically related to the project shall also be furnished.

c. Alternative materials may be considered. Such materials must be pre-approved in writing by the Engineer. Full-scale laboratory test results and associated engineered calculations quantifying the hydraulic capacity of alternative materials shall be furnished. Submitted calculations must be PE stamped by a duly licensed engineer in the jurisdiction of the project

Method of Measurement:

The quantity of Articulating Concrete Block mats to be measured for payment shall be the number of square feet computed between the limits shown on the Contract Drawings or within the limits established in writing by the Engineer prior to performing the work. No quantity will be included for material used for repair of ACB mat defects.

Basis of Payment:

The unit price bid per square foot for this item shall include the cost of furnishing all labor, materials, plant, equipment, insurance, samples, and incidentals necessary to complete the work including the cost of preparing the surface upon which the geotextile filter fabric is placed, all in accordance with the Contract Drawings, the specifications, and the directions of the Engineer.

Payment will be made under:

Pay Item	Pay Unit
Articulating Concrete Block	S.F.

ITEM #0900000A – NOISE MITIGATION (ESTIMATED COST)

Description:

Under this item, in the event the Contractor has satisfied the source level noise requirements as described in Section 1.10 (Article 1.10.05), and has also implemented all noise reduction materials and methods as described in Section 1.10 (Article 1.10.05), as amended in these Special Provisions and approved by the Engineer, the Engineer will direct the Contractor to implement the use of **additional** noise barriers, noise control curtain systems or other methods to reduce the noise levels or to alleviate the nuisance conditions. The Contractor may be required to prepare working drawings, stockpile noise reduction materials, construct, deploy, maintain and remove noise pollution control devices when and as directed by the Engineer.

Materials:

Noise reduction materials used for noise barriers and noise control curtains may be new or used. Used materials shall be of a quality and condition to perform their designed function. Noise control barriers and noise control curtains shall have a Sound Transmission Class of STC-30 or greater, based on certified sound transmission loss data taken according to ASTM Test Method E90. They shall also have a Noise Reduction Coefficient rating of NRC-0.85 or greater, based on certified sound absorption coefficient data taken according to ASTM Test Method C423.

Noise barriers using materials consistent with those as follows:

Noise barriers shall be constructed of 3/4-inch Medium Density Overlay (MDO) plywood sheeting, or other material of equivalent utility and appearance having a surface weight of 9.8 kilograms per square meter (2 lbs/sq.ft.) or greater.

Noise barriers shall be lined on one side with glass fiber, mineral wool, or other similar noise curtain type noise-absorbing material at least 50 mm (2-inches) thick.

Prefabricated acoustic barriers are available from various vendors. An equivalent barrier design can be submitted for approval in lieu of the plywood barrier described above.

Noise control curtains using materials consistent with those as follows:

Noise control curtains shall consist of durable, flexible composite material featuring a noise barrier layer bonded to sound-absorptive material on one side. The curtains noise barrier layer shall consist of a rugged, impervious material with a surface weight of at least 4.9 kilograms per square meter (1 lbs/sq.ft). The sound absorptive material shall include a protective face and be securely attached to one side of the flexible barrier over the entire face.

The noise curtain material used shall be weather and abuse resistant, and exhibit superior hanging and tear strength during construction. The curtain's noise barrier layer material shall have a minimum breaking strength of 21.2 KN/m (120 lb/in.) per FTMS 191 A-M5102 and

minimum tear strength of 5.25 KN/m (30 lb/in.) per ASTM D117. Based on the same test procedures, the noise curtain absorptive material facing shall have a minimum breaking strength of 17.5 KN/m (100 lb/in.) and minimum tear strength of 1.23 KN/m (7 lb/in.).

The noise curtain material shall be corrosion resistant to most acids, mild alkalies, road salts, oils, and grease. It also shall be mildew resistant, vermin proof, and non-hygroscopic. The noise curtain material shall be fire retardant and shall be subject to the review and approval of the Engineer, prior to procurement.

Construction Methods:

Noise barrier panels and noise curtains shall be attached to support frames constructed in sections to provide a moveable barrier designed to withstand 129 kph (80 mph) wind loads plus a 30 percent gust factor.

The noise curtain acoustical material shall be installed in vertical and horizontal segments with the vertical segments extending the full enclosure height. All seams and joints shall have a minimum overlap of 50 mm (2-inches) and be sealed using double grommets. Construction details shall be performed according to the manufacturer's recommendations.

The noise barrier panel/noise curtain height shall be designed to break the line-of-sight and provide at least a 5 dBA insertion loss between the noise producing equipment and the upper-most story of the receptor(s) requiring noise mitigation. If for practicality or feasibility reasons, which are subject to the review and approval of the Engineer, a barrier panel/curtain system can not be built to provide noise relief to all stories, then it must be built to the tallest achievable height.

When barrier units/curtain systems are joined together, the mating surfaces of the barrier sides shall be flush with each other. Gaps between barrier units/curtain systems, and between the bottom edge of the barrier panels/curtain systems and the ground, shall be closed with material that will completely fill the gaps, and be dense enough to attenuate noise.

The Contractor shall submit Working drawings for the design and details for the acoustical noise barrier/noise curtain enclosure framework and supports in accordance with Section 1.05.02 of the standard specifications.

Method of Measurement:

The sum of the money shown on the estimate and in the itemized proposal as “Estimated Cost” for this work will be considered the bid price even though payment will be made only for the actual costs incurred to implement the use of **additional** noise barriers, noise control curtain systems or other methods to reduce the noise levels or to alleviate the nuisance conditions which may include preparing working drawings, stockpiling noise reduction materials, constructing, deploying, maintaining and removing additional noise pollution control devices when and as directed by the Engineer. The estimated cost figure is not to be altered in any manner by the bidder. Should the bidder alter the amount shown, the altered figures will be disregarded, and the original price will be used to determine the total bid for the contract.

Basis of Payment:
The item "Noise Mitigation" shall be paid for in accordance with Article 1.09.04.

Pay Item	Pay Unit
Noise Mitigation	EST.

ITEM #0901003A – STEEL BOLLARD

Description:
The purpose of the steel bollard is to protect a traffic device, facility, or other object indicated in the plans against incidental damage from a motor vehicle. This item shall consist of furnishing and installing a steel bollard in a concrete footing, of the type specified, at the location, to the dimensions and details as shown on the plans in accordance with these specifications.

Materials:

1. Bollards shall be Stainless Steel Internal Locking Removable Bollards (SSR06080) 6", Medium security, manufactured by Calpipe Security Bollards, 12160 Woodruff Ave. Downey, CA 90241

   Catalog No. - SSR06080
   Material – Type 316 Stainless Steel, #4 Finish
   Mounting - Removable Shallow Mount (Item #PDT80980SMR)
   Cap- Flat Cap with reflective warning strip
   Keys – 5 Extra
2. Or Approved Equal.

Construction Methods: The steel post shall have an exposed length of 4 feet. The post shall be installed per the manufacture's recommendations. Post shall be embedded 21 inches set in a concrete footing of at least18 inches in diameter and 18" deep. In Lieu of a footing, the entire hole shall be filled with concrete. If installed in a grass area, the top 6 inches of the hole shall be back\filled with comparable material. The post shall eb filled with concrete. The top shall be a capped surface. No sharp edges, burrs, threads or other defects shall be exposed.

Method of Measurement:
This work will be measured for payment by the number of completed and accepted Steel Bollards. This item shall include but not be limited to all items required to furnish and install steel bollard in a concrete footing, concrete, Stainless Steel Internal Locking Removable Bollards (SSR06080), and other incidentals.

Basis of Payment:
This work will be paid for at the Contract unit price per "Steel Bollard," complete in place, which price shall include materials, equipment, tools, labor and work incidental thereto.

Pay Item:	Pay Unit
Steel Bollard	ea.

SECTION #0904504 – METAL BRIDGE RAIL (PEDESTRIAN)

Metal bridge rail (pedestrian) shall be constructed in accordance with CTDOT – Form 818, Article 9.04 Supplemented as follows:

Materials:
Add the Following:

All structural steel shall be A500 and hot dipped galvanized for prefabricated pedestrian bridge.

ITEM #0905001A – STONE WALL FENCE

Description:

This item shall consist of approved stones laid in mortar to form a standard stone wall fence of the dimensions and details shown on the plans, constructed where indicated on the plans in accordance with these specifications. The exposed sides and top of the wall shall be roughly 'natural' faced within the minimum and maximum dimensions called for, and all exposed stones shall fit neatly. Mortar should not be visible at the vertical surfaces; mortar should be set 2" inwards from face of the wall.

References:

A. ASTM A 123-02: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
B. ASTM C 97-02: Test Methods for Absorption and Bulk Specific Gravity of Dimension Stone.
C. ASTM C 119-04: Terminology Relating to Dimension Stone
D. ASTM C 170-90: Test Method for Compressive Strength of Dimension Stone
E. ASTM C 615-03: Specification for Granite Dimension Stone
F. ASTM F 593-02: Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
G. ASTM F 594-02: Specification for Stainless Steel Nuts
H. National Building Granite Quarries Association (NBGQA) Specifications for Architectural Granite.

Definitions:

A. Definitions contained in ASTM C 119 apply to this Section.
B. Footing: The prepared surface on which the wall is built
C. Cap Stones: Stones that make up the top course of the wall, covering the top of the final lift.

Materials:

Stone Source:

A. Basis-of-Design Product: Subject to compliance with requirements, provide Moonlit Rose® from Williams Stone Company or comparable stones by one of the following:
    a. Cold Spring Granite Company.
    b. Stony Creek Quarry.
    c. Williams Stone Company.
    d. Or, Approved Equal.

B. Each color of granite shall come from a single quarry, with sufficient reserves to satisfy the requirements of the project. The granite supplier shall have the capabilities to cut and finish the stone without delaying the project.

Stone:

A. Granite Building Stone Standard: ASTM C 615.

B. Special Shapes: Provide units of shape and dimensions that will produce walls of dimensions and profiles shown on Drawings and as follows:
   1. Batter: Provide units that offset from course below to provide batter.
   2. Base of Wall Width: 24 inches.
   3. Top Of Wall Width: 24 inches.
   4. Height: As indicated on drawings

C. Cap Units: Provide 3-inch thick cap units of shape shown with Peened surfaces.

D. Special Units: Provide corner units, end units, and other shapes as needed to produce walls of dimensions and profiles shown.

E. Cap Stone:
   1. Length: full width of the wall plus one inch out borne at each side at the top of the final lift.
   2. Size and Weight: Cap stones must individually be significant size and weight that they are difficult to dislodge or move from placement.

F. Stones must be of appropriate size and shape for the type or cap called for in the design.

G. Color and Texture: To closely match Architect's sample.

H. Finish: All exposed surfaces should be 'natural look' (not rectilinear sawn surfaces and edges)

Miscellaneous:

A. Anchors and Pins: Stainless-Steel: ASTM A 580/A 580M, Type: 304

Installation Materials:

A. Pins: Stainless steel pins as recommended by stone supplier for use with stone.

B. Leveling Base: Comply with requirements of Special Provision "Processed Aggregate Subbase".

Construction Methods:

Examination:

A. Prepare substrates using the methods recommended by the manufacturer for achieving best result for the substrates under project conditions.

B. Surfaces and Conditions: Prior to installing stone, examine the existing surfaces and conditions to receive the cut stone and verify surfaces and conditions are in accordance with the requirements and as shown on Drawings. Do not proceed until defective surfaces are brought into compliance.
    a. Examine surfaces and conditions with Installer present.

Preparation:

Prior to setting cut stone, clean all surfaces to remove accumulated dirt and stains. Clean thoroughly by scrubbing with non-metallic brushes followed by a drenching with clean water. Use only mild detergents that do not contain caustic fillers.

Placed Stone:

A. Field trim stone as stone is set.

B. Sort stone before it is placed in wall. Remove stone that does not comply with requirements or that is unsuitable for intended use.

C. Ashler Pattern: Arrange stones for accurate fit in ashlar pattern in a 'natural look' with variable course heights as shown, varied lengths, with offset between vertical joints as shown.

D. Arrange stones with color and size variations uniformly dispersed for an evenly blended appearance.

E. Set stone to comply with requirements shown on Drawings. Set stone accurately in locations shown with edges and faces aligned according to established relationships.

F. Construction Tolerances:
    a. Variation from Plumb Line:
        i. Vertical linesand surfaces of walls not to exceed:
            1. 1/4 inch in 10 feet (6 mm in 3 m).
            2. 3/8 inch in 20 feet (10 mm in 6 m).
            3. 1/2 inch in 40 feet (12 mm in 12 m) or more.
        ii. Expansion joints, and other conspicuous lines not to exceed:
            1. 1/8 inch in 10 feet (3 mm in 3 m).
            2. 1/4 inch in 20 feet (6 mm in 6 m) or more.

iii. Variation from Level:
1. Bed joints and cap units and other conspicuous lines, not to exceed:
a. 1/4 inch in 20 feet (6 mm in 6 m).
b. 1/2 inch in 40 feet (12 mm in 12 m) or more.

Adjusting:

A. Remove and replace stone not matching final samples and mockups.

B. Remove and replace stone not complying with requirements.

C. Replace non-complying stone to match final samples and mockups, comply with specified requirements. Replacement stone shall show no evidence of replacement.

D. Patching: Minor patching in small areas may be acceptable if the repair does not distract from the overall appearance of the finished project.

Protection:

A. At the end of each day's work, cover top of walls with a non-staining waterproof covering. Protect partially finished work when not being worked on.

Cleaning:

A. Clean stone as work progresses.

B. Final Cleaning: Clean stone as recommended by fabricator or stone producer.
a. Clean all finished stonework with a mild detergent using a fiber brush.
b. After cleaning, rinse with clean water.
c. Do not use acid or other caustic materials.

C. When cleaning is completed, remove temporary protection.

Stone Fabrication:

A. Fabricate stone in accordance with requirements, including Drawings and Shop Drawings.
1. Granite: NBGQA's "Specifications for Architectural Granite."

B. Cut stone to produce pieces of stone shown on Drawings and recommended by stone source, for faces, edges, beds, and backs.

C. Thickness of Stone: Provide thickness shown, but not less than the following:
1. Thickness: 10 inches
2. Course Height: 8 inches.

3. Cap Height: 3 inches.
4. Tolerance: Plus or minus 1/4 inch.

D. Dress joints (bed and vertical) straight and at right angle to face. Recess face of joints 2 inches from face of wall.

E. Shape stone for type of masonry (pattern) as follows:
   a. Sawed-bed ashlar with non-uniform course heights and non-uniform lengths as shown on Drawings.

F. Setting Bed:
   1. Type: Horizontal: ½ inch joint width, maximum, Vertical: 3/8 inch joint width, maximum.

G. Finish exposed faces and edges of stone to comply with requirements shown for finish and to match approved samples and mockups.
   1. Finish:
      a. Natural Cleft.

H. Carefully inspect stone at fabrication plant for compliance with requirements for appearance, material, and fabrication. Replace defective units before shipment.

Submittals:

A. Product Data: For each stone type and each manufactured product shown on Drawings or specified.
   1. For each stone variety used on Project, include physical property data.

B. Shop Drawings: For the following:
   1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
   2. Detail components embedded in masonry.

C. Samples: Submit samples for each stone type required, exhibiting the full range of color characteristics expected.
   1. Submit a minimum of 2 each, 8 inches x 8 inches and 2 inches x 10 inches in size, in each color and finish specified.
   2. In the case of more variegated stones, color photos shall be submitted in addition to the number of samples to show the full range of color and markings to be expected.
   3. Accessories embedded in masonry.

D. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used.

1. Submittal is for information only. Neither receipt of list nor approval of mockup constitutes approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Architect and approved in writing.

Quality Assurance:

A. Source Limitations for Stone: Obtain each stone variety from a single quarry.

B. Fabricator Qualifications: Engage experienced fabricator that has completed stone fabrication similar in material, design, and extent to that indicated for the project.

C. Installer Qualifications: Engage experienced installer that has completed stone installation similar in material, design, and extent to that indicated for the project.

D. Visual Mockup: Provide full sized mock-up of the approved stone or stones in the approved finishes, erected at a site agreed to by the Architect, Contractor, and the Fabricator. The approved mock-up shall become the standard for the project.
   a. Build mockup of areas as shown on Drawings.
   b. Size: 6 feet high wall that is a minimum of six feet long.
   c. Color consistency: demonstrate color consistency with mockup; color range shall not exceed range of color established by samples.
   d. Included typical components.
   e. Mockup may become part of the completed Work if approved at time of Substantial Completion.

Delivery, Storage and Handling:

A. Store and handle materials to prevent deterioration or damage.

B. Stone shall be carefully packed and loaded for shipment using reasonable care and customary precautions against damage in transit. Material, which may cause staining or discoloration shall not be used for blocking or packing.

C. The stone shall be stacked on timber or platforms at least 4 inches above the ground. Care shall be taken to prevent staining or discoloration during storage.

D. If storage is to be for a prolonged period, polyethylene or other suitable plastic film shall be placed between wood and finished surfaces of completely dry stone.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

F. Remove Soil to prevent staining face of stone.

Method of Measurement:

This work will be measured for payment by the number of linear feet of completed and accepted stone wall.

Structural steel pins shall not be measured for payment under this item. Reference special provision "Structural Pin Assembly - Stainless Steel".

Basis of Payment:

This work will be paid for at the Contract unit price per linear foot for "Stone Wall," complete in place, which price shall include materials, equipment, tools, labor and work incidental thereto; also all necessary excavation, refilling and disposal of surplus material.

Pay Item	Unit
Stone Wall	L.F.

ITEM #0910052A - MERRITT PARKWAY GUIDERAIL
ITEM #0912104A – DRILLING HOLE FOR GUIDERAIL POST

Description: Work under this item shall consist of a single steel-backed timber rail element fastened to steel posts and the appropriate treatment at fixed objects, bridge parapets and terminal ends as shown on the plans. It shall be erected in the locations sited and fabricated in conformity with the designations, dimensions and details shown on the plans or as ordered by the engineer.

Materials:

1. **Steel:** All steel posts, back-up rails, splice plates and channel rubrails which are to be used as "Weathering Steel", shall meet the requirements of ASTM A588. The fabricator shall notify the manufacturer that it is "Weathering Steel" (structural steel for use in bare, unpainted applications) and that the steel shall not be marked with paint or steel die stamped, but identification shall be stenciled with permanent ink. The dimensions of each component shall conform to the plans and ASTM A6. All steel posts shall be galvanized after fabrication to meet the requirements of ASTM A123 and conform to the galvanizing limits and tolerances shown on the plans. A single ¾" diameter hole may be drilled 2" from the top of each post, in the center of the web, to facilitate the galvanizing process on the bottom of all posts.

2. **Timber:** All timber rail and block-out components shall conform with the following:
   a) Commercial lumber grade No. 1 or better after treatment;
   b) AASHTO M 168;
   c) Minimum stress rating of 1350 psi
   d) Rough sawn (non-planed) or S4S (surface four side) Southern Yellow Pine or Douglas Fir- Larch with nominal dimensions as indicated on the plans. Variations in the size of any dimension shall not be more than ± ¼"
   e) All timber components shall be pressure treated with CCA or ACZA depending on species supplied conforming to AWPA Standard P5 to a minimum net retention of 0.60lb/cubic foot in the assay zone in accordance with AWPA Standard C14.
   f) All timber components shall be fabricated (including but not necessarily limited to cutting, drilling, dapping and chamfering) prior to treatment.
   g) All timber components shall be free of excess preservative and solvent at the conclusion of the treating process. Post treatment cleaning shall be by expansion bath or steaming in accordance with AWPA Standard C2;
   h) Kiln or air dried to a maximum moisture content of 25% after treatment (KDAT - 25);
   i) Grade-marked after treatment by an agency certified by the American Lumber Standard Committee (ALSC).

3. **Fasteners:** Round head bolts shall be manufactured in accordance with the sizes designated on the plans, the geometric specifications included in ANSI B18.5.1.2.2 and the material specifications for ASTM A588 steel. All round head bolts shall be marked with the manufactures symbol and A588. Hex Lag Screws shall be manufactured in accordance with

ASTM A307 Grade A specifications. All Hex Lag Screws shall be hot-dipped galvanized in accordance with ASTM A153 Class C.

Construction Methods: The steel posts shall be driven. The Contractor shall use suitable caps and equipment to prevent damage to the posts during driving. Where rock or boulders are encountered in driving the posts, the material shall be removed so as to make a hole of sufficient size to permit the setting of the post. The hole shall then be backfilled and thoroughly compacted before the driving of the posts.

The Contractor is cautioned that within the limits of any project, buried cables for illumination or utilities, which may be energized, may be present.

The posts shall be located as shown on the plans, set plumb and in alignment with the rail or rail treatments. The block outs and rail elements shall then be erected to produce a smooth continuous rail as shown on the plans.

Whenever rail or rail treatments are being constructed adjacent to roadways open to traffic, the Contractor shall complete the installation to and including the designated terminal treatment at the close of each day's work.

On long runs or other locations where it is not practical to complete the installation to and including the designed terminal treatment by the end of each day's work, the Contractor shall use temporary methods for terminating the beam rail so as to minimize any hazard caused by leaving the end of the beam rail exposed to traffic. Temporary methods for terminating the beam rail shall include lowering the rail end to the ground and providing adequate anchorage of the rail end by bolting, securing, burying, etc.

The Contractor shall submit to the Engineer for approval details of his proposed methods for temporary terminating the end section. No work shall be performed adjacent to the areas open to traffic until approval is given.

The Contractor shall be required to furnish extra length posts at transition areas or where field conditions warrant. These posts shall be of such length that the minimum depth in the ground, as shown on the plans, is maintained.

Before final erection, all galvanized elements which have been cut or worked so as to destroy the zinc coating and cause the base metal to be exposed shall have the exposed base metal thoroughly cleaned and brush coated with zinc rich touch up material.

Method of Measurement: The length of Merritt Parkway Guiderail measured for payment will be the number of linear feet of accepted rail of the type or designation installed, measured along the top of the rail between centers of end posts in each continuous section.

"Merritt Parkway Guiderail (Type) End Attachment" shall be measured for payment by the actual number of each attachment installed in accordance with the "Pay Limit for attachment" as designated on the plans.

"Merritt Parkway Guiderail Replacement Parts" shall be measured for payment by the lump sum quantity.

"Drilling Hole for Guiderail Post" shall be measured to the nearest 4" in depth of actual rock encountered and removed.

Basis of Payment: Merritt Parkway Guiderail will be paid for at the contract unit price per linear foot for the type or designation indicated on the plan or ordered by the Engineer, complete in place. The price shall include all materials, fittings, back-up rail, posts, delineators, equipment, and tools and labor incidental to the installation of the rail.

"Merritt Parkway Guiderail (Type) End Attachment" to parapets or barriers will be paid for at the contract unit price each as shown on the plans or as ordered by the Engineer, complete and in place. The price shall include all materials, fittings, back-up rails, posts, anchor bolts, attachment brackets, drilling and grouting, chemical anchoring material, delineators, equipment, removal and disposal of surplus material, removal of existing rail, tools and labor incidental to the installation of the rail.

Drilling in or removal of rock or boulders and backfilling with suitable material when required for the installation of posts will be paid for at the contract unit price per foot of depth for "Drilling Hole for Guiderail Post". The price shall include all materials, equipment, tools, and labor incidental thereto.

Pay Item	Pay Unit
Merritt Parkway Guiderail (Type)	L.F.
Drilling Hole for Guiderail Post	L.F.

ITEM #0913000A – REMOVE CHAIN LINK FENCE

Section 9.13 is supplemented as follows:

Description:
Add the following:

Under this item the Contractor shall remove existing chain link fence where shown on the plans, or as directed by the Engineer. If the fence being removed is located in pavement or concrete the Contractor shall fill all holes created by the removal with an Engineer approved non-shrink grout.

Method of Measurement:
Add the following:

Removal work will be measured for payment by the number of linear feet of chain link fence removed, including intermediate posts measured from outside to outside of terminal posts. Proper disposal and the filling of all holes shall be included in the cost of removal.

Basis of Payment:
Add the following:

This work will be paid for at the contract unit price per linear foot for "Remove Chain Link Fence." This price shall include removal of posts and fence fabric, grounding, filling of holes, equipment, tools and labor incidental thereto.

Pay Item	Pay Unit
Remove Chain Link Fence	L.F.

ITEM: 0914001A – Metal Handrail

Description:
This item shall consist of fabricating, \furnishing and installing metal handrails in a concrete footing, of a type specified, at the location, to the dimensions and details as show on the plans in accordance with these specifications. The purpose of the metal handrail is to protect the public while accessing elevated portions of the park and/or buildings.

References:

1. ASTM A580/A580M
2. ASTM F 594
3. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
4. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
5. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
6. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

Definitions:

Materials:

Performance Requirements:

A. Thermal Movements: Allow for thermal movement resulting from the following maximum change (range) in ambient temperature in the design, fabrication, and installation of installed metal stairs to prevent buckling, opening up of joints, and overstressing of welds and fasteners. Base design calculations on actual surface temperatures of metals due to cold and ice, solar heat gain, and nighttime sky heat loss.

   1. Temperature Change (Range): 180 deg F (100 deg C), material surfaces.

B. Structural Performance of Handrails and Guards: Provide handrails and guards capable of withstanding the following structural loads without exceeding the allowable design working stress of materials for handrails, railings, anchors, and connections:

   1. Handrails and Top Rail of Guards: Capable of withstanding the following loads applied as indicated:

      a. Concentrated load of 350 lbs. applied at any point and in any direction.
      b. Uniform load of 50 lbf/ft. (730 N/m) applied horizontally and concurrently with uniform load of 100 lbf/ft. (1460 N/m) applied vertically downward.
      c. Concentrated and uniform loads above need not be assumed to act concurrently.

   2. Infill Area of Guards: Capable of withstanding a horizontal concentrated load of 50 lbf (223 N) applied to 1 sq. ft. (0.09 sq. m) at any point in system, including panels, intermediate rails, balusters, or other elements composing infill area.

a. Load above need not be assumed to act concurrently with loads on top rails in determining stress on guards.

C. Seismic Performance: Withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. Component Importance Factor: 1.5.

Metals:

A. Metal Surfaces, General: For metal fabrications exposed to view in the completed Work, provide materials selected for their surface flatness, smoothness, and freedom from stains, discolorations, or surface blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

Stainless Steel:

A. Pipe: ASTM A 312/A 312M, Grade TP 316.

B. Sheet, Strip, Plate, and Flat Bar: ASTM A 666, Type 316.

C. Bars and Shapes: ASTM A 276, Type 316.

D. Woven-Wire Mesh Infill: Intermediate-crimp, woven-wire or woven-strap mesh, made from wire complying with ASTM A580/A580M, [Type 304] [Type 316], in a 0.98-inch- (25-mm-) wide by 0.59-inch- (15-mm-) deep welded stainless steel "C" frame.

1) Wire Mesh: Large, square; 70.1 percent open

Horizontal Multiline Infill Panels: 1/8-inch round stainless-steel tubing rods. Vertical Picket Infill Panels: 1/2-inch round stainless-steel pickets.

Installation Materials:

A. Fastener Materials: Unless otherwise indicated, provide the following:

1. Stainless-Steel Items: Type 316 stainless-steel fasteners.

B. Fasteners for Anchoring to Other Construction: Unless otherwise indicated, select fasteners of type, grade, and class required to produce connections suitable for anchoring indicated items to other types of construction indicated.

C. Provide concealed fasteners for interconnecting components and for attaching ornamental metal items to other work, unless otherwise indicated.

1. Provide fasteners having tamper-resistant-type heads at locations where fastener heads will remain exposed upon completion of the work.

D. Post-Installed Anchors: Chemical anchors.

1. Stud Material: Alloy Group 2 (A4) stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).

Miscellaneous:

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Wall-Mount Brackets for Handrails: Stainless steel, designed to provide 2-1/4" wall clearance when used with 1-1/2" diameter handrail.

1. Products: Subject to compliance with requirements, products that may be incorporated into the Work include the following or Comparable Product:
a. #1733 bracket with #1722 bracket filler plate; The Wagner Companies

Construction Method:

Examination:

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of ornamental metal.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

Delivery, Storage, and Handling:

A. Store ornamental metal inside a well-ventilated area, away from uncured concrete and masonry, and protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity.

B. Deliver and store cast-metal products in wooden crates surrounded by sufficient packing material to ensure that products will not be cracked or otherwise damaged.

Installation:

A. Provide anchorage devices and fasteners where needed to secure ornamental metal to in-place construction.

B. Perform cutting, drilling, and fitting required to install ornamental metal. Set products accurately in location, alignment, and elevation; measured from established lines and levels. Provide temporary bracing or anchors in formwork for items to be built into concrete, masonry, or similar construction.

C. Fit exposed connections accurately together to form tight, hairline joints or, where indicated, with uniform reveals and spaces for sealants and joint fillers. Where cutting, welding, and grinding are required for proper shop fitting and jointing of ornamental metal, restore finishes to eliminate evidence of such corrective work.

D. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.

E. Field Welding: Comply with applicable AWS specification for procedures of manual shielded metal arc welding and requirements for welding and for finishing welded connections in "Fabrication, General" Article. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.

F. Restore protective coverings that have been damaged during shipment or installation. Remove protective coverings only when there is no possibility of damage from other work yet to be performed at same location.

    1. Retain protective coverings intact; remove coverings simultaneously from similarly finished items to preclude nonuniform oxidation and discoloration.

G. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

    1. Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

Cleaning And Protection:

A. Unless otherwise indicated, clean metals by washing thoroughly with clean water and soap, rinsing with clean water, and drying with soft cloths.

B. Clean stainless steel according to metal finisher's written instructions in a manner that leaves an undamaged and uniform finish matching approved Sample.

C. Protect finishes of ornamental metal from damage during construction period with temporary protective coverings approved by ornamental metal fabricator. Remove protective covering at time of Substantial Completion.

D. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit or provide new units.

Fabrication:

A. Assemble items in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

B. Form ornamental metal to required shapes and sizes, true to line and level with true curves and accurate angles and surfaces. Finish exposed surfaces to smooth, sharp, well-defined lines and arris.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form simple and compound curves in bars and extruded shapes by bending members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces.

E. Provide 90-degree elbow wall returns at ends of wall-mounted handrails, unless otherwise indicated.

F. Close open ends of pipe by welding 3/16 inch thick steel plate in place or by use of prefabricated fittings, except where clearance of end of pipe and adjoining wall surface is 1/4 inch or less.

G. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm), unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

H. Mill joints to a tight, hairline fit. Cope or miter corner joints. Fabricate connections that will be exposed to weather in a manner to exclude water.

I. Provide weep holes where water may accumulate.

J. Provide necessary rebates, lugs, and brackets to assemble units and to attach to other work. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items, unless otherwise indicated.

K. Comply with AWS for recommended practices in shop welding. Weld behind finished

surfaces without distorting or discoloring exposed side. Clean exposed welded joints of flux, and dress exposed and contact surfaces.

Finishes:

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finishes for stainless steel may be either field-applied or shop-applied, as best-suited to produce optimal results for each item.

C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

Stainless- Steel Finishes:

A. Remove tool and die marks and stretch lines or blend into finish.

B. Unless otherwise indicated, grind and polish surfaces to produce uniform finish indicated, free of cross scratches.

1. Run grain of directionally textured finishes with long dimension of each piece.

C. Bright, Cold-Rolled, Unpolished Finish: No. 2B finish; provide specified finish on the following:

1. Plate, strip, bar and pipe material used for ornamental metal fabrications.

D. Dull Satin Finish: No. 6 finish; provide specified finish on the following:

1. Stainless steel guards and handrails.

E. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

Submittals:

A. Product Data: For each type of product indicated.

B. Shop Drawings: For ornamental metal. Include plans, elevations, component details, and attachments to other work. Indicate materials and profiles of each ornamental metal member, fittings, joinery, finishes, fasteners, anchorages, and accessory items.

a. Provide templates for anchors and bolts specified for installation under other Sections.

C. Samples for Initial Selection: For products involving selection of color, texture, or design, including mechanical finishes.

D. Samples for Verification: Provide sample with specified mechanical finish.

a. Sample section of stainless steel handrail, not less than 24-inches long; include one bend of 32.5 degrees in the running length of the sample and one 90 degree wall return with closed end at one end of the sample.

E. Mill Certificates: Signed by manufacturers of stainless-steel products certifying that products furnished comply with requirements.

F. Qualification Data: For fabricator and metal finisher.

Quality Assurance:

A. Fabricator Qualifications: A firm experienced in producing ornamental metal similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

B. Welding: Qualify procedures and personnel according to the following:
1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
3. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
4. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

C. Fabrication Tolerances: Variation from required lines shall not exceed 1/8" in 5 feet, or 1/4" maximum for the overall length of the fabricated item, whichever is less.

D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

Method of Measurement:

This work will be measured for payment by the number of Metal Handrails installed and accepted.

Basis of Payment:

This work will be paid for at the Contract unit price per “Metal Handrail,” complete in place, which price shall include materials, equipment, tools, labor and work incidental thereto.

Pay Item	Unit
Metal Handrail	ea.

ITEM #0914003A – WROUGHT IRON RAILING

All Wrought Iron railing shall be constructed in accordance with CTDOT – Form 818, Article 9.14, supplemented as follows:

Description:

This item is used at the Belvedere railing for protection from fall as well as to keep people, animals, and foreign objects out the cistern structure. This item shall consist of furnishing and installing a Wrought Iron Railing, of the type specified, at the location, to the dimensions and details as shown on the plans in accordance with these specifications.

References:

Definitions:

i. Railings: Wrought Iron Railings shall be installed at the curved edge of the Belvedere as indicated in the plans and details in accordance with these specifications.

ii. Guards: Wrought iron guards shall be installed at the discharge opening(s) of weirs/retaining walls equipped with adjacent, prefabricated concrete cisterns. Guards shall be of the type shown at their locations, to dimension and details as shown in the plans in accordance with these specifications.

Materials:

1) **Basis of Design:** Lawler Foundry's Hot Punched Bar Stock, with twisted pickets bar stock, and hammered iron handrail. Lawler foundry Corp.; www.lawlerfoundry.com;
Address: 4908 Powell Ave S, Birmingham, AL 35222
Phone: (205) 595-0596 / 205-624-9512.
Member of American Fence Association (AFA)

2) **Basis of Design:** Railings at Belvedere:
Lawler Foundry's ¾-inch Square Hot Punched Bart Stock # QC-23/08, diagonal holes, 6-1/2" L (14 lbs.); Hammered Iron Handrail # QC-1510, 1-5/8-inch x 5/16 inch – 10'L (16 bls.), and 3/8 inch twisted bar stock # BP 1538, 10' L (5lbs.).

3) **Basis of Design:** Guards at Weirs:
Lawler Foundry's 9/16-inch Plain Bar stock, # QC-1502, 10'L (11 bs.), welded to 1-1/2 inch wide x 1/2 inch thick flat iron frames. Anchor to surrounding surfaces.

Performance Requirements:

A. Thermal Movements: Allow for thermal movement resulting from the following maximum change (range) in ambient temperature in the design, fabrication, and installation of installed metal assemblies to prevent buckling, opening up of joints, and overstressing of welds and fasteners. Base design calculations on actual surface temperatures of metals due to both solar heat gain and nighttime sky heat loss.

(1) Temperature Change (Range): 180 deg F (100 deg C), material surfaces.

Metals:

A. Metal Surfaces, General: For metal fabrications exposed to view in the completed Work, provide materials selected for their surface flatness, smoothness, and freedom from stains, discolorations, or surface blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

Carbon Steel and Iron:

A. Steel Plates, Shapes, and Bars: ASTM A 36 (ASTM A 36M).

B. Steel Pipe: ASTM A 53, standard weight (Schedule 40), unless otherwise indicated, or another weight required by structural loads.

C. Steel Sheet, Cold Rolled: ASTM A 1008/A 1008M, either commercial steel, Type B, or structural steel, Grade 25, exposed.

E. Weathering Steel: High strength low-alloy structural steel with improved atmospheric corrosion resistance, ASTM A242 or ASTM A606-4.

F. Castings: Either gray or malleable iron, unless otherwise indicated.

(1) Gray Iron: ASTM A 48/A 48M, Class 30, unless another class is indicated or required by structural loads.
(2) Malleable Iron: ASTM A 47/A 47M.

G. Cast-in-Place Anchors in Concrete: Anchors of type indicated below, fabricated from corrosion-resistant materials capable of sustaining, without failure, the load imposed within a safety factor of 4, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

(1) Threaded or wedge type; galvanized ferrous castings, either ASTM A 47 (ASTM A 47M) malleable iron or ASTM A 27 (ASTM A 27M) cast steel. Provide bolts, washers, and shims as required, hot-dip galvanized per ASTM A 153.

Fasteners:

A. General: Unless otherwise indicated, provide Type 316 stainless-steel fasteners.

B. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, nuts and flat washers; ASTM F 593 for bolts and ASTM F 594 for nuts, Alloy Group 1.

C. Phillips Flat-Head Machine Screws: Stainless steel, ASME B18.6.3.

D. Post-Installed Anchors: Chemical anchors.

(1) Material for Exterior Locations and Where Stainless Steel is Indicated: Alloy Group 2 (A4) stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).

E. Anchor Bolts: ASTM F 1554, Grade 36.

(1) Provide stainless steel anchor bolts.

Shop Coatings:

A. Shop Primer:
(1) Sumper Coatings' Satin Shield; Sumper Coatings; Black 885N2100
(2) Approved Equal

Accessory Materials:

A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

(1) Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include the following or Equal:

(a) B-6 Construction Grout; W. R. Bonsal Co.
(b) Sonogrout 14; Sonneborn Building Products--ChemRex, Inc.

B. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

Fabrication:

A. Form metal fabrications from materials of size, thickness, and shapes indicated but not less than that needed to comply with performance requirements indicated. Work to dimensions indicated or accepted on shop drawings, using proven details of fabrication and support. Use type of materials indicated or specified for various components of each metal fabrication.

B. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

C. Form exposed work true to line and level, with accurate angles and surfaces and straight edges. Tolerances for installed work shall comply with the following:

(1) Variation from required lines shall not exceed 1/8" in 5 feet, or 1/4" maximum for the overall length of the fabricated item, whichever is less.

D. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

E. Ease exposed edges to a radius of approximately 1/32 inch (1 mm), unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

F. Weld corners and seams continuously to comply with the following:

(1) Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
(2) Obtain fusion without undercut or overlap.
(3) Remove welding flux immediately.
(4) At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing, and contour of welded surface matches those adjacent.

G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners wherever possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.

H. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

I. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

J. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.

Carbon Steel Finishes:

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

(1) Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
(2) Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
(1) Apply Sumter Coating's Satin Shield-direct-to metal product that yields a satin finish, using Satin Shield for primer and top coats.

B. Shop Priming: Items that are not hot-dip galvanized shall be shop primed.

(1) Preparation: Comply with minimum requirements indicated below for SSPC surface preparation specifications and, where indicated, environmental exposure conditions of installed metal fabrications:

(a) Exteriors (SSPC Zone 2A): SSPC-SP3 "Power Tool Cleaning."
(b) Interiors (SSPC Zone 1A): SSPC-SP3 "Power Tool Cleaning."

(2) Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

(a) Stripe paint all edges, corners, crevices, bolts, welds, and sharp edges.
(b) Dry film thickness of completed primer coat shall be not less than the minimum thickness recommended by the primer manufacturer.

Handrails And Guards:

A. General: Fabricate handrails and guards to comply with requirements indicated.

B. Interconnect railing and handrail members by butt-welding or welding with internal connectors, at fabricator's option, unless otherwise indicated.

(1) At tee and cross intersections, notch ends of intersecting members to fit contour of pipe to which end is joined, weld all around and grind smooth.

C. Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

D. Flanges, Fittings, and Anchors: Provide end closures, flanges, miscellaneous fittings, and anchors for interconnections and attachment of railings and handrails to other work. Furnish inserts and other anchorage devices for connecting railings and handrails to concrete or masonry work.

Fence Panels:

A. Unless otherwise indicated, fabricate units from weathering steel shapes, plates, and bars of profiles shown and smooth exposed edges. Cut, drill, and tap units to receive hardware, hangers, and similar items.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

Rough Hardware:

A. Furnish bent or otherwise custom fabricated bolts, plates, anchors, hangers, dowels, and other miscellaneous steel and iron shapes as required for framing and supporting woodwork, and for anchoring or securing woodwork to concrete or other structures.

B. Fabricate items to sizes, shapes, and dimensions required. Furnish malleable-iron washers for heads and nuts which bear on wood structural connections; elsewhere, furnish steel washers.

C. Finishing: Provide the following for locations indicated:

(1) Rough hardware to be installed at exterior locations or in exterior walls shall be stainless steel.

Miscellaneous Framing and Supports:

A. General: Provide steel framing and supports for applications indicated or which are not a part of structural steel framework, as required to complete work.

B. Fabricate units to sizes, shapes, and profiles indicated and required to receive adjacent other construction retained by framing and supports. Fabricate from structural steel shapes, plates, and steel bars of welded construction using mitered joints for field connection. Cut, drill, and tap units to receive hardware, hangers, and similar items.

(1) Equip units with integrally welded anchors for casting into concrete or building into masonry. Furnish inserts if units must be installed after concrete is placed.

(a) Except as otherwise indicated, space anchors 24 inches o.c. and provide minimum anchor units in the form of steel straps 1-1/4 inches wide x 1/4 inch x 8 inches long.

C. Finishing: Provide the following for locations indicated:

(1) Framing and supports to be installed at exterior locations shall be hot-dip galvanized after fabrication.
(2) All other framing and supports shall be shop primed.

Construction Method:

Preparation:

A. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, including concrete inserts, sleeves, anchor bolts, and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.

B. Set sleeves in concrete with tops flush with finish surface elevations; protect sleeves from water and concrete entry.

Installation:

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installation of metal fabrications. Set metal fabrication accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints, but cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with requirements for welding in “Fabrication, General” Article.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal fabrications to in-place construction; include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors as required.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete masonry or similar construction.

Adjusting And Cleaning:

A. Touch-Up Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 requirements for touch-up of field painted surfaces.

(1) Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

Submittals:

A. Product Data: For the following:

(1) Shop coating products.
(2) Grout.
(3) Post-installed anchors.

B. Shop drawings detailing fabrication and erection of each metal fabrication indicated. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other sections.

C. Welding Certificates: Copies of certificates for welding procedures and personnel.

D. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

Quality Assurance:

A. Fabricator Qualifications: Firm experienced in successfully producing metal fabrications similar to that indicated for this Project, with sufficient production capacity to produce required units without causing delay in the Work.

B. Welding: Qualify procedures and personnel according to the following:

(1) AWS D1.1, "Structural Welding Code--Steel."

(2) AWS D1.3, "Structural Welding Code--Sheet Steel."

C. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

Project Conditions:

A Field Measurements: Check actual locations of walls and other construction to which metal fabrications must fit, by accurate field measurements before fabrication; show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay of Work.

(1) Where field measurements cannot be made without delaying the Work, guarantee dimensions and proceed with fabrication of products without field measurements. Coordinate construction to ensure that actual opening dimensions correspond to guaranteed dimensions. Allow for trimming and fitting.

Sequencing And Scheduling:

A. Sequence and coordinate installation of handrails as follows:

(1) Install handrails only on completed construction. Do not support handrails temporarily by any means not satisfying structural performance requirements.

Method of Measurement:
This work will be measured for payment by the square feet of 'Wrought Iron Railing' installed and accepted. This item shall include but not be limited to all items required to furnish and install Wrought Iron Railing, required fasteners, concrete, and other incidentals.

Basis of Payment:
This work will be paid for at the Contract unit price per square foot of "Wrought Iron Railing," complete in place, which price shall include materials, equipment, tools, labor and work incidental thereto.

Pay Item:	Pay Unit
Wrought Iron Railing	SF.

ITEM #0914013A – ORNAMENTAL METAL FENCE

All Ornamental Metal Fence shall be constructed in accordance with CTDOT – Form 818 supplemented as follows:

Description:

This item is used at the Resilience Gateway and Pump Station Site to keep people, animals, and foreign objects out of adjacent properties. This item shall consist of furnishing and installing a Corten Steel Fence, of the type specified, at the location, to the dimensions and details as shown on the plans in accordance with these specifications.

References:

i. COR-TEN® steel is produced by SSAB under a license from US Steel Corporation.

ii. Suppliers/Fabricators:
   a. McDonald Construction, Inc., 40 NE Industrial Rd., Branford, CT 06405, Tel. 475 221-733; email: mcdonaldconstruction@snet.net
   b. Linders Specialty Company, 432 Atwater St., St. Paul, MN. 55117; Tel 651,488,0528; Email sales@lscmetalfab.com
   c. Approved Equal.

iii. SSAB AB, was earlier Svenskt Stål AB. It is the Swedish licensing company,

Definitions:

Ornamental Fence: A collection of Corten metal panels built of flat bars and steel tubes, anchored to alternating pre-existing, poured -in-place concrete panels.

Materials:

Performance Requirements:

A. Thermal Movements: Allow for thermal movement resulting from the following maximum change (range) in ambient temperature in the design, fabrication, and installation of installed metal assemblies to prevent buckling, opening up of joints, and overstressing of welds and fasteners. Base design calculations on actual surface temperatures of metals due to both solar heat gain and nighttime sky heat loss.

   (1) Temperature Change (Range): 180 deg F (100 deg C), material surfaces.

Metals:

A. Metal Surfaces, General: For metal fabrications exposed to view in the completed Work, provide materials selected for their surface flatness, smoothness, and freedom from stains, discolorations, or surface blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

B. Corten Steel: Cold Rolled Steel Manufactured To ASTM A1008 Specifications; ASTM 588 Grade A for Corten-A.

i) Steel Plates, Shapes, and Bars: ASTM A 36 (ASTM A 36M).

ii) Weathering Steel: Corten structural steel with improved atmospheric corrosion resistance, ASTM A242 or ASTM A606-4.

iii) Cast-in-Place Anchors in Concrete: Anchors of type indicated below, fabricated from corrosion-resistant materials capable of sustaining, without failure, the load imposed within a safety factor of 4, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

(1) Threaded or wedge type; ferrous castings, ASTM A 47 (ASTM A 47M) malleable iron. Provide bolts, washers, and shims as required.

Fasteners:

i) General: Unless otherwise indicated, provide Type 316 stainless-steel fasteners .

ii) Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, nuts and flat washers; ASTM F 593 for bolts and ASTM F 594 for nuts, Alloy Group 1.

iii) Phillips Flat-Head Machine Screws: Stainless steel, ASME B18.6.3.

iv) Post-Installed Anchors: Chemical anchors.

(1) Material for Exterior Locations and Where Stainless Steel is Indicated: Alloy Group 2 (A4) stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).

v) Anchor Bolts: ASTM F 1554, Grade 36.

(1) Provide stainless steel anchor bolts.

Accessory Materials:

i) Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

(1) Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include the following or Equal:

(a) B-6 Construction Grout; W. R. Bonsal Co.
(b) Sonogrout 14; Sonneborn Building Products--ChemRex, Inc.

ii) Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

Fabrication:

i) Form metal fabrications from materials of size, thickness, and shapes indicated but not less than that needed to comply with performance requirements indicated. Work to dimensions indicated or accepted on shop drawings, using proven details of fabrication and support. Use type of materials indicated or specified for various components of each metal fabrication.

ii) Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

iii) Form exposed work true to line and level, with accurate angles and surfaces and straight edges. Tolerances for installed work shall comply with the following:

(1) Variation from required lines shall not exceed 1/8" in 5 feet, or 1/4" maximum for the overall length of the fabricated item, whichever is less.

iv) Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

v) Ease exposed edges to a radius of approximately 1/32 inch (1 mm), unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

vi) Weld corners and seams continuously to comply with the following:

(1) Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
(2) Obtain fusion without undercut or overlap.
(3) Remove welding flux immediately.
(4) At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing, and contour of welded surface matches those adjacent.

vii) Form exposed connections with hairline joints, flush and smooth, using concealed fasteners wherever possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.

viii) Provide for anchorage of type indicated, coordinate with supporting structure. Fabricate and space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

ix) Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

x) Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.

Fence Panels:

i) Unless otherwise indicated, fabricate units from weathering steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible. Cut, drill, and tap units to receive hardware, hangers, and similar items.

ii) Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

Rough Hardware:

i) Furnish bent or otherwise custom fabricated bolts, plates, anchors, hangers, dowels, and other miscellaneous steel and iron shapes as required for framing and supporting woodwork, and for anchoring or securing woodwork to concrete or other structures.

ii) Fabricate items to sizes, shapes, and dimensions required. Furnish malleable-iron washers for heads and nuts which bear on wood structural connections; elsewhere, furnish steel washers.

iii) Finishing: Provide the following for locations indicated:

(1) Rough hardware to be installed at exterior locations shall be steel.
(2) All other rough hardware shall be shop primed.

Construction Method:

Preparation:

i) Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, including concrete inserts, sleeves, anchor bolts, and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.

ii) Set sleeves in concrete with tops flush with finish surface elevations; protect sleeves from water and concrete entry.

Installation:

i) Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installation of metal fabrications. Set metal fabrication accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

ii) Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints, but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units which have been hot-dip galvanized after fabrication, and are intended for bolted or screwed field connections.

iii) Field Welding: Comply with requirements for welding in "Fabrication, General" Article.

iv) Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal fabrications to in-place construction; include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors as required.

v) Provide temporary bracing or anchors in formwork for items that are to be built into concrete masonry or similar construction.

Adjusting And Cleaning:

(i) Verify that panels have been installed straight, plumbed and aligned. Clean per Corten Manufacturing recommendations.

Submittals:

i) Product Data: For the following:

(1) Shop coating products.
(2) Grout.
(3) Post-installed anchors.

ii) Shop drawings detailing fabrication and erection of each metal fabrication indicated. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other sections.

iii) Welding Certificates: Copies of certificates for welding procedures and personnel.

iv) Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

Quality Assurance:

i) Fabricator Qualifications: Firm experienced in successfully producing metal fabrications similar to that indicated for this Project, with sufficient production capacity to produce required units without causing delay in the Work.

ii) Welding: Qualify procedures and personnel according to the following:

(1) AWS D1.1, "Structural Welding Code--Steel."
(2) AWS D1.3, "Structural Welding Code--Sheet Steel."

iii) Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

Project Conditions:

i) Field Measurements: Check actual locations of walls and other construction to which metal fabrications must fit, by accurate field measurements before fabrication; show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay of Work.

(1) Where field measurements cannot be made without delaying the Work, guarantee dimensions and proceed with fabrication of products without field measurements. Coordinate construction to ensure that actual opening dimensions correspond to guaranteed dimensions. Allow for trimming and fitting.

Sequencing And Scheduling:

i) Sequence and coordinate installation of-ornamental panels as follows:

(1) Install fence panels only on completed construction. Do not support fence temporarily by any means not satisfying structural performance requirements.

Method of Measurement:
This work will be measured for payment by the square feet of 'Ornamental Metal Fence' installed and accepted. This item shall include but not be limited to all items required to furnish and install ornamental metal fence in a concrete footing, required fasteners, concrete, and other incidentals.

Basis of Payment:
This work will be paid for at the Contract unit price per square foot of "Ornamental Metal Fence," complete in place, which price shall include materials, equipment, tools, labor and work incidental thereto.

Pay Item:	Pay Unit
Ornamental Metal Fence	S.F.

ITEM #0915000 – TREE PROTECTION

All Tree Protection shall be constructed in accordance with CTDOT – Form 818, Article 9.15 Supplemented as follows:

Description:

Add the Following:

1. Tree Protection Zone (TPZ):
   Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and defined by a circle centered on the trunk with each tree with a minimum radius equal to 1' (one foot) for every 1" (one inch) of tree diameter (at 4.5' height), or preferred at 1.5' for every 1" unless indicated otherwise by the Owner's Representative.

2. Protect the tree and plant protection area at all times from compaction of the soil; damage of any kind to trunks, bark, branches, leaves and roots of all plants; and contamination of the soil, bark or leaves with construction materials, debris, silt, fuels, oils, and any chemicals substance. Notify the Owner's Representative of any spills, compaction or damage and take corrective action immediately using methods approved by the Owner's Representative.

3. Protection of existing trees and plants from damage as a result of the Contractor's operations including, but not limited to:
   a. Penalties and fines.
   b. Root pruning and construction pruning
   c. Maintenance and removal of in-place tree protection systems installed under this Contract.

4. Contractor will provide a Connecticut licensed arborist for tree pruning and removals related to work of this Section.

5. Submittals
   a. Proposed methods, materials, and schedule for root pruning shall be submitted for approval.

6. Damage Penalties
   a. Certain specimen trees adjacent to construction areas and in other key locations will be identified by the Owner and the Architect, and marked with red tags. Loss of any of these trees will result in fines assessed at $5,000 per tree. Damage to all other trees on the property will be assessed at the rate of $200 per inch caliper of the tree.
   b. A fine of $1,000 will be levied against the Contractor for each incident of construction inside tree protection areas.
   c. Damages to trees, shrubs, and other vegetation will be assessed by the Architect and Owner in accordance with the ISA Guide.

d. Trees or roots visibly damaged will cause the Owner to withold from the Contractor an assessed amount conforming to the requirements stipulated above for a period of two years. After that period the impact of the damage to any tree will be assessed accordingly.

e. If any trees or shrubs designated to be saved are damaged and replacement is required, a number and diameter of trees or shrubs of the same species and variety, as specified by the Owner and Architect, shall be furnished and planted by the Contractor. The total inch diameter of the replacement trees or shrubs shall equal the diameter of the tree or shrub to be replaced. The Contractor shall not be liable for any loss or damage which occurs while the Contractor is complying with instructions given by the Owner, Architect, or arborist working on the Project.

7. Only those trees located within the limits of improvements to be constructed as indicated, shall be removed.
   a. All trees to remain shall be flagged for review after the location of improvements to be constructed are staked in the field.
   b. Any tree to be removed shall be reviewed by the Architect and Owner for approval prior to removal.
   c. Trees to be preserved are represented by a solid line. Trees to be removed are represented by a dashed or ghosted line. Trees to be planted are graphically differentiated from existing trees.
   d. Obtain approval of installation of tree barricade fencing from Owner and Architect prior to the initiation of any removal of vegetation and construction.

Materials:

Add the Following:

1. Mulch
   a. Mulch shall be coarse, ground, from trees 27-36% and woody brush sources. The minimum range

of fine particles shall be 3/8 inch or less in size and a maximum size of individual pieces shall

be approximately 1 to 1-1/2 inch in diameter and maximum length of approximately 4 to 8 inches. No more that 25% of the total volume shall be fine particles and no more than 20% of total volume be large pieces.

   i.) It is understood that Mulch quality will vary significantly from supplier to supplier and region to region. The above requirements may be modified to conform to the source material from locally reliable suppliers as approved by the Owner's Representative.

   b. Submit supplier's product data that product meets the requirements and on gallon sample for approval.

2. Wood Chips
   From an arborist chipping operation with less than 20% by volume green leaves. Chips stockpiled from the tree removal process may be used.

3. Tree Protection Fencing
    a. Chain Link Fence: 6 feet tall metal chain link fence set on 2" galvanized posts secured minimum 1.5' in ground or on metal frame panels on movable core drilled concrete blocks of sufficient size to hold the fence erect in areas of existing paving to remain. Fence to have signage declaring Tree Protection Zone.
    b. Gates: For each fence type and in each separate fenced area, provide a minimum of one 3-foot-wide gate. Gates shall be lockable. The location of the gates shall be approved by the Owner's Representative.
    c. Submit supplier's product data that product meets the requirements for approval.
    d. Permitted Activities: Permitted/Required within TPZ
        i.) Mulching. During construction, spread wood chips within the TPZ 4" to 6" deep, leaving the trunk itself clear and without contact with mulch. Mulching helps prevent inadvertent compaction and moisture loss from occurring. 2-inch unpainted, untreated wood chips or equivalent is recommended for mulch material.
        ii.) Root Buffer. When areas under the tree canopy cannot be fenced, create a temporary buffer to cover the root zone (such as wood chips and plywood) that remain in place until final grading.
        iii.) Trunk Protection. During construction activities in tight spaces, it will be necessary to protect the trunk and buttress roots without the advantage of a standard Tree Protection Zone. Protective planking on the trunk as well as sandbags at the base of the tree would be required. Contractor to coordinate with the Owner's Representative.
        iv.) Irrigation, soil aeration with an air spade, fertilizing or other beneficial practices.
    e. Tree Protection Zone (TPZ) is a restricted activity zone where no soil disturbance is permitted unless coordinated with Owner's Representative. Site work planned near the critical root zone (CRZ) of a single tree or groups of trees to be preserved, requires a TPZ, TPZ fencing should be in place before undertaking any activities that might involve trenching or other disturbance to the tree's roots, such as:
        i.) Access roads
        ii.) Staging, storage, and temporary parking areas
        iii.) Paving or other impervious surfaces
        iv.) Temporary utility lines
        v.) Installation of pipe drainage, irrigation or other services.
        vi.) Stormwater management devices
        vii.) Grading that requires cut and fill
        viii.) Storage or parking of vehicles, building materials, refuse, excavated spoils or dumping of poisonous materials on or around trees and roots such as paint, petroleum products, concrete or stucco mix, dirty water
        ix.) The use of tree trunks as a winch support, anchorage, as a temporary power pole, sign posts or other similar function.
        x.) Cutting of tree roots by utility trenching, foundation digging, placement of curbs and trenches and other miscellaneous excavation or erosion control. If a

tree is adjacent to or near a steep slope or other critical area, approved erosion control or silt barriers may be necessary to prevent siltation and/or erosion within the TPZ. Do not install silt fence within the Tree Protection Zone. Far too often contractors trench through a tree's root zone to meet requirements for silt fence installation, causing more harm than good. Protective mulch (above) and permeable erosion control blankets can substantially reduce runoff within the TPZ.

xi.) Soil disturbance or grade change and drainage changes.

Site visit by a Tree Professional (Owners Representative) is needed if —advance planning fails and a trench must pass through the TPZ. Depending on specific site conditions, tree species, health, and position of any potential targets, trenching may be approved. If not, it could require risk mitigation and payment of a bond by the contractor. Alternative remedies can include tunneling (lateral boring) or re-routing utilities, and relocating or re-engineering walls to avoid roots of important trees. Walls and pipes can be moved, but a damaged tree cannot be repaired or readily replaced.

4. Tree Protection Sign
   Heavy-duty laminated cardboard signs, 8.5 inches x 11 inches, white colored background with black 2 inch high or larger letters block letters. The signs shall be attached to the tree protection fence every 50 feet on center. The tree protection sign shall read: "Tree Protection Zone - Keep Out Species_____, DBH ____,Environmental Contribution $___"

5. Tree Growth Regulator (TGR)
   a. Active ingredient Paclobutrazol, product used to limit canopy growth in order to free up energy resources for the tree
   b. Submit supplier's product data that meets the requirements for approval.

6. Matting
   a. Matting for vehicle and work protection shall be heavy duty matting designed for vehicle loading over tree roots, Alturnamats as manufactured by Alturnamats, Inc. Franklin, PA 16323 or approved equal.
   b. Submit supplier's product data that product meets the requirements for approval.

7. Geogrid (Geo textile)
   Geogrid shall be woven polyester fabric with PVC coating, Uni-axial or biaxial geogrid, inert to biological degradation, resistant to naturally occurring chemicals, alkalis, acids.
   a. Geogrid shall be Miragrid 2XT as manufactured by Ten Cate Nicholson, Norcross, GA. http://www.tencate.com or approved equal
   b. Submit suppliers product data that product meets the requirements for approval.

8. Filter Fabric
   Filter fabric shall be nonwoven polypropylene fibers, inert to biological degradation and resistant of naturally occurring chemicals, alkalis and acids.

a. Mirafi 135 N as manufactured by Ten Cate Nicolon, Norcross, GA. http://www.tencate.com or approved equal. Submit suppliers product data that product meets the requirements for

Construction Methods:

Add the Following:

1. Preparation
   a. Prior to the preconstruction meeting, layout the limits of the Tree Protection Zone and then alignments of required Tree Protection Fencing and any root pruning. Obtain the Owner's Representative's approval of the limits of the protection area and the alignment of all fencing and root pruning.
   b. Flag all trees and shrubs to be removed by wrapping orange plastic ribbon around the trunk and obtain the Owner's Representative's approval of all trees and shrubs to be removed prior to the start of tree and shrub removal. After approval, mark all trees and shrubs to be removed with orange paint in a band completely around the base of the tree or shrub 4.5 feet above the ground.
   c. Flag all trees and shrubs to remain with white plastic ribbon tied completely around the trunk or each tree and on a prominent branch for each shrub. Obtain the Owner's Representative's approval of all trees and shrubs to be remain prior to the start of tree and shrub removal.
   d. Prior to any construction activity at the site including utility work, grading, storage of materials, or installation of temporary construction facilities, install all tree protection fencing, filter Fabric, silt fence, tree protection signs, Geogrid, mulch and or wood chips as shown on the drawings.

2. Soil Moisture
   a. Volumetric soil moisture level, in all soils within the Tree Protection Zone shall be maintained above permanent wilt point to a depth of at least 8 inches. No soil work or other activity shall be permitted within the Tree Protection Zone when the volumetric soil moisture is above field capacity. The permanent wilt point and field capacity for each type of soil texture shall be defined as follows (numbers indicate percentage volumetric soil moisture).

      i.) Volumetric soil moisture shall be measured with a digital, electric conductivity meter. The meter shall be the Digital Soil Moisture Meter, DSMM500 by General Specialty Tools and Instruments, or approved equivalent meter.

   b. The Contractor shall confirm the soil moisture levels with a moisture meter. If the moisture is too high, suspend operations until the soil moisture drains to below field capacity.

Soil type	Permanent wilt point v/v	Field capacity v/v
Sand, Loamy sand, Sandy loam	5-8%	12-18%
Loam, Sandy clay, Sandy clay loam	14-25%	27-36%
Clay loam, Silt loam	11-22%	31-36%
Silty clay, Silty clay loam	22-27%	38-41%

3. Root Pruning:
   Prior to any excavating into the existing soil grade within 25 feet of the limit of the Tree Protection Zone or trees to remain, root prune all existing trees to a depth of 24 inches below existing grade in alignments following the edges of the Tree Protection And/ or as directed by the Owner's Representative. Root pruning shall be in conformance with ANSI A300 (part 8) latest edition.
   a. Using a rock saw, chain trencher or similar trenching device, make a vertical cut within 2 feet of the limit of grading.
   b. After completion of the cut, make clean cuts with a lopper, saw or pruner to remove all torn root ends on the tree side of the excavation, and backfill the trench immediately with existing soil, filling all voids.

4. Installation of Geogrids, Filter Fabric, Matting, Wood Chips and or Mulch.
   a. Install Geogrids, Filter Fabric, matting, Wood Chips and or Mulch in areas and depths shown on the plans and details or as directed by the Owner's representative. In general, it is the intent of this specification to provide the following levels of protection:

      i.) All areas within the Tree and Plant Protection area provide a minimum of 8 inches of Wood Chips or Mulch.
      ii.) Areas where foot traffic or storage of lightweight materials (upon approval by Owner's Representative) is anticipated to be unavoidable provide a layer of Filter Fabric under the 8 inches of Wood Chips or Mulch.
      iii.) Areas where occasional light vehicle traffic is anticipated to be unavoidable provide a layer of Geogrids under 8 inches of Wood Chips or Mulch.
      iv.) Areas where heavy vehicle traffic is unavoidable provide a layer of Geogrids under 8 - 12 inches of Wood Chips or Mulch and a layer of matting over the Wood Chips or Mulch such as AlturnaMat, ¾" plywood or ¼" steel plating.

   b. The Owner's Representative shall approve the appropriate level of protection.

   c. In the above requirements, light vehicle is defined as a track skid steer with a ground pressure of 4 psi or lighter. A heavy vehicle is any vehicle with a tire or track pressure of greater than 4 psi. Lightweight materials are any packaged materials that

can be physically moved by hand into the location. Bulk materials such as soil, or aggregate shall never be stored within the Tree and Plant Protection Area.

5. Protection
   Protect the Tree and Plant Protection Area at all times from compaction of the soil; damage of any kind to trunks, bark, branches, leaves and roots of all plants; and contamination of the soil, bark or leaves with construction materials, debris, silt, fuels, oils, and any chemicals substance. Notify the Owner's Representative of any spills, compaction or damage and take corrective action immediately using methods approved by the Owner's Representative.

6. General Requirements and Limitations for Operations within the Tree and Plant Protection Area
   a. The Contractor shall not engage in any construction activity within the Tree Protection Zone without the approval of the Owner's Representative including: operating, moving or storing equipment; storing supplies or materials; locating temporary facilities including trailers or portable toilets and shall not permit employees to traverse the area to access adjacent areas of the project or use the area for lunch or any other work breaks. Permitted activity, if any, within the Tree and Plant Protection Area maybe indicated on the drawings along with any required remedial activity as listed below.

   b. In the event that construction activity is unavoidable within the Tree Protection Zone, notify the Owner's Representative and submit a detailed written plan of action for approval. The plan shall include: a statement detailing the reason for the activity including why other areas are not suited; a description of the proposed activity; the time period for the activity, and a list of remedial actions that will reduce the impact on the Tree Protection Zone from the activity. Remedial actions shall include but shall not be limited to the following:

      i.) In general, demolition and excavation within the drip line of trees and shrubs shall proceed with extreme care either by the use of hand tools, directional boring and or Air Knife excavation where indicated or with other low impact equipment that will not cause damage to the tree, roots or soil.
      ii.) When encountered, exposed roots, 1 inch and larger in diameter shall be worked around in a manner that does not break the outer layer of the root surface (bark). These roots shall be covered in Wood Chips and shall be maintained above permanent wilt point at all times. Roots one inch and larger in diameter shall not be cut without the approval of the Owner's Representative. Excavation shall be tunneled under these roots without cutting them. In the areas where roots are encountered, work shall be performed and scheduled to close excavations as quickly as possible over exposed roots.

   c. Tree branches that interfere with the construction may be tied back or pruned to clear only to the point necessary to complete the work. Other branches shall only be

removed when specifically indicated by the Owner's Representative. Tying back or trimming of all branches and the cutting of roots shall be in accordance with accepted arboricultural practices (ANSI A300, part 8) and be performed under supervision of the Connecticut state licensed arborist.

d. Matting: Install temporary matting over the Wood Chips or Mulch to the extent indicated. Do not permit foot traffic, scaffolding or the storage of materials within the Tree Protection Zone to occur off of the temporary matting.

e. Trunk Protection: Protect the trunk of each tree to remain by covering it with a ring of 6 foot long 2-inch x 4 - inch planks loosely banded onto the tree with 3 steel bands. Wire (12 gauge galvanized or other approved method) the planks as necessary to hold them securely in place. Trunk protection must be kept in place no longer than 12 months. If construction requires work near a particular tree to continue longer than 12 months, the wire shall be inspected every six months and loosened if it is found to have become tight.

f. Air Excavation Tool: If excavation for footings or utilities is required within the Tree and Plant Protection Area, air excavation tool techniques shall be used where practical or as designed on the drawings.

   i.) Remove the Wood Chips from an area approximately 18 inches beyond the limits of the hole or trench to be excavated. Cover the Wood Chips for a distance of not less than 15 feet around the limit of the excavation area with Filter Fabric or plastic sheeting to protect the Wood Chips from silt. Mound the Wood Chips so that the plastic slopes towards the excavation.

   ii.) Using a sprinkler or soaker hose, apply water slowly to the area of the excavation for a period of at least 4 hours, approximately 12 hours prior to the work so that the ground water level is at or near field capacity at the beginning of the work. For excavations that go beyond the damp soil, rewet the soil as necessary to keep soil moisture near field capacity.

   iii.) Using an air excavation tool specifically designed and manufactured for the intended purpose, and at pressures recommended by the manufacturer of the equipment, fracture the existing soil to the shape and the depths required. Work at rates and using techniques that do not harm tree roots. Air pressure shall be a maximum of 90-100 psi.

      a.) The air excavation tool shall be "Air-Spade" as manufactured by Concept Engineering Group, Inc., Verona, PA (412) 826-8800, or Air Knife as manufactured by Easy Use Air Tools, Inc. Allison Park, Pa (866) 328-5723 or approved equal.

   iv.) Using a commercial, high-powered vacuum truck if required, remove the soil from the excavation produced by the Air Knife excavation. The vacuum truck should generally operate simultaneously with the hose operator, such that the soil produced is picked up from the excavation hole, and the exposed roots can be observed and not damaged by the ongoing operation. Do not drive the

vacuum truck into the Tree Protection Zone unless the area is protected from compaction as approved in advance by the Owner's Representative.

v.) Remove all excavated soil and excavated Wood Chips, and contaminated soil at the end of the excavation.

vi.) Schedule the work so that foundations or utility work is completed immediately after the excavation. Do not let the roots dry out. Mist the roots several times during the day. If the excavated area must remain open overnight, mist the roots and cover the excavation with black plastic.

vii.) Dispose of all soil in a manner that meets local laws and regulations.

viii.) Restore soil within the trench as soon as the work is completed. Utilize soil of similar texture to the removed soil and lightly compact with hand tools. Leave soil mounded over the trench to a height of approximately 10% of the trench depth to account for settlement.

ix.) Restore any Geogrids, Filter Fabric, Wood Chips or Mulch and or matting that was previously required for the area.

7. Tree Removal
   a. Remove all trees indicated by the drawings and specifications, as requiring removal, in a manner that will not damage adjacent trees or structures or compact the soil.

   b. Remove trees that are adjacent to trees or structures to remain, in sections, to limit the opportunity of damage to adjacent crowns, trunks, ground plane elements and structures.

   c. Do not drop trees with a single cut unless the tree will fall in an area not included in the Tree Protection Zone. No tree to be removed within 50 feet of the Tree Protection Zone shall be pushed over or up-rooted using a piece of grading equipment or otherwise.

   d. Protect adjacent paving, soil, trees, shrubs, ground cover plantings and understory plants to remain from damage during all tree removal operations, and from construction operations. Protection shall include the root system, trunk, limbs, and crown from breakage or scarring, and the soil from compaction.

   e. Remove stumps and immediate root plate from existing trees to be removed. Grind trunk bases and large buttress roots to a depth of the largest buttress root or at least 18 inches below the top most roots whichever is less and over the area of three times the diameter of the trunk (DBH) unless directed otherwise by the Owners Representative.

      i.) For trees where the stump will fall under new paved areas, grind roots to a total depth of 18 inches below the existing grade. If the sides of the stump hole still have greater than approximately 20% wood visible, continue grinding operation deeper and or wider until the resulting hole has less than 20% wood. Remove all wood chips produced by the grinding operation and

back fill in 8-inch lift layers with controlled fill of a quality acceptable to the site engineer for fill material under structures, compacted to 95% of the maximum dry density standard proctor. The Owner's Representative shall approve each hole at the end of the grinding operation.

ii.) In areas where the tree location is to be a planting bed or lawn, remove all woodchips and backfill stump holes with planting soil as defined in Specification Section Planting Soil, in maximum of 12-inch layers and compact to 80 - 85% of the maximum dry density standard proctor.

8. Pruning
   a. Within six months of the estimated date of substantial completion, have Connecticut licensed arborist prune all dead or hazardous branches larger than 2 inch in diameter from all trees to remain.

   b. Implement all pruning recommendations found in the arborist report.

   c. Prune any low, hanging branches and vines from existing trees and shrubs that overhang walks, streets and drives, or parking areas as follows:

      i.) Walks - within 8 feet vertically of the proposed walk elevation.
      ii.) Parking areas - within 12 feet vertically of the proposed parking surface elevation.
      iii.) Streets and drives - within 14 feet vertically of the proposed driving surface elevation.

   d. All pruning shall be done by a Connecticut licensed arborist in accordance with ANSI A300 (part 1), ISA BMP Tree Pruning (latest edition, and the "Structural Pruning: A Guide for the Green Industry", Edward Gilman, Brian Kempf, Nelda Matheny and Jim Clark, 2013 Urban Tree Foundation, Visalia, CA.

   e. Perform other pruning task as indicated on the drawings or requested by the Owner's Representative.

   f. Where tree specific disease vectors require, sterilize all pruning tools between the work in individual trees.

9. Tree Growth Regulator Injection (TGR)
   Unless otherwise directed by the Owners Representative, at the start of the construction contract period, treat all trees, indicated on the Plan, with Tree Growth Regulator at recommended rates, time of year and methods indicated by the product distributor. Applicator to be a Connecticut licensed arborist or under the supervision of one.

10. Watering

a. The Contractor shall be fully responsible to ensure that adequate water is provided to all plants to be preserved during the entire construction period. Adequate water is defined to be maintaining soil moisture above the permanent wilt point to a depth of 8 inches or greater.

b. The Contractor shall adjust the automatic irrigation system, if available, and apply additional water, using hoses or water tanks as required.

c. Periodically test the moisture content in the soil within the root zone to determine the water content.

11. Weed Removal
    a. During the construction period, control any plants that seed in and around the fenced Tree and Plant Protection area at least three times a year. Coordinate any weed eradication with the owner's representative.

        i.) All plants that are not shown on the planting plan or on the Tree and Plant Protection Plan to remain shall be considered as weeds.

    b. At the end of the construction period provide one final weeding of the Tree and Plant Protection Area.

12. Insect and Disease Control
    Monitor all plants to remain for disease and insect infestations during the entire construction period. Provide all disease and insect control required to keep the plants in a healthy state using the principles of Integrated Plant Management (IPM). All pesticides shall be applied by a Connecticut licensed pesticide applicator after approval of Owners Representative

13. Clean-up
    During tree and plant protection work, keep the site free of trash, pavements reasonably clean and work area in an orderly condition at the end of each day. Remove trash and debris in containers from the site no less than once a week.
    a. Immediately clean up any spilled or tracked soil, fuel, oil, trash or debris deposited by the Contractor from all surfaces within the project or on public right of ways and neighboring property.
    b. Once tree protection work is complete, wash all soil from pavements and other structures. Ensure that Mulch is confined to planting beds.
    c. Make all repairs to grades, ruts, and damage to the work or other work at the site.
    d. Remove and dispose of all excess Mulch, Wood Chips, packaging, and other material brought to the site by the Contractor.

14. Removal of Fencing and Other Tree and Plant Protection
    At the end of the construction period or when requested by the Owner's Representative remove all fencing, Wood Chips or Mulch, Geogrids and Filter Fabric, trunk protection and or any other Tree and Plant Protection material.

15. Damage or Loss to Existing Plants to Remain
    a. Any trees or plants designated to remain and which are damaged by the Contractor shall be replaced in kind by the Contractor at their own expense. Trees shall be replaced with an approved tree of similar species and of equal size or 6-inch caliper - whichever is less. If applicable, shrubs shall be replaced with a plant of similar species and equal size or the largest size plants reasonably available - whichever is less. Where replacement plants are to be less than the size of the plant that is damaged, the Owner's Representative shall approve the size and quality of the replacement plant.

    b. High value heritage (veteran, priority, specimen) trees will be identified by the Owners Representative and will have an individually assessed above and beyond above replacement process. This would be in the form of a bonding requirement over a period of five years at which time an assessment would be made of the condition of the heritage tree by the Owners Representative.

        i.) All trees and plants shall be installed per the requirements of Specification Section Planting.

    c. Plants that are damaged shall be considered as requiring replacement or appraisal in the event that the damage affects more than 25 % of the crown, 25% of the trunk circumference, or root protection area, or the tree is damaged in such a manner that the tree could develop into a potential hazard. Trees and shrubs to be replaced shall be removed by the Contractor at his own expense.

        i.) The Owner's Representative may engage an independent arborist to assess any tree or plant that appears to have been damaged to determine their health or condition.

    d. Any tree that is determined to be dead, damaged or potentially hazardous by the Owner's arborist and upon the request of the Owner's Representative shall be immediately removed by the Contractor at no additional expense to the owner. Tree removal shall include all clean-up of all wood parts and grinding of the stump to a depth sufficient to plant the replacement tree or plant, removal of all chips from the stump site and filling the resulting hole with topsoil.

        i.) Any remedial work on damaged existing plants recommended by the consulting arborist shall be completed by the Contractor at no cost to the owner. Remedial work shall include but is not limited to: soil compaction

remediation and vertical mulching, pruning and or cabling, insect and disease control including injections, compensatory watering, additional mulching, and could include application tree growth regulators (TGR) upon request by the Owners Representative.

ii.) Remedial work may extend up to two years following the completion of construction to allow for any requirements of multiple applications or the need to undertake applications at required seasons of the year.

Basis of Payment:

Add the Following:

Pay Item:	Pay Unit
Tree Protection	s.f.

SECTION #0921001A – CONCRETE SIDEWALK

Cast-in-place Concrete Paving: Broom Finish and Cast-in-Place Concrete Paving: Sandblasted Finish shall be constructed in accordance with CTDOT – Form 818, Article 9.21 Supplemented as follows:

Description:
Add the Following:

Mockup: A sample panel, 8 ft. x 8 ft. minimum, shall be constructed prior to start of concrete paving exhibiting surface finish/color, jointing, expansion joints and interface with adjacent paving and structures. The work will be inspected by the Landscape Architect. If the original sample panel is not acceptable, the Contractor shall construct additional sample panels until an accepted panel is obtained. The accepted panel shall become the standard for the entire job, and shall remain undisturbed until completion of all concrete paving.

Construction Methods:
Add the Following:

Broom Finish: shall have the horizontal surfaces of concrete surfaces which will be exposed shall be given a light broomed finish, with direction of grooves in concrete surface perpendicular to length of concrete band, slab, or pad. After concrete has set sufficiently to prevent coarse aggregate from being torn from surface, but before it has completely set, brooms shall be drawn across it to produce a pattern of small parallel grooves. Broomed surface shall be uniform, with no smooth, unduly rough or porous spots, or other irregularities. Coarse aggregate shall not be dislodged by brooming operation. No tooling of edges, expansion joints, or control joints.

Sandblasted Finish: shall be a light sand blast finish lightly exposing fine aggregate with no reveal, as on Landscape Architect's sample panel, approved sample, and mockup installation. Finish shall be free of surface defects such as migrated entrained air or entrapped air bubbles over 1/8 in. diameter, sand streaks, staining, lack of uniformity of color or finish, blotches, wash, form leakage or honeycomb, and physical damage, any of which shall be deemed cause for rejection.

Basis of Payment:
Add the Following:

Pay Item:	Pay Unit
Cast-in-place Concrete Paving – Broom Finish	s.f.
Cast-in-place Concrete Paving – Sandblasted Finish	s.f.

ITEM #0921002A – CONCRETE SIDEWALK - 8" THICK

Concrete sidewalks and concrete sidewalk ramps shall be constructed in accordance with Article 9.21, supplemented as follows:

Description:
Add the following:

The items shall conform to City sidewalk standards provided in the contract plans miscellaneous details.

Materials:
Replace the second sentence with the following:

Processed Coarse Aggregate Base shall meet requirements of M.05.01.

Add the following:

Welded wire fabric shall conform to Section M.06.

Construction Methods:
Replace Article 9.21.03.05 "Finishing" with the following:

The surface of concrete shall have a lightly broomed finish perpendicular to the travel way. The outside edges of the slab and all joints shall be edged with a ¼ inch radius edging tool. Each slab shall be divided into 2 or more sections by forming dummy joints with a jointing tool as directed.

Basis of Payment:
Add the following:

Pay Item	Pay Unit
Concrete Sidewalk – 8" Thick	s.f.

ITEM #0921020A – INTERLOCKING STONE PAVERS

All Interlocking Stone Pavers and Stone Erosion Protection shall be constructed in accordance with article 9.21, Supplemented as follows:

Description:

This item shall consist of approved stones laid in mortar or sand to form a standard walking surface of the dimensions and details shown on the plans, constructed where indicated on the plans in accordance with these specifications. This item also consists of the placement of larger granite stones/small boulders for erosion protection constructed where indicated on the plans in accordance with these specifications.

References:

A. ASTM A 123-02: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
B. ASTM C 97-02: Test Methods for Absorption and Bulk Specific Gravity of Dimension Stone.
C. ASTM C 119-04: Terminology Relating to Dimension Stone
D. ASTM C 170-90: Test Method for Compressive Strength of Dimension Stone
E. ASTM C 615-03: Specification for Granite Dimension Stone
F. ASTM F 593-02: Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
G. ASTM F 594-02: Specification for Stainless Steel Nuts
H. National Building Granite Quarries Association (NBGQA) Specifications for Architectural Granite.

Definitions:

A. Definitions contained in ASTM C 119 apply to this Section.

Materials:

Stone Source:

A. Basis-of-Design Product: Subject to compliance with requirements, provide Moonlit Rose® from Williams Stone Company or comparable stones by one of the following:
    a. Cold Spring Granite Company.
    b. Stony Creek Quarry.
    c. Williams Stone Company.
    d. Or, Approved Equal.

B. Each color of granite shall come from a single quarry, with sufficient reserves to satisfy the requirements of the project. The granite supplier shall have the capabilities to cut and finish the stone without delaying the project.

Stone:

A. Granite Building Stone Standard: ASTM C 615.

B. Unit Pavers:
   1. 4" thickness
   2. Varying sizes as indicated on plans
   3. Thermaled surface

C. Color and Texture: To closely match Architect's sample.

D. Finish: All exposed surfaces should be Thermaled.

E. Pavers with chips, cracks, or other structural or aesthetic defects shall not be used.

F. Rocks/boulders in their natural conditions (not cut, chiseled and/or refinished).

Miscellaneous:

Installation Materials:

A. Installation on Weir Surface Path:
   a. Edging: Stainless Steel edging shall be Ryerson Steel Landscaping Edging, manufactured by Ryerson Tull, Cleveland, OH 44114, or approved equal. Steel edging shall be shop fabricated, 3/16 in. thick x 4 in. deep, steel, primed and painted green. Edging shall be furnished in 20 ft. lengths.
   b. ¼" x 4" Stainless-Steel flat alignment bar between sloped and flat surfaces
   c. Mortar Base: 2" Mortar Base on Concrete slab
   d. Anchors and Pins: Stainless-Steel: ASTM A 580/A 580M, Type: 304

B. Installation on Belvedere Plaza Surface
   a. Sand Setting Base: Sand shall be a clean, sharp, natural sand conforming to ASTM C 33, except that the fineness modulus shall be 2.25 + 0.10.

   Gradation for setting bed sand shall be as follows:

Sieve Size	% Passing by Weight
3/8 in.	100
No. 4	95 - 100
No. 8	80 - 100

No. 16	50 - 85
No. 50	10 – 30
No. 100	5 - 15
No. 200	0 - 10

Gradation for joint filler sand shall be as follows:

i. Sand shall be a clean, washed, uniformly well graded masonry sand with 100 percent passing No. 16 (1.18-mm) sieve and no more than 10 percent passing No. 200 (0.075- mm) sieve, conforming to ASTM C 144, except that the fineness modulus shall be 2.25+ 0.10. Sand shall be from a single source. Source of supply shall not be changed during course of job without written permission of the Architect.

ii. Color of sand shall be uniform matching the paver in color, and shall be approved by the Architect.

b. Polymeric Joint Sand: Joint filler shall be polymeric joint sand, "TechniSeal Polymeric Joint Sand for Pavement Joints - HP", manufactured by TechniSeal, Inc., Boucherville, Canada J4B 7K2; Tel. 1-800-363-7560; or approved equal.

c. Base Course: Material for aggregate base course shall be a graded, granular, non-frost susceptible, freedraining material, consisting of either durable stone and coarse sand or of blast furnace slag, practically free from loam and clay, and which can be readily compacted to form a stable foundation.

d. Edging: Stainless Steel Angle anchored to concrete

Construction Methods:

Examination:

A. Prepare substrates using the methods recommended by the manufacturer for achieving best result for the substrates under project conditions.

B. Surfaces and Conditions: Prior to installing interlocking stone pavers, examine the existing surfaces and conditions to receive the cut stone and verify surfaces and conditions are in accordance with the requirements and as shown on Drawings. Do not proceed until defective surfaces are brought into compliance.

a. Examine surfaces and conditions with Installer present.

Preparation:

A. Remove substances from concrete substrates that could impair mortar bond, including curing and sealing compounds, form oil, and laitance.
B. Sweep concrete substrates to remove dirt, dust, debris, and loose particles.
C. Proof-roll prepared subgrade according to requirements in Section 312000 "Earth Moving" to identify soft pockets and areas of excess yielding. Proceed with unit paver installation only after deficient subgrades have been corrected and are ready to receive base course for unit pavers.

Installation:

A. Do not use unit pavers with chips, cracks, voids, discolorations, or other defects that might be visible or cause staining in finished work.

B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.

C. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.
   1. For concrete pavers, a block splitter may be used.

D. Joint Pattern: **As indicated on drawings**.

E. Tolerances: Do not exceed **1/16-inch unit-to-unit offset from flush (lippage) nor 1/8 inch in 24 inches and** 1/4 inch in 10 feet from level, or indicated slope, for finished surface of paving.

F. Expansion and Control Joints: Provide cork joint filler at locations and of widths indicated. Install joint filler before setting pavers. Make top of joint filler flush with top of pavers.

G. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.
   1. Install edge restraints to comply with manufacturer's written instructions. Install stakes at intervals required to hold edge restraints in place during and after unit paver installation.
   2. For metal edge restraints with top edge exposed, drive stakes at least 1 inch below top edge.
   3. Install job-built concrete edge restraints to comply with requirements in Section 06 04 00, Cast-in-Place Concrete.
   4. Where pavers set in mortar bed are indicated as edge restraints for pavers set in aggregate setting bed, install pavers set in mortar and allow mortar to cure before placing aggregate setting bed and remainder of pavers. Cut off mortar bed at a steep angle so it will not interfere with aggregate setting bed.
   5. Where pavers embedded in concrete are indicated as edge restraints for pavers set in aggregate setting bed, install pavers embedded in concrete and allow concrete

to cure before placing aggregate setting bed and remainder of pavers. Hold top of concrete below aggregate setting bed.

H. Install granite rocks/small boulders on graded surfaces adjacent to the lower weir for erosion control:

1. Proof-roll prepared subgrade according to requirements in Section 312000 "Earth Moving" to identify soft pockets and areas of excess yielding. Base Course: Material for aggregate base course shall be a graded, granular, non-frost susceptible, freedraining material, consisting of either durable stone and coarse sand or of blast furnace slag, practically free from loam and clay, and which can be readily compacted to form a stable foundation.

2. Place drainage geotextile over compacted base course, overlapping ends and edges at least 12 inches.

3. Place stones/boulders with a random pattern searching for a “natural look” combining different heights of boulders (boulders’ sizes).

Installation on Aggregate Setting-Bed:

I. Compact soil subgrade uniformly to at least [**95**] percent of [**ASTM D 698**] [**ASTM D 1557**] laboratory density.

J. Proof-roll prepared subgrade to identify soft pockets and areas of excess yielding. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

K. Place separation geotextile over prepared subgrade, overlapping ends and edges at least 12 inches.

L. Place aggregate base, compact by tamping with plate vibrator, and screed to depth indicated.

M. Place aggregate base, compact to 100 percent of ASTM D 1557 maximum laboratory density, and screed to depth indicated.

N. Place drainage geotextile over compacted base course, overlapping ends and edges at least 12 inches.

O. Place leveling course and screed to a thickness of 1 to 1-1/2 inches, taking care that moisture content remains constant, and density is loose and uniform until pavers are set and compacted.

P. Treat leveling course with herbicide to inhibit growth of grass and weeds.

Q. Set pavers with a minimum joint width of 1/16 inch and a maximum of 1/8 inch, being careful not to disturb leveling base. If pavers have spacer bars, place pavers hand tight against spacer bars. Use string lines to keep straight lines. Fill gaps between units that exceed [**3/8 inch**] with pieces cut to fit from full-size unit pavers.
   1. When installation is performed with mechanical equipment, use only unit pavers with spacer bars on sides of each unit.

R. Vibrate pavers into leveling course with a low-amplitude plate vibrator capable of a 3500- to 5000-lbf compaction force at 80 to 90 Hz. Use vibrator with neoprene mat on face of plate or other means as needed to prevent cracking and chipping of pavers. Perform at least three passes across paving with vibrator.
   1. Compact pavers when there is sufficient surface to accommodate operation of vibrator, leaving at least 36 inches of uncompacted pavers adjacent to temporary edges.
   2. Before ending each day's work, compact installed concrete pavers except for 36-inch width of uncompacted pavers adjacent to temporary edges (laying faces).
   3. As work progresses to perimeter of installation, compact installed pavers that are adjacent to permanent edges unless they are within 36 inches of laying face.
   4. Before ending each day's work and when rain interrupts work, cover pavers that have not been compacted and cover leveling course on which pavers have not been placed with nonstaining plastic sheets to protect them from rain.

S. Spread dry sand and fill joints immediately after vibrating pavers into leveling course. Vibrate pavers and add sand until joints are completely filled, then remove excess sand. Leave a slight surplus of sand on the surface for joint filling.

T. Do not allow traffic on installed pavers until sand has been vibrated into joints.

U. Repeat joint-filling process 30 days later.

Installation on Mortar Setting-Bed:

A. Saturate concrete subbase with clean water several hours before placing setting bed. Remove surface water about one hour before placing setting bed.

B. Apply mortar-bed bond coat over surface of concrete subbase about 15 minutes before placing mortar bed. Do not exceed 1/16-inch thickness for bond coat. Limit area of bond coat to avoid its drying out before placing setting bed.

C. Apply mortar bed over bond coat; spread and screed mortar bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated.

D. Place reinforcing wire over concrete subbase, lapped at joints by at least one full mesh and supported so mesh becomes embedded in the middle of mortar bed. Hold edges back from vertical surfaces approximately 1/2 inch.

E. Place mortar bed with reinforcing wire fully embedded in middle of mortar bed. Spread and screed mortar bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated.

F. Mix and place only that amount of mortar bed that can be covered with pavers before initial set. Before placing pavers, cut back, bevel edge, and remove and discard setting-bed material that has reached initial set.

G. Wet–pavers before laying if the initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested according to ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.

H. Place pavers before initial set of cement occurs. Immediately before placing pavers on mortar bed, apply uniform 1/16-inch- thick bond coat to mortar bed or to back of each paver with a flat trowel.

I. Tamp or beat pavers with a wooden block or rubber mallet to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances. Set each paver in a single operation before initial set of mortar; do not return to areas already set or disturb pavers for purposes of realigning finished surfaces or adjusting joints.

J. Spaced Joint Widths: Provide [**3/8-inch**] nominal joint width with variations not exceeding plus or minus [**3/16 inch**].

K. Grouted Joints: Grout paver joints complying with ANSI A108.10.

L. Grout joints as soon as possible after initial set of setting bed.
   1. Force grout into joints, taking care not to smear grout on adjoining surfaces.
   2. Clean pavers as grouting progresses by dry brushing or rubbing with dry burlap to remove smears before tooling joints.
   3. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
   4. If tooling squeezes grout from joints, remove excess grout and smears by dry brushing or rubbing with dry burlap and tool joints again to produce a uniform appearance.

M. Cure grout by maintaining in a damp condition for seven days unless otherwise recommended by grout or liquid-latex manufacturer.

Repairing, Pointing, And Cleaning:

A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

B. Pointing: During tooling of joints, enlarge voids or holes and completely fill with grout. Point joints at sealant joints to provide a neat, uniform appearance, properly prepared for sealant application.

C. Cleaning: Remove excess grout from exposed paver surfaces; wash and scrub clean.
   1. Remove temporary protective coating as recommended by coating manufacturer and as acceptable to paver and grout manufacturers.
   2. Do not allow protective coating to enter floor drains. Trap, collect, and remove coating material.

Protection:

A. At the end of each day's work, cover top of walls with a non-staining waterproof covering. Protect partially finished work when not being worked on.

Stone Fabrication:

A. Fabricate stone in accordance with requirements, including Drawings and Shop Drawings.
   1. Granite: NBGQA's "Specifications for Architectural Granite."

B. Cut stone to produce pieces of stone shown on Drawings and recommended by stone source, for faces, edges, beds, and backs.

C. Thickness of Stone: Provide thickness shown, but not less than the following:
   1. Thickness: 4 inches
   2. Tolerance: Plus or minus 1/8 inch.

D. Dress joints (bed) straight and at right angle to face.

E. Shape stone for type of Unit Pavers (pattern) as follows:
   a. Non-uniform widths and non-uniform lengths as shown on Drawings.

F. Setting Bed:
   1. 2” minimum mortar setting bed

G. Finish exposed faces and edges of stone to comply with requirements shown for finish and to match approved samples and mockups.
   1. Finish:
      a. Thermaled

H. Carefully inspect stone at fabrication plant for compliance with requirements for appearance, material, and fabrication. Replace defective units before shipment.

Submittals:

A. Product Data: For each stone type and each manufactured product shown on Drawings or specified.
    1. For each stone variety used on Project, include physical property data.

B. Shop Drawings: For the following:
    1. Interlocking Stone Pavers: Show sizes, profiles, expansion joint and joint locations, and locations of special shapes.
    2. Detail components embedded in masonry.

C. Samples: Submit samples for each stone type required, exhibiting the full range of color characteristics expected.
    1. Submit a minimum of 2 each, 8 inches x 8 inches and 2 inches x 10 inches in size, in each color and finish specified.
    2. In the case of more variegated stones, color photos shall be submitted in addition to the number of samples to show the full range of color and markings to be expected.
    3. Accessories embedded in masonry.
    4. Colored photographs of proposed granite rocks/boulders.

D. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used.
    1. Submittal is for information only. Neither receipt of list nor approval of mockup constitutes approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Architect and approved in writing.

Quality Assurance:

A. Source Limitations for Stone: Obtain each stone variety from a single quarry.

B. Fabricator Qualifications: Engage experienced fabricator that has completed stone fabrication similar in material, design, and extent to that indicated for the project.

C. Installer Qualifications: Engage experienced installer that has completed stone installation similar in material, design, and extent to that indicated for the project.

D. Visual Mockup: Provide full sized mock-up of the approved stone or stones in the approved finishes, erected at a site agreed to by the Architect, Landscape Architect, Contractor, and the Fabricator. The approved mock-up shall become the standard for the project.
    a. Build mockup of areas as shown on Drawings.

b. Size: 8 feet wide by 8 feet width minimum, exhibiting paver pattern, jointing, expansion joints and interface with adjacent paving and structures.
c. Color consistency: demonstrate color consistency with mockup; color range shall not exceed range of color established by samples.
d. Included typical components.
e. Mockup may become part of the completed Work if approved at time of Substantial Completion.

Delivery, Storage and Handling:

A. Store and handle materials to prevent deterioration or damage.

B. Stone shall be carefully packed and loaded for shipment using reasonable care and customary precautions against damage in transit. Material, which may cause staining or discoloration shall not be used for blocking or packing.

C. The stone shall be stacked on timber or platforms at least 4 inches above the ground. Care shall be taken to prevent staining or discoloration during storage.

D. If storage is to be for a prolonged period, polyethylene or other suitable plastic film shall be placed between wood and finished surfaces of completely dry stone.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

F. Remove Soil to prevent staining face of stone.

Method of Measurement:

This work will be measured for payment by the number of linear feet of completed and accepted stone surfaces.

Structural steel pins shall not be measured for payment under this item. Reference special provision “Structural Pin Assembly - Stainless Steel”.

Basis of Payment:

This work will be paid for at the Contract unit price per square foot for “Interlocking Stone Pavers,” complete in place, which price shall include materials, equipment, tools, labor and work incidental thereto; also all necessary excavation, refilling and disposal of surplus material.

Pay Item	Unit
Interlocking Stone Pavers	S.F.
Stone Erosion Protection	S.F.

ITEM #0921024A – CONCRETE PAVERS

All Interlocking Concrete Paving shall be constructed in accordance with article 9.21, Supplemented as follows:

This item shall consist of approved concrete pavers laid in sand to form a standard walking surface in pedestrian areas adjacent to the pump stations. In areas slated to be driven-over by service, emergency, other vehicles (plazas, streets, etc.), pavers should be set on mortar beds prepared to structural standards. These concrete pavers should be set in areas of the dimensions and details shown on the plans, constructed where indicated on the plans in accordance with these specifications. Refer to "M.03 Architectural Concrete".

Description:

This item shall consist of approved concrete pavers laid in mortar and/or sand to form a standard walking surface of the dimensions and details shown on the plans, constructed where indicated on the plans in accordance with these specifications.

References:

A. ASTM C140/C140M-21 Test Methods for Sampling and Testing Concrete Masonry Units and Related Units
B. ASTM C936/C936M Concrete interlocking paving units
C. ASTM C936-82: Requiring a minimum compressive strength of 8000 psi
D. ASTM C67: maximum absorption of 5% or less at 50 cycles of freeze thaw testing
E. ASTM F 593-02: Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs

Definitions:

A. Definitions contained in ASTM C 140 apply to this Section.

Materials:

Concrete Pavers:

A. Basis-of-Design Product: Precast Concrete Paver
   1. Manufacturer: Hanover Architectural Products, 5000 Hanover Rd. Hanover, PA 17331, HanoverPavers.com Contact: Brent Bevenour | Customer Representative – Northeast Region, bbevenour@hanoverpavers.com 800.426.4242 x123
      1) Model Brand: Hanover Prest Paver Model: PlankStone Paver Color: Natural
         a) Size: 5 7/8" x 23 ½"

b) Thickness: 2-1/4”
c) Finish: Tudor Finish, square edge
d) https://www.hanoverpavers.com/plankstone-pavers

B. Source Limitations: Obtain each type of unit paver, joint material, and setting material from single source with resources to provide materials and products of consistent quality in appearance and physical properties.

Installation Materials:

A. Edge Restraints: 3/16-inch raw steel edging:
1. Steel edging shall be Ryerson Steel Landscaping Edging, manufactured by Ryerson Tull, Cleveland, OH 44114, or approved equal. Steel edging shall be shop fabricated, 3/16 in. thick x 4 in. deep, steel, primed and painted green. Edging shall be furnished in 20 ft. lengths.

B. Aggregate Setting Bed Materials:
1. Graded Aggregate for Subbase: Sound, crushed stone or gravel complying with ASTM D 448 for Size No. 57 and requirements in Section 312000 "Earth Moving" for subbase material.
2. Sand for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C 33/C 33M for fine aggregate.
3. Sand for Joints: Fine, sharp, washed, natural sand or crushed stone with 100 percent passing No. 16 (1.18-mm) sieve and no more than 10 percent passing No. 200 (0.075-mm) sieve.

Miscellaneous:

A. Anchor and pins: Stainless-Steel ASTM A 580/A 580M, Type: 304

Construction Methods:

Examination:

A. Prepare substrates using the methods recommended by the manufacturer for achieving best result for the substrates under project conditions.

B. Surfaces and Conditions: Prior to installing pavers, examine the existing surfaces and conditions to receive the pavers and verify surfaces and conditions are in accordance with the requirements and as shown on Drawings. Do not proceed until defective surfaces are brought into compliance.
a. Examine surfaces and conditions with Installer present.

Preparation:

A. Prior to setting pavers in an aggregate setting bed, clean all surfaces to remove accumulated dirt and stains.

B. Prior to setting concrete pavers on a concrete substrate, verify that all levels and slopes are adequate, and that the integrity of the substrate slab has not been compromised.
C. Prior to setting pavers on a concrete substrate, remove substances from concrete substrates that could impair mortar bond, including curing and sealing compounds, form oil, and laitance.
D. Sweep concrete substrates to remove dirt, dust, debris, and loose particles.

Installation on Mortar Setting-Bed:

A. Saturate concrete subbase with clean water several hours before placing setting bed. Remove surface water about one hour before placing setting bed.

B. Apply mortar-bed bond coat over surface of concrete subbase about 15 minutes before placing mortar bed. Do not exceed 1/16-inch thickness for bond coat. Limit area of bond coat to avoid its drying out before placing setting bed.

C. Apply mortar bed over bond coat; spread and screed mortar bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated.

D. Place reinforcing wire over concrete subbase, lapped at joints by at least one full mesh and supported so mesh becomes embedded in the middle of mortar bed. Hold edges back from vertical surfaces approximately 1/2 inch.

E. Place mortar bed with reinforcing wire fully embedded in middle of mortar bed. Spread and screed mortar bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated.

F. Mix and place only that amount of mortar bed that can be covered with pavers before initial set. Before placing pavers, cut back, bevel edge, and remove and discard setting-bed material that has reached initial set.

G. Wet brick pavers before laying if the initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested according to ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.

H. Place pavers before initial set of cement occurs. Immediately before placing pavers on mortar bed, apply uniform 1/16-inch- thick bond coat to mortar bed or to back of each paver with a flat trowel.

I. Tamp or beat pavers with a wooden block or rubber mallet to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances. Set each paver in a single operation before initial set of mortar; do not return to areas already set or disturb pavers for purposes of realigning finished surfaces or adjusting joints.

J. Spaced Joint Widths: Provide ~~[3/8-inch] [1/2-inch] [3/4-inch]~~ ½-inch nominal joint width with variations not exceeding plus or minus [~~1/16-inch] [1/8-inch] [3/16-inch]~~ 3/16 inch.

K. Grouted Joints: Grout paver joints complying with ANSI A108.10.

L. Grout joints as soon as possible after initial set of setting bed.
   1. Force grout into joints, taking care not to smear grout on adjoining surfaces.
   2. Clean pavers as grouting progresses by dry brushing or rubbing with dry burlap to remove smears before tooling joints.
   3. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
   4. If tooling squeezes grout from joints, remove excess grout and smears by dry brushing or rubbing with dry burlap and tool joints again to produce a uniform appearance.

Cure grout by maintaining in a damp condition for seven days unless otherwise recommended by grout or liquid-latex manufacturer.

Placed Paver:

M. Do not use unit pavers with chips, cracks, voids, discolorations, or other defects that might be visible or cause staining in finished work.

N. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.

O. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.
   1. For concrete pavers, a block splitter may be used.

P. Joint Pattern: **As indicated on drawings**.

Q. Tolerances: Do not exceed **1/8 inch in 24 inches and** 1/4 inch in 10 feet from level, or indicated slope, for finished surface of paving.

R. Expansion and Control Joints: Provide cork joint filler at locations and of widths indicated. Install joint filler before setting pavers. Make top of joint filler flush with top of pavers.

S. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.
   1. Install edge restraints to comply with manufacturer's written instructions. Install stakes at intervals required to hold edge restraints in place during and after unit paver installation.
   2. For metal edge restraints with top edge exposed, drive stakes at least 1 inch below top edge.

3. Install job-built concrete edge restraints to comply with requirements in Section 03 30 00, Cast-in-Place Concrete.
4. Where pavers set in mortar bed are indicated as edge restraints for pavers set in aggregate setting bed, install pavers set in mortar and allow mortar to cure before placing aggregate setting bed and remainder of pavers. Cut off mortar bed at a steep angle so it will not interfere with aggregate setting bed.
5. Where pavers embedded in concrete are indicated as edge restraints for pavers set in aggregate setting bed, install pavers embedded in concrete and allow concrete to cure before placing aggregate setting bed and remainder of pavers. Hold top of concrete below aggregate setting bed.

1.2 AGGREGATE SETTING-BED APPLICATIONS

A. Compact soil subgrade uniformly to at least 95 percent of [**ASTM D 1557**] laboratory density.

B. Proof-roll prepared subgrade to identify soft pockets and areas of excess yielding. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

C. Place separation geotextile over prepared subgrade, overlapping ends and edges at least 12 inches.

D. Place aggregate sub-base and base, compact by tamping with plate vibrator, and screed to depth indicated.

E. Place aggregate sub-base and base, compact to 100 percent of ASTM D 1557 maximum laboratory density, and screed to depth indicated.

F. Place drainage geotextile over compacted base course, overlapping ends and edges at least 12 inches.

G. Place leveling course and screed to a thickness of 1 to 1-1/2 inches, taking care that moisture content remains constant and density is loose and uniform until pavers are set and compacted.

H. Treat leveling course with herbicide to inhibit growth of grass and weeds.

I. Set pavers with a minimum joint width of 1/16 inch and a maximum of 1/8 inch, being careful not to disturb leveling base. If pavers have spacer bars, place pavers hand tight against spacer bars. Use string lines to keep straight lines. Fill gaps between units that exceed 3/8 inch with pieces cut to fit from full-size unit pavers.
   1. When installation is performed with mechanical equipment, use only unit pavers with spacer bars on sides of each unit.

J. Vibrate pavers into leveling course with a low-amplitude plate vibrator capable of a 3500- to 5000-lbf compaction force at 80 to 90 Hz. Use vibrator with neoprene mat on face of plate or other means as needed to prevent cracking and chipping of pavers. Perform at least three passes across paving with vibrator.
   1. Compact pavers when there is sufficient surface to accommodate operation of vibrator, leaving at least 36 inches of uncompacted pavers adjacent to temporary edges.
   2. Before ending each day's work, compact installed concrete pavers except for 36-inch width of uncompacted pavers adjacent to temporary edges (laying faces).
   3. As work progresses to perimeter of installation, compact installed pavers that are adjacent to permanent edges unless they are within 36 inches of laying face.
   4. Before ending each day's work and when rain interrupts work, cover pavers that have not been compacted and cover leveling course on which pavers have not been placed with nonstaining plastic sheets to protect them from rain.

K. Spread dry sand and fill joints immediately after vibrating pavers into leveling course. Vibrate pavers and add sand until joints are completely filled, then remove excess sand. Leave a slight surplus of sand on the surface for joint filling.

L. Do not allow traffic on installed pavers until sand has been vibrated into joints.

M. Repeat joint-filling process 30 days later.

Protection:

A. At the end of each day's work, cover all setting beds with a non-staining waterproof covering. Protect partially finished work when not being worked on.

Cleaning:

A. Clean pavers as work progresses.

B. Final Cleaning: Cleaning: Remove excess grout from exposed paver surfaces; wash and scrub clean.
   a. Remove temporary protective coating as recommended by coating manufacturer and as acceptable to paver and grout manufacturers.
   b. Do not allow protective coating to enter floor drains. Trap, collect, and remove coating material.

C. When cleaning is completed, remove temporary protection.

Submittals:

A. Product Data: For each paver type and each manufactured product shown on Drawings or specified.

1. For each paving variety used on Project, include physical property data.

B. Shop Drawings: For the following:
   1. Pavers: Show sizes, profiles, coursing, and locations of special shapes.
   2. Detail components embedded in paving.

C. Samples: Submit samples for each paver type required, exhibiting the full range of color characteristics expected.
   1. Submit a minimum of 2 each, 8 inches x 8 inches and 2 inches x 10 inches in size, in each color and finish specified.
   2. In the case of more variable pavers, color photos shall be submitted in addition to the number of samples to show the full range of color and markings to be expected.
   3. Accessories embedded in paving

D. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used.
   1. Submittal is for information only. Neither receipt of list nor approval of mockup constitutes approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Architect and approved in writing.

Quality Assurance:

A. Fabricator Qualifications: Engage experienced fabricator that has completed concrete pavers fabrication similar in material, design, and extent to that indicated for the project.

B. Installer Qualifications: Engage experienced installer that has completed concrete pavers fabrication similar in material, design, and extent to that indicated for the project.

C. Visual Mockup: Provide full sized mock-up of the approved pavers in the approved finishes, erected at a site agreed to by the Architect, Landscape Architect, Contractor, and the Fabricator. The approved mock-up shall become the standard for the project.
   a. Build mockup of areas as shown on Drawings.
   b. Size: 8 feet wide by 8 feet long that is a minimum.
   c. Color consistency: demonstrate color consistency with mockup; color range shall not exceed range of color established by samples.
   d. Included typical components.
   e. Mockup may become part of the completed Work if approved at time of Substantial Completion.

Delivery, Storage and Handling:

A. Store and handle materials to prevent deterioration or damage.

B. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.

C. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

D. Store aggregates where grading and other required characteristics can be maintained, and contamination avoided.

E. Store asphalt cement and other bituminous materials in tightly closed containers.

Method of Measurement:

This work will be measured for payment by the number of square feet of completed and accepted Concrete Pavers.

Basis of Payment:

This work will be paid for at the Contract unit price per square foot for "Concrete Pavers," complete in place, which price shall include materials, equipment, tools, labor and work incidental thereto; also all necessary excavation, refilling and disposal of surplus material.

Pay Item	Unit
Concrete Pavers	S.F.

ITEM #09210XXA – UNIT PAVERS

All Unit Pavers and Stone Erosion Protection shall be constructed in accordance with CTDOT – Form 818, article 9.21, Supplemented as follows:

Materials:

Add the Following:

Unit Pavers shall be "Stony Creek Granite", supplied by Stony Creek Quarry, 99 Quarry Rd., Branford, CT 06405 or approved equal.

—Pavers shall have the bottom and the sides sawn. Top shall be thermal with no projection or depression exceeding 1/4 in.

—Color, texture, and finish shall match the sample at the office of the Landscape Architect, and shall be as approved by the Landscape Architect from samples submitted by the Contractor prior to delivery. Brick shall be uniform in color, size, appearance, and dimensions, and shall have smooth regular edges where they are closely butted.

—Unit Pavers installed on a sand setting bed. Joints between pavers shall be handtight filled with sand polymeric sand.

Test Report:

Submit reports from tests conforming to ASTM C 67 methods indicating:

a. Compressive strength, psi. (ASTM C 170)
b. Density, lbs./c.f. (ASTM C 97)
c. Absorption by weight, % (ASTM C 97)
d Abrasion resistance (ASTM C 241)
e. Flexural strength psi, (MPa) (ASTM C 880)

Mock-up:

A sample panel, 8 ft. x 8 ft. minimum, shall be constructed prior to start of granite pavers exhibiting paver pattern, jointing, expansion joints and interface with adjacent paving and structures. The work will be inspected by the Landscape Architect. If the original sample panel is not acceptable, the Contractor shall construct additional sample panels until an accepted panel is obtained. The accepted panel shall become the standard for the entire job, and shall remain undisturbed until completion of all concrete unit paving.

Shop drawings: of granite paving shall be submitted. Drawings shall indicate expansion joint and joint locations.

Samples: Furnish five individual granite pavers as samples, showing extreme variations in color and texture.

Base Course: Material for aggregate base course shall be a graded, granular, non-frost susceptible, free-draining material, consisting of either durable stone and coarse sand or of blast furnace slag, practically free from loam and clay, and which can be readily compacted to form a stable foundation.

Sand shall be a clean, sharp, natural sand conforming to ASTM C 33, except that the fineness modulus shall be 2.25 ± 0.10.

Gradation for setting bed sand shall be as follows:

Sieve Size	% Passing by Weight
3/8 in.	100
No. 4	95 - 100
No. 8	80 - 100
No. 16	50 - 85
No. 50	10 - 30
No. 100	5 - 15
No. 200	0 - 10

Gradation for joint filler sand shall be as follows:

- Sand shall be a clean, washed, uniformly well graded masonry sand with 100 percent passing No. 16 (1.18-mm) sieve and no more than 10 percent passing No. 200 (0.075-mm) sieve, conforming to ASTM C 144, except that the fineness modulus shall be 2.25+ 0.10. Sand shall be from a single source. Source of supply shall not be changed during course of job without written permission of the Landscape Architect.
- Color of sand shall be uniform matching the paver in color, and shall be approved by the Landscape Architect.

Polymeric Joint Sand: Joint filler shall be polymeric joint sand, "TechniSeal Polymeric Joint Sand for Pavement Joints - HP", manufactured by TechniSeal, Inc., Boucherville, Canada J4B 7K2; Tel. 1-800-363-7560; or approved equal.

Steel edging shall be Ryerson Steel Landscaping Edging, manufactured by Ryerson Tull, Cleveland, OH 44114, or approved equal. Steel edging shall be shop fabricated, 3/16 in. thick x 4 in. deep, steel, primed and painted green. Edging shall be furnished in 20 ft. lengths.

Surface tolerance shall be within 1/4 in. of required grade as measured with a 10 ft. straightedge in both the transverse and longitudinal directions.

Setting bed shall be protected from damage prior to setting pavers. Setting shall be done by competent workmen under adequate supervision, and in accordance with manufacturer's recommendations. Pavers shall be placed on the setting bed, to true line and plane and in required position.

Pavers with chips, cracks, or other structural or aesthetic defects shall not be used.

Pavers shall be set true to the required lines and grades in the pattern detailed on the Drawings. Pavers shall be tightly butted. Joints between pavers shall be uniform and shall not exceed 1/8 in.

Where required, pavers shall be accurately cut with a masonry or concrete saw. Cut edges shall be plumb and straight. Scoring and breaking will not be acceptable.

Basis of Payment

Add the Following:

Pay Item:	Pay Unit
Unit Pavers	ea.
Stone Erosion Protection	ea.

ITEM #0922103A – WOOD BOARDWALK

Wood Boardwalks shall be constructed in accordance with CTDOT – Form 818, article 9.22, Supplemented as follows:

Descriptions:
Add the Following:

Work includes: preparing site and soil, furnishing, preparing foundation components, aligning, leveling, plumbing and installing foundation components, setting and driving foundation pins, and capping pins.

Materials:
Add the Following:

Submittals:
—Submit shop drawings indicating profiles, sizes, connection attachments, and types of fasteners.
—Product Data: Submit product data to Landscape Architect for approval, consisting of complete manufacturers product description and specifications.
—Latest edition of Manufacturer's Installation Instructions for foundation system.
—Manufacturer's evaluation of foundation system load capacities for this project, including engineering reports.

Exposed Decking Lumber shall be of sound stock, new, straight, of consistent size, free of stains and mildew, and air dried to a moisture content of not more than 12%, by weight. Wood members shall be selected for best possible appearance from the grade of stock specified.

Decking shall be of sound stock, new, straight, of consistent size, free of stains and mildew, and air dried to a moisture content of not more than 12%, by weight. Wood members shall be selected for best possible appearance from the grade of stock specified.

Edges shall be eased to a radius of 1/8 in. All lumber shall be supplied 2 in. over the specified length to allow for final trim and proper fit in the field. Lumber shall be supplied unfinished in color tones of mellow browns, tans and silvers.

Grain pattern: Tight, mixed grain pattern.
Density/hardness: Hardness rating of 1155.
Moisture Content: Air dried to 12% moisture content (KD avail).

Allowable imperfections defined as Small drying cracks, small end splits (less than 5/32 in. in width), that do not impair strength of the material or fastening. Discoloration caused by weathering or chemical reaction. Bow or twist which can be removed using normal installation methods and tools.

Not Allowable Imperfections defined as Longitudinal heart cracks, internal cracks, firm or soft sap wood, fungi affects - (blue to gray, brown to red, white to yellow, or incipient decay). Bow or twist which cannot be removed using normal installation methods and tools.

Moisture Content: Air-dried to a moisture content of 12%.
Lumber Grade: Lumber shall be graded as per "Iron Woods Premium-CAH (Premium Clear All Heart) Grading Rules", defined as follows:

Lumber shall be graded both faces and both edges.
Lumber shall be straight grained and parallel cut without heart center.
Lumber shall be all heartwood, no sapwood allowed.
Lumber shall be in sound condition, free from worm holes or knots.

Concrete foundation system: shall be Pin Foundations, Inc. 8607 58th Ave. NW, Gig Harbor, WA 98332 (253) 858-8809, or approved equal.

Structural timber: for construction of the wood deck framing shall be treated Spruce No. 2 conforming to AITC 102. conforming to AITC 102.

Lumber shall bear the grade-trademark of the association under the rules or standards of which they were produced. Lumber grades shall be determined in accordance with ASTM D 245.

—Lumber shall bear the grade mark of an American Lumber Standards Committee, Board of Review-approved agency. Lumber shall conform to USDC PS 20.
—Lumber shall bear a mark of mill identification.

Treatment: Timber beams shall be pressure treated with chromated copper arsenate (CCA) conforming to AWPA P5.

Structural steel angles and plates shall conform to ASTM A 36, galvanized in accordance with ASTM A 123.

Fasteners and hardware shall be galvanized steel conforming to ASTM A 153. Bolts shall be high strength bolts conforming to ASTM A 325.

Decking Hardware: Provide stainless steel hardware required to complete this work and to attach this work in a secure and rigid manner to work of this and other trades. Rough hardware shall comply in all respects with requirements of the governing laws and codes.

Basis of Payment:
Add the Following:

Pay Item:	Pay Unit
Wood Boardwalk	lf

ITEM #0944000A – FURNISHING AND PLACING TOPSOIL

All Lawn shall be constructed in accordance with CTDOT – Form 818, Article 9.44 Supplemented as follows:

Description:

Add the Following:

Lawn Soil Profile: Planting soil shall placed to a depth of 6 inches

Planting Bed Soil Profile: Planting soil shall placed to a depth of 18 inches

Planting Bed Soil Profile at Slope: Planting soil shall placed to a minimum depth of 18 inches

Materials:

Add the Following:

Contractor's Testing:

The Contractor shall engage an independent testing agency, experienced in the testing of agricultural soils and acceptable to the Landscape Architect, to perform the topsoil/planting soil tests and analyses specified herein. All costs associated with testing shall be the Contractor's responsibility.

Particle size analysis shall include the following gradient of mineral content:

USDA Designation	Size in mm
Gravel	+ 2 mm
Very coarse sand	1-2 mm
Coarse sand	0.5-1 mm
Medium sand	0.25-0.5 mm
Fine sand	0.1-0.25 mm
Very fine sand	0.05-0.1 mm
Silt	0.002-0.05 mm
Clay	< 0.002 mm

Chemical analysis shall include the following:

—pH and buffer pH
—Percentage of organic content by oven-dried weight
—Nutrient levels by parts per million, including phosphorus, potassium, magnesium, manganese, iron, zinc, and calcium. Nutrient test shall include testing laboratory recommendations for supplemental additions to the soil, if necessary, based on the requirements for ornamental horticultural plants. Recommendations shall include rates at which additives are to be applied.
—Soluble salt by electrical conductivity of a 1:2 soil/water sample.

Planting Soil:
Planting soil shall be composed of a natural, fertile, friable soil typical of cultivated topsoils of the locality, suitable for the germination of seeds and support of vegetative growth, with additives, if required, to achieve particle distribution and organic content specifications. Topsoil shall be taken from a well-drained, arable site, free of subsoil, large stones, earth clods, sticks, stumps, clay lumps, roots, other objectionable, extraneous matter or debris nor contain toxic substances. Planting soil shall have a pH value between 5.5 and 6.5 and organic matter content of 5 to 10% of total dry weight.

Planting soil shall have the following mechanical analysis (see paragraph above for particle sizes):

Approximate Particle Distribution	
Gravel	Less than 10%
Coarse to medium sand	55 – 65%
Fine to very fine sand	15 – 25%
Silt	10– 20%
Clay	15 – 20%

Minimum planting soil nutrient levels shall be: Nitrogen @ 5% average of organic matter, Phosphorus @ .02 to .05% average of total soil content, Potassium @ 1.2% average of total soil content.

The Contractor shall provide the Landscape Architect with planting soil test results, as specified herein, before the start of planting operations. If planting soil does not fall within the required particle distribution, organic content, or pH range, it shall be adjusted to meet the specifications through the addition of sand, compost, limestone, or aluminum sulfate to bring it within the specified limits.

Existing Topsoil:
Existing topsoil from on-site source(s) may be used for planting soil, to the extent available, if it meets the requirements of this Section for planting soil, or if approved by the Landscape Architect.

Basis of Payment:
Add the Following:

Pay Item:	Pay Unit
Lawn Soil Profile	CY
Planting Bed Soil Profile	CY
Planting Bed Soil Profile at Slope	CY

ITEM #0947247A – BICYCLE STAND

Description:
Bicycle Stand shall be Loop Bicycle Rack, Manufactured by Landscape Forms, 7800 E. Michigan Ave. Kalamazoo, MI 49048. Install number of units as shown in the dedicated locations per the Plans and Details.

References:

A. ASTM Testing Standards:
1. ASTM B 117 – Standard Practice for Operating Salt Spray (Fog) Apparatus.
2. ASTM D 522 – Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings.
3. ASTM D 523 – Standard Test Method for Specular Gloss.
4. ASTM D 2247 – Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.
5. ASTM D 3359 – Standard Test Methods for Measuring Adhesion by Tape Test.
6. ASTM D 3363 – Standard Test Method for Film Hardness by Pencil Test.
7. ASTM G 155 – Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials.

B. ISO Testing Standards:
1. ISO 1520 – Paints and Varnishes – Cupping Test.
2. ISO 2815 – Paints and Varnishes – Buchholz Indentation Test.

Materials:

A. Basis of Design Product: Subject to compliance with requirements, provide:
   a. "Loop Bicycle Rack" from Landscape Forms, Inc,. 7800 E. Michigan Ave, Kalamazoo, Michigan 49048. Phone: (800) 521-2546. Fax (269) 381-3455. Website www.landscapeforms.com E-mail: specify@landscapeforms.com

B. Frame: Aluminum Casting – A356 ASTM B108 or A360 ASTM B108 & LFI 7.4.2-A1

C. Finishes:
   a. Finish on Metal: Landscape Forms, Inc. "Pangard II".
      i. Primer: Rust inhibitor.
      ii. Topcoat: Thermosetting TGIC polyester powder coat. UV, chip, and flake resistant.
      iii. Test Results: "Pangard II".
         1. Gloss Consistency, Gardner 60 Degrees, ASTM D 523: Plus or minus 5 percent from standard.
         2. UV Resistance, Color and Gloss, ASTM G 155, Cycle 7: Delta E less than 2 at 2.0 mils and less than 20 percent loss.
         3. Cross-Hatch Adhesion, ASTM D 3359, Method B: 100 percent pass.
         4. Flexibility Test, Mandrel, ASTM D 522: 3 mm at 2 mils.

5. Erichsen Cupping, ISO 1520: 8 mm.
6. Impression Hardness, Buchholz, ISO 2815: 95.
7. Impact Test, ASTM D 2794: 60 inch-pounds at 2.5 mils.
8. Pencil Hardness, ASTM D 3363: 2H minimum.
9. Corrosion Resistance, 1,500-Hour Test, ASTM B 117: Max undercutting 1 mm.
10. Humidity Resistance, 1,500-Hour Test, ASTM D 2247: Max blisters 1 mm.

D. Color: Stormcloud

Installation Materials:

A. Embedded Hardware Pack: (4) 5/16-18 UNC-2A fully threaded rods, 4" length, with Magni-coat.

Construction Methods:

Examination:

A. Examine areas to receive racks.
B. Notify Architect of conditions that would adversely affect installation or subsequent use.
C. Do not begin installation until unacceptable conditions are corrected.

Installation:

A. Install in accordance with manufacturer's instructions at locations indicated on the Drawings.
B. Install level.
C. Anchor securely in place.

Adjusting:

A. Finish Damage: Repair minor damages to finish in accordance with manufacturer's instructions and as approved by Architect.
B. Component Damage: Remove and replace damaged components that cannot be successfully repaired as determined by Architect.

Cleaning:

A. Clean rack promptly after installation in accordance with manufacturer's instructions.
B. Do not use harsh cleaning materials or methods that could damage finish.

Protection:

A. Protect installed racks to ensure that, except for normal weathering, racks will be without damage or deterioration at time of Substantial Completion.

Submittals:

A. Product Data: Submit manufacturer's product data, storage and handling requirements and recommendations, installation methods and available colors, styles, patterns and textures.
B. Shop Drawings: Submit manufacturer's shop drawings, including plans and elevations, indicating overall dimensions.
C. Samples: Submit manufacturer's samples of materials, finishes, and colors.
D. Warranty: Manufacturer's standard warranty.

Quality Assurance:

A. Product Support: Products are supported with complete engineering drawings and design patents.
B. Production: Orders are filled within a 40-day schedule.
C. Facility Operator: Welders and machine operators are certified.

Delivery, Storage and Handling:

A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.
B. Storage: Store materials in clean, dry area in accordance with manufacturer's instructions. Keep materials in manufacturer's original, unopened containers and packaging until installation.
C. Handling: Protect materials and finish during handling and installation to prevent damage.

Method of Measurement:

This work will be measured for payment by the number of Bicycle Stands installed and accepted.

Structural steel pins shall not be measured for payment under this item. Reference special provision "Structural Pin Assembly - Stainless Steel".

Basis of Payment:

This work will be paid for at the Contract unit price per "Bicycle Stand," complete in place, which price shall include materials, equipment, tools, labor and work incidental thereto; also all necessary excavation, refilling and disposal of surplus material.

Pay Item	Unit
Bicycle Stand	ea.

ITEM #0949603 – JUNIPERUS VIRGINIANA, EASTERN REDCEDAR, 8’ -10’ HT. B.B.
ITEM #0949XXXA – JUNIPERUS CHINENSIS, HOLLYWOOD JUNIPER, 8’ -10’ HT. B.B.
ITEM #0949XXXA – QUERCUS ALBA, WHITE OAK, 5 ½” – 6” CAL. B.B.
ITEM #0949878 – QUERCUS PALUSTRIS, PIN OAK, 3 ½” – 4” CAL. B.B.
ITEM #0949XXXA – QUERCUS COCCINEA, SCARLET OAK, 3 ½” – 4” CAL. B.B.
ITEM #0949XXXA – QUERCUS BICOLOR, SWAMP WHITE OAK, 7 ½” – 8” CAL. B.B.
ITEM #0949XXXA – QUERCUS PHELLOS, WILLOW OAK, 5 ½” – 6” CAL. B.B.
ITEM #0949XXXA – PLANTANUS X ACERFOLIA, LONDON PLANE TREE,
3 ½” – 4” CAL. B.B.
ITEM #0949XXXA– TILIA CORDATA, LITTLELEAF LINDEN, 5 ½” – 6” CAL. B.B.
ITEM #0949XXXA– NYSSA SYLVATICA, BLACK TUPELO, 3 ½” – 4” CAL. B.B.
ITEM #0949410 – RHUS AROMATICA ‘LO GRO’, LO GRO FRAGRANT SUMAC, 18''-24'' HT. B.B
ITEM #0949XXXA – GAYLUSSACIA BACCATA, BLACK HUCKLEBERRY,
5 GALLON CONTAINER
ITEM #0949XXXA – SALIX PURPUREA ‘NANA’, DWARF ARCTIC WILLOW,
5 GALLON CONTAINER
ITEM #0949XXXX – PRUNUS MARITIMA ‘NANA’, DWARF BEACH PLUM, 7 GALLON CONTAINER
ITEM #0949XXXX – MYRICA PENSYLVANICA, NORTHERN BAYBERRY, 7 GALLON CONTAINER
ITEM #0949XXXX – ILEX VERTICILLATE ‘RED SPRITE’, WINTERBERRY,
7 GALLON CONTAINER
ITEM #0949XXXX – VACCINIUM ANGUSTIFOLIUM, LOWBUSH BLUEBERRY,
5 GALLON CONTAINER

All Trees, Shrubs, Ground Covers, and Vines shall be constructed in accordance with Article 9.49 Supplemented as follows:

Construction Methods:
Add the Following:

Pre-installation Meeting: Prior to start of grading operations, the Contractor shall arrange an on-site meeting with the Landscape Architect for the purpose of establishing Contractor's schedule of operations and scheduling inspection procedures and requirements.

Selection: Contractor shall submit photos each and every tree for approval by Landscape Architect and a representative sample of each sub species, 10 individual photos or 20%, whichever number is larger. Photos shall capture full height of plant and root flare. In lieu of individual photos, Contractor may tag trees with Landscape architect. Acceptance of photo or tagging does not ensure acceptance of plant during installation if tree has been damaged, is in poor health, or does not comply with this specification at date of installation.

Substitutions: Before changes or substitutions can be considered due to unavailability of plant material, the contractor shall submit written evidence that he has advertised for at least a one month period in a trade journal such as the "Landscape Materials Information Service", with no response, or has undertaken other methods of locating plant material acceptable to the Landscape Architect.

Quality Control: Except as otherwise specified, size and grade of plant materials and their root balls shall conform to ANSI Z60.1.

Plants shall have outstanding form; symmetrical, heavily branched with an even branch distribution, densely foliated and/or budded, and a strong, straight, distinct leader where this is characteristic of species. Plants shall possess a normal balance for the species between height and spread. The Landscape Architect will be the final arbiter of acceptability of plant form.

Test Pit: Test drainage of five planting pits in locations as directed by the Landscape Architect. Pits shall be filled with water twice in succession. The time at which water is put into the pit for a second filling shall be noted. Landscape Architect shall then be notified of the time it takes for pit to drain completely. Planting operations shall not proceed until Landscape Architect has reviewed test drainage results.

Placement: Individual plant locations and outlines of shrub and ground cover areas to be planted shall be staked by the Contractor in ample time to allow inspection by the Landscape Architect. Digging shall not begin until locations are approved by the Landscape Architect.

Modify the Following:

Setting Plants: Ensure that the root flare or top of the root system in level with finished grade. Fully remove wire basket and fabric from Balled and Burlapped Plants (B.B.)

Establishment Period: All plant material shall be subject to a Two-Year Establishment Period.

Basis of Payment:
Add the Following:

Pay Item:	Pay Unit
Juniperus virginiana (8'- 10' HT. B.B.)	ea.
Juniperus chinensis (8'- 10' HT. B.B.)	ea.
Quercus alba (5 ½" – 6")	ea.
Quercus palustris (3 ½" – 4")	ea.
Quercus coccinea (3 ½" – 4")	ea.
Quercus bicolor (7 ½" – 8")	ea.
Quercus phellos (5 ½" – 6")	ea.
Plantanus X Acerfolia (3 ½" – 4")	ea.
Tilia cordata (5 ½" – 6")	ea.
Nyssa sylvatica (3 ½" – 4")	ea.
Rhus aromatica 'Lo Gro' (18"-24")	ea.
Gaylussacia baccata (5 Gallon)	ea.
Salix purpurea 'Nana' (5 Gallon)	ea.
Myrica pensylvanica (7 Gallon)	ea.
Vaccinium angustifolium (5 Gallon)	ea.
Prunus maritima 'Nana' (7 Gallon)	ea.
Ilex verticillate 'Red Sprite'(7 Gallon)	ea.

ITEM #0950019A – TURF ESTABLISHMENT – LAWN

All Lawn shall be constructed in accordance with CTDOT – Form 818, Article 9.50 Supplemented as follows:

Materials:

Lawn Seed Mix shall be the following:

Name of Seed	% by Weight in Mixture	Minimum % Purity	Minimum % Germination
Shadow II Chewings Fescue	30	95	87
Tiffany Chewings Fescue	30	95	90
Midnight Star Kentucky Bluegrass	25	90	87
Raven Kentucky Bluegrass	15	90	87

Erosion Control Matting shall be nonwoven bio-degradable geotextile.

ITEM #0951002A – TREE GRATE

All Tree Grates shall be constructed in accordance with CTDOT – Form 818, Article 9.51, Supplemented as follows:

Description:
Add the Following:

Tree Grate shall be Metropolitan Collection Manufacturer Neenah Foundry, Neenah Foundry Company, Box 729, Neenah, Wisconsin 54957-0729

Style – Metropolitan Collection, Rectangle
Series No – R-8815-1
Grate Size – 48" x 72"
Tree Opening Size – 18" - 24" diameter.
Slot Size – 0.25"
Finish – Unfinished cast iron, standard

Materials:
Add the Following:

Cast Iron
Testing: ASTM A-48, Class 25 or better.

Basis of Payment:
Add the Following:

Pay Item:	Pay Unit
Tree Grate	ea.

ITEM #0969030A - PROJECT COORDINATOR (MINIMUM BID)

Article 1.05.08 – Schedules and Reports of the Standard Specifications is hereby amended by the following:

Description:
Under this item the Contractor shall furnish the services of an administrative employee, entitled the Project Coordinator, for this Project, to coordinate and expedite all phases of the work required for the Project and to ensure that the construction schedule is maintained.

The minimum lump sum bid for this item shall be equal to $175,000 (one hundred seventy five thousand dollars). Failure of the Contractor to bid at least the minimum amount will result in the Department adjusting the Contractor's bid to include the minimum bid amount for this item.

The Project Coordinator's resume shall be submitted for approval by name, in writing, within seven (7) calendar days of the award of the Contract, and shall not be changed without prior written notice to the Department.

This resume must demonstrate the Project Coordinator is experienced and versatile in the preparation, interpretation and modification of Critical Path Method (CPM) construction schedules. This must include successful completion of at least three (3) construction projects of similar complexity, where they served in a lead scheduling capacity. If the Contractor does not have a person in their company that has these skills, then the Contractor shall engage the services of a Consultant, subject to the approval of the Engineer, for the scheduling work required. If a Consultant is engaged, they shall be present at the first meeting, along with the Project Contractor, prepared to discuss, in detail, the methods and techniques they propose to use. Thereafter, the Project Coordinator or the Consultant responsible for updating the CPM Schedule shall attend all meetings between the Contractor, its Subcontractors, and any other meetings, which will affect the CPM schedule. The Contractor shall prepare CPM Schedules utilizing the latest version of Primavera P6 Professional Project Management software.

Computer Software and Printer:
The Contractor shall provide the following equipment with all the required maintenance and repairs (to include labor and parts) throughout the Contract life. The Engineer reserves the right to expand or relax the specification to adapt to the software and hardware limitations and availability.

The Contractor shall provide the Engineer with a licensed copy registered in the Department's name of the latest versions of the software listed and maintain customer support services offered by the software producer for the duration of the project. The Contractor shall deliver to the Engineer all supporting documentation for the software and hardware including any instructions or manuals.

Software – Minimum Specification: The Contractor shall provide the Engineer with a licensed copy of the latest version of the Primavera P6 Professional Project Management

scheduling software, registered in the Department's name, and maintain the Primavera customer support service contract over the duration of the project.

Printer: An additional printer shall be provided that meets the printer specifications noted under contract item for "Construction Field Office" and is compatible with the software. This printer shall have the capabilities to print 11" x 17" paper size in color ink.

The Contractor is responsible for service and repairs to all computer hardware. All repairs must be performed within 24 hours. If the repairs require more than a 24 hours then a replacement must be provided.

Construction Methods:

The Project Coordinator shall attend all meetings between the Contractor and the Department, the Contractor and its Subcontractors, and any other meetings that affect the progress of the job. The Project Coordinator shall be knowledgeable of the status of all parts of the work throughout the length of the Contract.

The Contractor shall prepare a CPM schedule in accordance with the pertinent provisions of "Section 1.03 – Award and Execution of Contract," "Section 1.05 – Control of the Work," and "Section 1.08 – Prosecution of Progress" of the Standard Specifications. The schedules shall incorporate the Sequence of Construction as outlined on the Plans and in the Specifications. All other limiting factors that affect construction shall also be incorporated into the Schedules. All milestones or constrained dates within the schedule shall be clearly indicated.

Please delete any reference to Bar Chart under 1.05.08 – Schedule and Reports and replace with the following:

Critical Path Method (CPM)

Please add the following:

Proper relationship between all major activities shall be indicated. The major activities shown on the Critical Path Schedule shall be easily referenced to the Detailed Project Schedule when it is developed. Break down the work covered under each Special Provision into individual activities required and logically group related activities together within the CPM.
For this project, the major elements may be indicated to include, but is not limited to, the following item:

- Identification of any manpower, material, or equipment restrictions, as well as any activity requiring unusual shift work, such as double shifts, 6-day weeks, specified overtime or work at times other than regular days or hours (regular days and hours means a work week consisting of (5) 8 hour days).

All documents, which require approval by the Department, shall be clearly identified within the schedule. The Department shall be allocated a minimum of thirty (30) calendar days (exclusive of weekends and holidays) for review and approval of each submittal. Any submittals requiring

approval by an outside Agency (ConnDEEP, Coast Guard, Army Corps of Engineers, etc.) shall be allocated a minimum of sixty (60) calendar days. The Department shall not be held responsible for any delay associated with the approval or rejection of any substitution or other revisions proposed by the Contractor.

The schedule shall indicate the logic of the work for the major elements and components of work under the Contract, such as the planned mobilization of plant and equipment, sequences of operations, procurement of materials and equipment, duration of activities, type of relationship, lag time (if any), and such other information as it is necessary to present a clear statement of the intended activities.

The schedules shall consist of a network technique of planning, scheduling and control, shall be a clear statement of the logical sequence of work to be done, and shall be prepared in such a manner that the Contractor's work sequence shall be optimized between early start and late start restraints. The Contractor shall use the same criteria in a consistent manner throughout the term of the project. If, at any time, the Contractor alters logic, original durations, and descriptions, adds activities or activity codes or in any way modifies the Baseline Schedule, they must notify the Engineer of the change, in writing, presenting in detail the reasons for the change. The Engineer reserves the right to approve or reject any such change.

The critical path of the project must be identified on the CPM schedule. The critical path is the longest-duration path through the network. The significance of the critical path is that the activities that lie on it cannot be delayed without delaying the project. Because of its impact on the entire project, critical path analysis is an important aspect of project planning.

The critical path can be identified by determining the following four parameters for each activity:

1. ES - Earliest Start Time: the earliest time at which the activity can start given that its precedent activities must be completed first.
2. EF - Earliest Finish Time: equal to the earliest start time for the activity plus the time required to complete the activity.
3. LF - Latest Finish Time: the latest time at which the activity can be completed without delaying the project.
4. LS - Latest Start Time: equal to the latest finish time minus the time required to complete the activity.

The *float time* for an activity is the time between its earliest and latest start time, or between its earliest and latest finish time. Float is the amount of time that an activity can be delayed past its earliest start or earliest finish without delaying the project. Delays to activities on the critical path through the project network in which no float exists, that is, where ES=LS and EF=LF will delay the project.

Float available in the schedule, at any time shall not be considered for the exclusive use of either the Department or the Contractor. During the course of Contract, any float generated due to the

efficiencies of either party is not for the sole use of the party generating the float; rather it is a shared commodity to be reasonably used by either party. Project float will be a resource available to both the Department and the Contractor.

Lags will not be used when the creation of an activity will perform the same function. Lag durations contained in the schedule shall not have a negative value. The Contractor shall identify any lag proposed and provide an explanation for the purpose of the lag in the narrative report.

The Contractor shall incorporate custom data items, milestones, level of effort activities, etc. that do not alter the established activities or schedule logic, at the Department's request, for the purpose of sorting, tracking, or summarizing the schedule information.

Each CPM Schedule submittal shall include at a minimum; a narrative; an all activities Gannt chart report; a longest path Gannt chart report; a predecessor/successor report, and an Activity ID sorted report. The narrative shall include a discussion of work completed during the period; a listing of all changes made to the schedule since the prior update; description of the current overall longest path and any changes to it; current or anticipated delays; reasons for any early or late contractual milestones. All PDF reports, including the Primavera P6 project file, shall submitted as a single PDF portfolio file. The diagrams may be requested to be printed out by the Department and shall be on 22" x 34" sheets. Additional, more detailed diagrams for important aspects or phases of the work may be required on large or complex projects.

Activity I.D. numbers shall be keyed to the item numbers assigned on the detailed estimate sheet. The first three digits (four digits for highway illumination, signing, traffic signals and utility work) of the activity I.D. number shall be identical to the first three digits of the item number in the Contract. The remaining digits may be used to provide unique, orderly and sequential I.D. numbers for each activity.

Activity codes shall be added to the schedule dictionary at the direction of the Engineer. At a minimum, activity codes for responsibility (prime, subcontractor by name), location of work (bridge #, span #, sta. #, site, building, type of work, etc.) and stage or phase number should be included.

Calendars shall be Project Calendars (global calendars are not allowed).

1. Recovery Schedules: If, in the opinion of the Engineer, the updated schedule indicates that the Project has fallen behind schedule, or that a revision in sequence of operations may be necessary for any other reason, absent a justifiable time extension, the Contractor shall immediately institute all necessary steps to improve the Project's progress and shall submit such revised network diagrams, tabulations and operational plans, as may be deemed necessary by the Engineer, to demonstrate the manner in which an acceptable rate of progress will be regained.

Should the Contractor not demonstrate an ability to regain an acceptable rate of progress, the Engineer shall require the schedule to be resource loaded with the next monthly update. No additional compensation will be allowed for resource loading the schedule.

2. Two Week Look Ahead Schedules: The Contractor shall be required to produce and submit to the Engineer a biweekly schedule, to be updated and submitted the first business day of each week. This short-term schedule must be submitted in electronic format (i.e. .pdf, .xls, .doc, etc.), shall clearly indicate all work planned for the two-week period, and be of sufficient detail to identify specific work crew activities by location.

3. As-Built Schedules: Within thirty (30) calendar days of completion of the project, including all corrective work, the Contractor shall submit an "As-Built Schedule" showing the actual progress of all work. The PDF reports, including the Primavera P6 project file, shall submitted as a single PDF portfolio file.

The following shall also apply to Contracts administered under Section 1.20:

3. Daily Construction Reports: The Project Coordinator shall assist the Engineer in the preparation of a daily construction report by ensuring that each of the Contractor's employees and subcontractors working on the Project Site on a given day signs the Engineer's sign-in sheet for that day; and by keeping and providing to the Engineer its own daily list of employees and subcontractors who worked on the Project Site on that day.

Method of Measurement:

Within ten (10) calendar days of the award of the Contract, the Contractor shall submit to the Engineer for approval a breakdown of its lump sum bid price for this item detailing:

1. The development cost to prepare the Baseline Schedule in accordance with these specifications. Development costs shall not exceed 25% of the total cost of the item and shall include costs to furnish and install all specified hardware.

2. The cost to provide the services of the Project Coordinator, including costs to prepare and submit the Monthly Updates and Narrative; furnish and submit any Recovery Schedules; furnish and submit Two Week Look Ahead Schedules and maintenance of and supplies for the specified hardware noted above. A per month cost will be derived by taking this cost divided by the number of Contract months remaining from the date of acceptance of the Baseline Schedule.

3. The cost of submission and certification of the As-Built Schedule in accordance with these specifications. The submission and certification costs shall be no less than 2% of the total cost of the item.

4. Substantiation showing that the costs submitted are reasonable based on the Contractor's lump sum bid.

Upon approval of the payment schedule by the Engineer, payments for work performed will be made as follows:

1. Upon approval of the "Baseline" Schedule by the Engineer, the lump sum development cost will be certified for payment.

2. Upon receipt of each monthly narrative and update of the "Baseline" Schedule, the per month cost for the services of the Project Coordinator will be certified for payment.

3. Upon approval of the As-Built Schedule by the Engineer, the lump sum submission and certification cost will be certified for payment.

Basis of Payment:

This service will be paid for at the Contract lump sum price for "Project Coordinator" complete, which price shall include the preparation and submission of all schedules, narratives, updates, reports and submittals. The lump sum price shall also include the cost of providing a complete, licensed copy of the Primavera software which will remain the property of the Engineer, and all materials, equipment, labor and work incidental of this service.

The lump sum price will be certified for payment as described in "Method of Measurement" subject to the following conditions:

1. Any month where the monthly update of the "Baseline" CPM schedule is submitted late, without authorization from the Engineer, will result in the following actions:
    a. The monthly payment for the Project Coordinator item will be deferred to the next monthly payment estimate. If any monthly submittal is more than thirty (30) calendar days late, there will be no monthly payment for the services of the Project Coordinator.
    b. The greater of 5% of the monthly payment estimate or $25,000 will be retained from the monthly payment estimate until such time as the Contractor submits all required reports.
    c. If in the opinion of the Engineer, the Contractor is not in compliance with this specification, the Engineer may withhold all Contract payments.
2. In the event the Contract time extends beyond the original completion date by more than thirty (30) calendar days, and a time extension is granted to the Contractor, the Department may require additional CPM updates which will be paid for at the per month cost for the services of the Project Coordinator.
3. If the Contractor is not in compliance with this specification or has failed to submit a "Baseline" schedule, monthly update, or a Recovery Schedule for any portion of the work, the Engineer will withhold all Contract payments until the schedule is submitted to, and approved by, the Engineer.

Pay Item	Pay Unit
Project Coordinator	L.S.

ITEM #0969064A – CONSTRUCTION FIELD OFFICE, LARGE

Description: Under the item included in the bid document, adequate weatherproof office quarters with related furnishings, materials, equipment and other services, shall be provided by the Contractor for the duration of the work, and if necessary, for a close-out period determined by the Engineer. The office, furnishings, materials, equipment, and services are for the exclusive use of CTDOT forces and others who may be engaged to augment CTDOT forces with relation to the Contract. The office quarters shall be located convenient to the work site and installed in accordance with Article 1.08.02. This office shall be separated from any office occupied by the Contractor. Ownership and liability of the office quarters shall remain with the Contractor.

Furnishings/Materials/Supplies/Equipment: All furnishings, materials, equipment and supplies shall be in like new condition for the purpose intended and require approval of the Engineer.

Office Requirements: The Contractor shall furnish the office quarters and equipment as described below:

Description \ Office Size			Large	
Minimum Sq. Ft. of floor space with a minimum ceiling height of 7 ft.			1400	
Minimum number of exterior entrances.			2	
Minimum number of parking spaces.			10	

Office Layout: The office shall have a minimum square footage as indicated in the table above and shall be partitioned as shown on the building floor plan as provided by the Engineer.

Unless otherwise approved by the Engineer, office space shall be partitioned into segregated work areas for each user as follows:

- Each work area (or cubicle) shall be a minimum of 8 feet × 8 feet, with full height walls or tall cubicle partitions (minimum 6 feet high), placed to provide a minimum of 6 feet walking space around and between each user work area (for social distancing).
- Only one user (workstation/desk) per work area.
- Desks, tables and other work surfaces shall be arranged so that adjacent users do not face each other.

Tie-downs and Skirting: Modular offices shall be tied-down and fully skirted to ground level.

Lavatory Facilities: For field offices sizes Small and Medium the Contractor shall furnish a toilet facility at a location convenient to the field office for use by CTDOT personnel and such assistants as they may engage; and for field offices sizes Large and Extra Large the Contractor shall furnish two (2) separate lavatories with toilet (men and women), in separately enclosed rooms that are properly ventilated and comply with applicable sanitary codes. Each lavatory shall have hot and cold running water and flush-type toilets. For all facilities the Contractor shall supply lavatory and sanitary supplies as required.

Windows and Entrances: The windows shall be of a type that will open and close conveniently, shall be sufficient in number and size to provide adequate light and ventilation, and shall be fitted with locking devices, blinds and screens. The entrances shall be secure, screened, and fitted with a lock for which four keys shall be furnished. All keys to the construction field office shall be furnished to the CTDOT and will be kept in their possession while State personnel are using the office. Any access to the entrance ways shall meet applicable building codes, with appropriate handrails. Stairways shall be ADA/ABA compliant and have non-skid tread surfaces. An ADA/ABA compliant ramp with non-skid surface shall be provided with the Extra-Large field office.

Lighting: The Contractor shall equip the office interior with electric lighting that provides a minimum illumination level of 100 foot-candles at desk level height, and electric outlets for each desk and drafting table. The Contractor shall also provide exterior lighting that provides a minimum illumination level of 2 foot-candles throughout the parking area and for a minimum distance of 10 ft. on each side of the field office.

Parking Facility: The Contractor shall provide a parking area, adjacent to the field office, of sufficient size to accommodate the number of vehicles indicated in the table above. If a paved parking area is not readily available, the Contractor shall construct a parking area and driveway consisting of a minimum of 6 inches of processed aggregate base graded to drain. The base material will be extended to the office entrance.

Field Office Security: Physical Barrier Devices - This shall consist of physical means to prevent entry, such as: 1) All windows shall be barred or security screens installed; 2) All field office doors shall be equipped with dead bolt locks and regular day operated door locks; and 3) Other devices as directed by the Engineer to suit existing conditions.

Electric Service: The field office shall be equipped with an electric service panel, wiring, outlets, etc., to serve the electrical requirements of the field office, including: lighting, general outlets, computer outlets, electronics, etc., and meet the following minimum specifications:

A. 120/240 volt, 1 phase, 3 wire
B. Ampacity necessary to serve all equipment. Service shall be a minimum 100 amp dedicated to the construction field office.
C. The electrical panel shall include a main circuit breaker and branch circuit breakers of the size and quantity required.
D. Additional 120 volt, single phase, 20 amp, isolated ground dedicated power circuit with dual NEMA 5-20 receptacles will be installed at each desk and personal computer table (workstation) location.
E. Additional 120 volt, single phase, 20 amp, isolated ground dedicated power circuit with dual NEMA 5-20 receptacles will be installed, for use by the Telephone Company.
F. Additional 120-volt circuits and duplex outlets as required meeting National Electric Code requirements.
G. One exterior (outside) wall mounted GFI receptacle, duplex, isolated ground, 120 volt, straight blade.

H. After work is complete and prior to energizing, the State's CTDOT electrical inspector, must be contacted at 860-594-2240. (Do Not Call Local Town Officials)
I. Prior to field office removal, the CTDOT Office of Information Systems (CTDOT OIS) must be notified to deactivate the communications equipment.

Heating, Ventilation and Air Conditioning (HVAC): The field office shall be equipped with sufficient and properly operating, heating, air conditioning, and ventilation equipment to maintain a temperature range of 68°-80° Fahrenheit within the field office. The Contractor shall increase ventilation rates and increase the percentage of outdoor air that circulates into the system where possible.

Telephone Service: The Contractor shall provide telephone service with unlimited nation-wide calling plan. For a Small, Medium and Large field office this shall consist of the installation of two (2) telephone lines: one (1) line for phone/voice service and one (1) line dedicated for the facsimile machine. For an Extra-Large field office this shall consist of four (4) telephone lines: three (3) lines for phone/voice service and one (1) line dedicated for facsimile machine. The Contractor shall pay all charges.

Data Communications Facility Wiring: Contractor shall install a Category 6 568B patch panel in a central wiring location and Cat 6 cable from the patch panel to each PC station, Smart Board location, Multifunction Laser Printer/Copier/Scanner/Fax, terminating in a (Category 6 568B) wall or surface mount data jack. The central wiring location shall also house either the data circuit with appropriate power requirements or a Category 6 cable run to the location of the installed data circuit. The central wiring location will be determined by the CTDOT OIS staff in coordination with the designated field office personnel as soon as the facility is in place.

For Small, Medium and Large field offices the Contractor shall run a CAT 6 LAN cable a minimum length of 25 feet for each CTDOT networked device (including but not limited to: smartboards and Multi-Function Laser Printer/Copier/Scanner/Fax) to LAN switch area leaving an additional 10 feet of cable length on each side with terminated RJ45 connectors. For an Extra-Large field office, the Contractor shall run CAT 6 LAN cables from workstations, install patch panel in data circuit demark area and terminate runs with RJ45 jacks at each device location. Terminate runs to patch panel in LAN switch area. Each run / jack shall be clearly labeled with an identifying Jack Number.

The Contractor shall supply cables to connect the Wi-Fi printer to the Contractor supplied internet router and to workstations/devices as needed. These cables shall be separate from the LAN cables and data Jacks detailed above for the CTDOT network.

The number of networked devices anticipated shall be at least equal to the number of personal computer tables, Multi-Function Laser Printer/Copier/Scanner/Fax, and smartboards listed below.

The installation of a data communication circuit between the field office and the CTDOT OIS in Newington will be coordinated between the CTDOT District staff, CTDOT OIS staff and the local utility company once the Contractor supplies the field office phone numbers and anticipated installation date. The Contractor shall provide the field office telephone number(s) to the CTDOT

Project Engineer within 10 calendar days after the signing of the Contract as required by Article 1.08.02. This is required to facilitate data line and computer installations.

Additional Equipment, Facilities and Services: The Contractor shall provide at the field Office at least the following to the satisfaction of the Engineer:

Furnishing Description	Office Size			
			Large	
	Quantity			
Office desk (2.5 ft. x 5 ft.) with drawers, locks, and matching desk chair that have pneumatic seat height adjustment and dual wheel casters on the base.			5	
Standard secretarial type desk and matching desk chair that has pneumatic seat height adjustment and dual wheel casters on the base.			-	
Personal computer tables (4 ft. x 2.5 ft.).			5	
Drafting type tables (3 ft. x 6 ft.) and supported by wall brackets and legs; and matching drafter's stool that have pneumatic seat height adjustment, seat back and dual wheel casters on the base.			1	
Conference table, 3 ft. x 12 ft.			-	
Table – 3 ft. x 6 ft.			-	
Office Chairs.			8	
Mail slot bin – legal size.			1	
Non-fire-resistant cabinet.			2	
Fire resistant cabinet (legal size/4 drawer), locking.			2	
Storage racks to hold 3 ft. x 5 ft. display charts.			1	
Vertical plan racks for 2 sets of 2 ft. x 3 ft. plans for each rack.			2	
Double door supply cabinet with 4 shelves and a lock – 6 ft. x 4 ft.			1	
Case of cardboard banker boxes (Min 10 boxes/case)			2	
Open bookcase – 3 shelves – 3 ft. long.			2	
White Dry-Erase Board, 36" x 48"min. with markers and eraser.			1	
Interior partitions – 6 ft. x 6 ft., soundproof type, portable and freestanding.			6	
Coat rack with 20 coat capacity.			-	
Wastebaskets - 30 gal., including plastic waste bags.			1	
Wastebaskets - 5 gal., including plastic waste bags.			6	
Electric wall clock.			-	
Electronic Level			1	

Furnishing Description	Office Size			
			Large	
	Quantity			
Telephone.			3	
Full size stapler 20 (sheet capacity, with staples)			5	
Desktop tape dispensers (with Tape)			5	
8 Outlet Power Strip with Surge Protection			6	
Rain Gauge			1	
Business telephone system for three lines with ten handsets, intercom capability, and one speaker phone for conference table.			-	
Mini refrigerator - 3.2 c.f. min.			1	
Hot and cold-water dispensing unit. Disposable cups and bottled water shall be supplied by the Contractor for the duration of the project.			1	
Microwave, 1.2 c.f. , 1000W min.			1	
Fire extinguishers - provide and install type and *number to meet applicable State and local codes for size of office indicated, including a fire extinguisher suitable for use on a computer terminal fire.			*	
Electric pencil sharpeners.			2	
Electronic office type printing calculators capable of addition, subtraction, multiplication and division with memory and a supply of printing paper.			2	
Small Multi-Function Laser Printer/Copier/Scanner/Fax combination unit, network capable, as specified below under Computer Related Hardware and Software.				
Large Multi-Function Laser Printer/Copier/Scanner/Fax combination unit, network capable, as specified below under Computer Related Hardware and Software.			1	
Field Office Wi-Fi Connection as specified below under Computer Related Hardware and Software			1	
Wi-Fi Printer as specified below under Computer Related Hardware and Software.			1	
Digital Camera as specified below under Computer Related Hardware and Software.			3	
Video Projector as specified below under Computer Related Hardware and Software.			-	
Smart Board as specified below under Computer Related Hardware and Software.			-	
Conference Room Presentation Television as specified below under Computer Related Hardware and Software.			-	

Infrared Thermometer, including annual third-party certified calibration, case, and cleaning wipes.			1	
Concrete Curing Box as specified below under Concrete Testing Equipment.			1	
Concrete Air Meter and accessories as specified below under Concrete Testing Equipment as specified below. Contractor shall provide third party calibration on a quarterly basis.			1	
Concrete Slump Cone and accessories as specified below under Concrete Testing Equipment.			1	
First Aid Kit			1	
Disinfecting wipes, sprays, and other supplies (** as specified below under Maintenance).			**	
Hand sanitizer stations (*** maintain one full station at each entrance, restroom, and conference area).			***	
Flip Phones as specified under Computer Related Hardware and Software.			-	
Smart Phones as specified under Computer Related Hardware and Software.			-	

The furnishings and equipment required herein shall remain the property of the Contractor. Any supplies required to maintain or operate the above listed equipment or furnishings shall be provided by the Contractor for the duration of the project.

Computer Related Hardware and Software: The CTDOT will supply by its own means the actual Personal Computers for the CTDOT representatives. The Contractor shall supply the Field Office Wi-Fi Connection, Wi-Fi Printer, Digital Camera(s), Flip Phones, Smart Phones, Multifunction Laser Printer/Copier/Scanner/Fax, Video Projectors, and Smart Board(s), Conference Room Presentation Television, as well as associated hardware and software, meeting the requirements of this specification as well as the latest minimum specifications posted, as of the project advertising date, at CTDOTs web site http://www.ct.gov/dot/cwp/view.asp?a=1410&q=563904

Within 10 calendar days after the signing of the Contract but before ordering/purchasing the Wi-Fi Printer (separate from the Multifunction Laser Printer/Copier/Scanner/Fax), Field Office Wi-Fi, Digital Camera(s), Flip Phones, Smart Phones, Multifunction Laser Printer/Copier/Scanner/Fax, Video Projector(s) and Smart Board(s) as well as associated hardware, the Contractor must submit a copy of their proposed order(s) with catalog cuts and specifications to the Administering CTDOT District for review and approval. The Wi-Fi Printer, Wi-Fi Router, Flip Phones, Smart Phones, digital cameras, Projector(s) and Smart Board(s) will be reviewed by CTDOT District personnel. The Multifunction Laser Printer/Copier/Scanner/Fax will be reviewed by the CTDOT OIS. The Contractor shall not purchase the hardware, software, or services until the Administering CTDOT District informs them that the proposed equipment, software, and services are approved. The Contractor will be solely responsible for the costs of any hardware, software, or services purchased without approval.

The Contractor and/or their internet service provider shall be responsible for the installation and setup of the field office Wi-Fi, Wi-Fi printer, and the configuration of the wireless router as directed by the CTDOT. Installation will be coordinated with CTDOT District and Project personnel.

After the approval of the hardware and software, the Contractor shall contact the designated representatives of the CTDOT administering District, a minimum of 2 working days in advance of the proposed delivery or installation of the Field Office Wi-Fi Connection, Wi-Fi Printer, Digital Camera(s), Flip Phones, Smart Phones, Multifunction Laser Printer/Copier/Scanner/Fax, Video Projectors and Smart Board(s), as well as associated hardware, software, supplies, and support documentation.

The Contractor shall provide all supplies, paper, maintenance, service and repairs (including labor and parts) for the Wi-Fi printers, copiers, field office Wi-Fi, fax machines and other equipment and facilities required by this specification for the duration of the Contract. All repairs must be performed with-in 48 hours. If the repairs require more than 48 hours, then an equal or better replacement must be provided.

Once the Contract has been completed, the hardware and software will remain the property of the Contractor.

First Aid Kit: The Contractor shall supply a first aid kit adequate for the number of personnel expected based on the size of the field office specified and shall keep the first aid kit stocked for the duration that the field office is in service.

Rain Gauge: The Contractor shall supply install and maintain a rain gauge for the duration of the project, meeting these minimum requirements. The rain gauge shall be installed on the top of a post such that the opening of the rain gauge is above the top of the post an adequate distance to avoid splashing of rainwater from the top of the post into the rain gauge. The location of the rain gauge and post shall be approved by the Engineer. The rain gauge shall be made of a durable material and have graduations of 0.1 inches or less with a minimum total column height of 5 inches. If the rain gauge is damaged the Contractor shall replace it prior to the next forecasted storm event at no additional cost.

Electronic Level: The Contractor shall supply and maintain in working order, for the duration of the Contract, the number of electronic levels, identified in the Additional Equipment, Facilities and Services table of this specification. The electronic levels shall meet the following requirements:

A. 48-inch length, box beam type
B. IP65 water and dust proof
C. 0.1-degree accuracy
D. Backlit display
E. Carrying case included
F. New or like new condition

Concrete Testing Equipment: If the Contract includes items that require compressive strength cylinders for concrete, in accordance with the Schedule of Minimum Testing Requirements for Sampling Materials for Test, the Contractor shall provide the following equipment.

A. Concrete Cylinder Curing Box – meeting the requirements of Section 6.12 of the Standard Specifications.
B. Air Meter – The air meter provided shall be in good working order and meet the requirements of AASHTO T 152.
C. Slump Cone Mold – Slump cone, base plate, and tamping rod shall be provided in like-new condition and meet the requirements of AASHTO T119, Standard Test Method for Slump of Hydraulic-Cement Concrete.

All testing equipment will remain the property of the Contractor at the completion of the project.

Insurance Policy: The Contractor shall provide a separate insurance policy, with no deductible, in the minimum amount of five thousand dollars ($5,000) in order to insure all State-owned data equipment and supplies used in the office against all losses. The Contractor shall be named insured on that policy, and the CTDOT shall be an additional named insured on the policy. These losses shall include, but not be limited to theft, fire, and physical damage. The CTDOT will be responsible for all maintenance costs of CTDOT owned computer hardware. In the event of loss, the Contractor shall provide replacement equipment in accordance with current CTDOT equipment specifications, within seven days of notice of the loss. If the Contractor is unable to provide the required replacement equipment within seven days, the CTDOT may provide replacement equipment and deduct the cost of the equipment from monies due or which may become due the Contractor under the Contract or under any other contract. The Contractor's financial liability under this paragraph shall be limited to the amount of the insurance coverage required by this paragraph. If the cost of equipment replacement required by this paragraph should exceed the required amount of the insurance coverage, the CTDOT will reimburse the Contractor for replacement costs exceeding the amount of the required coverage.

Maintenance: During the occupancy by the CTDOT, the Contractor shall maintain all facilities and furnishings provided under the above requirements, and shall maintain and keep the office quarters clean through the use of professional cleaning including, but not limited to, vacuuming carpet, washing & waxing floors, cleaning restrooms, removal of trash, general cleaning, etc. The general cleaning of the office shall be at least twice weekly. Restrooms, portable toilets and all other high touch areas shall be cleaned and disinfected at least every two days using CDC and Department of Health recommended and non-hazardous techniques. High touch areas to be cleaned include but are not be limited to (depending on the facilities supplied):

A. Arms on chairs
B. Table/Desktops
C. Handrails
D. Doorknobs and handles

E. Countertops
F. Elevator buttons
G. Coffee pots
H. Refrigerator / microwave / dishwasher / toaster handles
I. Water dispensers
J. Cabinet and file drawer knobs / handles
K. Phones and keypads
L. Copier / printer / fax control buttons
M. Sinks and faucets
N. Light switches

In addition, the Contractor shall supply appropriate (CDC and Department of Health recommended and non-hazardous), cleaning and disinfection supplies (wipes and sprays), and single use gloves for the use of the CTDOT representatives, for disinfection of surfaces and equipment in between the 2 day interval noted above. The Contractor shall always maintain a minimum of 500 wipes and 100 pairs of disposable gloves in the field office.

Exterior areas shall be mowed and clean of debris. A trash receptacle (dumpster) with weekly pickup (trash removal) shall be provided. Snow removal, sanding and salting of all parking, walkway, and entrance ways areas shall be accomplished during a storm if on a workday during work hours, immediately after a storm and prior to the start of a workday. If snow removal, salting and sanding are not completed by the specified time, the State will provide the service and all costs incurred will be deducted from the next payment estimate.

Method of Measurement: The furnishing and maintenance of the construction field office will be measured for payment by the number of calendar months that the office is in place and in operation, rounded up to the nearest month.

There will not be any price adjustment due to any change in the minimum computer related hardware and software requirements.

Basis of Payment: The furnishing and maintenance of the Construction Field Office will be paid for at the Contract unit price per month for "Construction Field Office, Large," which price shall include all material, equipment, labor, service contracts, licenses, software, repair or replacement of hardware and software, related supplies, utility services, parking area, external illumination, trash removal, snow and ice removal, and work incidental thereto, as well as any other costs to provide requirements of this specified this specification.

Pay Item	Pay Unit
Construction Field Office, Large	Month

ITEM NO. 0971001A – MAINTENANCE AND PROTECTION OF TRAFFIC

Article 9.71.01 – Description *is supplemented by the following:*

The Contractor shall maintain and protect traffic as described by the following and as limited in the special provision for Section 1.08 - Prosecution and Progress:

Broad Street
The Contractor shall maintain and protect a minimum of 1 lanes of traffic in each direction with each lane on a paved travel path not less than 11 feet in width during Stage 1 and Stage 3.

Main Street
The Contractor shall maintain and protect a minimum of 1 lanes of traffic in each direction with each lane on a paved travel path not less than 11 feet in width during Stage 1 and Stage 2.

Commercial and Residential Driveways
The Contractor shall maintain access to and egress from all commercial and residential driveways throughout the Project limits. The Contractor will be permitted to temporarily close affected driveways while actively working with coordination and permission from the owner or proprietor.

Article 9.71.03 - Construction Methods *is supplemented as follows:*

General
Unpaved travel paths will only be permitted for areas requiring full depth and full width reconstruction. The unpaved section shall be the full width of the road and shall be perpendicular to the travel lanes. The Contractor will be allowed to maintain traffic on processed aggregate for a duration not to exceed 15 calendar days and opposing traffic lane dividers shall be used as a centerline.
The Contractor is required to delineate any raised structures within the travel lanes, so that the structures are visible day and night, unless there are specific Contract plans and provisions to temporarily lower these structures prior to the completion of work.

The Contractor shall schedule operations so that pavement removal and roadway resurfacing shall be completed full width across a roadway or bridge section by the end of a work shift, or as directed by the Engineer.

When the installation of all intermediate courses of bituminous concrete pavement is completed for the entire roadway, the Contractor shall then install the final course of bituminous concrete pavement.

When the Contractor is excavating adjacent to the roadway, the Contractor shall provide a 3 foot shoulder between the work area and travel lanes, with traffic drums spaced every 50 feet. At the end of the work shift if the vertical drop-off exceeds 3 inches, the Contractor shall provide a temporary bituminous concrete traversable slope of 4:1 or flatter that is acceptable to the Engineer.

The Contractor, during the course of any active overhead construction work, shall close the lanes directly below the work area for the entire length of time overhead work is being undertaken.

When an existing sign is to be relocated or replaced, the work shall be completed during the same work shift.

The field installation of a signing pattern shall constitute interference with existing traffic operations and shall not be allowed, except during the allowable periods.

Existing Signing
The Contractor shall maintain all existing signs within the Project limits throughout the duration of the Project. The Contractor shall temporarily relocate signs and sign supports as many times as deemed necessary, and shall install temporary sign supports if necessary and as directed by the Engineer.

Requirements for Winter
The Contractor shall schedule a meeting with representatives of the Department, including the offices of Maintenance and Traffic, and the Town/City to determine any interim traffic control measures the Contractor shall accomplish prior to winter to provide safety to motorists and permit adequate snow removal procedures. This meeting shall be held prior to October 31 of each year and will include, but not be limited to, discussion of the status and schedule of the following items: lane and shoulder widths, pavement restoration, traffic signal work, pavement markings, and signing.

Signing Patterns
The Contractor shall erect and maintain all signing patterns in accordance with the traffic control plans contained herein. Proper distances between advance warning signs and proper taper lengths are mandatory.

Final Pavement Markings
Refer to Pavement Marking for pavement marking requirements. Permanent epoxy resin pavement markings shall be installed in accordance with Section 12.10 and the applicable Traffic Engineering Standard Drawings.

If Temporary Plastic Pavement Marking Tape is installed, then the Contractor shall remove and dispose of these markings during the same work shift that the permanent epoxy resin pavement markings are to be installed. The cost of furnishing, installing and removing the Temporary Plastic Pavement Marking Tape shall be at the Contractor's expense.

Traffic Control During Construction Operations
The following guidelines shall assist field personnel in determining when and what type of traffic control patterns to use for various situations. These guidelines shall provide for a safer and more efficient movement of traffic through work zones and enhance the safety of work forces in the work area.

Traffic Control Patterns

Traffic control patterns shall be used when a work operation requires that all or part of any vehicle or work area protrudes onto any part of a travel lane or shoulder or is within the clear zone. For each situation, the installation of traffic control devices shall be based on the following:

- Speed and volume of traffic.
- Duration of operation.
- Exposure to hazards.

Traffic control patterns shall be uniform, neat, and orderly in order to command respect from the motorist.

Lane reduction tapers should be placed so that the entire length of the taper is installed on a tangent section of roadway and the entire taper area can be seen by the motorist.

All existing conflicting signs shall be removed, covered with an opaque material, or turned so that they are not legible to oncoming traffic prior to implementing a traffic control pattern. The existing signs shall be uncovered or reinstalled once the pattern is removed.

A buffer area should be provided during installation of a traffic control pattern and maintained for the duration of the work. The buffer area shall be free of any equipment, workers, materials, and parked vehicles.

Construction Traffic Control Plans 19 through 25 should be used for moving operations such as line striping, rumble strips, pothole patching, mowing, or sweeping when it is necessary for equipment to occupy a travel lane.

Traffic control patterns are not required for vehicles on an emergency patrol type activity or for a short duration stop of up to one hour, as long as the equipment is contained within the shoulder. Flashing lights, arrow boards, truck-mounted or trailer-mounted impact attenuators, and appropriate Trafficperson(s) shall be used when required.

In a situation not adequately covered by the Construction Traffic Control Plans, the Contractor shall contact the Engineer for assistance prior to setting up a traffic control pattern.

Placement of Signs

Signs shall be placed in a position that allows motorists the opportunity to reduce their speed prior to the work area. Signs shall be installed on the same side of the roadway as the work area. On multi-lane divided highways, advance warning signs shall be installed on both sides of the highway. On directional roadways (on-ramps, off-ramps, one-way roads) where the sight distance to signs is restricted, these signs should be installed on both sides of the roadway.

Allowable Adjustment of Signs and Devices Shown on the Construction Traffic Control Plans

The Construction Traffic Control Plans contained herein show the location and spacing of signs and devices under ideal conditions. Signs and devices should be installed as shown on these plans.

The proper application of the Construction Traffic Control Plans and installation of traffic control devices is dependent upon actual field conditions.

In the case of a horizontal or vertical sight restriction in advance of the work area, the traffic control pattern shall be extended to provide adequate sight distance for approaching traffic.

Adjustments to the Construction Traffic Control Plans shall only be made at the direction of the Engineer.

Table 1 indicates the minimum taper lengths required for a lane closure based on the posted speed limit and lane width of the roadway. These taper lengths shall only be used when the recommended taper lengths shown on the Construction Traffic Control Plans cannot be achieved.

Table 1 – Minimum Taper Length

POSTED SPEED LIMIT (MPH)	MINIMUM TAPER LENGTH FOR A SINGLE LANE CLOSURE (FEET)	
	FREEWAYS	SECONDARY ROADS
30 OR LESS	180	165
35	245	225
40	320	295
45	540	495
50	600	550
55	660	605
65	780	715

1. Work Zone Safety Meetings

1.a) Prior to the commencement of work, a Work Zone Safety Meeting shall be conducted with representatives from DOT Construction, Connecticut State Police (Local Barracks), Municipal Police, the Contractor (Project Superintendent) and the Traffic Control Subcontractor (if different than the prime Contractor) to review the traffic operations, lines of responsibility, and operating guidelines which will be used on the Project. DOT Traffic Engineering shall be invited to the Work Zone Safety Meeting. Other Work Zone Safety Meetings during the course of the Project should be scheduled as needed.

1.b) A Work Zone Safety Meeting Agenda shall be developed and used at the Meeting to outline the anticipated traffic control issues during the construction of this Project. Any issues that can't be resolved at these Meetings will be brought to the attention of the District Engineer and the Office of Construction. The agenda shall include:

i. Review Project scope of work and time;

ii. Review Section 1.08, Prosecution and Progress;
iii. Review Section 9.70, Trafficpersons;
iv. Review Section 9.71, Maintenance and Protection of Traffic;
v. Review Contractor's schedule and method of operations;
vi. Review special concern areas: ramps, turning roadways, medians, lane drops, etc.;
vii. Open discussion of work zone questions and issues;
viii. Discussion of review and approval process for changes in Contract requirements as they relate to work zone areas.

2. General

2.a) Traffic control patterns shall only be installed if the required minimum number of signs, traffic cones, traffic drums, and other equipment (i.e. one Arrow Board for each lane closed, two Truck-Mounted or Trailer-Mounted Attenuators (TMAs), Changeable Message Sign, etc.) are on Site.

2.b) The Contractor shall have spare maintenance and protection of traffic equipment (TMAs, Arrow Board, Changeable Message Sign(s), construction signs, traffic cones, traffic drums, etc.) available at all times in case of mechanical failures, etc. Spare maintenance and protection of traffic equipment installed as a result of a sudden equipment breakdown shall be replaced by the Contractor within 24 hours.

2.c) Failure of the Contractor to have the required minimum number of signs, personnel, and equipment, which results in the pattern not being installed, shall not be a reason for a time extension or claim for lost time.

2.d) In cases of differences of opinion between the Contractor and the Inspection staff, the Contractor shall follow the directions of the Engineer. The matter shall be brought to the District Office for resolution immediately or, in the case of work after regular business hours, on the next business day.

3. Installing and Removing Traffic Control Patterns

3.a) Lane closures shall be installed beginning with the advance warning signs and proceeding forward toward the work area.

3.b) Lane closures shall be removed in the reverse order, beginning at the end of the work area, or traffic control pattern, and proceeding back toward the advance warning signs.

3.c) Stopping traffic may be allowed within the allowable hours stated in Section 1.08.04:
i. For those activities stated within the Contract.
ii. During paving, milling operations, or similar activities where, in the middle of the operation, it is necessary to flip the pattern to complete the operation on the other half of the roadway so traffic does not travel across the longitudinal joint or difference in roadway elevation.

iii. To move slow moving equipment across live traffic lanes into the work area.

3.d) The Contractor shall adhere to using the proper signs, placing the signs correctly, and ensuring the proper spacing of signs.

3.e) Additional devices are required on entrance ramps, exit ramps, and intersecting roads to warn and/or move traffic into the proper travel path prior to merging with or exiting from the mainline traffic. This shall be completed before installing the mainline pattern past the ramp or intersecting roadway.

4. Use of Arrow Boards

4.a) On non-limited access roadways, the use of an Arrow Board for lane closures is optional. The roadway geometry, sight distance, and traffic volume shall be considered in the decision to use the Arrow Board.

4.b) A vehicle displaying an arrow board shall be equipped with high-intensity rotating, flashing, oscillating, or strobe lights.

4.c) The flashing arrow mode shall be used for lane closure (merge) tapers.

4.d) The flashing arrow mode shall not be used for temporary alternating one-way traffic operations or to laterally shift lanes of traffic.

4.e) The flashing double arrow mode shall only be used for closing a center lane on a multilane roadway where adjacent left and right lanes remain open.

4.f) For shoulder work or roadside work near the shoulder, the Arrow Board shall be positioned in the shoulder and the flashing alternating diamond mode should be used.

4.g) The flashing alternating diamond caution mode should also be used when supplemental Arrow Boards are positioned in an already closed lane.

5. Use of Truck-Mounted or Trailer-Mounted Impact Attenuators (TMAs)

5.a) On non-limited access roadways, the use of TMAs to install and remove patterns closing a lane(s) is optional. The roadway geometry, sight line distance, and traffic volume shall be considered in the decision to utilize the TMAs.

5.b) A TMA shall be placed prior to the first work area in the pattern. If there are multiple work areas within the same pattern, then additional TMAs shall be positioned at each additional work area as needed. The Arrow Board mounted on the TMA should be in the flashing alternating diamond caution mode when in the closed lane.

5.c) TMAs shall be positioned a sufficient distance prior to the workers or equipment being protected to allow for appropriate vehicle roll-ahead in the event that the TMA is hit, but not so far that an errant vehicle could travel around the TMA and into the work area. For additional placement and use details, refer to Section 18.06. Some operations, such as paving and concrete repairs, do not allow for placement of the TMA(s) within the specified distances. In these situations, the TMA(s) shall be placed at the beginning of the work area and shall be advanced as the paving or concrete operations proceed.

5.d) TMAs will be paid for in accordance with how the unit is used. If it is used as a TMA and is in the proper location as specified, then it will be paid for at the specified hourly rate for Truck-Mounted or Trailer-Mounted Impact Attenuator. When the TMA is used as an Arrow Board, it will be paid for at the daily rate for Arrow Board. If a TMA is used to install and remove a pattern and is also used as an Arrow Board in the same day, then the unit will be paid for as a Truck-Mounted or Trailer-Mounted Impact Attenuator for the hours used to install and remove the pattern, typically 2 hours (1 hour to install and 1 hour to remove). If the TMA is also used as an Arrow Board during the same day, then the unit will only be paid for at the daily rate as an Arrow Board.

6. Use of Traffic Drums and Traffic Cones

6.a) On all roadways:

i. Traffic drums shall be used in place of traffic cones in traffic control patterns that are in effect for more than a 36-hour duration.

ii. Traffic cones shall not be left unattended.

iii. Traffic cones with a minimum height of 42 inches shall be used when the posted speed limit is 45 MPH or above.

6.b) Typical spacing of traffic drums and/or cones shown on the Construction Traffic Control Plans in the Contract are maximum spacings and may be reduced to meet actual field conditions as required.

7. Use of Barricade Warning Lights

7.a) Barricade Warning Lights may be installed on channelizing devices when used in a merge taper. The Barricade Warning Lights shall flash in a sequential pattern when used in a merge taper. The successive flashing shall occur from the upstream end (beginning) of the merge taper to the downstream end (end) of the merge taper.

7.b) Type C Barricade Warning Lights may be used at night to delineate the edge of the travel way.

7.c) Type B Barricade Warning Lights shall be used on post-mounted advanced warning signs.

8. Use of Portable Changeable Message Signs (PCMS)

8.a) On non-limited access roadways, the use of PCMS for lane closures is optional. The roadway geometry, sight line distance, and traffic volume shall be considered in the decision to use the PCMS.

8.b) PCMS should be placed off the shoulder of the roadway and behind a traffic barrier, if practical. Where a traffic barrier is not available to shield the PCMS, it should be placed off the shoulder and outside of the clear zone. If a PCMS has to be placed on the shoulder of the roadway or within the clear zone, it should be placed on the paved shoulder with a minimum of five traffic drums placed in a taper in front of it to delineate its position. The taper shall meet minimum distance requirements for a shoulder closure. The PCMS shall be protected if it is used for a continuous duration of 36 hours or more.

8.c) The PCMS shall be removed from the clear zone and have the display screen cleared and turned 90 degrees away from the roadway when the PCMS is no longer required.

8.d) The PCMS should not be used within 1,000 feet of an existing PCMS or Variable Message Sign (VMS).

8.e) A PCMS message shall:

i. consist of no more than two phases;
ii. contain no more than three lines of text per phase;
iii. have no more than eight characters per line, including spaces.

8.f) The PCMS should be used for specific situations that need to command the motorist's attention which cannot be conveyed with standard construction signs. The PCMS should not be used for generic messages (ex.: Road Work Ahead, Bump Ahead, Gravel Road, etc.) or for messages that need to be displayed for long periods of time, such as during stage construction. These types of messages should be displayed with construction signs. Special signs shall be coordinated with the Office of Construction and the Division of Traffic Engineering for the proper layout/dimensions required.

8.g) Typical messages that are allowed on the PCMS are shown below. Approval must be received from the Office of Construction for any message(s) different than the typical messages shown in Figure 1.

8.h) All messages shall comply with the information provided in Tables 2 and 3.

Message No.	Phase 1	Phase 2
1	LEFT LANE CLOSED	MERGE RIGHT
2	2 LEFT LANES CLOSED	MERGE RIGHT
3	LEFT LANE CLOSED	REDUCE SPEED
4	2 LEFT LANES CLOSED	REDUCE SPEED
5	RIGHT LANE CLOSED	MERGE LEFT
6	2 RIGHT LANES CLOSED	MERGE LEFT
7	RIGHT LANE CLOSED	REDUCE SPEED
8	2 RIGHT LANES CLOSED	REDUCE SPEED
9	LANES CLOSED AHEAD	REDUCE SPEED
10	LANES CLOSED AHEAD	USE CAUTION
11	EXIT XX CLOSED	USE EXIT YY
12	EXIT XX CLOSED USE YY	FOLLOW DETOUR
13	2 LANES SHIFT AHEAD	USE CAUTION
14	3 LANES SHIFT AHEAD	USE CAUTION

Figure 1: Typical PCMS Messages

Table 2: Acceptable Abbreviations

Word Message	Standard Abbreviation	Word Message	Standard Abbreviation
Access	ACCS	Minimum	MIN
Afternoon / Evening	PM	Minor	MNR
Ahead	AHD	Minute(s)	MIN
Alternate	ALT	Monday	MON
Avenue	AVE, AV	Morning / Late Night	AM
Bicycle	BIKE	Mount	MT
Blocked	BLKD	Mountain	MTN
Boulevard	BLVD	National	NATL
Bridge	BR	Normal	NORM
CB Radio	CB	North	N
Center	CTR	Northbound	NBND
Center	CNTR	Oversized	OVRSZ
Chemical	CHEM	Parking	PKING
Circle	CIR	Parkway	PKWY
Compressed Natural Gas	CNG	Pavement	PVMT
Condition	COND	Pedestrian	PED
Congested	CONG	Place	PL
Construction	CONST	Pounds	LBS
Court	CT	Prepare	PREP
Crossing	XING	Quality	QLTY
Crossing (other than highway-rail)	XING	Right	RT
Downtown	DWNTN	Road	RD
Drive	DR	Roadwork	RDWK
East	E	Route	RT, RTE
Eastbound	EBND	Saint	ST
Electric Vehicle	EV	Saturday	SAT
Emergency	EMER	Service	SERV
Entrance, Enter	ENT	Shoulder	SHLDR
Exit	EX	Slippery	SLIP
Express	EXP	South	S
Expressway	EXPWY	Southbound	SBND
Feet	FT	Speed	SPD
Freeway	FRWY, FWY	State, county, or other non-US or non-Interstate numbered route	[Route Abbreviation determined by highway agency]**
Friday	FRI	Street	ST
Frontage	FRNTG	Sunday	SUN
Hazardous	HAZ	Telephone	PHONE
Hazardous Material	HAZMAT	Temporary	TEMP
High Occupancy Vehicle	HOV	Terrace	TER
Highway	HWY	Thruway	THWY
Highway-Rail Grade Crossing	RR XING	Thursday	THURS

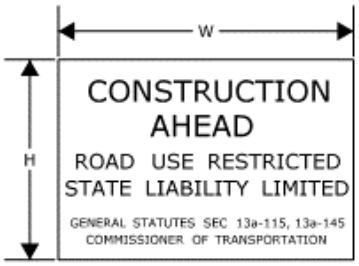
Hospital	HOSP	Tons of Weight	T
Hour(s)	HR, HRS	Traffic	TRAF
Information	INFO	Trail	TR
International	INTL	Travelers	TRVLRS
Interstate	I-	Tuesday	TUES
Junction / Intersection	JCT	Turnpike	TPK
Lane	LN	Two-Way Intersection	2-WAY
Left	LFT	Two-Wheeled Vehicles	CYCLES
Liquid Propane Gas	LP-GAS	Upper	UPR
Local	LOC	US Numbered Route	US
Lower	LWR	Vehicle(s)	VEH, VEHS
Maintenance	MAINT	Warning	WARN
Major	MAJ	Wednesday	WED
Maximum	MAX	West	W
Mile(s)	MI	Westbound	WBND
Miles Per Hour	MPH		

** A space and no dash shall be placed between the abbreviation and the number of the route.

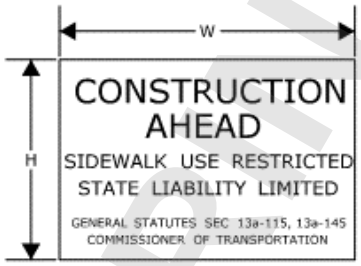
Table 3: Unacceptable Abbreviations

Unacceptable Abbreviation	Intended Word	Common Misinterpretation
ACC	Accident	Access (Road)
CLRS	Clears	Colors
DLY	Delay	Daily
FDR	Feeder	Federal
L	Left	Lane (Merge)
LT	Light (Traffic)	Left
PARK	Parking	Park
POLL	Pollution (Index)	Poll
RED	Reduce	Red
STAD	Stadium	Standard
WRNG	Warning	Wrong

SERIES 16 SIGNS



		W H
16-E	80-1605	84" x 60"
16-H	80-1608	60" x 42"
16-M	80-1613	30" x 24"



		W H
16-S	80-1619	48" x 30"

SIGN 16-S SHALL BE USED ON ALL PROJECTS THAT REQUIRE SIDEWALK RECONSTRUCTION OR RESTRICT PEDESTRIAN TRAVEL ON AN EXISTING SIDEWALK.

SERIES 16 SIGNS SHALL BE INSTALLED IN ADVANCE OF THE TRAFFIC CONTROL PATTERNS. SERIES 16 SIGNS SHOULD BE LOCATED TO ALLOW MOTORISTS THE OPPORTUNITY TO AVOID A WORK ZONE. SERIES 16 SIGNS SHOULD BE INSTALLED ON MAJOR INTERSECTING ROADWAYS THAT APPROACH THE WORK ZONE. ON LIMITED-ACCESS HIGHWAYS, THESE SIGNS SHOULD BE LOCATED IN ADVANCE OF THE NEAREST UPSTREAM EXIT RAMP AND ON ANY ENTRANCE RAMPS PRIOR TO OR WITHIN THE WORK ZONE LIMITS.

SIGNS 16-E AND 16-H SHALL BE POST-MOUNTED.

SIGN 16-E SHALL BE USED ON ALL FREEWAYS AND EXPRESSWAYS.

SIGN 16-H SHALL BE USED ON ALL RAMPS, OTHER STATE ROADWAYS AND MAJOR TOWN/CITY ROADWAYS.

SIGN 16-M SHALL BE USED ON OTHER TOWN ROADWAYS.

CONSTRUCTION TRAFFIC CONTROL PLAN
SERIES 16 SIGNS

SCALE: NONE

CONNECTICUT DEPARTMENT OF TRANSPORTATION
BUREAU OF ENGINEERING & CONSTRUCTION

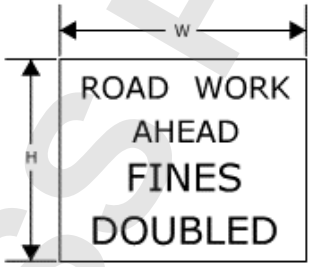
APPROVED Tracy L Fogarty Tracy L. Fogarty, P.E. 2013.10.09 16:30:32-04'00'
PRINCIPAL ENGINEER

REGULATORY SIGN "ROAD WORK AHEAD, FINES DOUBLED"

THE REGULATORY SIGN "ROAD WORK AHEAD FINES DOUBLED" SHALL BE INSTALLED FOR ALL WORK ZONES THAT OCCUR ON ANY STATE HIGHWAY AND MUNICIPAL ROAD IN CONNECTICUT WHERE THERE ARE WORKERS PRESENT ON THE HIGHWAY.

THE "ROAD WORK AHEAD FINES DOUBLED" REGULATORY SIGN SHALL BE PLACED AFTER THE SERIES 16 SIGN AND IN ADVANCE OF THE "ROAD WORK AHEAD" SIGN.

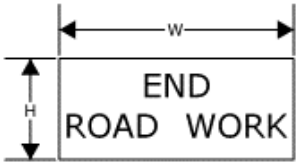
	W	H
31-1906	48"	42"
31-1907	60"	54"



"END ROAD WORK" SIGN

THE LAST SIGN IN THE PATTERN SHALL BE THE "END ROAD WORK" SIGN.

	W	H
80-9606	36"	18"
80-9612	48"	24"



CONSTRUCTION TRAFFIC CONTROL PLAN

ROAD WORK AHEAD SIGNS

SCALE: NONE

CONNECTICUT DEPARTMENT OF TRANSPORTATION
BUREAU OF ENGINEERING & CONSTRUCTION

APPROVED

Tracy L. Fogarty, P.E.
2019.09.12 15:54:44 -04'00'

PRINCIPAL ENGINEER

NOTES FOR TRAFFIC CONTROL PLANS

1. IF A TRAFFIC STOPPAGE OCCURS IN ADVANCE OF SIGN (A), THEN AN ADDITIONAL SIGN (A) SHALL BE INSTALLED IN ADVANCE OF THE STOPPAGE.

2. SIGNS (AA), (A), AND (D) SHOULD BE OMITTED WHEN THESE SIGNS HAVE ALREADY BEEN INSTALLED IN ADVANCE TO DESIGNATE A LARGER WORK ZONE THAN THE WORK ZONE THAT IS ENCOMPASSED ON THIS PLAN.

3. SEE TABLE 1 FOR ADJUSTMENT OF TAPERS IF NECESSARY.

4. TRAFFIC CONES AND PORTABLE CONSTRUCTION SIGNS SHALL NOT BE LEFT UNATTENDED.

5. ALL CONFLICTING SIGNS WITHIN THE LIMITS OF A ROADWAY / LANE CLOSURE AREA SHALL BE COVERED WITH AN OPAQUE MATERIAL WHILE THE CLOSURE IS IN EFFECT, AND UNCOVERED WHEN THE ROADWAY / LANE CLOSURE IS RE-OPENED TO ALL LANES OF TRAFFIC.

6. IF THIS PLAN REMAINS IN CONTINUOUS OPERATION FOR MORE THAN 48 HOURS, THEN ANY EXISTING CONFLICTING PAVEMENT MARKINGS SHALL BE ERADICATED OR COVERED, AND TEMPORARY PAVEMENT MARKINGS THAT DELINEATE THE PROPER TRAVELPATHS SHALL BE INSTALLED.

7. DISTANCES BETWEEN SIGNS IN THE ADVANCE WARNING AREA MAY BE REDUCED TO 100' ON LOW-SPEED URBAN ROADS (SPEED LIMIT $\leqslant$ 40 MPH).

8. IF THIS PLAN IS TO REMAIN IN OPERATION FROM SUNSET TO SUNRISE, INSTALL BARRICADE WARNING LIGHTS - HIGH INTENSITY ON ALL POST-MOUNTED DIAMOND SIGNS IN THE ADVANCE WARNING AREA.

9. A PORTABLE CHANGEABLE MESSAGE SIGN SHALL BE INSTALLED ONE HALF MILE TO ONE MILE IN ADVANCE OF THE LANE CLOSURE TAPER.

10 SIGN (P) SHALL BE MOUNTED A MINIMUM OF 7 FEET FROM THE PAVEMENT SURFACE TO THE BOTTOM OF THE SIGN.

TABLE 1 - MINIMUM TAPER LENGTHS

POSTED SPEED LIMIT (MILES PER HOUR)	MINIMUM TAPER LENGTH FOR A SINGLE LANE CLOSURE
30 OR LESS	180'
35	245'
40	320'
45	540'
50	600'
55	660'
65	780'

CONSTRUCTION TRAFFIC CONTROL PLAN

NOTES

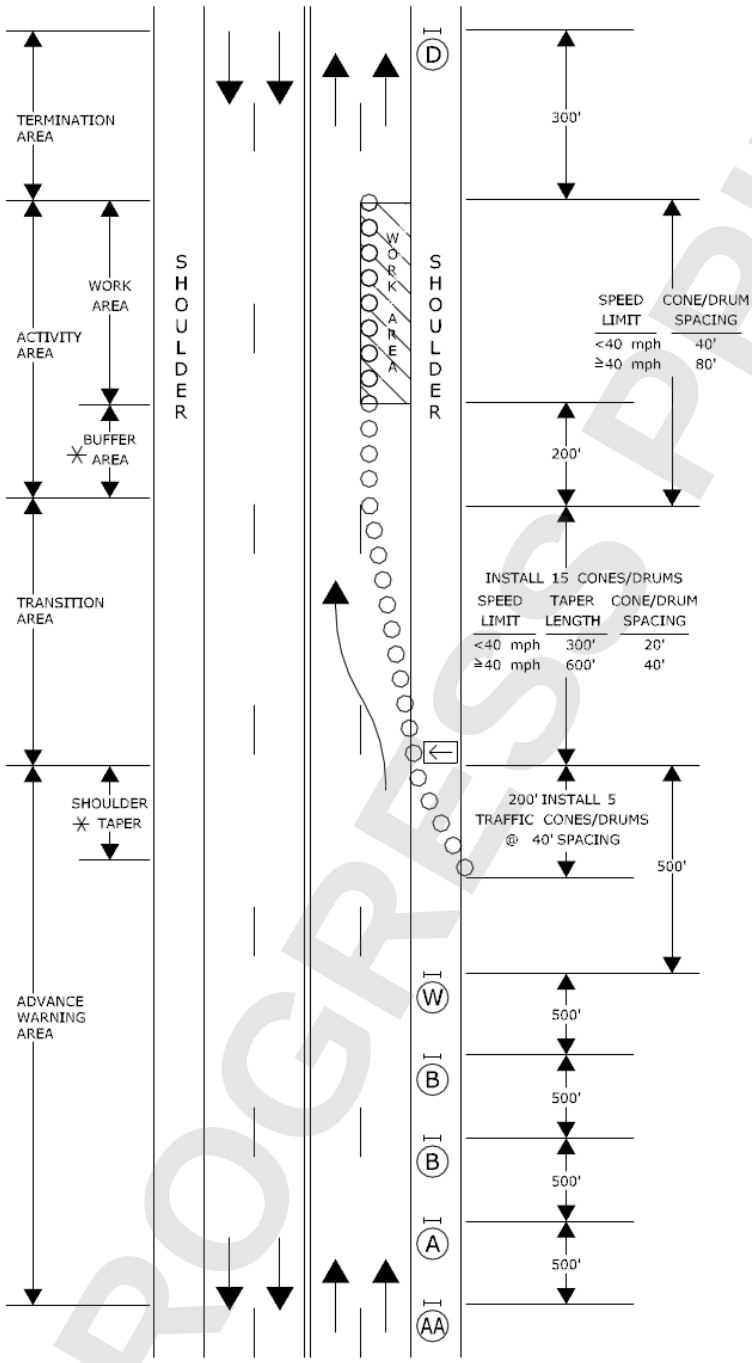
SCALE: NONE

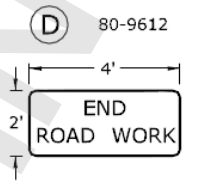
CONNECTICUT DEPARTMENT OF TRANSPORTATION
BUREAU OF ENGINEERING & CONSTRUCTION

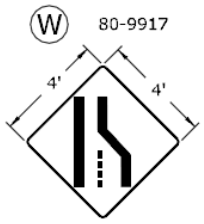
APPROVED Tracy L. Fogarty, P.E. 2019.09.13 08:47:47-04'00'
PRINCIPAL ENGINEER

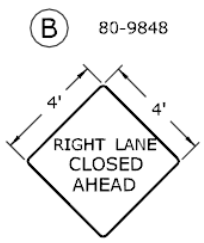
WORK IN RIGHT LANE - 4 LANE UNDIVIDED HIGHWAY

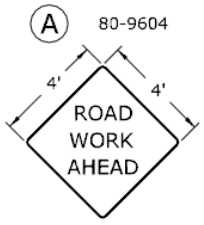
SIGN FACE
86 SQ. FT (MIN.)

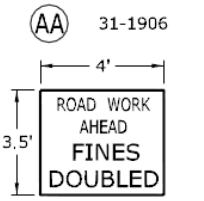












TRAFFIC CONE **OR** TRAFFIC DRUM
OPTIONAL TRAFFIC DRUM PORTABLE SIGN SUPPORT
HIGH MOUNTED INTERNALLY ILLUMINATED FLASHING ARROW

SCALE: NONE

CONSTRUCTION TRAFFIC CONTROL PLAN

PLAN 10

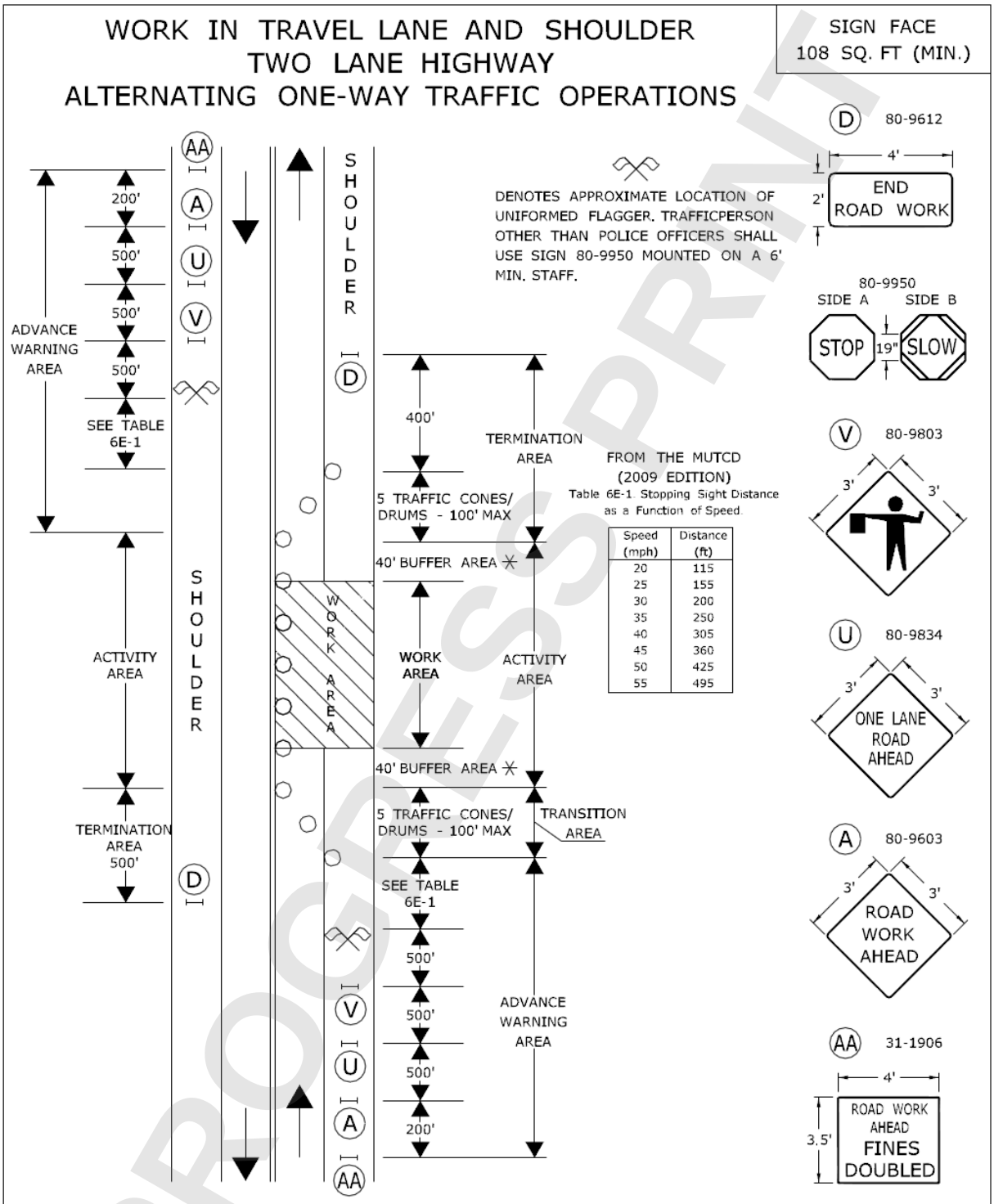
SEE NOTES 1, 2, 3, 4, 5, 6, 7, 8

CONNECTICUT DEPARTMENT OF TRANSPORTATION
BUREAU OF ENGINEERING & CONSTRUCTION

APPROVED _____ PRINCIPAL ENGINEER

Charles S. Harlow
2012.06.05 15:54:15-04'00'

WORK IN TRAVEL LANE AND SHOULDER
TWO LANE HIGHWAY
ALTERNATING ONE-WAY TRAFFIC OPERATIONS



CONNECTICUT DEPARTMENT OF TRANSPORTATION
BUREAU OF ENGINEERING & CONSTRUCTION

APPROVED _____ PRINCIPAL ENGINEER
Charles S. Harlow 2012.06.05 15:55:23-04'00'

WORK IN TRAVEL LANE AND SHOULDER
TWO LANE HIGHWAY
ALTERNATING ONE-WAY TRAFFIC OPERATIONS

SIGN FACE
108 SQ. FT (MIN.)

HAND SIGNAL METHODS TO BE USED BY UNIFORMED FLAGGERS

THE FOLLOWING METHODS FROM SECTION 6E.07, FLAGGER PROCEDURES, IN THE "MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES," SHALL BE USED BY UNIFORMED FLAGGERS WHEN DIRECTING TRAFFIC THROUGH A WORK AREA. THE STOP/SLOW SIGN PADDLE (SIGN NO. 80-9950) SHOWN ON THE TRAFFIC STANDARD SHEET TR-1220 01 ENTITLED, "SIGNS FOR CONSTRUCTION AND PERMIT OPERATIONS" SHALL BE USED.

A. TO STOP TRAFFIC

TO STOP ROAD USERS, THE FLAGGER SHALL FACE ROAD USERS AND AIM THE STOP PADDLE FACE TOWARD ROAD USERS IN A STATIONARY POSITION WITH THE ARM EXTENDED HORIZONTALLY AWAY FROM THE BODY. THE FREE ARM SHALL BE HELD WITH THE PALM OF THE HAND ABOVE SHOULDER LEVEL TOWARD APPROACHING TRAFFIC.

B. TO DIRECT TRAFFIC TO PROCEED

TO DIRECT STOPPED ROAD USERS TO PROCEED, THE FLAGGER SHALL FACE ROAD USERS WITH THE SLOW PADDLE FACE AIMED TOWARD ROAD USERS IN A STATIONARY POSITION WITH THE ARM EXTENDED HORIZONTALLY AWAY FROM THE BODY. THE FLAGGER SHALL MOTION WITH THE FREE HAND FOR ROAD USERS TO PROCEED.

C. TO ALERT OR SLOW TRAFFIC

TO ALERT OR SLOW TRAFFIC, THE FLAGGER SHALL FACE ROAD USERS WITH THE SLOW PADDLE FACE AIMED TOWARD ROAD USERS IN A STATIONARY POSITION WITH THE ARM EXTENDED HORIZONTALLY AWAY FROM THE BODY. TO FURTHER ALERT OR SLOW TRAFFIC, THE FLAGGER HOLDING THE SLOW PADDLE FACE TOWARD ROAD USERS MAY MOTION UP AND DOWN WITH THE FREE HAND, PALM DOWN.

◯ TRAFFIC CONE **OR** TRAFFIC DRUM
✳ OPTIONAL ⊗ TRAFFIC DRUM ⊢ PORTABLE SIGN SUPPORT
⟵ HIGH MOUNTED INTERNALLY ILLUMINATED FLASHING ARROW

SCALE: NONE

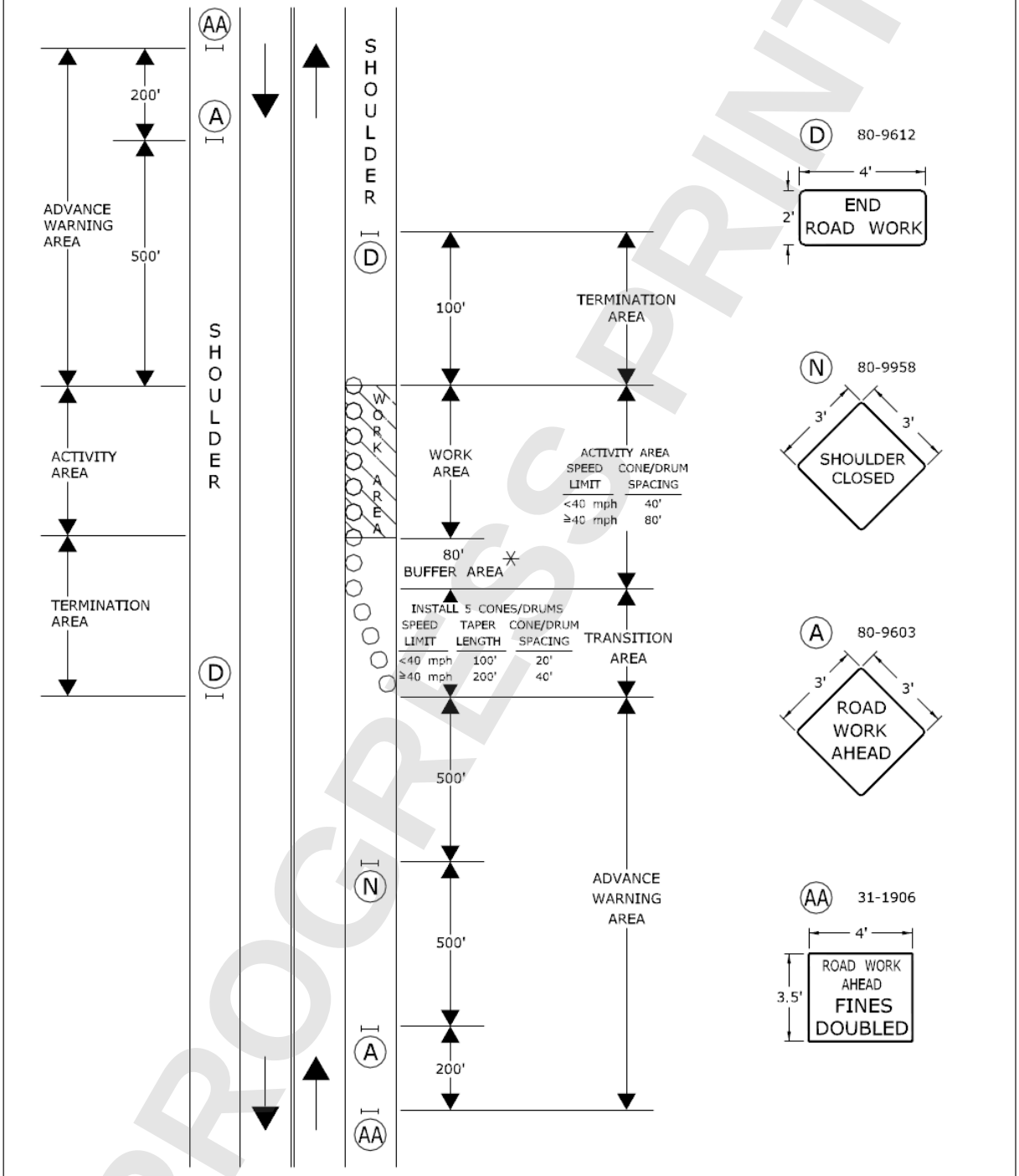
CONSTRUCTION TRAFFIC CONTROL PLAN
PLAN 13 - SHEET 2 OF 2
SEE NOTES 1, 2, 4, 6, 7, 8

CONNECTICUT DEPARTMENT OF TRANSPORTATION
BUREAU OF ENGINEERING & CONSTRUCTION

APPROVED _____ PRINCIPAL ENGINEER
Charles S. Harlow
2012.06.05 15:55:45-04'00'

WORK IN SHOULDER - TWO LANE HIGHWAY

SIGN FACE
71 SQ. FT (MIN.)



TRAFFIC CONE **OR** TRAFFIC DRUM
OPTIONAL TRAFFIC DRUM PORTABLE SIGN SUPPORT
HIGH MOUNTED INTERNALLY ILLUMINATED FLASHING ARROW

SCALE: NONE

CONSTRUCTION TRAFFIC CONTROL PLAN

PLAN 14

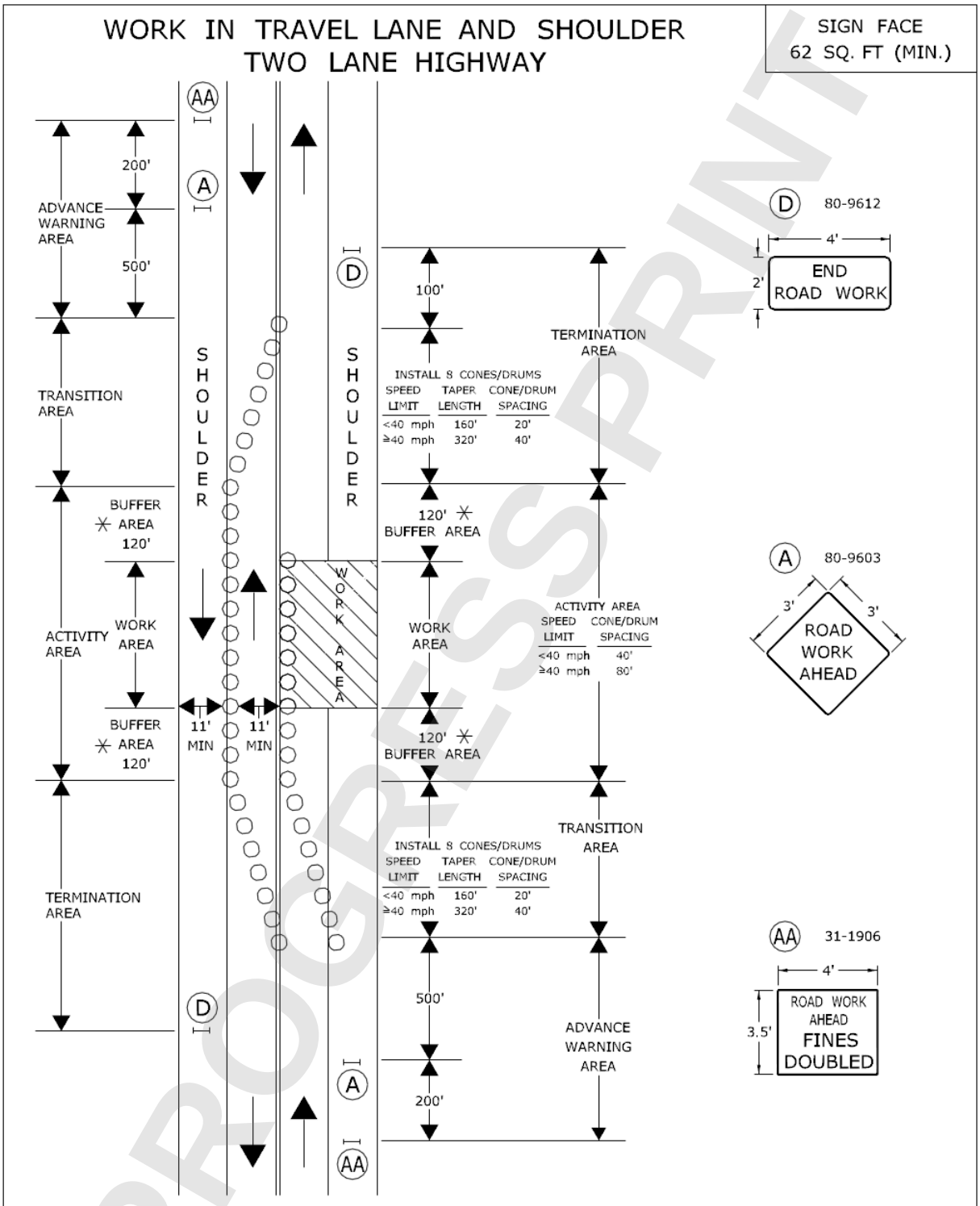
SEE NOTES 1, 2, 4, 7, 8

CONNECTICUT DEPARTMENT OF TRANSPORTATION
BUREAU OF ENGINEERING & CONSTRUCTION

APPROVED Charles S. Harlow 2012.06.05 15:56:09-04'00'
PRINCIPAL ENGINEER

WORK IN TRAVEL LANE AND SHOULDER
TWO LANE HIGHWAY

SIGN FACE
62 SQ. FT (MIN.)



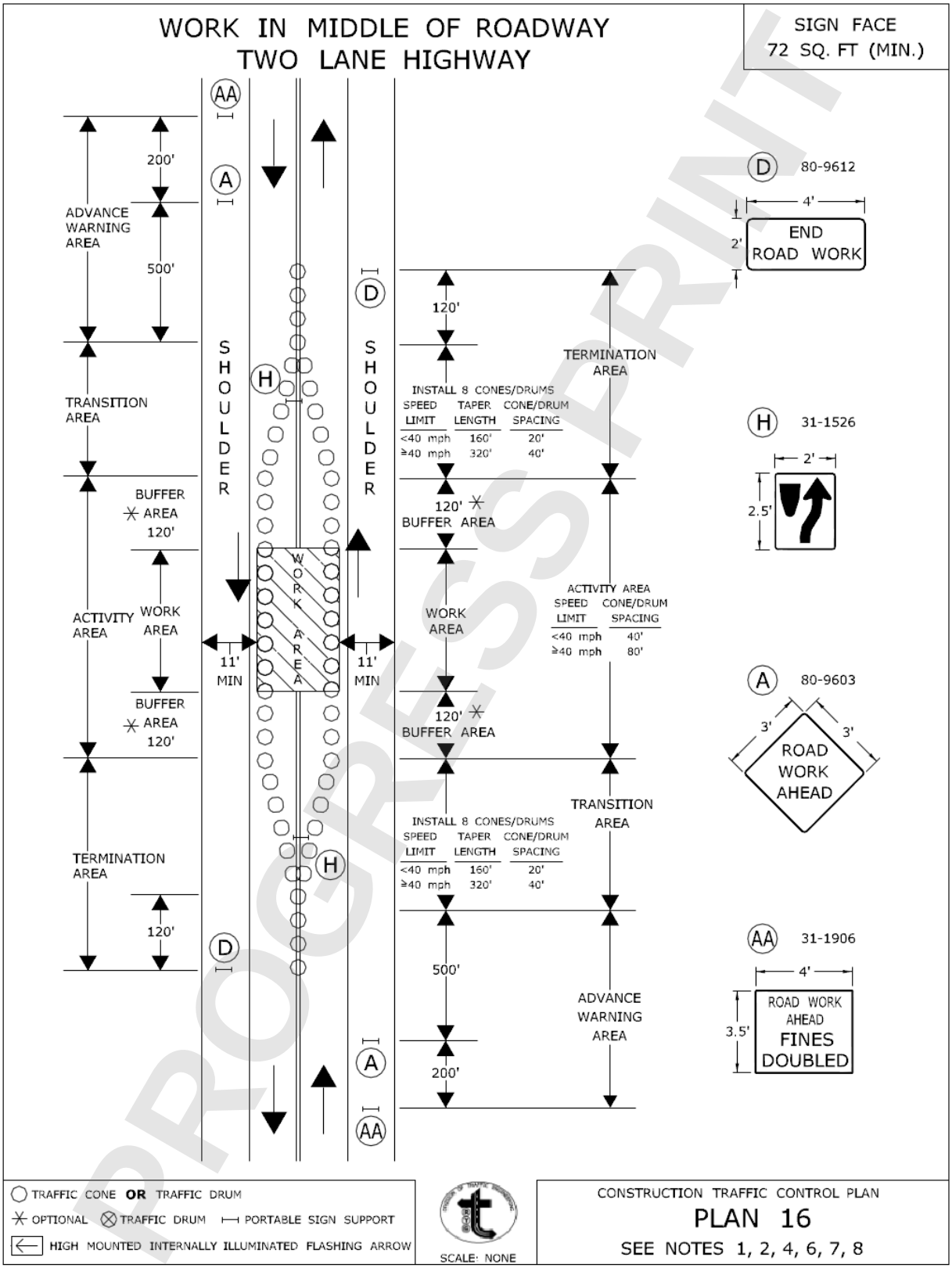
TRAFFIC CONE **OR** TRAFFIC DRUM
OPTIONAL TRAFFIC DRUM PORTABLE SIGN SUPPORT
HIGH MOUNTED INTERNALLY ILLUMINATED FLASHING ARROW

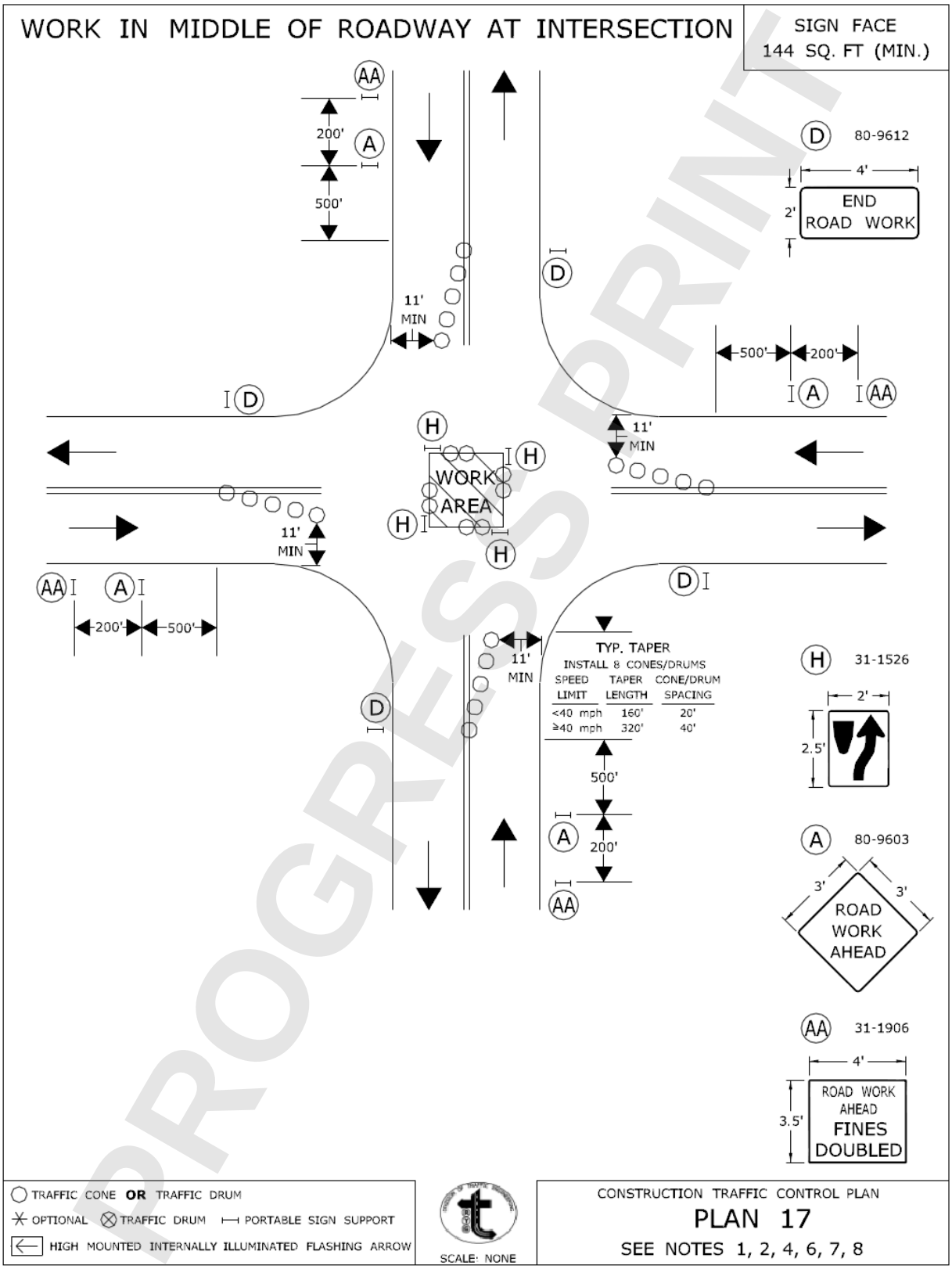
SCALE: NONE

CONSTRUCTION TRAFFIC CONTROL PLAN
PLAN 15
SEE NOTES 1, 2, 4, 6, 7, 8

CONNECTICUT DEPARTMENT OF TRANSPORTATION
BUREAU OF ENGINEERING & CONSTRUCTION

APPROVED Charles S. Harlow 2012.06.05 15:56:29-04'00'
PRINCIPAL ENGINEER





Article 9.71.05 – Basis of Payment *is supplemented by the following:*

The temporary relocation of signs and supports, and the furnishing, installation and removal of any temporary supports shall be paid for under the item "Maintenance and Protection of Traffic". Temporary overhead sign supports and foundations shall be paid for under the appropriate item(s).

The cost of furnishing, installing, and removing the material for the 4H:1V traversable slope shall be paid for under the item "Maintenance and Protection of Traffic".

ITEM #0979004A – CONSTRUCTION BARRICADE DETECTABLE

Section 9.79 is supplemented and amended as follows:

09.79.01—Description:

Replace the entire Article with the following:

Under this item the Contractor shall furnish all Construction Barricade Detectable required on the Project as stated in the item "Maintenance and Protection of Traffic," as shown on the plans, and as directed by the Engineer.

The Construction Barricade Detectable shall conform to the following:

1. have continuous detectable bottom and top surfaces able to be detected by a person with a visual disability traveling with the aid of a long cane;
2. the bottom of the bottom surface shall be no higher than 2 inches above the ground;
3. the top of the top surface shall be no lower than 32 inches above the ground;
4. the requirements of the 2016 AASHTO MASH.

09.79.02—Materials:

Delete the last sentence and add the following:

Prior to using Construction Barricade Detectable on the Project, the Contractor shall submit to the Engineer a copy of the Eligibility Letter issued by the FHWA to the manufacturer documenting that the barricades comply with the requirements of the 2016 AASHTO MASH and are eligible for reimbursement under the Federal-aid highway program.

Pay Item	**Pay Unit**
Construction Barricade Detectable	ea.

ITEM #0992089A – PICNIC TABLE

All Picnic Tables shall be constructed in accordance with CTDOT – Form 818, Supplemented as follows:

Description:

Add the Following:

Benches shall be "Table 75", manufactured by DuMor, Inc., Model Number 75-80D, Mifflintown, PA or approved equal.

Materials:

Add the Following:

Complete shop drawings of each item specified shall be submitted.

Where appropriate, and when approved by the Landscape Architect, manufacturer's catalogue cuts may be substituted for shop drawings.

Provide manufacturer's standard materials and accessories as required for assembly of units and as indicated on the assembly drawings. Provide unexposed aluminum, stainless steel or steel plates, angles and supports as required for complete assembly. Separate dissimilar materials to prevent electrolytic action.

The Contractor shall verify that finished grades and other operations affecting mounting surfaces have been completed prior to the installation of site furnishings. Site furnishings shall be installed plumb and true, at locations indicated, in accordance with the approved manufacturer's instructions.

Items shall be shipped knocked-down (KD) ready for site assembly. Packaged components shall be complete including all accessories and hardware. New parts shall be acquired from the manufacturer; substitute parts will not be accepted unless approved by the manufacturer. When the inspection of parts has been completed, the site furnishings shall be assembled and anchored according to manufacturer's instructions or as indicated. When site furnishings are assembled at the site, assembly shall not interfere with other operations or pedestrian and vehicular circulation.

Basis of Payment:

Add the Following:

Pay Item:	Pay Unit
Bench	ea.

ITEM #0992090A - BENCH

Description:
This item shall consist of furnishing and installing a bench, of the type specified, at the location, to the dimensions and details as shown on the plans in accordance with theses specifications. The purpose is provide a public amenity.

Benches shall be "Generation 50, Traditional Backed with (2) Arms" manufactured by Landscape Forms Inc., 7800 E. Michigan Ave., Kalamazoo, MI 49048, or approved equal.

References:

A. ASTM Testing Standards:
   1. ASTM B 117 – Standard Practice for Operating Salt Spray (Fog) Apparatus.
   2. ASTM D 522 – Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings.
   3. ASTM D 523 – Standard Test Method for Specular Gloss.
   4. ASTM D 2247 – Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.
   5. ASTM D 2794 – Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
   6. ASTM D 3359 – Standard Test Methods for Measuring Adhesion by Tape Test.
   7. ASTM D 3363 – Standard Test Method for Film Hardness by Pencil Test.
   8. ASTM G 155 – Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials.

B. ISO Testing Standards:
   1. ISO 1520 – Paints and Varnishes – Cupping Test.
   2. ISO 2815 – Paints and Varnishes – Buchholz Indentation Test.

Materials:

A. Basis of Design Product: Subject to compliance with requirements, provide:
   a. Generation 50, Traditional Backed with (2) Arms" manufactured by Landscape Forms Inc., 7800 E. Michigan Ave., Kalamazoo, MI 49048,
      i. Traditional, freestanding
      ii. Back option – Backed
      iii. Arms – Angled arms – end only
      iv. Face board style: straight cut face board
   b. or approved equal.

B. Seat and Back:
   a. Wood: consist of 2-3/16" x 1-3/8" solid wood interior boards. All boards have eased edges as well as ends.
   b. Domestically sourced thermally modified ash

C. Anchoring:
   a. Freestanding glides: 6/6 nylon

b. Surface mount: hardware included
c. (2) ½-13 stainless steel drop-in anchor
d. (2) custom surface mount bolt with ½-13 thread with Magni-coat
e. (2) ¼-20 x ½" slotted set screw with Magni-coat
f. (2) footpad, polypropylene, natural color

D. Finishes:
   a. Finish on Metal: Landscape Forms, Inc. "Pangard II".
      i. Primer: Rust inhibitor.
      ii. Topcoat: Thermosetting TGIC polyester powder coat. UV, chip, and flake resistant.
      iii. Test Results: "Pangard II".
         1. Gloss Consistency, Gardner 60 Degrees, ASTM D 523: Plus or minus 5 percent from standard.
         2. UV Resistance, Color and Gloss, ASTM G 155, Cycle 7: Delta E less than 2 at 2.0 mils and less than 20 percent loss.
         3. Cross-Hatch Adhesion, ASTM D 3359, Method B: 100 percent pass.
         4. Flexibility Test, Mandrel, ASTM D 522: 3 mm at 2 mils.
         5. Erichsen Cupping, ISO 1520: 8 mm.
         6. Impression Hardness, Buchholz, ISO 2815: 95.
         7. Impact Test, ASTM D 2794: 60 inch-pounds at 2.5 mils.
         8. Pencil Hardness, ASTM D 3363: 2H minimum.
         9. Corrosion Resistance, 1,500-Hour Test, ASTM B 117: Max undercutting 1 mm.
         10. Humidity Resistance, 1,500-Hour Test, ASTM D 2247: Max blisters 1 mm.
   b. Support Color: Stormcloud
   c. Arm Color: StormCloud

E. Finish on Wood:
   1. Wood for Exterior Use: Unfinished.
   2. Wood for Interior Use: Finished with "LF-80" catalyzed lacquer.

Construction Methods:

Examination:

A. Examine areas to receive benches.
B. Notify Architect of conditions that would adversely affect installation or subsequent use.
C. Do not begin installation until unacceptable conditions are corrected.

Installation:

A. Install benches in accordance with manufacturer's instructions at locations indicated on the Drawings.
B. Install benches level.

C. Anchor benches securely in place.

Adjusting:

A. Finish Damage: Repair minor damages to finish in accordance with manufacturer's instructions and as approved by Architect.
B. Component Damage: Remove and replace damaged components that cannot be successfully repaired as determined by Architect.

Cleaning:

A. Clean benches promptly after installation in accordance with manufacturer's instructions.
B. Do not use harsh cleaning materials or methods that could damage finish.

Protection:

A. Protect installed benches to ensure that, except for normal weathering, benches will be without damage or deterioration at time of Substantial Completion.

Delivery, Storage, And Handling:

A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.
B. Storage: Store materials in clean, dry area in accordance with manufacturer's instructions. Keep materials in manufacturer's original, unopened containers and packaging until installation.
C. Handling: Protect materials and finish during handling and installation to prevent damage.

Submittals:

A. Product Data: Submit manufacturer's product data, storage and handling requirements and recommendations, installation methods and available colors, styles, patterns and textures.
B. Shop Drawings: Submit manufacturer's shop drawings, including plans and elevations, indicating overall dimensions.
C. Samples: Submit manufacturer's samples of materials, finishes, and colors.
D. Warranty: Manufacturer's standard warranty.

Quality Assurance:

A. Product Support: Products are supported with complete engineering drawings and design patents.
B. Production: Orders are filled within a 40-day schedule.
C. Facility Operator: Welders and machine operators are certified.

Warranty Information:

A. Products will be free from defects in material and/or workmanship for a period of three years from the date of invoice.

B. The warranty does not apply to damage resulting from accident, alteration, misuse, tampering, negligence, or abuse.
C. Landscape Forms, Inc. shall, at its option, repair, replace, or refund the purchase price of any items found defective upon inspection by an authorized Landscape Forms service representative.
D. Purchasers should be aware that normal use of these high quality products can result in superficial damage affecting the finish. Scratches, nicks, and dents are to be considered normal wear and tear, and are not the responsibility of the manufacturer.

Method of Measurement:
This work will be measured for payment by the number of Benches installed and accepted.

Basis of Payment:
This work will be paid for at the Contract unit price per "Bench," complete in place, which price shall include materials, equipment, tools, labor and work incidental thereto.

Pay Item:	Pay Unit
Bench	ea.

ITEM #0992103A – TRASH CAN

Description:
This item shall consist of furnishing and installing a trash can, of the type specified, at the location, to the dimensions and details as shown on the plans in accordance with theses specifications. The purpose is to provide a public amenity and increase public cleanliness.

Trash Can shall be "Generation 50, Litter Receptacle" manufactured by Landscape Forms Inc., 7800 E. Michigan Ave., Kalamazoo, MI 49048, or approved equal.

References:

A. ASTM Testing Standards:
   1. ASTM B 117 – Standard Practice for Operating Salt Spray (Fog) Apparatus.
   2. ASTM D 522 – Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings.
   3. ASTM D 523 – Standard Test Method for Specular Gloss.
   4. ASTM D 2247 – Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.
   5. ASTM D 2794 – Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
   6. ASTM D 3359 – Standard Test Methods for Measuring Adhesion by Tape Test.
   7. ASTM D 3363 – Standard Test Method for Film Hardness by Pencil Test.
   8. ASTM G 155 – Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials.

B. ISO Testing Standards:
   1. ISO 1520 – Paints and Varnishes – Cupping Test.
   2. ISO 2815 – Paints and Varnishes – Buchholz Indentation Test.

Materials:

A. Basis of Design Product: Subject to compliance with requirements, provide:
   a. Generation 50, Litter Receptable manufactured by Landscape Forms Inc., 7800 E. Michigan Ave., Kalamazoo, MI 49048,
   b. or approved equal.

B. Style:
   a. Top opening unit

C. Mounting:
   a. Freestanding/surface mount: Non-corrosive anchoring hardware not included.

D. Lid: 11 gauge steel sheet. Welded to 7 gauge steel brackets with plastic bumpers. Hinged on one side.

E. Side panel: Constructed of 3/4" x 2" solid stock boards. Boards have eased edges. Secured to frame with Magni-coated screws

F. Exterior: Domestically sourced thermally modified ash.

G. Front panel: formed carbon steel sheet.
H. Inner frame: formed carbon steel sheet.
I. Liner: Rotationally molded linear low density polyethylene. Color is black.
J. Base: Rotationally molded linear low density polyethylene. Color is black. Base is filled with concrete for stability.

Finishes:

A. Finish on metal: Landscape Forms, Inc. "Pangard II".
   1. Primer: Rust inhibitor.
   2. Topcoat: Thermosetting polyester powdercoat. UV, chip, and flake resistant.
   3. Test Results: "Pangard II".
      a. Gloss, Garner 60 Degrees, ASTM D 523: Plus or minus 5.
      b. UV Resistance, Color and Gloss, ASTM G 155, Cycle 7: Delta E less than 2 at 2.0 mils and less than 20 percent loss.
      c. Cross-Hatch Adhesion, ASTM D 3359, Method B: 100 percent pass.
      d. Flexibility Test, Mandrel, ASTM D 522: 3 mm at 2 mils.
      e. Erichsen Cupping, ISO 1520: 8 mm.
      f. Impression Hardness, Buchholz, ISO 2815: 95.
      g. Impact Test, ASTM D 2794: 60 inches/pound at 2.5 mils.
      h. Pencil Hardness, ASTM D 3363: 2H minimum.
      i. Corrosion Resistance, 1,500-Hour Test, ASTM B 117: Max undercutting 1 mm.
      j. Humidity Resistance, 1,500-Hour Test, ASTM D 2247: Max blisters 1 mm.
   4. Color: Stormcloud
B. Finish on Wood:
   1. Wood for Exterior Use: Unfinished.

Construction Methods:

Examination:

A. Examine areas to receive litter receptacles.
B. Notify Architect of conditions that would adversely affect installation or subsequent use.
C. Do not begin installation until unacceptable conditions are corrected.

Installation:

A. Install litter receptacles in accordance with manufacturer's instructions at locations indicated on the Drawings.
B. Install litter receptacles level and plumb.
C. Anchor litter receptacles securely in place, if required.

Adjusting:

A. Finish Damage: Repair minor damages to finish in accordance with manufacturer's instructions and as approved by Architect.

B. Component Damage: Remove and replace damaged components that cannot be successfully repaired as determined by Architect.

Cleaning:

A. Clean litter receptacles promptly after installation in accordance with manufacturer's instructions.
B. Do not use harsh cleaning materials or methods that could damage finish.

Protection:

A. Protect installed litter receptacles to ensure that, except for normal weathering, receptacles will be without damage or deterioration at time of Substantial Completion.

Delivery, Storage, And Handling:

A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.
B. Storage: Store materials in clean, dry area in accordance with manufacturer's instructions. Keep materials in manufacturer's original, unopened containers and packaging until installation.
C. Handling: Protect materials and finish during handling and installation to prevent damage.

Submittals:

A. Product Data: Submit manufacturer's product data, storage and handling requirements and recommendations, installation methods and available colors, styles, patterns and textures.
B. Shop Drawings: Submit manufacturer's shop drawings, including plans and elevations, indicating overall dimensions.
C. Samples: Submit manufacturer's samples of materials, finishes, and colors.
D. Warranty: Manufacturer's standard warranty.

Quality Assurance:

A. Product Support: Products are supported with complete engineering drawings and design patents.
B. Production: Orders are filled within a 40-day schedule.
C. Facility Operator: Welders and machine operators are certified.

Warranty Information:

A. Products will be free from defects in material and/or workmanship for a period of three years from the date of invoice.
B. The warranty does not apply to damage resulting from accident, alteration, misuse, tampering, negligence, or abuse.

C. Landscape Forms, Inc. shall, at its option, repair, replace, or refund the purchase price of any items found defective upon inspection by an authorized Landscape Forms service representative.
D. Purchasers should be aware that normal use of these high quality products can result in superficial damage affecting the finish. Scratches, nicks, and dents are to be considered normal wear and tear, and are not the responsibility of the manufacturer.

Method of Measurement:
This work will be measured for payment by the number of Trash Cans installed and accepted.

Basis of Payment:
This work will be paid for at the Contract unit price per "Trash Can," complete in place, which price shall include materials, equipment, tools, labor and work incidental thereto.

Pay Item:	Pay Unit
Trash Can	ea.

ITEM #099209XA – ARCHITECTURAL CONCRETE SKIM COAT

Description: This work shall consist of furnishing, preparing, and installing cast-in-place architectural concrete, including form facings, and accessories, concrete materials, concrete mixture design, placement procedures, and finishes. Requirements in Section 06 04 00 "Cast in Place Concrete" apply to architectural concrete, except where more stringent requirements are indicated in this Section.

Materials: The materials for this work shall meet the following requirements, if applicable:

A. Concrete, General

1. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

    i. ACI 301 (ACI 301M).

    ii. ACI 303.1.

B. Form-Facing Materials

1. General: Comply with Section 06 04 00 "Cast-in-Place Concrete" for formwork and other form-facing material requirements.

2. Source Limitations: Obtain each type form-facing material from single source from single manufacturer.

3. Form-Facing Panels for As-Cast Finishes:

    i. Steel- and glass-fiber-reinforced plastic, or other approved nonabsorptive panel materials that provide continuous, true, and smooth architectural concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

    ii. Exterior-grade plywood panels, nonabsorptive, that will provide continuous, true, and smooth architectural concrete surfaces, high-density overlay, Class 1, or better, complying with DOC PS 1, or Finnish phenolic overlaid birch plywood.

4. Form Liners: Units of face design, texture, arrangement, and configuration indicated. Furnish with manufacturer's recommended liquid-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent surface treatments of concrete.

    i. Reckli 2/32 INN.

5. Chamfer Strips: Metal, rigid plastic, elastomeric rubber, or dressed wood, 3/4 by 3/4 inch (19 by 19 mm), minimum; nonstaining; in longest practicable lengths.

6. Form Joint Tape: Compressible foam tape; pressure sensitive; AAMA 800; minimum 1/4 inch (6 mm) thick.

7. Form Joint Sealant: Elastomeric sealant complying with ASTM C 920, Type M or Type S, Grade NS, that adheres to form joint substrates.

8. Sealer: Penetrating, clear, polyurethane wood form sealer formulated to reduce absorption of bleed water and prevent migration of set-retarding chemicals from wood.

9. Form-Release Agent: Commercially formulated, colorless form-release agent that will not bond with, stain, or adversely affect architectural concrete surfaces and will not impair subsequent treatments of those surfaces.

    i. Formulate form-release agent with rust inhibitor for steel form-facing materials.

10. Surface Retarder: Chemical liquid set retarder, for application on form-facing materials, capable of temporarily delaying final hardening of newly placed concrete surface to depth of reveal specified.

11. Form Ties: Factory-fabricated, internally disconnecting ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

    i. Furnish internally disconnecting ties that will leave no metal closer than 1-1/2 inches (38 mm) from the architectural concrete surface.

    ii. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

C. Concrete Materials

1. General: Comply with Section 06 04 00 “Cast-in-Place Concrete” for concrete materials, except as more stringent requirements are indicated below:

    i. Coarse aggregate shall have no dimension larger than ½".

    ii. Coarse aggregate shall have smooth surface.

    iii. Both coarse and fine aggregates shall be in the white to light gray color range.

2. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.

D. Curing Materials

1. Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.

E. Repair Materials

1. Epoxy Bonding Adhesive: ASTM C 881/C 881M two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements.

i. Types I and II, nonload bearing or load bearing as suitable for each installation, for bonding hardened or freshly mixed concrete to hardened concrete.

F. Concrete Mixtures

1. General: Comply with Section 06 04 00 “Cast-in-Place Concrete” for concrete mixtures.

2. Obtain each color, size, type, and variety of concrete mixture from single manufacturer with resources to provide cast-in-place architectural concrete of consistent quality in appearance and physical properties.

Construction Methods:

1. Preinstallation Conference: Conduct conference at Project site.

A. Require representatives of each entity directly concerned with cast-in-place architectural concrete to attend, including the following:

1. Contractor's superintendent.
2. Independent testing agency responsible for concrete design mixtures.
3. Ready-mix concrete manufacturer.
4. Cast-in-place architectural concrete Subcontractor.

B. Review concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction joints, forms and form-removal limitations, reinforcement accessory installation, concrete repair procedures, and protection of cast-in-place architectural concrete.

C. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials.

2. Submittals: All submittals shall include a title sheet with the following:

- Project number, town, and location.
- Structure number, when shown on the plans.
- Design code, as applicable.
- Contact information for fabricator – contact information shall include name and address of the fabricator and the name of contact person with phone number and email address.

A. Product Data: For each type of product.

B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1. Indicate amounts of mixing water to be withheld for later addition at Project site.

C. Formwork Shop Drawings: Show formwork construction, including form-facing joints, construction and contraction joints, form joint-sealant details, form tie locations and patterns, inserts and embedments, cutouts, cleanout panels, and other items that visually affect cast-in-place architectural concrete.

D. Placement Schedule: Submit concrete placement schedule before start of placement operations. Include locations of all joints, including construction joints.

E. Samples: For each of the following materials:

1. Form-facing panels.
2. Form ties.
3. Form liners.
4. Exposed aggregates.
5. Coarse- and fine-aggregate gradations.
6. Chamfers.

F. Samples for Verification: Architectural concrete Samples, cast vertically, approximately 18 by 18 by 2 inches (450 by 450 by 50 mm), of finishes, colors, and textures to match design reference sample. Include Sample sets showing the full range of variations expected in these characteristics.

G. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Form materials and form-release agents.

4. Repair materials.

H. Material Test Reports: For the following, by a qualified testing agency:

1. Aggregates. Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.

3. Fabrication and Manufacture: The fabrication and manufacture of the architectural concrete skim coat shall meet the requirements of Section 06 04 00 as supplemented by the following:

A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "NRMCA Quality Control Manual - Section 3, Certification of Ready Mixed Concrete Production Facilities."

B. Field Sample Panels: After acceptance of verification samples and before casting architectural concrete, produce field sample panels to demonstrate the accepted range of selections made under Sample submittals. Produce one full-scale curved panel (48" tall x 96" long x 12" thick, with 32' inside radius and top edge sloped at 0.75:12) with corrugated finish both sides, and one full-scale straight panel (48" tall x 96" long x 12" thick, with horizontal top edge) with corrugate finish one side and smooth Class B finish with light sandblast surface treatment the other side. Completed panels shall demonstrate the expected range of finish, color, and texture variations.

1. Locate field sample panels as directed by Architect.

2. Field sample panels shall be constructed on suitable foundations, shall include all reinforcing as detailed on the Drawings, and shall be provided with sufficient temporary bracing to ensure the stability of the panels until their removal from the site when they are no longer needed.

3. Each field sample panel shall include one T1 light fixture and appropriate power supply and concealed conduits to operate the fixtures; light fixtures shall be installed in a corrugated face of the panels at location selected by the Architect.

4. Each field sample panel shall incorporate one cold joint and two 48" long reveal features at locations selected by the Architect.

5. Demonstrate methods of curing, aggregate exposure, sealers, and coatings, as applicable.

6. In presence of Architect, damage part of an exposed-face surface for each finish, color, and texture, and demonstrate materials and techniques proposed for repair of tie holes and surface blemishes to match adjacent undamaged surfaces.

7. Provide additional field sample panels as necessary until results acceptable to the Architect are obtained.

8. Maintain accepted field sample panels during construction in an undisturbed condition as a standard for judging the completed Work.

9. Demolish and remove field sample panels when requested by the Architect.

4. Field Conditions:

A. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When average high and low temperature is expected to fall below 40 deg F (4.4 deg C) for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301 (ACI 301M).

2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.

3. Do not use calcium chloride, salt, or other materials containing antifreeze agents.

4. Do not use chemical accelerators unless otherwise specified and approved in design mixtures.

B. Hot-Weather Placement: Comply with ACI 301 (ACI 301M) and as follows:

1. Maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

5. Formwork Installation

A. General: Comply with Division 06 Section "Cast in Place Concrete" for formwork, embedded items, and shoring.

B. Limit deflection of form facing panels to not exceed ACI 303.1 requirements.

C. In addition to ACI 303.1 limits on form facing panel deflection, limit cast in place architectural concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:

1. Class A, 1/8 inch (3 mm).

D. Construct forms to result in cast in place architectural concrete that complies with ACI 117 (ASI 117M).

E. Construct forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast in place surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical. Kerf wood keyways, reglets, recesses, and the like, for easy removal.

1. Seal form joints and penetrations at form ties with form joint tape or form joint sealant to prevent cement paste leakage.

2. Do not use rust stained steel form facing material.

F. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

G. Chamfer exterior corners and edges of cast in place architectural concrete as shown on Drawings.

H. Coat contact surfaces of chamfer strips with sealer before placing reinforcement, anchoring devices, and embedded items.

I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

L. Coat contact surfaces of forms with form release agent, according to manufacturer's written instructions, before placing reinforcement.

M. Place form liners accurately to provide finished surface texture indicated. Provide solid backing and attach securely to prevent deflection and maintain stability of liners during concreting. Prevent form liners from sagging and stretching in hot weather. Seal joints of form liners and form liner accessories to prevent mortar leaks. Coat form liner with form release agent.

6. Reinforcement and Insert Installation

A. General: Comply with Section 06 04 00 "Cast-in-Place Concrete" for fabricating and installing steel reinforcement. Securely fasten steel reinforcement and wire ties against shifting during concrete placement.

B. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

7. Removing and Reusing Forms

A. Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 24 hours after placing concrete if concrete is hard enough to not be damaged by form removal operations and curing and protection operations are maintained.

1. Schedule form removal to maintain surface appearance that matches accepted field sample panels.

B. Leave formwork for beam soffits, joists, slabs, and other structural elements that support weight of concrete in place until concrete has achieved 28 day design compressive strength. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

C. Clean and repair surfaces of forms to be reused in the Work. Do not use split, frayed, delaminated, or otherwise damaged form facing material. Apply new form release agent.

D. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for cast in place architectural concrete surfaces.

8. Joints

A. Construction Joints: Install construction joints true to line, with faces perpendicular to surface plane of cast in place architectural concrete, so strength and appearance of concrete are not impaired, at locations indicated or as accepted by Architect.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated.

2. Form keyed joints as indicated.

3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam girder intersection.

4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.

5. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.

6. Use epoxy bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

B. Contraction Joints: Form weakened plane contraction joints true to line, with faces perpendicular to surface plane of cast in place architectural concrete, so strength and appearance of concrete are not impaired, at locations indicated or as accepted by Architect.

9. Concrete Placement

A. Before placing concrete, verify that installation of formwork, form release agent, reinforcement, and embedded items is complete and that required inspections have been performed.

B. Do not add water to concrete during delivery, at Project site, or during placement unless accepted by Architect.

C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301 (ACI 301M).

1. Do not add water to concrete after adding high range water reducing admixtures to mixture.

D. Deposit concrete continuously between construction joints. Deposit concrete to avoid segregation.

1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.

2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 303.1.

3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches (150 mm) into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. Do not permit vibrators to contact forms.

10. Finishes, General

A. Architectural Concrete Finish: Match Architect's design reference sample, identified and described as indicated, to satisfaction of Architect.

B. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces.

    1. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

C. Maintain uniformity of special finishes over construction joints unless otherwise indicated.

11. Architectural Concrete Finishes

A. Smooth Formed Finish: As cast concrete texture imparted by form facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Remove fins and other projections exceeding specified limits on formed surface irregularities. Repair and patch tie holes and defects.

B. Form Liner Finish: Produce a textured surface free of pockets, streaks, and honeycombs, and of uniform appearance, color, and texture.

C. Abrasive Blast Finish: Perform abrasive blasting after compressive strength of concrete exceeds 2000 psi (13.8 MPa). Coordinate with formwork removal to ensure that surfaces to be abrasive blasted are treated at same age for uniform results.

    1. Surface Continuity: Perform abrasive blast finishing in as continuous an operation as possible, maintaining continuity of finish on each surface or area of Work. Maintain required patterns or variances in depths of blast to match design reference sample or mockup.

    2. Abrasive Blasting: Abrasive blast corners and edges of patterns carefully, using backup boards, to maintain uniform corner or edge line. Determine type of nozzle, nozzle pressure, and blasting techniques required to match design reference sample or mockup.

    3. Depth of Cut: Use an abrasive grit of proper type and gradation to expose surrounding matrix surfaces to match design reference sample or mockup, as follows:

        a. Brush: Remove cement matrix to dull surface sheen and expose face of fine aggregate; with no significant aggregate reveal.

12. Concrete Protecting and Curing

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold weather protection and with ACI 301 (ACI 301M) for hot weather protection during curing.

B. Begin curing cast in place architectural concrete immediately after applying as cast formed finishes to concrete. Cure according to ACI 308.1, by one or a combination of the following methods that will not mottle, discolor, or stain concrete:

    1. Curing Compound: Mist concrete surfaces with water. Apply curing compound uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

13. Field Quality Control

A. General: Comply with field quality control requirements in Division 06 Section "Cast in Place Concrete."

14. Repair, Protection, and Cleaning

A. Repair and cure damaged finished surfaces of cast in place architectural concrete when approved by Architect. Match repairs to color, texture, and uniformity of surrounding surfaces and to repairs on accepted mockups.

    1. Remove and replace cast in place architectural concrete that cannot be repaired and cured to Architect's approval.

B. Protect corners, edges, and surfaces of cast in place architectural concrete from damage; use guards and barricades.

C. Protect cast in place architectural concrete from staining, laitance, and contamination during remainder of construction period.

D. Clean cast in place architectural concrete surfaces after finish treatment to remove stains, markings, dust, and debris.

E. Wash and rinse surfaces according to concrete finish applicator's written instructions. Protect other Work from staining or damage due to cleaning operations.

    1. Do not use cleaning materials or processes that could change the appearance of cast in place architectural concrete finishes.

Method of Measurement: This work will be measured for payment by the number of square feet of surface area of accepted architectural concrete skim coat as specified.

Basis of Payment: Architectural concrete skim coat will be paid for at the Contract unit price per square foot for "Architectural Concrete Skim Coat", complete in place, which price shall include furnishing, preparing, and installing the architectural concrete skim coat, all materials, equipment, tools, and labor incidental thereto.

Pay Item	Pay Unit
Architectural Concrete Skim Coat	s.f.

ITEM #099209XA – PIPE BENCH

All Benches shall be constructed in accordance with article 09.92, Supplemented as follows:
This item shall consist of furnishing and installing a bench, of the type specified, at the location, to the dimensions and details as shown on the plans in accordance with theses specifications. The purpose is provide a public amenity and educational exhibit.

Description:

This item shall consist of constructing a sitting bench out of an approved precast concrete sewer pipe, cut to size and shape to provide a smooth sitting surface of the dimensions and details shown on the plans, constructed where indicated on the plans in accordance with these specifications.

Bench to be designed in subsequent submissions out of 36" diameter precast concrete pipe containing a protective linear on the interior surface of the pipe. Each individual pipe bench shall be anchored to a poured-in-place, individual, reinforced concrete pad.

References:

A. A standard prefabricated reinforced concrete pipe is designated as a 'Standard RCP.' Prefabricated Concrete Manufacturer should be member of The National Precast Concrete association (NPCA).
Liner for precast concrete pipe shall be from an approved supplier for the AGRU Sure Grip® HDPE and PP-R Concrete Protective Liner system (AGRU America).

Definitions:

A. Reinforced Concrete Culvert, Storm Drain and Sewer Pipe ASTM C76/AASHTO M170. Standard RCP designs Class III pipe designed to pass a D-load test (ASTM C497).
Magni Coating: Magni 565, with a two-coat system and resistant to fluids, from Magni Anti-Corrosion Coatings - AFT Fasteners
https://www.aftfasteners.com › magni-coatings

Materials:

A. Benches shall be constructed modifying a Standard RCP prefab concrete pipe with "B-wall" type.

B. The inner side of the standard RCP pipe should have installed an AGRU Sure Grip® HDPE and PP-R Concrete Protective Liner system (AGRU America) pre-installed at the manufacturing shop/plant.

C. Finished wood covering the cut surfaces in the standard RCP pipe shall be smooth, treated wood domestically sourced thermally modified ash.

D. Poured-in-place, reinforced, setting concrete pad to set and anchor the bench on the site shall be as per structural designs.

E. Cast Concrete 60" Diameter x 48" inch long, prefabricated concrete pipe to be cut in accordance with drawings.

Seat and Back:

a. Wood: consist of 6 " x 10" inch x length of pipe, solid, treated wood boards. All boards have eased edges, corners, as well as ends.
b. Domestically sourced thermally modified ash

Anchoring:

a. Freestanding glides: 6/6 nylon
b. Surface mount: hardware
c. 3¾"-inch Dia. stainless steel drop-in anchor
d. ¾"-inch Dia. custom surface mount bolt with thread with Magni-coat
e. ¾"-inch Dia. slotted set screw with Magni-coat

Finishes:

a. Finish on Concrete:
    i. Unfinished exterior:
    ii. Grind-smooth exterior surfaces
    iii. Grind-smooth all exposed concrete edges
    iv. Curved edges at the perimeter of the setting concrete pad

b. Finish on Wood:
    1. Wood for Exterior Use: Smooth and unfinished.

Construction Methods:

A. Verify that RCP Manufacturer has being advised that these pipes will be used for finished work and to select good, clean, structurally sound, and without defects pipes at the plant prior to transportation to the site.

B. Verify that standard RCP that will be transformed into a bench is free of defects, cracks, deformations, etc.

C. Mark the pipe to follow dimensions and designs shown in plans and details.

D. Saw-cut pipe to create shape shown in drawings and details.

E. Grid-smooth all cuts and newly exposed edges, particularly the exposed steel bars.

F. Apply an epoxy coating at all exposed reinforcing steel bars' ends to prevent rust.

G. Pre-drill pilot holes in the cut edges of the pipes for proper anchoring of wood boards.
H. Install treated wood boards of prescribed sizes.

I. Heads of anchoring bolts shall be flush with the finish surface.

J. Anchoring bolts to the concrete pad shall be pre-drilled verifying that the top washer(s) and nut(s) are set below the pipes' exterior surface. Fill hole with epoxy grout to match color of concrete.

K. Protect the liner during construction of the bench and at the site.

L. Reinforced concrete setting pad at the site should follow the sizes and materials described in the plans and details.

M. Follow structural recommendations for the anchoring methods of the concrete pipe bench on the concrete setting pad.

Examination:

A. Examine areas to receive benches.

B. Notify Architect of conditions that would adversely affect installation or subsequent use.

C. Do not begin installation until unacceptable conditions are corrected.

D. Examine the pre-constructed benches prior to installation.

E. Notify Architect of pipe bench conditions that would adversely affect installation or subsequent use.

F. Do not begin installation of pipe benches until unacceptable conditions are corrected.

Installation:

A. Install benches in accordance with structural designs, instructions at locations indicated on the Drawings.

B. Install benches level.

C. Anchor benches securely in place as per structural designs and conditions.

Adjusting:

A. Finish Damage: Repair minor damages to finish in accordance with manufacturer's instructions and as approved by Architect.

B. Component Damage: Remove and replace damaged components that cannot be successfully repaired as determined by Architect.

Cleaning:

A. Clean benches promptly after installation. If cleaning is need on the standard RCP pipe(s), clean in accordance with manufacturer's instructions.

B. Do not use harsh cleaning materials or methods that could damage finish.

Protection:

A. Protect installed benches to ensure that, except for normal weathering, benches will be without damage or deterioration at time of Substantial Completion.

Delivery, Storage, And Handling:

A. Delivery: Deliver materials to site having been properly protected at the manufacturing plant for transportation and delivery, with labels clearly identifying product name and manufacturer.

B. Storage: Store materials in safe, clean, dry area until installation.

C. Handling: Protect materials and finish during handling and installation to prevent damage.

Submittals:

A. Product Data: Submit manufacturer's product data, storage and handling requirements and recommendations, and available colors, styles, patterns and textures.

B. Shop Drawings: Submit manufacturer's shop drawings, including plans and elevations, indicating overall dimensions.

C. Samples: Submit manufacturer's samples of materials, finishes, and colors.

Method of Measurement:
This work will be measured for payment by the number of Benches installed and accepted.

Basis of Payment:
This work will be paid for at the Contract unit price per "Pipe Bench," complete in place, which price shall include materials, equipment, tools, labor and work incidental thereto.

Pay Item:	Pay Unit
Pipe Bench	ea.

ITEM #1002008A – LIGHT POLE AND FIXTURES (DECORATIVE) WITH FUNCTIONS
ITEM #100200XA – LIGHT POLE AND FIXTURES (DECORATIVE)

All Light Poles – Pedestrian shall be constructed in accordance with CTDOT - Form 818, Article 10.02,

Supplemented as follows:

Description:
Add the Following:

Fixture shall be "Selux Modular Column" manufactured by Selux 5 Lumen Lane
P.O. Box 1060, High-land, NY 12528

Lamp Post: 12' Column
Catalog No. – MCB-*TBD*
Column Features – Speaker (SPxx), Twin Spot Module Single (TMSxx)
Options – USB & Suplex Receptacle with weather – proof cover (REC3), Panic Button, Smart City Features, WIFI, TBD
Material – Extruded Marine grade Aluminum, internal anchor base mounting plate
Finish – Semi-Matte Black

Luminaire: Exelia Gen5 LED
Catalog No. EXRL-4QD-4QD-XX-30-BL-240-EM
Material – Tiger Drylac certified polyester powder coast finish
Finish – Semi-Matte Black

Fixture shall be "Selux Modular Column" manufactured by Selux 5 Lumen Lane
P.O. Box 1060, High-land, NY 12528

Lamp Post: 12' Column
Catalog No. – MCB-*TBD*
Column Features – Speaker (SPxx), Twin Spot Module Single (TMSxx)
Options – None
Material – Extruded Marine grade Aluminum, internal anchor base mounting plate
Finish – Semi-Matte Black

Luminaire: Exelia Gen5 LED
Catalog No. EXRL-4QD-4QD-XX-30-BL-240-EM
Material – Tiger Drylac certified polyester powder coast finish
Finish – Semi-Matte Black

Materials:
Add the Following:

Pole mounted fixtures shall have concrete foundation with conduit and grounding spike. Foundation shall be designed for a steady wind speed of 90 mph with a gusting wind speed of 110 mph.

Lighting materials shall be UL approved or listed and shall conform to NFPA 70 requirements.

Light fixtures shall conform to all Dark Sky Requirements as defined in The "IES" (Illuminating Engineering Society of North America) Lighting Handbook, most recent edition.

Basis of Payment:
Add the Following:

Pay Item:	Pay Unit
Light Pole And Fixtures With Functions	ea.
Light Pole And Fixtures	ea.

ITEM #1004297 A – BOLLARD LIGHT

All Bollard Lights shall be constructed in accordance with CTDOT – Form 818, Article 10.04, Supplemented as follows:

Description:
Add the Following:

Fixture shall be "Selux Inula Bollard" manufactured by Selux 5 Lumen Lane
P.O. Box 1060, High-land, NY 12528

Luminaire: Inula Bollard
Catalog No. IBL-3-4QS-40-BL-277-REC4-EM
Material – Tiger Drylac certified polyester powder coast finish
Finish – Semi-Matte Black
Options – USB & Suplex Receptacle with weather – proof cover (REC4), Emergency Battery Pack
Material – Extruded Marine grade Aluminum, internal anchor base mounting plate
Finish – Semi-Matte Black

Materials:
Add the Following:

Bollard mounted fixtures shall have concrete foundation with conduit and grounding spike. Foundation shall be designed for a steady wind speed of 90 mph with a gusting wind speed of 110 mph.

Lighting materials shall be UL approved or listed and shall conform to NFPA 70 requirements.

Light fixtures shall conform to all Dark Sky Requirements as defined in The "IES" (Illuminating Engineering Society of North America) Lighting Handbook, most recent edition.

Basis of Payment:
Add the Following:

Pay Item:	Pay Unit
Bollard Light	ea.

ITEM #1006139A- WALL MOUNTED LUMINAIRE

All Wall Mounted Luminaire shall be constructed in accordance with CTDOT – Form 818, Article 10.06, Supplemented as follows:

Description:
Add the Following:

Materials:
Add the Following:

Basis of Payment:
Add the Following:

Pay Item:	Pay Unit
Wall Mounted Luminaire	ea.

ITEM NO. 1206023A - REMOVAL AND RELOCATION OF EXISTING SIGNS

Section 12.06 is supplemented as follows:

Article 12.06.01 – Description is supplemented with the following:
Work under this item shall consist of the removal and/or relocation of designated side-mounted sheet aluminum signs, sign posts, sign supports, and foundations where indicated on the plans or as directed by the Engineer. Work under this item shall also include furnishing and installing new sign posts and associated hardware for signs designated for relocation.

Article 12.06.03 – Construction Methods is supplemented with the following:
The Contractor shall take care during the removal and relocation of existing signs, sign posts, and sign supports that are to be relocated so that they are not damaged. Any material that is damaged shall be replaced by the Contractor at no cost to the State.

Foundations and other materials designated for removal shall be removed and disposed of by the Contractor as directed by the Engineer and in accordance with existing standards for Removal of Existing Signing.

Sheet aluminum signs designated for relocation are to be re-installed on new sign posts.

All City owned sheet aluminum signs and sign posts designated for removal are to be salvaged and delivered to the City. The Contractor shall confirm the intended delivery of the salvaged City owned sheet aluminum signs and posts at least seven days in advance by contacting XXXXX at (203) XXX-XXXX and shall deliver the signs to the following address:

City of Bridgeport
Bridegport Public Works Garage
475 Asylum Street
Bridgeport, Connecticut

Article 12.06.04 – Method of Measurement is supplemented with the following:
Payment under Removal and Relocation of Existing Signs shall be at the contract lump sum price which shall include all sheet aluminum signs, sign posts, and sign supports designated for relocation, all new sign posts and associated hardware for signs designated for relocation, all sheet aluminum signs, sign posts and sign supports designated for scrap or salvage, and foundations and other materials designated for removal and disposal, and all work and equipment required.

Article 12.06.05 – Basis of Payment is supplemented with the following:
This work will be paid for at the contract lump sum price for "Removal and Relocation of Existing Signs" which price shall include relocating designated sheet aluminum signs, sign posts, and sign supports, providing new posts and associated hardware for relocated signs, removing and disposing of foundations and other materials, and all equipment, material, tools and labor incidental thereto.

This price shall also include removing, loading, transporting, and unloading of sheet aluminum signs, sign posts, and sign supports designated for scrap or salvage and all equipment, material, tools and labor incidental thereto.

Pay Item	Pay Unit
Removal and Relocation of Existing Signs	L.S.

ITEM #1208931A – SIGN FACE - SHEET ALUMINUM (TYPE IX RETROREFLECTIVE SHEETING)

Section 12.08 is supplemented and amended as follows:

12.08.01—Description:

Add the following:

This item shall also include field testing of metal sign base posts as directed by the Engineer.

12.08.03—Construction Methods:

Delete the last sentence and add the following:

Metal sign base posts shall be whole and uncut. Sign base post embedment and reveal lengths shall be as shown on the plans. The Contractor shall drive the metal sign base posts by hand tools, by mechanical means or by auguring holes. If an obstruction is encountered while driving or placing the metal sign base post, the Contractor shall notify the Engineer who will determine whether the obstruction shall be removed, the sign base post or posts relocated, or the base post installation in ledge detail shall apply. Backfill shall be thoroughly tamped after the posts have been set level and plumb.

Field Testing of Metal Sign Posts: When the sign installations are complete, the Contractor shall notify the Engineer the Project is ready for field testing. Based on the number of posts in the Project, the Engineer will select random sign base posts which shall be removed by the Contractor for inspection and measurement by the Engineer. After such inspection is completed at each base post location, the Contractor shall restore or replace such portions of the work to the condition required by the Contract. Refer to the table in 12.08.05 for the number of posts to be field tested.

12.08.04—Method of Measurement:

Add the following:

The work required to expose and measure sign base post length and embedment depth using field testing methods, and restoration of such work, will not be measured for payment and shall be included in the general cost of the work.

12.08.05—Basis of Payment:

Replace the entire Article with the following:

This work will be paid for at the Contract unit price per square foot for "Sign Face - Sheet Aluminum" of the type specified complete in place, adjusted by multiplying by the applicable Pay

Factor listed in the table below. The price for this work shall include the completed sign, metal sign post(s), span-mounted sign brackets and mast arm-mounted brackets, mounting hardware, including reinforcing plates, field testing, restoration and replacement of defective base post(s), and all materials, equipment, and work incidental thereto.

Pay Factor Scale: Work shall be considered defective whenever the base post length or base post embedment depth is less than the specified length by more than 2 inches. If the number of defects results in rejection, the Contractor shall remove and replace all metal sign base posts on the Project, at no cost to the Department.

Number of Posts to be Tested and Pay Factors (Based on Number of Defects)

Number of Posts in Project =>	**51-100**	**101-250**	**251-1000**	**>1000**
Sample Size=>	**5 Posts**	**10 Posts**	**40 Posts**	**60 Posts**
0 Defects	1.0	1.0	1.025	1.025
1 Defect	0.9	0.95	0.975	0.983
2 Defects	Rejection	0.9	0.95	0.967
3 Defects	Rejection	Rejection	0.925	0.95
4 Defects	Rejection	Rejection	0.9	0.933
5 Defects	Rejection	Rejection	Rejection	0.917
6 Defects	Rejection	Rejection	Rejection	0.9
7 or more Defects	Rejection	Rejection	Rejection	Rejection

Note: Projects with 50 or fewer posts will not include field testing

ITEM #1302061A – ADJUST GATE BOX (WATER)

Description:

Work under this item shall include furnishing all labor and equipment for the adjustment of utility water gate/curb boxes, within the project limits to meet the proposed grades at each location as ordered by the Engineer. This work includes the necessary coordination with the utility companies and customers as required.

Materials:

All materials shall be provided by the Aquarion Water Company of Connecticut to the Contractor which shall meet the current standards of the affected utility.

Construction Methods:

The Contractor shall perform all work in coordination with the utility company and affected property owner and as directed by the Engineer. Certain work may require use of a licensed and/or certified tradesman when such work is required by local and/or state codes.

Any utility customer's service interruption shall be done in a manner that minimizes adverse impacts to the customer and affected utility.

Any work and materials supplied by the utility company shall be on a billable basis to the Contractor.

Any damage resulting from the Contractor's operations to the utility shall be corrected as ordered by the Engineer, without additional compensation to the Contractor.

Contractor shall adjust/lower gate boxes to match the exposed aggregate or milled surface grades where necessary to provide for safe traffic operations as directed by the Engineer. Prior to paving the final course, Contractor shall adjust/raise gate boxes to final grades.

Method of Measurement:

Adjust gate/curb box (water) to the final grades will be measured for payment as units, completed and accepted by the Engineer. Adjustment of gate/curb boxes to match the exposed aggregate or milled surface grades shall not be measured and paid for, but shall be included in the cost for Maintenance and Protection of Traffic.

Basis of Payment:

This work will be paid for at the contract unit price each for "Adjust Gate Box (Water)" to the final grades, complete in place, including materials, equipment, tools, labor and all incidental expenses.

Pay Item	Pay Unit
Adjust Gate Box (Water)	EA

ITEM #1403501A - RESET MANHOLE (SANITARY SEWER)

Description:

The Contractor shall reset to final grade the manhole frames and covers on manholes on the sanitary sewer main, all as shown, specified or directed. Also included is furnishing and installing additional manhole riser sections, if necessary.

Materials:

BRICK UNITS - Shall conform to ASTM C-32, Grade MS

MANHOLE RISER SECTIONS - Shall conform to ASTM C-478

MANHOLE RUNGS (STEPS) - Shall be 12 in. x 10 in. forged aluminum safety rung fabricated from 6061-T6 aluminum alloy as manufactured by ALCOA, or equal or colypolymer polypolymer steps in conformance with Paragraph II, ASTM A-615, Grade 400 for steel reinforcing rod. The steps shall be either Model PS-1B or PS2-PFSL as manufactured by M.A. Industries, Inc. Peach Tree City, GA, or equal.

MANHOLE EXTENSION RINGS - Shall conform to Article M.08.02-5 metal for drainage structures. The type of manhole extension will be designed so that the existing manhole cover when set in place, will have substantially the same bearing, fitness and load carrying capacity as existed in the existing manhole frame. The extension shall be designed to fit into the original manhole frame resting specifically on the flange area that originally supported the manhole cover.

Construction Methods:

The Contractor shall carefully excavate the sanitary sewer main manhole frame and cover and reset them to final grade.

The Contractor may be required to "unstack" the existing cone section so that riser sections can be added or deleted, where the change in grade is greater than 12 inches.

Any material damaged by the Contractor shall be repaired or replaced by the Contractor at no cost to the District.

Method of Measurement:

The work of resetting sanitary sewer manholes will be measured for payment by the number of manholes reset to grade and accepted by the Engineer.

Basis of Payment:

The work of resetting sanitary sewer manholes will be paid for at the contract unit price each bid for "Reset Manhole (Sanitary Sewer)" complete in place, which price shall include all labor and equipment to incorporate the manhole into the work. It shall also include the clearing, trenching, excavation and disposal of excavated materials, refilling trenches, furnishing additional material for refilling, grading, sheeting, bracing, pumping, and temporary and permanent resurfacing of disturbed areas.

Pay Item	Pay Unit
Reset Manhole (Sanitary Sewer)	EA.

ITEM #1504010A – TEMPORARY SUPPORT OF UTILITIES

Description:

Work under this item shall consist of designing, furnishing, placing and subsequently removing temporary sheet piling supports and protection shields which will be necessary to protect and/or stabilize the existing utilities during construction.

The work pertaining to the temporary support of utility pipes/facilities (including sanitary sewers and force mains, electrical and existing drainage facilities to remain in service) primarily involves the support and prevention of damages which are possible during the excavation and construction of the proposed facilities as shown on the plans.

The Contractor is advised that no service interruption resulting from his operations will be allowed, except as otherwise provided for in the Special Provision "Prosecution and Progress". Extreme caution shall be exercised during all stages of construction in order to preserve the existing utilities. A CTDOT representative shall be present at the installation of the temporary supports. Further attention shall be paid to "Section 1.07 - Legal Relations and Responsibilities," and the Notice to Contractor for "Protection of Existing Utilities".

The Contractor shall notify the Designer prior to the start of his work and shall be responsible for all coordination with the Department. The Contractor shall allow the Designer complete access to the work.

Contractors are cautioned that it is their responsibility to verify locations, conditions and field dimensions of all existing features, as actual conditions may differ from information indicated on the plans or contained elsewhere in these specifications.

Materials:

The materials for this work shall be of satisfactory quality for the purpose intended and shall be approved by the Designer. The material shall be intended for use in structures and shall be sound and capable of safely carrying the specified loads.

Construction Methods:

The Contractor shall prepare Working Drawings and computations showing his proposed method of support and protection for each utility to be supported and protected. Preparation of Working Drawings and computations shall conform to the requirements of Subarticle 1.20-1.05.02. The support shall safely carry all utility dead loads and any imposed loadings under all possible construction conditions. The utility protection shields shall safely carry any imposed loadings under all possible construction conditions. Said supports and protections shall be constructed in a manner that will not interfere with the removal of existing drainage pipes or structure or proposed drainage system installation.

The design shall be submitted to the Designer and the utility representative for review and approval. The design shall be submitted at least three (3) weeks prior to the beginning of construction. No work will be allowed in the vicinity of any utility until the Contractor receives approval of his support method from the utility representative and the Designer.

The Contractor shall use every effort to protect all utilities from damage of any nature that might result from carelessness or negligence in his operations. He shall be held solely and strictly responsible for any damage resulting from such carelessness and negligence.

A periodic inspection of the temporary utility support and protection shall be performed by the Contractor, as directed by the Designer.

The Contractor shall support and maintain the existing utilities until such time as the new underground systems have been installed and all trenches backfilled to finished grade above the utilities.

When the temporary utility support and protection systems are no longer required, they shall be removed from the site by the Contractor.

Method of Measurement:

This work, being paid for on a lump sum basis, will not be measured for payment.

Basis for Payment:

The work will he paid for at the contract lump sum price for "Temporary Support of Utilities," which price shall include designing and detailing the temporary supports and protection shields, furnishing and installing said supports and shields, and the removal of said supports and shields, including all materials, equipment, tools and labor incidental thereto.

Pay Item	Pay Unit
Temporary Support of Utilities	L.S.

ITEM # 1700001A – SERVICE CONNECTIONS (ESTIMATED COST)

Description: This work shall consist of disconnection, alteration and reconnection of those existing utility services owned by property owners at locations necessary to complete this project and as ordered by the Engineer. This work shall include the coordination with the affected utility companies and customers. Any damage caused by the Contractor or Subcontractors, as determined by the Engineer, shall be corrected by the Contractor in accordance with this specification.

Materials: All materials shall be provided by the Contractor and shall meet the current standards of the affected service.

Construction Methods: The Contractor shall perform all work in coordination with the Utility Company and affected property owner and as directed by the Engineer. Certain work may require use of a licensed and/or certified tradesman when such work is required by local and/or state codes.

Any utility customer's service interruption shall be done in a way that minimizes adverse impacts to the customer and affected utility.

Any work and materials supplied by the utility companies shall be on a billable basis to the Contractor.

Method of Measurement: The work and materials shall be measured for payment as provided for under Article 1.04.05 Extra Work.

The sum of money shown on the estimate and in the itemized proposal as "Estimated Cost" for this work will be considered the price bid even though payment will be made only for actual work performed. The estimated cost figure is not to be altered in any manner by the bidder. Should the bidder alter the amount shown, the altered figure will be disregarded and the original price will be used to determine the total amount for the contract.

Corrective work required to repair damage caused by the Contractor or its Subcontractors shall not be measured for payment.

Basis of Payment: This work will be paid as Extra Work.

Pay Item	Pay Unit
Service Connections (Estimated Cost)	EST.

ITEM #XXXXXXXA – PUMP STATION

Description:

Under this item, the Contractor shall complete the elements of work (architectural, structural, and communications) that make up the Major Lump Sum Item (MLSI), as depicted in this specification, the Contract Plans, and the CSI-formatted specifications. Refer to CTDOT – Form 818, Subarticle 1.02.04 for additional information in this regard.

All the CSI-formatted specifications contained in the contract documents apply to the MLSI.

The following elements of work constitute the MLSI:

- Wet Well Structure
- Building Structure
- Building Systems
- Pumping System

Structure excavation, compacted structural fill, dewatering, excavate handling/disposal and other related items of work associated with constructing the above MLSI elements are not part of the MLSI.

Any work incidental to another bid item which is not specifically described or included in the bid item, but which is required for performance and completion of the work required under the Contract, shall be considered to be included under this item.

Materials:

All materials shall be as required by the Contract Plans and as described in the CSI-formatted specifications that make up this MLSI.

Construction Methods:

All methods of construction shall conform to the requirements stipulated in the CSI-formatted specifications that make up the MLSI.

Method of Measurement:

This item will be paid for at the contract lump sum price for "Pump Station" complete.

Basis of Payment:

This item will be paid for at the contract lump sum price for "Pump Station", which price shall include all administrative and procedural requirements, material, equipment, labor, and work incidental thereto.

Pay Item	Pay Unit
Pump Station	L.S.

SECTION 03 11 00

CONCRETE FORMING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install concrete forming. The Work also includes:
      a. Designing forming systems in accordance with requirements of ACI 347 and the Contract Documents.
      b. Providing forming to accommodate the Work under this and other Sections and building into forming items such as sleeves, anchorage devices, inserts, pipe embedments, reinforcing, and all other items to be embedded in concrete for which placement is not specifically provided under other Sections.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before concrete forming Work.
   2. Coordinate forming Specifications with requirements for finished surfaces specified in Section 03 30 00, Cast-In-Place Concrete.

C. Related Sections:
   1. Section 03 15 00, Concrete Accessories.
   2. Section 03 30 00, Cast-In-Place Concrete.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ACI 117, Specifications for Tolerances for Concrete Construction and Materials and Commentary.
   2. ACI 301, Specifications for Structural Concrete.
   3. ACI 347, Guide to Formwork for Concrete.
   4. ASTM C805/C805M, Test Method for Rebound Number of Hardened Concrete.
   5. ASTM C1074, Practice for Estimating Concrete Strength by the Maturity Method.
   6. NIST PS 1, Structural Plywood.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Professional Engineer:

a. CONTRACTOR or formwork Supplier shall retain a registered professional engineer legally qualified to practice in same state as the Site. Professional engineer shall have at least five years experience designing formwork and falsework of the type required.

b. Responsibilities include:

1) Reviewing formwork and falsework performance and design criteria stated in the Contract Documents.

2) Preparing written requests for clarifications or interpretations of performance or design criteria for submittal to ENGINEER by CONTRACTOR.

3) Preparing or supervising preparation of design calculations verifying compliance of formwork and falsework with requirements of the Contract Documents.

4) Signing and sealing all calculations.

5) Certifying that:

a) Design of formwork and falsework was performed in accordance with performance and design criteria stated in the Contract Documents, and

b) Design conforms to all Laws and Regulations, and to prevailing standards of practice.

c) In place falsework, prior to concrete placement, complies with the intent of the forming design and complies with the Contract Documents.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Samples:

a. Plywood form material used for smooth form finish, four inches square minimum.

c. Controlled permeability forming liner material, eight inches square, minimum.

d. Form Liner Sample Panel:

1) Sample shall show texture and surface pattern, required backing, form tie treatment, and treatment at liner panel joints. Use form material to be used in the Work.

2) Minimum Size: Three feet by four feet.

B. Informational Submittals: Submit the following:

1. Shop Drawings: When requested by ENGINEER, submit Shop Drawings showing and indicating general construction of individual forms, including:

a. Jointing.

b. Special formed joints or reveals.
c. Location, pattern, and details of form tie placement, removal, and repair procedures.
d. Location and details for temporary openings.
f. Other items that would visually affect the finished concrete.

2. Design of Temporary Measures: Design of formwork and falsework is CONTRACTOR's responsibility. Submit the following:
   a. Falsework layout drawings with the seal and signature of CONTRACTOR's or Supplier's professional engineer. Layout drawings shall show bracing details, waler arrangements, location of shores, joint forming details, and details at connections to previously placed concrete. ENGINEER's review will be for general conformance to the requirements of the Contract Documents and ACI 347, as indicated for delegated design in the General Conditions.
   b. Design calculations for formwork and falsework, when requested by ENGINEER.
   c. Certification letter from CONTRACTOR's or Supplier's professional engineer stating that in-place falsework was inspected and complies with the intent of the falsework design.
3. Product Data: Manufacturer's data for proprietary materials, including form coatings, manufactured form systems, ties and accessories.
4. Manufacturer's Instructions: Installation instructions for proprietary materials, including form coatings, manufactured form systems, ties and accessories.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery and Storage:
   1. Upon delivery to the Site, place materials in area protected from weather.
   2. Store materials in accordance with manufacturer's recommendations.
   3. Store materials above ground on framework or blocking. Cover wood for forms and other accessory materials with protective, waterproof covering. Provide for adequate air circulation or ventilation under cover.

B. Handle materials in accordance with the manufacturers' recommendations. Do not damage materials during handling.

PART 2 – PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Design Criteria:
   1. Design, erect, support, brace and maintain forming in accordance with ACI 347 so that forming safely supports vertical and lateral loads that might be applied, until such loads can be supported by the concrete structure. Carry vertical and lateral loads to ground by forming system or in-place construction that has attained adequate strength for the purpose. Construct

forming so that concrete members and structures are of correct size, shape, alignment, elevation, and position.

2. Design forms and falsework to include values of live load, dead load, weight of moving equipment operated on forming, concrete mix, height of concrete drop, vibrator frequency, ambient temperature, foundation pressures, stresses, lateral stability, and other factors pertinent to safety of structure during construction.
3. Provide shores and struts with positive means of adjustment capable of taking up forming settlement during concrete placing operations, using wedges or jacks, or a combination thereof. Provide trussed supports when adequate foundations for shores and struts cannot be secured.
4. Support form facing materials by structural members spaced sufficiently close to prevent beyond tolerance deflection, in accordance with ACI 117. Fit forms placed in successive units for continuous surfaces to accurate alignment, free from irregularities and within allowable tolerances. For long-span members without intermediate supports, provide camber in forming as required for anticipated deflections resulting from weight and pressure of fresh concrete and construction loads.
5. Design and construct forming to be readily removable without impact, shock or damage to concrete surfaces and adjacent materials.
6. Provide forming sufficiently tight to prevent leakage of cement paste during concrete placing. Solidly butt joints and provide backup material at joints as required to prevent leakage and fins.

2.2 FORM MATERIALS

A. Forms for Smooth Finish Concrete:
   1. Unless otherwise shown or indicated in the Contract Documents, construct forming for smooth concrete surfaces with plywood, metal, metal-framed plywood-faced, or other panel type materials acceptable to ENGINEER, to provide continuous, straight, smooth as-cast surfaces with no wood grain or other surface texture imparted by forming. Provide in largest practical sizes to minimize number of joints and to conform to joint system shown or specified in the Contract Documents. Provide form material with sufficient thickness to withstand pressure of newly placed concrete without bow or deflection.

B. Forms for Standard Finish Concrete:
   1. Form concrete surfaces designated to have standard formed finish with plywood, lumber, metal, or other acceptable material. Provide lumber that is dressed on at least two edges and one side.

C. Forms for Architecturally Finished Concrete:
   1. Form finish concrete surfaces with units of face design, size, arrangement, and configuration as shown or as required to comply with approved Project job mock-up. Provide solid backing and form supports to ensure stability of form liners.
   2. Form Material: Overlaid plywood in accordance with NIST PS 1. Provide B-B high density overlaid concrete form, Class I.

3. Form Liners: Rigid PVC or fiberglass in pattern shown or indicated.
4. Form Reuse: To be determined by ENGINEER at time of installation.
5. Rustication Joints: Rigid PVC in profile shown or indicated.
6. Panel Joints: Conceal joints behind rustication joints, unless approved by ENGINEER in writing.

F. Form Ties:
1. Provide factory-fabricated metal form ties, designed to prevent form deflection, and to prevent spalling of concrete surfaces upon removal.
2. Unless otherwise shown or indicated in the Contract Documents, provide ties so that portion of tie remaining within concrete after removal of exterior parts of tie is at least 1.5 inches from the outer concrete surface. Unless otherwise shown or indicated in the Contract Documents, provide form ties that will leave a hole no larger than one-inch diameter in concrete surface.
3. Ties shall have waterstops on all exterior, below-grade walls, and walls subject to hydrostatic pressure.
4. Ties shall leave a uniform, circular hole when forms are removed.
5. Do not use removable ties unless accepted by ENGINEER. Removable ties are not allowed on exterior below-grade walls or walls subject to hydrostatic pressure. If removable ties are accepted, CONTRACTOR shall submit hole repair details for ENGINEER approval.
6. Wire ties are not allowed.
7. Do not use reinforcing bars shown by the Drawings as part of the form tie system unless approved by ENGINEER.

G. Form Coatings:
1. Provide commercial formulation form-coating compounds that will not bond with, stain, nor adversely affect concrete surfaces, and will not impair subsequent treatment of concrete surfaces requiring bond or adhesion, nor impede wetting of surfaces to be cured with water or curing compounds. For concrete surfaces that will be in contact with potable water or water that will be treated to become potable, form coating shall be a mineral oil base coating.

H. Controlled Permeability Formwork (CPF) Liner:
1. Provide surface densification for wall surfaces, where shown or indicated in the Contract Documents, through use of CPF liner material that wicks water and trapped air away from the form surface.
2. Product and Manufacturer: Provide one of the following CPF liner systems:
   a. Zemdrain MD manufactured by DuPont
   b. Or equal.
3. CPF liner shall consist of a filter layer constructed of 100% polypropylene fibers, thermally bonded, which is laminated to a plastic net that ensures drainage and provides stiffness to the liner. Material shall have the following properties:
   a. Non-compressible under concrete pressure.

b. Controlled pore size to permit drainage of excess water and air while retaining cement particles, mean pore size less than 35 microns.
c. Retains within its structure minimum of 0.5 liters of water per square meter of material.
d. Liner shall not leave filaments on the concrete surface.

4. CPF liner shall improve characteristics performance of concrete as follows:
   a. Surface Hardness: In tests performed in accordance with ASTM C805/C805M, mean rebound number calculated for CPF liner face shall exceed that of control face (cast using standard formwork without CPF liner and same concrete mix and placement procedures) by minimum of five rebound units.
   b. Surface shall have uniform texture and be free of minor surface defects due to trapped air.
5. Staples used for fastening the liner shall be stainless steel.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine substrate and conditions under which the Work will be performed and notify ENGINEER in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 FORM CONSTRUCTION

A. Construct forms in accordance with ACI 347; to the exact sizes, shapes, lines, and dimensions shown; as required to obtain accurate alignment, location, and grades; to tolerances specified; and to obtain level and plumb work in finish structures. Provide for openings, offsets, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required. Use selected materials to obtain required finishes. Finish shall be in accordance with approved mock-up or sample panel, when specified.

B. Allowable Tolerances:
   1. Construct forming to provide completed concrete surfaces complying with tolerances specified in ACI 117, ACI 301, and ACI 347.
      a. Architectural finish forming, and where shown or indicated on the Drawings, shall be Class A surface, 1/8-inch offset.
      b. Other surfaces exposed to view shall be Class B surface, 1/4-inch offset.
      c. Other surfaces shall be Class C surface, 1/2-inch offset.
   2. Tolerances apply to form offsets and to irregularities within the formed surface when measured with a straightedge over a five-foot distance.

C. Install forming and accessories for facilities in accordance with manufacturer's instructions, Laws and Regulations, and the Contract Documents.

D. Fabricate forms for easy removal without damaging concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where the slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like, to prevent swelling and assure ease of removal.

E. Provide temporary openings where interior area of forming is inaccessible for cleanout, for inspection before concrete placement, and for placing concrete. Brace temporary closures and set tightly to forms to prevent loss of cement paste. Locate temporary openings on forms in locations as inconspicuous as possible, consistent with requirements of the Work. Form intersecting planes of openings to provide true, clean-cut corners, with edge grain of plywood not exposed as form for concrete.

F. Falsework:
   1. Erect falsework and support, brace, and maintain falsework to safely support vertical, lateral, and asymmetrical loads applied until such loads can be supported by in-place concrete structures. Construct falsework so that adjustments can be made for take-up and settlement.
   2. Provide wedges, jacks or camber strips to facilitate vertical adjustments. Carefully inspect falsework and formwork during and after concrete placement operations to determine abnormal deflection or signs of failure; make necessary adjustments to produce finished Work of required dimensions.

G. Forms for Smooth Finish Concrete:

   1. Do not use metal cover plates for patching holes or defects in forms.
   2. Provide sharp, clean corners at intersecting planes, without visible edges or offsets. Back joints with extra studs or girts to maintain true, square intersections.
   3. Use extra studs, walers, and bracing to prevent bowing of forms between studs and to avoid bowed appearance in concrete. Do not use narrow strips of form material that will produce bow.
   4. Assemble forms so they may be readily removed without damage to exposed concrete surfaces.
   5. Form molding shapes, recesses, rustication joints and projections with smooth-finish materials, and install in forms with sealed joints to prevent displacement.

H. Corner Treatment:
   1. Form exposed corners of beams, walls, foundations, bases and columns to produce smooth, solid, unbroken lines, except as otherwise shown or indicated in the Contract Documents. Chamfer exposed corners.
   2. Form chamfers with 3/4-inch by 3/4-inch strips, unless otherwise shown or indicated in the Contract Documents, accurately formed and surfaced to

produce uniformly straight lines and tight edge joints. Use rigid PVC chamfers for architecturally formed concrete. Extend terminal edges to required limit and miter chamfer strips at changes in direction.

3. Reentrant or internal and unexposed corners may be formed either square or chamfered.

I. Joints:
   1. For joint treatment, comply with Section 03 15 00, Concrete Accessories. Locate joints as shown and specified.

J. Openings and Built-In Work:
   1. Provide openings in concrete forming shown or required under other Sections. Refer to Paragraph 1.1.B of this Section for coordination requirements.
   2. Accurately place and securely support items to be built into forms.

K. Sealing Forming:
   1. Forming joints shall be tight-fitting or otherwise sealed to prevent loss of cement paste.
   2. Provide forming resting against concrete surfaces with compressible gasket material between the concrete and edge of form, to fill irregularities and create tight seal.

L. Cleaning and Tightening:
   1. Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before concrete is placed. Retighten forms immediately after placing concrete, as required to eliminate cement paste leaks.

M. Tie Hole Repair:
   1. Repair tie holes in accordance with Section 03 30 00, Cast-In-Place Concrete.

3.3 FORM COATINGS

A. Coat form contact surfaces with non-staining form-coating compound before installing reinforcing materials. Do not allow excess form coating material to accumulate in forms or come into contact with surfaces that will be bonded to fresh concrete. Apply in compliance with manufacturer's instructions.

B. Coat steel forms with non-staining, rust-preventative form oil, or otherwise protect against rusting. Do not use rust-stained steel forming.

D. Do not use form coatings on form surfaces covered with CPF liner material.

3.4 INSTALLATION OF EMBEDDED ITEMS

A. Set and build into forming anchorage devices and other embedded items, shown, specified, or required under other Sections. Refer to Paragraph 1.1.B of this Section for coordination requirements. Use necessary setting drawings, diagrams, instructions, and directions.

B. Edge Forms and Screeds Strips for Slabs:
   1. Set edge forms or bulkheads and intermediate screed strips for slabs to obtain required elevations and contours in finished slab surface. Provide and secure units to support screeds.

3.5 CONTROLLED PERMEABILITY FORMING LINER

A. Where shown or indicated in the Contract Documents, install controlled permeability forming (CPF) liner material in accordance with manufacturer's instructions so that liner entirely and continuously covers forming surface.

B. Do not use form release agent on forms with CPF liner. Remove residual traces of release agent on previously used forms prior to placing liner.

C. Joints and seams in CPF liner shall be taped with materials recommended by liner manufacturer. Attach CPF liner to form surface at intermediate spacing to prevent buckles and ripples in liner material when warmed by fresh concrete placement. Spacing of attachments shall not exceed two feet.

D. Form panel edges, except the bottom, shall be taped around corner with materials recommended by liner manufacturer. Edges of penetrations through form, including form tie holes, shall be taped or otherwise sealed. Leave open the liner at bottom edge of forms to facilitate drainage.

E. CPF liner can be reused one time without removing liner from forms. Prior to reuse, wash the liner material and remove all concrete and other foreign material.

3.7 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Before placing concrete, check ties, tie cones, tie waterstops, embedded items, form coatings, forming stability, alignment, and tolerances. Make corrections and adjustments to ensure forming complies with intent of the forming design, proper stability of forming systems, and accurate size and location of concrete members.
   2. During concrete placing, check forming and related supports to ensure that forms are not displaced and that completed Work will be within specified tolerances.
   3. If forms are unsatisfactory in any way, either before or during concrete placing, stop or postpone placing of concrete until defects are corrected as

required by CONTRACTOR's or Supplier's professional engineer and accepted by ENGINEER.

3.8 REMOVAL OF FORMS

A. Determination of time between placing concrete and removing forms is CONTRACTOR's responsibility. Requirements specified in this Section are minimum times and requirements intended to ensure that concrete will support its own weight, and do not consider additional effects of the construction. Additional effects of the construction shall be accounted for by CONTRACTOR when determining time for removing forming. Time for removing of forms is subject to ENGINEER's acceptance.

B. Comply with requirements of ACI 301 and ACI 347, except as indicated in the Contract Documents.

C. Removal of Forms for Walls, Columns, Sides of Beams and Girders, and Slab and Foundation Edges:
   1. Comply with requirements of Table 03 10 00-A of this Section:

TABLE 03 10 00-A, REMOVAL OF FORMS

Component	Average Daily Ambient Air Temperature (deg F)				Min. Concrete Compressive Strength for Form Removal
	Over 70 F	60 F to 70 F	50 F to 60 F	Below 50 F	
Walls	One day	Two days	Three days	See Paragraph 3.8.C.2 of this Section	750 psi
Columns	Two days	Three days	Four days		1000 psi
Side of beams and girders	One day	One day	Two days		500 psi
Slab and foundation edges	One day	One day	Two days		500 psi

   2. When average daily ambient air temperature is below 50 degrees F, do not remove forms until concrete attains minimum compressive strength indicated in Table 03 10 00-A for form removal, and comply with Paragraph 3.8.C.3.b of this Section.
   3. Concrete Strength Requirements for Form Removal:
      a. For other than beams and elevated slabs, do not remove forms until concrete attains minimum concrete compressive strength indicated in Table 03 10 00-A for form removal.
      b. For beams and elevated slabs, do not remove supporting forms or shoring until concrete attains minimum of 90 percent of its specified compressive strength.

D. Alternative Criteria for Removing Forms for Walls, Columns, Sides of Beams and Girders, and Slab and Foundation Edges: CONTRACTOR has the option of submitting an alternative removal of forms table, together with supporting data, for ENGINEER's acceptance. Supporting data shall include representative field

data for each different placement ambient temperature condition and minimum of three tests per temperature condition to ensure that accurate correlation between concrete strength and placement temperature is obtained.

E. Determination of In-place Concrete Strength:
   1. Determine compressive strength of in-place concrete by compression test specimens cured at the Site under the same conditions of temperature and moisture as the concrete member under consideration.
   2. Alternately, determine compressive strength of in-place concrete by maturity factor procedure in accordance with ASTM C1074 and approved by ENGINEER. Location of embedded thermistors or thermocouples shall be as approved by ENGINEER.

F. When high-early strength concrete is used, time for removing the forms will be developed at the Site from the age/strength relationships established for the materials and proportions used by tests in accordance with ACI 301.

G. Leave form facing material in place for minimum of four days after concrete placement, unless otherwise approved by ENGINEER.

H. Continue curing, including bottom surfaces of slabs and beams, after form removal in accordance with Section 03 30 00, Cast-In-Place Concrete.

3.9 PERMANENT SHORES

A. Provide permanent shores in accordance with ACI 347.

B. Reshores are not allowed.

3.10 RE-USE OF FORMS

A. Clean and repair surfaces of forms to be re-used in the construction. Do not use split, frayed, delaminated, or otherwise damaged form facing material. Apply form coating compound material to concrete contact surfaces as specified for forming.

B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close all joints. Align and secure joints to avoid offsets. Do not use “patched” forms for exposed concrete surfaces. Form surfaces are subject to ENGINEER’s approval.

+ + END OF SECTION + +

SECTION 03 15 00

CONCRETE ACCESSORIES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install concrete accessories.

B. Related Sections:

   1. Section 03 11 00, Concrete Forming.
   2. Section 03 60 00, Grouting.
   3. Section 07 92 00, Joint Sealants.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ACI 301, Standard Specifications for Structural Concrete.
   2. ASTM D1752, Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
   3. CRD-C572, U.S. Army Corps of Engineers Specifications for Polyvinyl-Chloride Waterstop.

1.3 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Layout of construction and expansion joint locations. Submit and obtain approval prior to submitting concrete reinforcement Shop Drawings.
      b. For construction and expansion joints that require waterstops, submit layout of locations showing waterstop details. Indicate waterstop type, waterstop joint conditions, and details on how joint conditions will be handled.

      d. Layout of all control joint locations.

   2. Samples:
      a. Submit Sample, at least six inches long each, of each type of waterstop proposed for use.

      .

c. Submit Sample of each type of prefabricated PVC waterstop joint.

B. Informational Submittals: Submit the following:
1. Manufacturer's Instructions: Manufacturer's specifications and installation instructions for all materials required.

1.4 DELIVERY, STORAGE AND HANDLING

A. Transportation and Handling of Products:
1. Deliver materials to Site to ensure uninterrupted progress of the Work.
2. Comply with Section 01 65 00, Product Delivery Requirements.

B. Storage and Protection:
1. Store concrete joint materials on platforms or in enclosures or covered to prevent contact with ground and exposure to weather and direct sunlight. Comply with manufacturer's storage and protection requirements.
2. Comply with Section 01 66 00, Product Storage and Handling Requirements.

PART 2 – PRODUCTS

2.1 WATERSTOPS

A. Polyvinyl Chloride (PVC):
1. Material Requirements:
a. Waterstops shall be extruded from elastomeric PVC compound containing plasticizers, resins, stabilizers, and other materials necessary to meet requirements of the Contract Documents and requirements of CRD-C572. Do not use reclaimed or scrap material.
b. Tensile strength of finished waterstop: 1,400 psi, minimum.
c. Ultimate elongation of finished waterstop: 280 percent, minimum.
d. Minimum thickness shall be 3/8-inch over entire width of waterstop.
e. Provide waterstops with minimum of seven ribs equally spaced at each end on each side. First rib shall be at the edge. Ribs shall be a minimum of 1/8-inch in height.
f. Provide waterstops with hog rings or factory-installed grommets anchored to exterior ribs to facilitate tying waterstop in position.
2. Split waterstops are not allowed.
3. Construction Joints: Waterstops shall be flatstrip ribbed type, six-inch minimum width, unless otherwise shown or indicated in the Contract Documents.
4. Expansion Joints: Waterstops shall be centerbulb ribbed type, nine-inch minimum width, unless otherwise shown or indicated in the Contract Documents. Centerbulb shall have minimum outside diameter of 7/8-inch.
5. Product and Manufacturer: Provide one of the following:
a. W.R. Meadows, Inc.
b. Durajoint Concrete Accessories.
c. Greenstreak Plastic Products Company.

d. Paul Murphy Plastics Company.
e. Vinylex Corporation.
f. Or equal.

2.2 PREFORMED EXPANSION JOINT FILLER

A. Provide preformed expansion joint filler complying with ASTM D1752, Type I (sponge rubber) or Type II (cork).

2.3 CONCRETE CONSTRUCTION JOINT ROUGHENER

A. Provide water-soluble non-flammable, surface-retardant roughener.

B. Product and Manufacturer: Provide one of the following for the types of joints specified:
1. Rugasol-S, by Sika Corporation for horizontal joints only.
2. Concrete Surface Retarder-Formula S, by Euclid Chemical Company, for horizontal joints only.
3. Concrete Surface Retarder-Formula F, by Euclid Chemical Company, for vertical joints only.
4. TK-6100 Concrete Form Surface Retarder, by TK Products.
5. Or equal.

2.4 EPOXY BONDING AGENT

A. Provide a two-component epoxy-resin bonding agent.

B. Product and Manufacturer: Provide one of the following:
1. Sikadur 32 Hi-Mod LPL, by Sika Corporation.
2. Eucopoxy LPL, by the Euclid Chemical Company.
3. Resi-Bond J-58, by Dayton Superior.
4. Or equal.

2.5 EPOXY-CEMENT BONDING AGENT

A. Provide three component epoxy resin-cement blended formulated as bonding agent.

B. Product and Manufacturer: Provide one of the following:
1. Sika Armatec 110 EpoCem, as manufactured by Sika Corporation.
2. Duralprep A.C., as manufactured by the Euclid Chemical Company.
3. Emaco P24, as manufactured by MBT/ChemRex.
4. Or equal.

2.6 JOINT SEALANT AND ACCESSORIES

A. For joint sealants and accessories used on isolation joints, control joints, and expansion joints, refer to Section 07 92 00, Joint Sealants.

2.7 CONCRETE BOND BREAKERS

A. Provide asphalt-saturated rag felt building paper, not less in weight than commercially known as 15 pound felt building paper, which weighs 15 pounds per 100 square feet.

B. Chemical Bond Breaker:
   1. Provide medium solids resin solution chemical concrete bond breaker complying with ASTM C309, Type I, Class B.

2.8 NEOPRENE BEARING PADS

A. Product and Manufacturer: Provide one of the following:
   1. 65 Durometer, Sheet Neoprene No. 1200, as manufactured by Williams Products Company.
   2. Or equal.

2.9 RUBBER BONDING AGENT

A. Product and Manufacturer: Provide one of the following:
   1. Scotch-Grip 1300 Rubber Adhesive, as manufactured by 3M Company.
   2. Or equal.

PART 3 – EXECUTION

3.1 INSPECTION

A. CONTRACTOR and installing Subcontractor, if any, shall examine substrate and conditions under which the Work is to be performed and notify ENGINEER in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 CONSTRUCTION JOINTS

A. Comply with requirements of ACI 301 and the Contract Documents.

B. Locate and install construction joints as shown or indicated on the Drawings. Where not shown or indicated, locate joints to not impair strength of the structure; position joints at points of minimum shear. Location of joints shall be approved by ENGINEER. In addition to joints shown or indicated on the Drawings, locate construction joints as follows:
   1. In foundation mats, locate joints at spacing of approximately 40 feet. Joints shall be located within middle third of element span, unless otherwise shown or indicated on the Drawings. Element span shall be considered distance between piles or, as determined by ENGINEER, distance between bearing elements,

such as columns, exterior walls and interior walls. Place concrete in strip pattern, unless otherwise shown or indicated on the Drawings.

2. In walls, locate joints at a maximum spacing of 40 feet. Locate joints away from wall intersections a minimum of one-quarter of the clear span distance between wall intersections measured horizontally.
3. In structural slabs and beams, joints shall be located within middle third of element span and shall be located in compliance with ACI 301, unless otherwise shown or indicated on the Drawings.
4. In slabs on grade, locate joints at spacing of approximately 40 feet. Place concrete in strip pattern, unless otherwise shown or indicated on the Drawings.

C. Horizontal Joints:
1. Roughen concrete at interface of construction joints by abrasive blasting, hydroblasting, or using surface retardants and water jets to expose aggregate and remove accumulated concrete on projecting rebar immediately subsequent to form stripping, unless otherwise approved by ENGINEER. Immediately before placing fresh concrete, thoroughly clean existing contact surface using stiff brush or other tools and stream of pressurized water. Surface shall be clean and wet, and free from pools of water at time of placing fresh concrete.
2. Remove laitance, waste mortar, and other substances that may prevent complete adhesion. Where joint roughening was performed more than seven days prior to concrete placing or where dirt or other bond reducing contaminants are on surface, perform additional light abrasive blasting or hydroblasting to remove laitance and all bond-reducing materials just prior to concrete placement.

3. Provide over contact surface of concrete a six-inch layer of Construction Joint Grout as specified in Section 03 60 00, Grouting. Place fresh concrete before grout has attained its initial set. Placement of grout may be omitted if concrete mix has slump increased to at least six inches by addition of high range water reducer.

D. Vertical Joints:
1. Apply roughener to the form in thin, even film by brush, spray, or roller in accordance with manufacturer's instructions. After roughener is dry, concrete may be placed.
2. When concrete has been placed, remove joint surface forms as early as necessary to allow for removal of surface retarded concrete. Forms covering member surfaces shall remain in place as required under Section 03 11 00, Concrete Forming. Wash loosened material off with high-pressure water spray to obtain roughened surface subject to approval by ENGINEER. Alternately, surface shall be roughened by abrasive blasting or hydroblasting to expose aggregate. Outer one-inch of each side of joint face shall be masked and protected from blasting to avoid damaging member surface.

3.3 EXPANSION JOINTS

A. Comply with requirements of ACI 301 and this Section.

B. Locate and install expansion joints as shown and indicated in the Contract Documents. Install joint filler in accordance with manufacturer's instructions. Install sealants as specified in this Section.

3.4 CONTROL JOINTS

A. Provide control joints in non-water bearing slabs on grade as shown or indicated on the Drawings. Where control joints are not shown or indicated on the Drawings, space control joints at 24 to 36 times thickness of slab in both directions. Locate control joints only at places approved by ENGINEER.

B. A groove, with depth of at least 25 percent of the member thickness, shall be tooled, formed, or saw-cut in concrete. Groove shall be filled with joint sealant material in accordance with Section 07 92 00, Joint Sealants.

C. Where control joint is formed by sawcutting, make sawcut in presence of ENGINEER immediately after concrete has set sufficiently to support the saw and be cut without damage to concrete. Keep concrete continually moist during cutting. Joints shall be approximately 1/8-inch wide.

D. Control joints may be formed with tool or by inserting joint forming strip. After concrete has achieved design strength, remove upper portion of joint forming strip and fill void with sealant.

3.5 ISOLATION JOINTS

A. Provide isolation joint where sidewalk or other slab on grade abuts a concrete structure and slab on grade is not shown doweled into that structure. Form isolation joint by 1/2-inch joint filler with upper 1/2-inch of joint filled with sealant.

3.6 WATERSTOPS

A. General:
   1. Comply with ACI 301 and this Section. Make joints in accordance with manufacturer's instructions.
   2. Provide PVC waterstops, except where otherwise shown or indicated on the Drawings.
   3. Provide waterstops in all joints where concrete construction is below grade or intended to retain liquid. Install waterstop to the higher of: at least 12 inches above grade, or 12 inches above overflow liquid level in tanks.
   4. Waterstops shall be fully continuous for extent of joint and with waterstops in intersecting joints. Maintain waterstop continuity at transitions between waterstops in joints at different levels and orientations.
   5. In vertical joints in walls that are free at the top, waterstops shall extend no closer than six inches from top of wall.

6. In placing concrete around horizontal waterstops, with waterstop flat face in horizontal plane, work the concrete under waterstops by hand to avoid forming air and rock pockets.

B. Polyvinyl Chloride Waterstop:
   1. Waterstops shall be positively held from displacement during concrete placing. Tie waterstops to reinforcement or other rigid supports at maximum spacing of 18 inches so that waterstop is securely and rigidly supported in proper position during concrete placing. Continuously inspect waterstops during concrete placing to ensure proper positioning.
   2. Perform splicing in waterstops by heat sealing adjacent waterstop sections in accordance with manufacturer's printed recommendations. The following is required:
      a. Material shall not be damaged by heat sealing.
      b. Splices shall have tensile strength of not less than 60 percent of unspliced material's tensile strength.
      c. Maintain the continuity of waterstop ribs and of its tubular center axis.
   3. Only butt-type joints of ends of two identical waterstop sections shall be made while material is in forms.
   4. Prefabricated PVC Waterstop Joint:
      a. Joints with waterstops involving more than two ends to be jointed together, and joints that involve an angle cut, alignment change, or joining of two dissimilar waterstop sections, shall be prefabricated by CONTRACTOR or manufacturer prior to placing in the forms.
      b. Prefabricated joints shall have minimum of 2.0 feet of waterstop material beyond joint in each direction.
      c. Install prefabricated joint assembly in the forms and butt-weld each two-foot end to a straight-run portion of waterstop in place in the forms.
   5. Where centerbulb waterstop intersects and is jointed with non-centerbulb waterstop, seal end of centerbulb using additional PVC material as required.
   6. Symmetrical halves of waterstops shall be equally divided between concrete placements at joints and centered within joint width, unless shown or indicated otherwise in the Contract Documents. Place centerbulb waterstops in expansion joints so that centerbulb is centered on joint filler material.
   7. When waterstop is installed in the forms or embedded in first concrete placement and waterstop remains exposed to atmosphere for more than four days, implement suitable precautions to shade and protect exposed waterstop from direct rays of sun during entire exposure, until exposed portion of waterstop is embedded in concrete.
   8. Protect waterstop placed in joints intended for future concrete placement from direct rays of the sun by temporary means until permanent cover is installed, so that waterstop is not exposed to direct rays of the sun for more than four days total.

3.7 BONDING AGENT

A. Use epoxy bonding agent for bonding of fresh concrete to concrete that has been in place for at least 60 days, and for bonding to existing concrete.

B. Use epoxy-cement bonding agent for the following:
   1. Bonding toppings and concrete fill to concrete that has been in place for at least 60 days, and for bonding to existing concrete.
   2. For locations where bonding agent is required and concrete cannot be placed within open time period of epoxy bonding agent.

C. Use cement-water slurry as bonding agent for toppings and concrete fill to new concrete. Cement water slurry shall be worked into surface with stiff bristle broom and place the concrete before cement-water slurry dries.

D. Handle and store bonding agent in accordance with manufacturer's printed instructions and safety precautions.

E. Mix bonding agent in accordance with manufacturer's instructions.

F. Before placing fresh concrete, thoroughly roughen and clean hardened concrete surfaces and coat with bonding agent not less than 1/16-inch thick. Place fresh concrete while bonding agent is still tacky (within its open time), without removing in-place bonding agent coat, and as directed by manufacturer.

3.8 BEARING PAD INSTALLATION

A. Neoprene Bearing Pad: Install with water insensitive adhesive in accordance with manufacturer's instructions.

+ + END OF SECTION + +

SECTION 03 20 00

CONCRETE REINFORCING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install concrete reinforcing.
   2. Extent of concrete reinforcing is shown and indicated in the Contract Documents.
   3. Work includes fabrication and placement of reinforcing including bars, ties, and supports, and welded wire fabric for concrete, encasements, and fireproofing.

B. Related Sections:

   1. Section 03 15 00, Concrete Accessories.
   2. Section 05 05 33, Anchor Systems.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ACI 315, Details and Detailing of Concrete Reinforcement.
   2. ACI 318, Building Code Requirements for Structural Concrete.
   3. ACI 350, Code Requirements for Environmental Engineering Concrete Structures.
   4. ANSI/AWS D1.4, Structural Welding Code - Reinforcing Steel.
   5. ASTM A82, Specification for Steel Wire, Plain, for Concrete Reinforcement.
   6. ASTM A185, Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
   7. ASTM A615, Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   8. ASTM A706, Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
   9. ASTM E329, Specification for Agencies Engaged in Construction Inspection and/or Testing.
   10. Concrete Reinforcing Steel Institute (CRSI), CRSI 1MSP, Manual of Standard Practice.
   12. ICC Evaluation Service (ES) AC 308, Acceptance Criteria for Post-Installed Anchors in Concrete Elements.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Testing Laboratory: Shall meet requirements of ASTM E329 and shall have experience in the testing welded splices of reinforcing steel and tension testing of reinforcing bars set in adhesive in hardened concrete.
   2. Installer of Adhesive Dowels: Shall be experienced and certified by manufacturer of adhesive as possessing necessary training for installing manufacturer's products. Distributors or manufacturer's representatives shall not provide product training unless qualified as certified trainers by anchor manufacturer.

B. Certifications:
   1. Weld Procedures: For types of splices and grades of reinforcing used in the Work, weld procedures for welded reinforcing steel splices shall be certified in accordance with ANSI/AWS D1.4.
   2. Welders: For types of splices and grades of reinforcing used in the Work, welders shall be certified for welding reinforcing steel splices in accordance with ANSI/AWS D1.4.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Drawings for fabricating, bending, and placing concrete reinforcing. Comply with ACI 315, Parts A and B.
      b. For walls, show elevations at minimum scale of 1/4-inch to one foot.
         1) Elevations shall show all openings and reference details that identify additional reinforcing required around each opening.
         2) Elevations shall denote each wall intersection and reference a detail that identifies additional reinforcing required at wall intersection. As an alternate to providing separate details for each wall intersection, provide overall plan detailing only the additional wall intersection reinforcing for each wall intersection.
      c. For slabs and mats, show top and bottom reinforcing on separate plan views.
         1) Plans shall show all openings and shall reference details that identify additional reinforcing around each opening.
      d. Show bar schedules, stirrup spacing, diagrams of bent bars, location of bar splices, length of lap splices, arrangements, and assemblies, as required for fabricating and placing concrete reinforcing unless otherwise noted.
      e. Provide plans and elevations detailing location, spacing, and lengths of masonry wall dowels, where masonry is required. Coordinate location of dowels with masonry openings and with standard modular spacing. Submit masonry wall dowels with reinforcing submittal for element into which masonry dowel will be embedded. Coordinate with Section 04 05 05, Unit Masonry Construction.
      f. Splices shall be kept to a minimum. Avoid, when possible, splices in regions of maximum tensile stresses.

g. Drawings detailing location of all construction and expansion joints, as required under Section 03 15 00, Concrete Accessories, shall be submitted and approved before Shop Drawings for reinforcing are submitted.
h. Drawings detailing location, spacing, edge distance, and embedment depth of adhesive dowels. Adhesive system shall be submitted and approved before Shop Drawings with adhesive dowels are submitted.

2. Product Data:
a. Manufacturer's product data for adhesive, if not submitted under other Sections.
b. Adhesive manufacturer's test data and ICC ES report to verify specified capacity of adhesive dowels.

B. Informational Submittals: Submit the following:
1. Certificates:
a. Steel manufacturer's certificates of mill analysis, tensile, and bend tests for reinforcing steel.
b. Certification of welders and weld procedures for splices.
c. Adhesive manufacturer's certification verifying that installer is qualified and using proper installation procedures.
2. Manufacturer's Instructions:
a. Installation instructions for adhesive systems.
3. Special Procedure Submittals; Description of reinforcing weld locations and weld procedures.

1.5 DELIVERY, HANDLING, AND STORAGE

A. Deliver concrete reinforcing products to Site bundled, tagged, and marked. Use metal tags indicating bar size, lengths, and other information corresponding to markings on approved Shop Drawings.

B. Store concrete reinforcing products to prevent damage and accumulation of dirt and excessive rust. Store on heavy wood blocking so that reinforcing does not come into contact with the ground.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Reinforcing Bars: Shall be deformed in accordance with ASTM A615, and as follows:
1. Provide Grade 60 for all bars, unless indicated otherwise.
2. At beams and columns forming frames and wall boundary elements, where shown on the Drawings, provide ASTM A706 or ASTM A615, Grade 60, with tested actual maximum yield stress of 78,000 psi and ratio of actual tested tensile strength to tested yield strength not less than 1.25.

B. Mechanical Couplers: Reinforcement bars may be spliced with mechanical connection. Connection shall be full mechanical connection that shall develop in tension or compression, as required, at least 125 percent of specified yield strength (fy) of bar in accordance with ACI 318 and ACI 350. Where splices at the face of wall are shown or approved by ENGINEER, form saver-type mechanical couplers may be used. Form-saver couplers shall have integral plates designed to positively connect coupler to formwork.

C. Steel Wire: Shall be in accordance with ASTM A82.

D. Welded Smooth Wire Fabric: Shall be in accordance with ASTM A185.
   1. Furnish in flat sheets, not rolls.

E. Column Spirals: Hot-rolled rods for spirals, conforming to ASTM A615.

F. Supports for Reinforcement: Bolsters, chairs, spacers, and other devices for spacing, supporting and fastening reinforcing in place.
   1. Use wire bar type supports complying with CRSI 1 MSP recommendations, except as specified in this Section. Do not use wood, brick, or other unacceptable materials.
   2. For slabs on grade, use precast concrete blocks, four inches square in plan, with embedded tie wire as specified by CRSI 1 MSP. Precast concrete blocks shall have same or higher compressive strength as specified for concrete in which they are located.
   3. For concrete surfaces where legs of supports are in contact with forms, provide supports complying with CRSI 1 MSP as follows:
      a. At formed surfaces in contact with soil, weather, or liquid, or located above liquid, supports shall be CRSI Class 1 for maximum protection. Plastic coating on legs shall extend at least 0.5-inch upward from form surface.
      b. At interior dry surfaces (not located above liquid), supports shall be either Class 1 or Class 2 for moderate protection.
      c. At formed surfaces with an architectural finish, use stainless steel protected legs (Type B).
   4. Over waterproof membranes, use precast concrete chairs.

G. Adhesive Dowels:
   1. Dowels:
      a. Dowel reinforcing bars shall be deformed in accordance with ASTM A615, Grade 60.
   2. Adhesive:
      a. Requirements for adhesive are specified under requirements for concrete adhesive anchors in Section 05 05 33, Anchor Systems.

2.2 FABRICATION

A. General: Fabricate reinforcing bars to conform to required shapes and dimensions, with fabrication tolerances complying with CRSI 1 MSP. In case of fabricating errors, do not re-bend or straighten reinforcing in manner that injures or weakens material.

B. Unacceptable Materials: Reinforcing with one or more of the following defects is not allowed:
   1. Bar lengths, bends, and other dimensions exceeding specified fabrication tolerances.
   2. Bends or kinks not shown on approved Shop Drawings.
   3. Bars that do not meet or exceed their ASTM specification requirements when hand-wire-brushed, with respect to cross section, nominal weight, or average height of deformations.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine the substrate and conditions under which concrete reinforcing is to be placed and notify ENGINEER in writing of unsatisfactory conditions. Do not proceed with Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with applicable recommendations of Laws and Regulations, applicable standards, and CRSI 1 MSP for details and methods of reinforcing placement and supports.

B. Clean reinforcing to remove loose rust and mill scale, earth, ice, and other materials that reduce or destroy bond with concrete.

C. Position, support, and secure reinforcing against displacement during formwork construction and concrete placing. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as required.
   1. Place reinforcing to obtain minimum concrete coverages specified in ACI 318, AC I 350, and the Contract Documents. Arrange, space, and securely tie bars and bar supports together with 16-gage wire to hold reinforcing accurately in position during concrete placing. Set wire ties so that twisted ends are directed away from exposed concrete surfaces.
   2. Prior to placing concrete, using surveyor's level or string line, demonstrate to ENGINEER that specified cover of reinforcing has been attained.
   3. Do not secure reinforcing steel to forms with wire, nails, or other ferrous metal. Metal supports subject to corrosion shall not touch formed or exposed concrete surfaces.

D. Allowable Placing Tolerances: Comply with ACI 318, Chapter 7 - Details of Reinforcement, and ACI 350, Chapter 7 - Details of Reinforcement, except as specified in this Section:
   1. Concrete surfaces in contact with liquid shall have minimum of two inches of concrete over reinforcing steel.

E. Provide sufficient number of supports of strength required to carry reinforcing. Do not place reinforcing bars more than two inches beyond last leg of continuous bar support. Do not use supports as bases for runways for concrete conveying equipment and similar construction loads.

F. Lap Splices:
   1. Provide standard reinforcing splices by lapping ends, placing bars in contact, and tying tightly with wire. Comply with requirements shown for minimum lap of spliced bars as shown on the Drawings.

H. Mechanical Couplers:
   1. Mechanical butt splices shall be in accordance with recommendations of mechanical splicing device manufacturer. Butt splices shall develop 125 percent of specified minimum yield tensile strength of spliced bars or of smaller bar in transition splices. Bars shall be flame-dried before butt splicing. Provide adequate jigs and clamps or other devices to support, align, and hold longitudinal centerline of bars being butt spliced in straight line.

I. Welded Splices:
   1. When field welding of reinforcing is required on the Drawings or allowed by ENGINEER in writing, welding of reinforcing bars shall conform to ANSI/AWS D1.4. Preheating and rate of cooling requirements shall be based on bar steel chemistry and ANSI/AWS D1.4. Welded splices shall be sized and constructed to transfer minimum of 125 percent of specified minimum yield tensile strength of spliced bars or of smaller bar in transition splices. Unless otherwise allowed by ENGINEER in writing, welding of crossing bars (tack welding) for assembly of reinforcement is prohibited.
   2. Welding of wire to wire, and of wire or welded wire fabric to reinforcing bars or structural steels, shall conform to applicable provisions of ANSI/AWS D1.4 and ENGINEER's requirements for the particular application.
   3. After completing welding on coated reinforcing bars, repair coating damage as specified in this Section. Welds and steel splice members, when used to splice bars, shall be coated with same material used for repair of coating damage.

J. Adhesive Dowels:
   1. Comply with manufacturer's written installation instructions and requirements of this Section.
   2. Drill holes to adhesive system manufacturer's recommended drill bit diameter and to specified depth. Drill holes in hammering and rotation mode with carbide-tipped drill bits complying with tolerances indicated in ANSI B212.15. Core-drilled holes shall not be permitted.
   3. Before setting adhesive dowel, hole shall be made free of dust and debris by

method recommended by adhesive system manufacturer. Brush the hole with adhesive system manufacturer-approved brush and blow hole clean with clean, dry, oil-free compressed air to remove all dust and loose particles. Hole shall be dry as defined by adhesive system manufacturer.

4. Before injecting adhesive, obtain ENGINEER's concurrence that hole is dry and free of oil and other contaminants.
5. Prior to injecting adhesive into the drilled hole, dispense to an appropriate location for waste an initial amount of adhesive from the mixing nozzle until adhesive is a uniform color, indicating that product is properly mixed.
6. Inject adhesive into hole through injection system-mixing nozzle and extension tubes (as required) placed to bottom of hole. Withdraw nozzle's discharge end as adhesive is placed while keeping nozzle immersed to prevent formation of air pockets. Fill hole to depth that ensures that excess material is expelled from hole during dowel placing.
7. Twist dowel during insertion into partially filled hole to ensure full wetting of rod surface with adhesive. Insert rod slowly to avoid developing air pockets.
8. Provide adequate curing in accordance to adhesive system manufacturer's requirements prior to continuing with adjoining or adjacent Work that could impose or impart load on the dowels. Do not begin adjoining or adjacent Work until dowels are successfully tested or when approved by ENGINEER.
9. Limitations:
    a. Installation Temperature: Comply with manufacturer's instructions for installation temperature requirements. Provide temporary protection and other measures, such as heated enclosures, necessary to ensure that base material temperature complies with requirements of adhesive systems manufacturer during installation and adhesive system curing.
    b. Oversized Holes: Advise ENGINEER immediately if size of drilled hole is larger than recommended by adhesive system manufacturer. Cost of corrective measures, including but not limited to redesign of dowels due to decreased capacities, shall be paid by CONTRACTOR.

3.3 FIELD QUALITY CONTROL

A. Site Inspections and Tests:
    1. General:
        a. Do not place concrete until reinforcing is inspected, and permission for placing concrete is granted by ENGINEER. Concrete placed in violation of this provision will be rejected.
        b. Do not close up formwork for walls and other vertical members until reinforcing is inspected, and permission for placing concrete is granted by ENGINEER. Concrete placed in violation of this provision will be rejected.
        c. Correct defective Work by removing and replacing or correcting, as required by ENGINEER.
        d. CONTRACTOR shall pay cost of corrections and subsequent testing required to confirm integrity of post-installed anchors.

e. Testing laboratory shall submit test results to CONTRACTOR and ENGINEER within 24 hours of completion of test.

2. Site Tests:
   a. OWNER will employ testing laboratory to perform field quality testing of adhesive dowels at the Site.
      1) Testing shall comply with ASTM E488.
      2) Test at least ten percent of each type of adhesive dowel. If one or more dowels fail the test, CONTRACTOR shall pay cost to test all dowels of same diameter and type installed on the same day as the failed dowel.
      3) Test dowels to 60 percent of specified yield strength. ENGINEER will direct which dowels are to be tested.
      4) Apply test loads with hydraulic ram.
      5) Displacement of dowels shall not exceed D/10, where D is nominal diameter of dowel.
3. Inspection of Welded Splices: OWNER will employ testing laboratory to perform field quality control testing of welded splices. All welded splices shall be visually inspected. Radiographically test minimum of five percent of butt splice welds. Repair defective welds so that welds are completely sound.

B. Manufacturer's Services:
   1. Provide qualified adhesive manufacturer's representative at the Site during initial installation of adhesive dowel systems to train installing personnel in proper selection and installation procedures. Manufacturer's representative shall observe to verify that installer demonstrates proper installation procedures for adhesive dowels and adhesive material. Each installer shall be certified in writing by manufacturer as qualified to install adhesive anchors.

+ + END OF SECTION + +

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install cast-in-place concrete.
   2. The Work includes providing concrete consisting of portland cement, fine and coarse aggregate, water, and approved admixtures; combined, mixed, transported, placed, finished, and cured. The Work also includes:
      a. Providing openings in concrete to accommodate the Work under this and other Sections and building into the concrete all items such as sleeves, frames, anchorage devices, inserts, and all other items to be embedded in concrete Work.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate installation of items to be installed in the concrete Work.

C. Classifications of Concrete:
   1. Class "A" concrete shall be steel-reinforced and includes the following:
      a. All concrete, unless otherwise shown or indicated.
   2. Class "AF" concrete shall be steel-reinforced and may be used in lieu of Class "A" concrete for the following:
      a. Walls and foundations thicker than 16 inches.
   3. Class "AS" concrete shall be steel-reinforced and provided, where shown or indicated, for slabs not exposed to freezing and thawing where troweled finish is required.
   4. Class "B" concrete shall be placed without forms or with simple forms, with little or no reinforcing, and includes the following, unless otherwise shown or indicated:
      a. Concrete fill within structures.
      b. Duct banks.
      c. Unreinforced encasements.
      d. Curbs and gutters.
      e. Sidewalks.
      f. Thrust blocks.
   5. Class "C" concrete shall be steel-reinforced and provided where shown or indicated for slabs that require enhanced durability against wear.
   6. Class "D" concrete shall be unreinforced and used where required as concrete fill under foundations, filling abandoned piping, and where "lean concrete" or "mudmat" is shown or indicated in the Contract Documents.

D. Related Sections:
   1. Section 03 15 00, Concrete Accessories.
   2. Section 03 60 00, Grouting.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. AASHTO M 182, Specification for Burlap Cloth Made From Jute or Kenaf and Cotton Materials.
   2. AASHTO TP23, Test Method for Water Content of Freshly Mixed Concrete Using Microwave Oven Drying.
   3. ACI 117, Specifications for Tolerances for Concrete Construction and Materials and Commentary.
   4. ACI 214R, Evaluation of Strength Test Results of Concrete.
   5. ACI 301, Specifications for Structural Concrete.
   6. ACI 302.1R, Guide for Concrete Floor and Slab Construction.
   7. ACI 304R, Guide for Measuring, Mixing, Transporting and Placing Concrete.
   8. ACI 305R, Specification for Hot Weather Concreting.
   9. ACI 306R, Cold Weather Concreting.
   10. ACI 309R, Guide for Consolidation of Concrete.
   11. ACI 318, Building Code Requirements for Structural Concrete and Commentary.
   12. ACI 350/350R, Code Requirements for Environmental Engineering Concrete Structures and Commentary.
   13. ASTM C31/C31M, Practice for Making and Curing Concrete Test Specimens in the Field.
   14. ASTM C33, Specification for Concrete Aggregates.
   15. ASTM C39/C39M, Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   16. ASTM C42/C42M, Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
   17. ASTM C94/C94M, Specification for Ready-Mixed Concrete.
   18. ASTM C109/C109M, Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).
   19. ASTM C138/C138M, Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
   20. ASTM C143/C143M, Test Method for Slump of Hydraulic- Cement Concrete.
   21. ASTM C150, Specification for Portland Cement.
   22. ASTM C157/C157M, Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
   23. ASTM C171, Specification for Sheet Materials for Curing Concrete.
   24. ASTM C172, Practice for Sampling Freshly Mixed Concrete.
   25. ASTM C231, Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
   26. ASTM C260, Specification for Air-Entraining Admixtures for Concrete.
   27. ASTM C309, Specification for Liquid Membrane-Forming Compounds for

Curing Concrete.

28. ASTM C330, Specification for Lightweight Aggregates for Structural Concrete.
29. ASTM C494/C494M, Specification for Chemical Admixtures for Concrete.
30. ASTM C618, Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
31. ASTM C882/C882M, Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
32. ASTM C989, Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars.
33. ASTM C1064/C1064M, Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete.
34. ASTM C1077, Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation.
35. ASTM C1240, Specification for Silica Fume Used in Cementitious Mixtures.
36. ASTM D1042, Test Method for Linear Dimensional Changes of Plastics Under Accelerated Service Conditions.
37. ASTM D3574, Standard Test Methods for Flexible Cellular Materials—Slab, Bonded, and Molded Urethane Foams.
38. ASTM E96/E96M, Test Methods for Water Vapor Transmission of Materials
39. ASTM E329, Specification for Agencies Engaged in Construction Inspection and/or Testing.
40. ASTM E1643, Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.
41. ASTM E1745, Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.
42. NSF/ANSI 61, Drinking Water System Components - Health Effects.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Concrete Testing Laboratory:
      a. Employ independent testing laboratory experienced in design and testing of concrete materials and mixes to perform material evaluation tests and to design concrete mixes. Employ different laboratories for design of concrete mixes and field testing.
         1) Testing agency shall be in accordance with ASTM E329 and ASTM C1077.
         2) Testing laboratory shall have been inspected and passed within previous two years by Cement and Concrete Reference Laboratory (CCRL) of NIST for: testing concrete aggregates, and for preparing and testing concrete trial batches with or without admixtures. Testing laboratory shall provide documentation indicating how deficiencies, if any, in most recent CCRL inspection report were corrected.
         3) Selection of testing laboratory is subject to OWNER's acceptance.
         4) Submit written description of proposed concrete testing laboratory giving qualifications of personnel, laboratory facilities, and equipment, and other information requested by ENGINEER.

2. Water Reducing Admixture Manufacturer:
    a. Water-reducing admixtures shall be manufactured under strict quality control in facilities operated under a quality assurance program. Submit copy of manufacturer's quality assurance handbook to document program existence.
    b. Manufacturer shall maintain a concrete testing laboratory approved by CCRL at NIST.
    c. Manufacturer shall be capable of providing services of qualified field service representatives at the Site.

B. Laboratory Trial Batch:
    1. Each concrete mix design specified shall be verified by laboratory trial batch, unless indicated otherwise.
    2. For classes of concrete that require air-entrainment, test the trial batch at highest percentage of air allowed for that class of concrete.
    3. Perform the following testing on each trial batch:
        a. Aggregate gradation for fine and coarse aggregates.
        b. Fly ash testing to verify meeting specified properties, unless fly ash Supplier submits certification by an independent testing laboratory.
        c. Slump.
        d. Air content.
        e. Compressive strength based on three cylinders each tested at seven days and at 28 days.
        f. Shrinkage test in accordance with this Section, for Class "A" concrete and Class "AF" concrete.
    4. Submit for each trial batch the following information:
        a. Project identification name and number (if applicable).
        b. Date of test report.
        c. Complete identification of aggregate source of supply.
        d. Tests of aggregates for compliance with the Contract Documents.
        e. Scale weight of each aggregate.
        f. Absorbed water in each aggregate.
        g. Brand, type, and composition of cementitious materials.
        h. Brand, type, and amount of each admixture.
        i. Amounts of water used in trial mixes.
        j. Proportions of each material per cubic yard.
        k. Gross weight and yield per cubic yard of trial mixtures.
        l. Measured slump.
        m. Measured air content.
        n. Compressive strength developed at seven days and 28 days, from not less than three test cylinders cast for each seven day and 28 day test, and for each design mix.
        o. Shrinkage test results where required and as specified in this Section. Report results and averages for original length and at zero, seven, 14, 21, and 28 days of drying.

D. Shrinkage Test:
   1. Perform drying shrinkage tests for trial batch as specified in this Section.
   2. Drying shrinkage specimens shall be four-inch by four-inch by 11-inch prisms with effective gage length of ten inches; fabricated, cured, dried, and measured in accordance with ASTM C157 modified as follows: remove specimens from molds at an age of 23 hours, plus-or-minus one hour, after trial batching; shall be placed immediately in water at 70 degrees F plus-or-minus three degrees F for at least 30 minutes; and shall be measured within 30 minutes thereafter to determine original length and then submerged in saturated lime water at 73 degrees F plus-or-minus three degrees F. Measurement to determine expansion expressed as percentage of original length shall be made at age of seven days. Length at age of seven days shall be base length for drying shrinkage calculations (zero days drying age). Immediately afterward store specimens in humidity-controlled room maintained at 73 degrees F plus-or-minus three degrees F, and 50 percent (plus-or-minus four percent) relative humidity for remainder of test. Obtain measurements to determine shrinkage expressed as percentage of base length and report measurements separately for seven, 14, 21, and 28 days of drying after seven days of moist curing.
   3. Determine drying shrinkage deformation of each specimen as the difference between base length (at zero days drying age) and length after drying at each test age. Determine average drying shrinkage deformation of specimens to nearest 0.0001-inch at each test age. If drying shrinkage of a specimen departs from average of that test age by more than 0.0004-inch, results obtained from that specimen shall be disregarded. Report results of shrinkage test to nearest 0.001 percent of shrinkage. Compression test specimens shall be taken in each case from same concrete used for preparing drying shrinkage specimens. Tests shall be considered part of normal compression tests for the Work.
      Allowable shrinkage limitations shall be as specified in Part 2 of this Section.

E. Component Supply and Compatibility:
   1. Provide all admixture materials from a single manufacturer.

F. Sample Panels:
   1. Provide Sample panels of wall finishes, each at least 12 inches by 12 inches by three inches thick. Revise Sample panels to produce acceptable finished concrete surfaces.
      a. Provide additional Sample panels as required if original results are unsatisfactory as determined by ENGINEER.
   2. Continuity of color and texture for exposed concrete surfaces is important. Maintain such controls and procedures, in addition to those specified, as necessary to provide continuous match of concrete Work with approved Samples.

G. Mock-up Panels:
   1. Provide mock-up panels representative of specified finished surfaces (--1--), at locations on the Site directed by ENGINEER. Form, reinforce, mix, cast, cure, and finish mock-up panels using selected materials and construction methods

proposed for the Work. Provide mock-up panels as follows:

a. Wall section of L-shaped panels, approximately four feet high by three feet each side by eight inches thick and set on an 18-inch wide by eight-inch thick base, unless otherwise shown or indicated. Form faces to represent each specified formed surface finish. Include not less than two form ties, two form panel intersections, one vertical construction joint, and one horizontal construction joint. Construction joints are in Section 03 15 00, Concrete Accessories.

b. Column section, approximately four feet high and not less than 12-inch diameter for round sections, and not less than 12 inches in the least dimension for rectangular sections, for each specified formed finish, unless otherwise shown or indicated. Set column sections on a six-inch thick concrete base extending eight inches beyond column. Chamfer exposed edges of rectangular Sample columns.

c. Slab-on-grade section, approximately four feet square and minimum of four inches thick for each applied finish, with at least one construction joint and one expansion joint, if used.

d. Pan-formed section using at least two pan form units. Set units to illustrate method of blending exposed pan joints.

2. Reinforce mock-up panels as required to prevent cracking and to be structurally stable or as shown or indicated; reinforcing steel shall not be less than 0.25 percent of the gross concrete cross section in each direction.

3. Protect mock-up panels from damage and do not remove approved mock-up panels without written ENGINEER's permission. When directed by ENGINEER, demolish mock-up panels and remove from the Site.

I. Designated Finish Sample Areas:

1. ENGINEER will identify areas of concrete members, to serve as reference examples of acceptable concrete finishes, from first members constructed for each finish.
2. At each area so designated, complete the finish as specified.
3. Where specified concrete finish is not obtained, repair the member to provide an acceptable finish. Adjust construction techniques to produce the required finish.
4. Clearly mark each Sample area with name of specified finish to cause no damage to finish.
5. Protect Sample areas from damage and maintain access to view Sample areas.

J. Concrete Coordination Conference:

1. Conduct concrete coordination conference to review detailed requirements of CONTRACTOR's proposed concrete design mixes, to discuss procedures for producing proper concrete construction, and to clarify roles of the parties involved. CONTRACTOR shall organize and schedule the conference and prepare and distribute to all parties attending conference minutes of the conference.

2. Conduct concrete coordination conference no later than 14 days after the date the Contract Times commence running. Conference shall be held at mutually

agreed upon date and time; conference shall be held at the Site unless otherwise mutually agreed upon. Notify all parties to attend concrete coordination conference not less than five days prior to scheduled date of conference.

3. All parties involved in the concrete Work shall attend concrete coordination conference including, but not limited to, the following:
   a. CONTRACTOR.
   b. Field testing services representative.
   c. Concrete Subcontractor (if any).
   d. Reinforcing steel Subcontractor (if any) and reinforcing steel Supplier and detailer.
   e. Concrete Supplier.
   f. Admixture manufacturer's representative.
   g. ENGINEER.
   h. Resident Project Representative (if any).

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. List of concrete materials and proportions for the proposed concrete mix designs. Include data sheets, test results, certifications, and mill reports to qualify the materials proposed for use in the mix designs. Do not start laboratory trial batch testing until this submittal is approved by ENGINEER.
      b. Laboratory Trial Batch Reports: Submit laboratory test reports for concrete cylinders, materials, and mix design tests.
      c. Ready-mixed Concrete: Submit the following information.
         1) Physical capacity of mixing plant.
         2) Trucking facilities available.
         3) Estimated average amount of the specified concrete that can be produced and delivered to the Site during a normal, eight-hour day, excluding output to other customers.
   2. Product Data:
      a. Manufacturers' specifications with application and installation instructions for proprietary materials and items, including admixtures and bonding agents.
   3. Samples:
      a. Submit Samples of materials as specified and as requested by ENGINEER. Include with each Sample names of product and Supplier, and description.
      b. Colored Cement Pigment Color Samples: Submit complete selection of manufacturer's standard and custom colors for final selection by ENGINEER.

B. Informational Submittals: Submit the following:
   1. Certifications:
      a. Notarized certification of conformance to reference standards used in this Section, when required by ENGINEER.

2. Delivery Tickets: Copies of all delivery tickets for each load of concrete delivered to or mixed at the Site. Each delivery tickets shall contain the information in accordance with ASTM C94 along with project identification name and number (if any), date, mix type, mix time, quantity and amount of water introduced.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Transportation, Delivery, and Handling:
   1. Materials used for concrete shall be clean and free from foreign matter during transportation and handling and kept separate until measured and placed into concrete mixer.
   2. Implement suitable measures during hauling, piling, and handling to ensure that segregation of coarse and fine aggregate particles does not occur and grading is not affected.

B. Storage:
   1. For storage, provide bins or platforms with hard, clean surfaces.

PART 2 – PRODUCTS

2.2 CEMENTITIOUS MATERIALS

A. Cement:
   1. Portland cement shall be Type II(MH) ASTM C150. Type I or Type II may be used in lieu of Type II(MH) when approved by ENGINEER.
   2. Portland cement shall be produced by one facility. Alternate cement sources may be used provided that mix design has been approved and acceptable trial batch verifying performance has been made.
   3. Do not use cement that has deteriorated because of improper storage or handling.

B. Fly Ash Mineral Admixture:
   1. Mineral admixtures, when used, shall conform to the requirements of ASTM C618 Class F, except as follows:
      a. The loss on ignition shall be a maximum of four percent.
      b. The maximum percent of sulfur trioxide (SO3) shall be 4.0.
   2. Fly ash shall be considered to be a cementitious material.
   3. Laboratory trial batches shall be tested to determine compliance with strength requirements, times of setting, slump, slump loss, and shrinkage characteristics.

C. Ground Granulated Blast Furnace Slag:
   1. Ground granulated blast furnace slag (GGBS) mineral admixture, when used, shall conform to ASTM C989, Grade 120.
   2. GGBS is considered a cementitious material.
   3. Perform laboratory tests on trial batches to determine compliance with strength

requirements, times of setting, slump, slump loss, and shrinkage characteristics.

D. Silica Fume Mineral Admixture:
   1. Silica fume mineral admixture shall be dry compacted or slurry form and shall conform to ASTM C1240. Silica fume is considered a cementitious material. Application rate shall be seven percent by weight of cement, unless indicated otherwise.

E. For all classes of concrete, when Type II(MH) Cement is used, fly ash or GGBS may be used within the following percentages by weight. When Type II Cement is used, fly ash or GGBS shall be used within the following percentages by weight. When Type I Cement is used, in lieu of Type II(MH) Cement, fly ash or GGBS shall be used such that total tricalcium aluminate content (C3A) of the resulting cementitious material is not greater than eight percent.
   1. When fly ash is used, material shall have minimum of 20 percent and maximum of 25 percent of total weight of cementitious material.
   2. When GGBS is used, material shall have minimum of 40 percent and maximum of 50 percent of total weight of cementitious material.

2.3 AGGREGATES

A. General:
   1. Aggregates shall conform to ASTM C33, Class Designation 4S, and as specified in this Section.
   2. Do not use aggregates containing soluble salts or other substances, such as iron sulfides, pyrite, marcasite, ochre, or other materials, that can cause stains on exposed concrete surfaces.

B. Fine Aggregate:
   1. Provide clean, sharp, natural sand free of loam, clay, lumps, and other deleterious substances.
   2. Dune sand, bank run sand, and manufactured sand are unacceptable.

C. Coarse Aggregate:
   1. Provide clean, uncoated, processed aggregate containing no clay, mud, loam, or foreign matter, as follows:

      a. Crushed stone, processed from natural rock or stone.
      b. Washed gravel, either natural or crushed. Slag, pit gravel, and bank run gravel are unacceptable.

2.4 WATER

A. Water used in producing and curing concrete shall be clean and free of injurious

quantities of oils, acids, alkalis, organic materials, and other substances that may be deleterious to concrete and steel.

2.5 CONCRETE ADMIXTURES

A. Provide admixtures in accordance with product manufacturer's published instructions. Admixtures shall be compatible with each other. Admixtures shall not contain thiocyanates, shall not contain more than 0.05 percent chloride ion, and shall be non-toxic in the concrete mix after 30 days. Do not use admixtures that have not been incorporated and tested in the accepted mixes, unless otherwise approved by ENGINEER.

B. Air Entraining Admixtures: ASTM C260.
   1. Air entraining admixture shall be vinsol resin or vinsol rosin-based.

C. Water-Reducing Admixture: ASTM C494, Type A.
   1. Proportion Class "A", Class "AF", Class "AS", and Class "B" concrete with non-air entraining, normal setting, water-reducing, aqueous solution of modified organic polymer. Admixture shall not contain lignin, nitrates, or chlorides added during manufacturing.

D. High Range Water-Reducing Admixture (HRWR): ASTM C494, Type F/G.
   1. Use high range water-reducing admixture in the concrete classifications so specified or indicated. Use of HRWR admixture is allowed at CONTRACTOR's option in all other classifications of concrete. When used, HRWR admixture shall be added to concrete in accordance with admixture manufacturer's published instructions. Specific admixture formulation shall be as recommended by admixture manufacturer for Project conditions.

E. Set Control Admixtures: In accordance with ASTM C494. Use the following as required:
   1. Type B, Retarding.
   2. Type C, Accelerating.
   3. Type D, Water reducing and Retarding.
   4. Type E, Water reducing and Accelerating.
   5. Type F, Water-reducing, high range admixtures.
   6. Type G, Water-reducing, high range, and retarding admixtures.

F. Calcium Chloride: Do not use calcium chloride.

G. Shrinkage Reducing Admixture:
   1. Shrinkage reducing admixture may be used in mix design when necessary to conform to specified shrinkage limitations, provided that specified strength requirements are complied with and there is no reduction in sulfate resistance in the concrete and no increase in concrete permeability.

H. Corrosion-Inhibiting Admixtures:
   1. Corrosion-inhibiting admixture shall be calcium nitrite solution containing minimum of 30 percent calcium nitrite. Admixture shall be added at dosage rate of five gallons per cubic yard of concrete.
   2. Product and Manufacturer: Provide one of the following:
      a. DCI or DCI-S, by Grace Construction Products.
      b. Rheocrete CNI, by Master Builders, Inc.
      c. Eucon CIA, by Euclid Chemical Company.
      d. Or equal.
   3. Adjust quantity of mix water to account for water portion of calcium nitrite solution.
   4. Provide retarding admixtures as required, if set time is accelerated.

I. Colored Cement Pigments:
   1. Provide the following, where shown or indicated: Commercial iron oxide, manganese dioxide, ultramarine blue, chromium oxide, or carbon black compounded for use in concrete.
   2. Product and Manufacturer: Provide one of the following:
      a. Truetone Mortar Colors by Frank D Davis Company, subsidiary of Rockwood Industries, Inc.
      b. Sonobrite by Sonneborn Building Products, division of Rexnord Chemical Products, Inc.
      c. Or equal.
   3. Do not exceed pigment-to-cement ratios, by weight, of one-to-35 for carbon black, and one-to-seven for other pigments.
   4. ENGINEER will select colors from manufacturer's full range of standard colors.

2.6 PROPORTIONING AND DESIGN OF MIXES

A. Prepare concrete design mixes in accordance with Table 03 30 00-A:

TABLE 03 30 00-A
CONCRETE DESIGN MIX CRITERIA

Concrete Class	Coarse Aggregate[1]		Minimum Cementitious (lbs/cu yd)	Max. W/CM[4]	Slump[2]	Air (%)	Min. Comp Strength[3] (psi)
	Size A	Size B					
Class "A"	No. 57	No. 8	564	0.42	4" max.	6 +/- 1	4,500

Class “AF”	No. 467	No. 8	517	0.42	4" max.	5 +/- 1	4,500
Class “AS”	No. 57	No. 8	564	0.42	4” max.	-	4,500
Class “B”	No. 57 or No. 67		517	0.50	4" max.	6 +/- 1	3,000
Class “C”	N. 57 or No. 67		564	0.40	4" max.	3 Max.	5,000
Class “D”	Any ASTM C33		No requirements				2,000

Notes Applicable to Table 03 30 00-A:

1. Coarse aggregate size numbers refer to ASTM C33. Where Size A and B are designated in Table 03 30 00-A, it is intended that the smaller Size B aggregate is to be added, replacing a portion of the coarse or fine aggregate, in the minimum amount necessary to make a workable and pumpable mix with sand content not exceeding 41 percent of total aggregate.
2. Slumps indicated are prior to addition of high range water reducer (super plasticizer).
3. Mix designs shall be made for all but Class “D”, which does not require trial batch, so that the compressive strength achieved for laboratory trial batches will not be less than 125 percent of specified design strength.
4. Quantity of water to be used in the determination of water-cementitious materials (W/CM) ratio shall include free water on aggregates in excess of SSD and water portion of admixtures.

C. Adjustment to Concrete Mixes: Mix design adjustments may be requested by CONTRACTOR when characteristics of materials, Site conditions, weather, test results, or other circumstances warrant; at no additional cost to OWNER and as approved by ENGINEER. Before using adjusted concrete mixes, laboratory test data and strength results shall be submitted to and approved by ENGINEER.

D. Admixtures:

1. Use air-entraining admixture in concrete, unless otherwise shown or indicated. Add air-entraining admixture at admixture manufacturer’s prescribed rate to produce concrete at point of placement having air content within prescribed limits.
2. Use water-reducing or high-range water-reducing admixtures in all Class “A” and Class “AF” concrete.
3. Use amounts of admixtures recommended by admixture manufacturer for climatic conditions prevailing at the Site at time of placing. Adjust quantities and types of admixtures as required to maintain quality.

E. If adding water at the Site is desired, withhold water at the batch plant so that specified water-cement (or cementitious material) ratio is not exceeded. Addition of water shall be accordance with ASTM C94. After high-range water-reducing admixture is incorporated into the batch, addition of water is not allowed.

F. Slump Limits with High-Range Water Reducer:
   1. Slump shall not exceed four inches prior to adding high-range water reducer and shall not exceed eight inches, measured at point of placement, after adding high-range water reducer.

G. Shrinkage Limitation:
   1. Concrete shrinkage for specimens cast in laboratory from trial batch with total water of 30.2 gallons per cubic yard or less, as measured at 21-day drying age and at 28-day drying age shall not exceed 0.039 percent and 0.045 percent, respectively. For trial batch with total water of 32.7 gallons per cubic yard or greater respective limits shall not exceed 0.035 percent and 0.040 percent. Limits in between shall be linear interpolated. Use mix design for construction that complies with trial batch shrinkage requirements. Shrinkage limitations apply to Class "A" concrete and Class "AF" concrete.
   2. Trial Batch Does Not Comply with Shrinkage Limitation:
      a. If trial batch results do not comply with shrinkage limitation specified in the Contract Documents, redesign the mix to reduce shrinkage.
      b. After mix has been repeatedly redesigned and ENGINEER is satisfied that all reasonable means to provide concrete mix that complies with shrinkage requirement have been exercised; and mix design still fails to comply with shrinkage limitation in the Contract Documents, ENGINEER reserves the right to accept the higher-shrinkage mix, provided that the quantity of shrinkage reinforcing in structures is increased.
      c. "Reasonable means" will be construed as reducing the total water content to a maximum of 27 gallons per cubic yard, having the large aggregate blended so that eight percent to 18 percent of combined aggregate is retained on each sieve, using an alternate aggregate source, and a combination of these means.
      d. Basis for shrinkage reinforcing increase will be proportional to amount that shrinkage value is over the specified shrinkage limitation and will be determined by ENGINEER. The cost of providing additional shrinkage reinforcement will be paid by the Owner.

H. Color: Provide colored concrete where shown and indicated. Incorporate pigments into concrete mix according to pigment manufacturer's written instructions. Match color of Sample approved by ENGINEER.

2.7 BONDING AGENT

A. Provide epoxy and epoxy-cement bonding agents in accordance with Section 03 15 00, Concrete Accessories.

2.8 CONCRETE CURING MATERIALS

A. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 10 ounces per square yard and complying with AASHTO M 182, Class 3.

B. Curing Mats: Shall be heavy carpets or cotton mats, quilted at four inches on centers, and weighing minimum of 12 ounces per square yard when dry.

C. Moisture-Retaining Cover: Provide one of the following, complying with ASTM C171:
   1. Waterproof paper.
   2. Polyethylene film.
   3. White burlap polyethylene sheet.

D. Liquid Curing Compound: ASTM C309 Type 1-D (water retention requirements):
   1. Provide fugitive dye.
   2. Curing compound shall be applied by roller or power sprayer.

2.9 FINISHING AIDS

A. Evaporation Retardant:
   1. Product and Manufacturer: Provide one of the following:
      a. Confilm, by Master Builders.
      b. Eucobar, by Euclid Chemical Company.
      c. SikaFilm, by Sika Corporation.
      d. Or equal.

2.10 CRACK INJECTION MATERIALS

A. Structural Crack Repair System:
   1. Epoxy for Injection: Low-viscosity, high-modulus moisture insensitive type.
   2. Products and Manufacturers: Provide one of the following:
      a. Sikadur 35, Hi-Mod L.V. and Sikadur 31, Hi-Mod Gel, by Sika Corporation.
      b. Eucopoxy Injection Resin, by Euclid Chemical Company.
      c. Or equal.

B. Non-structural Crack Repair System:
   1. Hydrophobic Polyurethane Chemical Grout:
      a. Provide hydrophobic polyurethane that forms a flexible gasket.
      b. Products and Manufacturers: Provide one of the following:
         1) SikaFix HH LV, by Sika Chemical Company.
         2) Hydro Active Flex SLV, by De Neef Construction Chemicals, Inc.
         3) Or equal.
      c. Shrinkage limit shall not exceed 4.0 percent in accordance with ASTM D1042.
      d. Minimum elongation of 250 percent in accordance with ASTM D3574.
      e. Minimum tensile strength of 150 psi in accordance with ASTM D3574.

2. Hydrophilic Acrylate-Ester Resin:
    a. Hydrophilic crack repair system shall be acrylate-ester resin that forms a flexible gasket and increase in volume a minimum of 50 percent when in contact with water.
    b. Products and Manufacturers: Provide one of the following:
        1) Duroseal Multigel 850, manufactured by BBZ USA, Inc.
        2) Superflex SR, by De Neef Construction Chemicals, Inc.
        3) Or equal.

2.11 CONCRETE REPAIR MATERIALS

A. Concrete repair mortar shall be pre-packaged, polymer-modified cementitious repair mortar with the following minimum properties:
    1. Compressive Strength at One Day: 2,000 psi (ASTM C109).
    2. Compressive Strength at 28 Days: 6,000 psi (ASTM C109).
    3. Bond Strength at 28 Days: 1,800 psi (ASTM C882 modified).

B. Products and Manufacturers: Provide one of the following:
    1. Five Star Structural Concrete, by Five Star Products, Inc. Use formulation recommended by manufacturer for the specific application conditions.
    2. SikaTop 122 Plus, SikaTop 123 Plus, SikaTop 111 Plus, or Sikacem 133, by Sika Corporation. Use formulation from among those listed in this paragraph recommended by manufacturer for specific application conditions.
    3. Emaco S88-CA or S66-CR, by Master Builders Inc. Use formulation from among those listed in this paragraph recommended by manufacturer for specific application conditions.
    4. Verticoat, Verticoat Supreme, or Euco SR-VO, by Euclid Chemical Company. Use formulation from among those listed in this paragraph recommended by manufacturer for specific application conditions.
    5. Or equal.

C. Cement Mortar: Shall consist of mix of one part cement to 1.5 parts sand with sufficient water to form trowelable consistency. Minimum compressive strength at 28 days shall be 4,000 psi. Where required to match the color of adjacent concrete surfaces, blend white portland cement with standard portland cement so that, when dry, patching mortar matches the color of surrounding concrete.

2.14 VAPOR RETARDER

A. Vapor Retarder:
    1. Vapor retarder membrane shall comply with the following.
        a. Water Vapor Transmission Rate, ASTM E96: 0.04 perms or lower.
        b. Water Vapor Retarder, ASTM E1745: Meets or exceeds Class C.
        c. Thickness of Retarder (plastic), ACI 302 1R: Not less than 10 mils.
    2. Products and Manufacturers: Provide one of the following:
        a. Stego Wrap 10-mil Vapor Retarder, by Stego Industries LLC.

b. Griffolyn 10-mil, by Reef Industries.
c. Moistop Ultra, by Fortifiber Industries.
d. Or equal.

B. Accessories:
1. Provide accessories by same manufacturer as vapor retarder.
2. Seam Tape:
a. Tape shall have water vapor transmission rate (ASTM E96) of 0.3 perms or lower.
b. Products and Manufacturers: Provide one of the following:
1) Stego Tape by Stego Industries LLC.
2) Griffolyn Fab Tape by Reef Industries.
3) Moistop Tape by Fortifiber Industries.
4) Or equal.
3. Vapor Proofing Mastic:
a. Mastic shall have a water vapor transmission rate ASTM E96, 0.3 perms or lower.
4. Pipe Boots:
a. Construct pipe boots from vapor barrier material, pressure sensitive tape, mastic, or a combination thereof, in accordance with manufacturer's recommendations.

2.15 SOURCE QUALITY CONTROL

A. Concrete materials may require testing, as directed by ENGINEER, at any time during the Work if concrete quality is in question. Provide access to material stockpiles and facilities at all times. Tests shall be done at no expense to OWNER.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine the substrate and conditions under which the Work will be performed and notify ENGINEER in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 CONCRETE MIXING

A. General:
1. Concrete may be produced at batch plants or by the ready-mixed process. Batch plants shall comply with recommendations of ACI 304R and have sufficient capacity to produce concrete of qualities required and in quantities required to comply with the accepted Progress Schedule. All plant facilities are subject to acceptance of ENGINEER.
2. Mixing:
a. Mix concrete with a rotating type batch machine, except where hand mixing of very small quantities is approved by ENGINEER.

b. Remove hardened accumulations of cement and concrete from drum and blades to ensure proper mixing action.
c. Replace mixer blades upon loss of ten percent of mixer blades' original height.

C. Ready-Mix Concrete:
1. Comply with ASTM C94 and the Contract Documents.
a. Plant Equipment and Facilities: Conform to requirements of NRMCA certification.
b. Mix concrete in revolving-type truck mixers that are in good condition and produce thoroughly mixed concrete conforming to the Contract Documents.
c. Do not exceed rated capacity of mixer.
d. Mix concrete for minimum of two minutes after arrival at the Site, or as recommended by mixer manufacturer.
e. Do not allow drum to mix while in transit.
f. Mix at proper speed until concrete is discharged from mixer.
g. Maintain adequate facilities at the Site for continuous delivery of concrete at required rates.
h. Provide access to mixing plant for ENGINEER upon request.

2. When silica fume is used in dry compacted form, comply with the following mix requirements and ensure full dispersion:
a. For all types of mixing equipment, increase mix times by 40 percent over minimum mix time required to achieve mix uniformity defined in ASTM C94.
b. For truck-mixed and central-mixed concrete, maximum allowable batch size shall be 80 percent of maximum in accordance with ASTM C94.

D. Maintain equipment in proper operating condition, with drums cleaned before charging each batch. Schedule rates of delivery to prevent delay of placing concrete after mixing, or holding dry-mixed materials too long in mixer before the adding water and admixtures.

3.3 TRANSPORTING CONCRETE

A. Transport and place concrete not more than 90 minutes after water has been added to the dry ingredients.

B. Avoid spilling and separation of concrete mixture during transportation.

C. Do not place concrete in which the ingredients have separated.

D. Do not retemper partially set concrete.

E. Use suitable equipment for transporting concrete from mixer to forms.

3.4 PREPARATION FOR CONCRETING

A. Submit to ENGINEER laboratory trial batch test results for proposed mixes at least 15 days prior to start of Work. Do not begin concrete production until associated laboratory trial batch test result submittal has been approved by ENGINEER.

B. Notify ENGINEER a minimum of 24 hours in advance of placing concrete to allow for inspection of form work, joints, waterstops, reinforcement, embedded items, and vapor retarders. The section to be placed shall be fully prepared for concrete placement at the time of notice. Confirm inspection status with ENGINEER a minimum of 4 hours prior to concrete placement. Do not begin placing concrete until Work is in conformance with the Contract Documents.

C. Subgrade surfaces shall be thoroughly wetted by sprinkling, prior to the placing of any concrete, and these surfaces shall be kept moist by frequent sprinkling up to the time of placing concrete thereon. The surface shall be free from standing water, mud, and debris at the time of placing concrete.

D. Reinforcing steel and embedded items shall be completely cleaned of mortar, loose rust, form release compounds, dirt, or any other substance which would interfere with proper bonding with concrete. Protective coatings on embedded aluminum items shall continuously cover the surface to be in contact with concrete. Any defects in the coating shall be repaired.

E. Do not place concrete until flow of water entering space to be filled with concrete has been properly stopped or has been diverted by pipes, or other means, and carried out of the forms, clear of the Work. Do not deposit concrete underwater, and do not allow water to rise on concrete surfaces until concrete has attained its initial set. Do not allow water to flow over concrete surface in manner and or velocity that will injure concrete surface finish. Provide temporary pumping or other dewatering operations for removing water as required.

F. Prepare joint surfaces in accordance with Section 03 15 00, Concrete Accessories.

G. Installation of Vapor Retarder:
   1. Provide vapor retarder under slabs-on-grade and outside walls to receive resilient floor finishes, carpet, ceramic and slate tile, chemical resistant coatings, and where shown or indicated on the Drawings.
   2. Install in accordance with manufacturer's instructions, ASTM E1643, and the following:
      a. Unroll vapor retarder with longest dimension parallel with direction of the pour.
      b. Lap vapor retarder over footings and seal to foundation walls.
      c. Overlap vapor retarder joints by six inches and seal with vapor retarder manufacturer's tape.
      d. Seal penetrations, including pipes, in accordance with vapor retarder manufacturer's instructions.

e. Penetration of vapor retarder is not allowed except for reinforcing steel and permanent utilities.
f. Repair damaged areas of vapor retarder by providing, for each damaged area, patch of vapor retarder material and overlapping damaged area with the patch by six inches on each side, and securely and continuously taping all four sides of patch to undamaged vapor retarder.

3.5 CONCRETE PLACEMENT

A. General:
1. Place concrete continuously, so that no concrete will be placed on concrete that has hardened sufficiently to cause formation of seams or planes of weakness within the section. If section cannot be placed continuously, provide construction joints in accordance with Section 03 15 00, Concrete Accessories.
2. Deposit concrete as nearly as practical in its final location to avoid segregation due to rehandling or flowing. Do not subject concrete to action that may cause segregation.
3. Screed concrete that is to receive other construction to proper level to avoid excessive skimming or grouting.
4. Do not use concrete that becomes non-plastic and unworkable, or does not conform to required quality limits, or that has been contaminated by foreign materials. Do not use retempered concrete. Remove rejected concrete from the Site and dispose of it in conformance with Laws and Regulations.
5. Do not place concrete until forms, bracing, reinforcing, and embedded items are each in final position and secure.
6. Do not place footings in freezing weather unless adequate precautions are taken against frost action.
7. Do not place footings, piers or pile caps on frozen soil.
8. Unless otherwise instructed, place concrete only when ENGINEER is present.
9. Allow minimum of three days between adjoining concrete placements.

B. Bonding for Next Concrete Pour:
1. Prepare for bonding of fresh concrete to concrete that has set but is not fully cured, as follows:
a. Thoroughly wet the surface but allow no free-standing water.
b. For horizontal surfaces place a six-inch layer of Construction Joint Grout, as specified in Section 03 60 00, Grouting, over the hardened concrete surface.
c. Place fresh concrete before the grout has attained its initial set.
2. Accomplish bonding of fresh concrete to fully cured, hardened, existing concrete by using a bonding agent as specified in Section 03 15 00, Concrete Accessories.

C. Concrete Conveying:
1. Handle concrete from point of delivery at the Site, transfer to concrete conveying equipment, and transfer to locations of final deposit as rapidly as

practical by methods that prevent segregation and loss of concrete mix materials.

2. Provide mechanical equipment for conveying concrete to ensure continuous flow of concrete at delivery end of conveyor. Provide runways for wheeled concrete conveying equipment from concrete delivery point to locations of final deposit. Keep interior surfaces of conveying equipment, including chutes, free of hardened concrete, debris, water, snow, ice, and other deleterious materials.
3. Do not use chutes for distributing concrete, unless accepted by ENGINEER.
4. Pumping concrete is allowed, however do not use aluminum pipe for conveying concrete.

D. Placing Concrete into Forms:

1. Deposit concrete in forms in horizontal layers not deeper than 18 inches each and in manner that avoids inclined construction joints. Where placement consists of several layers, place concrete at such rate that concrete being integrated with fresh concrete while still plastic.
2. Do not allow concrete to free-fall within the form from height exceeding four feet. Where high-range water reducer is used to extend slump to at least six inches, maximum allowable free-fall of concrete is six feet. Use "elephant trunks" to prevent free-fall and excessive splashing of concrete on forms and reinforcing. Discontinue free-falls in excess of four feet if there is evidence of segregation.
3. Remove temporary spreaders in forms when concrete placing has reached elevation of such spreaders.
4. Consolidate concrete placed in forms by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures for consolidating concrete in accordance with applicable recommended practices in ACI 309. Vibration of forms and reinforcing is not allowed unless otherwise accepted by ENGINEER.
5. Where height of concrete placement in walls exceeds 14 feet, provide temporary windows in formwork to facilitate vibration. Properly close temporary windows when height of concrete approaches windows. Determine location, size, and spacing of temporary windows to suit equipment used.
6. Do not use vibrators to transport concrete inside of forms. Insert and withdraw vibrators vertically at uniformly-spaced locations not farther than the visible effectiveness of the vibrator. Place vibrators to rapidly penetrate the layer of concrete and at least six inches into the preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion, limit the duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcing and other embedded items without causing segregation of concrete mix.
7. Do not place concrete in beam and slab forms until concrete previously placed in columns and walls is no longer plastic.
8. Prevent voids in the concrete. Force concrete under pipes, sleeves, openings, and inserts from one side until visible from the other side.

E. Placing Concrete Slabs:

1. Deposit and consolidate concrete slabs in continuous operation, within limits of construction joints, until placing of a slab panel or section is completed.
2. Consolidate concrete during placing operations using mechanical vibrating equipment, so that concrete is thoroughly worked around reinforcing and other embedded items and into corners.
3. Consolidate concrete placed in beams and girders of supported slabs, and against bulkheads of slabs on ground, as specified in this Article for formed concrete structures.
4. Bring slab surfaces to correct elevation and level. Smooth the surface, leaving surface free of humps or hollows. Do not sprinkle water on surface while concrete is plastic. Do not disturb slab surfaces prior to commencing concrete finishing.

5. Where slabs are placed in conditions of high temperature or wind that could lead to formation of plastic shrinkage cracks, provide evaporation retardant applied in accordance with retardant manufacturer's recommendations, when required by ENGINEER. Use evaporation retardant on slabs containing silica fume mineral admixture.

F. Quality of Concrete Work:
1. Concrete shall be solid, compact, and smooth, and free of laitance, cracks, and cold joints.
2. Concrete for liquid-retaining structures, and concrete in contact with earth, water, or exposed directly to the elements shall be watertight.
3. Cut out and properly replace to extent directed by ENGINEER, or repair to satisfaction of ENGINEER, surfaces with cracks or voids, that are unduly rough, or are defective in any other way. Thin patches or plastering are unacceptable.
4. Leaks through concrete that exhibit flowing water, and cracks, holes, or other defective concrete in areas of potential leakage, shall be repaired and made watertight.
5. Repair, removal, and replacement of defective concrete as directed by ENGINEER shall be at no additional cost to OWNER.

G. Cold Weather Placing:

1. Protect concrete Work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures, in compliance with ACI 306 and the Contract Documents.
2. When air temperature has fallen to or may be expected to fall below 40 degrees F, provide adequate means to maintain temperature in area where concrete is being placed between 50 degrees F and 70 degrees F for at least seven days after placing. Provide temporary housings or coverings including tarpaulins or plastic film. Maintain temporary heating and protection as necessary so that ambient temperature does not fall more than 30 degrees F in the 24 hours following the seven-day period. Avoid rapid dry-out of concrete due to overheating and avoid thermal shock due to sudden cooling or heating.

3. When air temperature has fallen to or is expected to fall below 40 degrees F, uniformly heat water and aggregates before mixing for concrete as required to obtain concrete mixture temperature not less than 55 degrees F and not more than 85 degrees F at point of placement.
4. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials. Before placing concrete, verify that forms, reinforcing, and adjacent concrete surfaces are entirely free of frost, snow, and ice.
5. Do not use salt or other materials containing antifreeze agents. Do not use chemical accelerators or set-control admixtures unless approved by ENGINEER and tested in mix design proposed for use.

H. Hot Weather Placing:
1. When hot weather conditions exist that would impair the quality and strength of concrete, place concrete in compliance with ACI 305 and the Contract Documents.

2. When ambient air temperature is at or above 90 degrees F and rising, cool ingredients before mixing concrete to maintain concrete temperature at time of placement below 80 degrees F. When ambient air temperature is at or above 90 degrees F and falling, cool the ingredients before mixing concrete to maintain concrete temperature at time of placement below 85 degrees F. In no case shall the concrete temperature at time of placement exceed 90 degrees F.
3. Mixing water may be chilled or chopped ice may be used to control concrete temperature provided the water equivalent of ice is calculated in total amount of mixing water. If required, reduce the time from addition of mix water to placement, or use set-retarding admixture.
4. Cover reinforcing materials with water-soaked burlap if ambient air temperature becomes too hot, so that reinforcing material temperature does not exceed ambient air temperature immediately before embedment of reinforcing in concrete.
5. Wet forms thoroughly before placing concrete.
6. Do not place concrete at temperature that causes difficulty from loss of slump, flash set, or cold joints.
7. Do not use set-control admixtures unless approved by ENGINEER in mix design.
8. Obtain ENGINEER's approval of substitute methods and materials proposed for use.

3.6 FINISHING OF FORMED SURFACES

A. Standard Form Finish:
1. Standard form finish shall be basically smooth and even, but is allowed to have texture imparted by the form material used. Repair defects in accordance with the Contract Documents.
2. Use standard form finish for the following:
   a. Exterior vertical surfaces from foundation up to one foot below grade.

b. Vertical surfaces not exposed to view.
c. Other areas shown or indicated.

B. Smooth Form Finish:
1. Produce smooth form finish by selecting form materials that will impart smooth, hard, uniform texture. Arrange panels in orderly and symmetrical manner with minimum of seams. Repair and patch defective areas in accordance with the Contract Documents.
2. Use smooth form finish for the following:
a. Exterior surfaces exposed to view.
b. Surfaces to be covered with coating material. Coating material may be applied directly to concrete or may be a covering bonded to concrete such as waterproofing, dampproofing, painting, or other similar system.
c. Interior vertical surfaces of liquid-containers.
d. Interior and exterior exposed beams and undersides of slabs.
e. Surfaces to receive abrasive blasted finish.
f. Surfaces to receive smooth rubbed or grout cleaned finish.
g. Other areas shown or indicated.

C. Smooth Rubbed Finish:
1. Provide smooth rubbed finish to concrete surfaces that have received smooth form finish and where defects have been repaired, as follows:
a. Rubbing of concrete surfaces not later than the day after form removal.
b. Moistening of concrete surfaces and rubbing with carborundum brick or other abrasive until uniform color and texture is produced. Do not apply cement grout other than that created by the rubbing process.
2. Use smooth rubbed finish for the following:
a. Interior exposed walls and other vertical surfaces.
b. Exterior exposed walls and other vertical surfaces down to one foot below grade.
c. Interior and exterior horizontal surfaces, except exterior exposed slabs and steps.
d. Interior exposed vertical surfaces of liquid-containing structures down to one foot below normal operating liquid level.
e. Other areas shown or indicated.

D. Grout Cleaned Finish:
1. Provide grout cleaned finish to concrete surfaces that have received smooth form finish and where defects have been repaired, as follows:
a. Combine one part portland cement to 1.5 parts fine sand by volume, and mix with water to consistency of thick paint. Blend standard portland cement and white portland cement, in proportions determined by trial patches, so that final color of dry grout will closely match adjacent concrete surfaces.
b. Thoroughly wet concrete surface and apply grout uniformly by brushing or spraying immediately to wetted surfaces. Scrub surface with cork float or stone to coat surface and fill surface holes. Remove excess grout by scraping, followed by rubbing with clean burlap to remove visible grout

film. Keep grout damp during setting period by using fog spray on surface for at least 36 hours after final rubbing. Complete each area the same day the area is started, with limits of each area being natural breaks in the finished surface.

2. Use grout cleaned finish for the following:
   a. Interior exposed walls and other vertical surfaces.
   b. Exterior exposed walls and other vertical surfaces down to one foot below grade.
   c. Interior and exterior horizontal surfaces, except exterior exposed slabs and steps.
   d. Interior exposed vertical surfaces of liquid-containing structures down to one foot below normal operating liquid level.
   e. Other areas shown.

E. Abrasive Blasted Finish:
   1. Provide abrasive blasted finish where shown or indicated.
   2. Where abrasive blasted finish is required, apply finish to smooth formed finish after end of curing period, with defects repaired, to match approved finish provided on mock-up or Sample panel, as applicable.
   3. Heavy Abrasive Blasted Finish: Abrasive blast to uniformly expose coarse aggregate.
   4. Light Abrasive Blasted Finish: Abrasive blast to uniformly expose fine aggregate.

F. Related Unformed Surfaces:
   1. At tops of walls, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces, strike off smooth and finish with texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise shown or indicated.

.7 SLAB FINISHES

A. Float Finish:
   1. After placing concrete slabs, do not work the surface further until ready for floating. Begin floating when surface water has disappeared or when concrete has stiffened sufficiently. Check and level the surface plane to tolerance not exceeding 1/4-inch in ten feet when tested with a ten-foot straightedge placed on surface at not less than two different angles. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to uniform, smooth, granular texture.
   2. Use float finish for the following:
      a. Interior exposed horizontal surfaces of liquid-containing structures, except those to receive grout topping.
      b. Exterior below-grade horizontal surfaces.
      c. Surfaces to receive additional finishes, except as shown or indicated.

B. Trowel Finish:

1. After floating, begin first trowel finish operation using power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over the surface.
2. Consolidate concrete surface by the final hand troweling operation. Finish shall be free of trowel marks, uniform in texture and appearance, and with surface plane tolerance not exceeding 1/8-inch in ten feet when tested with a ten foot straight edge. Grind smooth surface defects that would otherwise project through applied floor covering system.
3. Use trowel finish for the following:
    a. Interior exposed slabs, unless otherwise shown or indicated.
    b. Slabs that receive one of the following: resilient flooring, carpeting, or ceramic tile.

C. Non-Slip Broom Finish:
1. Immediately after float finishing, slightly roughen concrete surface by brooming in direction perpendicular to main traffic route. Use fine fiber-bristle broom, unless otherwise directed by ENGINEER. Coordinate required final finish with ENGINEER before applying finish.
2. Use non-slip broom finish for the following:
    a. Exterior exposed horizontal surfaces subject to lightweight foot traffic.
    b. Interior and exterior concrete steps and ramps.

D. Special Finish, Troweled Polyester Composition:
1. For floors receiving troweled polyester composition finish, the following apply:
    a. Provide wood float finish.
    b. Elevation shall be uniform within 1/4-inch tolerance in ten feet.
    c. Use approved curing and hardening compound or proper moist curing procedures.
    d. Cure slabs for 21 days minimum prior to topping.
    e. Protect slabs against oil and greases. Remove from slab surface dripping, flaking, and loose substances and other bonded foreign particles that might prevent adhesion of composition.
    f. Patch and repair other floor imperfections in accordance to finish manufacturer's recommendations.

E. Shake-On Metallic Finish:
1. For each slab shown or indicated to receive shake-on metallic finish, provide application of shake-on metallic hardener at rate of two pounds per square foot. First shake shall comprise two-thirds of specified quantity of hardener. Provide first application after initial floating operation, unless climatic conditions dictate earlier application. Shake-on metallic hardener shall be floated in the second application. Surface shall be floated again after second application to properly bond hardener to base concrete slab. Surface shall then be troweled at least twice to smooth, dense finish.
2. Furnish field service upon five days notice by the hardener manufacturer to assist CONTRACTOR in obtaining maximum benefits of product under prevailing conditions at the Site. Hardener manufacturer's representative shall

attend concrete coordination conference required in Article 1.3 of this Section.

3. Use shake-on metallic hardener finish with Class "C" concrete for slabs shown or indicated on the Drawings as receiving this finish.
4. Protect slabs against oil and greases. Remove from slab surface dripping, flaking, or loose substances and other bonded foreign particles that might prevent adhesion of finish.
5. Patch and repair other floor imperfections in accordance with hardener manufacturer's recommendations.

F. Scratched Finish:
   1. After providing float finish, roughen concrete surface with rake before concrete's final set. Amplitude of surface shall be minimum of 1/4-inch.
   2. Provide scratched finish for the following:
      a. Horizontal surfaces that will receive grout topping or concrete equipment pad.
      b. Surfaces so indicated on the Drawings or elsewhere in the Contract Documents.

3.8 CONCRETE CURING AND PROTECTION

A. General:
   1. Protect freshly placed concrete from premature drying, excessive cold or hot temperatures, and maintain without drying at relatively constant temperature for period necessary for hydration of cement and proper hardening of concrete.
   2. Start curing after placing and finishing concrete, as soon as free moisture has disappeared from concrete surface. Keep surface continuously moist during entire curing period. Cure for a minimum of 10 days and in accordance with ACI 301 procedures. For concrete sections over 30-inches thick, the curing

period shall be for a minimum of 14 days. Avoid rapid drying at end of final curing period.

3. For curing, use water that is free of impurities that could etch or discolor exposed concrete surfaces.
4. Confine water for curing to area being cured.

B. Curing Methods: Curing methods are specified below. Curing methods to be used on each type of concrete surface are specified elsewhere in this Article.
   1. Water Curing. Cure by one of the following methods:
      a. Keep concrete surface continuously wet.
      b. Ponding or immersion.
      c. Continuous water-fog spray.
      d. Covering concrete surface with curing mats, thoroughly saturating mats with water, and keeping mats continuously wet with sprinklers or porous hoses. Place curing mats to cover concrete surfaces and edges with four-inch horizontal lap over adjacent mats; provide eight-inch lap over adjacent mats at vertical surfaces. If necessary, weigh down curing cover to maintain contact with concrete surface.
   2. Form Curing. Cure by one of the following methods:
      a. Forms shall be maintained and loosened during curing period.
      b. Immediately after forms are loosened or removed, continue with the required curing method as applicable, for remainder of curing period.
      c. Where wood forms are kept in place, apply water to keep forms wet.
   3. Moisture Retaining Cover Curing. Cure as follows:
      a. Cover concrete surfaces with the required moisture retaining cover for curing concrete, placed in widest practical width with sides and ends lapped at least three inches and sealed using waterproof tape or adhesive. Immediately repair holes or tears during curing period using cover material and waterproof tape.
   4. Liquid Compound Curing. Cure as follows:

      a. Unless otherwise approved by ENGINEER, provide water curing or form curing. Request to use liquid curing compound will be considered by ENGINEER on case-by-case basis. Construction joints, formed surfaces prior to receiving specified form finish, and concrete to receive surface treatment where surface treatment will be bonded to concrete surface (such as, but not limited to grout fill, hardener, coatings, lining, water repellent, painting, resilient flooring, terrazzo flooring, ceramic tile, quarry tile, chemical resistant coatings, or other applications) shall be water-cured or form-cured.
      b. In liquid-retaining structures, provide water curing or form curing, unless other curing method is approved by ENGINEER. Requests to use liquid curing compound will be considered by ENGINEER on case-by-case basis. Request shall provide valid construction reason or safety reason for using liquid compound curing including reason why other curing methods are not viable.
      c. Apply curing compounds immediately after final finishing or after terminating water curing. Apply curing compound in continuous

operation by power spray equipment in accordance with curing compound manufacturer's directions. If areas are subjected to rainfall within three hours after completing curing compound application, area shall be recoated. Maintain coating continuity and repair areas damaged during curing period.

d. When liquid curing compound is used, apply first coat of liquid curing compound at compound manufacturer's recommended coverage rate, and subsequently apply second coat at identical rate, thus providing twice the curing compound manufacturer's recommended coverage.

e. At end of curing period, remove liquid curing compound where required.

C. Formed Surfaces: Use the following curing methods:

1. Walls That Will Retain Liquid or That are Under Ground Surface:
   a. If forms are wood, form curing is allowed for entire curing period. If forms are steel, form curing is allowed for maximum of three days after which forms shall be removed so that concrete is free of the forms for remainder of the curing process.
   b. Immediately after the forms are loosened or removed, continue with water curing for remainder of curing period.
   c. When wall surface will not receive surface treatment and when allowed by ENGINEER, use of liquid curing compound is allowed. Before using liquid compound curing, use water curing or form curing for at least the first three days of curing.
2. Formed Slab Underside and Beam Surfaces Where Will Retain Liquid:
   a. Form curing is allowed for the full curing period.
   b. Immediately after forms are loosened or removed, continue with water curing for remainder of curing period.
   c. When slab surface will not receive surface treatment and when allowed by ENGINEER, use of liquid curing compound is allowed.
3. Vertical Joint Surfaces and Surfaces to Receive Surface Treatment:
   a. Form curing is allowed for entire curing period.
   b. Immediately after forms are loosened or removed, continue with water curing for remainder of curing period.
4. Cure other formed surfaces using an appropriate curing method specified in the Contract Documents.

D. Unformed Surfaces: Treat with one of the following curing methods:

1. Slabs and Mats That Will Retain Liquid or are Below Ground Surface:
   a. Water curing.
   b. Moisture-retaining cover curing when allowed by ENGINEER.
   c. When slab or mat surface will not receive surface treatment and when allowed by ENGINEER, use of liquid curing compound is allowed. Before using liquid compound curing, use water curing or form curing for at least the first three days of curing.
2. Construction Joint Surfaces and Slab and Mat Surfaces to Receive Surface Treatment.
   a. Water curing.
   b. Moisture-retaining cover curing.

3. Cure other formed surfaces using an appropriate curing method specified in the Contract Documents.

E. Temperature of Concrete During Curing:
   1. When ambient temperature is 40 degrees F or less, continuously maintain concrete temperature between 50 degrees F and 70 degrees F throughout curing period. When necessary, before concrete placing provide for temporary heating, covering, insulation, or housing as required to continuously maintain specified temperatures and moisture conditions throughout concrete curing period. Provide cold weather protection in accordance with ACI 306.
   2. When the ambient temperature is 80 degrees F and above, or during other climatic conditions that would cause too-rapid drying of concrete, before starting concrete placing, provide wind breaks and shading as required, and fog spraying, wet sprinkling, or moisture retaining coverings as required. Continuously protect concrete throughout concrete curing period. Provide hot weather protection in accordance with ACI 305, unless otherwise specified.
   3. Maintain concrete temperature as uniformly as possible and protect from rapid ambient temperature changes. Avoid concrete temperature changes that exceed five degrees F in one hour and 50 degrees F in 24-hour period.

F. Protection:
   1. During curing period, protect concrete from damaging mechanical disturbances including load stresses, heavy shock, excessive vibration, and damage by rain and flowing water. Protect finished concrete surfaces from damage by subsequent construction operations.

3.9 CONCRETE INSTALLATION TOLERANCES

A. Installation Tolerances:
   1. Concrete placement tolerances, unless otherwise specified in the Contract Documents, shall be in accordance with ACI 117.
   2. Notify ENGINEER in writing when concrete placement does not conform with required tolerances, as soon as the condition is known to CONTRACTOR.
   3. When concrete installation does not conform to required tolerances, do not repair or correct by grinding unless specified in the Contract Documents or approved by ENGINEER in writing.
   4. Verification Measurements:
      a. If surfaces where tolerances are in question, obtain measurements to verify conformance with tolerances in manner acceptable to ENGINEER.
      b. If surfaces tolerances are in question, cost of obtaining measurements shall be at no additional cost to the OWNER.
      c. Before obtaining measurements, obtain ENGINEER's acceptance of method proposed for obtaining measurements.
      d. After obtaining measurements, submit measurements to ENGINEER.
   5. Submit with verification measurements submittal proposed method to rectify out-of-tolerance concrete. Do not start repair Work without obtaining ENGINEER's approval.

3.10 FIELD QUALITY CONTROL

A. Field Testing Services:
   1. OWNER will employ testing laboratory to perform field quality control testing for concrete. ENGINEER will direct the testing requirements.
   2. CONTRACTOR shall provide all curing and necessary cylinder storage as specified in Section 01 45 28, On-Site Facilities for Testing Laboratory.

A. Field Testing Services:
   1. CONTRACTOR shall employ an independent testing laboratory to perform field quality control testing for concrete. ENGINEER will direct where samples are to be obtained.
   2. Testing laboratory shall make standard compression test cylinders and entrained air tests as specified in this Article, under direct observation by ENGINEER or Resident Project Representative.
   3. Testing laboratory will provide all labor, material, and equipment required for sampling and testing concrete, including: scale, glass tray, cones, rods, molds, air tester, thermometer, and other incidentals required.
   4. Provide all curing and necessary cylinder storage as specified in Section 01 45 28, On-Site Facilities for Testing Laboratory.
   5. Refer to Article 1.3 of this Section for required testing laboratory qualifications.

B. Quality Control Testing During Construction:
   1. Perform sampling and testing for field quality control during placement of concrete, as follows:
      a. Sampling Fresh Concrete: ASTM C172.
      b. Slump: ASTM C143; one test for each concrete load at point of discharge.
      c. Concrete Temperature: ASTM C1064; one for every two concrete loads at point of discharge, and when a change in the concrete is observed. Test each load when time from batching to placement exceeds 75 minutes.
      d. Air Content: ASTM C231; one for every two concrete load at point of discharge, and when a change in the concrete is observed.
      e. Unit Weight: ASTM C138; one for every two concrete loads at point of discharge, and when a change in the concrete is observed.
      f. Compression Test Specimens:
         1) In accordance with ASTM C31; make one set of compression cylinders for each 50 cubic yards of concrete, or fraction thereof, of each mix design placed each day. Each set shall be four standard cylinders, unless otherwise directed by ENGINEER.
         2) Cast, store, and cure specimens in accordance with ASTM C31.
         3) Test and record the following when cylinders are cast: slump, concrete temperature, air content, and unit weight.

g. Compressive Strength Tests:
   1) In accordance with ASTM C39; one specimen tested at seven days, and three specimens tested at 28 days.
   2) Adjust mix design if test results are unsatisfactory and resubmit for approval.
   3) Concrete that does not comply with strength requirements will be considered as defective Work.

h. Water/Cementitious Materials Ratio: Perform one test from each sample from which compression test specimens are taken, in accordance with AASHTO TP23.

i. Within 24 hours of completion of test, testing laboratory will submit certified copy of test results to CONTRACTOR and ENGINEER.

C. Evaluation of Field Quality Control Tests:
   1. Do not use concrete delivered to final point of placement having slump, concrete temperature, total air content or unit weight outside specified values.
   2. Water/Cementitious Materials Ratio:
      a. When water content testing indicates water/cementitious materials ratio to exceed specified requirements by greater than 0.02, remaining batches required to complete concrete placement shall have water content decreased in the mix and water reducing admixture dosage increased as required to bring subsequently-batched concrete within specified water/cementitious materials ratio.
      b. Perform additional testing to verify compliance with specified water/cementitious materials ratio.
      c. Do not resume concrete production for further concrete placement until CONTRACTOR has identified cause of excess water in the mix and revised batching procedures, or adjusted the mix design (and obtained ENGINEER's associated approval) to bring water/cementitious materials ratio into conformance with the Contract Documents.
   3. Compressive Strength:
      a. Compressive strength tests for laboratory-cured cylinders will be acceptable if the averages of all sets of three consecutive compressive strength tests results equal or exceed specified 28-day design compressive strength of the associated type or class of concrete, and no individual strength test falls below required compressive strength by more than 500 psi.
      b. Questionable Field Conditions During Concrete Placement:
         1) Where questionable field conditions exist during concrete placement or immediately thereafter, strength tests of specimens cured under field conditions will be required by ENGINEER to check adequacy of curing and protecting of concrete placed. Specimens shall be molded at the same time and from the same samples as laboratory-cured specimens.
         2) Provide improved means and procedures for protecting concrete when 28-day compressive strength of field-cured cylinders is less than 85

percent of companion laboratory cured cylinders.

3) When laboratory-cured cylinder strengths are appreciably higher than minimum required compressive strength, field-cured cylinder strengths need not exceed minimum required compressive strength by greater than 500 psi even though the 85 percent criterion may not be met.

4) If individual tests of laboratory-cured specimens produce strengths more than 500 psi below the required minimum compressive strength, or if tests of field-cured cylinders indicate deficiencies in protection and curing, provide additional measures to ensure that load-bearing capacity of the structure is not jeopardized or impaired. If likelihood of low-strength concrete is confirmed and evaluations indicate load-bearing capacity may have been reduced, perform tests of cores from the concrete in question at CONTRACTOR's expense.

c. If compressive strength tests fail to indicate compliance with minimum requirements of the Contract Documents, concrete represented by such tests will be considered defective.

D. Testing Concrete Structure for Strength:

1. When there is evidence that strength of in-place concrete does not comply with the Contract Documents, CONTRACTOR shall employ the services of concrete testing laboratory to obtain cores from hardened concrete for compressive strength determination. Cores and tests shall comply with ASTM C42 and the following:
   a. Obtain at least three representative cores from each concrete member or suspect area of concrete at locations directed by ENGINEER.
   b. Strength of concrete for each series of cores will be acceptable if average compressive strength is at least 85 percent of specified compressive strength and no single core is less than 75 percent of required 28-day required concrete compressive strength.
   c. Testing laboratory shall submit test results to ENGINEER on same day that tests are completed. Include in test reports Project name and number (if any), date of sampling and testing, CONTRACTOR name, name of concrete testing laboratory, exact location of test core in the Work, type or class of concrete represented by core sample, nominal maximum size aggregate, design compressive strength, compression breaking strength, and type of break (corrected for length-diameter ratio), direction of applied load to core with respect to horizontal plane of concrete as placed, and moisture condition of the core at time of testing.
2. Fill core holes solid with non-shrink grout in accordance with Section 03 60 00, Grouting, and finish to match adjacent concrete surfaces.
3. If results of core tests are unacceptable or if it is impractical to obtain cores, perform static load test and evaluations complying with ACI 318 and ACI 350, as directed by ENGINEER.

E. Concrete Tolerance Verification Measurements: Refer to Article 3.9 of this Section.

F. Supplier's Services:
   1. Water-Reducing Admixture Manufacturer: Furnish services of qualified concrete technician employed by admixture manufacturer to assist in proportioning concrete for optimum use of admixture. Concrete technician shall advise on proper addition of admixture to concrete and on adjustment of concrete mix proportions to meet changing conditions at the Site.

3.11 MISCELLANEOUS CONCRETE ITEMS

A. Temporary Openings:
   1. Openings in concrete walls and slabs required for passage of Work are allowed only upon approval of ENGINEER.
   2. Temporary openings made in concrete shall be provided with waterstop in below-ground or liquid-retaining members and structures. Reinforcement going through and around the opening shall be made continuous to provide continuity and shall be approved by the ENGINEER.
   3. Temporary openings that remain in concrete structures shall be filled with the same class of concrete as the adjoining construction, after the Work causing need for temporary opening is complete, unless otherwise shown or directed by ENGINEER. Mix, place, and cure concrete as specified in this Section to blend with in-place construction. Provide miscellaneous concrete filling shown or required to complete the Work.

B. Bases or Pads for Piping, Panels, and Equipment:
   1. Unless specifically shown or indicated otherwise, provide concrete bases or pads for equipment, floor-mounted panels, and floor-mounted supports for piping and similar construction. Provide all concrete pad and base Work not specifically included under other Sections (--1--).
   2. Dimensions and Elevations:
      a. Coordinate and construct bases and pads to dimensions shown or indicated, or as required to comply with equipment, panel, or piping manufacturer's requirements and elevations indicated on the Drawing.
      b. Unless otherwise shown or indicated, place concrete bases for equipment up to one-inch below the equipment manufacturer's base or mounting plate.
      c. Where specific dimensions or elevations are not shown or indicated, bases and pads shall be six inches thick and extend three inches outside dimensions of the equipment, panel, or supports.
   3. Finish: Bases and pads outside of areas to receive non-shrink grout shall have smooth trowel finish, unless special finish such as terrazzo, ceramic tile, quarry tile, or heavy-duty concrete topping is required. In such cases, provide appropriate concrete finish. Surfaces of bases and pads to receive non-shrink grout shall have broom finish.

C. Curbs:
   1. Provide monolithic finish to interior curbs by stripping forms while concrete is

still green followed by steel-troweling surfaces to hard, dense finish with corners, intersections, and terminations slightly rounded.

2. Exterior curbs shall have rubbed finish for vertical surfaces and broomed finish for top surfaces.

D. Steel Pan Stairs:
   1. Provide concrete fill for steel pan stair treads, landings, and associated items. Screed, tamp, and finish concrete surfaces as shown or indicated.
      a. Cast into the concrete fill safety inserts and accessories as shown or indicated.

3.12 REPAIR OF CONCRETE PLACED UNDER THIS CONTRACT

A. Repair of Formed Surfaces:
   1. Repair the following defects in all formed finishes:
      a. Spalls, air bubbles, rock pockets, form depressions, and other defects that are more than 1/4-inch in depth.
      b. Holes from tie rods and other form tie systems.
      c. Fins, offsets, and other projections that extend more than 1/4-inch beyond designated concrete member surface.
      d. Structural cracks, as defined by ENGINEER.
      e. Non-structural cracks greater than 0.010-inch wide as defined by ENGINEER. In liquid-retaining structures, elevated slabs subject to the elements or washdowns, below-grade members, and cracks that evidence leakage. Where it is not possible to verify whether a crack is leaking, repair the crack.
   2. Repair the following defects in smooth-finish surfaces, in addition to those listed above in this Section:
      a. Spalls, air bubbles, rock pockets, form depressions, and other defects that extend to more than 1/2-inch in width in any direction, no matter how deep.
      b. Spalls, air bubbles, rock pockets, form depressions, and other defects of any size that exceed three in number in a 12-inch by 12-inch area, or 12 in number in a three-foot by three-foot area.

c. Fins, offsets, and other projections shall be completely removed and smoothed.
d. Scratches and gouges in concrete surface.
e. Texture and color irregularities. In liquid-retaining surfaces, texture and color irregularities need not be repaired when greater than 12 inches below minimum normal operating liquid surface elevation, except where such defects are indicative of reduced durability.

3. Where smooth rubbed or grout cleaned finish is specified, minor surface defects repairable by the finishing process need not be repaired prior to finish application, when approved by ENGINEER.

B. Method of Repair of Formed Surfaces:

1. Immediately after removing forms, repair and patch defective areas with cement mortar or concrete repair mortar as directed by ENGINEER. Make repairs made to liquid-retaining structures and below-grade surfaces with repair mortar only. Repair form tie holes in liquid-retaining or below-grade surfaces with non-shrink grout in accordance with Section 03 60 00, Grouting.
2. Honeycombs, Rock Pockets, and Holes Left by Tie Rods and Bolts:
   a. Cut out honeycomb, rock pockets, voids, and holes left by tie rods and bolts, down to solid concrete but, in no case, to depth less than one-inch for cement mortar and 1/2-inch for repair mortar. Make edges of cuts perpendicular to concrete surface.
   b. Before placing cement mortar, thoroughly clean and brush-coat area to be patched with specified bonding agent.
   c. When using concrete repair mortar, use of bonding agent is optional; prepare the surface and place mortar in accordance with mortar manufacturer's recommendations.
   d. Repairs at exposed-to-view surfaces shall match the color of surrounding concrete, except color matching is not required for interior surfaces of liquid-retaining surfaces up to one foot below typical minimum liquid level. Impart texture to repaired surfaces to match texture of existing adjacent surfaces. Provide test areas at inconspicuous locations to verify mixture, texture, and color match before proceeding with patching.
   e. Compact mortar in place and strike off slightly higher than the surrounding surface.
3. Structural Cracks: Pressure-grout structural cracks using injectable epoxy installed using pressurized system. Apply in accordance with epoxy manufacturer's directions and recommendations.
4. Non-structural Cracks: Shall be pressure-grouted using hydrophobic or hydrophilic resin. Install in accordance with resin manufacturer's directions and recommendations.
5. Determination of the crack type shall be made by the ENGINEER.
6. Holes Through Concrete:
   a. Using plunger-type gun or other suitable device, fill holes extending through concrete from least-exposed face, using flush stop held at exposed face; completely fill the hole with specified repair material.

b. At below-grade and liquid-containing members, fill holes with concrete repair mortar and use color-matched cement mortar for outer two inches at exposed-to-view surfaces.

7. Where powerwashing or scrubbing is not adequate, abrasive blast exposed-to-view surfaces that require removal of stains, grout accumulations, sealing compounds, and other substances marring the surfaces. Use sand finer than No. 30 and air pressure from 15 to 25 psi.

C. Repair of Unformed Surfaces:

1. Test unformed surfaces, such as monolithic slabs, for smoothness and to verify surface plane to specified tolerances for each surface and finish. Correct low and high areas in accordance with this Section.
2. Test unformed surfaces sloped to drain for trueness of slope, in addition to smoothness, using template having the required slope. Correct high and low areas in accordance with this Section.
3. Repair finish of unformed surfaces containing defects that adversely affect concrete durability. Surface defects include crazing, cracks in excess of 0.01-inch wide, spalling, popouts, honeycombs, rock pockets, and other objectionable conditions.
4. Repair structural cracks in all structures and non-structural cracks in liquid-retaining structures. In liquid-retaining structures, where dry face of concrete member can be observed, repair all cracks evidencing any rate of water flow through crack. Where dry face of member cannot be observed, repair all cracks.

D. Methods of Repair of Unformed Surfaces:

1. Correct high areas in unformed surfaces by grinding, after concrete has cured sufficiently so that repairs can be made without damage to adjacent areas.
2. Correct low areas in unformed surfaces, during or immediately after completion of surface finishing, by cutting out low areas and replacing with fresh concrete. Finish repaired areas to blend into adjacent concrete. Where repairs are required and concrete has already set, sawcut around perimeter of area to be repaired to depth of 1/2-inch and remove concrete so that minimum thickness of repair is 1/2-inch. Apply specified concrete repair mortar in accordance with repair mortar manufacturer's directions and recommendations.
3. Repair defective areas, except random cracks and single holes not exceeding one-inch diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts, and expose reinforcing steel with at least 3/4-inch clearance all around. Minimum thickness of repair shall be 1.5 inches. Dampen concrete surfaces in contact with patching concrete and brush with specified bonding agent. Place patching concrete while bonding agent is tacky. Mix patching concrete of same materials and proportions to provide concrete of same classification as original, adjacent concrete. Place, compact, and finish as required to blend with adjacent finished concrete. Cure in the same manner as adjacent concrete.
4. Repair isolated, random, non-structural cracks (in members that are not below grade or liquid-retaining), and single holes not greater than one-inch diameter,

by dry-pack method. Groove top of cracks, and cut out holes to sound concrete, and clean repair area of dust, dirt, and loose particles. Dampen all cleaned concrete surfaces and brush with the specified bonding agent. Place dry-pack before cement grout takes its initial set. Mix dry-pack, consisting of one part portland cement to 2.5 parts fine aggregate passing No. 16 mesh sieve, using only enough water as required for handling and placing. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched areas continuously moist for at least 72 hours.

5. Structural cracks shall be pressure-grouted using injectable epoxy. Apply in accordance with epoxy manufacturer's directions and recommendations.
6. Non-structural cracks in below-grade and liquid-retaining structures shall be pressure-grouted using hydrophilic resin. Apply in accordance with resin manufacturer's directions and recommendations.
7. Determination of crack type will be by ENGINEER.

E. Other Methods of Repair:
   1. Repair methods not specified in this Section may be used when approved by ENGINEER.

+ + END OF SECTION + +

SECTION 03 60 00

GROUTING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install grout and perform grouting Work.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before grouting Work.

C. Related Sections:

   1. Section 03 15 00, Concrete Accessories.
   2. Section 03 30 00, Cast-In-Place Concrete.

D. Application and Grout Material:
   1. The following is a listing of grouting applications and the corresponding type of grout material to be provided for the associated application. Unless shown or indicated otherwise in the Contract Documents, provide grout in accordance with the following:

TABLE 03 60 00-A, GROUT APPLICATIONS AND MATERIAL TYPES

Application	Required Grout Material Type
Beam and column (one- or two-story height) base plates and precast concrete bearing less than 16 inches in the least dimension	Class II Non-Shrink
Column base plates and precast concrete bearing (greater than two-story height or larger than 16 inches in the least dimension)	Class I Non-Shrink
Base plates for storage tanks and other non-motorized equipment, and motorized equipment or machinery less than 50 horsepower	Class I Non-Shrink (unless otherwise recommended by equipment manufacturer)
Motorized equipment or machinery equal to and greater than 50 horsepower, and	Class III Non-Shrink Epoxy (unless otherwise recommended by equipment

motorized equipment or machinery equipment less than 50 horsepower subject to severe shock loads or high vibration	manufacturer)
Filling blockout spaces for embedded items such as railing posts, guide frames for hydraulic gates, and similar applications	Class II Non-Shrink (Class I where placement time exceeds 15 minutes)
Grout fill or grout toppings less than four inches thick	Grout Fill
Grout fill greater than four inches thick	Class "B" Concrete in accordance with Section 03 30 00, Cast-In-Place Concrete
Grout for setting filter underdrain blocks, and for filling voids between filter underdrain blocks, and for filling voics between filter underdrain blocks and walls	Filter Underdrain Blocks Grout
Applications not listed above, where grout is indicated on the Drawings	Class I Non-Shrink, unless shown or indicated otherwise

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ACI 211.1, Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
   2. ACI 301, Structural Concrete for Buildings.
   3. ASTM C33/C33M, Specification for Concrete Aggregates.
   4. ASTM C109/C109M, Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).
   5. ASTM C230/C230M, Specification for Flow Table for Use in Tests of Hydraulic Cement.
   6. ASTM C531, Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
   7. ASTM C579, Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
   8. ASTM C827, Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures.
   9. ASTM C882/C882M, Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear.
   10. ASTM C939, Text Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method).
   11. ASTM C1107/C1107M, Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
   12. ASTM C1181, Test Methods for Compressive Creep of Chemical-Resistant Polymer Machinery Grouts.
   13. NSF/ANSI 61, Drinking Water System Components - Health Effects.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Grout Testing Laboratory:
      a. Independent testing laboratory employed for design and testing of grout materials and mixes shall comply with testing laboratory requirements in Section 03 30 00, Cast-in-Place Concrete and other applicable requirements in the Contract Documents.
   2. Manufacturer: Shall have a minimum of five years experience of producing products substantially similar to that required and shall be able to submit documentation of at least five satisfactory installations that have been in successful operation for at least five years each.
   3. Manufacturer's Field Service Technician: When required, provide services of manufacturer's full-time employee, factory-trained in handling, use, and installing the products required, with at least five years of experience in field applications of the products required.

B. Trial Batch:
   1. Each grout fill and construction joint grout mix proportion and design shall be verified by laboratory trial batch or field experience methods. Comply with ACI 211.1 and submit to ENGINEER a report with the following data:
      a. Complete identification of aggregate source of supply.
      b. Tests of aggregates for compliance with specified requirements.
      c. Scale weight of each aggregate.
      d. Absorbed water in each aggregate.
      e. Brand, type, and composition of cement.
      f. Brand, type, and amount of each admixture.
      g. Amounts of water used in trial mixes.
      h. Proportions of each material per cubic yard.
      i. Unit weight and yield per cubic yard of trial mixtures.
      j. Measured slump.
      k. Measured air content.
      l. Compressive strength developed at seven days and 28 days, from not less than three test specimens cast for each seven-day and 28-day test, and for each design mix.
   2. Laboratory Trial Batches: When laboratory trial batches are used to select grout proportions, prepare test specimens and conduct strength tests as specified in ACI 301.
   3. Field Experience Method: When field experience methods are used to select grout proportions, establish proportions as specified in ACI 301.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Schedule of Project-specific grout applications, installation locations, and the grout type proposed for each.
      b. List of grout materials and proportions for the proposed mix designs. Include data sheets, test results, certifications, and mill reports to qualify

the materials proposed for use in the mix designs. Do not start laboratory trial batch testing until submittal is approved by ENGINEER.

c. Trial Batch Reports: Submit laboratory test reports for grout materials and mix design tests.

2. Product Data:

a. Data sheets, certifications, and manufacturer's specifications for all materials proposed for use.

B. Informational Submittals: Submit the following:

1. Manufacturer's Instructions:

a. Special instructions for shipping, storing, protecting, and handling.

b. Installation instructions for the materials.

2. Field Quality Control Submittals:

a. Report field testing results for each required time period. (e.g., seven-day tests, 28-day tests). Submit within 24 hours after completion of associated test. Each test report shall include results of all testing required at time of sampling.

3. Supplier Reports:

a. Submit written report of results of each visit to Site by Supplier's field service technician, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.

4. Qualifications Statements:

a. Testing laboratory, when not submitted under other Sections.

b. Manufacturer, when submittal of qualifications is required by ENGINEER.

c. Manufacturer's field service technician, when submittal of qualifications is required by ENGINEER.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Storage of Materials: Store grout materials in a dry location, protected from weather and protected from moisture.

PART 2 – PRODUCTS

2.1 GENERAL

2.2 NON-SHRINK GROUT MATERIALS

A. General: Non-shrink grout shall be a prepackaged, inorganic, flowable, non-gas-liberating, non-metallic, cement-based grout requiring only the addition of water. Manufacturer's instructions shall be printed on each bag or container in which the materials are packaged. Specific formulation for each type or class of non-shrink

grout specified in this Section shall be that recommended by the grout manufacturer for the particular application.

B. Class I Non-Shrink Grout:
   1. Class I non-shrink grouts shall have a minimum 28-day compressive strength of 7,000 psi. Use grout for precision grouting and where water-tightness and non-shrink reliability in both plastic and hardened states is critical, in accordance with Table 03 60 00-A in this Section.
   2. Products and Manufacturer: Provide one of the following:
      a. Masterflow 928, by Master Builders, Inc.
      b. Five Star Grout, by Five Star Products, Inc.
      c. Hi-Flow Grout, by Euclid Chemical Company.
      d. Or equal.
   3. Comply with ASTM C1107/C1107M, Grade C and B (as modified below) when tested using amount of water required to achieve the following properties:
      a. Fluid consistency (20 to 30 seconds) shall be in accordance with ASTM C939.
      b. At temperatures of 45, 73.4, and 95 degrees F.
   4. Length change from placing to time of final set shall not have shrinkage greater than the expansion measured at three or fourteen days. Expansion at three or fourteen days shall not exceed the 28-day expansion.
   5. Non-shrink property shall not be based on chemically-generated gas or gypsum expansion.
   6. Fluid grout shall pass through the flow cone, with continuous flow, one hour after mixing.

C. Class II Non-Shrink Grout:
   1. Class II non-shrink grouts shall have minimum 28-day compressive strength of 7,000 psi. Use grout for general-purpose grouting applications in accordance with Table 03 60 00-A in this Section.
   2. Products and Manufacturer: Provide one of the following:
      a. Construction Grout, by Master Builders, Inc.
      b. FSP Construction Grout, by Five Star Products, Inc.
      c. NS Grout, by Euclid Chemical Company.
      d. Or equal.
   3. Comply with ASTM C1107/C1107M and the following when tested using the quantity of water required to achieve the following properties:
      a. Flowable consistency (140 percent flow in accordance with ASTM C230/C230M, five drops in 30 seconds).
      b. Fluid working time of at least 15 minutes.
      c. Flowable for at least 30 minutes.
   4. When tested, grout shall not bleed at maximum allowed water.
   5. Non-shrink property shall not be based on chemically-generated gas or gypsum expansion.

D. Class III Non-Shrink Epoxy Grout:
   1. Epoxy grout shall be a pourable, non-shrink, 100-percent solids system.

2. Products and Manufacturer: Provide one of the following:
   a. E3G, by Euclid Chemical Company.
   b. Sikadur 42 Grout Pak, by Sika Corporation.
   c. HP Epoxy Grout, by Five Star Products, Inc.
   d. Or equal.
3. Epoxy grout system shall have three components: resin, hardener, and specially blended aggregate, all pre-measured and prepackaged. Resin component shall not contain non-reactive diluents. Resins containing butyl glycidyl ether (BGE) or other highly volatile and hazardous reactive diluents are unacceptable. Variation of component ratios is not allowed without specific recommendation by manufacturer. Manufacturer's instructions shall be printed on each container in which products are packaged.
4. The following properties shall be attained with the minimum quantity of aggregate allowed by epoxy grout manufacturer.
   a. Vertical volume change at all times before hardening shall be between zero percent shrinkage and 4.0 percent expansion when measured in accordance with ASTM C827 (modified for epoxy grouts by using an indicator ball with specific gravity between 0.9 and 1.1).
   b. Length change after hardening shall be less than 0.0006-inch per inch and coefficient of thermal expansion shall be less than 0.00003-inch per inch per degree F when tested in accordance with ASTM C531.
   c. Compressive creep at one year shall be less than 0.001-inch per inch when tested under a 400-psi constant load at 140 degrees F in accordance with ASTM C1181.
   d. Minimum seven-day compressive strength shall be 14,000 psi when tested in accordance with ASTM C579
   e. Grout shall be capable of maintaining at least a flowable consistency for minimum of 30 minutes at 70 degrees F.
   f. Shear bond strength to portland cement concrete shall be greater than shear strength of concrete when tested in accordance with ASTM C882/C882M.
   g. Minimum effective bearing area shall be 95 percent.

2.3 GROUT MATERIALS OTHER THAN NON-SHRINK GROUT

A. General: Materials for grouts (other than non-shrink grouts) shall be in accordance with Section 03 30 00, Cast-In-Place Concrete, except as otherwise specified in this Section.

B. Grout Fill:
   1. Grout fill shall be comprised of cement, fine aggregate, coarse aggregate, water, and admixtures proportioned and mixed in accordance with this Section.
      a. Minimum Compressive Strength: 4,000 psi at 28 days.
      b. Maximum Water-Cement Ratio: 0.45 by weight.
      c. Coarse Aggregate: ASTM C33/C33M, No. 8 size.
      d. Fine Aggregate: ASTM C33/C33M, approximately 60 percent by weight of total aggregate.
      e. Air Content: Seven percent (plus or minus one percent).

f. Minimum Cement Content: 564 pounds per cubic yard.
g. Slump for grout fill shall be adjusted to match placing and finishing conditions and shall not exceed four inches.

C. Construction Joint Grout:
1. Construction joint grout shall be comprised of cement, fine aggregate, coarse aggregate, water, and admixtures proportioned with similar cementitious characteristics as Class "A" concrete specified in Section 03 30 00, Cast-In-Place Concrete. Mix design shall result in grout that is flowable with high mortar content. Mix requirements are:
a. Minimum Compressive Strength: 4,500 psi at 28 days.
b. Maximum Water-Cement Ratio: 0.42 by weight.
c. Coarse Aggregate: ASTM C33/C33M, No. 8 size.
d. Fine Aggregate: ASTM C33/C33M, approximately 60 percent by weight of total aggregate.
e. Air Content: Seven percent (plus or minus one percent).
f. Minimum Cement Content: 752 pounds per cubic yard.
g. Slump for Construction Joint Grout: Seven inches (plus or minute one inch).

D. Filter Underdrain Blocks Grout:
1. Grout shall comply with Article 2.1 of this Section. Grout shall consist of one part cement to two parts sand with shrinkage-reducing admixture. Class I or Class II non-shrink grout may be used in lieu of filter underdrain blocks grout.
a. Minimum Compressive Strength: 4,000 psi at 28 days.
b. Maximum Water-Cement Ratio: 0.45 by weight.

2.4 CURING MATERIALS

A. Curing materials shall comply with Section 03 30 00, Cast-in-Place Concrete, and shall be as recommended by the manufacturer of prepackaged grouts.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine substrate and conditions under which grouting will be performed and notify ENGINEER in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. General:
1. Place grout as shown and indicated, and in accordance with Laws and Regulations and grout manufacturer's instructions. If manufacturer's instructions conflict with the Contract Documents, obtain clarification or interpretation from ENGINEER before proceeding.

2. Consistency of non-shrink grouts shall be as required to completely fill the space to be grouted for the particular application. Do not install grout for dry-packing without approval of ENGINEER. When dry-packing is approved by ENGINEER, dry-pack consistency shall be such that grout has sufficient water to ensure hydration and grout strength development, and remains plastic, moldable, and that does not flow.
3. Grouting shall comply with temperature and weather limitations in Section 03 30 00, Cast-In-Place Concrete.
4. Cure grout in accordance with grout manufacturer's instructions for prepackaged grout and Section 03 30 00, Cast-In-Place Concrete, for grout fill.

B. Columns and Beams:
1. After shimming columns and beams to proper elevation, securely tighten anchors. Properly form around base plates allowing sufficient room around edges for placing grout. Provide adequate depth between bottom of base plate and top of concrete base to assure that void is completely filled with non-shrink grout.

C. Equipment Bases:
1. Install equipment in accordance to manufacturer's recommendations, Laws, and Regulations, and the Contract Documents. After shimming equipment to proper elevation, securely tighten anchors. Properly form around base plates, allowing sufficient room around edges for placing grout. Provide adequate depth between bottom of equipment base and top of concrete base to ensure that voids are completely filled with non-shrink grout.

D. Handrail Posts:
1. After posts have been properly inserted into holes or sleeves, fill annular space between posts and sleeve with non-shrink grout. Bevel grout at juncture with post so that water will flow away from post.

D. Construction Joints:
1. Place a six-inch minimum thick layer of construction joint grout over contact surface of concrete at interface of horizontal construction joints in accordance with Section 03 15 00, Concrete Accessories, and Section 03 30 00, Cast-In-Place Concrete.

E. Grout Fill:
1. All mechanical, electrical, and finish work shall be completed prior to placing grout fill. Base slab shall be provided with a scratched finish in accordance with Section 03 30 00, Cast-In-Place Concrete. Roughen existing slabs shall by abrasive blasting or hydroblasting exposing aggregates to ensure bonding to base slab.
2. Minimum thickness of grout fill shall be one-inch. Where finished surface of grout fill is to form an intersecting angle of less than 45 degrees with concrete surface against which grout will be placed, form a key in the concrete surface at the intersection point. Key shall be minimum of 3.5 inches wide by 1.5 inches deep.

3. Thoroughly clean and wet base slab prior to placing grout fill. Do not place grout fill until slab is completely free of standing water. A thin coat of neat Type II cement slurry shall be broomed into surface of slab. Place grout fill while slurry is wet. Grout fill shall be compacted by rolling or tamping, brought to elevation, and floated. In tanks and basins where scraping-type equipment will be installed, grout fill shall be screeded by blades attached to revolving mechanism of equipment in accordance with procedures recommended by equipment manufacturer after grout is brought to elevation.
4. Grout fill placed on sloping slabs shall be installed uniformly from bottom of slab to top, for full width of placement.
5. Test grout fill surface with a straight edge to detect high and low spots; immediately correct high and low spots in grout fill. When grout fill has hardened sufficiently, grout fill shall be steel troweled to provide a smooth surface free of bug holes and other imperfections. While an acceptable type of mechanical trowel may be used in this operation, the last pass over the grout fill surface shall be by hand-troweling. During finishing, do not apply the following to the grout fill surface: water, dry cement, or mixture of dry cement and sand.
6. Cure and protect grout fill in accordance with Section 03 30 00, Cast-In-Place Concrete.

3.3 FIELD QUALITY CONTROL

A. Field Testing Services:
   1. OWNER will employ testing laboratory to perform field quality control testing for grout. ENGINEER will direct the testing requirements.
   2. CONTRACTOR shall provide all curing and necessary cube storage as specified in Section 01 45 28, On-Site Facilities for Testing Laboratory.
   3. Comply with testing laboratory requirements in Section 03 30 00, Cast-In-Place Concrete for required testing laboratory qualifications.

B. Quality Control Testing During Construction:
   1. Grout Fill: Perform sampling and testing for field quality control during grout fill placing as follows:
      a. Sampling Fresh Grout Fill: ASTM C172.
      b. Slump: ASTM C143; one test for each load of grout at point of discharge.
      c. Air Content: ASTM C231; one sample for every two grout loads at point of discharge, and when a change in the grout is observed.
      e. Compression Test Specimens:
         1) In accordance with ASTM C109/C109M; make one set of compression cubes for each 50 cubic yards of grout, or fraction thereof, of each mix design placed each day. Each set shall be four standard cubes, unless otherwise directed by ENGINEER.

   2. Non-shrink Grout: Perform sampling and testing for field quality control during non-shrink grout placing as follows:

a. Perform compression testing of non-shrink grout in accordance to ASTM C109/C109M at intervals during construction as selected by ENGINEER. Make a set of four specimens for testing compressive strength at a period of time selected by the ENGINEER.
b. Perform compression tests on epoxy grout and fabricate specimens for epoxy grout testing in accordance with ASTM C579, Method B, at intervals during construction as selected by the ENGINEER. Make a set of four specimens for testing compressive strength at a period of time selected by ENGINEER.

C. Evaluation of Field Quality Control Tests:
1. Do not use grout, delivered to final point of placement, having slump or total air content that does not comply with the Contract Documents.
2. Compressive strength tests for laboratory-cured cubes will be acceptable if averages of all sets of three consecutive compressive strength test results equal or exceed the required 28-day design compressive strength of the associated type of grout.
3. If the compressive strength tests do not comply with the requirements in the Contract Documents, the grout represented by such tests will be considered defective and shall be removed and replaced, or subject to other action required by ENGINEER, at CONTRACTOR's expense.

D. Manufacturer's Services:
1. Manufacturers of proprietary materials shall make available upon 72 hours notification the services of qualified, full time employee, experienced in serving as a field service technician for the products required, to aid in assuring proper use of products under the actual conditions at the Site.

+ + END OF SECTION + +

SECTION 05 05 33

ANCHOR SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install anchor systems.
   2. This Section includes all anchor systems required for the Work, but not specified under other Sections.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before anchor systems Work.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ACI 318, Building Code Requirements for Structural Concrete.
   2. ACI 350, Code Requirements for Environmental Engineering Concrete Structures.
   3. ACI 355.2, Qualification of Post-Installed Mechanical Anchors in Concrete.
   4. ANSI B212.15, Cutting Tools - Carbide-tipped Masonry Drills And Blanks For Carbide-tipped Masonry Drills.
   5. ANSI/MSS SP-58, Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation.
   6. ASTM A194/A194M, Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   7. ASTM A276, Specification for Stainless Steel Bars and Shapes.
   8. ASTM A493, Specification for Stainless Steel Wire and Wire Rods for Cold Heading and Cold Forging.
   9. ASTM A563, Specification for Carbon and Alloy Steel Nuts.
   10. ASTM A1011/A1011M, Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
   11. ASTM B633, Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
   12. ASTM C307, Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings.
   13. ASTM C881/C881M, Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
   14. ASTM D695, Test Method for Compressive Properties of Rigid Plastics.

15. ASTM D790, Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
16. ASTM E329, Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.
17. ASTM E488, Test Methods for Strength of Anchors in Concrete and Masonry Elements.
18. ASTM F593, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
19. ASTM F594, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
20. ASTM F1554, Specification for Anchor Bolts, Steel, 36, 55 and 105-ksi Yield Strength.
21. FS A-A-1922A, Shield, Expansion (Caulking Anchors, Single Lead).
22. FS A-A-1923A, Concrete Expansion Anchors.
23. FS A-A-1925A, Shield, Expansion (Nail Anchors).
24. FS A-A-55614, Shield, Expansion (non-drilling expansion anchors).
25. ICC-ES AC01, Acceptance Criteria for Expansion Anchors in Masonry Elements.
26. ICC-ES AC58, Acceptance Criteria for Adhesive Anchors in Masonry Elements.
27. ICC-ES AC60, Acceptance Criteria for Anchors in Unreinforced Masonry Elements.
28. ICC-ES AC193, Acceptance Criteria for Mechanical Anchors in Concrete Elements.
29. ICC-ES AC308, Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.
30. ISO 3506-1, Mechanical Properties of Corrosion-Resistant Stainless Steel Fasteners -- Part 1: Bolts, Screws and Studs.
31. NSF/ANSI 61, Drinking Water System Components – Health Effects.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Testing Laboratory: Shall comply with ASTM E329 and shall be experienced in tension testing of post-installed anchoring systems.
   2. Post-installed Anchor Installer:
      a. Mechanical Anchors: Installer shall be experienced and trained by post-installed anchor system manufacturer in proper installation of manufacturer's products. Product installation training by distributors or manufacturer's representatives is unacceptable unless the person furnishing the training is qualified as a trainer by the anchor manufacturer.
      b. Adhesive Anchors: Installation shall be performed by personnel certified under an applicable certification program. Certification shall include written and performance tests in accordance with the ACI/CRSI Adhesive Anchors Installer Certification Program, or equivalent. Description of equivalent programs shall be submitted for

ENGINEER's approval and shall be accepted by the building official having jurisdiction.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Listing of all anchor systems products intended for use in the Work including product type, intended location in the Project, and embedded lengths.
   2. Product Data:
      a. Manufacturer's specifications, load tables, dimension diagrams, acceptable base material conditions, acceptable drilling methods, and acceptable bored hole conditions.
      b. When required by ENGINEER, copies of valid ICC ES reports that presents load-carrying capacities and installation requirements for anchor systems.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. For each type of anchor bolt or threaded rod, submit copies of laboratory test reports and other data required to demonstrate compliance with the Contract Documents.
      b. Post-installed anchor system manufacturer's certification that installer received training in the proper installation of manufacturer's products required for the Work.
      c. For each adhesive anchor installer, submit ACI/CRSI Adhesive Anchor Installer Certification.
   2. Manufacturer's Instructions:
      a. Installation instructions for each anchor system product proposed for use, including bore hole cleaning procedures and adhesive injection, cure and gel time tables, and temperature ranges

1.5 DELIVERY, STORAGE AND HANDLING

A. Storage and Protection:
   1. Keep materials dry during delivery and storage.
   2. Store adhesive materials within manufacturer's recommended storage temperature range.
   3. Protect anchor systems from damage at the Site. Protect products from corrosion and deterioration.

PART 2 – PRODUCTS

2.1 SYSTEM PERFORMANCE

A. General:
   1. At locations where conditions dictate that Work specified in other Sections is to be of corrosion resistant materials, provide associated anchor systems of stainless steel materials, unless other corrosion-resistant anchor system material is specified. Provide anchor systems of stainless steel materials where stainless steel materials are required in the Contract Documents.
   2. Stainless Steel Nuts:
      a. For anchor bolts and adhesive anchors, provide ASTM A194/A194M, Grade 8S (Nitronic 60) stainless steel nuts for stainless steel anchors used for anchoring equipment, gates, and weirs, and other locations, if any, where the attachment will require future removal for operation or maintenance. Provide lock washer or double nuts on each anchorage device provided for equipment, as required by equipment manufacturer.
      b. For other locations, provide for each anchorage device a nut as specified or as required by anchor manufacturer. When ASTM A194/A194M, Grade 8S (Nitronic 60) nuts are not required for anchor bolts and adhesive anchors as specified in this Section, provide anti-seizing compound where stainless steel rods are used with stainless steel nuts of the same type.
   3. Materials that can contact potable water or water that will be treated to become potable shall be listed in NSF/ANSI 61.

B. Design Criteria
   1. Size, Length, and Load-carrying Capacity: Comply with the Contract Documents. When size, length or load-carrying capacity of anchor system is not otherwise shown or indicated, provide the following:
      a. Anchor Bolts: Provide size, length, and capacity required to carry design load based on values and requirements of Paragraph 3.2.A of this Section. For conditions outside limits of critical edge distance and spacing in Paragraph 3.2.A of this Section, minimum anchor bolt embedment as shown or indicated in Paragraph 3.2.A of this Section apply and capacity shall be based on requirements of Laws and Regulations, including applicable building codes.
      b. Adhesive Anchors, Expansion Anchors, or Concrete Inserts: Provide size, length, type, and capacity required to carry design load. Anchor capacity shall be based on the procedures required by the building code in effect at the Site. Where Evaluation Service Reports issued by the ICC Evaluation Service are required in this Section, anchor capacities shall be based on design procedure required in the applicable ICC Evaluation Service Report.
         1) General: Determine capacity considering reductions due to installation and inspection procedures, embedment length, strength of base fastening materials, spacing, and edge distance, as indicated in the manufacturer's design guidelines. For capacity determination, concrete shall be assumed to be in the cracked condition, unless calculations demonstrate that the anchor system

will be installed in an area that is not expected to crack under any and all conditions of design loading.

2) Concrete Adhesive Anchors: Unless otherwise shown or indicated in the Contract Documents or approved by ENGINEER, provide minimum embedment depth of the greater of the following: required to develop tensile strength of anchor, or a minimum embedment of 10 anchor diameters; and minimum anchor spacing and edge distance of 12 anchor diameters.
3) Concrete Masonry Adhesive Anchors: Unless otherwise shown or indicated in the Contract Documents or approved by ENGINEER, provide minimum anchor spacing and edge distance as indicated in anchor manufacturer's instructions.
4) Concrete Expansion Anchors: Unless otherwise shown or indicated in the Contract Documents or approved by ENGINEER, provide minimum embedment depth of six anchor diameters, and minimum anchor spacing and edge distance of seven anchor diameters.
5) Concrete Masonry Expansion Anchors: Unless otherwise shown or indicated in the Contract Documents or approved by ENGINEER, provide minimum anchor spacing and edge distance as indicated in anchor manufacturer's instructions.
6) Concrete Undercut Anchors: Unless otherwise shown or indicated in the Contract Documents, or approved by ENGINEER, provide minimum anchor spacing and edge distance as tabulated in anchor manufacturer's instructions.

2. Design Loads. Comply with the Contract Documents. When design load of supported material, equipment, or system is not otherwise shown or indicated, provide the following:
   a. Equipment Anchors: Use design load recommended by equipment manufacturer. When equipment can be filled with fluid, use loads that incorporate equipment load and load imposed by fluid.
   b. Pipe Hangers and Supports: Use full weight of pipe, and fluid contained in pipe that are tributary to the support plus the full weight of valves and accessories located between the hanger or support being anchored and the next hanger or support.
   c. Hangers and Supports for Electrical Systems, and HVAC, Plumbing, and Fire Suppression Systems and Piping: Use the full weight of supported system that is tributary to the support plus the full weight of accessories located between the hanger or support being anchored and the next hanger or support. When piping or equipment is to be filled with fluid, anchor systems shall be sized to support such loads in addition to the weight of the equipment, piping, or system, as applicable.
   d. Delegated Design: When anchor systems are used for supporting materials, equipment, or systems delegated to a design professional retained by CONTRACTOR, Subcontractor, or Supplier, provide anchor system suitable for loads indicated in delegated design

documents and consistent with the design intent expressed in the Contract Documents.

C. Application:
   1. Anchor Bolts:
      a. Where anchor bolt is shown or indicated, use cast-in-place anchor bolt unless another anchor type is approved by ENGINEER.
      b. Provide anchor bolts as shown or indicated, or as required to secure structural element to appropriate anchor surface.
   2. Concrete Adhesive Anchors:
      a. Use where adhesive anchors are shown or indicated for installation in concrete.
      b. Suitable for use where subject to vibration.
      c. Suitable for use in exterior locations or locations subject to freezing.
      d. Suitable for use in submerged, intermittently submerged, or buried locations.
      e. Do not use in overhead applications, unless otherwise shown or approved by ENGINEER.
      f. Do not use for pipe hangers, unless otherwise shown or approved by ENGINEER.
   3. Concrete Masonry Adhesive Anchors:
      a. Use where adhesive anchors are shown or indicated for installation in grout-filled or hollow masonry units.
      b. Suitable for use where subject to vibration.
      c. Suitable for use in exterior locations or locations subject to freezing.
      d. Do not use for pipe hangers, unless otherwise shown or approved by ENGINEER.
   4. Concrete Wedge Expansion Anchors:
      a. Use where expansion anchors are shown or indicated for installation in concrete.
      b. Do not use where subject to vibration.
      c. Do not use in exterior locations or locations subject to freezing.
      d. Do not use in submerged, intermittently submerged, or buried locations.
      e. Suitable for use in overhead applications.
   5. Grout-filled Concrete Masonry Wedge Expansion Anchors:
      a. Use where expansion anchors are shown or indicated for installation on the interior face of grout-filled unit masonry.
      b. Do not use where subject to vibration.
      c. Do not use in exterior locations or locations subject to freezing.
   6. Hollow Concrete Masonry Sleeve Expansion Anchors:
      a. Use where expansion anchors are shown or indicated for installation in hollow concrete unit masonry or solid brick.
      b. Do not use for attaching safety-related systems, such as piping conveying hazardous or potentially hazardous materials, or fire suppression systems.
      c. Do not use where subject to vibration.

d. Do not use in exterior locations or locations subject to freezing.

7. Drop-in Expansion Anchors:
   a. Use drop-in expansion anchors installed in concrete where light-duty anchors are required to support piping or conduit two-inch diameter or smaller.
   b. Do not use for attaching safety-related systems, such as piping conveying hazardous or potentially hazardous materials, or fire suppression systems.
   c. Do not use where subject to vibration.
   d. Do not use at submerged, intermittently submerged, or buried locations.
   e. Do not use in exterior locations or locations subject to freezing.
   f. Suitable for use in overhead applications.
8. Concrete Undercut Anchors:
   a. Use where undercut anchors are shown or indicated for installation in concrete.
   b. Suitable for use where subject to vibration.
   c. Do not use in submerged, intermittently submerged, or buried locations.
   d. Do not use in exterior locations or locations subject to freezing.
   e. Suitable for use in overhead applications.
9. Concrete Inserts:
   a. Use only where shown or indicated in the Contract Documents.
   b. Allowed for use to support pipe hangers and pipe supports for pipe size and loading recommended by the concrete insert manufacturer.
10. Drive-In Expansion Anchors:
    a. Use drive-in expansion anchors installed in concrete, precast concrete, grouted masonry units, or brick, where light-duty anchors are required to support piping or conduit one-inch diameter and smaller.
    b. Do not use for attaching safety-related systems, such as piping conveying hazardous or potentially hazardous materials, or fire suppression systems.
    c. Do not use in overhead applications.
11. For Use in Precast Concrete Planks:
    a. To support piping or conduit six-inch diameter and smaller, use low-profile drop-in anchors, hollow concrete masonry adhesive anchors, or through-bolts.
    b. For piping greater than six-inch diameter, or to support safety-related systems, use through-bolts. Each through-bolt shall consist of threaded rod, nuts, washers, and bearing plate.

2.2 MATERIALS

A. Anchor Bolts:
   1. Interior Dry Non-corrosive Locations: Provide straight threaded carbon steel rods complying with ASTM F1554, Grade 36, with heavy hex nuts

complying with ASTM A563 Grade A, unless otherwise shown or indicated on the Drawings. Hooked anchor bolts are unacceptable.

2. Exterior, Buried, Submerged Locations, or When Exposed to Wastewater: Provide stainless steel straight threaded rods complying with ASTM F593, AISI Type 316, Condition A, with ASTM F594, AISI Type 316, stainless steel nuts. Provide ASTM A194/A194M, Grade 8S (Nitronic 60) stainless steel nuts where required. Other AISI types may be used when approved by ENGINEER. Hooked bolts are unacceptable.
3. Equipment: Provide anchor bolts complying with material requirements of this Section and equipment manufacturer's requirements relative to size, embedment length, and anchor bolt projection. Anchor bolts shall be straight threaded rods with washers and nuts as specified in this Section. Hooked bolts are unacceptable.
4. Anchoring of Structural Elements: Provide anchor bolts of size, material, and strength shown or indicated in the Contract Documents.

B. Concrete Adhesive Anchors:
   1. General:
      a. Adhesive anchors shall consist of threaded rods anchored into hardened concrete using an adhesive system.
   2. Products and Manufacturers: Provide one of the following:
      a. HIT-RE 500-SD Injection Epoxy Adhesive Anchoring System, by Hilti Fastening Systems, Inc.
      b. SET-XP Epoxy-Tie Adhesive, by Simpson Strong-Tie Company, Inc.
      c. Or equal.
   3. Adhesive:
      a. Adhesive system shall use two-component adhesive mix.
      b. Epoxy adhesives shall comply with physical requirements of ASTM C881/C881M, Type IV, Grade 2 and 3, Class A, B, and C, except gel times.
      c. Adhesives shall have a current evaluation report by ICC Evaluation Service for use in both cracked and uncracked concrete with seismic recognition for SDC A through F as tested and assessed in accordance with ICC-ES AC308.
      d. Adhesives shall have minimum bond strength and minimum design bond strength (bond strength multiplied by strength reduction factor) in accordance with Table 05 05 33-A:

TABLE 05 05 33-A:
ADHESIVE BOND STRENGTH [1,2]

Anchor	Uncracked Concrete		Cracked Concrete	
Rod Diameter / Dowel Size	**Bond Strength (psi)**	**Design Bond Strength (psi)**	**Bond Strength (psi)**	**Design Bond Strength (psi)**
3/8-inch / #3	2040	1300	1090	700
1/2-inch / #4	1920	1200	920	560
5/8-inch / #5	1830	1150	710	390
3/4-inch / #6	1760	1050	710	460
7/8inch / #7	1670	900	610	340
1-inch / #8	1650	1050	850	460
- / #9	1900	1000	800	400
1.25-inch/ #10	1580	1000	730	400

Table Notes:
1. Bond strengths listed for hammer-drilled, dry hole.
2. Bond strengths listed for maximum short term concrete temperature of 110 degrees F and maximum long term concrete temperature of 75 degrees F.

4. Anchor:
   a. Provide continuously-threaded, AISI Type 316 stainless steel adhesive anchor rod. Threaded rods shall comply with the concrete adhesive anchor manufacturer's specifications as included in the ICC Service Evaluation Report for the anchor submitted. Nuts shall have specified proof load stresses equal to or greater than the minimum tensile strength of the stainless steel threaded rod used. Provide ASTM A194/A194M, Grade 8S (Nitronic 60) stainless steel nuts where required.

C. Concrete Masonry Adhesive Anchors:
   1. General:
      a. Grout-filled concrete masonry adhesive anchors shall consist of threaded rods anchored into grout-filled concrete block masonry using an adhesive system.
      b. Hollow concrete masonry adhesive anchors shall consist of threaded rods with a cylindrical mesh steel or plastic screen tube anchored into hollow concrete block masonry using an adhesive system.
   2. Products and Manufacturers: Provide one of the following:
      a. HIT-HY 70 Hybrid Adhesive Anchor System, by Hilti Fastening Systems, Inc.
      b. Acrylic-Tie Adhesive, by Simpson Strong-Tie Company, Inc.
      c. Or equal.
   3. Adhesive:
      a. Adhesive system shall use two-component adhesive mix.
      b. Hybrid adhesives shall comply with the following:
         1) ASTM D695 compressive yield strength greater than 7,200 psi on a seven-day cure.

c. Adhesives shall have current ICC Evaluation Service Report for use in grout-filled concrete masonry, tested and assessed in accordance with ICC-ES AC 58 and ICC-ES AC 60.

4. Anchor:
   a. Provide stainless steel adhesive anchor rod complying with ASTM F593, AISI Type 316, Condition CW, with ASTM F594, AISI Type 316 stainless steel nuts. Provide ASTM A194/A194M, Grade 8S (Nitronic 60) stainless steel nuts where required.
5. Mesh Screen Tube (for hollow masonry applications):
   a. Provide with mesh size, length, and diameter as specified by adhesive anchor manufacturer.

D. Concrete Wedge Expansion Anchors:
1. General:
   a. Concrete wedge expansion anchors shall consist of stud, wedge, nut, and washer.
2. Products and Manufacturers: Provide one of the following:
   a. Kwik Bolt TZ Wedge Anchor, by Hilti Fastening Systems, Inc.
   b. Strong Bolt 2 Wedge Anchor, by Simpson Strong-Tie Company, Inc.
   c. Or equal.
3. Anchors shall comply with physical requirements of FS A-A-1923A, Type 4. Provide concrete wedge expansion anchors suitable for use in cracked and uncracked concrete in accordance with ACI 318 and ACI 350, Appendix D. Demonstrate suitability of cracked concrete wedge anchors in accordance with ACI 355.2 prequalification tests.
4. Interior Dry Non-corrosive Locations: Provide carbon steel anchors complete with nuts and washers, zinc plated, in accordance with ASTM B633.
5. Other Locations: Provide expansion anchors complete with nuts and washers, AISI Type 304 stainless steel anchor body, in accordance with ASTM A276 or ASTM A493.
7. Concrete wedge expansion anchors shall have a current ICC Evaluation Service Report for use in both cracked and uncracked concrete with seismic recognition in seismic design Categories A through F when tested and assessed in accordance with ICC-ES AC193.

E. Drop-in Expansion Anchors:
1. General:
   a. Drop-in expansion anchors shall each consist of an internally threaded, deformation-controlled expansion anchor with pre-assembled expander plug.
2. Products and Manufacturers: Provide one of the following:
   a. HDI Drop-In Anchors, by Hilti Fastening Systems, Inc.
   b. Drop-In Anchor, by Simpson Strong-Tie Company, Inc.
   c. Or equal.
3. Provide carbon steel anchors complete with nuts and washers, zinc plated, in accordance with ASTM B633, complying with physical requirements of FS

A-A-55614, Type I. Anchors shall be flush or shell type. Provide low-profile anchors for use in precast concrete planks.

F. Concrete Undercut Anchors:
   1. General:
      a. Each concrete undercut anchor shall consist of threaded stud, thick-walled expansion sleeve, expander coupler, and nut and washer. Anchors shall be pre-set type or through-set type, as shown on the Drawings.
   2. Products and Manufacturers: Provide one of the following:
      a. HDA Undercut Anchor, by Hilti Fastening Systems, Inc.
      b. DUC Ductile Undercut Anchor, by USP Structural Connectors.
      c. Or equal
   3. Provide concrete undercut expansion anchors in accordance with ACI 318 and ACI 350, Appendix D. Demonstrate suitability of cracked concrete undercut anchors in accordance with ACI 355.2 prequalification tests.
   4. Installed anchor shall exhibit form fit between bearing elements and the undercut in the concrete.
   5. Interior Dry Non-Corrosive Locations: Provide carbon steel anchors, complete with nuts and washers, zinc plated, in accordance with ASTM B633.
   6. Other Locations: Provide stainless steel anchors, complete with nuts and washers, manufactured of AISI Type 316 stainless steel or materials complying with ISO 3506-1 and having corrosion resistance equivalent to AISI Type 316 stainless steel.
   7. Concrete undercut anchors shall have a current ICC Evaluation Service Report for use in both cracked and uncracked concrete for seismic recognition for seismic design Categories A through F when tested and assessed in accordance with ICC-ES AC193.

G. Concrete Inserts:
   1. Manufacturers: Provide products of one of the following:
      a. Unistrut Corporation.
      b. Cooper B-Line, Inc.
      c. Anvil International, Inc.
      d. Or equal.
   2. Spot Concrete Inserts:
      a. Provide inserts recommended by insert manufacturer for required loading. Inserts shall comply with ANSI/MSS SP-58, malleable iron, Type 18. Spot inserts shall allow for lateral adjustment and have means for attachment to forms. Provide nuts compatible with insert and to suit threaded hanger rod sizes.
   3. Continuous Concrete Inserts:
      a. Provide inserts recommended by insert manufacturer for required loading. Inserts shall be continuous type and shall be manufactured from minimum 12-gage cold-formed channel sections, complying with ASTM A1011/A1011M, stainless steel, Grade 33, complete with

styrofoam inserts, end caps, and means for attaching to forms. Provide channel nuts compatible with insert suitable for threaded hanger rod sizes.

4. Provide inserts with plain finish.

H. Drive-In Expansion Anchors:
   1. General:
      a. Drive-In expansion anchors shall each consist of stainless steel drive pin and expanding alloy body.
   2. Products and Manufacturers: Provide one of the following:
      a. Metal HIT Anchor, by Hilti Fastening Systems, Inc.
      b. Zinc Nailon Anchor, by Simpson Strong-Tie Company, Inc.
      c. Or equal.
   3. Provide Type 304 stainless steel drive pin with zinc alloy body. Anchor shall comply with physical requirements of FS A-A-1925A, Type 1.

I. Unless approved by ENGINEER, do not use power-actuated fasteners or other types of bolts and fasteners not specified in this Section.

J. Anti-Seizing Compound:
   1. Products and Manufacturers: Provide one of the following:
      a. Pure Nickel Never-Seez, by Bostik.
      b. Nickel-Graf, by Anti-Seize Technology.
      c. Or equal.
   2. Provide pure nickel anti-seizing compound.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which materials will be installed and advise ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Anchor Bolts:
   1. Provide anchor bolts as shown or indicated in the Contract Documents, or as required to secure structural element to the appropriate anchor surface.
   2. Locate and accurately set anchor bolts using templates or other devices as required, prior to placing concrete. Wet setting of anchor bolts is unacceptable.
   3. Protect threads and shank from damage during installation and subsequent construction operations.

4. Unless otherwise shown or approved by ENGINEER anchor bolts shall comply with Table 05 05 33-B:

TABLE 05 05 33-B:
SINGLE ANCHOR ALLOWABLE LOADS ON ANCHOR BOLTS [1]

Bolt Diameter (inch)	F1554 Grade 36 F593 Type 316, Condition A				F1554 Grade 55			
	Minimum Embedment (inch)	Minimum Edge Distance and Spacing[2] (inch)	Shear[3,4] (lb)	Tension[3] (lb)	Minimum Embedment (inch)	Minimum Edge Distance and Spacing[2] (inch)	Shear[3] (lb)	Tension[3] (lb)
1/2	6	9	1,262	2,420	8.5	12.75	1,660	3,190
5/8	7.5	11.25	2,010	3,860	10.5	15.75	2,640	5,080
3/4	9	13.5	2,974	5,720	13	19.5	3,910	7,520
7/8	10.5	15.75	4,106	7,890	15	22.5	5,400	10,390
1	12	18	5,386	10,360	17	25.5	7,090	13,450
1 1/8	13.5	20.25	6,787	13,052	19	28.5	8,930	16,580
1 1/4	15	22.5	8,617	16,572	21	31.5	11,340	20,040

Table Notes:

1. Table is based on ACI 318 and ACI 350, Appendix D, f'_c = 4000 psi. Table 05 05 33-B is not applicable to anchor bolts embedded in grouted masonry.
2. Critical edge distance and spacing are indicated in the table. Capacity of anchor bolts for other combination of edge distances and spacing shall be evaluated in accordance with ACI 318 and ACI 350, Appendix D.
3. Values for shear and tension listed are not considered to act concurrently. Interaction of tension and shear will be evaluated by ENGINEER in accordance with ACI 318 and ACI 350, Appendix D.

B. Adhesive Anchors, Undercut Anchors, and Expansion Anchors – General:
   1. Prior to drilling, locate existing reinforcing steel in vicinity of proposed holes. If reinforcing conflicts with proposed hole location, obtain ENGINEER's approval of alternate hole locations to avoid drilling through or damaging existing reinforcing bars.

C. Adhesive Anchors:
   1. Comply with manufacturer's written installation instructions and the following.
   2. Drill holes to adhesive system manufacturer's recommended drill bit diameter to the specified depth. Drill holes in hammering and rotation mode with carbide-tipped drill bits that comply with the tolerances of ANSI B212.15. Core-drilled holes are unacceptable.
   3. Before setting adhesive anchor, hole shall be made free of dust and debris by method recommended by adhesive anchor system manufacturer. Hole shall be brushed with adhesive system manufacturer-approved brush and blown clean with clean, dry, oil-free compressed air to remove all dust and loose particles. Hole shall be dry as defined by adhesive system

manufacturer.

4. Before injecting adhesive, obtain ENGINEER's concurrence that hole is dry and free of oil and other contaminants.
5. Prior to injecting adhesive into the drilled hole, dispense, to a location appropriate for such waste, an initial amount of adhesive from the mixing nozzle, until adhesive is uniform color.
6. Inject adhesive into hole through injection system-mixing nozzle and necessary extension tubes, placed to bottom of hole. Discharge end shall be withdrawn as adhesive is placed but kept immersed to prevent formation of air pockets. Fill hole to depth that ensures that excess material is expelled from hole during anchor placement.
7. Twist anchors during insertion into partially-filled hole to guarantee full wetting of rod surface with adhesive. Insert rod slowly to avoid developing air pockets.
8. Provide adequate curing in accordance to adhesive system manufacturer's requirements prior to continuing with adjoining Work that could place load on installed adhesive anchors. Do not begin adjoining Work until adhesive anchors are successfully tested or when allowed by ENGINEER.
9. Limitations:
    a. At time of anchor installation, concrete shall have compressive strength (f'c) of not less than 2,500 psi.
    b. At time of anchor installation, concrete shall have age of not less than 21 days.
    c. Installation Temperature: Comply with manufacturer's instructions for installation temperature requirements. Provide temporary protection and other measures, such as heated enclosures, necessary to ensure that base material temperature complies with anchor systems manufacturer's requirements during installation and curing of adhesive anchor system.
    d. Oversized Holes: Advise ENGINEER immediately if size of drilled hole is larger than recommended by anchor system manufacturer. Cost of corrective measures, including but not limited to redesign of anchors due to decreased anchor capacities, shall be paid by CONTRACTOR.
    e. Embedment depths shall be based on installation in normal-weight concrete with compressive strength of 2,500 psi when embedded in existing concrete, and 4,000 psi when embedded in new concrete.

D. Expansion Anchors:
    1. Comply with expansion anchor manufacturer's written installation instructions and the following:
    2. Drill holes using anchor system manufacturer's recommended drill bit diameter and to the specified depth. Drill holes in hammering and rotation mode with carbide-tipped drill bits complying with tolerances of ANSI B212.15. Core drilled holes are unacceptable.
    3. Before installing anchor, hole shall be made free of dust and debris by method recommended by anchor system manufacturer. Hole shall be

brushed with anchor system manufacturer-approved brush and blown clean with clean, dry, oil-free compressed air to remove all dust and loose particles.

4. Before installing anchor, obtain ENGINEER's concurrence that hole is dry and free of oil and other contaminants.
5. Protect threads from damage during anchor installation. Drive anchors not less than four threads below surface of the attachment. Set anchors to anchor manufacturer's recommended torque using a torque wrench.

E. Concrete Undercut Anchors:
   1. Comply with undercut anchor manufacturer's written installation instructions and the following.
   2. Protect threads from damage during anchor installation.
   3. Drill hole to anchor manufacturer's specified depth and diameter using a drill bit matched to the specific anchor.
   4. Before setting the undercut anchor, hole shall be free of dust and debris using method recommended by undercut anchor system manufacturer. Hole shall be blown clean with clean, dry, oil-free compressed air to remove all dust and loose particles.
   5. Insert the anchor by hand until anchor reaches bottom of hole.
   6. Set anchor in accordance with manufacturer's instructions using anchor manufacturer's specified setting tool.
   7. Verify that the setting mark is visible on the threaded rod above the sleeve.
   8. Anchor shall be set to manufacturer's recommended torque, using a torque wrench.

F. Concrete Inserts:
   1. Comply with concrete insert manufacturer's installation instructions.
   2. Inserts shall be flush with slab bottom surface.
   3. Protect embedded items from damage during concrete placing. Ensure that embedded items are securely fastened to prevent movement during concrete placing, and ensure that embedded items do fill with concrete during concrete placing.
   4. Inserts intended for piping greater than four-inch diameter shall be provided with hooked rods attached to concrete reinforcing.

G. Anti-Seizing Compound:
   1. Provide anti-seizing compound in accordance with anti-seizing compound manufacturer's installation instructions, at locations indicated in Paragraph 2.1.B of this Section.
   2. Do not use anti-seizing compound at locations where anchor bolt or adhesive anchor will contact potable water or water that will be treated to become potable.

3.3 CLEANING

A. After embedding concrete is placed, remove protection and clean bolts and inserts.

3.4 FIELD QUALITY CONTROL

A. Site Tests:
   1. OWNER will employ testing agency to perform field quality tensile testing of production adhesive anchors at the Site, unless otherwise specified.
      a. Testing shall comply with ASTM E488.
      b. Test at least ten percent of all types of adhesive anchors. If one or more adhesive anchors fail the test, CONTRACTOR shall pay cost of testing, or at ENGINEER's option CONTRACTOR may arrange for testing paid by CONTRACTOR, for all adhesive anchors of same diameter and type installed on the same day as the failed anchor. If anchors installed on the same day as the failed anchor also fail the test, ENGINEER may require retesting of all anchors of the same diameter and type installed in the Work. CONTRACTOR shall be responsible for retesting costs.
      c. ENGINEER will direct which adhesive anchors are to be tested and indicate test load to be used
      d. Apply test loads with hydraulic ram.
      e. Displacement of post-installed anchors shall not exceed D/10, where D is nominal diameter of anchor being tested.
   2. Mechanical Anchors:
      a. Responsibility:
         1) OWNER will employ testing agency to perform field quality control tensile testing of mechanical anchors at the Site.
         2) CONTRACTOR shall demonstrate competence in installing mechanical anchors by performing field quality control tests.
      b. Perform field quality control tests on test anchors at location directed by ENGINEER. Test anchors shall not be part of the finished Work.
      c. Test not less than one installation of each type of mechanical anchor used in the Work.
         1) ENGINEER will indicate test loads to be used.
         2) Testing shall comply with ASTM E488.
         3) Apply test loads with hydraulic ram.
      d. Anchors that fail to reach the specified test load shall be considered as not passing the test and shall be re-tested at no additional cost to OWNER.
      e. Testing agency shall submit test results to CONTRACTOR and ENGINEER within 24 hours of completion of test.
   3. Correct defective Work by removing and replacing or correcting, as directed by ENGINEER.
   4. CONTRACTOR shall pay for all corrections and subsequent testing required to confirm competence in the installation of post-installed mechanical anchors.

5. Testing agency shall submit test results to CONTRACTOR and ENGINEER within 24 hours of completion of test.

B. Manufacturer's Services:
   1. Provide at the Site services of qualified adhesive manufacturer's representative during initial installation of adhesive anchor systems to train CONTRACTOR's personnel in proper installation procedures. Manufacturer's representative shall observe to confirm that installer demonstrates proper installation procedures for adhesive anchors and adhesive material.

+ + END OF SECTION + +

SECTION 05 12 00

STRUCTURAL STEEL FRAMING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install structural steel framing, including surface preparation and shop priming.
   2. Structural steel framing is the Work defined in AISC 303, Section 2, and as shown or indicated in the Contract Documents. The Work also includes:
      a. Providing openings in and attachments to structural steel framing to accommodate the Work under this and other Sections, and providing for structural steel framing items such as anchorage devices, studs, and all items required for which provision is not specifically included under other Sections.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before structural steel framing Work.

C. Related Sections:
   1. Section 03 60 00, Grouting.
   2. Section 05 05 33, Anchor Systems.
   3. Section 09 91 00, Painting.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. AISC 303, Code of Standard Practice for Steel Buildings and Bridges.
   2. AISC 325, Steel Construction Manual.
   3. AISC 360, Specification for Structural Steel Buildings.
   4. ASME B46.1, Surface Texture (Surface Roughness, Waviness and Lay).
   5. ASTM A6/A6M, Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
   6. ASTM A36/A36M, Specification for Carbon Structural Steel.
   7. ASTM A53/A53M, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   8. ASTM A108, Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
   9. ASTM A194/A194M, Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.

10. ASTM F3125, Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength.
11. ASTM A500/A500M, Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
12. ASTM A563, Specification for Carbon and Alloy Steel Nuts.
13. ASTM A572/A572M, Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
14. ASTM A992/A992M, Specification for Structural Steel Shapes.
15. ASTM F436, Specification for Hardened Steel Washers.
16. ASTM F593, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
17. ASTM F959, Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners.
18. ASTM F1852, Specification for "Twist off" Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
19. AWS D1.1/D1.1M, Structural Welding Code-Steel.
20. ISO 2859-1, Sampling Procedures for Inspection by Attributes -- Part 1: Sampling Schemes Indexed by Acceptance Quality Limit (AQL) for Lot-by-Lot Inspection.
21. ISO 4017, Hexagon Head Screws -- Product Grades A and B.
22. RCSC Specification for Structural Joints Using High-Strength Bolts.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Steel Fabricator:
      a. Structural steel fabricating plant shall possess current certificate from AISC stating that the fabrication facility complies with requirements for certification of "Standard for Steel Building Structures (STD)" of AISC's quality certification program. Fabricating plant shall maintain this certification throughout time of fabrication for this Project.
   2. Welders and Welding Processes:
      a. Qualify welding processes and welding operators in accordance with AWS D1.1/D1.1M, Section 5, Qualification.
      b. Each welder employed on or to be employed for the Work shall possess current AWS certification in the welding process with which welder will be working. Certifications shall be current and valid throughout the Work.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:

a. Complete details and schedules for fabrication and shop assembly of members and details, schedules, procedures, and diagrams showing proposed sequence of erection. Shop Drawings shall not be reproductions of Contract Drawings.
b. Include complete information for fabrication of the structure's components, including but not limited to location, type, and size of bolts, details of blocks, copes and cuts, connections, camber, holes, member sizes and lengths, and other pertinent data. Clearly indicate welds using standard AWS notations and symbols, and clearly show or indicate size, length, and type of each weld.
c. Setting drawings, templates, and directions for installing anchorage devices.

2. Product Data:
   a. Manufacturer's specifications and installation instructions for products listed below.
      1) High-strength bolts of each type, including nuts and washers.
      2) Welding electrodes and rods.
      3) Load indicator bolts and washers.

B. Informational Submittals: Submit the following:
1. Certificates.
   a. Fabricator's AISC quality certification.
   b. Welders' certifications.
   c. Certified reports of laboratory tests on previously-manufactured, identical materials, and other data as necessary, to demonstrate compliance with the Contract Documents for the materials listed below:
      1) Structural steel of each type, including certified mill reports indicating chemical and physical properties.
      2) High-strength bolts of each type, including nuts and washers.
2. Supplier Instructions:
   a. Installation data, handling, and storage instructions.
3. Source Quality Control Submittals:
   a. When performed or when required by ENGINEER, submit results of source quality control testing and inspections performed at the mill or shop.

1.5 DELIVERY, STORAGE AND HANDLING

A. Storage:
1. Protect steel members and packaged materials from corrosion and deterioration.
2. Do not store materials in or on the building or structure in manner that may cause distortion or damage to structural steel members, building, or supporting structures.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Steel Types:
   1. W-Shapes and WT-Shapes: ASTM A992/A992M.
   2. S-shapes and Channels: ASTM A572/A572M, Grade 50.
   3. Hollow Structural Sections: ASTM A500/A500M, Grade C
   4. Angles, Plates, and Bars: ASTM A36/A36M.
   5. Steel Pipe: ASTM A53/A53M, Grade B.

B. Anchorages, Fasteners, and Connectors:
   1. Anchorage Devices: Refer to Section 05 05 33, Anchor Systems.
   2. Headed Stud Type Shear Connectors: ASTM A108, Grades 1010/1020, complying with AWS D1.1/D1.1M, Section 7.
   3. High-Strength Threaded Fasteners: Heavy hexagonal structural bolts, heavy hexagon nuts, and hardened washers, as follows:
      a. Unless otherwise indicated, fasteners shall be quenched and tempered medium-carbon steel bolts, nuts and washers, complying with ASTM F3125, Grade A325, Type I, nuts complying with ASTM A563C, A563DH or A194/A194M 2H, and hardened washers complying with ASTM F436. Bolts, nuts and washers shall be hot-dip galvanized where shown or indicated.
      b. Tension control bolts, when used, shall comply with ASTM F1852.
      c. Compressible washer-type direct-tension indicators, when used, shall comply with ASTM F959, Type 325.
   4. Threaded Rod: Provide threaded rods with heavy hexagon nuts, and hardened washers, as follows:
      a. Interior and Dry Locations: Provide threaded carbon steel rods complying with ASTM A36, with heavy hex nuts complying with ASTM A563A, unless otherwise shown or indicated on the Drawings.
      b. Exterior, Buried, or Submerged Locations, or When Exposed to Wastewater: Provide stainless steel threaded rods complete with washers complying with ASTM F593, AISI Type 316, Condition A, with ASTM A194/A194M, Grade 8S (nitronic 60) stainless steel nuts. Other AISI types may be used when approved by ENGINEER.

C. Electrodes for Welding: E70XX complying with AWS D1.1/D1.1M.

2.2 FABRICATION

A. Shop Fabrication and Assembly:
   1. General:
      a. Fabricate and assemble structural assemblies in the shop to greatest extent possible. Fabricate items of structural steel in accordance with AISC 325, the Contract Documents, and as shown on approved Shop

Drawings. Provide camber in structural members as shown or indicated.

b. Properly mark and match-mark materials for field assembly. Fabricate for delivery sequence that will expedite erection and minimize handling of materials for storage and minimize handling at the Site.

c. Where finishing is required, complete the assembly, including welding of units, before commencing finishing operations. Provide finish surfaces of members exposed-to-view in the completed Work that are free of markings, burrs, and other defects.

B. Connections:

1. Shop Connections:

a. Unless otherwise shown or indicated, shop connections may be welded or high-strength bolted connections. Welds shall be 3/16-inch minimum.

b. Where reaction values of beam are not shown or indicated, connections shall be detailed to support one-half the total uniform load capacity tabulated in tables contained in AISC 325 for allowable loads on beams for the associated shape, span, and steel specified for the beam.

c. Shop-welded connections shall be detailed to eliminate or minimize eccentricity in the connection.

d. End-connection angles fastened to webs of beams and girders, and the thickness of angles, size, and extent of fasteners or shop welds, shall comply with tables of "Framed Beam Connections" in AISC 325. Connections shall be two-sided, unless otherwise shown or indicated.

2. Field Connections:

a. Field connections, unless otherwise shown or indicated, shall be made with high-strength bolts, and shall be bearing-type connections.

b. Use field welding only where shown or indicated or where approved by ENGINEER.

3. High-Strength Bolted Construction:

a. Provide high-strength threaded fasteners in accordance with RCSC Specifications for Structural Joints using High-Strength Bolts.

b. High-strength bolt design shear values shall be as specified in AISC 325 for bolts with threads in the shear plane for bearing type connections, or as specified in this Section for slip-critical connections.

c. Bolted connections shown or indicated as "SC" shall comply with slip-critical connection requirements in RCSC Specifications for Structural Joints Using High-Strength Bolts.

1) Faying surfaces shall have a Class A surface condition.

2) Slip-critical bolts shall be fully pre-tensioned to 70 percent of minimum specified tensile strength of the bolt using one of the following methods:

a) Turn of nut with matchmarking.

b) Twist-off tension control bolt (ASTM F1852).

c) Direct tension indicator washer (ASTM F959).

d. Minimum bolt diameter shall be 3/4-inch, unless otherwise shown or indicated.

4. Welded Construction: Comply with AWS D1.1/D1.1M for procedures, appearance, and quality of welds, and methods used in correcting defective welding Work.
5. Where rigid connections are required by stresses shown or indicated, provide web shear reinforcement and stiffeners in accordance with AISC 360.

C. Bracing:
1. Bracing for which stress is not shown or indicated shall have minimum two-bolt connection, or shop-welded connection of equivalent strength.
2. Vertical bracing and knee braces connecting to columns shall be on the centerline of columns, unless otherwise shown or indicated.
3. Knee braces shall be at 45-degree angle, unless otherwise shown or indicated.
4. Gussets shall be not less than 3/8-inch thick, unless otherwise shown or indicated.

D. Columns: Column shafts shall have finished bearing surface roughness not greater than 500 micro-inch in accordance with ASME B46.1, and ends shall be square within tolerances for milled ends in accordance with ASTM A6/A6M at the base and at splice lines.

E. Structural Tubing: Properly seal structural tubing to protect internal surfaces.

F. Holes and Appurtenances for Other Work:
1. Provide holes required for securing other work to structural steel framing, and for passage of other work through steel framing members, as shown on the approved Shop Drawings. If large block-outs are required and approved, reinforce the webs to develop specified shears. Provide threaded nuts welded to framing and other specialty items as shown or indicated to receive other work.
2. Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame-cut holes or enlarge holes by burning. Drill holes in bearing plates.

2.3 FINISHING

A. Surface Preparation and Shop Priming: Structural steel shall be primed in the shop. For surface preparation and shop priming requirements refer to Section 09 91 00, Painting.

2.4 SOURCE QUALITY CONTROL

A. Inspection and Testing at the Mill or Shop:

1. Perform fabricator's standard procedures for source quality control, including inspections and testing.
2. Materials and fabrication procedures shall be subject to inspection and tests in mill and shop, conducted by a qualified inspection laboratory. Such inspections and tests do not relieve CONTRACTOR of responsibility for providing the Work in accordance with the Contract Documents.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which the Work will be performed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 ERECTION

A. General: Comply with AISC 303, AISC 360, and the Contract Documents.

B. Temporary Shoring and Bracing: Provide temporary shoring and bracing members with connections of sufficient strength to bear imposed loads. Remove temporary members and connections when permanent members are in place and final connections are made. Provide temporary guy-lines to achieve proper alignment of structures as erection proceeds.

C. Temporary Planking: Provide temporary planking and working platforms as necessary to effectively complete the Work. Provide sufficient planking to comply with Laws and Regulations, and provide tightly-planked substantial floor within two stories or 30 feet, whichever is less, below each tier of steel beams on which work is performed.

D. Anchorage Devices:
1. Provide anchorage devices, including anchor bolts, and other connectors required for securing structural steel to foundations and other in-place construction.
2. Provide templates and other devices necessary for presetting anchorage devices to accurate locations.
3. Refer to Section 05 05 33, Anchor Systems, for anchorage requirements.

E. Setting Bases and Bearing Plates:
1. Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen to improve bond to surfaces. Clean bottom surface of base and bearing plates.
2. Set loose and attached base plates and bearing plates for structural members on steel wedges or other adjusting devices.

3. Tighten anchorage devices after supported members are positioned and plumbed. Do not remove wedges or shims, but if protruding, cut off flush with edge of base or bearing plate prior to packing with grout.
4. Place grout between bearing surfaces and bases or plates in accordance with Section 03 60 00, Grouting. Finish exposed surfaces, protect installed materials, and allow to cure in accordance with grout manufacturer's instructions, and as otherwise required.
5. Do not use leveling plates or wood wedges.

F. Field Assembly:
1. Set structural frames accurately to the lines and elevations shown and indicated. Align and adjust the various members forming part of a complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
2. Level and plumb individual members of structure within tolerances as specified in AISC 325. For members requiring accurate alignment, provide clip angles, lintels, and other members, with slotted holes for horizontal adjustment at least 3/8-inch in each direction, or more when required.
3. Splice members only where shown or indicated.

G. Erection Bolts: On exposed-to-view, welded construction, remove erection bolts, fill holes with plug welds, and grind smooth at exposed surfaces.

H. Connections:
1. Comply with AISC 325 for bearing, adequacy of temporary connections, alignment, and the removal of paint on surfaces adjacent to field welds.
2. Do not enlarge inadequate holes in members by burning or by using drift pins, except in secondary bracing members. Ream holes that must be enlarged to admit bolts.

I. Gas Cutting: Do not use gas-cutting torches for correcting fabrication defects in structural framing. Cutting will be allowed only on secondary members that are not under stress, as approved by ENGINEER. Finish gas-cut sections equal to a sheared appearance, when allowed.

J. Touch-up Painting:
1. Unless otherwise specified, comply with touch-up painting requirements in Section 09 91 00, Painting.
2. Immediately after erection, clean field welds, bolted connections, and damaged or abraded areas of shop-applied paint. Apply paint to exposed areas with the same paint or coating material applied in the shop. Apply by brush or spray to provide not less than the dry film thickness specified in Section 09 91 00, Painting.

3.3 FIELD QUALITY CONTROL

A. Site Tests and Inspections: Materials and erection procedures shall be subject to inspection and tests at the Site conducted by qualified inspection laboratory. Such inspections and tests do not relieve CONTRACTOR of responsibility for providing the Work in accordance with the Contract Documents.

1. OWNER will engage independent testing and inspection laboratory to inspect high-strength bolted connections and welded connections and to perform tests and prepare test reports.
    a. Testing laboratory shall conduct and interpret tests, prepare and state in each report of results whether test specimens comply with the Contract Documents and specifically indicate all deviations.
    b. High-strength Bolted Connections: Each high-strength bolted connection shall be visually inspected. Inspection shall identify whether the Work complies with Sections 2, 3, and 8 of RCSC Specifications for Structural Joints Using High-Strength Bolts.
        1) For connections that are slip-critical or subject to axial tension, inspector shall verify proper pre-tensioning.
        2) For connections that are not slip critical and not subject to direct tension, bolt does not need to be inspected for bolt tension, but shall be visually inspected to verify that plies of connected elements are in snug contact.
        3) Where bolts or connections are defective, correct defective workmanship, remove and replace, or correct as required defective bolts and connections. CONTRACTOR shall pay for correcting defective Work and tests required to confirm integrity of corrected Work.
    c. Welds: Each weld shall be visually inspected.
        1) Where visually defective welds are evident, further test welds using non-destructive methods. If welds are determined to be acceptable, OWNER will pay for non-destructive testing. When welds are defective, CONTRACTOR shall pay for non-destructive testing.
        2) Correct, or remove and replace, defective Work as directed by ENGINEER.
        3) CONTRACTOR shall pay for corrections and subsequent tests required to determine weld compliance with the Contract Documents.

+ + END OF SECTION + +

SECTION 05 21 00

STEEL JOIST FRAMING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install steel joist framing.
   2. Extent of steel joist framing is shown or indicated on the Drawings, including basic layout.
   3. Types of joists required are:
      a. K-series open-web steel joists.
   4. The Work also includes:
      a. Providing attachments to steel joist framing to accommodate the Work under this and other Sections and providing for steel joist framing all items required for which provision is not included under other Sections.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before steel joist framing Work.

C. Related Sections:
   1. Section 05 05 33, Anchor Systems.
   2. Section 05 12 00, Structural Steel Framing.
   3. Section 09 91 00, Painting.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. AISC Research Council on Structural Connections (RCSC) Specifications for Structural Joints Using High-Strength Bolts.
   2. ASTM A307, Specification for Carbon Steel Bolts, Studs, and Threaded Rod, 60,000 PSI Tensile Strength.
   3. ASTM F3125, Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength.
   4. AWS D1.1/D1.1M, Structural Welding Code – Steel.
   5. SJI Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Fabricator: Materials and products shall be fabricated by firm regularly engaged in manufacturing the types of steel joist required. Manufacturer shall have at least two years of experience fabricating joists similar to those required.
2. Welders and Welding Work:
    a. Qualify welding processes and welding operators in accordance with AWS D1.1/D1.1M, Section 5 Qualifications.
    b. Provide certification that welders to be employed on the Work have satisfactorily passed AWS qualification tests within previous 12 months. Ensure that all certifications are current.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
    1. Shop Drawings:
        a. Detailed drawings showing layout of joist units, headers, special connections, jointing and accessories. Include the mark, number, type, location, and spacing of joists and bridging.
        b. Provide location drawings for installing anchorage devices.
    2. Product Data:
        a. Copies of manufacturer's specifications and product data for each type of joist and its accessories.

B. Informational Submittals: Submit the following:
    1. Certifications:
        a. Manufacturer's certification that joists comply with SJI Specifications.
        b. Copies of AWS certification for each welder.
    2. Manufacturer's Instructions:
        a. Copies of manufacturer's installation instructions for each type of joist and its accessories.
    3. Site Quality Control Submittals:
        a. Submit results of testing and inspection performed at the Site by testing agency employed by CONTRACTOR.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle steel joists as recommended in SJI Specifications and the Contract Documents. Handle and store joists to avoid deforming members and avoid imposing excessive stresses.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Steel: Comply with SJI Specifications and applicable requirements of Section 05 12 00, Structural Steel Framing.

B. Unfinished Threaded Fasteners: ASTM A307, Grade A, regular hexagon type, low carbon steel.

C. High-Strength Threaded Fasteners: ASTM F3125, Grade A325 heavy hexagon structural bolts with nuts and hardened washers.

2.2 MANUFACTURERS

A. Products and Manufacturers: Provide one of the following:
   1. Open Web Steel Joists, K-Series, by Vulcraft, Division of Nucor Corporation.
   2. Open Web Steel Joists, K-Series, by New Millennium Building Systems, Division of Steel Dynamics, Inc.
   3. Or equal.

2.3 FABRICATION

A. General: Fabricate steel joists in accordance with SJI Specifications and the Contract Documents.

B. Bottom Chord: Joists with bottom chords consisting of round bars are not allowed.

C. Holes in Chord Members:
   1. Provide holes in chord members where shown or indicated for securing other work to steel joists.

D. Extended Ends:
   1. Provide extended ends on steel joists where shown or indicated, complying with manufacturer's standards and requirements of applicable SJI Specifications and load tables.

E. Ceiling Extension:
   1. Provide ceiling extensions in areas having ceilings attached directly to steel joist bottom chord. Provide either an extended bottom chord element or separate unit, to suit manufacturer's standards, of sufficient strength to support ceiling construction. Extend ends to within 1/2-inch of finished wall surface, unless otherwise shown or indicated.

F. Bridging:
   1. Provide horizontal or diagonal-type bridging for open web joists, complying with SJI Specifications.

G. End Anchorage: Provide end anchorages to secure joists to adjacent construction, complying with SJI Specifications, unless otherwise shown or indicated in the Contract Documents.

H. Header Units: Provide header units to support interrupted open web joists at openings in floor or roof system not framed with steel shapes.

2.4 FINISHING

A. Surface Preparation and Shop Priming: Perform surface preparation and apply primer coat to steel joists in the shop, in accordance with specified in Section 09 91 00, Painting.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine substrate and conditions under which the Work is to be performed and notify ENGINEER in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 ERECTION

A. Install and secure steel joists in accordance with SJI Specifications, approved Shop Drawings, and the Contract Documents.

B. Anchors:
   1. Provide anchorage devices to be installed in concrete and masonry construction. Furnish templates for accurate location of anchorages in other Work.
   2. Comply with Section 05 05 33, Anchor Systems.

C. Placing Joists:
   1. Do not install steel joists until supporting Work is in place and secured. Place joists on supporting Work, adjust, and align in accurate locations and spacing before permanently fastening.
   2. Provide temporary bridging, connections, and anchors to ensure lateral stability during construction.

D. Bridging:
   1. Install bridging simultaneously with joist erection.

E. Fastening Joists:
   1. Field-weld joists to supporting steel framework in accordance with SJI Specifications for type of joists used. Coordinate welding sequence and procedure with placing of joists.
   2. Bolt joists to supporting steel framework in accordance with SJI Specifications for type of joists used.
      a. Provide unfinished, threaded fasteners for bolted connections, except where high-strength bolts or welded connections are shown or indicated in the Contract Documents.

F. Touch-up Painting:

1. Unless otherwise shown or indicated in the Contract Documents, comply with requirements for touch-up painting in Section 09 91 00, Painting.
2. After joist installation, paint the following: all field-bolted heads and nuts, welded areas, and abraded or rusty surfaces on joists and steel supporting members. Wire-brush surfaces and clean with solvent before painting. Paint exposed areas with the same paint used for shop painting. Apply by brush or spray to provide minimum dry film thickness specified in Section 09 91 00, Painting.

3.3 FIELD QUALITY CONTROL

A. The OWNER will engage an independent testing and inspection agency to inspect high-strength bolted connections and welded connections and to perform tests and prepare test reports.
   1. All high-strength bolted connections shall be visually inspected. Inspection shall be made to verify compliance with Sections 2, 3 and 8 of AISC RCSC Specifications for Structural Joints Using ASTM F3125, Grade A325 or A490 Bolts. For connections that are slip critical or subject to axial tension, inspector shall verify that proper pretensioning was provided. For connections that are not slip critical nor subject to direct tension, bolt does not need to be inspected for bolt tension, and shall be visually inspected to verify that plies of connected elements have been brought into snug contact. Where bolts and connections Work are defective, CONTRACTOR shall correct improper workmanship, remove and replace, or correct as instructed, all defective bolts and connections. CONTRACTOR shall pay for all corrections and subsequent tests required to confirm integrity of connections.
   2. Testing agency shall conduct and interpret tests and shall state in each report whether test specimens comply with requirements, and shall specifically state all deviations.
   3. Provide access for special inspectors and testing agency to places where steel joist Work is fabricated or produced.
   4. Testing agency may inspect structural steel joists at fabricator's shop before shipment; however, ENGINEER reserves the right, at any time before completion and readiness for final payment, to reject defective Work.
   5. Welds shall be visually inspected. Where defective welds are observed, welds shall be tested using non-destructive methods by certified testing laboratory. If welds are found to be satisfactory, OWNER will pay for testing. Where welds are defective, CONTRACTOR shall pay for testing. CONTRACTOR shall correct defective Work, remove and replace, or correct as instructed, all welds found to be defective. CONTRACTOR shall pay for all corrections and subsequent tests required to confirm weld integrity.
   6. Correct defective structural steel joist Work which inspection and laboratory test reports indicate do not comply with the Contract Documents. Perform additional tests, as necessary, to confirm non-compliance of the original Work, and as necessary to demonstrate compliance of corrected Work.

+ + END OF SECTION + +

SECTION 05 31 23

STEEL ROOF DECKING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install galvanized steel roof decking.
   2. Steel roof decking Work shall include all incidentals required to complete the Work. The Work also includes:
      a. Cutting and flashing of openings to accommodate the Work under this and other Specification Sections, and providing for the steel roof decking all items required for which provision is not specifically included under other Sections.

B. Coordination:
   1. Review installation procedures under this and other Specification Sections and coordinate the installation of items to be installed with or before steel roof decking Work.

C. Related Sections:
   1. Section 05 12 00, Structural Steel Framing.
   2. Section 09 91 00, Painting.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. AISI S100, North American Specification for the Design of Cold-Formed Steel Structural Members, with Supplements.
   2. ANSI/SDI RD1.0, Steel Roof Deck.
   3. ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   4. ASTM B633, Specification for Electrodeposited Coatings of Zinc on Iron and Steel
   5. ASTM C1513 Specification for Steel Tapping Screws for Cold-Formed Steel Framing Connections
   6. ASTM F1941, Specification for Electrodeposited Coatings on Mechanical Fasteners, Inch and Metric
   7. AWS D1.3/D1.3M, Structural Welding Code – Sheet Steel.
   8. ICC-ES AC43, Acceptance Criteria for Steel Deck Roof and Floor Systems.
   9. ICC-ES AC70, Acceptance Criteria for Fasteners Power Driven Into Concrete, Steel, and Masonry Elements.

10. ICC-ES AC118, Acceptance Criteria for Tapping Screw Fasteners.
11. MIL-P-21035B, Paint, High Zinc Dust Content Galvanizing Repair.
12. SAE J78, Steel Self-Drilling Tapping Screws.
13. SDI MOC2, Manual of Construction with Steel Deck.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer:
      a. Manufacturer shall have not less than five years experience producing products substantially similar to those required and, upon ENGINEER's request, shall submit evidence of not less than five installations in satisfactory operation for not less than five years each.
   2. Erector:
      a. Engage an experienced erector to perform the Work of this Section who has specialized in erecting and installing steel roof decking similar to that required for the Project and who is acceptable to the steel roof decking manufacturer.
      b. Submit name and qualifications to ENGINEER, with the following information for not less than three successful, completed projects:
         1) Names and telephone numbers of owners, and architects or engineers responsible for each project.
         2) Approximate contract cost of the steel roof decking work.
         3) Area of roof decking installed.
   3. Welders and Welding Processes:
      a. Qualify welding processes and welding operators in accordance with AWS D1.3/D1.3M.
      b. Submit certification that each welder employed on or to be employed for the Work possesses current AWS certification in the welding process with which welder will be working. Certifications shall be current and valid throughout the Work.

B. Component Supply and Compatibility:
   1. Obtain all products required in this Section, regardless of component manufacturer, from a single steel roof decking manufacturer.
   2. Steel roof decking manufacturer shall prepare, or review and approve, all Shop Drawings and other submittals for components furnished under this Section.
   3. Components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by steel roof decking manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Erection drawings showing the extent of coverage of each section of metal deck. Show deck cross section, size and spacing of welds to

supports, side laps, and end laps. Show adaptations around openings and other special conditions that detail the method of fastening sections to supporting construction, the procedure for attaching end closure plates and butt joint cover plates, miscellaneous flashing, and accessories.

b. Listing of all mechanical fastener products proposed for use in the Work including product type, and intended location in the Work.

2. Product Data:
   a. Manufacturer's catalogs, literature, specifications, load tables, and dimension diagrams for the following:
      1) Steel Deck and accessories; including load tables that indicate uniform load capacities and diaphragm shear strengths for the appropriate deck, span conditions, and fastening system. Include the section properties for the specified deck.
      2) Mechanical Fasteners: Including acceptable base material conditions and thickness ranges for each type of fastener, copies of valid ICC-ES reports that provide evaluation criteria, load carrying capacities and installation requirements.
3. Samples:
   a. Steel Deck: Submit Sample, 12 inches by 12 inches, of each type of deck proposed for use in the Work.
   b. Mechanical Fasteners: Representative Samples of mechanical fasteners proposed for use in the Work.
   c. Review will be for type and finish only. Compliance with other requirements is exclusive responsibility of CONTRACTOR.

B. Informational Submittals: Submit the following:
1. Qualifications Statements: As specified in Paragraph 1.3.A of this Section for the following:
   a. Manufacturer, when requested by ENGINEER.
   b. Erector.
   c. Welders and welding processes.

PART 2 – PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. System Description:
1. Provide steel roof decking systems at the locations shown on the Drawings.
2. Deck configuration is indicated in Paragraph 2.3.A of this Section.

B. Design and Performance Criteria:
1. Unless otherwise shown or indicated, material, design, fabrication and erection shall be in accordance with AISI S100 and ANSI/SDI RD1.0.
2. Determine the properties of steel roof deck sections on the basis of the effective design width as limited by AISI S100. Provide not less than the

deck section properties shown, including section modulus and moment of inertia per foot of width.

3. Allowable Deflection: The lesser of the following: 1/240 of span (centerline to centerline), or one inch, under the uniformly-distributed design live load. Spans are to be considered center-to-center of supports.
4. Allowable Diaphragm Shear Strength: Provide deck, fasteners and fastener layout that provide a shear strength that meets or exceeds the design shear strength shown or indicated.

2.2 MATERIALS

A. Galvanized Steel Sheet:
   1. Material: ASTM A653/A653M, structural steel, with yield strength of not less than 33 ksi.
   2. Zinc Coating shall be G60 on each side.
   3. Minimum nominal thickness before coating shall be 20-gage, unless otherwise indicated.

B. Deck shall have sheet lengths that are continuous over three or more spans, wherever practicable.

C. Accessories shall be formed of the same material used for the steel deck.

D. Miscellaneous Steel Shapes: Refer to Section 05 12 00, Structural Steel Framing.

E. Galvanizing Repair Paint: High zinc-dust content paint for repairing damaged galvanized surfaces. Paint shall be in accordance with MIL-P-21035B.

F. Flexible Closure Strips for Deck: Manufacturer's standard vulcanized, closed-cell, synthetic rubber.

G. Mechanical Fasteners: Anchorage of the steel deck using mechanical fasteners, either powder actuated, pneumatically driven, or screws, will be allowed in lieu of welding, when the fasteners comply with the following:
   1. Design Requirements: Comply with ANSI/SDI RD1.0. Type and spacing of fastener shall be equal to or greater than the puddle weld method shown or specified. Documentation in the form of ICC-ES reports, test data, diaphragm design tables or design charts shall be submitted by the fastener manufacturer as a basis for obtaining approval for this method of attachment.
   2. Powder-Actuated and Pneumatic Fasteners:
      a. Fasteners shall have a current evaluation report by ICC-ES for use in fastening metal deck to steel substrate, as tested and assessed in accordance with ICC-ES AC43, and ICC-ES AC70.
      b. Products and Manufacturers: Provide one of the following.
         1) X-ENP-19 L15, X-HSN 24 Powder Actuated Fasteners, by Hilti, Inc.

2) K65056, K65062, SD65075, K64062, SDK63075 Air/Safe Fastening System, by Pneutek.
3) Or equal.

c. Substrate: Do not use powder-actuated or pneumatically-driven fasteners if supporting structural steel substrate is less than 1/8-inch thick.
d. Material: Hardened carbon steel.
e. Hardness: Minimum 52 Rockwell.
f. Shape and Manufacturing Process: Knurled shank, forged point. Manufacturing process shall include steps to ensure fastener ductility and quality.
g. Shank Diameter: 0.145-inch minimum.
h. Head/Washer Diameter: Nominal 1/2-inch minimum.
i. Finish: Zinc-coated complying with ASTM B633, Sc. 1, Type III.

3. Self-Drilling Self Tapping Screws:
a. Fasteners shall have a current evaluation report by ICC-ES for use in fastening metal deck side laps, as tested and assessed in accordance with ICC-ES AC43 and ICC-ES AC118.
b. Products and Manufacturers: Provide one of the following.
1) S-SLC 01 M HWH, S-SLC 02 M HWH Side Lap Connectors, by Hilti, Inc.
2) Grabber Self Drilling Screws, by Grabber Construction Products, Inc.
3) Or equal.
c. Manufacture screws from heat-treated steel wire. Comply with SAE J78 and ASTM C1513.
d. Substrate: Do not use screw fasteners if the supporting structural steel substrate is greater than 1/8 inch thick.
e. Material: Carbon steel.
f. Size: Provide number 10 screws for deck gages 22 thru 26, number 12 screws for thicknesses greater than 22 gage.
g. Finish: Zinc-coated in accordance with ASTM F1941.

2.3 FABRICATION

A. General:
1. Form deck units in lengths to span three or more supports with flush, telescoped or nested two-inch end laps and nesting side laps, unless otherwise shown. Provide deck configurations complying with SDI MOC2, and as specified in this Section.

B. Wide-Rib Deck:
1. Depth: Approximately 1.5 inches; ribs spaced approximately six inches on centers; width of rib opening at roof surface not more than 2.5 inches; width of bottom rib surface not less than 1.75 inches.
2. Products and Manufacturers: Provide one of the following:
a. Type B Roof Deck, by Vulcraft, a Division of Nucor Corporation.

b. Type B Roof Deck, by New Millennium Building Systems, a Division of Steel Dynamics, Inc.
c. Type B Roof Deck, by DACS, Inc.
d. Or equal.

C. Roof Sump Pans:
1. Fabricate each from one piece galvanized sheet steel, not less than 14-gage thickness, of the same quality as deck units, with level bottoms and sloping sides to direct water flow to drain, unless otherwise shown.
2. Provide sump pans of adequate size to receive roof drains and with bearing flanges not less than three inches wide.
3. Recess pans not less than 1.5 inches below roof deck surface, unless otherwise shown or required by deck configuration.
4. Holes for drains shall be cut in the field.

D. Cant Strips:
1. Fabricate cant strips of galvanized sheet steel, not less than 20-gage thickness, of the same quality as the deck units.
2. Bend cant strips to form a 45-degree cant not less than five inches wide, with top and bottom flanges not less than two inches wide, unless otherwise shown.
3. Provide cant strips in ten-foot lengths, where possible.

E. Steel Filler and Closure Strips:
1. Fabricate steel closure strips of galvanized sheet steel, not less than 20-gage thickness, of same quality as the deck units.
2. Form to the configuration required to provide tight-fitting closures at open ends and sides of decking.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work will be performed and notify ENGINEER in writing of unsatisfactory conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. General:
1. Install roof deck units and accessories in accordance with manufacturer's recommendations, and approved Shop Drawings and other approved submittals, and in accordance with the Contract Documents.
2. Install deck in a continuous operation to avoid delaying the construction.

B. Placing Roof Deck Units:

1. Place roof deck units on supporting steel framework and adjust to final position with ends bearing on supporting members and accurately aligned end to end before permanently fastening. Lap ends not less than two inches. Do not stretch or contract the side-lap interlocks. Place deck units flat and square, secured to adjacent framing without warp or excessive deflection.
    a. Do not place deck units on concrete or masonry supporting structure until concrete or masonry has cured properly and is dry.
2. Form deck sheet at longitudinal sides in such manner that sides will overlap and interlock, and preclude the possibility of the dripping of cement paste from the concrete placed on it. End laps shall occur over bearings only.
3. Coordinate and cooperate with structural steel erector in locating deck bundles to prevent overloading of structural members
4. Do not use deck units for storage or working platforms until permanently secured.
5. Steel deck shall provide a continuous uniform slope, with practically flush top surfaces, and shall be installed in straight and continuous rows, as far as practicable, with ribs at right angles to the supporting members.
6. Erect and properly align deck prior to fastening deck to supporting steel.

C. Fastening Deck Units: Fasten steel deck units to steel framework by the arc-welding process or with approved mechanical fasteners.
    1. Welding:
        a. Welds shall be free of sharp points and edges. Clean welds immediately, by chipping or wire brushing, and coat welds with zinc dust type primer paint.
        b. Welding shall be performed by qualified welders in accordance with AWS D1.3.
        c. Weld deck units to the steel supporting members using the welding pattern shown.
        d. Weld deck units to the steel supporting members by 5/8-inch diameter fusion area puddle welds at each deck rib, unless otherwise shown.
        e. Weld deck units to parallel framing supports with 5/8-inch diameter fusion area puddle welds at 12 inches on centers, unless otherwise shown.
        f. Weld deck units at sidelaps with 5/8-inch diameter fusion area puddle welds at mid-span, unless otherwise shown.
        g. Weld deck units to perimeter edge supports with 5/8-inch diameter fusion area puddle welds at 12 inches on centers, unless otherwise shown.
        h. Weld connection angles and plates to supporting members and deck with 5/8-inch diameter fusion welds at 12 inches on centers, unless otherwise shown.
        i. Before insulation is installed, replace welds found to be defective.
    2. Mechanical Fastening:
        a. Comply with manufacturer's requirements for installation procedures for mechanical fastener attachment methods.
        b. Fasten deck units to the steel supporting members using the fastener pattern shown.

c. Fasten deck units to the steel supporting members with specified fasteners at each deck rib, unless otherwise shown.
d. Fasten deck units to parallel framing supports with specified fasteners at 12 inches on centers, unless otherwise shown.
e. Fasten deck units at sidelaps with specified self-drilling screws at 12 inches on centers, unless otherwise shown.
f. Fasten deck units to perimeter edge supports with specified fasteners at 12 inches on centers, unless otherwise shown.
g. Fasten connection angles and plates to supporting members and deck with specified fasteners at 12 inches on centers, unless otherwise shown.
h. Before insulation is installed, replace all fasteners found to be defective.

D. Cutting and Fitting:
1. Cut and fit roof deck units and accessories around other work projecting through or adjacent to the roof deck. Provide neat, square and trim cuts.

E. Reinforcing at Openings:
1. Provide additional steel reinforcing and closure pieces as required for strength, continuity of deck, and to support other work, unless otherwise shown.
2. Reinforce roof deck around openings less than 15 inches in any dimension by means of a flat steel sheet placed over the opening and fastened to the top surface of deck. Provide steel sheet of the same quality as deck units, not less than 20-gage thickness, and not less than 12 inches wider and 12 inches longer than the opening. Provide welds or mechanical fasteners at each corner and spaced not more than 12 inches on centers along each side.

F. Roof Sump Pans:
1. Place roof sump pans over openings provided in the roof deck and fasten to the top deck surface. Space fasteners or welds not more than 12 inches on centers with at least one attachment at each corner. Cut opening in the bottom of roof sump to accommodate drain size shown.

G. Cant Strips:
1. Fasten cant strips to the top surface of roof deck, and secure to wood nailers with galvanized steel screws, and to steel framing with welds or galvanized steel self-tapping screws. Space fasteners or welds at 12 inches on centers and lap end joints not less than three inches and secure with galvanized steel sheet metal screws.

H. Closure Strips:
1. Provide steel closure strips at open uncovered ends and edges of roof deck, and in the voids between deck and other construction. Fasten into position to provide a complete deck installation.

****

NTS: DELETE PARAGRAPH "a", BELOW, WHEN FIRE-RESISTANCE RATED CONSTRUCTION IS REQUIRED OR FLEXIBLE CLOSURES ARE NOT ALLOWED.
****

a. Provide flexible closure strips, instead of steel closures, at CONTRACTOR's option, wherever such use will ensure complete closure. Install with adhesive in accordance with manufacturer's instructions.

I. Roof Insulation Support:
   1. Provide steel closure strips for supporting roof insulation where rib openings in the top surface of roof deck occur adjacent to edges and openings. Fasten closure strips into position.

J. Touch-up Painting:
   1. After completion of roof deck installation, wire-brush clean and paint scarred and damaged areas, welds, and rust spots on supporting steel members in accordance with Section 09 91 00, Painting.
   2. Touch-up galvanized top and bottom surfaces of deck units with galvanizing repair paint applied in accordance with the paint manufacturer's instructions and recommendations.

3.3 FIELD QUALITY CONTROL

A. OWNER will employ testing laboratory to inspect welded connections and to perform tests and prepare test reports.
   1. All welds will be subject to visual inspection. Where visually deficient welds are observed, welds will be tested using non-destructive methods by certified testing laboratory. If welds are found to be satisfactory, OWNER will pay for testing. Where welds are found unacceptable or deficient, CONTRACTOR will pay for testing. CONTRACTOR shall correct improper workmanship, remove and replace, or correct as instructed, welds found unacceptable or deficient. CONTRACTOR shall pay for corrections and subsequent tests required to confirm the integrity of the weld.
   2. Correct deficiencies in steel roof deck Work that inspection and laboratory test reports indicate do not comply with the Contract Documents. Perform additional tests as required to confirm non-compliance of the original Work, and as may be necessary to demonstrate compliance of corrected Work.
   3. Work not in compliance with the Contract Documents and, where the Contract Documents do not include detailed requirements, Work that is not in accordance with generally-accepted standards of the trade, will be deemed defective. All Work that is defective shall be corrected or replaced as directed by ENGINEER. Corrections, re-design, and replacement of defective Work shall be at CONTRACTOR's expense

+ + END OF SECTION + +

SECTION 05 50 00 – METAL FABRICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This section includes but is not necessarily limited to the following metal fabrications:

1. Handrails and guards.
2. Gates and fence panels.
3. Ladders and ladder cages.
4. Rough hardware.
5. Miscellaneous steel framing and supports for applications not specified in other Sections.

1.3 COORDINATION

A. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Shop coating products.
2. Grout.
3. Post-installed anchors.

B. Shop drawings detailing fabrication and erection of each metal fabrication indicated. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other sections.

1.5 INFORMATIONAL SUBMITTALS

A. Welding Certificates: Copies of certificates for welding procedures and personnel.

B. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: Firm experienced in successfully producing metal fabrications similar to that indicated for this Project, with sufficient production capacity to produce required units without causing delay in the Work.

B. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."
2. AWS D1.3, "Structural Welding Code--Sheet Steel."

C. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.7 PROJECT CONDITIONS

A. Field Measurements: Check actual locations of walls and other construction to which metal fabrications must fit, by accurate field measurements before fabrication; show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay of Work.

1. Where field measurements cannot be made without delaying the Work, guarantee dimensions and proceed with fabrication of products without field measurements. Coordinate construction to ensure that actual opening dimensions correspond to guaranteed dimensions. Allow for trimming and fitting.

1.8 SEQUENCING AND SCHEDULING

A. Sequence and coordinate installation of handrails as follows:

1. Install handrails only on completed construction. Do not support handrails temporarily by any means not satisfying structural performance requirements.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Thermal Movements: Allow for thermal movement resulting from the following maximum change (range) in ambient temperature in the design, fabrication, and installation of installed metal assemblies to prevent buckling, opening up of joints, and overstressing of welds and fasteners. Base design calculations on actual surface temperatures of metals due to both solar heat gain and nighttime sky heat loss.

1. Temperature Change (Range): 180 deg F (100 deg C), material surfaces.

2.2 METALS, GENERAL

A. Metal Surfaces, General: For metal fabrications exposed to view in the completed Work, provide materials selected for their surface flatness, smoothness, and freedom from stains, discolorations, or surface blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

2.3 CARBON STEEL AND IRON

A. Steel Plates, Shapes, and Bars: ASTM A 36 (ASTM A 36M).

B. Steel Pipe: ASTM A 53, standard weight (Schedule 40), unless otherwise indicated, or another weight required by structural loads.

C. Steel Sheet, Cold Rolled: ASTM A 1008/A 1008M, either commercial steel, Type B, or structural steel, Grade 25 (Grade 170), exposed.

D. Weathering Steel: High strength low-alloy structural steel with improved atmospheric corrosion resistance, ASTM A242 or ASTM A606-4.

E. Castings: Either gray or malleable iron, unless otherwise indicated.

1. Gray Iron: ASTM A 48/A 48M, Class 30, unless another class is indicated or required by structural loads.
2. Malleable Iron: ASTM A 47/A 47M.

F. Cast-in-Place Anchors in Concrete: Anchors of type indicated below, fabricated from corrosion-resistant materials capable of sustaining, without failure, the load imposed within

a safety factor of 4, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

1. Threaded or wedge type; galvanized ferrous castings, either ASTM A 47 (ASTM A 47M) malleable iron or ASTM A 27 (ASTM A 27M) cast steel. Provide bolts, washers, and shims as required, hot-dip galvanized per ASTM A 153.

2.4 FASTENERS

A. General: Unless otherwise indicated, provide Type 316 stainless-steel fasteners .

B. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, nuts and flat washers; ASTM F 593 (ASTM F 738M) for bolts and ASTM F 594 (ASTM F 836M) for nuts, Alloy Group 1 (A1).

C. Phillips Flat-Head Machine Screws: Stainless steel, ASME B18.6.3 (ASME B18.6.7M).

D. Post-Installed Anchors: Chemical anchors.

1. Material for Exterior Locations and Where Stainless Steel is Indicated: Alloy Group 2 (A4) stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).

E. Anchor Bolts: ASTM F 1554, Grade 36.

1. Provide hot-dip zinc-coated anchor bolts.

2.5 SHOP COATINGS

A. Shop Primer: Universal modified-alkyd primer.

1. Moore's IMC Alkyd Metal Primer No. M06; Benjamin Moore.
2. Kem Kromik Universal Metal Primer B50NZ6/B50WZ1; Sherwin-Williams.

2.6 ACCESSORY MATERIALS

A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include the following or Equal:

a. B-6 Construction Grout; W. R. Bonsal Co.
b. Sonogrout 14; Sonneborn Building Products--ChemRex, Inc.

B. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

2.7 FABRICATION, GENERAL

A. Form metal fabrications from materials of size, thickness, and shapes indicated but not less than that needed to comply with performance requirements indicated. Work to dimensions indicated or accepted on shop drawings, using proven details of fabrication and support. Use type of materials indicated or specified for various components of each metal fabrication.

B. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

C. Form exposed work true to line and level, with accurate angles and surfaces and straight edges. Tolerances for installed work shall comply with the following:

1. Variation from required lines shall not exceed 1/8" in 5 feet, or 1/4" maximum for the overall length of the fabricated item, whichever is less.

D. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

E. Ease exposed edges to a radius of approximately 1/32 inch (1 mm), unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

F. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing, and contour of welded surface matches those adjacent.

G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners wherever possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.

H. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

I. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

J. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.

2.8 CARBON STEEL FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
2. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

B. Shop Priming: Items that are not hot-dip galvanized shall be shop primed.

1. Preparation: Comply with minimum requirements indicated below for SSPC surface preparation specifications and, where indicated, environmental exposure conditions of installed metal fabrications:

   a. Exteriors (SSPC Zone 2A): SSPC-SP3 "Power Tool Cleaning."
   b. Interiors (SSPC Zone 1A): SSPC-SP3 "Power Tool Cleaning."

2. Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

   a. Stripe paint all edges, corners, crevices, bolts, welds, and sharp edges.
   b. Dry film thickness of completed primer coat shall be not less than the minimum thickness recommended by the primer manufacturer.

2.9 HANDRAILS AND GUARDS

A. General: Fabricate handrails and guards to comply with requirements indicated.

B. Interconnect railing and handrail members by butt-welding or welding with internal connectors, at fabricator's option, unless otherwise indicated.

1. At tee and cross intersections, notch ends of intersecting members to fit contour of pipe to which end is joined, weld all around and grind smooth.

C. Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

D. Provide wall returns at ends of wall-mounted handrails, unless otherwise indicated.

E. Close exposed ends of pipe by welding 3/16 inch thick steel plate in place or by use of prefabricated fittings, except where clearance of end of pipe and adjoining wall surface is 1/4 inch or less.

F. Flanges, Fittings, and Anchors: Provide end closures, flanges, miscellaneous fittings, and anchors for interconnections of pipe and attachment of railings and handrails to other work. Furnish inserts and other anchorage devices for connecting railings and handrails to concrete or masonry work.

G. Handrails and guards shall be hot-dip galvanized.

2.10 GATES AND FENCE PANELS

A. Unless otherwise indicated, fabricate units from weathering steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible. Cut, drill, and tap units to receive hardware, hangers, and similar items.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

2.11 LADDERS AND LADDER CAGES

A. General: Fabricate ladders and ladder cages for the locations shown, with dimensions, spacings, details and anchorages as indicated. Comply with requirements of ANSI A14.3.

B. Fit rungs in centerline of side rails, plug weld and grind smooth on outer rail faces.

C. Support each ladder at top and bottom and at intermediate points spaced not more than 5'-0" o.c. by means of welded or bolted steel brackets.

1. Size brackets to hold centerline of ladder rungs clear of the wall surface by not less than 7 inches.
2. Extend side rails 42 inches above top rung, and return rails to wall or structure unless other secure handholds are provided. If the adjacent structure does not extend above the top rung, goose-neck the extended rails back to the structure to provide secure ladder access.

D. Provide non-slip surface on top of each rung, either by coating the rung with aluminum oxide granules set in epoxy resin adhesive, or by using a type of manufactured rung which is filled with aluminum oxide grout.

E. Ladders and ladder cages shall be hot-dip galvanized.

F. Ladder Safety Posts: Telescoping post designed for permanently attachment to the top two rungs of a fixed ladder.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include the following or Equal Product:

a. LadderUP safety post Model LU-2 (hot-dip galvanized steel); The Bilco Company.

2.12 ROUGH HARDWARE

A. Furnish bent or otherwise custom fabricated bolts, plates, anchors, hangers, dowels, and other miscellaneous steel and iron shapes as required for framing and supporting woodwork, and for anchoring or securing woodwork to concrete or other structures.

B. Fabricate items to sizes, shapes, and dimensions required. Furnish malleable-iron washers for heads and nuts which bear on wood structural connections; elsewhere, furnish steel washers.

C. Finishing: Provide the following for locations indicated:

1. Rough hardware to be installed at exterior locations or in exterior walls shall be hot-dip galvanized after fabrication.
2. All other rough hardware shall be shop primed.

2.13 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports for applications indicated or which are not a

part of structural steel framework, as required to complete work.

B. Fabricate units to sizes, shapes, and profiles indicated and required to receive adjacent other construction retained by framing and supports. Fabricate from structural steel shapes, plates, and steel bars of welded construction using mitered joints for field connection. Cut, drill, and tap units to receive hardware, hangers, and similar items.

1. Equip units with integrally welded anchors for casting into concrete or building into masonry. Furnish inserts if units must be installed after concrete is placed.

a. Except as otherwise indicated, space anchors 24 inches o.c. and provide minimum anchor units in the form of steel straps 1-1/4 inches wide x 1/4 inch x 8 inches long.

C. Finishing: Provide the following for locations indicated:

1. Framing and supports to be installed at exterior locations shall be hot-dip galvanized after fabrication.
2. All other framing and supports shall be shop primed.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, including concrete inserts, sleeves, anchor bolts, and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.

B. Set sleeves in concrete with tops flush with finish surface elevations; protect sleeves from water and concrete entry.

3.2 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installation of metal fabrications. Set metal fabrication accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints, but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units which have been hot-dip galvanized after fabrication, and are intended for bolted or screwed field

connections.

C. Field Welding: Comply with requirements for welding in "Fabrication, General" Article.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal fabrications to in-place construction; include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors as required.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete masonry or similar construction.

3.3 ADJUSTING AND CLEANING

A. Touch-Up Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 requirements for touch-up of field painted surfaces.

1. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 05 50 00

SECTION 05 50 13

MISCELLANEOUS METAL FABRICATIONS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish miscellaneous metal fabrications including surface preparation and shop priming.
   2. The Work also includes:
      a. Providing openings in miscellaneous metal fabrications to accommodate the Work under this and other Sections, and attaching to miscellaneous metal fabrications all items such as sleeves, bands, studs, fasteners, and all items required for which provision is not specifically included under other Sections.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate the Work to be installed with, or attached to miscellaneous metal fabrications Work.
   2. Hot-dip Galvanizing: Coordinate with steel fabricator detailing for and fabrication of assemblies to be hot-dip galvanized, to minimize distortion during galvanizing process.

C. Related Sections:
   1. Section 03 60 00, Grouting.
   2. Section 05 05 33, Anchor Systems.
   3. Section 05 52 14, Steel Handrails and Railings.
   4. Section 05 53 11, Steel Grating.
   5. Section 09 91 00, Painting,

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI A14.3, Ladders – Fixed –Safety Requirements.
   2. ANSI Z359.1, Safety Requirements for Personal Fall Arrest Systems, Subsystems, and Components.
   3. ASTM A36/A36M, Specification for Carbon Structural Steel.
   4. ASTM A53/A53M, Specification for Pipe Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   5. ASTM A123/A123M, Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   6. ASTM A153/A153M, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

7. ASTM A240/A240M, Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels and for General Applications.
8. ASTM A276/A276M, Specification for Stainless Steel Bars and Shapes.
9. ASTM A320/A320M, Specification for Alloy-Steel and Stainless Steel Bolting Materials for Low-Temperature Service.
10. ASTM A384/A384M-02 Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies.
11. ASTM A480/A480M, Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
12. ASTM A500, Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
13. ASTM A572/A572M, Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
14. ASTM A992/A992M, Specification for Structural Steel Shapes.
15. ASTM B209, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
16. ASTM B211, Specification for Aluminum and Aluminum-Alloy Bar, Rod and Wire.
17. ASTM B221, Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
18. ASTM B308/B308M, Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
19. ASTM B429, Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
20. AWS D1.1/D1.1M, Structural Welding Code – Steel.
21. AWS D1.2/D1.2M, Structural Welding Code – Aluminum.
22. AWS D1.6, Structural Welding Code – Stainless Steel.
23. NAAMM, Metal Finishes Manual.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Welding:
      a. Qualify welding processes and welding operators in accordance with AWS D1.1/D1.1M, D1.2/D1.2M, or D1.6, as applicable.
      b. When requested by ENGINEER, provide certification that each welder employed on or to be employed for the Work have satisfactorily passed AWS qualification tests within previous 12 months. Ensure that all certifications are current.

B. Regulatory Requirements: Conform to the following:
   1. 29 CFR 1910, Occupational Health and Safety Standards.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:

a. Fabrication and erection details for assemblies of miscellaneous metal Work. Include plans, elevations, and details of sections and connections. Show anchorage and accessory items. Include setting drawings and templates for locating and installing miscellaneous metal items and anchorage devices.

2. Product Data:
   a. Copies of manufacturer's specifications, load tables, dimension diagrams, anchor details, and installation instructions for products to be used in miscellaneous metal Work.
3. Samples:
   a. Sets of representative Samples of materials including nosings, rungs, and other finished products as requested by ENGINEER. ENGINEER's review will be for color, texture, style, and finish only. Compliance with other requirements is exclusive responsibility of CONTRACTOR.

B. Informational Submittals: Submit the following:
1. Test and Evaluation Reports:
   a. Mill test report that indicate chemical and physical properties of each type of material, when requested by ENGINEER.
2. Qualifications Statements:
   a. Copies of welder's certifications, when requested by ENGINEER.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packing, Shipping, Handling and Unloading:
1. Deliver products to Site to ensure uninterrupted progress of the Work. Deliver anchorage materials to be embedded in other construction in ample time to prevent delaying the Work.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Steel:
1. W-Shapes and WT-Shapes: ASTM A992/A992M.
2. S-Shapes and Channels: ASTM A572/A572M, Grade 50.
3. Hollow Structural Sections: ASTM A500, Grade C.
4. Angles, Plates, Bars: ASTM A36/A36M.
5. Steel Pipe: ASTM A53/A53M, Grade B.

B. Aluminum:
1. Aluminum Shapes: ASTM B308/B308M, Alloy 6061-T6, ASTM B 221, Alloy 6061-T6.
2. Aluminum Tubes and Pipes: ASTM B429, Alloy 6061-T6.
3. Aluminum Bars and Rod: ASTM B211, Alloy 6061-T6.
4. Aluminum Plates: ASTM B209, Alloy 6061-T6.

C. Stainless Steel:
   1. Bars and Shapes: ASTM A276/A276M
   2. Plates and Sheets: ASTM A240/A240M or ASTM A480/A480M, Type 304L or Type 316 stainless steel.
   3. Submerged or Intermittently Submerged: Type 316 stainless steel.
   4. Non-submerged: Type 304L stainless steel.

D. Stainless Steel Fasteners and Fittings: ASTM A 320/A 320M, Type 304L or Type 316 Stainless Steel.

E. Zinc-coated Hardware: ASTM A153/A153M.

2.2 MISCELLANEOUS METAL ITEMS

A. Shop Assembly:
   1. Pre-assemble items in the shop to the greatest extent possible to minimize field-splicing and field-assembly of units at the Site. Disassemble units only to extent necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Aluminum Ladders:
   1. Fabricate ladders for locations shown or indicated with dimensions, spacing, details, and anchorages as shown and specified. Comply with OSHA 29 CFR 1910 and ANSI A14.3, except as otherwise shown or specified.
      a. Unless otherwise shown, provide 1.5-inch diameter continuous side rails, spaced at least 1.5 feet apart.
      b. Provide extruded square rungs, spaced maximum of 12 inches on centers, with non-slip surface on top of each rung. Adhesive strips for non-slip surfaces are not acceptable.
   2. Fit rungs in centerline of side rails, plug weld, and grind smooth on outer rail faces.
   3. Support each ladder at top and bottom and at intermediate points spaced not more than five feet on centers.
   4. Use welded or bolted brackets, designed for adequate support and anchorage, and to hold ladder clear of wall surface with minimum of seven inches between wall and centerline of rungs.
   5. Unless otherwise shown or approved by ENGINEER, extend rails 3.5 feet above top rung, and return rails to wall or structure, unless other secure handholds are provided. If adjacent structure does not extend above top rung, goose-neck extended rails back to structure to provide secure ladder access.
   6. Use extruded aluminum conforming to alloy and temper 6061-T6.

C. Aluminum Ladder Safety Cages:
   1. Fabricate ladder safety cages from extruded flat bars, assembled by welding.
   2. Unless otherwise shown or indicated, provide 1/2-inch by three-inch top, bottom and intermediate hoops spaced not more than five feet on centers; and 3/8-inch by two-inch vertical bars, secured to each hoop.
   3. Space vertical bars approximately nine inches on centers.

4. Fasten assembled safety cage to ladder rails and adjacent construction as shown or indicated.
5. Grind welds, sharp edges, and projections smooth.
6. Comply with OSHA 29 CFR 1910 and ANSI A14.3.
7. Use extruded aluminum conforming to alloy and temper 6061-T6.

D. Shelf Angles:
1. Provide structural steel shelf angles of sizes shown, for attachment to concrete or masonry construction. Provide slotted holes to receive 3/4-inch bolts, spaced not more than six inches from ends and not more than 2.0 feet on centers, unless otherwise shown.
   a. Provide galvanized shelf angles on outdoor construction.
2. Provide wedge-type concrete inserts, complete with fasteners, for attachment of shelf angles to cast-in-place concrete.

E. Aluminum Stair Nosings:
1. Manufacturers: Provide products of one of the following:
   a. Supergrit Type 241BF by Wooster Products, Inc.
   b. Or equal.
2. Fabricate extruded aluminum nosing of sizes and configurations as shown on the Drawings.
   a. Unless otherwise shown, provide ribbed abrasive filled type, using black abrasive filler.
3. Provide anchors for embedding in concrete, either integral or applied to treads, as standard with manufacturer.

F. Wheel Guards:
1. Manufacturers: Provide products of one of the following:
   a. R-4986-DG, by Neenah Foundry Company.
   b. Or equal.
2. Provide bolted-type wheel guards, 3/4-inch thick minimum, of hollow core gray iron casting, and of size and shape as shown.
3. Provide holes for countersunk anchorage devices and grouting.
4. Anchor wheel guards to concrete or masonry construction in compliance with manufacturer's instructions.
4. Fill cores solidly, using grout as specified in Section 03 60 00, Grouting.
5. Armored-concrete type wheel guards are not acceptable.

G. Fall Prevention System:
1. Provide each ladder with a fall prevention system complying with 29 CFR 1910, ANSI A14.3, and ANSI Z359.1.
2. System shall consist of a carrier rail securely and permanently attached to ladder, over which travels a sleeve to which harness belt can be attached.
3. Products and Manufacturers: Provide products of one of the following:
   a. Saf-T-Climb by North Safety Products.
   b. Or equal.
4. Rail:
   a. Notched at six-inch intervals and constructed of galvanized steel.

b. Provide ladder attachments/rail mounting brackets of same material as rail, and as required by Supplier.
c. For all ladders, include provisions to secure safety sleeve to carrier rail at top of vertical ladder so that sleeve will not slide down rail when safety belt is unsnapped.
d. Ladders Below Hatches: Rail for ladder shall extend from bottom of ladder to top of ladder. Provide telescoping safety post as specified in this Article.
e. Ladders Not Below Hatches: Rail for ladder shall extend from bottom of ladder to above horizontal landing or roof at top of ladder, Provide removable extension section at top of ladder. Arrange rail to allow climber to land on landing or roof without unsnapping climber's safety harness

5. Accessories: Provide with each ladder the following, all furnished by fall prevention system Supplier:
a. One safety sleeve compatible for use with the rail. Sleeve shall be cast bronze with five zinc-plated steel roller bearings. Sleeve shall travel smoothly on straight or curved rail.
b. One safety harness that attaches to sleeve. Harness shall be of woven, high-strength nylon, with padded straps and forged steel buckles and rings. Harness shall distribute impact forces of a fall over climber's thighs, buttocks, chest, and shoulders.
c. One shock-adsorbing Y-lanyard no longer than six feet, complying with ANSI Z359.1. Lanyard shall be 5/8-inch diameter nylon rope with double-locking snap hooks at each end.

H. Safety Post:
1. Provide safety post for each fixed access ladder located below an access hatch. Safety post shall be manufactured of high-strength structural material with telescoping tubular section that locks automatically when fully extended.
2. Products and Manufacturers: Provide products of one of the following:
a. LadderUP Safety Post by Bilco Company
b. Or equal.
3. Use upward and downward movement of post shall be controlled by stainless steel spring balancing mechanism.
4. Safety post shall be hot-dip galvanized steel.

I. Manhole Steps:
1. Provide manhole steps as shown on the Drawings. Conform to requirements of 29 CFR 1910 and ANSI A14.3.
2. Products and Manufacturers: Provide one of the following:
a. R-1982-W, manufactured by Neenah Foundry Company.
b. Or equal.
3. Vertical separation of steps shall be uniform at maximum of 12 inches on centers. Steps shall project evenly from manhole or chamber walls.
4. Material: Extruded aluminum.

J. Stainless Steel Bar Racks and Rakes:

1. Provide manually cleaned bar racks as shown on the Drawings.
2. Fabricate of all-stainless steel welded construction in accordance with details on the Drawings.
3. Bar size and spacing shall provide clear openings as shown.
4. Provide plates, angles, bars, and fasteners as shown.
5. Provide approved rake of suitable length and spacing to match rack dimensions.

K. Bollards:
1. Provide Schedule 80 galvanized steel pipe filled with concrete as shown on the Drawings. Paint as required in accordance ith Section 09 91 00, Painting. Unless otherwise shown or specified, finish-paint bollard "Safety Yellow."

L. Miscellaneous Framing and Supports:
1. Provide miscellaneous metal framing and supports that are not part of structural steel framework and are required to complete the Work.
2. Fabricate miscellaneous units to sizes, shapes, and profiles shown on the Drawings or, if not shown, of required dimensions to receive adjacent grating, plates, tanks, doors, and other work to be retained by the framing.
3. Except as otherwise shown, fabricate from structural shapes, plates, and bars, of all-welded construction using mitered corners, welded brackets, and splice plates and minimum number of joints for field connection.
4. Cut, drill, and tap units to receive hardware and similar items to be anchored to the Work.
5. Furnish units with integrally welded anchors for casting into concrete or building into masonry. Furnish inserts if units are to be installed after concrete is placed.
    a. Except as otherwise shown, space anchors, 2.0 feet on centers, and provide units the equivalent of 1.25-inch by 1/4-inch by eight-inch strips.
    b. Galvanize exterior miscellaneous frames and supports.
    c. Where shown or indicated, galvanize miscellaneous frames and supports that are not to be installed outdoors.
6. Miscellaneous steel framing and supports shall be hot-dip galvanized and finish-painted, unless otherwise shown or indicated.
7. For railings, refer to Section 05 52 14, Steel Handrails and Railing.
8. For grating requirements refer to Section 05 53 11, Steel Grating.
9. Surface preparation and painting of galvanized surface shall conform to Section 09 91 00, Painting

M. Steel Raised-pattern Floor Plate:
1. Provide raised-pattern floor plate conforming to ASTM A786/A786M and manufacturer's standards. Plates shall be of thicknesses shown.
2. Products and Manufacturers: Provide products of one of the following:
    a. 4-Way Safety Steel Plate, by Ryerson Tull Company.
    b. Raised Pattern Floor Steel Plate, by Central Steel and Wire Company.
    c. Or equal.
3. Provide removable plates at locations and sizes shown. Provide perforated plates where shown.

4. Provide each plate section with four lifting handles as recommended by manufacturer. Lifting handles shall be recessed, drop-handle type. Maximum weight of checkered plate shall be 150 pounds.
5. Finish: Hot-dip galvanize in accordance with ASTM A123/A123M.

N. Fasteners and Hardware: Provide Type 316 stainless steel fasteners for aluminum fabrications and zinc-coated hardware for galvanized fabrications, unless otherwise shown or specified.

O. Anchors and Expansion Anchors: Refer to Section 05 05 33, Anchor Systems.

2.3 FINISHING

A. Surface Preparation and Shop Priming: Perform surface preparation and apply primer coat to miscellaneous metal fabrications in the shop. Conform to surface preparation and shop priming requirements in Section 09 91 00, Painting.

B. Galvanizing:
1. Galvanizing of fabricated steel items shall comply with ASTM A123/A123M.
2. Details of fabrication of steel items and assemblies to be hot-dip galvanized shall conform to recommendations of ASTM A384/A384M to minimize the potential for distortion.

C. Aluminum Finish: Provide natural mill finish for aluminum Work unless otherwise shown or specified.

2.4 SOURCE QUALITY CONTROL

A. Tests and Inspections:
1. Materials and fabrication procedures shall be subject to inspection and tests in the mill, shop, and field, conducted by a qualified inspection agency. Such inspections and tests will not relieve CONTRACTOR of responsibility for providing materials and fabrication procedures complying with the Contract Documents.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine conditions under which the Work is to be performed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install miscellaneous metal fabrications accurately in location, alignment, and elevation, plumb, level, true, and free of rack, measured from established lines and levels. Brace temporarily or anchor temporarily in formwork where fabrications are to be built into concrete, masonry, or other construction.

B. Anchor securely as shown and as required for the intended use, using concealed anchors where possible.

C. Fit exposed connections accurately together to form tight, hairline joints. Field-weld steel connections that are not to be exposed joints and cannot be shop-welded because of shipping size limitations. Comply with AWS D1.1/D1.1M, D1.2/D1.2M and D1.6, as applicable to the material being welded. Grind steel joints smooth and touch-up shop paint coat. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication, and are intended for bolted or screwed field connections.

D. Protection of Aluminum from Dissimilar Materials:
   1. Coat surfaces of aluminum that will contact dissimilar materials such as concrete, masonry, and steel, in accordance with Section 09 91 00, Painting.

+ + END OF SECTION + +

SECTION 05 51 00 – METAL STAIRS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section

1.2 SUMMARY

A. This Section includes the following:

1. Industrial Class metal stairs with steel-grating treads.
2. Handrails and guards attached to the metal stairs and stair platforms.

B. Related Sections include the following:

1. Division 01 Section "Quality Requirements" for inspection of welded and bolted connections.
2. Division 05 Section “Structural Steel Framing.”
3. Division 05 Section "Metal Fabrications” for handrails and guards not attached to metal stairs or stair platforms.
4. Division 09 Section "Painting" for field finish painting of shop-primed metal stairs and guards.

1.3 COORDINATION

A. Coordinate installation of anchorages for metal stairs. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

B. Coordinate locations of hanger rods and struts with other work so that they do not encroach on required stair width and are within the fire-resistance-rated stair enclosure.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Abrasive nosings and inserts.
2. Gratings.
3. Shop coating products.
4. Grout.
5. Post-installed anchors.

B. Shop Drawings: Show fabrication and installation details for metal stairs. Include plans, elevations, sections, and details of metal stairs and their connections. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other Sections.

1. Shop drawings shall be signed and sealed by the qualified professional engineer responsible for their preparation.
2. Include structural analysis data for design of the work of this Section, signed and sealed by the responsible qualified professional engineer.

1.5 INFORMATIONAL SUBMITTALS

A. Welding Certificates: Copies of certificates for welding procedures and personnel.

B. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

1.6 QUALITY ASSURANCE

A. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in the State of Connecticut and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of metal stairs (including handrails and railing systems) that are similar to those indicated for this Project in material, design, and extent.

B. Fabricator Qualifications: A firm experienced in producing metal stairs similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

C. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."
2. AWS D1.3, "Structural Welding Code--Sheet Steel."
3. AWS D1.6, "Structural Welding Code--Stainless Steel."

D. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation. Acceptance of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

1. Build mockup to demonstrate fabrication and installation characteristics for each different type of tread, stringer, and guard.
2. Accepted mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

E. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification.

1. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers.
2. Protect steel members and packaged materials from corrosion and deterioration.
3. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures.

a. Repair or replace damaged materials or structures as directed.

1.8 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction to which metal stairs must fit by accurate field measurements before fabrication; show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay of Work.

1. Where field measurements cannot be made without delaying the Work, guarantee dimensions and proceed with fabrication of products without field measurements. Coordinate construction to ensure that actual opening dimensions correspond to guaranteed dimensions. Allow for trimming and fitting.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Thermal Movements: Allow for thermal movement resulting from the following maximum change (range) in ambient temperature in the design, fabrication, and installation of installed metal stairs to prevent buckling, opening up of joints, and overstressing of welds and fasteners. Base design calculations on actual surface temperatures of metals due to both solar heat gain and nighttime sky heat loss.

1. Temperature Change (Range): 180 deg F (100 deg C), material surfaces.

B. Delegated Design: Engage a qualified professional engineer, as defined in Division 01 Section "Quality Requirements," to design metal stairs, guards and handrails.

C. Structural Performance: Provide metal stairs capable of withstanding the following structural loads without exceeding the allowable design working stress of the materials involved, including anchors and connections. Apply each load to produce the maximum stress in each component of metal stairs.

1. Treads and Platforms of Metal Stairs: Capable of withstanding a uniform load of 100 lbf/sq. ft. (4.79 kN/sq. m) or a concentrated load of 300 lbf (1.33 kN) on an area of 4 sq. in. (25.8 sq. cm), whichever produces the greater stress.
2. Stair Framing: Capable of withstanding stresses resulting from loads specified above in addition to stresses resulting from guard and railing system loads.
3. Limit deflection of treads, platforms, and framing members to L/360 or 1/4 inch (6.4 mm), whichever is less.

D. Structural Performance of Handrails and Guards: Provide handrails and guards capable of withstanding the following structural loads without exceeding the allowable design working stress of materials for handrails, railings, anchors, and connections:

1. Handrails and Top Rail of Guards: Capable of withstanding the following loads applied as indicated:

    a. Concentrated load of 200 lbf (890 N) applied at any point and in any direction.
    b. Uniform load of 50 lbf/ft. (730 N/m) applied horizontally and concurrently with uniform load of 100 lbf/ft. (1460 N/m) applied vertically downward.
    c. Concentrated and uniform loads above need not be assumed to act concurrently.

2. Infill Area of Guards: Capable of withstanding a horizontal concentrated load of 50 lbf (223 N) applied to 1 sq. ft. (0.09 sq. m) at any point in system, including panels, intermediate rails, balusters, or other elements composing infill area.

    a. Load above need not be assumed to act concurrently with loads on top rails in determining stress on guards.

E. Seismic Performance of Stairs: Metal stairs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. Component Importance Factor: 1.5.

2.2 METALS, GENERAL

A. Metal Surfaces, General: For metal fabrications exposed to view in the completed Work, provide materials selected for their surface flatness, smoothness, and freedom from stains, discolorations, or surface blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

2.3 CARBON STEEL AND IRON

A. Steel Plates, Shapes, and Bars: ASTM A 36 (ASTM A 36M).

B. Steel Pipe: ASTM A 53, standard weight (Schedule 40), unless otherwise indicated, or another weight required by structural loads.

C. Steel Sheet, Cold Rolled: ASTM A 1008/A 1008M, either commercial steel, Type B, or structural steel, Grade 25 (Grade 170), exposed.

D. Castings: Either gray or malleable iron, unless otherwise indicated.

1. Gray Iron: ASTM A 48/A 48M, Class 30, unless another class is indicated or required by structural loads.
2. Malleable Iron: ASTM A 47/A 47M.

2.4 EXTERIOR FASTENERS

A. General: Unless otherwise indicated, provide Type 316 stainless-steel fasteners.

B. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, nuts and flat washers; ASTM F 593 (ASTM F 738M) for bolts and ASTM F 594 (ASTM F 836M) for nuts, Alloy Group 1 (A1).

C. Phillips Flat-Head Machine Screws: Stainless steel, ASME B18.6.3 (ASME B18.6.7M).

D. Post-Installed Anchors: Chemical anchors.

1. Material for Exterior Locations and Where Stainless Steel is Indicated: Alloy Group 2 (A4) stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).

E. Anchor Bolts: ASTM F 1554, Grade 36.

1. Provide hot-dip zinc-coated anchor bolts.

2.5 ACCESSORY MATERIALS

A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include the following or Equal:

a. B-6 Construction Grout; W. R. Bonsal Co.
b. Sonogrout 14; Sonneborn Building Products--ChemRex, Inc.

B. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

2.6 FABRICATION, GENERAL

A. Provide complete stair assemblies, including metal framing, hangers, struts, handrails, railings, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.

1. Join components by welding, unless otherwise indicated.
2. Use connections that maintain structural value of joined pieces.

B. Shop Assembly: Preassemble stairs in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

C. Form exposed work true to line and level, with accurate angles and surfaces and straight edges. Tolerances for installed work shall comply with the following:

1. Variation from required lines shall not exceed 1/8" in 5 feet, or 1/4" maximum for the overall length of the fabricated item, whichever is less.
2. The dimensional variation in the depth of any two adjacent treads or in the height of any two adjacent risers shall not exceed 3/16" (4.8 mm).
3. The dimensional variation between the largest and smallest riser or between the largest and smallest tread shall not exceed 3/8" (9.5 mm) in any flight.

D. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a

radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

E. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.

2.7 FINISHES, GENERAL

A. Comply with NAAMM "Metal Finishes Manual" for recommendations relative to application and designations of finishes.

B. Finish metal fabrications after assembly.

C. Finishes for stainless steel may be either field-applied or shop-applied, as best-suited to produce optimal results for each item.

D. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

2.8 CARBON STEEL FINISHES

A. Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
2. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

2.9 STEEL-FRAMED STAIRS

A. NAAMM Stair Standard: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, "Metal Stairs Manual," for class of stair designated, unless more stringent requirements are specified or shown on the Drawings.

1. Industrial class.

B. Stair Framing: Fabricate stringers as indicated. Provide closures for exposed ends of channel stringers. Construct platforms of structural-steel channel headers and miscellaneous framing members as indicated. Bolt or weld headers to stringers; bolt or weld framing members to stringers and headers. If using bolts, fabricate and join so bolts are not exposed on finished surfaces.

C. Metal Risers, Subtread Pans, and Subplatforms: Form to configurations shown from steel sheet of thickness necessary to support indicated loads, but not less than 0.0677 inch (1.7 mm).

1. Steel Sheet: Uncoated cold-rolled steel sheet, unless otherwise indicated.
2. Shape metal pans to include nosing integral with riser.
3. Provide subplatforms of configuration indicated. Weld subplatforms to platform framing.

2.10 HANDRAILS AND GUARDS

A. General: Fabricate handrails and guards to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including post spacings and anchorage, but not less than that needed to withstand indicated loads.

B. Interconnect tubular members by butt-welding or welding with internal connectors, at fabricator's option, unless otherwise indicated.

1. At tee and cross intersections, cope ends of intersecting members to fit contour of tube to which end is joined, and weld all around and grind smooth.

C. Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

D. Close exposed ends of pipe by welding 3/16 inch thick steel plate in place or by use of prefabricated fittings, except where clearance of end of pipe and adjoining wall surface is 1/4 inch or less.

E. Flanges, Fittings, and Anchors: Provide end closures, flanges, miscellaneous fittings, and anchors for interconnecting railings and for attaching to other work. Furnish inserts and other anchorage devices for connecting to concrete or masonry work.

1. Connect guard posts to stair framing by direct welding, unless otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Loading Requirements: Assemble and install the work of this Section to comply with Part 1 paragraph "Performance Requirements," above.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free from rack.

C. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

E. Field Welding: Comply with requirements for welding in "Fabrication, General" Article.

F. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete, unless otherwise indicated.

G. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.2 INSTALLING HANDRAILS AND GUARDS

A. Adjust handrails and railing systems before anchoring to ensure matching alignment at abutting joints. Space posts at spacing indicated or, if not indicated, as required by design loads. Plumb posts in each direction. Secure posts and railing ends to stair construction welding directly to steel supporting members.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect welded and bolted connections.

1. Bolted Connections: Bolted connections will be inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
2. Welded Connections: Field welds will be visually inspected according to AWS D1.1/D1.1M.

B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

3.4 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.

END OF SECTION 05 51 00

SECTION 05 52 14

STEEL HANDRAILS AND RAILINGS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified or required to furnish steel handrail and railing systems.
   2. The extent of the Work shall be as shown and includes the following types:
      a. Steel pipe handrails and railings.
      b. Galvanized steel pipe handrails and railings.
   3. Provide openings in and attachments to the steel handrails and railings to accommodate the Work under this and other Sections. Provide all items for the steel handrails and railings such as anchor bolts, fasteners, studs, and all items required for which provision is not specifically included under other Sections.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before the steel handrails and railings Work.

C. Related Sections:
   1. Section 03 60 00, Grouting.
   2. Section 05 05 33, Anchor Systems.
   3. Section 05 12 00, Structural Steel Framing.
   4. Section 09 91 00, Painting. (Specifications for surface preparation and shop priming required under this Section are under Section 09 91 00, Painting.)

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
   1. American National Standards Institute, (ANSI).
      a. ANSI A12.1, Safety Requirements for Floor, Wall, Railings and Toeboards.
      b. ANSI A 1264.1, Safety Requirements for Work Place Floor and Wall Openings, Stairs and Railing Systems.
   2. American Society for Testing and Materials, (ASTM).
      a. ASTM A 36/A 36M, Specification for Carbon Structural Steel.
      b. ASTM A 47/A 47M, Specification for Ferritic Malleable-Iron Castings.
      c. ASTM A 48/A 48M, Specification for Gray Iron Castings.
      d. ASTM A 53/A 53M, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
      e. ASTM A 123/A 123M, Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

f. ASTM A 153/A 153M, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
g. ASTM A 307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
h. ASTM A 501, Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
i. ASTM A 554, Specification for Welded Stainless Steel Mechanical Tubing.
j. ASTM A 743/A 743M, Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion-Resistant for General Application.

3. American Welding Society, (AWS).
   a. AWS D1.1/D1.1M, Structural Welding Code-Steel.
4. National Association of Architectural Metal Manufacturers, (NAAMM).
   a. NAAMM, Metal Finishes Manual.
5. Occupational Safety and Health Administration, (OSHA).
   a. OSHA Part 1910.23, Guarding Floor and Wall Openings and Holes.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have a minimum of five years experience producing substantially similar products and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.
   2. Manufacturer of railing system shall guarantee, in writing, the availability of replacement parts and components for a period of not less than five years after completion of the Work.

B. Component Supply and Compatibility:
   1. Obtain all products included in this Section regardless of the component manufacturer from a single steel handrails and railings manufacturer.
   2. The steel handrails and railings manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
   3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the steel handrails and railings manufacturer.

C. Codes:
   1. Comply with the applicable requirements of OSHA and the Uniform Building Code.
   2. If there is a conflict between the OSHA requirements and the Uniform Building Code comply with whichever requirement is more stringent.

D. Qualifications for Welding Work:
   1. Qualify welding processes and welding operators in accordance with AWS "Structural Welding Code" D1.1/D1.1M, Section 5, Qualification.

2. Provide certification that all welders employed on or to be employed for the Work have satisfactorily passed AWS qualification tests within the previous 12 months. CONTRACTOR shall ensure that all certifications are kept current.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Samples:
      a. Samples of each type of metal finish, including typical welded or bolted connections, not less than 6-inches long. Samples will be reviewed for color and texture only. Compliance with all other requirements is the exclusive responsibility of CONTRACTOR.
   2. Shop Drawings:
      a. Detailed drawings for the fabrication and erection of steel handrails and railings. Include plans, elevations, layouts and details of sections and connections. Show anchorage items.
   3. Delegated Design Submittals:
      a. All calculations for complete structural analysis of the handrail and railing systems, including calculations showing compliance with system performance criteria specified. The calculations shall be prepared, signed and sealed by a Registered Professional Engineer licensed in the State of Connecticut.

B. Informational Submittals: Submit the following:
   1. Source Quality Control Submittals:
      a. Furnish certification by manufacturer that loading tests have been performed on the handrail, and that it conforms to all applicable OSHA and ANSI requirements for load and deflection.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:
   1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of that Work.
   2. Protect painted and galvanized handrails and railings from abuse so as to prevent nicks, gouges and dents.

B. Storage and Protection:
   1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.

C. Acceptance at Site:
   1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 PERFORMANCE CRITERIA

A. Performance Criteria:
   1. Maintain the visual design concept shown, and the technical requirements specified, including modules, profiles, alignment of components and requirements for finish.
   2. Provide handrail and railing systems that conform to the Uniform Building Code and OSHA, Part 1910.23, including the 200-pound loading requirement. In addition, the system shall conform to the following requirements:
      a. Completed railing and handrail systems shall withstand a uniform lateral force of 40-pounds per linear foot and a vertical uniform force of 50-pounds per linear foot, both applied simultaneously at the top of the handrail and railing.
      b. Intermediate and bottom rails shall withstand simultaneously applied lateral uniform forces of 40-pounds per linear foot and a vertical load of 50-pounds per linear foot, however, lateral and vertical loads on intermediate and bottom railings need not be considered in the detailing and fabrication of posts and anchorages.
      c. For railings having panels, the panels shall be detailed and fabricated to withstand a uniform lateral load of twenty pounds per square foot.
      d. Concentrated 200-pound load and uniform force conditions shall not be applied simultaneously.
      e. Other pertinent requirements ceded to ANSI A1264.1 by the Uniform Building Code.
      f. Bending stresses shall not exceed 60 percent of the yield stress of the material. Applied loads shall not produce permanent deflection in the completed Work when loads are removed.
      g. Select schedule of pipe, minimum diameter, loadings and maximum post spacing specified in order to limit deflection in each single-span of railing and handrail to 1.5-inches maximum and on railing posts to 1.4-inches maximum and with a safety factor of 1.65:1 for all Work.
   3. Thermal Control: Provide adequate expansion within fabricated systems that allows for a thermal expansion and contraction caused by a material temperature change of 140°F to -20°F without warp or bow of system components. Distance between expansion joints shall be based on providing a 1/4-inch wide joint at 70°F, which accommodates a movement of 150 percent of the calculated amount of movement for the specified temperature range.
   4. Provide expansion joints in handrail and railing systems where systems cross expansion joints in structure.
   5. Provide handrail and railing systems as shown. Where handrail or railing systems are required by either the governing authority having jurisdiction at the Site or the Occupational Safety and Health Act of 1970, or the Americans with Disabilities Act of 1990, handrail and railing systems of the type specified herein shall be provided.

6. Configuration of all handrail and railing systems components shall be as shown. Verify dimensions at the Site without causing delay in the Work.
7. Except where detailed dimensions are shown, indicate required locations for posts, space posts maximum five feet on centers.
8. Where details show post location requirements at or near end of runs, uniformly space intermediate posts as required to meet loading and deflection criteria specified, but not greater than maximum spacing specified. Where posts are shown at straight walkways and other locations where railing is provided on each side, locate railing system posts opposite each other; do not stagger.
9. Fabricator is responsible for structural analysis and detailing of handrails and railings systems. Provide complete structural calculations and verification of other system performance criteria and Shop Drawings for all handrail and railing members, anchors and all other support system components prepared, signed and stamped with the seal of a Registered Professional Engineer licensed to practice in the State of Connecticut and recognized as an expert in the specialty involved.

2.2 MANUFACTURERS

A. Products and Manufacturers: Provide one of the following:
   1. Carbon steel railing, as manufactured by Pleasant Mount Welding, Incorporated.
   2. Projection Welded steel railing, as manufactured by Grossman Steel and Aluminum Corporation.
   3. Or equal.

2.3 MATERIALS

A. Steel Plates, Shapes and Bars: ASTM A 36/A 36M.

B. Steel Pipe: ASTM A 53/A 53M, Type E or Type S, Grade A; 1.90-inches OD; standard weight (Schedule 40), unless otherwise shown or specified.

C. Steel Tubing: ASTM A 501.

D. Gray Iron Castings: ASTM A 48/A 48M, Class 30.

E. Malleable Iron Castings: ASTM A 47/ 47M, grade as required.

F. Fasteners: ASTM A 307.

G. Carbon Steel, Welded, Pipe Handrails and Railings:
   1. Use a steel, welded pipe railing system with posts, top and intermediate rails, and welded joints.

2.4 FABRICATION

A. General: Form exposed Work true to line and level with accurate angles and surfaces and straight sharp edges. Form bent-metal corners to the smallest radius possible without causing grain separation or otherwise impairing the Work.

B. Fabricate to profiles shown.

C. Connections:
   1. Welded Connections: Cope intersections of rails and posts, weld joints and grind smooth. Butt weld end-to-end joints of railings or use welding connectors.
      a. Weld corners and seams continuously and as follows:
         1) Painted and Galvanized Railings: In accordance with AWS D1.1/D1.1M, Section 10.
      b. Grind exposed welds smooth and flush, to match and blend with adjoining surfaces.

D. Toeboards: Provide toeboards of same material as railings on railings around openings, platforms, and balconies. Fabricate to the dimensions and details shown. Securely fasten toeboard in place with not more than 1/4-inch clearance above floor level. Toeboards shall conform to the requirements of OSHA Part 1910.23, Section (e).

E. Brackets, Flanges, and Anchors: Provide brackets, flanges, and anchors for railing posts and for handrail supports. Furnish inserts and sleeves as required for anchorage to concrete or masonry. Components shall be in accordance with manufacturer's recommendations.

F. Finish:
   1. Painted Railings: Refer to Article 2.4, below.
   2. Galvanized Railings: Galvanize all railings, including pipe, fittings, brackets, fasteners and other ferrous metal components in accordance with ASTM A 123/A 123M. If handrails are mechanically fastened as specified above, all ferrous components, except pipe, shall be galvanized in accordance with ASTM A 153/A 153M.

2.4 PAINTING

A. Surface Preparation and Shop Priming: All steel handrails and railing shall be primed in the shop. Surface preparation and shop priming requirements are included herein, but are specified in Section 09 91 00, Painting.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR shall examine the conditions under which the Work is to be installed and notify the ENGINEER, in writing, of conditions detrimental to the

proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

B. Make adjustments required to place system in proper operating condition.

3.2 ASSEMBLY OF PROPRIETARY RAILING SYSTEMS

A. Assemble systems in strict accordance with manufacturer's recommendations for installation and as shown.

3.3 INSTALLATION

A. Fastening to In-Place Construction:
   1. Provide anchorage devices and fasteners where necessary for securing handrails and railing items to in-place construction, including threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts and other connectors, as required. Use devices and fasteners that are compatible with installed material.

B. Cutting, Fitting and Placement:
   1. Perform cutting, drilling and fitting required for installation. Set the Work accurately in location, alignment and elevation, plumb, level, true and free of rack, measured from established lines and levels.
   2. Fit exposed connections accurately together to form tight hairline joints. Field welding will not be permitted, unless approved by ENGINEER. Do not cut or abrade the surfaces of units, which have been coated or finished after fabrication, and are intended for field connections.
   3. Permanent splice connections shall be made in accordance with manufacturer's instructions.
   4. Provide approved slip connections in top and bottom rails at each expansion joint.
   5. Space posts on centers, eight feet maximum, unless otherwise shown.
   6. Adjust railings prior to securing in place, to ensure proper matching at butting joints and correct alignment throughout their length. Plumb posts in each direction. Secure posts and rail ends to building construction as follows:
      a. Anchor posts in concrete by means of sleeves set and anchored into the concrete floor slab. Provide closure secured to the bottom of the sleeve. Unless otherwise shown, after the posts have been inserted into the sleeves, fill the annular space between posts and sleeves solid with grout as specified in Section 03 60 00, Grouting. Crown grout around posts so that drainage will be away from posts.
      b. CONTRACTOR may, at their option, anchor posts in concrete by core drilling holes in areas selected by him and approved by ENGINEER. Drill holes not less than 1-inch greater than the outside diameter of post. Reinforcing steel shall not be cut by the core drilling. Fill the annular space with grout as specified above.

c. Anchor posts to steel with stringer or support flanges, angle type or floor type as required by conditions, shop connected to posts and bolted to the steel supporting members.
d. Side mount posts by fastening them securely in brackets attached to steel or concrete fascia as shown, and in complete accordance with manufacturer's instructions.
e. Provide removable railing sections and sleeves as shown. Accurately locate sleeves to match post spacing.

7. Secure handrails to walls with wall brackets and end fittings as shown. Drill wall plate portion of the bracket to receive one bolt, unless otherwise shown for concealed anchorage. Locate brackets as shown or, if not shown, at not more than eight feet on centers. Provide flush-type wall return fittings with the same projection as that shown for wall brackets. Secure wall brackets and wall return fittings to building construction as follows: Refer to Section 05 05 33, Anchor Systems.

3.4 REPAIR

A. Touch-up Painting:
1. Unless otherwise specified below, comply with all requirements of touch-up painting specified in Section 09 91 00, Painting.
2. Immediately after erection, clean field welds and all damaged and abraded areas of the shop paint. Apply paint to all exposed areas with the same material used for shop painting. Apply by brush or spray to provide a minimum dry film thickness as specified in Section 09 91 00, Painting.

B. Galvanized Railings: Repair damaged zinc coating by cleaning the area and removing defective coating. Paint cleaned area with one brush coat of an approved zinc repair material, compatible with paint as specified in Section 09 91 00, Painting.

C. Remove stained or otherwise defective Work and replace with material that meets the requirements of these Specifications.

3.5 FIELD QUALITY CONTROL

A. The OWNER will engage an independent testing and inspection agency to inspect the welded connections and to perform tests and prepare test reports.
1. All welds will be subject to visual inspection. Where visually deficient welds are observed, the welds will be tested using non-destructive methods by a certified testing laboratory. If welds are found to be satisfactory, OWNER will pay for testing. Where welds are found unacceptable or deficient, CONTRACTOR will pay for testing. CONTRACTOR will correct improper workmanship, remove and replace, or correct as instructed, all welds found unacceptable or deficient. CONTRACTOR will pay for all corrections and subsequent tests required to confirm the integrity of the weld.
2. The independent testing and inspection agency shall complete a report for all the Work. The report shall summarize the observations made by the inspector and be submitted to the ENGINEER.

+ + END OF SECTION + +

SECTION 05 53 11

STEEL GRATING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified and required to furnish and install steel grating and frames.
   2. The Work includes:
      a. Providing grating, frames, and appurtenances.
      b. Providing openings in grating to accommodate the Work under this and other Sections and attaching to steel grating all items such as sleeves, bands, studs, fasteners, and items required for which provision is not specifically included under other Sections.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before steel grating Work.

C. Related Sections:
   1. Not used.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ASTM A36/A36M, Specification for Carbon Structural Steel.
   2. ASTM A510, Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel.
   3. ASTM A1011/A1011M, Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
   4. MS MIL-P-21035, Paint, High Zinc Dust Content Galvanizing Repair.
   5. NAAMM MBG 531, Metal Bar Grating Manual.
   6. NAAMM MBG 533, Welding Specifications for Fabrication of Steel, Aluminum and Stainless Bar Grating.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer: Shall have at least five years experience manufacturing products substantially similar to those required and shall be able to submit documentation of at least five installations in satisfactory operation for at least five years each.

B. Component Supply and Compatibility:
   1. Obtain all products included in this Section regardless of component manufacturer from a single steel grating manufacturer.
   2. Steel grating manufacturer shall review and approve or prepare all Shop Drawings and other submittals for all components furnished under this Section.
   3. Components shall be suitable for the specified service conditions and shall be integrated into overall assembly by steel grating manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Fabrication and erection of all steel gratings Work. Include plans, elevations, and details of sections and connections. Show anchorage and accessory items.
      b. Setting drawings and templates for location and installation of anchorage devices.
   2. Product Data:
      a. Manufacturer's specifications, load tables, dimension diagrams, anchor details, and installation instructions.
   3. Samples:
      a. Representative Samples of steel grating, appurtenances, and other finished materials requested by ENGINEER. ENGINEER's review will be for type and finish only. Compliance with all other requirements is responsibility of CONTRACTOR.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packing, Shipping, Handling, and Unloading:
   1. Deliver products to the Site to ensure uninterrupted progress of the Work. Deliver anchorage materials to be embedded in concrete in ample time to prevent delaying the Work.
   2. Comply with Section 01 65 00, Product Delivery Requirements.

B. Storage and Protection:
   1. Protect materials from corrosion and deterioration.
   2. Comply with Section 01 66 00, Product Storage and Handling Requirements.

PART 2 – PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Steel Grating: Provide steel grating complying with the following:

1. Grating Design Loads: Uniform live load shall be as shown or indicated in the Contract Documents. Where live load is not shown or indicated, uniform live and concentrated loads shall be as indicated in the table below, whichever results in the greater design stresses.

	Live Load	Concentrated Load
a.	100 psf	500 lbs. per foot of grating width at center of span

2. Maximum Clear Span Deflection for Uniform Live Loads: 1/120 of span, but not more than 1/4-inch.
3. Maximum Fiber Stress: 18,000 psi.
4. Minimum Size of Members:
   a. Minimum size of bearing bars shall be within standard mill tolerance of that indicated in load tables in NAAMM MBG 531 for applicable loading and deflection requirements.
   b. Minimum dimensions of cross bars shall be as indicated in the tables of Minimum Standard Cross Bars and Connecting Bars in NAAMM MBG 531.
5. Banding bar shall be 1/4-inch thick minimum. Top of banding bar shall be flush with top of grating unless otherwise shown or indicated. Banding bar shall be 1/4-inch shorter than bearing bar height.

B. Stair Treads: Provide steel stair treads complying with the following:
1. Stair Tread Design Loads: Concentrated live load shall be:
   a. 300 pounds on front five inches of tread at center of tread span of up to and including 5.5 feet.
   b. 300 pounds on front five inches of tread at the one-third points of tread span of greater than 5.5 feet.
2. Maximum Clear Span Deflection for Concentrated Live Loads: 1/240 of span, but not more than 1/4-inch.
3. Maximum Fiber Stress: 18,000 psi.
4. Minimum Size of Members:
   a. Minimum size of bearing bars shall be within standard mill tolerance as indicated in load tables in NAAMM MBG 531 for applicable loading and deflection requirements.
   b. Minimum dimensions of cross bars shall be as indicated in the tables of Minimum Standard Cross Bars and Connecting Bars in NAAMM MBG 531.
5. Carrier plate shall be 1/4-inch thick minimum. Top of carrier plate shall be flush with top of grating, unless otherwise shown or indicated. Provide carrier plate with hole and slot for attaching to stringer.

2.2 MANUFACTURERS

A. Grating, Products and Manufacturers: Provide grating of one of the following:
1. Weldforged, manufactured by IKG Industries.
2. Light Duty Welded grating, manufactured by Ohio Gratings, Inc.
3. Or equal.

B. Stair Treads, Products and Manufacturers: Provide stair treads by one of the following:
   1. Weldforged Treads, manufactured by IKG Industries.
   2. Light Duty Welded Treads, manufactured by Ohio Gratings, Inc.
   3. Or equal.

2.3 MATERIALS

A. Hot rolled carbon steel sheet and strip bearing bars and cross bars shall comply with ASTM A1011/A1011M, Commercial Steel (CS Type 2).

B. Structural steel bearing bars and cross bars shall comply with ASTM A36/A36M.

C. Wire rod Cross Bars: ASTM A510, except that permissible tolerance on diameter of coarse round wire shall be plus-0.005-inch

D. Frames: Steel complying with ASTM A36/A36M.

E. Galvanizing Repair Paint: High zinc-dust content paint for repairing damaged galvanized surfaces complying with MS MIL-P-21035.

2.4 FABRICATION

A. Use materials of minimum depth and thickness specified and as required to comply with performance criteria shown or indicated in the Contract Documents.

B. Provide grating as follows:
   1. Grating Type: Welded rectangular bearing bars with cross bars resistance-welded at right angles to bearing bars.
   2. Depth: One inch, minimum.
   3. Bearing Bars: Minimum one-inch by 3/16-inch spaced at 1-3/16-inch on centers.
   4. Cross Bars: Welded to bearing bars at maximum spacing of four inches on centers.
   5. Surface: Plain.
   6. Finish: Hot-dip galvanized.

C. Provide stair treads as follows:
   1. Tread Type: Welded rectangular bearing bars with cross bars resistance-welded at right angles to bearing bars.
   2. Depth: One inch minimum.
   3. Bearing Bars: Minimum one-inch by 3/16-inch spaced at 1-3/16-inch on centers.
   4. Cross Bars: Welded to bearing bars at maximum spacing of four inches on centers.
   5. Surface: Plain.
   6. Nosing: Cast aluminum abrasive nosing.

7. Finish: Hot-dip galvanized.

D. Provide cutouts in grating for passage of piping, electrical conduit, valve stems, columns, ducts, and similar work. Where more than two bearings bars are included in a cut out, provide banding bars of same dimensions as bearing bars around opening welded to grating component parts.

E. Gratings shall be accurately fabricated, free from warps, twists, and other defects that would affect grating appearance or grating serviceability.

F. Tops of grating bearing bars and cross bars shall be in the same plane.

G. Welding shall comply with NAAMM MBG 533. Welds shall be ground smooth at top and bearing surfaces.

H. Openings in and edges of grating sections shall be banded with flat banding bars as specified in this Section, welded along the line of cutout or to end of grating panel.

I. Size each section of grating to weigh not more than 150 pounds, unless otherwise indicated in the Contract Documents.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine conditions under which Work is to be performed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with installation until unsatisfactory conditions are corrected.

B. Check all dimensions at the Site after piping and equipment are in place and determine exact locations of openings and cutouts.

3.2 INSTALLATION

A. Fastening to In-Place Construction:
   1. Use anchorage devices and fasteners to secure steel grating to supporting members or prepared openings, as recommended by manufacturer.
   2. For steel grating having bearing bars at 1-3/16-inch on centers or greater, provide four saddle clip anchors designed to fit over two bearing bars, and four stud bolts with washers and nuts for each grating panel, unless otherwise shown or indicated in the Contract Documents. For bearing bars spacing less than 1-3/16-inch on centers, provide anchors in accordance with manufacturer's recommendations.

B. Cutting, Fitting, and Placing:

1. Perform cutting, drilling and fitting required for installation. Set the Work accurately in location, alignment and elevation, plumb, level, true, and free of rack. Do not use wedges or shimming devices.
2. Where grating is penetrated by piping, electrical conduit, ducts, structural members, or similar protrusions, cut openings neatly and accurately to size and attach banding bar as specified.
3. Divide panels into sections only to extent required for installation where steel grating is to be installed around previously installed piping, electrical conduit, ducts, structural members, or similar protrusions.

C. Steel gratings in concrete floors shall be removable and shall be arranged in sizes to be readily lifted. Provide steel gratings in concrete with steel angle frames having mitered corners and welded joints. Grind exposed joints smooth. Frames shall have welded anchors set into concrete. Angle size shall match grating depth selected for flush fit.

D. Clearance at ends or between sections of steel grating shall be not more than 1/4-inch.

E. Tops of steel gratings shall be set flush with surrounding construction.

F. Steel gratings shall be set with full and uniform end bearing on frames to preclude rocking movement; do not use wedges or similar shimming devices.

G. Remove stains, cement droppings, oils, dirt, grease, paint, and other foreign matter.

H. Repair galvanized coating, damaged in the shop or during field erection, with galvanizing repair paint applied in accordance with the repair paint manufacturer's instructions and recommendations.

+ + END OF SECTION + +

SECTION 05 54 63

FLOOR ACCESS HATCH COVERS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install floor access hatch covers.
   2. The Work also includes:
      a. Providing openings in and attachments to floor access hatch covers to accommodate the Work under this and other Sections, and providing for floor access hatch covers items such as anchorage devices, and all items required for which provision is not specifically included under other Sections.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate the installation of items to be installed with or before floor access hatch covers Work.

C. Related Sections:
   1. Section 09 91 00, Painting.

1.2 REFERENCES

A. Standards referenced in this Section:
   1. AASHTO Standard Specifications for Highway Bridges.
   2. MIL-P-21035B, Military Specification, Paint, High Zinc Dust Content Galvanizing Repair.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer:
      a. Manufacturer shall have not less than five years experience producing products substantially similar to those specified and, upon ENGINEER's request, shall submit documentation of not less than five satisfactory installations in place for not less than five years each.

B. Component Supply and Compatibility:
   1. Obtain all products included in this Section regardless of the component manufacturer from a single floor access hatch covers manufacturer. Furnishing covers from more than one manufacturer is unacceptable.

2. Floor access hatch covers manufacturer shall prepare, or shall review and approve, all Shop Drawings and other submittals for all components furnished under this Section.
3. Components shall be suitable for specified service conditions and shall be integrated into the overall assembly by the floor access hatch covers manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Detailed plans and other drawings showing location of products and direction of door swing; floor access hatch cover schedules indicating cover location, material, type, loading capacity, and other information; and fabrication details for the access hatch covers Work, including materials, thickness of metals, finishes, latching or locking provisions, type of anchorages, and accessory items.
   2. Product Data:
      a. Copies of manufacturer's literature and specifications for each type of floor access hatch incorporated in the Work.

B. Informational Submittals: Submit the following:
   1. Supplier Instructions:
      a. Installation data, including setting drawings and templates.
   2. Qualifications Statements:
      a. Manufacturer, when requested by ENGINEER.

1.4 DELIVERY, STORAGE AND HANDLING

A. Packing and Shipping:
   1. Protect mill finish and other finish during shipping and installation by an attached, adhesive-backed vinyl material that is removable during and after installation of the access hatch cover.

B. Storage and Protection:
   1. Protect steel members and packaged materials from corrosion and deterioration.

1.5 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive OWNER of other rights or remedies OWNER may otherwise have under the

Contract Documents and shall be in addition to, and run concurrent with, other warranties made by CONTRACTOR under the Contract Documents. The obligations of CONTRACTOR under the Contract Documents shall not be limited in any way by the provisions of the specified special warranty.

B. Special Warranty:
   1. Provide manufacturer's written warranty, running to the benefit of OWNER, agreeing to correct, or at option of OWNER, remove or replace structural components of the products specified in this Section found to have defect in material and workmanship during a period of five years after the date of Substantial Completion.

PART 2 – PRODUCTS

2.1 GENERAL

A. General:
   1. Provide manufacturer's standard fabricated access hatch cover units, modified when necessary to comply with the Contract Documents. Where standard units are not available for the sizes and types required, provide custom-fabricated units of the same quality as manufacturer's similar standard-sized units.
   2. Fabricate each access hatch cover unit in the shop, complete with anchors, gaskets, hardware, and accessory items, as required.
   3. Galvanizing Repair Paint: For repairing damaged galvanized surfaces, provide high zinc-dust content paint complying with MIL-P-21035B.

B. Provide floor access hatch covers in accordance with Table 05 54 63-A, Floor Access Hatch Covers Schedule:

TABLE 05 54 63-A, FLOOR ACCESS HATCH COVERS SCHEDULE

Hatch No.	Size		Material	Leaf Type	Frame Type	Remarks
	Width (inches)	Length[1] (inches)				

Notes:
1. On single-leaf floor access hatches, length includes the hinge side.

2.2 CHANNEL-FRAME TYPE ACCESS HATCH COVERS

A. Aluminum Floor Access Hatch Covers – Channel Frame Type:
   1. Design Live Load: 300 pounds per square foot.
   2. Products and Manufacturers: Provide one of the following:
      a. Single-Leaf Door Aluminum Access Hatch Cover:

1) Model TPS, by U.S.F Fabrication, Inc.
2) Type J-AL, by The Bilco Company.
3) Or equal.

b. Double-Leaf Door Aluminum Access Hatch Cover:
1) Model TPD, by U.S.F. Fabrication, Inc.
2) Type JD-AL, by The Bilco Company.
3) Or equal.

3. Cover: Not less than 1/4-inch thick, aluminum diamond-pattern plate cover. Provide flush drop-handle for lifting the cover.
4. Frame: Extruded aluminum channel frame with manufacturer's standard anchor tabs or continuous anchor flange around perimeter for anchorage to concrete.
5. Drain Coupling: 1.5-inch diameter NPT threaded drain coupling welded under the channel frame for connection of a drain pipe.
6. Gasket: EPDM gasket mechanically attached to the channel frame.
7. Hinges: Type 316 stainless steel, heavy-duty butt hinges with Type 316 stainless steel pin fastened to door with Type 316 stainless steel tamper-resistant bolts.
8. Latch: Type 316 stainless steel, watertight, slam-type latch with inside lever handle and outside removable exterior turn/lift handle fastened to leaf (door) with tamper-resistant Type 316 stainless steel bolts. Latch release shall be protected by a flush, gasketed, removable screw plug.
9. Lift Assistance: Open-style stainless steel compression springs with Type 316 stainless steel guide tubes. Automatic Type 316 stainless steel hold-open arm with grip handle release.
10. Fall-Through Prevention System: Provide access hatch cover manufacturer's standard safety grating of FRP or aluminum, constructed for live load capacity of not less than 300 psf. Provide hinges and lift-assist to allow grating sections to automatically lock in place in full-open 90-degree position. Provide hold-open arm and release assembly of aluminum or Type 316 stainless steel. Grating shall be colored OSHA "Safety Yellow" or "Safety Orange".
11. Finish: Mill finish.

B. Aluminum Floor Access Hatch Covers (H-20 Loading) – Channel Frame Type:
1. Design Live Load: H-20 truck loading in accordance with AASHTO Standard Specifications for Highway Bridges, intended for use in off-street locations that may occasionally be subject to H-20 wheel loads.
2. Products and Manufacturers: Provide one of the following:
a. Single-Leaf Door Aluminum Access Hatch Cover:
1) Model THS, by U.S.F Fabrication.
2) Type J-AL H-20, by The Bilco Company.
3) Or equal.

b. Double-Leaf Door Aluminum Access Hatch Cover:
1) Model THD, by U.S.F Fabrication.
2) Type JD-AL H-20, by The Bilco Company.
3) Or equal.

3. Cover: Not less than 1/4-inch thick, aluminum diamond-pattern plate cover

with stiffener plates, as required. Provide flush drop-handle for lifting the cover.

4. Frame: Extruded aluminum channel frame with manufacturer's standard anchor tabs or continuous anchor flange around the perimeter for anchorage to concrete.
5. Drain Coupling: 1.5-inch diameter NPT threaded drain coupling welded under the channel frame for connection of a drain pipe.
6. Gasket: EPDM gasket mechanically attached to the channel frame.
7. Hinges: Type 316 stainless steel, heavy-duty butt hinges with Type 316 stainless steel pin fastened to door with Type 316 stainless steel tamper resistant bolts.
8. Latch: Type 316 stainless steel, watertight, slam-type latch with inside lever handle and outside removable exterior turn/lift handle fastened to leaf (door) with tamper-resistant Type 316 stainless steel bolts. Latch release shall be protected by a flush, gasketed, removable screw plug.
9. Lift Assistance: Open-style stainless steel compression springs with Type 316 stainless steel guide tubes. Automatic Type 316 stainless steel hold-open arm with grip handle release.
10. Fall-Through Prevention System: Provide access hatch cover manufacturer's standard safety grating of FRP or aluminum, constructed for live load capacity of not less than 300 psf. Provide hinges and lift-assist to allow grating sections to automatically lock in place in full-open 90-degree position. Provide hold-open arm and release assembly of aluminum or Type 316 stainless steel. Grating shall be colored OSHA "Safety Yellow" or "Safety Orange".
11. Finish: Mill finish.

C. Galvanized Steel Floor Access Hatch Covers – Channel Frame Type:
   1. Design Live Load: 300 pounds per square foot.
   2. Products and Manufacturers: Provide one of the following:
      a. Single-Leaf Door Galvanized Steel Access Hatch Cover:
         1) Model TPS, by U.S.F. Fabrication, Inc.
         2) Type J-GALV, by The Bilco Company.
         3) Or equal.
      b. Double-Leaf Door Galvanized Steel Access Hatch Cover:
         1) Model TPD, by U.S.F. Fabrication.
         2) Type JD-GALV, by The Bilco Company.
         3) Or equal.
   3. Cover: Not les than 1/4-inch thick, hot-dip galvanized steel diamond-pattern plate cover. Provide flush drop-handle for lifting the cover.
   4. Frame: Hot-dip galvanized steel channel frame with manufacturer's standard anchor tabs or continuous anchor flange around the perimeter for anchorage to concrete.
   5. Drain Coupling: 1.5-inch diameter NPT threaded drain coupling welded under the channel frame for connection of a drain pipe.
   6. Gasket: Neoprene gasket mechanically attached to the channel frame.
   7. Hinges: Tamper-resistant, heavy-duty hinges with Type 316 stainless steel pin fastened to door with Type 316 stainless steel tamper-resistant bolts.

8. Latch: Type 316 stainless steel, watertight, slam-type latch with inside lever handle and outside, removable exterior turn/lift handle fastened to leaf (door) with tamper-resistant Type 316 stainless steel bolts. Latch release shall be protected by a flush, gasketed, removable screw plug.
9. Lift Assistance: Open-style stainless steel compression springs with Type 316 stainless steel guide tubes. Automatic Type 316 stainless steel hold-open arm with grip handle release.
10. Fall-Through Prevention System: Provide access hatch cover manufacturer's standard safety grating of FRP or aluminum, constructed for live load capacity of not less than 300 psf. Provide hinges and lift-assist to allow grating sections to automatically lock in place in full-open 90-degree position. Provide hold-open arm and release assembly of aluminum or Type 316 stainless steel. Grating shall be colored OSHA "Safety Yellow" or "Safety Orange".
11. Finish: Hot-dip galvanized. Finish-paint system over galvanized finish is not required.

D. Galvanized Steel Floor Access Hatch Covers (H-20 Loading) – Channel Frame Type:
1. Design Live Load: H-20 truck loading in accordance with AASHTO Standard Specifications for Highway Bridges, intended for use in off-street locations occasionally subject to H-20 wheel loads.
2. Products and Manufacturers: Provide one of the following:
   a. Single-Leaf Door Galvanized Steel Access Hatch Cover:
      1) Model THS, by U.S.F Fabrication, Inc.
      2) Type J-GALV H-20, by The Bilco Company.
      3) Or equal.
   b. Double-Leaf Door Galvanized Steel Access Hatch Cover:
      1) Model THD, by U.S.F. Fabrication, Inc.
      2) Type JD-GALV H-20, by The Bilco Company.
      3) Or equal.
3. Cover: Not less than 1/4-inch thick, hot-dip galvanized steel diamond-pattern plate cover, with stiffener plates as required. Provide flush drop handle for lifting the cover.
4. Frame: Hot-dip galvanized steel channel frame with manufacturer's standard anchor tabs or continuous anchor flange around the perimeter for anchorage to concrete.
5. Drain Coupling: 1.5-inch diameter NPT threaded drain coupling welded under the channel frame for connection of a drain pipe.
6. Gasket: Neoprene gasket mechanically attached to the channel frame.
7. Hinges: Tamper-resistant heavy-duty hinges with Type 316 stainless steel pin fastened to door with Type 316 stainless steel tamper-resistant bolts.
8. Latch: Type 316 stainless steel, watertight, slam-type latch with inside lever handle and outside removable exterior turn/lift handle fastened to door with tamper-resistant Type 316 stainless steel bolts. Latch release shall be protected by a flush, gasketed, removable screw plug.
9. Lift Assistance: Open-style stainless steel compression springs with Type 316 stainless steel guide tubes. Automatic Type 316 stainless steel hold-open

10. Fall-Through Prevention System: Provide access hatch cover manufacturer's standard safety grating of FRP or aluminum, constructed for live load capacity of not less than 300 psf. Provide hinges and lift-assist to allow grating sections to automatically lock in place in full-open 90-degree position. Provide hold-open arm and release assembly of aluminum or Type 316 stainless steel. Grating shall be colored OSHA "Safety Yellow" or "Safety Orange".
11. Finish: Hot-dip galvanized. Finish-paint system over galvanized finish is not required.

E. Stainless Steel Floor Access Hatch Covers – Channel Frame Type:
1. Design Live Load: 300 pounds per square foot.
2. Products and Manufacturers: Provide one of the following:
   a. Single-Leaf Door Stainless Steel Access Hatch Cover:
      1) Model TPS, by U.S.F. Fabrication, Inc.
      2) Type J-SS, by The Bilco Company.
      3) Or equal.
   b. Double-Leaf Door Stainless Steel Access Hatch Cover
      1) Model TPD, by U.S.F. Fabrication, Inc.
      2) Type JD-SS, by The Bilco Company.
      3) Or equal.
3. Cover: Not less than 1/4-inch thick, Type 316 stainless steel diamond-pattern plate cover. Provide flush drop handle for lifting the cover.
4. Frame: Type 316 stainless steel channel frame with manufacturer's standard anchor tabs or continuous anchor flange around the perimeter for anchorage to concrete.
5. Drain Coupling: 1.5-inch diameter NPT threaded drain coupling welded under the channel frame for connection of a drain pipe.
6. Gasket: Neoprene gasket mechanically attached to the channel frame.
7. Hinges: Tamper-resistant, heavy-duty hinges with Type 316 stainless steel pin fastened to door with Type 316 stainless steel tamper-resistant bolts.
8. Latch: Type 316 stainless steel, watertight, slam-type latch with inside lever handle and outside, removable exterior turn/lift handle fastened to leaf (door) with tamper-resistant Type 316 stainless steel bolts. Latch release shall be protected by a flush, gasketed, removable screw plug.
9. Lift Assistance: Open-style stainless steel compression springs with Type 316 stainless steel guide tubes. Automatic Type 316 stainless steel hold-open arm with grip handle release.
10. Fall-Through Prevention System: Provide access hatch cover manufacturer's standard safety grating of FRP or aluminum, constructed for live load capacity of not less than 300 psf. Provide hinges and lift-assist to allow grating sections to automatically lock in place in full-open 90-degree position. Provide hold-open arm and release assembly of aluminum or Type 316 stainless steel. Grating shall be colored OSHA "Safety Yellow" or "Safety Orange".
11. Finish: Type 316 stainless steel.

F. Stainless Steel Floor Access Hatch Covers (H-20 Loading) – Channel Frame

Type:

1. Design Live Load: H-20 truck loading in accordance with AASHTO Standard Specifications for Highway Bridges, intended for use in off-street locations occasionally subject to H-20 wheel loads.
2. Products and Manufacturers: Provide one of the following:
   a. Single-Leaf Door Stainless Steel Access Hatch Cover:
      1) Model THS, by U.S.F Fabrication, Inc.
      2) Type J-SS H-20, by The Bilco Company.
      3) Or equal.
   b. Double-Leaf Door Stainless Steel Access Hatch Cover:
      1) Model THD, by U.S.F Fabrication, Inc.
      2) Type JD-SS H-20, by The Bilco Company.
      3) Or equal.
3. Cover: Not less than 1/4-inch thick Type 316 stainless steel diamond-pattern plate cover with stiffener plates, as required. Provide flush drop handle for lifting the cover.
4. Frame: Type 316 stainless steel channel frame with manufacturer's standard anchor tabs or continuous anchor flange around the perimeter for anchorage to concrete.
5. Drain Coupling: 1.5-inch diameter NPT threaded drain coupling welded under the channel frame for connection of a drain pipe.
6. Gasket: Neoprene gasket mechanically attached to the channel frame.
7. Hinges: Tamper-resistant, heavy-duty hinges with Type 316 stainless steel pin fastened to leaf (door) with Type 316 stainless steel tamper-resistant bolts.
8. Latch: Type 316 stainless steel, watertight, slam-type latch with inside lever handle and outside, removable exterior turn/lift handle fastened to leaf (door) with tamper-resistant Type 316 stainless steel bolts. Latch release shall be protected by a flush, gasketed, removable screw plug.
9. Lift Assistance: Open-style stainless steel compression springs with Type 316 stainless steel guide tubes. Automatic Type 316 stainless steel hold-open arm with grip handle release.
10. Fall-Through Prevention System: Provide access hatch cover manufacturer's standard safety grating of FRP or aluminum, constructed for live load capacity of not less than 300 psf. Provide hinges and lift-assist to allow grating sections to automatically lock in place in full-open 90-degree position. Provide hold-open arm and release assembly of aluminum or Type 316 stainless steel. Grating shall be colored OSHA "Safety Yellow" or "Safety Orange".
11. Finish: Type 316 stainless steel.

G. Drain piping for floor access hatch covers with channel frames is under Section (--1--).

H. Provide Schedule 40 PVC drain piping from the floor access hatch cover channel frame routed as indicated in the Contract Documents.

2.3 ANGLE-FRAME TYPE ACCESS HATCH COVERS

A. Aluminum Floor Access Hatch Covers – Angle Frame Type:
   1. Design Live Load: 300 pounds per square foot.
   2. Products and Manufacturers: Provide one of the following:
      a. Single-Leaf Door Aluminum Access Hatch Cover:
         1) Model APS300, by U.S.F. Fabrication, Inc.
         2) Type K, by The Bilco Company.
         3) Or equal.
      b. Double-Leaf Door Aluminum Access Hatch Cover:
         1) Model APD300, by U.S.F. Fabrication, Inc.
         2) Type KD, by The Bilco Company.
         3) Or equal.
   3. Cover: Not less than 1/4-inch thick aluminum diamond-pattern plate cover. Provide flush drop handle for lifting the cover.
   4. Frame: Extruded aluminum angle frame with manufacturer's standard anchor tabs or continuous anchor flange around the perimeter for anchorage to concrete.
   5. Hinges: Tamper-resistant, heavy-duty hinges with Type 316 stainless steel pin fastened to leaf (door) with Type 316 stainless steel tamper-resistant bolts.
   6. Latch: Type 316 stainless steel, watertight, slam-type latch with inside lever handle and outside, removable exterior turn/lift handle fastened to leaf (door) with tamper-resistant Type 316 stainless steel bolts. Latch release shall be protected by a flush, gasketed, removable screw plug.
   7. Lift Assistance: Open-style stainless steel compression springs with Type 316 stainless steel guide tubes. Automatic Type 316 stainless steel hold-open arm with grip handle release.
   8. Finish: Mill finish.

B. Galvanized Steel Floor Access Hatch Covers – Angle Frame Type:
   1. Design Live Load: 300 pounds per square foot.
   2. Products and Manufacturers: Provide one of the following:
      a. Single-Leaf Door Galvanized Steel Access Hatch Cover:
         1) Model APS300, by U.S.F. Fabrication, Inc.
         2) Type Q, by The Bilco Company.
         3) Or equal.
      b. Double-Leaf Door Galvanized Steel Access Hatch Cover:
         1) Model APD300, by U.S.F. Fabrication, Inc.
         2) Type Q, by The Bilco Company.
   3. Cover: Not less than 1/4-inch thick diamond-pattern hot-dip galvanized steel plate. Provide flush drop handle for lifting the cover.
   4. Frame: Hot-dip galvanized steel angle frame with manufacturer's standard anchor tabs or continuous anchor flange around the perimeter for anchorage to concrete.
   5. Hinges: Tamper-resistant, heavy-duty hinges with Type 316 stainless steel pin fastened to leaf (door) with Type 316 stainless steel tamper-resistant bolts.
   6. Latch: Type 316 stainless steel, watertight, slam-type latch with inside lever

handle and outside removable exterior turn/lift handle fastened to leaf (door) with tamper-resistant Type 316 stainless steel bolts. Latch release shall be protected by a flush, gasketed, removable screw plug.

7. Lift Assistance: Open-style stainless steel compression springs with Type 316 stainless steel guide tubes. Automatic Type 316 stainless steel hold-open arm with grip handle release.
8. Fall-Through Prevention System: Provide access hatch cover manufacturer's standard safety grating of FRP or aluminum, constructed for live load capacity of not less than 300 psf. Provide hinges and lift-assist to allow grating sections to automatically lock in place in full-open 90-degree position. Provide hold-open arm and release assembly of aluminum or Type 316 stainless steel. Grating shall be colored OSHA "Safety Yellow" or "Safety Orange".
9. Finish: Hot-dip galvanized. Finish-paint system over galvanized finish is not required.

C. Stainless Steel Floor Access Hatch Covers – Angle Frame Type:
   1. Design Live Load: 300 pounds per square foot.
   2. Products and Manufacturers: Provide one of the following:
      a. Single-Leaf Door Stainless Steel Access Hatch Cover:
         1) Model APS300, by U.S.F. Fabrication, Inc.
         2) B-FHA Series Single Leaf, by Babcock Davis Associates, Inc.
      b. Double-Leaf Door Stainless Steel Access Hatch Cover:
         1) Model APD300, by U.S.F. Fabrication, Inc.
         2) B-FHA Series Double Leaf, by Babcock Davis Associates, Inc.
         3) Or equal.
   3. Cover: Not less than 1/4-inch thick, Type 316 stainless steel diamond-pattern plate cover. Provide flush drop-handle for lifting the cover.
   4. Frame: Type 316 stainless steel angle frame with manufacturer's standard anchor tabs or continuous anchor flange around the perimeter for anchorage to concrete.
   5. Hinges: Tamper-resistant, heavy-duty hinges with Type 316 stainless steel pin fastened to leaf (door) with Type 316 stainless steel tamper-resistant bolts.
   6. Latch: Type 316 stainless steel, watertight, slam-type latch with inside lever handle and outside removable exterior turn/lift handle fastened to leaf (door) with tamper-resistant Type 316 stainless steel bolts. Latch release shall be protected by a flush, gasketed, removable screw plug.
   7. Lift Assistance: Open-style stainless steel compression springs with Type 316 stainless steel guide tubes. Automatic Type 316 stainless steel hold-open arm with grip handle release.
   8. Finish: Type 316 stainless steel.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which floor access hatch cover Work will be performed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install floor access hatch covers in accordance with approved Shop Drawings and other approved submittals, the Contract Documents, and manufacturer's instructions.

B. Set floor access hatch covers level and true to line or grade, without warp or rack.

C. Drain Piping for Channel Frames:
   1. Provide drain piping from the floor access match cover channel frame routed as shown or indicated on the Drawings.
   1. Provide drain piping from the floor access hatch cover channel frame and route to the nearest floor drain or sump pit in a manner that does not obstruct access for facility operations and maintenance.
   2. After installation, fill drain piping with water. Drain piping shall be free of visible leaks.

D. Protection of Aluminum from Dissimilar Materials: Coat surfaces of aluminum in contact with dissimilar materials such as concrete, masonry, steel, and other metals in accordance with Section 09 91 00, Painting.

E. Galvanized Covers: Where zinc coating is damaged, touch-up abraded surfaces with galvanizing repair paint applied in accordance with the paint manufacturer's instructions and recommendations.

3.3 ADJUSTING AND CLEANING

A. Adjust leafs of floor access hatch covers as necessary to provide proper operations.

B. Remove stains, concrete splatter, oils, grease, and other foreign materials necessary and provide clean, finished surfaces.

+ + END OF SECTION + +

SECTION 05 56 00

METAL CASTINGS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install metal castings.
   2. Castings include metal items that are not part of miscellaneous metal fabrications or metal systems in other Specifications Sections.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before metal castings Work.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI A14.3, Safety Requirements for Fixed Ladders.
   2. ASTM A48/A48M, Specification for Gray Iron Castings.
   3. ASTM A126, Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   4. ASTM C478, Specification for Precast Reinforced Concrete Manhole Sections.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer: Shall have at least five years experience manufacturing products substantially similar to those required and shall be able to submit documentation of at least five installations in satisfactory operation for at least five years each.

B. Component Supply and Compatibility:
   1. Obtain all frame, lid or cover, grate, and manhole step products included in this Section regardless of component manufacturer, from a single castings manufacturer.
   2. Obtain all hydrostatic pressure relief valve products included in this Section regardless of component manufacturer, from a single castings manufacturer.
   3. Castings manufacturer shall review and approve or prepare all Shop Drawings and other submittals for all components furnished under this Section.
   4. Components shall be constructed for specified service conditions and shall be integrated into overall assembly by castings manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Fabrication and installation of all casting assemblies. Include plans, elevations, and details of sections and connections. Show anchorage and accessory items. Include setting drawings for location and installation of castings and anchorage devices.
   2. Product Data:
      a. Copies of manufacturer's catalog information for the products proposed for use, specifications, load tables, dimension diagrams, anchor details, and installation instructions.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. Furnish certification, signed by authorized officer of CONTRACTOR and notarized, stating that all components are furnished by the same manufacturer.
      b. Manufacturer's certification that the casting or lot of castings was made, sampled, tested and inspected in accordance with ASTM A48.
   2. Qualifications Statements: Submit qualifications for the following:
      a. Manufacturer, when required by ENGINEER.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling, and Unloading:
   1. Deliver products to the Site to ensure uninterrupted progress of the Work. Deliver anchorage materials to be embedded in concrete in ample time to prevent delaying the Work.
   2. Comply with Section 01 65 00, Product Delivery Requirements.

B. Storage and Protection:
   1. Protect materials from corrosion and deterioration.
   2. Comply with Section 01 66 00, Product Storage and Handling Requirements.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Round Manhole Frame with Solid Lid:
   1. Material: ASTM A48/A48M, Class 35 B.
   2. Products and Manufacturers: Provide one of the following:
      a. R-1530, manufactured by Neenah Foundry Company.
      b. E-1920, manufactured by East Jordan Iron Works, Inc.
      c. Or equal.

B. Round Manhole Frame with Vented Lid:
   1. Material: ASTM A48/A48M, Class 35 B.
   2. Products and Manufacturers: Provide one of the following:
      a. R-1654, manufactured by Neenah Foundry Company.
      b. E-1850, manufactured by East Jordan Iron Works, Inc.
      c. Or equal.

C. Round Manhole Frame with Open Grate:
   1. Material: ASTM A48/A48M, Class 35 B.
   2. Products and Manufacturers: Provide one of the following:
      a. R-1792-GG, manufactured by Neenah Foundry Company.
      b. V-3610-3, manufactured by East Jordan Iron Works, Inc.
      c. Or equal.

D. Round Manhole Frame with Solid Bolted Lid:
   1. Material: ASTM A48/A48M, Class 35 B.
   2. Products and Manufacturers: Provide one of the following:
      a. R-1916-C2, manufactured by Neenah Foundry Company.
      b. E-1561, manufactured by East Jordan Iron Works, Inc.
      c. Or equal.

E. Round Manhole Frame with Solid Lid – Flush Top:
   1. Material: ASTM A48/A48M, Class 35 B.
   2. Products and Manufacturers: Provide one of the following:
      a. R-6060, manufactured by Neenah Foundry Company.
      b. 1625, manufactured by East Jordan Iron Works, Inc.
      c. Or equal.

F. Catch Basin Frame with Grate:
   1. Material: ASTM A48/A48M, Class 35 B.
   2. Products and Manufacturers: Provide one of the following:
      a. R-2501, manufactured by Neenah Foundry Company.
      b. E-1045 M2, manufactured by East Jordan Iron Works, Inc.
      c. Or equal.

G. Curb Inlet Frame Grate and Curb Box:
   1. Material: ASTM A48/A48M, Class 35 B.
   2. Products and Manufacturers: Provide one of the following:
      a. R-3067, manufactured by Neenah Foundry Company.
      b. E-7030 M52, manufactured by East Jordan Iron Works, Inc.
      c. Or equal.

H. Valve Box Frame and Lid:
   1. Material: ASTM A48/A48M, Class 35 B.
   2. Products and Manufacturers: Provide one of the following:
      a. R-7506-F, manufactured by Neenah Foundry Company.
      b. 3671, manufactured by East Jordan Iron Works, Inc

c. Or equal.

I. Heavy-Duty H-20 Trench Frame with Solid Cover:
   1. Material: ASTM A48/A48M, Class 35 B.
   2. Products and Manufacturers: Provide one of the following:
      a. R-4990-FX, Type D Cover, manufactured by Neenah Foundry Company.
      b. 6956, manufactured by East Jordan Iron Works, Inc.
      c. Or equal.

J. Heavy-Duty H-20 Trench Frame with Grated Cover:
   1. Material: ASTM A48/A48M, Class 35 B.
   2. Products and Manufacturers: Provide one of the following:
      a. R-4990-FX, Type A Cover, manufactured by Neenah Foundry Company.
      b. 6956, manufactured by East Jordan Iron Works, Inc.
      c. Or equal.

K. Floor-type Hydrostatic Pressure Relief Valves:
   1. Provide floor-type hydrostatic pressure relief valves suitable for installation in cast-in-place concrete foundations as shown or indicated on the Drawings.
   2. Products and Manufacturers: Provide one of the following:
      a. R-5000, Type C, manufactured by Neenah Foundry Company.
      b. F-1493-T, manufactured by Clow Valve Company.
      c. Or equal.
   3. Cover and grate shall be removable but shall be constructed so that neither can be separated from valve body due to groundwater pressure around the structure served by the valve.
   4. Material:
      a. Cover, body, and grate shall be cast iron complying with ASTM A126, Class B.
      b. Seats shall be Nitrile (Buna-N) rubber, bonded to the cover, mating with machined bronze seat in the body.
   5. Provide length equal to thickness of concrete foundation slab shown or indicated on the Drawings.

L. Wall-type Hydrostatic Pressure Relief Valves:
   1. Wall-type hydrostatic pressure relief valves shall be suitable for installation in cast-in-place concrete walls as shown or indicated on the Drawings.
   2. Products and Manufacturers: Provide one of the following:
      a. R-5000, Type C, manufactured by Neenah Foundry Company.
      b. F-1493, manufactured by Clow Valve Company.
      c. Or equal.
   3. Material:
      a. Flap gate and body shall be of cast iron complying with ASTM A126, Class B.
      b. Body seat ring and hinge pin shall be of furnished of machined bronze.

c. Gate shall be provided with a neoprene rubber seat cemented and mechanically retained in place by retainer plate.

4. Provide length equal to thickness of concrete wall shown or indicated on the Drawings.

M. Manhole Steps:

1. Provide manhole steps as shown on the Drawings. Comply with requirements of ASTM C478 and ANSI A14.3.
2. Products and Manufacturers: Provide one of the following:
   a. R-1982-F, manufactured by Neenah Foundry Company.
   b. 8512, manufactured by East Jordan Iron Works.
   c. Or equal.
3. Material: Cast gray iron.

2.2 FABRICATION

A. Fabrication, General:

1. Castings shall be of uniform quality, free of sand holes, gas holes, shrinkage cracks, and other surface defects.
2. Castings shall be ground smooth and well-cleaned by shot blasting in the shop.
3. Design and fabricate round frames and covers to prevent rocking and rattling under traffic loads that will be imposed in actual use.
4. Fabricate castings true to pattern so that component parts fit together.
5. Each casting shall be identifiable and, depending on its size, shall indicate the following: name of producing foundry, ASTM material designation, individual part number, and cast or heat date. Castings shall include all lettering shown or indicated on the Drawings.

PART 3 – EXECUTION

3.1 INSPECCTION

A. Examine conditions under which Work is to be performed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Comply with casting manufacturer's printed instructions and the Contract Documents. Where castings are installed on precast concrete, fabricated fiberglass, or other fabricated products, install casting in accordance with requirements of manufacturer of product on which casting will be installed.

B. Set castings accurately to required location, alignment, and elevation, plumb, level, true and free of rack, measured from established lines and levels. Where applicable, brace temporarily or anchor temporarily in formwork.

C. Manhole Steps:
   1. Install gray cast iron manhole steps as shown on the Drawings. Comply with requirements of ASTM C478 and ANSI A14.3.
   2. Vertical separation of steps shall be uniform at maximum of 12 inches on centers. Steps shall project evenly from walls.

+ + END OF SECTION + +

SECTION 06 10 00 – ROUGH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Wood furring, grounds, nailers, and blocking not specified elsewhere.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 06 Section “Sheathing” for insulated plywood roof and wall sheathing.

1.3 DEFINITIONS

A. Rough Carpentry: Carpentry work not specified in other Sections and not exposed to view, unless otherwise specified.

B. Dimension Lumber: Lumber of 2 inches nominal (38 mm actual) size or greater but less than 5 inches nominal (114 mm actual) size in least dimension.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Indicate type of preservative used and net amount of preservative retained.
2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Include physical properties of treated materials.
3. For fire-retardant treatments, include physical properties of treated plywood both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.

4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
5. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

1.5 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For the following, from ICC-ES:

1. Wood-preservative-treated wood.
2. Fire-retardant-treated wood.
3. Engineered wood products.
4. Power-driven fasteners.
5. Post-installed anchors.
6. Metal framing anchors.

1.6 QUALITY ASSURANCE

A. Wood Standards: Provide products meeting the following standards:

1. Lumber Standards, Southern Yellow Pine: Southern Pine Inspection Bureau.
2. Plywood Standard: American Plywood Association.
3. Factory-mark each piece of lumber and plywood with type, grade, mill and grading agency, except omit marking from surfaces to be exposed with transparent finish or without finish.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Keep materials under cover and dry. Protect from weather and contact with damp or wet surfaces. Stack lumber, plywood, and other panels. Provide for air circulation within and around stacks and under temporary coverings.

1. For lumber and plywood pressure treated with waterborne chemicals, place spacers between each bundle to provide air circulation.

PART 2 - PRODUCTS

2.1 DIMENSION LUMBER

A. General: Comply with DOC PS 20 and applicable rules of lumber grading agencies certified by the American Lumber Standards Committee Board of Review.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified.
3. Provide dressed lumber, S4S, unless otherwise indicated.
4. Provide dry lumber with 19 percent maximum moisture content at time of dressing for 2-inch nominal (38-mm actual) thickness or less, unless otherwise indicated.

B. Fabricate miscellaneous lumber from dimension lumber of sizes indicated and into shapes shown.

C. Species and Grade: No. 2 Southern Yellow Pine.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category Use Category UC3b for exterior construction not in contact with ground.

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.

B. Except where more stringent requirements are indicated, kiln-dry material after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood. Do not use material that is warped or does not comply with requirements for untreated material.

C. Mark each treated item with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.

D. Application: Treat items indicated on Drawings, and the following:

1. Wood sills, floor plates, sleepers, blocking, furring, stripping, and similar concealed members attached to steel, masonry or concrete.
2. Wood sills, floor plates, sleepers, blocking, furring, stripping, and similar concealed members less than 18 inches (460 mm) above grade.
3. Plywood subflooring installed over open framing directly above grade.

2.3 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.

1. For use in fastening through or to preservative-treated wood, provide fasteners manufactured from stainless steel, Grade as best suited for each attachment condition.

B. Nails, Wire, Brads, and Staples: FS FF-N-105.

C. Powder-Driven Fasteners: CABO NER-272.

D. Wood Screws: ASME B18.6.1.

E. Lag Bolts: ASME B18.2.1. (ASME B18.2.3.8M)

F. Bolts: Steel bolts complying with ASTM A 307, Grade A (ASTM F 568, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers.

2.4 MISCELLANEOUS MATERIALS

A. Self-Adhering Sheet Underlayment, Polyethylene Faced: ASTM D 1970, minimum of 40-mil- (1.0-mm-) thick, slip-resisting, polyethylene-film-reinforced top surface laminated to SBS-modified asphalt adhesive, with release paper backing; cold applied.

1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include the following or Comparable Product

a. WIP 200; Carlisle Coatings & Waterproofing, Inc.
b. Ice and Water Shield; W.R. Grace

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Discard units of material with defects that impair quality of rough carpentry and that are too small to use with minimum number of joints or optimum joint arrangement.

B. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted.

C. Fit rough carpentry to other construction; scribe and cope as required for accurate fit. Correlate location of furring, nailers, blocking, grounds, and similar supports to allow attachment of other construction.

3.2 WOOD GROUNDS, NAILERS, BLOCKING, AND SLEEPERS

A. Install wood grounds, nailers, blocking, and sleepers where shown, and where required for screeding, attaching or supporting other work. Form to shapes shown and cut as required

for true line and level of attached work. Coordinate locations with other work involved.

B. Attach to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated. Build into masonry during installation of masonry work. Where possible, anchor to formwork before concrete placement.

1. Provide one layer of self-adhering sheet underlayment to separate treated wood (both lumber and plywood) from metal to which it is attached, or with which it would otherwise be in contact.

END OF SECTION 06 10 00

SECTION 06 16 00 - SHEATHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Insulated plywood sheathing.

B. Related Sections include the following:

1. Division 07 Section "Fluid-Applied Membrane Air Barriers" for treatment of joints in insulated plywood wall sheathing.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Include physical properties of treated materials.
2. For fire-retardant treatments, include physical properties of treated plywood both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5516.
3. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
4. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

B. Manufacturer’s installation instructions for insulated plywood wall sheathing, including schedule of fastener types and spacings.

1.4 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For the following, from ICC-ES:

1. Fire-retardant-treated plywood.

1.5 QUALITY ASSURANCE

A. Wood Standards: Provide products meeting the following standards:

1. Plywood Standard: American Plywood Association.
2. Factory-mark each piece of plywood with type, grade, mill and grading agency.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages, containers, or bundles bearing brand name and identification of manufacturer or supplier.

B. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes. Stack gypsum panels flat with spacers beneath and between each bundle to provide air circulation.

PART 2 - PRODUCTS

2.1 INSULATED PLYWOOD SHEATHING

A. Insulated Plywood Roof Sheathing: Closed cell polyisocyanurate foam core bonded to a coated glass facer on one side and to a 3/4-inch fire-retardant treated plywood panel on the other side.

1. Panel Thickness: 4.2-inch.
2. Panel R-Value: 22.7
3. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include the following or Equal Product:

a. Xci Ply (Class A); Hunter Panels.

B. Insulated Plywood Wall Sheathing: Closed cell polyisocyanurate foam core bonded to a coated glass facer on one side and to a 5/8-inch fire-retardant treated plywood panel on the other side.

1. Panel Thickness: 2.1-inch.
2. Panel R-Value: 9.8
3. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include the following or Equal Product:

a. Xci Ply (Class A); Hunter Panels.

2.2 FIRE-RETARDANT-TREATED PLYWOOD

A. General: Where fire-retardant-treated materials are indicated, materials shall comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.

1. Treatment shall not promote corrosion of metal fasteners.
2. Treatment Type: Interior Type A High-Temperature (HT).

    a. Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D3201 at 92 percent relative humidity.

3. Design Value Adjustment Factors: Treated lumber shall be tested according to ASTM D5664, and design value adjustment factors shall be calculated according to ASTM D6841. For enclosed roof framing, framing in attic spaces, and where high-temperature fire-retardant treatment is indicated, provide material with adjustment factors of not less than 0.85 modulus of elasticity and 0.75 for extreme fiber in bending for Project's climatological zone.

C. Except where more stringent requirements are indicated, kiln-dry plywood after treatment to a maximum moisture content of 15 percent. Do not use material that is warped or does not comply with requirements for untreated material.

D. Identify fire-retardant-treated plywood with appropriate classification marking of qualified testing agency.

2.3 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

B. Screws for Fastening Insulated Plywood Roof Sheathing: FM Approved Hunter Panel SIP/SD Panel Fasteners for steel roof deck application. Fasteners have a 3/16 inch (5 mm) shank and are corrosion resistant with oversized heads. Length of fasteners shall be as recommended by Hunter Panels; refer to the Hunter Panels application guide for instructions.

1. Fasteners shall penetrate metal roof deck a minimum of 1 inch (25 mm).

C. Screws for Fastening Insulated Plywood Wall Sheathing: FM Approved Hunter Panel

SIP/SD Panel Fasteners for CMU wall application. Fasteners have a 3/16 inch (5 mm) shank and are corrosion resistant with oversized heads. Length of fasteners shall be as recommended by Hunter Panels; refer to the Hunter Panels application guide for instructions.

2.4 MISCELLANEOUS MATERIALS

A. Concealed Flashing: Rubberized-asphalt composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 0.040 inch (1.0 mm).

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work included the following or Equal Product:

a. Carlisle Coatings & Waterproofing; CCW-705-TWF Thru-Wall Flashing.
b. Grace Construction Products, a unit of W. R. Grace & Co. - Conn.; Perm-A-Barrier Wall Flashing.
c. Heckmann Building Products Inc.; No. 82 Rubberized-Asphalt Thru-Wall Flashing.

B. Self-Adhering Sheet Underlayment, Polyethylene Faced: ASTM D 1970, minimum of 40-mil- (1.0-mm-) thick, slip-resisting, polyethylene-film-reinforced top surface laminated to SBS-modified asphalt adhesive, with release paper backing; cold applied.

1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include the following or Equal Product:

a. WIP 200; Carlisle Coatings & Waterproofing, Inc.
b. Ice and Water Shield; W.R. Grace

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting substrates and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.

B. Install plywood panels with the long dimension or strength axis of the panel across

supports, unless indicated otherwise on Drawings, and with panel continuous over two or more spans.

1. Panel end joints shall occur over framing.
2. Stagger panel end joints in adjacent rows.
3. Unless otherwise indicated by the panel manufacturer, space panels as follows:

    a. Underlayment: 1/32 inch (0.8 mm) apart at panel ends and edges
    b. All other panels: 1/8 inch (3 mm) apart at panel ends and edges

C. Cut panels at penetrations, edges, and other obstructions of work; fit closely to abutting construction unless otherwise indicated.

D. Securely attach to substrate by fastening as indicated, complying with the following:

1. Table 2304.9.1, "Fastening Schedule," in the ICC's International Building Code.
2. ICC-ES evaluation report for fastener.

E. Coordinate sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.

F. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

G. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

3.3 PLYWOOD SHEATHING INSTALLATION

A. General: Comply with applicable recommendations in APA Form No. E30, "Engineered Wood Construction Guide," for types of plywood panels and applications indicated.

B. Fastening Methods: Fasten panels with screws.

C. Protection, Plywood Roof Sheathing: Install self-adhering sheet underlayment in accordance with manufacturer’s recommendations to protect plywood roof sheathing until roofing is applied.

END OF SECTION 06 16 00

SECTION 07 27 26 – FLUID-APPLIED MEMBRANE AIR BARRIERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Fluid-applied membrane air barrier, vapor permeable.

B. Related Sections include the following:

1. Division 04 Section "Unit Masonry Assemblies" for embedded flashings.
2. Division 06 Section "Sheathing" for insulated plywood sheathing.
3. Division 07 Section "Joint Sealants" for joint-sealant materials and installation.

1.3 DEFINITIONS

A. ABAA: Air Barrier Association of America.

B. Air-Barrier Material: A primary element that provides a continuous barrier to the movement of air.

C. Air-Barrier Accessory: A transitional component of the air barrier that provides continuity.

D. Air Barrier Assembly: The collection of air barrier materials and auxiliary materials applied to an opaque wall, including joints and junctions to abutting construction, to control air movement through the wall.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Include installers of other construction connecting to air barrier, including roofing, waterproofing, architectural precast concrete, masonry, sealants, windows, glazed

curtain walls, and door frames.
2. Review air barrier requirements including surface preparation, substrate condition and pretreatment, minimum substrate curing period, forecasted weather conditions, special details and sheet flashings, mockups, installation procedures, sequence of installation, testing and inspecting procedures, and protection and repairs.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include manufacturer's written instructions for evaluating, preparing, and treating each substrate; technical data; dry film thickness; and tested physical and performance properties of products.

B. Shop Drawings: For air-barrier assemblies.

1. Show locations and extent of air-barrier materials, accessories, and assemblies specific to Project conditions.
2. Include details for substrate joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
3. Include details of interfaces with other materials that form part of air barrier.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Certificates: From air-barrier manufacturer, certifying compatibility of air barrier and accessory materials with Project materials that connect to or that come in contact with the barrier.

C. Product Test Reports: For each air-barrier assembly, for tests performed by a qualified testing agency.

D. Field quality-control reports

1.7 QUALITY ASSURANCE

A. Applicator Qualifications: A firm experienced in applying air barrier materials similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.

B. Mockups: Before beginning installation of air barrier, at location acceptable to Architect

build mockups of exterior wall assembly approximately 10' x 10', incorporating backup wall construction, external cladding, window, door frame and sill, insulation, and flashing to demonstrate surface preparation, crack and joint treatment, and sealing of gaps, terminations, and penetrations of air barrier membrane.

1. Include building corner condition and base of wall/slab condition.
2. If Architect determines mockups do not comply with requirements, reconstruct mockups and apply air barrier until mockups are approved.
3. Acceptance of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Accepted mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store liquid materials in their original undamaged packages in a clean, dry, protected location and within temperature range required by air barrier manufacturer.

B. Remove and replace liquid materials that cannot be applied within their stated shelf life.

C. Protect stored materials from direct sunlight.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Apply air barrier within the range of ambient and substrate temperatures recommended in writing by air-barrier manufacturer.

1. Protect substrates from environmental conditions that affect air-barrier performance.
2. Do not apply air barrier to a damp or wet substrate or during snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Source Limitations: Obtain primary air-barrier materials and air-barrier accessories from single source from single manufacturer.

B. VOC Content: 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24) and complying with VOC content limits of authorities having jurisdiction.

2.2 PERFORMANCE REQUIREMENTS

A. General: Air barrier shall be capable of performing as a continuous vapor-permeable air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air barrier assemblies shall be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.

B. Air Barrier Assembly Air Leakage: Not to exceed 0.04 cfm x sq. ft. of surface area at 1.57 lbf/sq. ft. (0.2 L/s x sq. m of surface area at 75 Pa), when tested according to ASTM E 2357.

C. Water Vapor Permeance: ASTM E96 Method B: > 10 perms.

D. Flame Spread and Smoke Development, ASTM E84: Class A.

2.3 FLUID-APPLIED MEMBRANE AIR BARRIER

A. Fluid-Applied, Vapor-Permeable Membrane Air Barrier: ~~UV-resistant black~~ Water-based membrane-forming coating system.

1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include the following or Comparable Product:

a. Henry Company; Air-Bloc 33MR.
b. Meadows, W. R., Inc.; Air-Shield LMP ~~(black)~~ .

2.4 AUXILIARY MATERIALS

A. General: Auxiliary materials recommended by air barrier manufacturer for intended use and compatible with air barrier membrane. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.

B. Primer: Liquid waterborne primer recommended for substrate by manufacturer of air barrier material.

C. Counterflashing Strip: Modified bituminous, 40-mil- (1.0-mm-) thick, self-adhering sheet consisting of 32 mils (0.8 mm) of rubberized asphalt laminated to an 8-mil- (0.2-mm-) thick, crosslaminated polyethylene film with release liner backing.

D. Joint Reinforcing Strip: Air barrier manufacturer's glass-fiber-mesh tape.

E. Substrate Patching Membrane: Manufacturer's standard trowel-grade substrate filler.

F. Adhesive and Tape: Air barrier manufacturer's standard adhesive and pressure-sensitive adhesive tape.

G. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304, not less than 0.0187 inch (0.5 mm) thick, and Series 300 stainless-steel fasteners.

H. Sprayed Polyurethane Foam Sealant: 1- or 2-component, foamed-in-place, polyurethane foam sealant, 1.5 to 2.0 lb/cu. ft (24 to 32 kg/cu. m) density; flame spread index of 25 or less according to ASTM E 162; with primer and noncorrosive substrate cleaner recommended by foam sealant manufacturer.

I. Modified Bituminous Transition Strip: Vapor-retarding, 40-mil- (1.0-mm-) thick, smooth-surfaced, self-adhering; consisting of 36 mils (0.9 mm) of rubberized asphalt laminated to a 4-mil- (0.1-mm-) thick polyethylene film with release liner backing.

J. Adhesive-Coated Transition Strip: Vapor-permeable, 17-mil- (0.43-mm-) thick, self-adhering strip consisting of an adhesive coating over a permeable laminate with a permeance of 37 perms (2145 ng/Pa x s x sq. m).

K. Joint Sealant: ASTM C 920, single-component, neutral-curing silicone; Class 100/50 (low-modulus), Grade NS, Use NT related to exposure, and, as applicable to joint substrates indicated, Use O. Comply with Division 07 Section "Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance.

1. Verify that substrates are sound and free of oil, grease, dirt, excess mortar, or other contaminants.
2. Verify that concrete has cured and aged for minimum time period recommended by air barrier manufacturer.
3. Verify that concrete is visibly dry and free of moisture.
4. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

A. Clean, prepare, treat, and seal substrate according to manufacturer's written instructions.

Provide clean, dust-free, and dry substrate for air barrier application.

B. Mask off adjoining surfaces not covered by air barrier to prevent spillage and overspray affecting other construction.

C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.

D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate patching membrane.

E. Remove excess mortar from masonry ties, shelf angles, and other obstructions.

F. At changes in substrate plane, apply sealant or termination mastic beads at sharp corners and edges to form a smooth transition from one plane to another.

G. Cover gaps in substrate plane and form a smooth transition from one substrate plane to another with stainless-steel sheet mechanically fastened to structural framing to provide continuous support for air barrier.

H. Bridge isolation joints, expansion joints, and discontinuous wall-to-wall, deck-to-wall, and deck-to-deck joints with air-barrier accessory material that accommodates joint movement according to manufacturer's written instructions and details.

3.3 JOINT TREATMENT

A. Insulated Plywood Sheathing: Fill joints greater than 1/4 inch (6 mm) with sealant according to ASTM C 1193 and with air barrier manufacturer's written instructions. Apply first layer of fluid air barrier membrane at joints. Tape joints with joint reinforcing strip after first layer is dry. Apply a second layer of fluid air barrier membrane over joint reinforcing strip.

3.4 ACCESSORIES INSTALLATION

A. Install accessory materials according to air-barrier manufacturer's written instructions and details to form a seal with adjacent construction and ensure continuity of air and water barrier.

1. Coordinate the installation of air barrier with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.
2. Install transition strip on roofing membrane or base flashing so that a minimum of 3 inches (75 mm) of coverage is achieved over each substrate.
3. Unless manufacturer recommends in writing against priming, apply primer to substrates

at required rate and allow it to dry. Limit priming to areas that will be covered by air-barrier material on same day. Reprime areas exposed for more than 24 hours.

B. Connect and seal exterior wall air-barrier material continuously to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.

C. At end of each working day, seal top edge of strips and transition strips to substrate with termination mastic.

D. Apply joint sealants forming part of air-barrier assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

E. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply transition strip so that a minimum of 3 inches (75 mm) of coverage is achieved over each substrate. Maintain 3 inches (75 mm) of full contact over firm bearing to perimeter frames, with not less than 1 inch (25 mm) of full contact.

1. Transition Strip: Roll firmly to enhance adhesion.

F. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, and doors, and miscellaneous penetrations of air-barrier material with foam sealant.

G. Seal strips and transition strips around masonry reinforcing or ties and penetrations with termination mastic.

H. Seal top of through-wall flashings to air barrier with an additional 6-inch- (150-mm-) wide, transition strip.

I. Seal exposed edges of strips at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.

J. Repair punctures, voids, and deficient lapped seams in strips and transition strips. Slit and flatten fishmouths and blisters. Patch with transition strips extending 6 inches (150 mm) beyond repaired areas in strip direction.

3.5 PRIMARY AIR-BARRIER MATERIAL INSTALLATION

A. Apply air-barrier material to form a seal with strips and transition strips and to achieve a continuous air barrier according to air-barrier manufacturer's written instructions and details. Apply air-barrier material within manufacturer's recommended application temperature

ranges.

1. Unless manufacturer recommends in writing against priming, apply primer to substrates at required rate and allow it to dry.
2. Limit priming to areas that will be covered by air-barrier material on same day. Reprime areas exposed for more than 24 hours.
3. Where multiple prime coats are needed to achieve required bond, allow adequate drying time between coats.

B. Apply air-barrier material to form a continuous unbroken air barrier. Apply air-barrier material in full contact around protrusions such as masonry ties.

1. Install air barrier material in one or more separate coats as necessary to achieve a total dry film thickness as recommended in writing by the manufacturer to comply with performance requirements. Apply additional material as needed to achieve void- and pinhole-free surface, but do not exceed thickness on which required vapor permeability is based.

C. Do not cover air barrier until it has been inspected and any deficiencies corrected.

D. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.

3.6 FIELD QUALITY CONTROL

A. Inspect air barrier materials and installation to ensure the following:
1. Continuity of air barrier system has been achieved throughout the building envelope with no gaps or holes.
2. Dry film thickness meets manufacturer's requirements.
3. Continuous structural support of air barrier system has been provided.
4. Laps in strips and transition strips have complied with minimum requirements and have been shingled in the correct direction (or mastic has been applied on exposed edges), with no fishmouths.
5. Termination mastic has been applied on cut edges.
6. Strips and transition strips have been firmly adhered to substrate.
7. Compatible materials have been used.
8. Transitions at changes in direction and structural support at gaps have been provided.
9. Connections between assemblies (membrane and sealants) have complied with requirements for cleanliness, preparation and priming of surfaces, structural support, integrity, and continuity of seal.
10. All penetrations have been sealed.

B. Correct deficiencies in or remove air barrier that does not comply with requirements; repair

substrates and reapply air barrier components.

3.7 CLEANING AND PROTECTION

A. Protect air barrier system from damage during application and remainder of construction period, according to manufacturer's written instructions.

1. Protect air barrier from contact with incompatible materials and sealants not approved by air barrier manufacturer.

B. Clean spills, stains, and soiling from construction that would be exposed in the completed work using cleaning agents and procedures recommended by manufacturer of affected construction.

C. Remove masking materials after installation.

END OF SECTION 07 27 26

SECTION 074113.19 - BATTEN-SEAM METAL ROOF PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Batten-seam metal roof panels.
2. Accessory items, including sheet metal flashings, trim, gutters, and downspouts, as needed for a complete installation.

B. Related Sections include the following:

1. Division 07 Section "Metal Wall and Soffit Panels."

1.3 DEFINITIONS

A. Metal Roof Panel Assembly: Metal roof panels, attachment system components, miscellaneous metal framing, and accessories necessary for a complete weathertight roofing system.

1.4 PERFORMANCE REQUIREMENTS

A. General: Provide installed metal roof panel assembly that remains watertight; does not permit the passage of water; and resist specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction.

B. Delegated Design: Design metal roof panel assembly, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

C. Structural Performance: Provide metal roof panel assemblies capable of withstanding wind loads as indicated on the Structural Drawings under in-service conditions, based on testing manufacturer's standard units according to ASTM E 330 and ASTM E 1592 by a

qualified independent testing and inspecting agency.

D. Uplift Resistance: Class 90 per UL 580.

E. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 1646 at the following test-pressure difference:

1. Test-Pressure Difference: 6.24 lbf/sq. ft. (300 Pa).

F. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 216 deg F (120 deg C), material surfaces.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of roof panel and accessory.

B. Shop Drawings: Show fabrication and installation layouts of metal panels; details of edge conditions, side-seam and endlap joints, panel profiles, corners, anchorages, trim, flashings, closures, gutters and other accessories; and special details. Distinguish between factory- and field-assembled work.

C. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:

1. Metal Roof Panels: 12 inches (300 mm) long by actual panel width. Include fasteners, clips, closures, and other metal roof panel accessories.
2. Accessories: 12-inch- (300-mm-) long Samples for each type of accessory.

1.6 INFORMATIONAL SUBMITTALS

A. Delegated-Design Submittal: For metal roof panel assembly indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

B. Qualification Data: For qualified Installer and professional engineer.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:

1. General: Qualified firm that is approved, authorized, or licensed by roof panel manufacturer to install manufacturer's product and that is eligible to receive manufacturer's warranty.
2. Experience: Approved by roof panel manufacturer for installation of specified roof panels for not less than 12 months prior to the start of this Project, and with at least three successful similar roof installations during that time period.
3. Workmen: Trained and approved by roof panel manufacturer.

B. Source Limitations: Obtain all metal roof panels and sheet metal from single source from single manufacturer.

C. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. At roof hip selected by the Architect, build mockup, including fascia, approximately four panels wide each way from hip; include all components required for a complete installation.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

D. Roofing Pre-Application Conference: Not more than 7 days prior to anticipated start of metal roofing installation; conduct conference at Project site to comply with requirements of Division 01 Section "Project Management and Coordination." Notify participants at least 5 working days before conference.

1. Meet with Architect, Owner's Representative, testing and inspecting agency representative, metal roof panel Installer, metal roof panel manufacturer's representative, and installers whose work interfaces with or affects metal roof panels including installers of roof accessories and roof-mounted equipment.
2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
3. Review methods and procedures related to metal roof panel installation, including manufacturer's written instructions.
4. Examine deck substrate conditions for compliance with requirements, including flatness and attachment to structural members.
5. Review structural loading limitations of deck during and after roofing.
6. Review flashings, special roof details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect metal roof panels.

7. Review governing regulations and requirements for insurance, certificates, and testing and inspecting if applicable.
8. Review temporary protection requirements for metal roof panel assembly during and after installation.
9. Review roof observation and repair procedures after metal roof panel installation.
10. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

E. Roofing Completion Conference: Not more than 7 days prior to anticipated completion of metal roofing installation; conduct conference at Project site to comply with requirements of Division 01 Section "Project Management and Coordination." Notify participants at least 5 working days before conference.

1. Meet with Architect; Owner's Representative; roofing Installer; and roofing system manufacturer's representative.
2. Complete rooftop walk over and review: Perimeter edges; sheet metal; walls; curbs and other equipment; drains; rooftop penetrations; site cleanup.
3. Review Contractor-provided punchlist.
4. Review Project record requirements.
5. Discuss responsibility for roof system protection until project completed.
6. Document proceedings, including corrective measures or actions required, and furnish copy of record to each participant.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, sheets, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal roof panels for protection during transportation and handling.

B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal panels on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Protect strippable protective covering on metal panels from exposure to sunlight and high humidity, except to extent necessary for period of metal roof panel installation.

1.9 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit metal roof panel work to be performed according to

manufacturer's written instructions and warranty requirements.

B. Field Measurements: Verify actual dimensions of construction contiguous with metal roof and soffit panels by field measurements before fabrication.

1.10 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

B. Coordinate metal roof and soffit panels with rain drainage work, flashing, trim, and construction of decks, walls, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.11 WARRANTY

A. General Warranty: The warranties specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Structural failures including rupturing, cracking, or puncturing.
   b. Deterioration of metals and other materials beyond normal weathering.

2. Warranty Period: Twenty years from date of Substantial Completion.
3. Owner’s signature shall not be required on manufacturer’s written warranty document.

C. Special Weathertightness Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.

1. Warranty Period: 20 years from date of Substantial Completion.
2. Owner’s signature shall not be required on manufacturer’s written warranty document.

D. Special Project Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering Work of this Section for the following

warranty period:

1. Warranty Period: 2 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANEL MATERIALS

A. Stainless Steel Sheet: ASTM A240/A240M, Type 316, fully annealed.

1. Nominal Thickness: 0.0188 inch (0.477 mm.
2. Exterior Finish: ASTM A480/A480M No. 4.

2.2 BATTEN-SEAM METAL ROOF PANELS

A. Provide factory-formed metal roof panel assembly designed to be installed by covering vertical side edges of adjacent panels with battens and mechanically attaching panels to supports using concealed clips. Include battens and accessories required for weathertight installation.

B. Narrow-Profile, Snap-on-Batten-Seam Metal Roof Panels : Formed with vertical ribs at panel edges and a flat pan between ribs; designed for independent installation by mechanically attaching panels to supports using concealed clips located under one side of panels, engaging the opposite edge of adjacent panels, and installing 3/8- to 1/2-inch- (10- to 13-mm-) wide, snap-on battens over panel joints.

1. Basis-of-Design Product: The design of the metal roof panels is based on the product named below. Subject to compliance with requirements, provide the named product or Equal Product.

   a. Type “B” Batten Roofing System; Overly Mfg. Company

2. Material: Stainless steel, 26 gauge.
3. Clips: Continuous units, with expansion provisions; secure to supporting structure to meet wind load resistance requirements.

   a. Material: Stainless steel.

2.3 UNDERLAYMENT MATERIALS

A. Self-Adhering, High-Temperature Underlayment Sheet: Slip-resisting, polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; approved by metal roofing manufacturer for use with 20-year warranty installation.

1. Thermal Stability: Stable after testing at 240 deg F (116 deg C); ASTM D 1970.
2. Low-Temperature Flexibility: Passes after testing at minus 20 deg F (29 deg C); ASTM D 1970.
3. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include the following or Equal Product:

a. Carlisle Residential, a division of Carlisle Construction Materials; WIP 300HT.
b. Grace Construction Products, a unit of W. R. Grace & Co.; Ultra.
c. Henry Company; Blueskin PE200 HT.
d. Kirsch Building Products, LLC; Sharkskin Ultra SA.
e. Owens Corning; WeatherLock Metal High Temperature Underlayment.

2.4 ACCESSORY MATERIALS

A. Roof Panel Accessories: Provide components approved by roof panel manufacturer and as required for a complete metal roof panel assembly including trim, copings, corner units, ridge closures, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal roof panels unless otherwise indicated.

1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal roof panels.
2. Closure Strips: Closed-cell, expanded, cellular, rubber or cross-linked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or premolded to match metal roof panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
3. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.

B. Flashing and Trim: Formed from same material as roof panels. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers.

C. Gutters: Formed from same material as roof panels, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch- (2400-mm-) long sections, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual." Provide custom gutter supports as shown on Drawings.

D. Downspouts: Formed from same material as roof panels. Fabricate in 10-foot- long sections, complete with formed elbows and offsets, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual."

E. Pipe Flashing: Premolded, EPDM pipe collar with flexible aluminum ring bonded to base.

1. Aluminum ring shall have paint finish to match color of metal roof panels.
2. Provide adjustable stainless steel bands to create watertight seal between pipe and EPDM pipe collar.

F. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads.

1. For exposed fasteners, provide heads matching color of metal roof panels by means of plastic caps or factory-applied coating. Provide EPDM or neoprene sealing washers.
2. Fasteners used for attachment into pressure-treated lumber or plywood shall be Type 304 stainless steel.

G. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.5 FABRICATION

A. Fabricate and finish metal roof panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes and as necessary to fulfill indicated performance requirements. Comply with indicated profiles and with dimensional and structural requirements.

B. Provide panel profile for full length of panel.

C. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

D. Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of item indicated.

1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.

2. End Seams: Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.
3. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
4. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
5. Fabricate cleats and attachment devices of size and metal thickness recommended by SMACNA's "Architectural Sheet Metal Manual" or by metal roof panel manufacturer for application, but not less than thickness of metal being secured.

2.6 FINISHES

A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal roof panel supports, and other conditions affecting performance of the Work.

B. Examine primary and secondary roof framing to verify that structural panel support members and anchorages have been installed within alignment tolerances required by metal roof panel manufacturer.

C. Examine solid roof sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal roof panel manufacturer.

D. Examine roughing-in for components and systems penetrating metal roof panels to verify actual locations of penetrations relative to seam locations of metal roof panels before metal roof panel installation.

E. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

G. Coordinate installing roofing system components so that they are not exposed to precipitation or left exposed at the end of the workday.

3.2 PREPARATION

A. Clean substrates of substances harmful to roofing system, including removing projections capable of interfering with proper installation.

B. Miscellaneous Framing: Install subpurlins, eave angles, furring, and other miscellaneous roof panel support members and anchorage according to metal roof panel manufacturer's written instructions.

3.3 INSTALLATION OF UNDERLAYMENT

A. Self-Adhering Sheet Underlayment: Install over underlayment ply provided as part of roof sheathing installation; apply primer if required to ensure adequate adhesion. Comply with temperature restrictions of underlayment manufacturer for installation. Apply underlayment to completely cover roof decks, wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches (150 mm) staggered 24 inches (600 mm) between courses. Overlap side edges not less than 3-1/2 inches (90 mm). Roll laps with roller. Cover underlayment within 14 days.

B. Install flashings to cover underlayment to comply with requirements specified in Division 07 Section "Sheet Metal Flashing and Trim."

3.4 METAL ROOF PANEL INSTALLATION, GENERAL

A. Provide metal roof panels of single continuous length from eave to ridge.

B. Install metal roof panels as follows:

1. Commence metal roof panel installation and install minimum of 300 sq. ft. (27.8 sq. m.) in presence of factory-authorized representative.
2. Field cutting of metal panels by torch is not permitted.
3. Provide metal closures at rake edges, rake walls, and each side of ridge and hip caps.
4. Flash and seal metal roof panels with weather closures at eaves, rakes, and perimeter of all openings.
5. Install ridge and hip caps as metal roof panel work proceeds.
6. Install metal flashing to allow moisture to run over and off metal roof panels.

C. Metal Protection: Where dissimilar metals will contact each other or corrosive

substrates, protect against galvanic action by painting contact surfaces with bituminous coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal roof panel manufacturer.

1. Coat back side of roof panels with bituminous coating where roof panels will contact wood, ferrous metal, or cementitious construction.

D. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal roof panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by metal roof panel manufacturer.
   1. Seal metal roof panel end laps with double beads of tape or sealant, full width of panel. Seal side joints where recommended by metal roof panel manufacturer.
   2. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants."

3.5 INSTALLATION OF BATTEN-SEAM METAL ROOF PANELS

A. Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.

   1. Shim or otherwise plumb substrates receiving metal panels.
   2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
   3. Install screw fasteners in predrilled holes.
   4. Locate and space fastenings in uniform vertical and horizontal alignment.
   5. Install flashing and trim as metal panel work proceeds.
   6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
   7. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
   8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.

B. Fasteners: Use stainless steel fasteners.

C. Anchor Clips: Anchor metal roof panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.

D. Metal Protection: Where dissimilar metals contact each other or corrosive substrates,

protect against galvanic action as recommended in writing by metal panel manufacturer.

E. Batten-Seam Metal Roof Panel Installation: Fasten metal roof panels to supports with concealed clips at each batten-seam joint at location, spacing, and with fasteners recommended by manufacturer.

1. Install clips to supports with self-drilling fasteners.
2. Apply battens to metal roof panel seams, fully engaged to provide weathertight joints.
3. Watertight Installation:

a. Apply a continuous ribbon of sealant or tape to seal joints of metal panels, using sealant or tape as recommend by manufacturer as needed to make panels watertight.
b. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
c. At panel splices, nest panels with minimum 6-inch (152-mm) end lap, sealed with sealant and fastened together by interlocking clamping plates.

F. Clipless Metal Panel Installation: Fasten metal panels to supports with screw fasteners at each lapped joint at location and spacing recommended by manufacturer.

3.6 ACCESSORY INSTALLATION

A. General: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal roof panel assembly including trim, copings, ridge closures, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.

B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

1. Install exposed flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed

within 24 inches (600 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).

C. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to metal roof panels as recommended by manufacturer.

3.7 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align metal roof panel units within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines as indicated and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

3.8 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect metal roof panel installation, including accessories. Report results in writing.

B. Remove and replace applications of metal roof panels where inspections indicate that they do not comply with specified requirements.

C. Additional inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.9 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal roof panels are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of metal roof panel installation, clean finished surfaces as recommended by metal roof panel manufacturer. Remove metal shavings daily, and maintain metal roof panels in a clean condition during construction.

B. Replace metal roof panels that have been damaged.

1. Touch-up paint shall not be used to repair finish damage to metal roof panels.

3.10 ROOFING INSTALLER'S WARRANTY

A. WHEREAS <NAME> of <ADDRESS>, herein called the "Roofing Installer," has

performed roofing and associated work ("work") on the following project:

1. Owner:
2. Address:
3. Building Name/Type:
4. Address:
5. Area of Work:
6. Date of Substantial Completion:
7. Warranty Period:
8. Expiration Date:

B. AND WHEREAS Roofing Installer has contracted (either directly with Owner or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

C. NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period he will, at his own cost and expense, make or cause to be made such repairs to or replacements of said work as are necessary to correct faulty and defective work and as are necessary to maintain said work in a watertight condition.

D. This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:

    a. lightning;
    b. hurricanes, tornadoes, hailstorm, and other unusual phenomena of the elements;
    c. earthquakes;
    d. fire;
    e. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
    f. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work;
    g. vapor condensation on bottom of roofing; and
    h. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by Owner.

2. When work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof has been paid by Owner or by another responsible party so designated.
3. The Roofing Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents, resulting

from leaks or faults or defects of work.

4. During Warranty Period, if Owner allows alteration of work by anyone other than Roofing Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void on date of said alterations, but only to the extent said alterations affect work covered by this Warranty. If Owner engages Roofing Installer to perform said alterations, Warranty shall not become null and void, unless Roofing Installer, before starting said work, shall have notified Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate work, thereby reasonably justifying a limitation or termination of this Warranty.
5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, or other use or service more severe than originally specified, this Warranty shall become null and void on date of said change, but only to the extent said change affects work covered by this Warranty.
6. The Owner shall promptly notify Roofing Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Roofing Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.
7. shall not operate to restrict or cut off Owner from other remedies and resources lawfully available to Owner in cases of roofing failure. Specifically, this Warranty shall not operate to relieve Roofing Installer of responsibility for performance of original work according to requirements of the Contract Documents, regardless of whether Contract was a contract directly with Owner or a subcontract with Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this <DAY> day of <MONTH>, 20<YEAR>.

1. Authorized Signature:
2. Name:
3. Title:

END OF SECTION 074113

SECTION 074213 - METAL WALL AND SOFFIT PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Metal panels installed with concealed fasteners.

B. Related Sections include the following:

1. Division 07 Section "Metal Roof Panels."

1.3 DEFINITION

A. Metal Panel Assembly: Metal panels, attachment system components, miscellaneous metal framing, and accessories necessary for a complete system.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site. Review methods and procedures related to interlocking metal wall panel assembly including, but not limited to, the following:

1. Meet with Owner, Architect, metal wall panel Installer, and installers whose work interfaces with or affects interlocking metal wall panel assembly including installers of wall accessories and wall-mounted equipment.
2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
3. Review methods and procedures related to metal wall panel installation.

4. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.
5. Review flashings, special wall panel assembly details, wall penetrations, equipment curbs, and condition of other construction that will affect metal wall panel installation.
6. Review governing regulations and requirements for insurance, certificates, and testing and inspecting if applicable.
7. Review temporary protection requirements for metal walls during and after installation.
8. Review wall observation and repair procedures after metal wall panel installation.
9. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.5 ACTION SUBMITTALS

A. Product Data: Include manufacturer's product specifications, standard details, certified product test results, and general recommendations, as applicable to materials and finishes for each component and for total panel assemblies.

B. Shop Drawings: Include plans; elevations; sections and details. Show layouts of panels, details of corner conditions, joints, panel profiles, supports, anchorages, trim, flashings, closures, and special details. Distinguish between factory- and field-assembled work.

C. Samples for Verification: For each type of exposed finish, prepared on Samples of size indicated below. Samples shall involve normal color and texture variations; include sample sets showing the full range of variations expected.

1. Sample Size: Manufacturer’s standard, but not less than 2" x 2".

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

B. Mockups: Before installing metal wall and soffit panels, construct mockups for each form of construction required to verify selection made under Sample submittals and to demonstrate aesthetic effects and qualities of materials and execution. Build mockups to comply with the following requirements, using exposed and concealed materials and forming methods indicated for completed work.

1. Install mockup at location directed by the Architect. Mockup shall be of sufficient size and complexity to demonstrate all panel edge/perimeter conditions and installation methods.
2. Approval of mockups is for other material and construction qualities specifically approved by Architect in writing.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless such deviations are specifically approved by Architect in writing.
4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, sheets, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.

B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Retain strippable protective covering on metal panel for period of metal panel installation.

1.8 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

B. Field Measurements: Verify location of structural members and openings in substrates by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1. Established Dimensions: Where field measurements cannot be made without

delaying the Work, either establish opening dimensions and proceed with fabricating metal panels without field measurements or allow for trimming panel units. Coordinate construction to ensure actual locations of structural members and to ensure opening dimensions correspond to established dimensions.

1.9 COORDINATION

A. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including rupturing, cracking, or puncturing.
b. Deterioration of metals and other materials beyond normal weathering.

2. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General: Provide manufactured metal panel assemblies complying with performance requirements indicated and capable of withstanding structural movement, thermally induced movement, and exposure to weather without failure.

B. Structural Performance: Provide manufactured metal panel assemblies capable of withstanding wind loads as indicated on the Structural Drawings under in-service conditions with deflection no greater than 1/180 of the span, based on testing manufacturer's standard units according to ASTM E 330 by a qualified independent testing and inspecting agency.

C. Thermal Movements: Allow for thermal movements from ambient and surface

temperature changes to prevent buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of thermal movements. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 140 deg F (78 deg C), ambient; 200 deg F (111 deg C), material surfaces.

2.2 PANEL MATERIALS

A. Stainless Steel Sheet: ASTM A240/A240M, Type 316, fully annealed.

1. Thickness: 24 gauge.
2. Surface: Smooth, flat finish.
3. Exterior Finish: ASTM A480/A480M No. 4.

2.3 METAL PANELS

A. General: Provide factory-formed metal wall panels designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports. Include accessories required for complete installation.

B. Metal Wall Panel Type 1:

1. Basis-of-Design Product: The design of this panel is based on the product listed below. Subject to compliance with requirements, products that may be incorporated into the Work include the following or Comparable Product:

a. Bermuda XP; Overly Mfg. Company.

C. Metal Wall Panel Type 2:

1. Basis-of-Design Product: The design of this panel is based on the product listed below. Subject to compliance with requirements, products that may be incorporated into the Work include the following or Comparable Product:

a. Rainscreen LS; Overly Mfg. Company.

2.4 MISCELLANEOUS MATERIALS

A. General: Unless otherwise specified, provide components required for a complete metal panel assembly including trim, copings, fasciae, mullions, sills, corner units, clips, seam covers, flashings, fillers, closure strips, and similar items. Match materials, colors and finishes of panels.

B. Miscellaneous Metal Framing, General: ASTM C 645, cold-formed metallic-coated steel sheet, ASTM A 653/A 653M, G60 (Z180) hot-dip galvanized or coating with equivalent corrosion resistance unless otherwise indicated.

1. Shapes: As indicated on the Drawings
2. Thickness: As required to resist design wind loads, but not less than 16 gauge.

C. Fasteners for Miscellaneous Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten miscellaneous metal framing members to substrates.

1. For use in fastening through or to preservative-treated wood, provide fasteners manufactured from stainless steel, alloy as best-suited for each application.

D. Panel Fasteners: Non-corrosive type, as recommended by the panel manufacturer. Provide self-tapping screws and other suitable fasteners designed to withstand building design loads. Fasteners shall be minimum #14 diameter, self-tapping, with hex head.

E. Provide panel clips designed to engage into panel flange.

F. Metal Flashing: Unless noted otherwise, shall be same material and gauge as for panel where exposed.

2.5 FABRICATION

A. General: Fabricate and finish panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of item indicated.

1. Form exposed sheet metal accessories that are without excessive oil canning,

buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.

C. Apply bituminous coating or other permanent separation materials on concealed panel surfaces where panels would otherwise be in direct contact with substrate materials that are non-compatible or could result in corrosion or deterioration of either materials or finishes.

2.6 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical ~~and painted~~ finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements indicated for conditions affecting performance of metal panels.

1. Panel Supports and Anchorage: Examine framing to verify that structural panel support members and anchorage have been installed to meet requirements of panel manufacturer.
2. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal panel manufacturer.

B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C754 and metal panel manufacturer's written recommendations..

3.3 PANEL INSTALLATION

A. General: Comply with panel manufacturer's written instructions and recommendations for installation, as applicable to project conditions and supporting substrates. Anchor panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Locate and space fasteners in true vertical and horizontal alignment. Use proper tools to obtain controlled, uniform compression.

B. Accessories: Install components required for a complete metal panel assembly including trim, copings, fasciae, mullions, sills, corner units, clips, seam covers, flashings, fillers, closure strips, and similar items.

C. Align visible edges of panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.

D. Install screw fasteners with power tools having controlled torque adjusted to provide fully-tightened installation without damage to washer, screw threads, or panels. Install screws in predrilled holes.

E. Separate dissimilar metals by painting each metal surface in area of contact with a bituminous coating or by other permanent separation as recommended by manufacturers of dissimilar metals.

F. Installation Tolerances: Shim and align panel units within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on level, plumb, and location lines as indicated and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

3.4 ACCESSORY INSTALLATION

A. General: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal panel assembly including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.

B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

1. Install exposed flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (605 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).

3.5 CLEANING AND PROTECTING

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

B. After metal panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.

C. Damaged Units: Replace panels and other components of the Work that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

D. Cleaning: Remove temporary protective coverings and strippable films, if any, as soon as each panel is installed. On completion of panel installation, clean finished surfaces

as recommended by panel manufacturer and maintain in a clean condition during construction.

END OF SECTION 074213

SECTION 07 92 00 – JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes:

1. Nonstaining silicone joint sealants.
2. Mildew-resistant joint sealants.
3. Latex joint sealants.

B. Related Sections include the following:

1. Division 07 Sections “Metal Roof Panels” and “Metal Wall and Soffit Panels” for sealing of joints in those items.
2. Division 08 Section "Door Hardware" for thresholds installed in sealant bed.

1.3 ACTION SUBMITTALS

A. Product Data: For each joint-sealant product.

B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

C. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- (13-mm-) wide joints formed between two 6-inch- (150-mm-) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

D. Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each kind of joint sealant, for tests performed by manufacturer and witnessed by a qualified testing agency.

B. Preconstruction Laboratory Test Reports: From sealant manufacturer, indicating the following:

1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
2. Interpretation of test results and written recommendations for primers and substrate preparation are needed for adhesion.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has specialized in installing joint sealants similar in material, design, and extent to those indicated for this Project and whose work has resulted in joint-sealant installations with a record of successful in-service performance.

B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.

C. Mockups: Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multicomponent materials.

B. Store and handle materials in compliance with manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 40 deg F (4.4 deg C).
2. When joint substrates are wet.

B. Joint-Width Conditions: Do not proceed with installation of joint sealants where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.

C. Joint-Substrate Conditions: Do not proceed with installation of joint sealants until contaminants capable of interfering with adhesion are removed from joint substrates.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.

B. VOC Content of Interior Sealants: Provide sealants and sealant primers for use inside the weatherproofing system that comply with the following limits for VOC content when calculated according to 40 CFR 59, Part 59, Subpart D (EPA Method 24):

1. Architectural Sealants: 250 g/L.
2. Sealant Primers for Nonporous Substrates: 250 g/L.
3. Sealant Primers for Porous Substrates: 775 g/L.

C. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range for this characteristic.

2.2 NONSTAINING MEDIUM-MODULUS SILICONE JOINT SEALANTS

A. Nonstaining Joint Sealants: No staining of substrates when tested according to ASTM C 1248.

B. Silicone, Nonstaining, S, NS, 50, NT: Nonstaining, single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 50, Use NT.

C. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include the following or Comparable Products:

a. 795; Dow Corning.
b. Silpruf NB; GE Construction Sealants.

2.3 HIGH-MODULUS SILICONE JOINT SEALANTS

A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.

B. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include the following or Comparable Products:

a. 799; Dow Corning.
b. NuFlex 319, NUCO Industries, Inc.

2.4 URETHANE JOINT SEALANTS

A. Urethane, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C 920, Type S, Grade P, Class 25, Uses T and NT.

B. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include the following or Comparable Products:

a. Chem-Calk 950; Bostik Inc.
b. MasterSeal SL 1; BASF Corp.

2.5 LATEX JOINT SEALANTS

A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.

B. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include the following or Comparable Product:

1. AC-20 + Silicone; Pecora Corporation.
2. Alex Plus; DAP Products, Inc.

2.6 JOINT-SEALANT BACKING

A. General: Provide sealant backings of material and type that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for

applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C 1330, of type indicated below and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance:

1. Type C: Closed-cell material with a surface skin.

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

2.7 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants with joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to

comply with joint sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
2. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air. Porous joint surfaces include the following:

    a. Concrete.
    b. Masonry.
    c. Cast stone.
    d. Stone.
    e. Portland cement stucco.
3. Remove laitance and form-release agents from concrete.
4. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.

    a. Metal.
    b. Glass.
    c. Glazed surfaces of ceramic tile.

B. Joint Priming: Prime joint substrates where recommended in writing by joint sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations of ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of sealant backings.
2. Do not stretch, twist, puncture, or tear sealant backings.
3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and back of joints.

E. Install sealants by proven techniques to comply with the following and at the same time backings are installed:

1. Place sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses provided for each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealants from surfaces adjacent to joint.
2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
3. Provide concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.

3.4 CLEANING

A. Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite

such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from the original work.

3.6 JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Joints in horizontal traffic surfaces.

1. Joint-sealant: Urethane joint sealant.
2. Joint-sealant color: As selected by the Architect for each location from manufacturer's full range of colors.
3. Joint types:

    a. Isolation and contraction joints in cast-in-place concrete slabs.
    b. Control and expansion joints in brick pavers.
    c. Joints between plant-precast architectural concrete paving units.
    d. Joints in stone paving units [including steps].
    e. Tile control and expansion joints.
    f. Terrazzo control and expansion joints.
    g. Joints between different materials listed above.
    h. Other joints as indicated on Drawings.

B. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces.

1. Joint-sealant: Nonstaining medium-modulus silicone joint sealant.
2. Joint-sealant color: As selected by the Architect for each location from manufacturer's full range of colors.
3. Joint types:

    a. Expansion and movement joints between masonry materials and adjacent dissimilar materials.
    b. Exterior perimeter joints around frames of doors, windows and louvers.
    c. Exterior perimeter joints around items that penetrate through exterior walls.
    d. Joints between sheet metal flashings and adjacent dissimilar material(s).
    e. Expansion and movement joints in Portland cement plaster and in unit masonry assemblies.
    f. Expansion and movement joints between cast stone units.
    g. Other joints as indicated on Drawings.

C. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces.

1. Joint-sealant: Highy-modulus silicone joint sealant.

2. Joint-sealant color: As selected by the Architect for each location from manufacturer's full range of colors.
3. Joint types:

    a. Joints in sheet metal flashings and trim.
    b. Joints between metal panels.
    c. Other joints as indicated on Drawings.

D. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces not subject to significant movement.

1. Joint-sealant: Latex sealant.
2. Joint-sealant color: As selected by the Architect for each location from manufacturer's full range of colors.
3. Joint types:

    a. Interior perimeter joints around items that penetrate through exterior walls.
    b. Interior perimeter joints around frames of doors, windows and louvers.

END OF SECTION 07 92 00

SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Standard hollow metal doors and frames.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 09 Section "Painting" for field painting of steel doors and frames.

1.3 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.

1.4 COORDINATION

A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

B. Coordinate requirements for installation of door hardware, electrified door hardware, and access control and security systems.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, core descriptions, fire-resistance ratings, and finishes.

B. Shop Drawings: Include the following:

1. Elevations of each door type.
2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
4. Locations of reinforcement and preparations for hardware.
5. Details of each different wall opening condition.
6. Details of anchorages, joints, field splices, and connections.
7. Details of accessories.
8. Details of moldings, removable stops, and glazing.
9. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.

C. Product Schedule: Submit schedule of doors and frames using same reference numbers for details and openings as those on Drawings. Coordinate with final door hardware schedule.

1.6 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each type of hollow-metal door and frame assembly, for tests performed by a qualified testing agency.

B. Oversize Construction Certification: For assemblies required to be fire-rated and exceeding limitations of labeled assemblies.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver doors and frames cardboard-wrapped or crated to provide protection during transit and job storage.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store doors and frames at building site under cover. Place units on minimum 4-inch-(100-mm-) high wood blocking. Avoid using nonvented plastic or canvas shelters that could create a humidity chamber. If cardboard wrappers on doors become wet, remove cartons immediately. Provide minimum 1/4-inch (6-mm) spaces between stacked doors to promote air circulation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include the following:

1. Ceco Door
2. Steelcraft

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Rated Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.

B. Structural Performance: Provide doors and frames capable of withstanding the effects of gravity loads and the following loads and stresses without evidencing permanent deformation:

1. Exterior Doors and Frames: Withstand wind-load design pressures indicated on the Structural drawings.

C. Windborne-Debris-Impact-Resistance Performance: At exterior door openings that contain glazing, provide impact-protective doors and frames that pass missile-impact and cyclic-pressure tests when tested according to ASTM E 1886 and ASTM E 1996 for Wind Zone 2.

1. Large Missile Test: For openings located within 30 feet (9.144 m) of grade.
2. Small-Missile Impact: For exterior openings located more than 30 feet (9.1 m) above grade.

2.3 STANDARD HOLLOW METAL DOORS AND FRAMES

A. General: Provide hollow metal doors and frames of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces unless otherwise indicated. Comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Classification of Doors and Frames: Extra-heavy-duty, SDI A250.8, Level 3 and SDI

A250.4, Level A.

1. Hollow Metal Doors: Provide doors complying with requirements indicated below:

    a. Exterior and Interior Doors: Model 2 (Seamless).
    b. Face Sheets: Fabricate faces of doors and panels from the following types of steel sheet, based on installation locations as indicated.

        1) At the following locations, face sheets shall be metallic-coated steel sheet, minimum thickness of 0.067 inch (1.7 mm), with minimum A60 (ZF180) coating.

            a) Exterior door openings.
            b) Interior door openings to toilet rooms.
            c) Interior door openings to janitor rooms.

        2) At locations other than those indicated above, face sheets shall be uncoated steel sheet, minimum thickness of 0.053 inch (1.3 mm).

    c. Core Construction:

        1) Exterior Doors: Manufacturer's standard bonded polyurethane insulated core, with U-factor of not more than 0.10 deg Btu/F x h x sq. ft. (0.57 W/K x sq. m) when tested according to ASTM C 518.
        2) Interior Doors: Manufacturer's standard bonded kraft-paper honeycomb core.
        3) Fire-Rated Doors: Manufacturer's standard bonded mineral board core.

    d. Edge Bevel for Single-Acting Doors:

        1) Lock Edge: Beveled.
        2) Hinge Edge: Provide manufacturer's standard beveled or square edge.

    e. Top and Bottom Edges: Closed with flush or inverted 0.042-inch- (1.0-mm-) thick, end closures or channels of same material as face sheets.
    f. Hardware Reinforcement: Comply with ANSI/SDI A250.6.

2. Hollow Metal Frames: Fabricate frames to profiles shown, and complying with requirements indicated below:

    a. Door Frame Material: Fabricate frames from the following types of steel sheet, based on installation locations as indicated.

        1) At the following locations, fabricate frames from metallic-coated steel sheet, minimum thickness of 0.067 inch (1.7 mm), with minimum A60 (ZF180) coating.

a) Exterior door openings.
b) Interior door openings to toilet rooms.
c) Interior door openings to janitor rooms.

2) At locations other than those indicated above, fabricate frames from metallic-coated steel sheet, minimum thickness of 0.053 inch (1.3 mm), with minimum A60 (ZF180) coating.

b. Frame Construction:

1) Frame corners shall be made with mitered or coped joints.
2) Frame corner joints shall be face-welded.
3) Welds shall be ground flush and smooth to provide seamless appearance.
4) Restore galvanized finish at welded areas with galvanizing repair paint.

3. Plaster Guards: Provide minimum 0.0179-inch- (0.45-mm-) thick steel plaster guards or mortar boxes at back of hardware cutouts where mortar or other materials might obstruct hardware operation and to close off interior of openings.

2.4 FRAME ANCHORS

A. Jamb Anchors:

1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches (610 mm) of frame height above 7 feet (2.1 m).
3. Postinstalled Expansion Anchor: Minimum 3/8-inch- (9.5-mm-) diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.

B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.

C. Floor Anchors for Concrete Slabs with Underlayment: Adjustable-type anchors with extension clips, allowing not less than 2-inch (51-mm) height adjustment. Terminate bottom of frames at top of underlayment.

D. Material: ASTM A 879/A 879M, Commercial Steel (CS), 04Z (12G) coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M; hot-dip galvanized according to ASTM A 153/A 153M, Class B.

2.5 LOUVERS

A. Provide louvers for ~~interior~~ exterior doors, where indicated, which comply with SDI 111, with blades or baffles formed of 0.020-inch- (0.5-mm-) thick, cold-rolled steel sheet set into 0.032-inch- (0.8-mm-) thick steel frame.

1. Sightproof Louver: Stationary louvers constructed with inverted-V or inverted-Y blades.

B. Form corners of moldings with hairline joints. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.

2.6 MATERIALS

A. Cold-Rolled Steel Sheets: ASTM A 366/A 366M, Commercial Steel (CS), or ASTM A 620/A 620M, Drawing Steel (DS), Type B; stretcher-leveled standard of flatness.

B. Hot-Rolled Steel Sheets: ASTM A 569/A 569M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum A60 (ZF180) metallic coating.

D. Frame Anchors: Steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.

E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.

F. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow metal frames of type indicated.

G. Mineral-Wool Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

H. Grout: ASTM C 476, except with a maximum slump of 4 inches (102 mm), as measured according to ASTM C 143/C 143M.

I. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for

15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

J. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.

2.7 FABRICATION

A. General: Fabricate hollow metal door and frame units to comply with ANSI A250.8 and to be rigid, neat in appearance, and free from defects including warp and buckle. Where practical, fit and assemble units in manufacturer's plant. Clearly identify work that cannot be permanently factory assembled before shipment, to assure proper assembly at Project site.

B. Tolerances: Comply with SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."

C. Fabricate concealed stiffeners, reinforcement, edge channels, louvers, and moldings from either cold- or hot-rolled steel sheet.

D. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.

1. Sidelite and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by welding.
2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
3. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.

    a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
    b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

E. Hardware Preparation: Prepare doors and frames to receive mortised and concealed hardware according to final door hardware schedule and templates provided by hardware supplier. Comply with applicable requirements in ANSI A250.6 and ANSI A115 Series specifications for door and frame preparation for hardware.

1. For concealed overhead door closers, provide space, cutouts, reinforcement, and provisions for fastening in top rail of doors or head of frames, as applicable.
2. Reinforce doors and frames to receive surface-applied hardware. Drilling and

tapping for surface-applied hardware may be done at Project site.

3. Locate hardware as indicated on reviewed Shop Drawings or, if not indicated, according to ANSI A250.8.

F. Stops and Moldings: Provide stops and moldings around louvers where indicated. Form corners of stops and moldings with mitered hairline joints.

1. Provide stops and moldings flush with face of door, and with beveled or square stops, as selected by Architect.
2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames. Provide loose stops and moldings on inside of hollow-metal doors and frames.
4. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.
5. Provide stops for installation with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches (230 mm) o.c. and not more than 2 inches (51 mm) o.c. from each corner.

2.8 FINISHES

A. Doors and Frames: Primer finish for field painting. Clean, pretreat, and apply manufacturer's standard primer.

1. Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 - EXECUTION

3.1 PREPARATION

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces. Touch up factory-applied finishes where spreaders are removed.

B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted

door hardware.

3.2 INSTALLATION

A. General: Install hollow metal doors, frames, and accessories plumb, rigid, properly aligned, and securely fastened in place. Comply with approved Shop Drawings and with manufacturer's written instructions.

B. Placing Frames: Comply with provisions of ANSI/SDI A250.11, unless otherwise indicated.

1. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. Check plumbness, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances. After wall construction is completed, remove temporary braces and spreaders, leaving surfaces smooth and undamaged.

    a. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
    b. Install frames with removable glazing stops located on secure (free-to-exit) side of opening.
    c. Install door silencers in frames before grouting.
    d. Field apply bituminous coating to backs of frames that are filled with grout containing antifreezing agents.

2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.

    a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.

3. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.
4. In-Place Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
5. Installation Tolerances: Adjust hollow metal door frames for squareness, alignment, twist, and plumb to the following tolerances:

    a. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
    b. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a

horizontal line parallel to plane of wall.

c. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
d. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs at floor.

C. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.

1. Non-Fire-Rated Standard Steel Doors:

a. Jambs and Head: 1/8 inch (3 mm) plus or minus 1/16 inch (1.6 mm).
b. Between Edges of Pairs of Doors: 1/8 inch (3 mm) plus or minus 1/16 inch (1.6 mm).
c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch (9.5 mm
d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch (19 mm).

2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.

3.3 ADJUSTING AND CLEANING

A. Remove grout and other bonding material from hollow metal work immediately after installation.

B. Prime Coat Touchup: Immediately after setting frames into place, sand smooth any rusted or damaged areas of prime coat and apply touchup of compatible air-drying primer.

END OF SECTION 081113

SECTION 08 34 83 – FLOOR DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes floor doors.

1.3 ACTION SUBMITTALS

A. Product data for each type of floor door assembly specified, including details of construction relative to materials, individual components, profiles, and finishes.

B. Schedule: Provide complete door and frame schedule, including types, general locations, sizes, construction details, latching or locking provisions, and other data pertinent to installation.

C. Shop Drawings showing location, type, sizes, floor construction details, latching or locking provisions, and other data pertinent to installation for each floor door, including attachment to other work.

PART 2 - PRODUCTS

2.1 ALUMINUM FLOOR DOORS

A. Aluminum Floor Door:

1. Basis-of-Design Product: The design of the floor doors is based on the products listed below. Subject to compliance with requirements, products that may be incorporated into the Work include the following or Equal Product:

    a. Type J-AL (single-leaf) and JD-AL (double-leaf)-Channel Frame-300 PSF; The BILCO Company
2. Frame: Extruded aluminum frame with built in anchor flange around the perimeter.
3. Loading Capacity: 300-lbf/sq. ft. (14.4-kN/sq. m) pedestrian live load.

4. Hardware: Engineered composite compression spring tubes and steel compression springs packed in grease. Type 316 Stainless steel hinges. All other hardware is zinc plated/chromate sealed.

    a. Hinges: Continuous heavy-duty type 316 stainless steel hinge.
    b. Latch: Stainless-steel slam latch.
    c. Lock: Keyed deadbolt lock with threaded protection plug on pull side; turn knob on opposite side.

2.2 MATERIALS

A. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666. Remove tool and die marks and stretch lines, or blend into finish.

B. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T6.

C. Aluminum-Alloy Rolled Tread Plate: ASTM B 632/B 632M, Alloy 6061-T6.

D. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

E. Frame Anchors: Same material as door face.

F. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

2.3 FABRICATION

A. General: Provide floor doors manufactured as integral units ready for installation.

B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

C. Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure floor doors to types of supports indicated.

D. Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed.
    1. For cylinder locks, furnish two keys per lock and key all locks alike.

E. Aluminum: After fabrication, apply manufacturer's standard protective coating on aluminum that will come into contact with concrete.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Comply with manufacturer's written instructions for installing floor doors.

3.3 ADJUSTING

A. Adjust doors and hardware, after installation, for proper operation.

END OF SECTION 08 34 83

SECTION 084119 - STAINLESS-STEEL-FRAMED STOREFRONTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Exterior storefront framing.
2. Trim and accessories as necessary to provide a complete installation.

B. Related sections include the following:

1. Division 07 Section "Joint Sealants" for joint sealants installed around perimeter of stainless-steel storefront system.
2. Division 08 Section "Glazing."

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site to comply with requirements of Division 01 Section "Project Management and Coordination."

1.4 ACTION SUBMITTALS

A. Product Data: For each product specified. Include details of construction relative to materials, dimensions of individual components, profiles, and finishes.

B. Shop Drawings: For stainless-steel-framed storefronts. Include plans, elevations, sections, full-size details, and attachments to other work.

1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
2. Include full-size isometric details of each vertical-to-horizontal intersection of stainless-steel-framed storefronts, showing the following:

a. Joinery, including concealed welds.
b. Anchorage.
c. Expansion provisions.
d. Glazing.
e. Flashing and drainage.

3. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
4. Details shall include accurate depiction of surrounding construction to which the work of this Section must attach, finish to or made watertight against.

C. Delegated-Design Submittal: For stainless-steel-framed systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of stainless-steel-framed systems.
2. Include design calculations.

D. Samples for Initial Selection: Samples of actual materials used for storefront framing to demonstrate appearance of completed work.

1.5 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For stainless-steel-framed storefronts, for tests performed by a qualified testing agency.

B. Product Test Reports: For stainless-steel-framed storefronts, for tests performed either by manufacturer and witnessed by a qualified testing agency or by a qualified testing agency.

1.6 QUALITY ASSURANCE

A. Engineering Responsibility: Prepare data for stainless-steel-framed systems, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in systems similar to those indicated for this Project.

B. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

C. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating systems without field measurements. Coordinate construction to ensure actual dimensions correspond to established dimensions.

1.8 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Special Warranty: Submit a written warranty executed by the manufacturer agreeing to repair or replace components of storefront systems that fail in materials or workmanship within the specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including, but not limited to, excessive deflection.
b. Noise or vibration created by wind and thermal and structural movements.
c. Failure of system to meet performance requirements.
d. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
e. Failure of operating components to function normally.
f. Water penetration through fixed glazing and framing areas.
g. Adhesive sealant failures.
h. Cohesive sealant failures.

2. Warranty Period: 2 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Division 01 Section "Quality Requirements," to design stainless-steel-framed storefronts.

B. General Performance: Comply with performance requirements specified, as determined by testing of stainless-steel-framed storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.

1. Stainless-steel-framed storefronts shall withstand movements of supporting structure including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
2. Failure also includes the following:

a. Thermal stresses transferring to building structure.
b. Glass breakage.
c. Noise or vibration created by wind and thermal and structural movements.
d. Loosening or weakening of fasteners, attachments, and other components.
e. Failure of operating units.
f. Sealant failure.

C. Glazing: Physically and thermally isolate glazing from framing members.

D. Dimensional Tolerances: Provide storefront systems that accommodate dimensional tolerances of building frame and other adjacent construction.

E. Structural Loads:

1. Wind Loads: As indicated on the Drawings.
2. Other Design Loads: As indicated on the Drawings.

F. Deflection of Framing Members: At design wind pressure, as follows:

1. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane not exceeding 1/175 of the glass edge length for each individual glazing lite, or an amount that restricts edge deflection of individual glazing lites to ½ inch (13 mm), whichever is smaller.
2. Deflection Parallel to Glazing Plane: Limited to amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch (3.2 mm).

G. Structural: Test according to ASTM E 330 as follows:

1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
2. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural

distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
3. Duration: As required by design wind velocity, but not less than 10 seconds.

H. Air Infiltration: Test according to ASTM E 283 for infiltration as follows:

1. Fixed Framing and Glass Area: Maximum air leakage of 0.06 cfm/sq. ft. (0.30 L/s per sq. m) at a static-air-pressure differential of 6.24 lbf/sq. ft. (300 Pa).

I. Water Penetration under Static Pressure: Test according to ASTM E 331 as follows:

1. No evidence of water penetration through fixed glazing and framing areas when tested according to a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 15 lbf/sq. ft. (720 Pa).

J. Water Penetration under Dynamic Pressure: Test according to AAMA 501.1 as follows:

1. No evidence of water penetration through fixed glazing and framing areas when tested at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 15 lbf/sq. ft. (720 Pa).
2. Maximum Water Leakage: No uncontrolled water penetrating assemblies or water appearing on assemblies' normally exposed interior surfaces from sources other than condensation. Water leakage does not include water controlled by flashing and gutters, or water that is drained to exterior.

K. Interstory Drift: Accommodate design displacement of adjacent stories indicated.

1. Design Displacement: As indicated on Structural Drawings.
2. Test Performance: Complying with criteria for passing based on building occupancy type when tested according to AAMA 501.4 at design displacement and 1.5 times the design displacement.

L. Seismic Performance: Stainless-steel-framed storefronts shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. Seismic Drift Causing Glass Fallout: Complying with criteria for passing based on building occupancy type when tested according to AAMA 501.6 at design displacement and 1.5 times the design displacement.
2. Vertical Interstory Movement: Complying with criteria for passing based on building occupancy type when tested according to AAMA 501.7 at design displacement and 1.5 times the design displacement.

M. Thermal Movements: Provide storefront systems, including anchorage, that accommodate thermal movements of systems and supporting elements resulting from the

following maximum change (range) in ambient and surface temperatures without buckling, damaging stresses on glazing, failure of joint sealants, damaging loads on fasteners, failure of doors or other operating units to function properly, and other detrimental effects.

1. Temperature Change (Range): 140 deg F (78 deg C), ambient; 200 deg F (111 deg C), material surfaces.
2. Thermal Cycling: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.

    a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of 180 deg F (82 deg C).
    b. Low Exterior Ambient-Air Temperature: 0 deg F (minus 18 deg C).

2.2 STAINLESS-STEEL-FRAMED STOREFRONT SYSTEMS

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include the following or Equal Product:

1. Prosteel Stainless Steel Storefront; Tajima Corp USA

B. Source Limitations: Obtain all components of stainless-steel-framed storefront system, including framing and accessories, from single manufacturer.

2.3 MATERIALS

A. Stainless-Steel: Provide framing members mechanically formed from cold-rolled, ASTM A240/A240M, austenitic stainless steel sheet, Type 316.

2.4 FRAMING SYSTEMS

A. Framing Members: Manufacturer's standard stainless-steel framing members of thickness required and reinforced as required to support imposed loads.

1. Glazing System: Retained mechanically with gaskets on four sides.
2. Glazing Plane: Center set.
3. Finish: High-performance organic finish.
4. Fabrication Method: Field-fabricated stick system.

B. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.

C. Brackets and Reinforcements: Provide manufacturer's standard brackets and reinforcements that are compatible with adjacent materials. Provide nonstaining, nonferrous shims for aligning system components.

2.5 GLAZING SYSTEMS

A. Glazing as specified in Division 08 Section "Glazing."

B. Glazing Gaskets: Manufacturer's standard pressure-glazing system of black, resilient glazing gaskets, setting blocks, and shims or spacers, fabricated from an elastomer of type and in hardness recommended by system and gasket manufacturer to comply with system performance requirements. Provide gasket assemblies that have corners sealed with sealant recommended by gasket manufacturer.

C. Spacers, Setting Blocks, Gaskets, and Bond Breakers: Manufacturer's standard permanent, nonmigrating types in hardness recommended by manufacturer, compatible with sealants, and suitable for system performance requirements.

D. Bond-Breaker Tape: Manufacturer's standard TFE-fluorocarbon or polyethylene material to which sealants will not develop adhesion.

E. Glazing Sealants: As recommended by manufacturer.

2.6 ACCESSORIES

A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
2. Reinforce members as required to retain fastener threads.
3. Do not use exposed fasteners, except for hardware application. For hardware application, use countersunk Phillips flat-head machine screws finished to match framing members or hardware being fastened, unless otherwise indicated.

B. Anchors: 3-way adjustable anchors that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.

1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123 or ASTM A 153 requirements.

C. Concealed Flashing: Rubberized-asphalt composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density,

cross-laminated polyethylene film to produce an overall thickness of not less than 0.040 inch (1.0 mm).

1. Available Products: Subject to compliance with requirements, products that may be included in the Work included the following or Equal Product:

    a. Carlisle Coatings & Waterproofing; CCW-705-TWF Thru-Wall Flashing.
    b. Grace Construction Products, a unit of W. R. Grace & Co. - Conn.; Perm-A-Barrier Wall Flashing.
    c. Heckmann Building Products Inc.; No. 82 Rubberized-Asphalt Thru-Wall Flashing.

D. Sealants and joint fillers for joints at perimeter of storefront systems as specified in Division 07 Section "Joint Sealants."

E. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements, except containing no asbestos, formulated for 30-mil (0.762-mm) thickness per coat.

2.7 FABRICATION

A. Form or extrude stainless-steel shapes before finishing.

B. Welding: Weld components to comply with referenced AWS standard. Weld before finishing components to greatest extent possible. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Fabricate components that, when assembled, will have the following characteristics:

1. Profiles that are sharp, straight, and free of defects or deformations.
2. Accurately fitted joints with ends coped or mitered.
3. Physical and thermal isolation of glazing from framing members.
4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
5. Provisions for field replacement of glazing from interior.
6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

D. Fabricate components to drain water passing joints and condensation and moisture occurring or migrating within the system to the exterior.

E. Fabricate framing in profiles indicated for flush glazing (without projecting stops). Provide subframes and reinforcing of types indicated or, if not indicated, as required for

a complete system.

F. Glazing Channels: Provide minimum clearances for thickness and type of glass indicated according to FGMA's "Glazing Manual."

G. Storefront Framing: Fabricate components for stick method construction (head- and sill-receptor frame construction with shear-block construction at intermediate horizontal components.)

H. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.8 STAINLESS-STEEL FINISHES

A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations relative to applying and designating finishes.

B. Stainless Steel Finishes: Remove tool and die marks and stretch lines, or blend into finish. Grind and polish surfaces to produce uniform finish, free of cross scratches. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
   1. Finish: Directional Satin Finish: No. 4

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General:

   1. Comply with manufacturer's written instructions.
   2. Do not install damaged components.
   3. Fit joints to produce hairline joints free of burrs and distortion.
   4. Rigidly secure nonmovement joints.
   5. Install anchors with separators and isolators to prevent metal corrosion and

electrolytic deterioration and to prevent impeding movement of moving joints.

6. Seal perimeter and other joints watertight unless otherwise indicated.

B. Install components to drain water passing joints, condensation occurring in glazing channels, condensation occurring within framing members, and moisture migrating within the system to the exterior.

C. Set continuous sill members and flashing in a full sealant bed to provide weathertight construction, unless otherwise indicated. Comply with requirements of Division 07 Section "Joint Sealants."

1. Do not seal or otherwise obstruct weep holes or drainage passages.

D. Install framing components plumb and true in alignment with established lines and grades without warp or rack of framing members.

E. Install glazing in conformance with manufacturer's instructions and to comply with wind load requirements.

F. Install perimeter sealant to comply with requirements of Division 07 Section "Joint Sealants," unless otherwise indicated.

3.3 ERECTION TOLERANCES

A. Erection Tolerances: Install storefront systems to comply with the following maximum tolerances:

1. Plumb: 1/8 inch in 10 feet (3 mm in 3 m); 1/4 inch in 40 feet (6 mm in 12 m).
2. Level: 1/8 inch in 20 feet (3 mm in 6 m); 1/4 inch in 40 feet (6 mm in 12 m).
3. Alignment: Where surfaces abut in line, limit offset from true alignment to 1/16 inch (1.5 mm); where a reveal or protruding element separates aligned surfaces by less than 2 inches (50.8 mm), limit offset to 1/4-inch (6.3 mm). Where surfaces meet at corners, limit offset from true alignment to 1/32 inch (0.8 mm).
4. Diagonal Measurements: Limit difference between diagonal measurements to 1/8 inch (3 mm).
5. Location: Limit variation from plane or location shown on Shop Drawings to 1/8 inch in 12 feet (3 mm in 3.7 m); 1/4-inch (6.3 mm) over total length.

3.4 CLEANING AND PROTECTION

A. Remove excess sealant and glazing compounds, and dirt from surfaces.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer

and Installer, that ensure storefront systems are without damage or deterioration at the time of Substantial Completion.

END OF SECTION 084119

SECTION 084523 - FIBERGLASS-SANDWICH-PANEL WALL ASSEMBLIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes assemblies incorporating fiberglass sandwich panels and aluminum frame systems as follows:

1. Wall assemblies (translucent wall panels).

B. Related sections include the following:

1. Division 07 Section “Sheet Metal Flashing and Trim.”
2. Division 07 Section “Sealants.”
3. Division 08 Section “Fiberglass-Sandwich-Panel Skylight System.”

1.3 PERFORMANCE REQUIREMENTS

A. Provide assemblies, including anchorage, capable of withstanding, without failure, the effects of the following:

1. Structural loads.
2. Thermal movements.
3. Movements of supporting structure.
4. Dimensional tolerances of building frame and other adjacent construction.

B. Failure includes the following:

1. Deflection exceeding specified limits.
2. Water leakage.
3. Thermal stresses transferred to building structure.
4. Noise or vibration created by wind and thermal and structural movements.
5. Loosening or weakening of fasteners, attachments, and other components.
6. Delamination of fiberglass-sandwich-panel faces from panel cores.

C. Design Wind Loads: As indicated on the Structural drawings.

D. Windborne-Debris-Impact-Resistance Performance: Provide fiberglass-sandwich-panel assemblies that pass missile-impact and cyclic-pressure tests when tested according to ASTM E 1886 and testing information in ASTM E 1996.

1. Large-Missile Impact: For exterior openings located within 30 feet (9.1 m) of grade.
2. Small-Missile Impact: For exterior openings located more than 30 feet (9.1 m) above grade.

E. Deflection of Vertical Assemblies: Limited to 1/60 of clear span for each assembly component.

F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 140 deg F (78 deg C), ambient; 200 deg F (111 deg C), material surfaces.

1.4 PERFORMANCE TESTING

A. Provide assemblies that comply with test-performance requirements indicated, as evidenced by reports of tests performed on manufacturer's standard assemblies by a qualified independent testing agency.

B. Structural-Performance Test: ASTM E 330.

1. Performance at Design Load: When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
2. Performance at Maximum Test Load: When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main supporting members exceeding 0.2 percent of span.
3. Test Durations: As required by design wind velocity but not less than 10 seconds.

C. Air-Infiltration Test: ASTM E 283.

1. Minimum Static-Air-Pressure Difference: 6.24 lbf/sq. ft. (300 Pa).
2. Maximum Air Leakage: 0.01 cfm/sq. ft. (0.05 L/s per sq. m).

D. Test for Water Penetration under Static Pressure: ASTM E 331.

1. Minimum Static-Air-Pressure Difference: 20 percent of positive wind-load design pressure, but not less than 15 lbf/sq. ft. (719 Pa).
2. Water Leakage: None.

E. Test for Water Penetration under Dynamic Pressure: AAMA 501.1

1. Minimum Dynamic-Air-Pressure Difference: 20 percent of positive wind-load design pressure, but not less than 15 lbf/sq. ft. (719 Pa).
2. Water Leakage: No uncontrolled water penetrating aluminum-framed systems or water appearing on systems' normally exposed interior surfaces from sources other than condensation. Water leakage does not include water that is controlled by flashing and gutters and drained to the exterior, or water that cannot damage adjacent materials or finishes.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for aluminum components of panel assemblies.

B. Shop Drawings: For panel assemblies. Include plans, elevations, sections, details, and attachments to other work.

1. Include details of provisions for assembly expansion and contraction and for draining moisture within the assembly to the exterior.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.

E. Fabrication Samples: Of each framing system intersection and adjacent panels, made from 12-inch (305-mm) lengths of full-size framing members and showing details of the following:

1. Joinery.
2. Anchorage.
3. Expansion provisions.
4. Fiberglass-sandwich panels.
5. Flashing and drainage.

F. Delegated-Design Submittal: For panel assemblies indicated to comply with performance requirements and design criteria, including analysis data signed and sealed

by the qualified professional engineer responsible for their preparation.

1. Provide calculations of all horizontal and vertical reactions exerted by the skylights on curbs and support construction not provided by this Section.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for panel assemblies. Reports shall verify that the material will meet all performance requirements of this specifications and project, based on comprehensive testing of current products. Previously completed test reports will be acceptable if for current manufacturer and indicative of products used on this project. Test reports required are:

1. Flame Spread and Smoke Developed (UL 723) – Submit UL Card
2. Burn Extent (ASTM D-635)
3. Color Difference (ASTM D-2244)
4. Abrasion/Erosion Resistance (ASTM D-4060)
5. Impact Strength (UL 972)
6. Bond Tensile Strength (ASTM C-297 after aging by ASTM D-1037) note all 5 parts are required
7. Bond Shear Strength (ASTM D-1002) after 5 different aging conditions
8. Beam Bending Strength (ASTM E-72
9. Insulation U-Factor (NFRC-100)
10. NFRC System Certification
11. Condensation Resistance Factor (AAMA 1503)
12. Class A Roof Covering Burning Brand (ASTM E-lO8)

C. Manufacturer's Quality-Control Documentation: Submit current documentation indicating regular, independent quality control monitoring under a nationally recognized building code review and listing program.

D. Field quality-control reports.

E. Warranties: Sample of special warranties.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For panel assemblies to include in maintenance manuals.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: For fiberglass-sandwich panels, a qualified manufacturer whose facilities, processes, and products are monitored by an independent, accredited quality-control agency for compliance with applicable requirements in ICC-ES AC04, "Sandwich Panels," or ICC-ES AC177, "Translucent Fiberglass Reinforced Plastic (FRP) Faced Panel Wall, Roof and Skylight Systems."

B. Installer's Qualifications: Manufacturer's authorized representative who is trained and approved for installation of panel assemblies required for this Project.

C. NFRC Certification: Provide fiberglass sandwich panels that are certified for U-factors indicated according to NFRC 100 and listed in its "National Fenestration Council Incorporated - Certified Products Directory."

D. Product Options: Information on Drawings and in Specifications establishes requirements for panel assemblies' aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including testing conducted by an independent testing agency and in-service performance.

1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

E. Preconstruction Testing: Provide panel assemblies that comply with test-performance requirements indicated, as evidenced by reports of tests performed on manufacturer's standard panel assemblies.

F. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Build mockup of two adjacent complete panel assemblies within finished building rough opening at location selected by the Architect.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

G. Preinstallation Conference: Conduct conference at Project site.

1.9 PROJECT CONDITIONS

A. Field Measurements: Verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating systems without field measurements. Coordinate construction to ensure actual dimensions correspond to established dimensions.

1.10 DELIVERY, STORAGE AND HANDLING

A. Deliver panel system, components and materials in manufacturer's standard protective packaging.

B. Store panels on the long edge; several inches above the ground, blocked and under cover in accordance with manufacturer's storage and handling instructions.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of panel assemblies that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including, but not limited to, excessive deflection.
b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
c. Water leakage.

2. Warranty Period: Five years from date of Substantial Completion.

B. Special Fiberglass-Sandwich-Panel Warranty: Manufacturer's standard form in which manufacturer agrees to replace panels that exhibit defects in materials or workmanship.

1. Defects include, but are not limited to, the following:

a. Fiberbloom.
b. Delamination of coating, if any, from exterior face sheet.
c. Color change exceeding requirements.
d. Delamination of panel face sheets from panel cores.

2. Warranty Period: 10 years from date of Substantial Completion.

C. Special Aluminum-Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes fail within specified warranty period. Warranty does not include normal weathering.

1. Failures include, but are not limited to, checking, crazing, peeling, chalking, and fading of finishes.
2. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: The design of the fiberglass-sandwich-panel assemblies is based on the products of the Kalwall Corporation. Subject to compliance with requirements, provide the named product or Comparable Product by the following or prior-approved alternate manufacturer:

1. Major Industries, Inc.
2. Structures Unlimited, Inc.

2.2 ALUMINUM FRAMING SYSTEM

A. Aluminum: Alloy and temper recommended in writing by manufacturer for type of use and finish indicated.

1. Sheet and Plate: ASTM B 209 (ASTM B 209M).
2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
3. Extruded Structural Pipe and Tubes: ASTM B 429.

B. Components: Manufacturer's standard extruded-aluminum members of thickness required and reinforced as required to support imposed loads.

1. Construction: Thermally broken; framing members are composite assemblies of two separate extruded-aluminum components permanently bonded by a material of low thermal conductance.

C. Exposed Flashing and Closures: Manufacturer's standard aluminum components not less than 0.040 inch (1.016 mm) thick.

D. Frame-System Gaskets: Manufacturer's standard.

E. Frame-System Sealants: As recommended in writing by manufacturer.

1. Provide sealants for use inside of the weatherproofing system that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

F. Anchors, Fasteners, and Accessories: Manufacturer's standard, corrosion-resistant, nonstaining, and nonbleeding; compatible with adjacent materials.

1. At closures, retaining caps, or battens, use ASTM A 193/A 193M, 300 series stainless-steel screws.
2. Where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration, use self-locking devices.
3. At movement joints, use slip-joint linings, spacers, and sleeves of material and type recommended in writing by manufacturer.

G. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.

H. Frame System Fabrication:

1. Fabricate components before finishing.
2. Fabricate components that, when assembled, have the following characteristics:
   a. Profiles that are sharp, straight, and free of defects or deformations.
   b. Accurately fitted joints with ends coped or mitered.
   c. Internal guttering systems or other means to drain water passing joints, condensation occurring within components, and moisture migrating within the assembly to exterior.
3. Fabricate sill closures with weep holes and for installation as continuous component.
4. Reinforce components as required to receive fastener threads.

I. Concealed Flashing: Corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.

J. Corrosion-Resistant Coating: Cold-applied asphalt mastic, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.3 FIBERGLASS-SANDWICH-PANELS

A. Panel Construction: Assembly of uniformly colored, translucent, thermoset, fiberglass-reinforced-polymer face sheets bonded to both sides of a grid core and

complying with requirements applicable to panel materials in ICBO ES AC04, "Sandwich Panels."

1. Face-Sheet, Self-Ignition Temperature: 650 deg F (343 deg C) or more per ASTM D 1929.
2. Face-Sheet Burning Extent: 1 inch (25 mm) or less per ASTM D 635.
3. Face-Sheet, Smoke-Developed Index: 450 or less per ASTM E 84.
4. Interior Face-Sheet, Flame-Spread Index: Not more than 25 per ASTM E 84.

B. Panel Thickness: 2-3/4 inches (70 mm).

C. Panel U-Factor: Not more than 0.23 (1.31), measured in Btu/sq. ft. x h x deg F (W/sq. m x K) according to NFRC 100 or ASTM C 1363 using procedures described in ASTM C 1199 and ASTM E 1423.

D. Light Transmission: Not less than 20 percent.

E. Solar Heat Gain Coefficient: Not more than 0.19.

F. Panel Strength Characteristics:

1. Maximum Panel Deflection: 3-1/2 inches (89 mm) when a 4-by-12-foot (1.2-by-3.6-m) panel is tested according to ASTM E 72 at 34 lbf/ sq. ft. (1.6 kPa), with a maximum 0.090-inch (2.3-mm) set deflection after 5 minutes.
2. Panel Support Strength: Capable of supporting, without failure, a 300-lbf (1334 N) concentrated load when applied to a 3-inch- (76-mm-) diameter disk according to ASTM E 661.

G. Grid Core: Mechanically interlocked extruded-aluminum I-beams, with a minimum flange width of 7/16 inch (11.1 mm).

1. Extruded Aluminum: ASTM B 221 (ASTM B 221M), in alloy and temper recommended in writing by manufacturer.
2. I-Beam Construction: Thermally broken; two separate extruded-aluminum components permanently bonded by a material of low thermal conductance.
3. Grid Pattern: “Vertikal” style (full panel-length rectangles.)

H. Exterior Face Sheet:

1. Thickness: 0.070 inches (1.778 mm).
2. Color: Crystal.
3. Color Stability: Not more than 3.0 units Delta E when measured according to ASTM D 2244 after outdoor weathering in southern Florida according to procedures in ASTM D 1435 with panels mounted facing south and as follows:

a. Panel Mounting Angle: Not more than 5 or 45 degrees from horizontal.
b. Exposure Period: 60 months.

4. Erosion Protection: Manufacturer's standard.

I. Interior Face Sheet:

1. Thickness: 0.045 inch (1.143 mm).
2. Color: White.

J. Fiberglass-Sandwich-Panel Adhesive: ASTM D 2559.

1. Compatible with facing and core materials.
2. Tensile and shear bond strength of aged adhesive ensures permanent adhesion of facings to cores, as evidenced by testing according to ASTM C 297 and ASTM D 1002 after accelerated aging procedures that comply with aging requirements for adhesives with high resistance to moisture in ICBO ES AC05, "Sandwich Panel Adhesives."

2.4 FABRICATION

A. Frame System Fabrication:

1. Fabricate components before finishing.
2. Fabricate components that, when assembled, have the following characteristics:

a. Profiles that are sharp, straight, and free of defects or deformations.
b. Accurately fitted joints with ends coped or mitered.
c. Internal guttering systems or other means to drain water passing through joints, condensation occurring within components, and moisture migrating within assembly to exterior.

3. Fabricate sill closures with weep holes and for installation as continuous component.
4. Reinforce components as required to receive fastener threads.

B. Panel Fabrication: Factory assemble and seal panels.

1. Laminate face sheets to grid core under a controlled process using heat and pressure to produce straight adhesive bonding lines that cover width of core members and that have sharp edges.

a. White spots indicating lack of bond at intersections of grid-core members are limited in number to 4 for every 40 sq. ft. (3.7 sq. m) of panel and limited in diameter to 3/64 inch (1.2 mm).

2. Fabricate with grid pattern that is symmetrical about centerlines of each panel.
3. Fabricate panel to allow condensation within panel to escape.
4. Reinforce panel corners.

2.5 ALUMINUM FINISHES

A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations relative to applying and designating finishes.

B. Finish designations prefixed by AA conform to the system established by the Aluminum Association for designating aluminum finishes.

C. High-Performance Organic Finish (2-Coat Fluoropolymer): AA-C12C40R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: conversion coating; Organic Coating: manufacturer's standard 2-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with AAMA 2605 and with coating and resin manufacturers' written instructions.

1. Color: Custom mica/pearlescent color, to match color provided by the Architect.

D. Aluminum Sheet (Brake Metal): Same finish as aluminum extrusions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General:

1. Comply with manufacturer's written instructions.
2. Do not install damaged components.
3. Fit joints between aluminum components to produce hairline joints free of burrs and

distortion.
4. Rigidly secure nonmovement joints.
5. Install anchors with separators and isolators to prevent metal corrosion, electrolytic deterioration, and immobilization of moving joints.
6. Seal joints watertight unless otherwise indicated.

B. Metal Protection: Where aluminum components will contact dissimilar materials, protect against galvanic action by painting contact surfaces with corrosion-resistant coating or by installing nonconductive spacers as recommended in writing by manufacturer for this purpose.

C. Install continuous aluminum sill closures with weatherproof expansion joints and locked and sealed corners. Locate weep holes at rafters.

D. Install components to drain water passing through joints, condensation occurring within aluminum members and panels, and moisture migrating within assembly to exterior.

E. Install components plumb and true in alignment with established lines and elevations.

F. Erection Tolerances: Install panel assemblies to comply with the following maximum tolerances:

1. Alignment: Limit offset from true alignment to 1/32 inch (0.8 mm) where surfaces abut in line, edge to edge, at corners, or where a reveal or protruding element separates aligned surfaces by less than 3 inches (76 mm); otherwise, limit offset to 1/8 inch (3.2 mm).
2. Location and Plane: Limit variation from true location and plane to 1/8 inch in 12 feet (3.2 mm in 3.7 m), but no greater than 1/2 inch (13 mm) over total length.

3.3 CLEANING

A. Clean fiberglass-sandwich-panel assemblies inside and outside, immediately after installation, according to manufacturer's written recommendations.

END OF SECTION 084523

SECTION 084523 - FIBERGLASS-SANDWICH-PANEL SKYLIGHT SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes the pre-engineered self supporting insulated translucent sandwich panel skylight system, together with all accessories as shown, specified, and necessary for a complete installation. Work includes providing:

1. Structural aluminum box beam superstructure with permanent lifting eye-hooks.
2. Aluminum installation system with exterior accessible anchor bolts.
3. Flat factory-prefabricated structural insulated translucent sandwich panels.
4. Removable aluminum flashing attached to skylights.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 07 Section "Sealants."
2. Division 08 Section "Fiberglass-Sandwich-Panel Wall Assemblies."

1.3 SUBMITTALS

A. Submit manufacturer's product data. Include construction details, material descriptions, profiles and finishes of skylight components.

B. Submit shop drawings. Include elevations and details.

C. Submit manufacturer's color charts showing the full range of colors available for factory-finished aluminum.

1. Submit samples for each exposed finish required, in same thickness and material indicated for the work and in size indicated below. If finishes involve normal color variations, include sample sets consisting of two or more units showing the full range of variations expected.

a. Sandwich panels: 14" x 28" units
b. Factory finished aluminum: 5" long sections

D. Submit Installer Certificate, signed by installer, certifying compliance with project qualification requirements.

E. Submit product reports from a qualified independent testing agency indicating each type and class of panel system complies with the project performance requirements, based on comprehensive testing of current products. Previously completed reports will be acceptable if for current manufacturer and indicative of products used on this project.

1. Reports required are:

a. International Building Code Evaluation Report
b. Flame Spread and Smoke Developed (UL 723) – Submit UL Card
c. Burn Extent (ASTM D 635)
d. Color Difference (ASTM D 2244)
e. Impact Strength (UL 972)
f. Bond Tensile Strength (ASTM C 297 after aging by ASTM D 1037)
g. Bond Shear Strength (ASTM D 1002)
h. Beam Bending Strength (ASTM E 72)
i. Fall Through Resistance (ASTM E 661)
j. Insulation U-Factor (NFRC 100)
k. NFRC System U-Factor Certification (NFRC 700)
l. Solar Heat Gain Coefficient (NFRC or Calculations)
m. Condensation Resistance Factor (AAMA 1503)
n. Air Leakage (ASTM E 283)
o. Structural Performance (ASTM E 330)
p. Water Penetration (ASTM E 331)
q. Class A Roof Covering Burning Brand (ASTM E 108)
r. UL Listed Class A Roof System (UL 790) (Optional) – Submit UL Card
s. ASTM E1886/1996 or TAS 201, 202 and 203
t. Daylight Autonomy

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications

1. Material and products shall be manufactured by a company continuously and regularly employed in the manufacture of specified materials for a period of at least ten consecutive years and which can show evidence of those materials being satisfactorily used on at least six projects of similar size, scope and location. At least three of the projects shall have been in successful use for ten years or longer.

2. Panel system must be listed by an ANSI accredited Evaluation Service, which requires quality control inspections and fire, structural and water infiltration testing of sandwich panel systems by an accredited agency.
3. Quality control inspections shall be conducted at least once each year and shall include manufacturing facilities, sandwich panel components and production sandwich panels for conformance with AC177 "Translucent Fiberglass Reinforced Plastic (FRP) Faced Panel Wall, Roof and Skylight Systems" as issued by the ICC-ES.

B. Installer's Qualifications: Installation shall be by an experienced installer, which has been in the business of installing specified skylight systems for at least two consecutive years and can show evidence of satisfactory completion of projects of similar size, scope and type.

1.5 PERFORMANCE REQUIREMENTS

A. The manufacturer shall be responsible for the configuration and fabrication of the complete self-supporting skylight panel system.

1. Include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
2. Standard skylight system shall have less than 0.01 cfm/ft² air leakage by ASTM E 283 at 6.24 PSF (50 mph) and no water penetration by ASTM E 331 at 15 PSF; and structural testing by ASTM E 330.
3. Structural Loads: As indicated on the Drawings.

B. Windborne Debris Impact Resistance Performance

1. Translucent panels shall be impact-resistant meeting the requirements of an approved impact-resisting standard: ASTM E 1996 and ASTM E 1886 or TAS 201, 202 and 203.
2. Panel System shall designed to meet Missile “D” per ASTM E 1996.

1.6 DELIVERY STORAGE AND HANDLING

A. Deliver panel system, components and materials in manufacturer's standard protective packaging.

B. Store panels on the long edge; several inches above the ground, blocked and under cover in accordance with manufacturer's storage and handling instructions.

1.7 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Special Warranty: Submit a written warranty executed by the manufacturer agreeing to repair or replace components of the insulated translucent sandwich panel skylight system that fail in materials or workmanship within the specified warranty period. Failure of materials or workmanship shall include leakage, excessive deflection, deterioration of finish on metal in excess of normal weathering, defects in accessories, insulated translucent sandwich panels and other components of the work.

1. Warranty Period: 2 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Basis-of-Design Products: The design of the insulated translucent sandwich panel skylight system is based on the product listed below. Subject to compliance with requirements, provide the named product or Equal Product.

1. Center-Ridge Translucent Gable-End Skylight with 2.5/12 pitch; Structures Unlimited, Inc.

a. Skylight unit shall be removable as a complete unit by lifting eye-hooks with a crane. Disassembling individual or small groups of panels does not meet the design intent and is not acceptable.

2.2 PANEL COMPONENTS

A. Face Sheets

1. Translucent faces: Manufactured from glass fiber reinforced thermoset resins, formulated specifically for architectural use.

a. Thermoplastic (e.g. polycarbonate, acrylic) faces are not acceptable.
b. Face sheets shall not deform, deflect or drip when subjected to fire or flame.

2. Exterior face sheets:

a. Color stability: Full thickness of the exterior face sheet shall not change color more than 3 CIE Units DELTA E by ASTM D 2244 after 5 years outdoor South Florida weathering at 5° facing south, determined by the average of at least three white samples with and without a protective film or coating to ensure long-term color stability. Color stability shall be unaffected by abrasion or scratching.
b. Strength: Exterior face sheet shall be uniform in strength, with panel meeting ASTM E1996 and ASTM E1886 or TAS 201, 202 and 203.

3. Interior face sheets:

a. Flame spread: Underwriters Laboratories (UL) listed, which requires periodic unannounced retesting, with flame spread rating no greater than 25 and smoke developed no greater than 250 when tested in accordance with UL 723.
b. Burn extent by ASTM D 635 shall be no greater than 1".

4. Appearance:

a. Exterior face sheets: 0.060" thick, white, Hurricane Hi-Impact SW.
b. Interior face sheets: 0.045" thick, white, smooth.
c. Face sheets shall not vary more than ± 10% in thickness and be uniform in color.

B. Grid Core: Interlocking I-beam grid core shall be of 6063-T6 or 6005-T5 alloy and temper with provisions for mechanical interlocking of muntin-mullion and perimeter. Width of I-beam shall be no less than 7/16".

1. Grid Pattern: Shoji.
2. Grid Module Dimensions: Manufacturer’s standard.

C. Laminate Adhesive

1. Heat and pressure resin type adhesive engineered for structural sandwich panel use, with minimum 25-years field use. Adhesive shall pass testing requirements specified by the International Code Council "Acceptance Criteria for Sandwich Panel Adhesives".
2. Minimum tensile strength of 750 PSI when the panel assembly is tested by ASTM C 297 after two exposures to six cycles each of the aging conditions prescribed by ASTM D 1037.
3. Minimum shear strength of the panel adhesive by ASTM D 1002 after exposure to four separate conditions:

a. 50% Relative Humidity at 68° F: 540 PSI
b. 182° F: 100 PSI
c. Accelerated Aging by ASTM D 1037 at room temperature: 800 PSI
d. Accelerated Aging by ASTM D 1037 at 182° F: 250 PSI

2.3 PANEL CONSTRUCTION

A. Provide sandwich panels of flat fiberglass reinforced translucent face sheets laminated to a grid core of mechanically interlocking I-beams. The adhesive bonding line shall be straight, cover the entire width of the I-beam and have a neat, sharp edge.

1. Thickness: 2-3/4"
2. Panel U-factor by NFRC certified laboratory, 2-3/4" aluminum grid: 0.29.
3. Light transmission: 15%
4. Solar heat gain coefficient: 0.23.

https://www.kalwall.com/technology/performance/thermal-performance/

B. Standard panels shall deflect no more than 1.9" at 30 PSF in 10' 0" span without a supporting frame by ASTM E 72.

C. Standard panels shall withstand 1200° F fire for minimum one hour without collapse or exterior flaming.

D. Skylight System: Skylight system shall pass Class A Roof Burning Brand Test By ASTM E 108.

E. Skylight System shall meet the fall through requirements of OSHA 1910.23 as demonstrated by testing in accordance with ASTM E 661, thereby not requiring supplemental screens or railings.

2.4 BATTENS AND PERIMETER CLOSURE SYSTEM

A. Closure system: Extruded aluminum 6063-T6 and 6063-T5 alloy and temper clamp-tite screw type closure system.
B. Sealing tape: Manufacturer's standard, pre-applied to closure system at the factory under controlled conditions.

C. Fasteners: 300 series stainless steel screws for aluminum closures, excluding final fasteners to the building.

D. Finish: Manufacturer's factory applied finish, which meets the performance requirements of AAMA 2604.

1. Color: As selected by the Architect from manufacturer’s standard colors.

2.5 SUPERSTRUCTURE

A. The superstructure shall be pre-fabricated of extruded aluminum alloy 6005-T5, 6005A-T61 or 6061-T6 box beams. Ferrous metals shall not be allowed. All parts shall be pre-assembled at the factory and knocked down for shipment. System shall be a Rigid Frame design.

1. Aluminum structural system design and calculations must be furnished in accordance with the Aluminum Association "Specifications for Aluminum Structures" and the applicable building code. Design calculations must be prepared and stamped by a qualified professional engineer.

B. Finish: Manufacturer's factory applied finish, which meets the performance requirements of AAMA 2604.

1. Color: As selected by the Architect from manufacturer’s standard colors.

C. The superstructure of removable skylight unit shall incorporate permanent lifting eye-hooks that allow for the unit to be lifted by crane.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Installer shall examine substrates, supporting structure and installation conditions.

B. Do not proceed with panel installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Metal Protection:

1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.
2. Where aluminum will contact concrete, masonry or pressure treated wood, protect against corrosion by painting contact surfaces with bituminous paint or method recommended by manufacturer.

3.3 INSTALLATION

A. Install the skylight system in accordance with the manufacturer's installation

recommendations and reviewed shop drawings.

1. Anchor component parts securely in place by permanent mechanical attachment system.
2. Accommodate thermal and mechanical movements.
3. Set perimeter framing in a full bed of sealant compound, or with joint fillers or gaskets to provide weather-tight construction.

B. Install joint sealants at perimeter joints and within the panel system in accordance with manufacturer's installation instructions.

3.4 FIELD QUALITY CONTROL

A. Water Test: Installer shall test skylights according to procedures in AAMA 501.2.

B. Repair or replace work that does not pass testing or that is damaged by testing, and retest work.

3.5 CLEANING

A. Clean the skylight system interior and exterior, immediately after installation in accordance with manufacturer's written recommendations.

END OF SECTION 084523

SECTION 08 71 00 – DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes items known commercially as finish or door hardware that are required for swing, sliding, and folding doors, except special types of unique hardware specified in the same sections as the doors and door frames on which they are installed.

B. This Section includes the following:

1. Mechanical door hardware.
2. Door trim units.
3. Thresholds and perimeter seals.

C. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 08 Section "Hollow Metal Doors and Frames."

1.3 SUBMITTALS

A. Product data including manufacturers' technical product data for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.

B. Final hardware schedule coordinated with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1. Final Hardware Schedule Content: Based on hardware indicated, organize schedule into "hardware sets" indicating complete designations of every item required for each door or opening. Include the following information:

a. Type, style, function, size, and finish of each hardware item.
b. Name and manufacturer of each item.
c. Fastenings and other pertinent information.
d. Location of each hardware set cross referenced to indications on Drawings both on floor plans and in door and frame schedule.

e. Explanation of all abbreviations, symbols, and codes contained in schedule.
f. Mounting locations for hardware.
g. Door and frame sizes and materials.
h. Keying information.

2. Accompanying the Final Hardware Schedule, submit letter of verification from the Door Hardware supplier certifying that scheduled door hardware for each opening has been carefully reviewed and coordinated to ensure proper function and operation, without interference or conflict of the various items of door hardware with each other, with the door or frame, with the door or frame trim or moulding, or with the surrounding construction.
3. Submittal Sequence: Submit final schedule at earliest possible date particularly where acceptance of hardware schedule must precede fabrication of other work that is critical in the Project construction schedule. Include with schedule the product data, samples, shop drawings of other work affected by door hardware, and other information essential to the coordinated review of schedule.
4. Keying Schedule: Submit separate detailed schedule indicating clearly how the Owner's final instructions on keying of locks has been fulfilled.

C. Templates for doors, frames, and other work specified to be factory prepared for the installation of door hardware. Check shop drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and an Architectural Hardware Consultant who is available during the course of the Work to consult with Contractor, Architect, and Owner about door hardware and keying.

1. Scheduling Responsibility: Preparation of door hardware and keying schedules..

B. Architectural Hardware Consultant Qualifications: A person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and who is currently certified by DHI as follows:

1. For door hardware, Architectural Openings Consultant (AOC).

C. Source Limitations: Obtain each type of door hardware from a single manufacturer.

D. Means of Egress Doors: Latches do not require more than 15 lbf (67 N) to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.

E. Preinstallation Conference: Conduct conference at Project site.

1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Inspect and discuss preparatory work performed by other trades.
3. Inspect and discuss electrical roughing-in for electrified door hardware.
4. Review sequence of operation for each type of electrified door hardware.
5. Review required testing, inspecting, and certifying procedures.

1.5 PRODUCT HANDLING

A. Provide secure lock-up for door hardware delivered to the Project, but not yet installed. Control handling and installation of hardware items that are not immediately replaceable so that completion of the Work will not be delayed by hardware losses both before and after installation.

1.6 COORDINATION

A. Coordinate layout and installation of floor-recessed door hardware with floor construction. Cast anchoring inserts into concrete. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include the following or Equal Products:

1. Full-Mortise Hinges:

a. Hager Hinge Co.:

1) BB1191 (5-knuckle, ball-bearing, full-mortise; stainless steel)
2) 1191 (5-knuckle, full-mortise; stainless steel)

b. McKinney:

1) TA2314 (5-knuckle, ball-bearing, full-mortise; stainless steel)

2) T2314 (5-knuckle, full-mortise; stainless steel)

2. Mortise Locks:

   a. Corbin-Russwin Architectural Hardware: ML2000 Series with RWA trim.
   b. Schlage - I-R Security & Safety: L 9000 Series with 02 lever and type “A” rose.

3. Surface-Mounted Overhead Closers:

   a. LCN: 4011/4111 Series
   b. Sargent Manufacturing Co.: 281 Series

4. Concealed Overhead Stops: Without hold-open feature

   a. Glynn-Johnson: 100 Series 100H Series H = hold-open
   b. Sargent: 690 Series 690H Series

5. Manual Flush Bolts:

   a. Hager Hinge Co.: 282D
   b. Ives: FB458

6. Wall Stops:
   a. Hager Hinge Co.: 232W
   b. Ives: WS406CVX

7. Perimeter Seal Set: For jambs and head of door opening

   a. National Guard Products, Inc.: 137SA
   b. Pemko Manufacturing Co., Inc.: 303AS

8. Exterior Thresholds:

   a. National Guard Products, Inc.: 896N
   b. Pemko Manufacturing Co., Inc.: 2005AT

2.2 MATERIALS AND FABRICATION

A. Manufacturer's Name Plate: Do not use manufacturers' products that have manufacturer's name or trade name displayed in a visible location (omit removable nameplates) except in conjunction with required fire-rated labels and as otherwise acceptable to Architect.

   1. Manufacturer's identification will be permitted on rim of lock cylinders only.

B. Base Metals: Produce hardware units of basic metal and forming method indicated, using

manufacturer's standard metal alloy, composition, temper, and hardness, but in no case of lesser (commercially recognized) quality than specified for applicable hardware units by applicable ANSI/BHMA A156 series standards for each type of hardware item and with ANSI/BHMA A156.18 for finish designations indicated. Do not furnish "optional" materials or forming methods for those indicated, except as otherwise specified.

C. Fasteners: Provide hardware manufactured to conform to published templates, generally prepared for machine screw installation. Do not provide hardware that has been prepared for self-tapping sheet metal screws, except as specifically indicated.

D. Furnish screws for installation with each hardware item. Provide Phillips flat-head screws except as otherwise indicated. Finish exposed (exposed under any condition) screws to match hardware finish or, if exposed in surfaces of other work, to match finish of this other work as closely as possible including "prepared for paint" surfaces to receive painted finish.

E. Provide concealed fasteners for hardware units that are exposed when door is closed except to the extent no standard units of type specified are available with concealed fasteners. Do not use thru-bolts for installation where bolt head or nut on opposite face is exposed in other work unless their use is the only means of reinforcing the work adequately to fasten the hardware securely. Where thru-bolts are used as a means of reinforcing the work, provide sleeves for each thru-bolt or use sex screw fasteners.

2.3 HINGES, BUTTS, AND PIVOTS

A. Templates: Except for hinges and pivots to be installed entirely (both leaves) into wood doors and frames, provide only template-produced units.

B. Screws: Provide Phillips flat-head screws complying with the following requirements:

1. For metal doors and frames install machine screws into drilled and tapped holes.
2. For wood doors and frames install wood screws.
3. Finish screw heads to match surface of hinges or pivots.

C. Hinge Pins: Except as otherwise indicated, provide hinge pins as follows:

1. Out-Swing Exterior Doors: Nonremovable pins.
2. Out-Swing Corridor Doors with Locks: Nonremovable pins.
3. Interior Doors: Nonrising pins.
4. Tips: Flat button and matching plug, finished to match leaves.
5. Corners: Square.

D. Number of Hinges: Provide number of hinges indicated but not less than 3 hinges per door leaf for doors 90 inches (2250 mm) or less in height and one additional hinge for each 30 inches (750 mm) of additional height.

E. Hinge Size: 4-1/2" x 4-1/2".

F. Hinge Weight: Unless otherwise indicated, provide the following:

1. Entrance Doors: Heavy-weight hinges.
2. Doors with Closers: Antifriction-bearing hinges.
3. Interior Doors: Standard-weight hinges.

G. Hinge Base Metal: Stainless steel, with stainless-steel pin.

2.4 LOCK CYLINDERS AND KEYING

A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, Appendix A. Incorporate decisions made in keying conference, and as follows:

1. ~~Grand~~ Master Key System: Cylinders are operated by a change key, and by a master key.

B. Equip locks with manufacturer's standard 6-pin tumbler cylinders.

C. Metals: Construct lock cylinder parts from brass or bronze, stainless steel, or nickel silver.

D. Comply with Owner's instructions for masterkeying and, except as otherwise indicated, provide individual change key for each lock that is not designated to be keyed alike with a group of related locks.

E. Key Material: Provide keys of nickel silver only.

F. Key Quantity: Furnish 3 change keys for each lock and 5 master keys for each master system.

1. Furnish one extra blank for each lock.
2. Deliver keys to Owner.

2.5 LOCKS AND LATCHES, GENERAL

A. Latches and Locks for Means of Egress Doors: Comply with NFPA 101. Latches shall not require more than 15 lbf (67 N) to release the latch. Locks shall not require use of a key, tool, or special knowledge for operation.

B. Lock Trim: Comply with the following:

1. Lever: Wrought.
2. Escutcheon (Rose): Wrought.

C. Lock Throw: Comply with testing requirements for length of bolts, and as follows:

1. Mortise Locks: Minimum 3/4-inch (19-mm) latchbolt throw.

D. Backset: 2-3/4 inches (70 mm), unless otherwise indicated.

2.6 MECHANICAL LOCKS AND LATCHES

A. Standards: Comply with the following:

1. Mortise Locks and Latches: BHMA A156.13.

B. Mortise Locks: Stamped steel case with steel or brass parts; BHMA Grade 1; Series 1000.

C. Certified Products: Provide door hardware listed in the following BHMA directories:

1. Mechanical Locks and Latches: BHMA's "Directory of Certified Locks & Latches."

2.7 STRIKES

A. General: Provide manufacturer's standard wrought box strike for each latch or lock bolt, with curved lip extended to protect frame, finished to match hardware set, unless otherwise indicated.

1. Provide flat lip strikes for locks with 3-piece, antifriction latchbolts as recommended by manufacturer.
2. Provide extra long strike lips for locks used on frames with applied wood casing trim.
3. Provide recess type top strikes for bolts locking into head frames, unless otherwise indicated.
4. Provide dust-proof strikes for foot bolts, except where special threshold construction provides nonrecessed strike for bolt.
5. Provide roller type strikes where recommended by manufacturer of the latch and lock units.

2.8 DOOR BOLTS

A. Flush Bolts: BHMA Grade 1, designed for mortising into door edge.

1. Flush Bolt Heads: Minimum of ½-inch- (12.7-mm-) diameter rods of brass, bronze, or stainless steel with minimum 12-inch- (305-mm-) long rod for doors up to 84 inches (2134 mm) in height. Provide longer rods as necessary for doors exceeding 84 inches (2134 mm).

B. Bolt Throw: Comply with testing requirements for length of bolts to comply with labeled fire door requirements, and as follows:

1. Mortise Flush Bolts: Minimum 3/4-inch (19-mm) throw.

2.9 CLOSERS AND DOOR CONTROL DEVICES

A. Surface Closers: BHMA Grade 1.

B. Certified Products: Provide door closers listed in BHMA's "Directory of Certified Door Closers."

C. Location: Except as otherwise approved by the Architect, mount closers on the room side of doors.

D. Size of Units: Comply with the manufacturer's recommendations for size of door control unit depending on size of door, exposure to weather, and anticipated frequency of use.

1. Where parallel arms are used, provide closer unit one size larger than recommended for use with standard arms.

E. ADAAG-Compliant Manual Closers: Provide only adjustable units complying with ANSI A117.1 provisions for door opening force and delayed action closing.

F. Provide grey resilient parts for exposed bumpers.

2.10 DOOR TRIM UNITS

A. Materials: Fabricate protection plates from the following:

1. Stainless Steel: 0.050 inch (1.3 mm) thick; beveled top and 2 sides.

B. Fasteners: Provide manufacturer's standard exposed fasteners for door trim units consisting of either machine screws or self-tapping screws.

C. Furnish protection plates (kickplates) in sizes as follows:

1. Push-side Mounting: 1-1/2 inches (38 mm) less than door width by 8" high.
2. Pull-side Mounting: ½ inch (13 mm) less than door width by 8" high.

2.11 DOOR SILENCERS

A. General: Provide gray rubber door silencers at all hollow metal door frames that do not receive weatherstripping or sound gasketing.

1. Single-Door Frames: Provide three door silencers per frame.

2.12 WEATHERSTRIPPING AND SEALS

A. General: Provide continuous weatherstripping on exterior doors; attach with noncorrosive fasteners.

B. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strip is easily replaceable and readily available from stocks maintained by manufacturer.

C. Weatherstripping at Jambs and Heads: Provide bumper-type resilient insert and metal retainer strips, surface applied unless shown as mortised or semimortised, and of following metal, finish, and resilient bumper material:

1. Extruded aluminum with natural anodized finish, 0.062-inch (1.6-mm) minimum thickness of main walls and flanges.
2. Solid neoprene conforming to MIL R 6855, Class II, Grade 40.

a. Flexible, hollow bulb or loop insert.

2.13 THRESHOLDS

A. General: Except as otherwise indicated, provide standard metal threshold unit of type, size, and profile as shown or scheduled.

B. Types: Provide units, formed to accommodate change in floor elevation where needed, fabricated to accommodate door hardware and to fit door frames, and as follows:

1. Length of each threshold shall be equal to overall width of door frame (door opening plus face width of door frame on each side of door opening.)
2. Thresholds shall be coped to door frames.
3. At exterior doors, provide units with contact-type neoprene bulb insert.

2.14 HARDWARE FINISHES

A. Standard: BHMA A156.18.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

1. Selected Finish: Satin stainless steel; US32D / BHMA 630.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mount hardware units at heights indicated in following applicable publications, except as specifically indicated or required to comply with governing regulations and except as otherwise directed by Architect.

1. "Recommended Locations for Builders Hardware for Standard Steel Doors and Frames" by the Door and Hardware Institute.
2. NWWDA Industry Standard I.S.1.7, "Hardware Locations for Wood Flush Doors."

B. Install each hardware item in compliance with the manufacturer's instructions and recommendations. Where cutting and fitting is required to install hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation or application of surface protection with finishing work specified in the Division 09 Sections. Do not install surface-mounted items until finishes have been completed on the substrates involved.

C. Set units level, plumb, and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.

D. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.

E. Set thresholds for exterior doors in full bed of elastomeric sealant complying with requirements specified in Division 07 Section "Joint Sealers."

F. Weatherstripping and Seals: Comply with manufacturer's instructions and recommendations to the extent installation requirements are not otherwise indicated.

3.2 ADJUSTING, CLEANING, AND DEMONSTRATING

A. Adjust and check each operating item of hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate freely and smoothly or as intended for the application made.

1. Where door hardware is installed more than one month prior to acceptance or occupancy of a space or area, return to the installation during the week prior to acceptance or occupancy and make final check and adjustment of all hardware items in such space or area. Clean operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices to compensate for final operation of heating and ventilating equipment.

B. Clean adjacent surfaces soiled by hardware installation.

C. Instruct Owner's personnel in the proper adjustment and maintenance of door hardware and hardware finishes.

D. Six-Month Adjustment: Approximately six months after the date of Substantial Completion, the Installer, accompanied by representatives of the manufacturers of latchsets and locksets and of door control devices, and of other major hardware suppliers, shall return to the Project to perform the following work:

1. Examine and re-adjust each item of door hardware as necessary to restore function of doors and hardware to comply with specified requirements.
2. Consult with and instruct Owner's personnel in recommended additions to the maintenance procedures.
3. Replace hardware items that have deteriorated or failed due to faulty design, materials, or installation of hardware units.
4. Prepare a written report of current and predictable problems (of substantial nature) in the performance of the hardware.

3.3 PRELIMINARY HARDWARE SCHEDULE

A. **** * * NOT YET DETERMINED * * ****

END OF SECTION 08 71 00

SECTION 088100 - GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:

1. Stainless-Steel- Framed storefronts.

1.3 DEFINITIONS

A. Manufacturer: A firm that produces primary glass or fabricated glass as defined in referenced glazing publications.

B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.

C. Deterioration of Laminated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

1.4 COORDINATION

A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.5 ACTION SUBMITTALS

A. Product Data: For each glass product and glazing material indicated.

B. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

1.6 INFORMATIONAL SUBMITTALS

A. Product Certificates: Signed by manufacturers of glass and glazing products certifying that products furnished comply with requirements.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed glazing similar in material, design, and extent to that indicated for Project and whose work has resulted in construction with a record of successful in-service performance.

B. Source Limitations for Glass: Obtain each scheduled Glass Type from a single manufacturer.

C. Source Limitations for Glazing Accessories: Obtain glazing accessories from one source for each product and installation method indicated.

D. Safety Glass: Category II materials complying with testing requirements in 16 CFR 1201 and ANSI Z97.1.

1. Subject to compliance with requirements, permanently mark safety glass with certification label of Safety Glazing Certification Council or another certification agency acceptable to authorities having jurisdiction.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials according to manufacturer's written instructions and as needed to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
   1. Do not install liquid glazing sealants when ambient and substrate temperature conditions are outside limits permitted by glazing sealant manufacturer or below 40 deg F (4.4 deg C).

1.10 WARRANTY

A. General Warranty: Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Manufacturer's Special Warranty on Laminated Glass: Manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

   1. Warranty Period: 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Glass Design: Glass thicknesses indicated are minimums and are for detailing only. Determine glass thicknesses by analyzing Project loads and in-service conditions in accordance with the IBC and ASTM E 1300. Provide glass lites for various size

openings in nominal thicknesses indicated, but not less than thicknesses and in strengths (annealed or heat treated) required to meet or exceed the following criteria:

1. Design Wind Loads: As indicated on the Drawings.
2. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch (25 mm), whichever is less.
3. Differential Shading: Design glass to resist thermal stresses induced by differential shading within individual glass lites.

C. Windborne-Debris-Impact-Resistance Performance: Exterior glazing shall comply with basic-protection testing requirements in ASTM E 1996 for Wind Zone 3 when tested according to ASTM E 1886. Test specimens shall be no smaller in width and length than glazing indicated for use on Project and shall be installed in same manner as glazing indicated for use on Project.

1. Large-Missile Impact: For openings located within 30 feet (9.1 m) of grade.
2. Small-Missile Impact: For openings located more than 30 feet (9.1 m) above grade.

D. Safety Glass: At locations indicated below and at other locations as indicated on the Drawings, provide Safety Glass complying with Quality Assurance article of this Section.

1. Glazed panels in fixed and operating doors.
2. Glazed panels within 24 inch radius of the edge of any door, measured in the closed position, and with the lower edge of the glazed panel less than 60" above the floor at the door.
3. Glazing in a fixed or operating panel, other than those locations described in 1 and 2 above, that meets the following criteria:

    a. Exposed area of the individual pane is greater than 9 square feet; and
    b. Bottom edge of the individual pane is less than 18" above the floor; and
    c. Top edge of the individual pane is greater than 36" above the floor; and
    d. There is one or more walking surfaces within 36" of the plane of the glazing, measured horizontally and in a straight line .

2.2 GLASS PRODUCTS, GENERAL

A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in

referenced standards.

1. GANA Publications: "Laminated Glazing Reference Manual" and "Glazing Manual."

B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

C. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than the thickness indicated.

1. Minimum Glass Thickness for Exterior Lites: Not less than 6 mm, except that thickness of individual glass panes in laminated glass shall not be less than 3 mm.

2.3 MONOLITHIC GLASS

A. Clear Annealed Float Glass: ASTM C 1036, Type I, Class 1 (clear), Quality-Q3.

2.4 LAMINATED GLASS

A. Standard Laminated Glass: ASTM C 1172, and complying with other requirements specified. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.

1. Laminate glass with ionoplast interlayer to comply with interlayer manufacturer's written recommendations.
2. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
3. Interlayer Color: Clear, all plys.

2.5 PATTERNED GLASS

A. Patterned Glass: ASTM C 1048, Type II (patterned glass, flat), Class 1 (clear), Form 3 (patterned), Quality q8 (glazing), Finish f1 (patterned one side); of pattern indicated in the Patterned-Glass Schedule at the end of Part 3.

2.6 ELASTOMERIC GLAZING SEALANTS

A. General: Provide products of type indicated, complying with the following requirements:

1. Compatibility: Select glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
3. VOC Content: For sealants used inside of the weatherproofing system, not more than 250 g/L when calculated according to 40 CFR 59, Subpart D.
4. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range for this characteristic.

B. Elastomeric Glazing Sealant Standard: Comply with ASTM C 920.

2.7 GLAZING GASKETS

A. Dense Compression Gaskets: Molded or extruded gaskets of material indicated below, complying with standards referenced with name of elastomer indicated below, and of profile and hardness required to maintain watertight seal:

1. EPDM, ASTM C 864.
2. Silicone, ASTM C 1115.

B. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned gaskets of material indicated below; complying with ASTM C 509, Type II, black; and of profile and hardness required to maintain watertight seal:

1. EPDM.
2. Silicone.

2.8 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted

in installation.

B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

C. Setting Blocks: Elastomeric material with a Shore A durometer hardness of 85, plus or minus 5.

D. Spacers: Elastomeric blocks or continuous extrusions with a Shore A durometer hardness required by glass manufacturer to maintain glass lites in place for installation indicated.

E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

F. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

2.9 FABRICATION OF GLASS AND OTHER GLAZING PRODUCTS

A. Fabricate glass and other glazing products in sizes required to glaze openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing standard, to comply with system performance requirements.

1. Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.

a. Temperature Change (Range): 140 deg F (78 deg C), ambient; 200 deg F (111 deg C), material surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine framing glazing, with Installer present, for compliance with the following:

1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.

2. Presence and functioning of weep system.
3. Minimum required face or edge clearances.
4. Effective sealing between joints of glass-framing members.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that leave visible marks in the completed Work.

3.3 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Glazing channel dimensions, as indicated on Drawings, provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by Project conditions during installation.

C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.

D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction sealant-substrate testing.

E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

G. Provide spacers for glass lites where the length plus width is larger than 50 inches (1270 mm) as follows:

1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
2. Provide 1/8-inch (3-mm) minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.

I. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

J. Set glass lites with proper orientation so that coatings face exterior or interior as specified.

K. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

L. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 GASKET GLAZING (DRY)

A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

E. Install gaskets so they protrude past face of glazing stops.

3.5 CLEANING AND PROTECTION

A. Immediately after installation remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.

1. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.

C. Remove and replace glass that is damaged during construction period.

D. Wash glass on both exposed surfaces not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

3.6 GLASS SCHEDULE

A. Glass Type G-1: Where glass of this designation is indicated, provide clear 2-ply laminated annealed glass complying with the following:

1. Overall Unit Thickness and Thickness of Each Ply: 1/4" (nominal) and 3mm.
2. Interlayer Thickness: 60 mils.
3. Inboard and Outboard Plys: Type I (transparent glass, flat), Class 1 (clear) float glass; Condition A (uncoated surfaces).

B. Glass Type G-2: Where glass of this designation is indicated, provide patterned 2-ply laminated annealed glass, geometric pattern p2, complying with the following:

1. Overall Unit Thickness: 9/16" (nominal).
2. Interlayer Thickness: 60 mils.
3. Outboard Ply: Type I (transparent glass, flat), Class 1 (clear) float glass; Condition A (uncoated surfaces); 3mm thick.
4. Inboard Ply: Type II (patterned flat glass), Class 1 (clear), Form 3 (patterned) float glass; Condition A (uncoated surfaces), with pattern on #4 face.

    a. Basis-of-Design Product: The design this Glass Type is based on the product listed below. Subject to compliance with requirements, products that may be incorporated into the Work include the following or Comparable Product:

        1) "Industrex," AFG Industries, Inc.
        2) Thickness: 5/32-inch.

END OF SECTION 088100

SECTION 099100 - PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Surface preparation and field painting of specific building materials and components as indicated in this Section and as noted on the Drawings.

    a. Surface preparation, priming, touch-up priming, and finish coats specified in this Section are in addition to shop priming and surface treatment specified in other Sections.
    b. Paint colors shall match color selections provided by the Architect.

2. Shop primer for structural steel.

B. Painting is not required on finished surfaces, concealed surfaces, operating parts, and labels.

1. Finished surfaces not to be painted include, but are not limited to, the following:

    a. Hot-dip galvanized steel.

2. Except for shop priming of structural steel, surfaces in the following concealed or generally inaccessible areas are not required to be painted:

    a. Furred areas.
    b. Pipe spaces.
    c. Duct shafts.

3. Operating parts not to be painted include moving parts of operating equipment such as the following:

    a. Valve and damper operators.
    b. Linkages.

c. Sensing devices.
d. Motor and fan shafts.

4. Labels: Do not paint over Underwriter's Laboratories, Factory Mutual or other code-required labels, or over piping, duct or conduit identification labels, or over equipment name, identification, performance rating, or nomenclature plates.

C. Related Sections: The following Sections contain requirements that relate to this section:

1. Division 05 Section "Structural Steel" for surface preparation and shop priming of structural steel.

1.3 DEFINITIONS

A. "Paint" includes all coating systems materials, primers, emulsions, enamels, stains, sealers, fillers, and other applied materials whether used as prime, intermediate, or finish coats.

B. Gloss Levels:

1. Gloss Level 1 (Flat): Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.
2. Gloss Level 2 (Matte): Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
3. Gloss Level 3 (Eggshell): 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
4. Gloss Level 4 (Satin): 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.
5. Gloss Level 5 (Semi-Gloss): 35 to 70 units at 60 degrees, according to ASTM D 523.
6. Gloss Level 6 (Gloss): 70 to 85 units at 60 degrees, according to ASTM D 523.

1.4 SUBMITTALS

A. Product Data: Manufacturer's technical information, label analysis, and application instructions for each material proposed for use.

1. List each material and cross-reference the specific coating and finish system and application. Identify each material by the manufacturer's catalog number and general classification.

B. Samples for initial color selection in the form of manufacturer's color charts.

C. Samples for verification purposes: Provide samples of each color and material to be applied, with texture to simulate actual conditions, on representative samples of the actual substrate. Define each separate coat, including block fillers and primers. Use representative colors when preparing samples for review. Resubmit until required sheen, color, and texture are achieved.

1. Provide a list of material and application for each coat of each sample. Label each sample as to location and application.
2. Submit samples on the following substrates for the Architect's review of color and texture only:

a. Concrete: Provide two 8- by 8-inch samples on 5/8" gypsum wallboard for each color and finish.
b. Ferrous Metal: Provide two 4-inch-square samples for each color and finish.

1.5 QUALITY ASSURANCE

A. Coordination of Work: Review other Sections in which primers are provided to ensure compatibility of the total systems for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.

1. Notify the Architect of problems anticipated using the materials specified.

B. Field Samples: On wall surfaces and other exterior components, duplicate finishes of prepared samples. Provide full-coat finish samples on at least 100 sq. ft. of surface until required sheen, color and texture are obtained; simulate finished lighting conditions for review of in-place work.

1. Final acceptance of colors will be from job-applied samples.
2. The Architect will select one room or surface to represent surfaces and conditions for each type of coating and substrate to be painted. Apply coatings in this room or surface in accordance with the schedule or as specified. After finishes are accepted, this room or surface will be used for evaluation of coating systems of a similar nature.

C. Material Identification: Paint material containers shall display manufacturer's product identification label(s); unlabeled containers shall not be used.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the job site in the manufacturer's original, unopened packages and containers bearing manufacturer's name and label and the following information:
1. Product name or title of material.

2. Product description (generic classification or binder type).
3. Federal Specification number, if applicable.
4. Manufacturer's stock number and date of manufacture.
5. Contents by volume, for pigment and vehicle constituents.
6. Thinning instructions.
7. Application instructions.
8. Color name and number.

B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 deg F (7 deg C). Maintain containers used in storage in a clean condition, free of foreign materials and residue.

1. Protect from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing, and application.

1.7 JOB CONDITIONS

A. General: Except where more stringent requirements are indicated below, comply with paint manufacturers' recommendations regarding acceptable environmental conditions for application and curing of paints.

1. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).
2. Do not apply paint in snow, rain, fog, or mist, when the relative humidity exceeds 85 percent, at temperatures less than 5 deg F (3 deg C) above the dew point, or to damp or wet surfaces.
3. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by the manufacturer during application and drying periods.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include the following:

1. Benjamin Moore and Co. (Moore)
2. The Sherwin-Williams Company (S-W)
3. Tnemec Co., Inc. (Tnemec)

2.2 PAINT, GENERAL

A. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

B. Colors: Provide color and gloss selections made by the Architect.

2.3 PAINT PRODUCTS

A. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include the following or Equal Products:

B. Structural Steel Shop Primer: Modified aromatic polyurethane primer.

1. Tnemec: Series 1 Omnithane

C. Structural Steel Spot Primer: Modified aromatic polyurethane primer.

1. Tnemec: Series 1 Omnithane

D. Galvanized Structural Steel Primer: Self-crosslinking hydrophobic acrylic primer.

1. Tnemec: Series 115 Unibond.

E. General Purpose Metal Primer: Water based, emulsion type, anti-corrosive primer.

1. Moore: Ultra Spec HP Acrylic Metal Primer.
2. S-W: Pro Industrial Pro-Cryl Universal Acrylic Primer.

F. High Performance Metal Paint: HDP acrylic polymer.

1. Tnemec: Series 1029 Enduratone.

G. General-Purpose Metal Paint: Water based, corrosion resistant acrylic coating, gloss finish.

1. Moore: Ultra Spec HP D.T.M. Acrylic Gloss Enamel.

2. S-W: Pro Industrial DTM Acrylic Gloss.

H. Concrete Stain: 100% acrylic polymer.

1. Tnemec: Chemprobe Confotmal Stain WB, Series 617.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions under which painting will be performed for compliance with requirements for application of paint. Do not begin paint application until unsatisfactory conditions have been corrected.

1. Start of painting will be construed as the Applicator's acceptance of surfaces and conditions within a particular area.

3.2 PREPARATION

A. General Procedures: Remove hardware and hardware accessories, plates, signs, machined surfaces, lighting fixtures, and similar items in place that are not to be painted, or provide surface-applied protection prior to surface preparation and painting. Remove these items if necessary for complete painting of the items and adjacent surfaces. Following completion of painting operations in each space or area, have items reinstalled by workers skilled in the trades involved, except do not reinstall signs when so directed by the Architect.

1. Clean surfaces before applying paint or surface treatments. Remove oil and grease prior to cleaning. Schedule cleaning and painting so that dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.

B. Surface Preparation: Clean and prepare surfaces to be painted in accordance with the manufacturer's instructions for each particular substrate condition and as specified.

1. Provide barrier coats over incompatible primers or remove and reprime. Notify Architect in writing of problems anticipated with using the specified finish-coat material with substrates primed by others.
2. Ferrous Metals, Non-Galvanized: Spot power tool clean all failed areas in accordance with SSPC-SP3.C-SP3. Feather-edge the remaining intact coatings with the failed areas to create a smooth transition, clean with solvents recommended by primer manufacturer, and touch up with the same primer as the shop coat.
3. Ferrous Metals, Galvanized: Remove all soluble and insoluble contaminants and corrosion. Remove any storage stains per Section 6.2 of ASTM D6386.

Chemically treat with etching surfacer in accordance with manufacturer's instructions; ensure that all surfaces have been effectively and uniformly treated.

a. Subject to compliance with requirements, products that may be incorporated into the Work include the following or Equal Product:

1) Great Lakes Laboratories "Clean 'n Etch"
2) Henkel “Galvaprep 5"

C. Materials Preparation: Carefully mix and prepare paint materials in accordance with manufacturer's directions.

1. Maintain containers used in mixing and application of paint in a clean condition, free of foreign materials and residue.
2. Stir material before application to produce a mixture of uniform density; stir as required during application. Do not stir surface film into material. Remove film and, if necessary, strain material before using.
3. Use only thinners approved by the paint manufacturer, and only within recommended limits.

D. Tinting: Tint each undercoat a lighter shade to facilitate identification of each coat where multiple coats of the same material are applied. Tint undercoats to match the color of the finish coat, but provide sufficient differences in shade of undercoats to distinguish each separate coat.

3.3 APPLICATION

A. General: Apply paint in accordance with manufacturer's instructions and to recommendations in "MPI Manual." Use applicators and techniques best suited for substrate and type of material being applied. Give special attention to ensure that surfaces, including edges, corners, crevices, welds and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces. All parts of mouldings and ornaments shall be left clean and true to details, without undue amount of paint left in corners and depressions. Make edges of paint adjoining other materials or colors sharp and clean, without overlapping.

1. Do not paint over Underwriter's Laboratories, Factory Mutual or other code-required labels, or over piping, duct or conduit identification labels, or over equipment name, identification, performance rating, or nomenclature plates.
2. Paint systems are indicated in paint schedules at end of this Section.
3. Omit primer on metal surfaces that have been shop-primed and touch up painted.
4. Provide finish coats that are compatible with primers used.
5. The number of coats and film thickness required is the same regardless of the application method. Do not apply succeeding coats until the previous coat has

cured as recommended by the manufacturer. Sand between applications where sanding is required to produce an even smooth surface in accordance with the manufacturer's directions.

6. The number of coats specified in each paint system are the minimum number which will provide satisfactory results. Apply additional coats when undercoats, stains, or other conditions show through final coat of paint until paint film is of uniform finish, color, and appearance.
7. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, grilles, suspend ceilings, and similar components are in place. Extend coatings in these areas as required to maintain the system integrity and provide desired protection.
8. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces.
9. Paint surfaces behind permanently fixed equipment or furniture with prime coat only before final installation of equipment.
10. Paint interior surfaces of ducts, where visible through registers or grilles, with a flat, nonspecular black paint.
11. Paint panels used to close off back side of louvered openings, where visible through louvers, with a flat, nonspecular black paint.
12. Paint back sides of access panels and removable or hinged covers to match exposed surfaces.
13. Finish exterior doors on tops, bottoms, and side edges same as exterior faces.
14. Sand lightly between each succeeding enamel coat.

B. Paint Colors: Paint colors shall be as selected by the Architect for each area and surface within that area.

C. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.

1. Allow sufficient time between successive coats to permit proper drying. Do not recoat until paint has dried to where it feels firm, and does not deform or feel sticky under moderate thumb pressure and where application of another coat of paint does not cause lifting or loss of adhesion of the undercoat.

D. Minimum Coating Thickness: Apply materials at not less than the manufacturer's recommended spreading rate. Provide a total dry film thickness of the entire system as recommended by the manufacturer.

E. Prime Coats: Before application of finish coats, apply a prime coat of material as recommended by the manufacturer to material that is required to be painted or finished and has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to assure a finish coat with no burn through or other defects due to insufficient sealing.

F. Pigmented (Opaque) Finishes: Completely cover to provide an opaque, smooth surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.

G. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not in compliance with specified requirements. Where a portion of the finish is damaged or otherwise unsatisfactory, refinish the entire plane; spot finish repairs will not be acceptable.

3.4 CLEANING

A. Cleanup: At the end of each work day, remove empty cans, rags, rubbish, and other discarded paint materials from the site.

B. Upon completion of painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping, using care not to scratch or damage adjacent finished surfaces.

3.5 PROTECTION

A. Protect work of other trades, whether to be painted or not, against damage by painting. Correct damage by cleaning, repairing or replacing, and repainting, as acceptable to the Architect.

B. Provide "wet paint" signs to protect newly painted finishes. Remove temporary protective wrappings provided by others for protection of their work after completion of painting operations.

1. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces. Comply with procedures specified in PDCA P1.

3.6 PAINT SCHEDULE

A. General: Provide the following paint systems for the various substrates indicated. Dry film thickness for each coat shall be as recommended by the coating manufacturer.

B. Structural Steel, Shop Primed: Semi-gloss finish; 1 intermediate coat and 1 topcoat over shop primer.

1. Intermediate Coat: High Performance Intermediate Primer.

2. Top Coat: High Performance Metal Paint.

C. Structural Steel, Galvanized: Semi-gloss finish; 1 primer coat and 1 topcoat.

1. Primer: Galvanized Structural Steel Primer.
2. Top Coat: High Performance Metal Paint.

D. Pipe and Pipe Fittings; Electrical Conduit and Accessories: Gloss finish; 2 top coats over primer coat.

1. Primer: General Purpose Metal Primer.
2. First and Second Top Coats: General Purpose Metal Paint.

E. Concrete: Penetrating stain; 2 coats.

1. First and Second Coats: Concrete Stain.

END OF SECTION 099100

SECTION 101400 - SIGNAGE

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, tools, equipment, and incidentals as shown, specified, and required to furnish and install signage.
   2. Extent of signage is shown and specified.
   3. Types of products required include the following:

      a. Room identification, information, entry and directional signs.
      c. Health, safety, warning, and fire extinguisher location signs.
      d. Cast metal dedication plaque.
      e. Exterior building identification signs.
      f. Site entry, directional and information signs.
      g. Individual dimensional letters and numbers.
      h. Stainless steel fasteners, supports, very-high-bond high-performance mounting tape, primers and other accessories.

B. Coordination:
   1. Coordinate adhesives and fasteners with mounting surfaces. Review other Sections to ensure compatibility of signage mounting accessories with various surfaces on which signage will be installed.
   2. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before signage Work.

C. Related Sections:
   1. Section 03 30 00, Cast-In-Place Concrete.
   2. Section 09 91 00, Painting.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. AA DSA-45, Designation System for Aluminum Finishes.
   2. ANSI Z535.2, Environmental and Facility Safety Signs.
   3. ASTM B26/B26M, Specification for Aluminum-Alloy Sand Castings.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Signage Manufacturers:
   a. Engage firms specializing in producing types of products specified, in compliance with the Contract Documents, with documented record of successful in-service performance, and that possess sufficient production capacity to avoid delaying the Work.
   b. Submit to ENGINEER name and experience record of manufacturers.

B. Component Supply and Compatibility:
   1. Obtain each separate type of signage from a single Supplier and from a single manufacturer.

C. Regulatory Requirements: Comply with applicable requirements of the following:
   1. OSHA, 29 CFR Part 1910.1200, Hazard Communication Standard.
   2. OSHA, 29 CFR Part 1910, Subpart Z, Toxic and Hazardous Substances.
   3. OSHA, 29 CFR Part 1910.144, Safety Color Code for Marking Physical Hazards.
   4. OSHA, 29 CFR Part 1910. 145, Specification for Accident Prevention Signs and Tags.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Schedule of all signage required for the Work, indicating signage type location, and other information to demonstrate compliance with the Contract Documents.
      b. Fabrication and erection information for each type of signage
      c. Complete, camera-ready, color graphic layouts of custom- designed signs based on specified requirements and manufacturer recommendations.
      e Complete selection of each specified manufacturer's standard and custom graphic layouts and pictograms, colors, and alphabetic/text styles.
      f. Full-size graphic layout drawings for plaques, individual dimensional letters and numbers, and other items where final graphic appearance is necessary prior to signage fabrication, incorporating all required graphic features specified or shown.
      g. Mounting and Installation Data:
         1) Drawings of and information on anchorages and accessory items.
         2) Submit location template drawings for items supported or anchored to permanent construction.

3) Coordinate mounting position, method, and proposed mounting accessories and fasteners with actual Project conditions. Indicate required mounting accessories on plan drawings showing locations of required exit signs based on measurements taken at the Site. Show final location and identify type of mounting surface for each exit sign. Coordinate location of exit signs for non-interference with other Work and as required by authorities having jurisdiction.

2. Product Data:
   a. Copies of manufacturer's technical data, including catalog information and specifications, for each product specified.
3. Samples:
   a. Each color and finish of exposed materials and accessories required for signage.
   b. Sample Signage:
      1) Full-size representative sample of each individual-type letter and number specified, demonstrating alphabetic style/text type, material, color and finish specified.
   c. ENGINEER's review of Samples will be for color and texture only. Compliance with other requirements is CONTRACTOR's responsibility.

B. Informational Submittals: Submit the following:
   1. Manufacturer's Instructions:
      a. Templates for anchorages to be installed in concrete or masonry.
      b. Manufacturer's instructions and recommendations for support and foundations of signs installed outdoors.

C. Closeout Submittals: Submit the following:
   1. Warranty Documentation:
      a. General and special warranties required under this Section.

1.5 WARRANTY

A. General Warranty: The special warranty specified for each type of sign in this Article shall not deprive OWNER of other rights or remedies OWNER may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by CONTRACTOR under the Contract Documents. The obligations of CONTRACTOR under the Contract Documents shall not be limited in any way by the provisions of the specified special warranty.

B. Special Warranty on Products:
   1. Provide each signage manufacturer's written warranty, running to the benefit of OWNER, agreeing to correct, or at option of OWNER, remove or replace

materials specified in this Section found to be defective during a period of five years after the date of Substantial Completion.

2. Special warranty shall cover defective Work that includes, but is not limited to, the following:
   a. Deterioration of metal and polymer finishes beyond normal weathering.
   b. Deterioration of embedded graphic image colors and sign lamination.

PART 2 – PRODUCTS

2.1 SYSTEM PERFORMANCE

A. General:
   1. Details shown or indicated for signage, such as alpha-numeric and text type representation, letter spacing, designs of borders, and other graphic features, are generic and intended only to establish text, general positions, and symbols.
   2. Colors shall be brilliant, distinctive shades, matching the safety colors specified in ANSI Z535.1 and OSHA 1910.144.

2.2 PANEL SIGNS – ROOM IDENTIFICATION, INFORMATION, ENTRY, AND DIRECTIONAL

A. Products and Manufacturers: Provide one of the following:
   1. Graphic Blast MP and FG ADA System and Custom Design ADA Series, by Best Sign Systems, Inc.
   2. Blast Etched Fiberglass and Blast Etched Melamine Signs, by **Visigraph** Corporation.
   3. Or equal.

B. Panel Signs – Room Identification, Information, Entry, and Directional:
   1. Materials:
      a. Interior Signs: Three-ply, self-extinguishing melamine plastic.
      b. Exterior Signs: One-piece fiberglass.
   2. Size and Thickness: 0.125-inch thick; eight inches by eight inches with 1/2-inch radiused corners.

2.3 PANEL SIGNS – HEALTH, SAFETY, WARNING, FLOOR LOADING, AND FIRE EXTINGUISHER LOCATION

A. Product Description: Provide rigid fiberglass reinforced plastic signs with fade-resistant embedded graphics.

B. Products and Manufacturers: Provide one of the following:
   1. Graphic Blast Word and Picture Series, by Best Sign Systems, Inc.
   2. Blast Etched Fiberglass Signs, by Visigraph Corporation.
   3. Or equal.

C. General:
   1. Size and Thickness: 0.125-inch thick; 10 inches by 14 inches, unless otherwise shown or indicated.

D. Safety Instruction Signs: Standard color of sign background shall be white; panel shall be green with white letters and numbers. Letters and numbers used against white background shall be black.

E. Caution Signs: Standard color of sign background shall be yellow; panel shall be black with yellow letters and numbers.

F. Danger Signs: Standard color of sign background shall be white; panel shall be black with red insert with white letters and numbers. Letters and numbers used against white background shall be black.

G. Warning Signs: Standard color of sign background shall be orange; panel shall be black with orange insert with black letters and numbers. Letters and numbers used against orange background shall be black.

H. No Smoking Signs: Standard color of sign background shall be white. Letters and numbers used against white background shall be red.

I. Fire Extinguisher Location Signs (surface-mounted units only): Standard color of sign background shall be red with white letters and numbers. Each sign shall include international fire extinguisher pictogram and directional arrow indicating location of fire extinguisher.

L. Auxiliary Products:
   1. Mounting Brackets: Provide sign manufacturer's standard mounting brackets for installing projected or double-sided signs.

2.4 CAST METAL DEDICATION PLAQUES

A. Provide cast metal plaques free from pits, scale, sand holes or other defects. Provide hand-tooled and buffed borders with raised copy to produce plaque manufacturer's standard satin polished finishes.

B. Products and Manufacturers: Provide one of the following:
   1. Cast bronze Dedication Plaque, by Show and Tell Products.
   2. Cast bronze Dedication Plaque, by the Southwell Company.
   3. Or equal.

C. Cast bronze, copper alloy UNSC83600 complying with ASTM B584 and as designated by ASTM E527; two feet wide by 2.5 feet high, with (--1--) alphabet and with dark statuary bronze CDA-M31C5506x finish produced using aqueous sulfide conversion chemical.

D. In general, four sizes of letters shall be used to provide a symmetrical, well-spaced tablet. Letter sizes shall be generally as follows:
   1. Municipality and Date: 7/8-inch.
   2. Site or Facility Name: 1/2-inch.
   3. Individual Names and Companies: 7/16-inch.
   4. Title and Cities: 5/16-inch.

E. Layout: General arrangement for cast metal dedication plaque is indicated below. In plaque layout submittal and plaques provided for the Project, replace bracketed text below with the required names and information.

LAYOUT TO BE DETERMINED

F. Mechanical Finish and Design: Provide plaque with raised, flat borders with fine, satin directionally-textured finish. Field background shall be uniform stipple finish.

G. Mounting and Fasteners: Plaque shall be flush-mounted; with concealed mounting with stainless steel threaded studs set in epoxy adhesive.

H. Protective Coating: Provide with two coats of manufacturer's clear, methyl methacrylate monomer air-dried protective coating system with dry film thickness of not less than 1.0 mil.

2.5 PANEL SIGNS – EXTERIOR BUILDING IDENTIFICATION

A. Products and Manufacturers: Provide one of the following:
   1. Graphic Blast Wall Mounted Signs, by Best Manufacturing Sign Systems, Inc.
   2. Blast Etched Fiberglass Exterior Signs by **Visigraph** Corporation.
   3. Or equal.

B. Material: Provide surface-etched lettering and pictograms, sandblasted on an opaque three-ply laminate of 1/4-inch thick flat three-ply glass-reinforced resin sheet with non-glare surface and contrasting color core suitable for continuous operating temperatures of 190 degrees F.

C. Alphabet and Graphics: Provide four-inch high [text style to be determined] alphabet; upper and lower case letters and matching arrow type face.

D. Provide opaque white letters on opaque [color to be determined] background with concealed, flush-mounted fasteners at each corner. Provide 1 sign each 15 inches by 15 inches with 1/8-inch radiused corners.

2.6 INDIVIDUAL DIMENSIONAL CAST CHARACTERS

A. Provide individual cast metal letters and numbers with smooth, flat faces, sharp corners, true lines, and accurate profiles.

B. Products and Manufacturers: Provide one of the following:
   1. Cast Bronze Individual Letters and Numbers, by Gemini, Inc.
   2. Cast Bronze Individual Letters and Numbers, by Visigraph Corporation.
   3. Or equal.

C. Material:

1. Bronze, Copper Development Association Designation Alloy, UNSC83450; 88 percent copper, 2.5 percent tin, two percent lead, 6.5 percent zinc and one percent nickel, in accordance with ASTM E527; with dark statuary bronze oxidized CDA-M31C5506x finish produced using aqueous sulfide conversion chemical.
2. Provide letters and numbers with both faces and edges with satin finish.
3. Provide integral cast lugs in the back of letters and numbers and tap to receive threaded mounting studs.

D. Style and Height: Provide [height to be determined]-inch high, [depth to be determined]-inch deep [style to be determined] type face.

E. Mounting: Provide each letter and number with not less than two 4-inch long by 1/8-inch diameter threaded bronze studs.

F. Provide the following individual dimensional cast letters and numbers located where shown or indicated:
1. [text to be determined]

2.7 PANEL SIGNS – SITE ENTRY, DIRECTIONAL, AND INFORMATION

A. Products and Manufactures: Provide one of the following:
1. Series 820 Post and Panel Signs, by ASI Sign Systems, Inc.
2. Custom Post and Panel Signs, by Andco Industries Corporation.
3. Or equal.

B. Fiberglass sheets, not less than 1/8-inch thick, bonded to extruded aluminum internal structure, to form a seamless monolithic sign panel. Provide the following:
1. Posts: Four-inch diameter, 6063-T52 alloy extruded aluminum posts, notched to receive sign panel. Provide posts to height of six feet above finished grade and extending below ground to extent shown or indicated.
2. Finish: Two coats of colored polyurethane and one coat of clear polyurethane; factory-applied to posts and sign panels. Provide complete selection of manufacturer's standard and custom colors.
3. Graphics: Subsurface, photo-mechanically incorporated utilizing an integral graphic process.
4. Color: ENGINEER will select maximum of three colors, in addition to white and black. All colors and OWNER logo, in addition to white and black, will appear on each sign.
5. Letter Style: [style to be determined] with matching directional arrows.

2.8 AUXILIARY MATERIALS

A. Very-High-Bond High-Performance Bonding Tape:
   1. Provide all surface-mounted signage with very-high-bond foam tape backing except where specified as requiring mechanical fasteners.
   2. Products and Manufacturers: Provide one of the following:
      a. Scotch Brand (Very-High-Bond) 4942 VHB Double Coated Acrylic Foam Tape and No. 94 Acrylic Primer, by 3M Industrial Tape and Specialties Division.
      b. Or equal.
   3. Provide a very-high-bonding pressure sensitive joining system consisting of double-coated conformable acrylic foam tape and release liners.
   4. Thickness: 0.045-inch.
   5. Tape Width: 1.5 inches.
   6. Color: Dark gray.
   7. Bonding Adhesive: Acrylic; very-high-bond, solvent and shear resistance.
   8. Primer: High-performance tape manufacturers recommended acrylic primer.

B. Fasteners: Provide fasteners of non-magnetic stainless steel of size and type required and recommended by the associated individual signage manufacturer.

C. Anchors and Inserts: Provide nonferrous metal or hot-dipped galvanized anchors and inserts. Provide toothed stainless steel or lead expansion bolts for drilled-in-place anchors.

D. Mounting Brackets:
   1. Provide manufacturer's standard mounting brackets for each of the following sign types: hanging, projected, double-sided.
   2. Provide inserts, and mechanical and adhesive anchoring devices as specified in this Article for installation of signage.

2.9 FABRICATION

A. Shop Assembly:
   1. Fabricate and preassemble items in the shop to the greatest extent possible.
   2. Disassemble units only to extent necessary for shipping and handling limitations.
   3. Clearly mark units for reassembly and coordinated installation.

2.10 SOURCE QUALITY CONTROL

A. Fabrication Tolerances:

1. Produce smooth, even, level sign panel surfaces, constructed to remain flat under installed conditions within tolerance of plus or minus 1/16-inch measured diagonally across each sign.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine substrates and conditions under which signage will be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. General:
   1. Location:
      a. Install signage and appurtenances at the locations shown or indicated. When locations are not shown or indicated, install signage at locations directed by ENGINEER.
      b. Lightly mark and locate position of each sign. Obtain ENGINEER's acceptance of marked locations before mounting.
   2. Installation – General:
      a. Install signs level, plumb, and at proper height.
      b. Signage shall be securely mounted with concealed, very-high-bond acrylic foam tape, specified adhesives, or mechanical fasteners where specified. Attach signs to surfaces in accordance with sign manufacturer's instructions, unless otherwise shown or indicated.
      c. Provide very-high-bond acrylic foam tape on back of signage using a full perimeter of specified tape. Leave no gaps in tape perimeter at back of signage; peel off second release liner and press onto surfaces.
   3. Repair or replace damaged units.

B. Panel Signs – Room Identification, Directional, and Information Signs:
   1. Where permanent identification is provided for rooms and spaces, install signs on the wall adjacent to the latch side of the door.
   2. Where there is no wall space on the latch side of the door, including at double leaf doors, install signs on the nearest adjacent wall.
   3. Mounting height shall be in accordance with ADA-ABA Accessibility Guidelines in areas accessible to disabled people. For other areas install signs with five feethes from the finished floor to centerline of sign. Mount such

signage so that a person may approach within three inches of the sign without encountering protruding objects or, when reading sign, be forced to stand within the swing of a door.

C. Panel Signs – Site Entry, Directional, and Information Signs:
   1. Install posts to concrete footings in accordance with sign manufacturer's written instructions.
   2. Attach sign panels to posts in accordance with sign manufacturer's written instructions.

F. Cast Metal Dedication Plaques:
   1. Install plaques using standard fastening methods to comply with plaque manufacturer's instructions for type of wall surface on which plaque will be installed.
   2. Concealed Mounting: Install plaques by inserting threaded studs into tapped lugs on back of plaque. Set in pre-drilled holes filled with quick-setting cement.

G. Individual Dimensional Characters:
   1. Install characters using standard fastening methods to comply with manufacturer's written instructions for character form, type of mounting, wall construction, and condition of exposure indicated. Provide heavy paper template to establish character spacing and to locate holes for fasteners.
   2. Flush Mounting: Install characters with backs in contact with wall surface.

3.3 PROTECTION AND CLEANING

A. After installation, clean soiled signage surfaces in accordance with manufacturer's written instructions.

B. Protect signage from damage until completion of the Work.

END OF SECTION 101400

SECTION 10 44 00 - FIRE PROTECTION SPECIALTIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install all fire protection specialties Work.
   2. Extent of fire protection specialties Work is shown and specified.
   3. Types of fire protection specialties Work required includes:
      a. Dry chemical extinguishers.
      b. Carbon dioxide extinguishers.
      c. Mounting accessories and miscellaneous fasteners.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate installation of items that must be installed with or before fire protection specialties.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. UL Fire Classification Rating.

1.3 QUALITY ASSURANCE

A. Component Supply and Compatibility:
   1. Provide fire protection specialties products from one manufacturer.

B. Regulatory Requirements: Provide fire protection specialties approved and labeled by UL.

1.4 SUBMITTALS

A. Action Submittals:
   1. Product Data: Submit the following:
      a. Manufacturer's technical data, certification of UL rating, and installation instructions for fire protection specialties.

PART 2 - PRODUCTS

2.1 FIRE EXTINGUISHERS

A. General: Provide manufacturer's standard mounting brackets for portable fire extinguishers size as specified.

B. Multi-Purpose Dry Chemical Fire Extinguishers:
   1. Ten-pound capacity, enameled steel container with pressure-indicating gauge, for Class A, Class B, Class C fires, UL rating 4A-60 BC.
   2. Products and Manufacturers: Provide one of the following:
      a. Cosmic Model 10E by J.L. Industries.
      b. Or equal.

C. Carbon Dioxide Fire Extinguishers:
   1. Ten-pound enameled steel container capacity, for Class B and Class C fires UL rating.
   2. Products and Manufacturers: Provide one of the following:
      a. Sentinel Model 10 by J.L. Industries.
      b. Or equal.

2.2 ACCESSORIES

A. Mounting Brackets: Manufacturer's standard steel, designed to secure extinguisher, of sizes required for types and capacities of extinguishers indicated, with plated or baked-enamel finish.
   1. Provide mounting bracket for each extinguisher.

B. Identification: Provide lettering to comply with authorities having jurisdiction for letter style, color, size, spacing, and location.
   1. Identify bracket-mounted extinguishers not in cabinets with the words "FIRE EXTINGUISHER" in red letter decals applied to wall surface.
      a. Application Process: Die-cut vinyl.
      b. Lettering Color: Red.
      c. Orientation: Vertical.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine substrates and conditions under which fire protection specialties will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with Work until unsatisfactory conditions have been corrected in manner acceptable to ENGINEER.

3.2 INSTALLATION OF FIRE EXTINGUISHERS

A. When exact locations of fire protection specialties are not shown on Drawings, locate as directed by ENGINEER.

B. Securely fasten products to structure, square and plumb, per Supplier's instructions. Install extinguishers at locations and heights as shown on the Drawings, and as follows:
   1. Install fire extinguishers with gross weight less than 40 pounds with top of fire extinguisher no more than 4.0 feet above finished floor.
   2. Clearance between bottom of fire extinguisher and finished floor shall be at least four inches.

C. Recharge fire extinguishers provided under this Contract so that most recent inspection date coincides as nearly as possible with date of Substantial Completion. Inform OWNER in writing of next required inspection and recharging date.

3.3 FIRE EXTINGUISHER SCHEDULE

A. Type A – Dry chemical extinguisher, wall-mounted.

B. Type B – Carbon dioxide extinguisher, wall-mounted.

END OF SECTION 10 44 00

SECTION 23 05 29

HANGERS AND SUPPORTS FOR HVAC DUCTWORK, PIPING, AND EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, tools, equipment, and incidentals as shown, specified, and required to furnish and install hangers and supports complete with required appurtenances for HVAC ductwork, piping, and equipment.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the hangers and supports for HVAC ductwork, piping, and equipment Work.

C. Related Sections:
   1. Section 03 60 00, Grouting.
   2. Section 05 05 33, Anchor Systems.
   3. Section 05 50 13, Miscellaneous Metal Fabrications.

1.2 REFERENCES

A. American National Standards Institute (ANSI).
   1. ANSI B1.1 – Unified Inch Screw Threads (ASME B1.1).

B. American Society of Civil Engineers (ASCE).
   1. ASCE 7 – Minimum Design Loads for Buildings and Other Structures.

C. American Society for Testing and Materials (ASTM).
   1. ASTM A36/A36M – Standard Specification for Carbon Structural Steel.
   2. ASTM A47/A47M – Standard Specification for Ferritic Malleable Iron Castings.
   3. ASTM A123/A123M – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   4. ASTM A153/A153M – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   5. ASTM A307 – Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
   6. ASTM A575 – Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades.
   7. ASTM A668/A688M – Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use.

D. American Welding Society (AWS).
   1. AWS B2.1 – Specification for Welding Procedure and Performance Qualification.

E. Federal Specifications (FS).
   1. FS WW-H-171 – Hangers and Supports, Pipe.

F. Manufacturers Standardization Society (MSS).
   1. MSS SP 58 – Pipe Hangers and Supports-Materials, Design and Manufacture.
   2. MSS SP 69 – Pipe Hangers and Supports - Selection and Application.

G. National Fire Protection Association (NFPA).
   1. NFPA 90A – Standard for the Installation of Air-Conditioning and Ventilating Systems.

H. Sheet Metal and Air Conditioning Contractors National Association (SMACNA).
   1. HVAC Duct Construction Standards – Metal and Flexible.
   2. Seismic Restraint Manual: Guidelines for Mechanical Systems.
   3. Thermoset FRP Duct Construction Manual.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer:
      a. Minimum of five years of experience producing substantially similar equipment and able to show evidence of at least five installations in satisfactory operation for at least five years.
   2. Professional Engineer:
      a. Engage a registered professional engineer legally qualified to practice the State of New York and experienced in providing engineering services of the kind indicated.
      b. Submit qualifications data.
      c. Responsibilities include but are not necessarily limited to:
         1) Carefully reviewing system performance and design criteria stated in the Contract Documents.
         2) Preparing written requests for clarifications or interpretations of performance or design criteria for submittal to ENGINEER by CONTRACTOR.
         3) Preparing or supervising the preparation of design calculations and related drawings, Shop Drawings, testing plan development, test-result interpretation and a comprehensive engineering analysis verifying compliance of the system with the requirements of the Contract Documents.
         4) Signing and sealing all calculations and design drawings, and Shop Drawings.
         5) Certifying that:
            a) it has performed the design of the system in accordance with the performance and design criteria stated in the Contract Documents, and
            b) the said design conforms to all applicable local, state and federal codes, rules and regulations, and to the prevailing standards of practice.
   3. Installer:

a. Engage an experienced installer to perform the work of this Section who has specialized in installing hangers and supports for HVAC ductwork, piping, and equipment similar to that required for this Project and who is acceptable to manufacturer.
b. Submit name and qualifications to ENGINEER along with the following information on a minimum of three successful projects:
1) Names and telephone numbers of owners, architects or engineers responsible for projects.
2) Approximate contract cost of the hangers and supports for HVAC ductwork, piping, and equipment.
3) Amount of area installed.

4. Welding:
a. Qualify processes and operators in accordance with AWS B2.1 as appropriate for material to be welded.
b. Provide certification that operators employed on or to be employed for the Work have satisfactorily passed AWS qualification tests within previous 12 months. Ensure that all certifications are current.

B. Component Supply and Compatibility:
1. Obtain all equipment included in this Section regardless of the component manufacturer from a single hangers and supports for HVAC ductwork, piping, and equipment manufacturer.
2. Require the hangers and supports for HVAC ductwork, piping, and equipment manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall equipment assembly by the hangers and supports for HVAC ductwork, piping, and equipment manufacturer.

C. Regulatory Requirements:
1. International Building Code (IBC).
2. National Fire Protection Association (NFPA).
3. Local and State Building Codes and Ordinances.
4. Permits: CONTRACTOR shall obtain and pay for all required permits, fees and inspections.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
1. Shop Drawings:
a. Drawings showing fabrication methods, assembly, accessories, and installation details.
b. Setting drawings, templates, and directions for the installation of anchor bolts and other anchorages.
c. Drawings showing floor supported components and installation arrangement.
2. Product Data:
a. Manufacturer's literature, illustrations, specifications, weight, dimensions, required clearances, materials of construction, and performance data for all equipment.

b. Complete component list.
c. Detailed description of each component.
d. Catalog cut sheets for each component.
e. Deviations from Contract Documents. Any exceptions to the Contract Documents must be clearly defined. CONTRACTOR shall be responsible for any additional expenses that may occur due to any exception made.
f. Other technical data related to specified material and equipment as requested by ENGINEER.

3. Delegated Design Submittals:
   a. 1/4-inch scale HVAC ductwork, piping, and equipment layouts, dimensioned to show length of runs, with all expansion joints, alignment guides, anchors and appurtenances required for proper control of HVAC ductwork, piping, and equipment forces. The drawings shall include all forces acting on the HVAC ductwork, piping, and equipment and the corresponding reactions of the compensation and anchor devices provided.
   b. All drawings, design calculations, and a letter indicating that the hanger and support systems have been properly designed shall be signed and sealed by a registered professional engineer legally qualified to practice in the State of New York.

B. Informational Submittals: Submit the following:
1. Certificates:
   a. Independent certification reports.
2. Manufacturer Instructions:
   a. Instructions and recommendations for handling, storing, protecting the equipment.
   b. Installation Data.
3. Source Quality Control Submittals:
   a. Factory test reports.
4. Qualifications Statements:
   a. Manufacturer, when requested by ENGINEER.
   b. Professional Engineer, when requested by ENGINEER.
   c. Installer, when requested by ENGINEER.
   d. Welding, when requested by ENGINEER.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packing, Shipping, Handling, and Unloading:
1. Deliver materials to the Site to ensure uninterrupted progress of the Work.
2. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete, in ample time to prevent delay of that Work.
3. Comply with manufacturer's recommendations for rigging of equipment.

B. Storage and Protection:
1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.

2. Store all equipment in covered storage off the ground and prevent condensation and in accordance with the manufacturer's recommendations for long-term storage.

C. Acceptance at Site:
   1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if any loss or damage exists to equipment or components. Replace lost equipment or components and repair damage to new condition, in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Design Criteria:
   1. Designs generally accepted as exemplifying good engineering practice and using stock or production parts shall be utilized wherever possible.
   2. Accurate weight balance calculations shall be made to determine the required force at each hanger and support location and the weight load at each force concentration point.
   3. Hangers and supports shall be capable of supporting and restraining HVAC ductwork, piping, and equipment in all conditions of operation. They shall allow free expansion and contraction and prevent excessive stress resulting from transferred weight being induced into the HVAC ductwork, piping, and equipment.
   4. Hangers and supports shall be designed so that they cannot become disengaged by movements of the supported HVAC ductwork, piping, and equipment.
   5. Rod length shall be limited to a maximum length of eight linear feet.
   6. HVAC ductwork, piping, and equipment that cannot be hung by rod and hanger arrangement shall be floor or wall supported.
   7. All structural components shall be designed based on static and dynamic loads imposed by the supported HVAC ductwork, piping, and equipment and shall include a safety factor of 2 for the yield strength. Minimum angle sizes shall be 2-inch x 2-inch x1/4-inch.
   8. Load ratings, materials and installation shall be consistent with the recommendations from the latest edition of MSS SP 58, MSS SP 69, and FS WW-H-171.
   9. Hanger and support design calculations for all HVAC ductwork, piping, and equipment shall be signed and sealed by a registered professional engineer legally qualified to practice the State of New York.

2.2 MANUFACTURERS

A. Manufacturer: Provide product of one of the following:
   1. Erico International Corporation.
   2. Anvil International.
   3. Or equal.

2.3 DETAILS OF CONSTRUCTION

A. Materials:
   1. Hangers, supports, restraints, and appurtenances located in in the wet well shall be Type 316 stainless steel.
   2. Hangers, supports, restraints, and appurtenances located in the electrical room shall be hot dipped galvanized steel in accordance with ASTM A123/A123M and ASTM A153/A153M.
   3. Hangers, supports, restraints, and appurtenances located outdoors shall be Type 316 stainless steel.
   4. Steel used for the support of uninsulated copper piping or plastic piping shall be PVC coated.

B. Components of hangers and supports shall conform to the following:
   1. Bolts: ASTM A307, Grade A, unless otherwise specified below.
   2. Forgings: ASTM A668/A688M.
   3. Malleable Iron: ASTM A47/A47M.
   4. Rods and Bars: ASTM A575.
   5. Threads: Unified Screw Threads, Class 2A and 2B, ANSI B1.1.
   6. Structural Steel: ASTM A36/A36M.

C. Hanger Attachments: The following types of attachments shall be considered acceptable:
   1. Adjustable Steel Clevis: FS WW-H-171E, Type 1.
   2. Steel Double Bolt Pipe Clamp: FS WW-H-171E, Type 3.
   3. Steel Pipe Clamp: FS WW-H-171E, Type 4.
   4. Adjustable Swivel Pipe Ring: FS WW-H-171E, Type 6.
   5. Adjustable Steel Band Hanger: FS WW-H-171E, Type 7.
   6. Riser Clamp: FS WW-H-171E, Type 8.
   7. Light-Duty Clevis Hanger: FS WW-H-171E, Type 12.
   8. Long Clips: FS WW-H-171E, Type 26.
   9. Offset J-Hooks: FS WW-H-171E, Type 27.
   10. Steel Pipe Covering Protection Saddle: FS WW-H-171E, Type 40A.
   11. Insulation Protection Shield: FS WW-H-171E, Type 41.
   12. Pipe Saddle Support: FS WW-H-171E, Type 37.
   13. Pipe Stanchion Saddle: FS WW-H-171E, Type 38.
   14. Pipe Saddle Support with Base: FS WW-H-171E, Type 36.
   15. Adjustable Roller Hanger: FS WW-H-171E, Type 42.

D. Structural Attachments: The following types of attachments shall be considered acceptable:
   1. Side Beam Clamp: FS WW-H-171E, Type 20.
   2. Center I-Beam Clamp: FS WW-H-171E, Type 21.
   3. Welded Steel Bracket: FS WW-H-171E, Types 32 and 33.
   4. Side Beam Bracket: FS WW-H-171E, Type 35.

E. Hanger Rod Attachments: Use as required to complete assembly:
   1. Forged Steel Clevis: FS WW-H-171E, Type 14.
   2. Adjustable Turnbuckle: FS WW-H-171E, Type 15.

3. Forged Steel Welders Eye Nut: FS WW-H-171E, Type 17.

F. Concrete anchorage shall be provided in accordance with Section 05 05 33, Anchor Systems.

G. Miscellaneous metal fabrications shall be provided in accordance with Section 05 50 13, Miscellaneous Metal Fabrications.

2.4 SOURCE QUALITY CONTROL

A. Shop Tests:
   1. Equipment shall be completely manufactured and pre-assembled in accordance with Reference Standards. Perform the following tests and inspections at factory before shipment:
      a. Tested and inspected for approval as a unit by Underwriters Laboratories Inc., UL Label or equal.
      b. Factory test equipment to ensure that the entire package has been properly fabricated and assembled, that the package meets the specified performance requirements including manufacturer's data report.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine conditions under which materials and equipment will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

B. Take field measurements where required prior to installation to ensure proper fitting of Work.

3.2 PREPARATION

A. Surface Preparation:
   1. Attachment to hollow core slabs or double tee slabs shall be provided in accordance with details shown on the structural drawings to prevent damage to pre-stressing strands.

3.3 INSTALLATION

A. General:
   1. Install the equipment in accordance with the Contract Documents and by manufacturer's instructions and recommendations. Obtain written interpretation from ENGINEER in the event of conflict between manufacturer's instructions and recommendations and the Contract Documents.
   2. Install in accordance with Laws and Regulations.
   3. Do not modify structures to facilitate installation of equipment, unless approved in writing by ENGINEER.
   4. Installation to conform to requirements of all local and state codes.

B. Ductwork:
   1. The construction and installation of hangers and supports for ductwork shall conform to the recommendations given in the SMACNA HVAC Duct Construction Standards, the SMACNA Seismic Restraint Manual, and the SMACNA Thermoset FRP Duct Construction Manual, except as specified.
   2. Hanger rods shall have threaded ends.
   3. All ductwork shall be supported from trapeze type hangers. No sheet metal duct hangers or straps will be allowed.
   4. A pair of rods shall be provided at each duct support point.
   5. For nonmetal ductwork, there shall be not less than a 1/4-inch buildup of FRP over the duct at each support. Each support shall be furnished with a 1/8-inch thick Teflon sheet to shield the duct from the support.

C. Piping:
   1. Insulated pipes with vapor barriers shall have an insulation protection shield conforming to FS WW-H-171E, Type 41 tack-welded to hanger.
   2. Insulated pipes without vapor barriers shall have a steel protection saddle conforming to FS WW-H-171E, Type 40A.
   3. All uninsulated copper piping shall be supported by plastic coated steel pipe attachments.
   4. All piping shall be braced as required, to prevent sway in any direction.
   5. All insulated piping 3-inch diameter and larger shall be supported by roller hangers conforming to FS WW-H-171E, Type 42.
   6. Additional supports shall be placed immediately adjacent to any change in direction.
   7. Supports for Vertical Piping:
      a. Provide riser clamp placed under hub, fitting or coupling with approved solid bearing on steel sleeve at each floor level.
      b. Where riser clamps are used with plastic piping they shall be modified so as not to exert any compressive forces on the pipe.
      c. Support spacing shall not exceed code requirements.
   8. Allow clearances for expansion and contraction of piping.

D. Anchorages and Base Plates:
   1. Provide anchorages in new or existing concrete, as applicable, in accordance with equipment manufacturer's recommendations and the Contract Documents. Install anchors in accordance with Section 05 05 33, Anchor Systems.
   2. Where used, pour concrete bases up to one inch below equipment baseplate or support leg as applicable. Base with equipment mounted shall then be accurately shimmed to grade and spaces between filled with non-shrink grout in accordance with Section 03 60 00, Grouting. After grout has reached its initial set, exposed edges shall be neatly cut back 1/2 inch.

3.4 ADJUSTING

A. Adjust all equipment for proper settings.

3.5 CLEANING

A. Thoroughly clean all equipment and accessories prior to installation.

B. Remove all dirt, rust, dust, etc. from equipment and accessories after installation.

C. Remove and dispose of all debris and waste from the Site resulting from installation.

3.6 SCHEDULES

A. Hangers and Supports for Ductwork:
   1. Spacing:
      a. Ductwork shall be supported at distances not exceeding the spacing specified below:
         1) Metal Ductwork:
            a) Maximum Spacing: 10 feet.
         2) Flexible and Other Factory-Made Ductwork (such as FRP):
            a) Maximum Spacing: In accordance with the manufacturer's installation instructions.
   2. Hanger Rod Sizes:
      a. Hanger rods shall be sized based on static and dynamic loads imposed by the supported ductwork and shall include a safety factor of 2 for the yield strength.
      b. Rod load shall not exceed rod manufacturer's recommended capacity.

B. Hangers and Supports for Piping:
   1. Spacing:
      a. Piping shall be supported at distances not exceeding the spacing specified below or in accordance with MSS SP 58:
         1) Copper Tube:
            a) Maximum Horizontal Spacing: 6 feet.
            b) Maximum Vertical Spacing: 10 feet.
         2) Copper Pipe:
            a) Maximum Horizontal Spacing: 12 feet.
            b) Maximum Vertical Spacing: 10 feet.
         3) Steel Pipe:
            a) Maximum Horizontal Spacing: 12 feet.
            b) Maximum Vertical Spacing: 15 feet.
   2. Hanger Rod Sizes:
      a. Hanger rods shall be sized based on static and dynamic loads imposed by the supported piping and shall include a safety factor of 2 for the yield strength.
      b. Rod load shall not exceed rod manufacturer's recommended capacity.

C. Hangers and Supports for HVAC Equipment:
   1. Provide spacing and hanger rod sizes in accordance with equipment manufacturer's installation instructions.

+ + END OF SECTION + +

SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, tools, equipment, and incidentals as shown, specified, and required to perform the testing, adjusting, and balancing for HVAC as specified herein.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the testing, adjusting, and balancing for HVAC Work.

C. Related Sections:
   1. Section 10 14 00, Signage.

1.2 REFERENCES

A. Associated Air Balance Council (AABC).
   1. AABC National Standards for Total System Balance.

B. American National Standards Institute/American Industrial Hygiene Association (ANSI/AIHA).
   1. ANSI/AIHA Z9.5 – Laboratory Ventilation.

C. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).
   1. ASHRAE Handbook – Fundamentals.

D. National Environmental Balancing Bureau (NEBB).
   1. NEBB Procedural Standards for Testing Adjusting Balancing of Environmental Systems.

E. Sheet Metal and Air Conditioning Contractors National Association (SMACNA).
   1. SMACNA HVAC Systems – Testing, Adjusting & Balancing Handbook.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Balancer:
      a. Engage an experienced balancer to perform the work of this Section who has specialized in testing, adjusting, and balancing for HVAC systems similar to that required for this Project.

b. Minimum of five years of experience in testing, adjusting, and balancing substantially similar equipment and able to show evidence of at least five installations in satisfactory operation for at least five years.
c. Submit name and qualifications to ENGINEER along with the following information on a minimum of five successful projects:
    1) Names and telephone numbers of owners, architects, or engineers responsible for projects.
    2) Approximate contract cost of the testing, adjusting, and balancing for HVAC Work.
    3) Amount of area tested, adjusted, and balanced.
    4) Biographical information on employee proposed to directly supervise the testing, adjusting, and balancing Work.

B. Regulatory Requirements:
1. Associated Air Balance Council (AABC).
2. National Electrical Code (NEC).
3. National Environmental Balancing Bureau (NEBB).
4. National Fire Protection Association (NFPA).
5. Underwriters Laboratories Inc. (UL).
6. Local and State Building Codes and Ordinances.
7. Permits: CONTRACTOR shall obtain and pay for all required permits, fees and inspections.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
1. Product Data:
    a. Data sheets with name of devices, manufacturer's name, model number, latest date of calibration, and correction factors for each testing, adjusting, and balancing instruments.
    b. Other technical data related to specified material and equipment as requested by ENGINEER.

B. Informational Submittals: Submit the following:
1. Certificates:
    a. Certification by National Environmental Balancing Bureau (NEBB), Association Air Balance Council (AABC), or equal.
2. Source Quality Control Submittals:
    a. Specimen copies of report forms for ENGINEER's review and approval.
        1) Forms shall be 8-1/2 by 11-inch paper for loose-leaf binding, with blanks for certification of report and listing all required testing, adjusting, and balancing requirements and ratings.
3. Field Quality Control Submittals:
    a. Written startup and field test reports presenting results of required field testing, adjusting, and balancing.
        1) Certified reports shall be in typed format on approved forms imprinted with the company's name.
        2) Reports shall include procedure outline used to test, adjust, and balance the systems and the types of instruments used.

3) Minimum three certified copies of testing, adjusting, and balancing reports to the ENGINEER for review.
4) Reports must be submitted to ENGINEER and OWNER for approval prior to OWNER's acceptance for responsibility.

4. Qualifications Statements:
   a. Balancer, when requested by ENGINEER.

C. Closeout Submittals: Submit the following:
1. Maintenance Contracts:
   a. Maintenance and Repair:
      1) Provide all labor, tools, and equipment to provide a Preventive Maintenance Program and make repairs for all equipment and controls during the One Year Correction Period after the Final Acceptance by OWNER. CONTRACTOR shall provide the following services for the same period of one year:
         a) Receive calls for all problems and take steps to immediately correct deficiencies, which may exist.
         b) Provide a monthly inspection of all equipment and record the findings on a checklist hereinafter specified.
         c) Provide a Preventive Maintenance Schedule for the principle items of equipment.
         d) Respond to OWNER and make repairs for all equipment and controls within 24 hours of notification by OWNER.
   b. Check List:
      1) Provide a checklist and post a copy of it, where directed by the OWNER.
      2) Include each piece of equipment specified or shown.
      3) Provide four columns for required quarterly inspections.
      4) Provide columns for the following:
         a) Equipment condition.
         b) Equipment operation.
         c) Equipment lubrication.
         d) Preventive maintenance.
      5) Preventive maintenance shall be performed in accordance with the manufacturer's recommendations and accepted practice.
2. Operations and Maintenance Data:
   a. Submit complete Installation, Operation and Maintenance Manuals, including, test reports, maintenance data and schedules, description of operation, and spare parts information.
   b. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operations and Maintenance Data.

1.5 SITE CONDITIONS

A. Environmental Requirements:
1. Testing, adjusting, and balancing for HVAC shall be performed when outside ambient conditions are approximate to the local ASHRAE Handbook –

Fundamentals design conditions for heating and for cooling for all heating and cooling functions.

PART 2 - PRODUCTS

2.1 EQUIPMENT PERFORMANCE

A. Equipment Description:
   1. Air Balance Instruments:
      a. Provide all velometers, anemometers, pitot tubes, differential air pressure gages, manometers, hook gages, static pressure probe units, and all other instruments and accessories as required to perform all air balance tests of HVAC equipment, ducts, registers, grilles, etc.
      b. Flow-measuring hoods (manufactured, not fabricated) shall be acceptable for measurement of ceiling diffuser performance only.
   2. System Performance Measuring Instruments:
      a. Provide insertion thermometers, sling psychrometers, tachometers, revolution counters, clamp-on volt-ammeter recorders, and other instruments as required to measure all facets of the complete HVAC system performance.

B. Performance Criteria:
   1. Instrumentation shall be in accordance with NEBB, AABC, or SMACNA requirements and shall be calibrated to the accuracy standards demanded by these organizations.

2.2 ACCESSORIES

A. Balancing Sheaves and Belts:
   1. Balancing sheaves and belts shall be provided for all belt driven equipment.
   2. Sheaves and belts shall be provided to match construction and duty provided by the equipment manufacturer.
   3. Equipment sheaves and belts replaced or not required to achieve balancing shall be submitted to the OWNER as spare parts.

2.3 IDENTIFICATION

A. All equipment and component identification shall be provided in accordance with Section 10 14 00, Signage.

PART 3 - EXECUTION

3.1 INSPECTION

A. Heating, ventilating and air conditioning equipment and components shall be completely installed and in continuous operation, as required, to accomplish the testing, adjusting and balancing Work specified.

B. Inspect all HVAC equipment and components for proper operation prior to testing, adjusting and balancing.
   1. Fan Belt Deflection: Not less than 1/4-inch or more than 1/2-inch.
   2. Finned Coils: Plate type fins shall be combed out with a fin comb for the appropriate fin spacing. Helical fins shall be straightened with blunt bladed instrument.

C. Pre-Startup Inspection:
   1. Verify proper equipment mounting and setting.
   2. Verify that control, interlock, and power wiring is complete.
   3. Verify alignment of motors and drives.
   4. Verify proper piping connections and accessories.
   5. Verify that lubrication is completed.

D. First Run Observations:
   1. Verify direction of rotation.
   2. Verify setting of safety controls.
   3. Monitor heat build-up in bearings.
   4. Check motor loads against nameplate data.

E. Equipment Check:
   1. Verify proper overload heater sizes.
   2. Verify function of safety and operating controls.
   3. Verify proper operation of equipment.
   4. Report on inspection, observation and checking procedures.

F. Promptly report defects which may affect the Work to ENGINEER.

G. Should corrective measures caused by faulty installation require re-testing, adjusting, and balancing, such Work shall be at no additional cost to the OWNER.

3.2 APPLICATION

A. General:
   1. Test, adjust, and balance all systems, ductwork, piping, etc. and their control systems in accordance with the AABC National Standards for Total System Balance, NEBB Procedural Standards for Testing Adjusting Balancing of Environmental Systems, SMACNA HVAC Systems - Testing, Adjusting & Balancing Handbook, or in compliance with the standard procedure manual published by the testing, adjusting, and balancing organization affiliated with CONTRACTOR. CONTRACTOR shall submit one copy of the standard procedure manual to the ENGINEER for their records.
   2. CONTRACTOR shall provide all necessary instruments, tools, ladders, etc. to complete all testing, adjusting, and balancing Work.
   3. CONTRACTOR shall assume full responsibility for safe keeping of all instruments, tools, ladders, etc. during the course of the Work.
   4. CONTRACTOR shall be solely responsible for the protection and safeguarding of the Work and shall provide every protection against accidents, injury, and damage to persons and property.

5. CONTRACTOR shall keep dust, dirt, and debris to an absolute minimum and reinstall all removed ceiling components to their original positions at the end of each day's Work.
6. CONTRACTOR shall be fully responsible for removal and reinstallation of ceiling system and replacement of any component damaged.
7. CONTRACTOR shall install additional access panels at no extra cost to the OWNER, as is required to gain access to equipment concealed above ceilings, behind walls, or any other concealed space.
8. Systems shall be tested, adjusted, and balanced with clean filters and strainers.
9. Where equipment is provided with a variable speed controller (VSC) or variable frequency drive (VFD), balance the equipment first with the VSC or VFD and then with balancing dampers (air systems) or valves (hydronic systems). All systems shall be optimized through the VSC or VFD by balancing with the minimum static pressure needed to meet design flow conditions.

B. Air Systems:
   1. Preliminary:
      a. Identify and list size, type, and manufacturer of all equipment to be tested, including air terminals.
   2. Central Systems:
      a. Test rpm for all equipment, including adjusting of each fan, air handling unit, and air conditioning unit to design requirements within the limits of mechanical equipment provided.
      b. Test and record motor voltages and running amperes including motor nameplate data, and starter heater ratings for each unit as listed above.
      c. Make pitot tube traverse of main supply, exhaust and return ducts, determine airflow at all fans and units and adjust fans and units to within five percent of design requirements.
      d. Test and record system static pressure, suction, and discharge.
      e. Test and adjust system for design outside air, (cfm).
      f. Test and adjust system for design recirculated air, (cfm).
      g. Test and record heating apparatus entering air temperatures, (dry bulb).
      h. Test and record cooling apparatus entering air temperatures, (dry bulb and wet bulb).
      i. Test and record heating apparatus leaving air temperatures, (dry bulb).
      j. Test and record cooling apparatus leaving air temperatures, (dry bulb and wet bulb).
      k. Record all fan and air handling unit speeds.
      l. Record air quantity delivered by each fan and air-handling unit.
   3. Distribution:
      a. Sheave and belt replacement shall be provided as the first means of accomplishing the balancing Work before volume dampers are adjusted from their initial open positions.
      b. Adjust volume dampers, control dampers, splitter dampers, etc., to proper design airflow in main ducts, branch ducts, and zones.
   4. Air Terminals:

a. Identify each air terminal as to location and determine required flow reading.
b. Test and adjust each air terminal to within tolerance of design requirements as listed below.
    1) Positive Zones:
        a) Diffusers and Supply Air Terminals: 0 percent to +10 percent.
        b) Exhaust and Return Air Terminals: 0 percent to -10 percent.
    2) Negative Zones:
        a) Diffusers and Supply Air Terminals: 0 percent to -10 percent.
        b) Exhaust and Return Air Terminals: 0 percent to +10 percent.
    3) Neutral Zones:
        a) All Air Terminals: -10 percent to +10 percent.
c. Test procedure on air terminals shall include recording comparison of required airflow and observed airflow, adjustment of terminal, and recording of final airflow.
d. Adjust flow patterns from air terminal units to minimize drafts to the extent that the design and equipment permits.

5. Verification:
    a. Prepare summation of readings of observed airflow for each system, compare with required airflow, and verify that duct losses are within specified allowable range.
    b. Verify design airflow at fans as described above.
    c. If determined that the air system has not been properly balanced, CONTRACTOR shall rebalance and recheck all equipment and components in the presence of the ENGINEER and as accepted by the ENGINEER.

C. Automatic Temperature Control System:
    1. In cooperation with Section 23 09 00, Instrumentation and Control for HVAC, and the control manufacturer's representative, set and adjust automatically operated devices to achieve required sequence of operations.
    2. Testing organization shall verify all controls for proper calibration and list those controls requiring adjustment by control system installer.

3.3 SCHEDULES

A. Test, adjust, and balance the HVAC systems.

+ + END OF SECTION + +

SECTION 23 31 16

FRP DUCTWORK

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all professional services labor, materials, tools, equipment and incidentals as shown, specified and required to design, field measure, furnish and install all fiberglass reinforced plastic (FRP) ductwork and accessories complete with auxiliary equipment as shown, specified and/or required for proper system operation.
   2. The ductwork system shall be specifically designed, constructed, and installed for the equipment being served.
   3. Contractor shall secure the services of a single System Supplier to design, engineer and furnish ductwork materials, taking into consideration design criteria specified, use of stiffener ribs, supports, hangers, anchors and seismic restraints for all ductwork and accessories furnished under this Section. Ductwork Manufacturer shall perform sufficient stress analysis calculations, including support interface and distance between supports, thermal expansion and contraction of ductwork and determination of final design details for all expansion joints and flexible connectors.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with, or before, the FRP ductwork and accessories Work.

C. Related Sections:
   1. Section 05 05 33, Anchor Systems.
   2. Section 10 14 00, Signage.
   3. Section 23 05 29, Hangers and Supports for HVAC Piping and Equipment.
   4. Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.

1.2 REFERENCES

A. Comply with reference standards, except as otherwise shown or specified within this Section. Where reference is made to one of the standards, the revision in effect at time of bid opening shall apply. General Requirements of this Contract shall supersede Standards in case of conflict.

B. Where referenced industry standards are in conflict, the more stringent and conservative engineering rules and fabrication methods shall govern design, manufacturing and quality control. Reference to ASME RTP-1 pertains only to

those areas within this Section that specifically reference Articles from this standard.

C. Air Movement and Control Association International, Inc. (AMCA).
   1. AMCA Standard 500-D – Laboratory Methods of Testing Dampers for Rating.
   2. AMCA Publication 511 – Certified Ratings Program - Product Rating Manual for Air Control Devices.

D. American Society of Mechanical Engineers (ASME).
   1. ASME RTP-1-2011 Reinforced Thermoset Plastic Corrosion-Resistant Equipment.

E. American Society for Testing and Materials (ASTM).
   1. ASTM E84-10b – Standard Test Method for Burning Characteristics of Building Materials.
   2. ASTM C33 – Standard Specification for Concrete Aggregates
   3. ASTM C582-09 – Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion-Resistant Equipment.
   4. ASTM D638-10 – Standard Test Method for Tensile Properties of Plastics.
   5. ASTM D790-10 – Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics Electrical Insulating Materials.
   6. ASTM D2563-08 – Standard Practice for Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts.
   7. ASTM D2583-07 – Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.
   8. ASTM D2584-08 – Standard Test Method for Ignition Loss of Cured Reinforced Resins.
   11. ASTM D3982-08 – Standard Specification for Contact Molded "Fiberglass" (Glass Fiber Reinforced Thermosetting Resin) Ducts.
   12. ASTM D5421-10 – Standard Specification for Contact Molded "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Flanges.

1.3 DEFINITIONS

A. System Supplier: The System Supplier shall be Contractor and Manufacturer jointly, where contract duties for Contractor and Manufacturer are defined within this specification Section.

B. Acronyms:
   1. Bis-A: Bisphenol-A
   2. CB: Corrosion Barrier
   3. CoNap: Cobalt Napthinate
   4. EVER: Epoxy Vinyl Ester Resin
   5. FR: Fire Retardant
   6. FRP: Fiberglass Reinforced Plastic

7. MEKP: Methyl Ethyl Keytone Peroxide
8. OS: Outer Surface
9. SL: Structural Layer
10. SS: Stainless Steel

1.4 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer:
      a. Minimum of ten years of experience producing substantially similar equipment and able to show evidence of at least thirty installations in satisfactory operation for at least five years in the continental United States.
      b. Ductwork shall be manufactured by a single company at a single location in the United States, with undivided responsibility for performance.
      c. FRP ductwork and accessories shall be fabricated in a heated and well ventilated structure protected from weather and temperature extremes (minimum 50 F). Entire fabrication, curing and assembly process of any piece of FRP equipment shall be indoors.
      d. Manufacturer's service person that will be providing Manufacturer's Services in accordance with this Section shall have a minimum of five (5) years full time experience directly with Manufacturer, including twenty (20) field and five (5) training/inspection assignments during their employ. Service person shall also be OSHA 29 CFR 1926 Construction Safety certified through a minimum ten (10) hour course. Direct or independent sales representatives are not permitted to perform Manufacturer's services. Data for each application shall include project reference, scope, design basis and complete current reference information.
   2. Contractor's Professional Engineer:
      a. Engage a registered professional engineer legally qualified to practice engineering in the jurisdiction where the Project is located and experienced in providing engineering services of the kind indicated.
      b. Submit qualifications data.
      c. Responsibilities include but are not necessarily limited to:
         1) Carefully reviewing FRP ductwork and accessories system performance and design criteria stated in the Contract Documents.
         2) Preparing written requests for clarifications or interpretations of performance or design criteria for submittal to Engineer by Contractor.
         3) Preparing or supervising the preparation of design calculations and related drawings, Shop Drawings, testing plan development, test-result interpretation and a comprehensive engineering analysis verifying compliance of the FRP ductwork and accessories system with the requirements of the Contract Documents.
         4) Providing all design calculations for hangers, supports, anchors and seismic restraints.

5) Signing and sealing all calculations and design drawings, and Shop Drawings.
6) Certifying that:
    a) it has performed the design of the FRP ductwork and accessories system in accordance with the performance and design criteria stated in the Contract Documents, and
    b) the said Manufacturer's design conforms to all applicable local, state and federal codes, rules and regulations, and to the prevailing standards of practice.

3. Manufacturer's Professional Engineer:
    a. Engage a registered professional engineer legally qualified to practice engineering and experienced in providing the engineering services of the kind indicated. Professional engineer may be an employee of manufacturer.
    b. Submit qualifications data, where engineer shall demonstrate a minimum of five (5) years' experience engineering for fifteen (15) fiberglass reinforced plastic pipe or ductwork applications of similar scope and complexity. Data for each application shall include project reference, scope, design basis and complete current reference information.
    c. Responsibilities include but are not necessarily limited to:
    d. Preparing or supervising the preparation of design calculations and related drawings, Shop Drawings, testing plan development, test-result interpretation and a comprehensive engineering analysis verifying compliance of the ductwork system with the requirements of the Contract Documents.
    e. Signing and sealing all calculations and drawings.
    f. Preparing or supervising the preparation of shop test set ups.
    g. Performing or supervising the performance of shop tests, interpretation and engineering analysis of shop test data and preparation of test reports.
    h. Certifying that the tests performed and results achieved conform to the Contract Documents.
4. Contractor:
    a. Contractor shall have at least five years' experience in the installation of the Work specified. He shall employ only tradesmen with specific skills, training and experience in this type of Work.
    b. Contractor shall have undivided responsibility as a single firm for performance and other requirements for the installation of the Work specified herein.
    c. Contractor shall qualify laminators performing secondary bonding to field join sections of ductwork through certified training and inspection provided by the ductwork Manufacturer as a Manufacturer's services requirement of this Section.

B. Component Supply and Compatibility:
1. Obtain all equipment included in this Section regardless of the component manufacturer from a single ductwork manufacturer.

2. Require the ductwork equipment manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall equipment assembly by the ductwork equipment manufacturer.

C. Comply with applicable provisions of Regulatory Requirements and others having jurisdiction:
1. Factory Mutual (FM).
2. National Electrical Code (NEC).
3. National Fire Protection Association (NFPA).
4. Underwriters Laboratories Inc. (UL).
5. Local and State Building Codes and Ordinances.
6. Permits: Contractor shall obtain and pay for all required permits, fees and inspections.

D. Ductwork Certifications:
1. AMCA labels shall be affixed to all dampers requiring a performance rating by this Section.

1.5 SUBMITTALS

A. Action Submittals: Submit the following per Section 01 33 00 Submittal Procedures:
1. Contractor shall submit Working, Shop and Assembly Drawings and material specifications as prepared by Contractor and relevant Manufacturer for approval of Engineer in accordance with requirements of Division 1 General Requirements of Specifications. Working, Shop and Assembly Drawings with related details shall include, but not be limited to:
a. Drawings showing fabrication methods, assembly, accessories, installation details and wiring diagrams, with plans, elevations, sections, components, piece numbers, outside diameters at support interface points and attachments to other work.
b. 1/4-inch scale duct layouts dimensioned to show length of runs, sizes, support spacing and expansion provisions.
c. Schedules for:
1) Round and rectangular duct sizes, thicknesses, weights per foot, vacuum and pressure ratings and allowable spans,
2) Ductwork laminate construction details for all compositions.
3) Ductwork joint details showing width, thickness, tapering and composition of butt wraps.
4) Flange dimensions for inside and outside diameter, flange, hub and neck thickness plus bolt hole and circle diameter.
5) Flange data for number and size of bolts plus recommended bolt torque minimum and maximum values.
d. Construction and attachment details for reinforcing ribs, transitions, reducers, elbows, nozzles, flanges, access doors, turning vanes, louvers, dampers, grilles and valves.

e. FRP buildups at supports and hangers plus shear collars, support rings and pedestals used individually or in conjunction with supports of another material of construction.
f. Shop and field joint locations, with numbering system for each field joint keyed to individually prepackaged butt and wrap field joint kit.
g. Field but wrap joint details.
h. Field trim allowance at field joint locations.
i. Sloped top flat surfaces of outdoor rectangular ductwork.
j. Individual hangers, supports, anchors and seismic restraints with configurations, dimensions, thickness and weights shown.
k. Mounting requirements.
l. Penetrations through fire-rated and other partitions.
m. Setting drawings, templates, and directions for the installation of anchor bolts, and other anchorages.
n. Standard and custom color selection charts for outer surface.
o. Dampers and leakage performance ratings.
p. Expansion joints
q. Flexible connectors.
r. Deviations from Contract Documents. Any exceptions to the Contract Documents shall be clearly defined. Contractor shall be responsible for any additional expenses that may occur due to any exception made.
s. Other technical data related to specified material and equipment as requested by Engineer.

2. Delegated Design Submittals:
   a. Contractor shall submit Design Calculations for review. Calculations shall include:
      1) Ductwork Manufacturer engineering:
         a) Wall thickness determination based on stress analysis considering loads imposed on ductwork as a result of process and environmental design criteria plus configuration and location of hangers, supports, anchors and seismic restraints. Analysis shall also include support interface and distance between supports, thermal expansion and contraction of ductwork and determination of compression, extension and deflection details for all expansion joints and flexible connectors.
         b) Reinforcing rib design calculations, including determination of moment of inertia and proof of design where adhesives may be used.
         c) Demonstration of flange thickness design for flanges greater than 36-in diameter following rules in ASME RTP-1 Non-Mandatory Appendix NM-12 FRP Flange Design.
         d) FRP shear collar design for vertical support and/or anchor interface.
         e) Demonstration of physical properties used in all design calculations in accordance with ASME RTP-1 Part 2 Materials and Part 7 Shop Qualification.

f) All calculations shall be signed and sealed by a registered professional engineer legally qualified to practice engineering employed or contracted by the Manufacturer.
g) Any and all other such ductwork design calculations required to fulfill the requirements of this Section.

2) Contractor engineering:
a) The support system, comprised of hangers, supports, anchors and seismic restraints based on stress analysis considering loads imposed on support structures as a result of process and environmental design criteria plus configuration and location of support structures. Analysis shall also include interface and distance between support structures, thermal expansion and contraction of ductwork.
b) Any and all other such calculations required to fulfill the requirements of this Section.
c) All calculations shall be signed and sealed by registered professional engineer legally qualified to practice engineering in the jurisdiction where the Project is located.

3. Samples:
a. Submit manufacturer's standard color Samples of finish coating system. Engineer will select finish color. Engineer's review of Samples is for color only; compliance with all other requirements is Contractor's responsibility.

4. Testing Plans, Procedures, and Testing Limitations:
a. Plan for performing required shop testing, to include visual and dimensional inspection, Barcol hardness and acetone sensitivity testing plus related forms from quality control procedures.
b. Plan for performing required field testing, to include visual and dimensional inspection, Barcol hardness and acetone sensitivity testing plus related forms from quality control procedures.

5. Test and Evaluation Reports:
a. UL Label, Fire Dampers.
b. Damper leakage tests from an AMCA approved testing laboratory.

6. Supplier Instructions:
a. Instructions and recommendations for handling, storing, protecting the equipment.
b. Installation Data.
c. Instructions for:
1) Field joining of ductwork with butt wrap joints, including quality control procedures that assure all material is properly applied, laminate quality meets specifications and complete resin cure is achieved.
2) Handling hazardous materials, including Material Safety Data Sheets (MSDS) for all hazardous materials used to perform field butt wrap joint work.
3) Managing fiberglass dust and styrene emissions propagated through cutting, grinding and laminating operations.
4) Making FRP flange connections.

5) Ductwork handling, cleaning, inspecting, repairing start-up, and troubleshooting.

7. Source Quality Control Submittals:
   a. Written report presenting results of required shop inspection and testing.
   b. Tabulation in check list forms to indicate ductwork laminate compliance with ASTM D 2563 Table I, Level II visual acceptance levels.
   c. Submit a letter stating that the resins proposed in the fabrication of the FRP ductwork will give satisfactory performance under the specified service conditions or a corrosion resistance chart indicating same.
   d. Certified literature indicating compliance with proposed pressure and vacuum classification.
   e. Tolerance checks, including ductwork out of roundness or square and lengths plus flange face flatness, warpage, perpendicularity and cant.
   f. Any other Factory test reports required by this section.
8. Field Quality Control Submittals:
   a. Written report presenting results of required field inspection and testing. Report shall include but not be limited to:
      1) Received quality conformance of ductwork and installation materials.
      2) Butt wrap joint materials suitability for use.
      3) Ductwork butt edge gaps at joint fit up.
      4) Surface preparation for butt wrap joints.
      5) Complete application of all butt wrap material layers.
      6) Paste protrusion past ductwork inner surface.
      7) Butt wrap laminate visual quality.
      8) Proper cure of field applied butt wrap joints.
9. Supplier Reports:
   a. Submit written report of results of each visit to Site by Supplier's service personnel, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
10. Special Procedure Submittals:
    a. Contractor shall provide plan for managing fiberglass dust and styrene emissions propagated through field cutting, grinding and laminating operations.
11. Qualifications Statements:
    a. Manufacturer and Manufacturer's service person, when requested by Engineer.
    b. Professional Engineer, when requested by Engineer.
    c. Contractor, when requested by Engineer.
    d. Testing Agency, when requested by Engineer.

B. Closeout Submittals: Submit the following:
   1. Record Documentation:
      a. During progress of the Work keep an up-to-date set of the Drawings showing field and Shop Drawing modifications. Immediately upon completion of the Work, submit "pdf" of CADD drawings showing the actual in place installation of all ductwork and equipment installed under this Section at a scale satisfactory to the Owner. The drawings shall show

all ductwork on plans and in sections, with all reference dimensions and elevations required for complete Record Drawings of the systems. Two paper prints shall also be furnished. The prints and electronic copies of the CADD files shall be furnished no later than 30 days after completion of the Contract and prior to final payment.

C. Maintenance Material Submittals: Furnish the following:
   1. Spare Parts:
      a. As recommended by the FRP duct manufacturer.
   2. Extra Stock Materials:
      a. As recommended by the FRP duct manufacturer.
   3. Tools:
      a. As recommended by the FRP duct manufacturer.
   4. Spare parts, extra stock materials, and tools shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the Owner at the conclusion of the Project.

1.6 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:
   1. Manufacturer shall properly prepare and protect ductwork from damage under normal circumstances.
      a. Ductwork is to be shipped complete, with no fiberglass related laminating work or fabrication permitted outside of the manufacturing facility.
      b. Round ductwork larger than 30 inches in diameter or rectangular ductwork with one dimension larger than 30 inches shipped horizontally shall be mounted on padded cradles of sufficient size to prevent damage and adequately support ductwork. All smaller sizes of ductwork shall be blocked. Suitable skid or dunnage shall be provided for ductwork shipped vertically. Cradles, skids and dunnage shall stay with ductwork for protection prior to installation.
      c. Sufficiently cross brace openings to maintain roundness or squareness within standard tolerances. Plug or cover all openings to prevent entrance of undesirables such as stones, dirt, water or debris.
      d. Protect all flange faces with durable flat blinds securely fastened to them, where covering material extends to or beyond flange edges.
      e. Accessories not reliably attached to ductwork for transportation purposes and cradled or skidded shall be properly packaged and shipped to prevent damage.
      f. Nesting small diameter ductwork sections inside large diameters is forbidden. No components are allowed to be shipped inside ductwork.
      g. Load freight with sufficient clearances all around to eliminate potential adjacent interferences. Firmly secure and protect all freight to prevent shifting or other movement during transportation. Nozzles, lugs, brackets or other projections shall not be used for securing freight.
      h. Nozzles, lugs, brackets or other projections shall not be used for lifting or rotating ductwork. Skids and cradles shall be configured and oriented

during transport for ease of offloading and handling at site with crane or lift truck.

2. Manufacturer shall properly package butt and wrap field joint materials and supplies.
    a. Each fiberglass butt and wrap field joint shall be individually packaged in a water proof container and labeled, with all reinforcement precut by the manufacturer and properly sequenced in the package.
    b. Labeling shall designate size, location keyed to drawings and laminate sequence.
    c. One (1) extra kit per joint type and size shall be provided.
    d. Resin and Catalyst (hardener) shall be packaged and properly labeled in Department of Transportation (DOT) approved five (5) gallon or smaller pails. Separate pails shall be provided for Inner Corrosion Barrier, Structural Layer and Outer Surface resin, Finish Coat resin and Paste used to fill allowable gaps at fit up of joints.
    e. An extra 35% more resin shall be supplied than theoretically required given butt and wrap kit resin to glass ratios.
    f. Resin shipped for field work shall have a minimum six (6) month shelf life, with non-consumed resin removed from the jobsite upon completion of the installation.
    g. All cups, brushes, stir sticks and rollers required shall be supplied by the manufacturer and bulk packaged.
3. Deliver materials to the Site to ensure uninterrupted progress of the Work.
4. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete, in ample time to prevent delay of that Work.
5. Comply with manufacturer's recommendations for rigging of equipment.

B. Storage and Protection:
    1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
    2. Store all equipment in covered storage off the ground and prevent condensation and in accordance with the manufacturer's recommendations for long-term storage.
    3. Store all field butt and wrap joint materials and related supplies furnished by the Manufacturer in an area that is dry, between 35 and 75 degrees F for maximum shelf life, properly protected from humidity and away from any direct sunlight and potential source of ignition or fire.

C. Acceptance at Site:
    1. All boxes, crates and packages shall be inspected by Contractor upon delivery to the Site. Contractor shall notify Engineer, in writing, if any loss or damage exists to equipment or components. Replace lost equipment or components and repair damage to new condition, in accordance with manufacturer's instructions.

1.7 SITE CONDITIONS

A. Environmental Requirements:
   1. All fiberglass reinforced plastic joint work shall be done at temperatures between 60 and 90 degrees Fahrenheit and humidity less than 80%, without exposure to wind, rain, snow, direct sunlight and any other wet and extreme temperature conditions beyond the ranges permitted. Temporary weather tight temperature and humidity controlled shelters shall be provided by the Contractor where needed during field but wrap joining procedures.

B. Installation of ductwork:
   1. Actual installation temperature shall be verified with design by the Manufacturer for expansion and contraction considerations as it pertains to ductwork lengths and expansion joint operation. Contractor shall support such evaluation with field information as needed.
   2. Ductwork shall be stabilized and isolated from any and all movement during FRP butt and wrap field joint work.

1.8 SEQUENCING

A. As built outside diameter of FRP buildups located at support points shall be coordinated with the Contractor supplied support steel such that steel is fabricated to provide full contact with duct buildups as shown on Manufacturer's drawings.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Design Criteria:
   1. Design calculations supporting ductwork component thicknesses shall include all applicable loads individually or in combination, whereas required by Section References, federal, state and local building codes and best engineering practices.
   2. Chemical Exposure: 200 ppm Sulfuric Acid, 5 ppm Hydrogen Sulfide, 10 ppm Sodium Hypochlorite and 10 ppm Sodium Hydroxide.
   3. Design Pressure/Vacuum: +/-15-inches water column.
   4. Weight of ductwork, accessories and other interconnected equipment or materials.
   5. Accumulation of liquid, sludge and solids buildup in ductwork.
   6. Locations of hangers, supports, anchors and seismic restraints.
   7. Air Temperature: Fabrication, installation, and operating temperatures shall be factored into the design to account for compression, elongation and misalignment resulting from temperature swings within the materials and for sizing expansion joints.
   8. Wind Loads: Refer to the Structural Drawings.
   9. Snow Loads: Refer to the Structural Drawings.

B. Performance Criteria:
   1. The ductwork system shall be free from leakage, deflection, pulsation, vibration, chatter or any other such condition when ductwork system is in or out of operation.

2. Expansion joint and flexible connector deflection shall be within design criteria submitted during all modes of operation and throughout all times of the year.
3. No stress cracks shall be observed in any inside or outside surfaces or radii of FRP system components.

2.2 MANUFACTURERS

A. Manufacturers: Provide product of one of the following:
   1. Perry Fiberglass Products, Inc., Westlake, OH
   2. Kenway; Augusta, ME.
   3. Composites USA; North East, MD.
   4. Or approved equal.

2.3 DETAILS OF CONSTRUCTION

A. Ductwork:
   1. Ductwork shall be hand lay-up, spray-up and/or filament wound construction in accordance with ASTM D3982 and specific ASME RTP-1 articles as referenced within this Section.
   2. Ductwork shall meet Class I fire retardant rating per ASTM E84 with a flame spread of less than or equal to 25.
   3. Physical properties used in all design calculations shall be developed and demonstrated in accordance with ASME RTP-1 Part 2 Materials and Part 7 Shop Qualification.
   4. All laminate thicknesses for ductwork shall be calculated such that 10:1 factor of safety for internal and 5:1 for external pressure has been provided, with strain limited to 0.001 for hand lay-up laminates per ASME RTP-1 Subpart 2A. Strain for filament wound laminates shall be limited to 1/10 of strain at failure, where strain at failure must be proven by ductwork Manufacturer per applicable articles of ASME RTP-1 Subpart 2A through testing or Subpart 2B through lamination analysis plus 6-930 Physical Property and Laminate Reinforcing Content Tests. Laminate designs used for proof of allowable strain used in calculations submitted shall be representative of same laminate sequence and resin to glass ratio as used for ductwork shown on drawings submitted..
   5. Safety factors for combined loads shall be 10:1 for sustained loads and 5:1 for intermittent loads, where intermittent are combined individual loads or individual combined with sustained loads. As a minimum, loadings to be considered are defined in Article 2.1 above. The greater laminate thicknesses as determined by paragraph 2.3 A.6 and 7 herein shall be used.
   6. Minimum longitudinal tensile strength shall be 9,000 psi for all Structural Layer laminate designs.
   7. All exterior ductwork shall be designed and fabricated to span minimum spacing as shown or specified. Ductwork wall thickness shall be suitably designed with reinforcing ribs incorporated where necessary to achieve span, within acceptable deflection tolerance.

8. Maximum allowable deflection for any size ductwork or span shall be the lesser of 1/2-in or 1/2-percent of span under worse case operating and weather conditions.
9. Buckling between supports shall be taken into consideration through stress analysis.
10. Ductwork systems large than 60-in diameter for round and 20-ft in circumference for rectangular shall be analyzed using formal Pipe Stress Analysis (PSA), such as Caesar II, ALGOR PipePak or equal. Stress shall be fully evaluated at all critical locations, including flanges, elbows, tees, wyes, hangers, supports, anchors and seismic restraints.
11. Ductwork shall be reinforced at each support, hanger, anchor and seismic restraint with a minimum 1/4-in FRP buildup. This reinforcement shall cover and extend 3-in beyond the bearing surface. Buildups shall be flat, smooth and fully contact support pads.
12. FRP Pedestal supports and shear collars for vertical support and/or anchor interfaces shall be provided. Design calculations and drawings illustrations shall be included in the shop drawing submittals.
13. Buried ductwork shall be designed to support soil loads and water table affects plus vehicular traffic.
14. Ductwork runs, rises and fittings shall be fabricated to the fullest extent in the manufacturer's shop with shop applied exterior butt and wrap joints. No fitting or component site fabrication is permitted.
15. Reinforcing Ribs:
    a. Design calculations shall be submitted to substantiate rib and duct wall design given all design criteria and deflection limits defined above, including demonstration for moment of inertia achieved with rib type selected.
    b. Rib construction shall be detailed on shop drawings.
    c. Where half round ribs are utilized on ductwork, the minimum moment of inertia shall be determined per ASME RTP-1 Section 3A-330.
    d. Ribs shall be installed at point of ductwork manufacture and located so as not to interfere with supports, hangers, anchors, seismic restraints and other such interconnected or adjacent equipment, accessories, materials and building structures.
16. Fittings:
    a. All fittings such as elbows, laterals, tees, and reducers shall be hand lay-up construction and have the same internal dimensions as the adjacent duct.
17. Butt Wrap Joints:
    a. All ductwork joints shall be butt wrap per ASTM D3982 Article 9.2 Joints. Bell and spigot joints may be used for alignment purposes only, whereas no adhesives are used and step from bell end to inserted spigot shall tapper 6:1 with smooth butt wrap transition between joined sections. All outer surfaces of joint overlays are to be coated with a resin finish coat containing paraffin wax.
    b. All gaps between mating edges of ductwork and fittings shall be less than or equal to 3/8-inches per ASTM C582 Article 9.2.4 and maximum offset of lesser of 1/4-inch or two (2) times edge thickness divided by three (3)

prior to application of paste and butt wrap joint material. Paste used to fill gaps shall not protrude more than 1/8-inch past inner surface of ductwork, fitting or transition wall.

c. Total width of overlays for butt-wrap joints shall be not less than 6-inches for thicknesses up to 0.30-inches, 8-inches from greater than .030 to 0.49-inches thick and 12-inches from greater than 0.49 to 0.76-inches thick. Overlay widths where bell and spigot joint alignment is utilized shall be increased by 6 times the step dimension form bell end to inserted spigot.

d. At least one (1) field butt wrap joint shall be allowed for in each change in direction and elevation, with a minimum of 6-in field trim included and shown on drawings by the Manufacturer at each field joint location. Field joints shall also be located at dimension "H" from duct flange faces per ASTM D3982 Figure 4 Standard Duct Dimensions. Duct flanges mating with dampers, fans, flex connectors and other related equipment shall be properly aligned and reliably bolted together with no undue stresses prior to applying butt wrap joint material.

e. No adhesive joints are allowed.

18. Nozzle and Branch Connections:
    a. Nozzle connections shall meet ASME RTP-1 Article 4-430 and be Flush-Type per Figure 4-12, where structural overlay is placed as All Exterior material. Instillation shall follow ASME RTP-1 Figure 4-4. Inside overlay material is not required.
    b. Nozzles shall project 6-in from outside diameter of ductwork.
    c. All nozzles 4-in and smaller shall have Plate-Type gussets per ASME RTP-1 Figure 4-13, where complete contact with back of flange is required.
    d. Branch connections shall be perpendicular or 45 degrees per ASTM D3982 Figure 4.
    e. Cutout reinforcement shall be provided following ASME RTP-1 and good engineering practices for all nozzle and branch connections.
    f. FRP Threaded couplings and nipples shall be installed following the same requirements above as specified for nozzles of the same size. Thermoplastic and metallic couplings and nipples are not allowed.
19. Flange Connections:
    a. All connections to expansion joints, flexible connectors, fans, dampers, louvers, registers, hatches, covers, tank vents, vessels, condensate drain piping, instrumentation or other equipment shall be flanged with 6-in projection where flange is not on a straight run of ductwork. Auxiliary equipment directly screwed into fiberglass ductwork is not allowed.
    b. Flanges shall be hand lay-up flat full face flange on straight section (pipe) or integrally molded construction. Flange face shall be textured by lightly hand sanding with block sander to move surface gloss imparted by mold surface. Flange on straight section (pipe) type flanges shall have no voids or filler material where pipe joins flange lay-up.
    c. All bolt holes shall be shop drilled by Manufacturer using calibrated template and back spot faced or otherwise formed for flat and parallel seating of SAE or ASME B18.22.1 Type A Narrow washer seat, with all flange exterior and machined surfaces resin finish coated. Randomly

match drilling flanges in manufacturer's shop or field drilling of any kind is not allowed.

d. Flange construction and dimensions shall meet ASTM D5421 for all tank vent, condensate drain piping and instrumentation connections and D3982 for all other connections.
e. Flange flatness, warpage, perpendicularity and cant tolerances specified within Referenced standards and this Section shall be strictly adhered to. Flange faces refaced or machined to meet tolerances shall have the Corrosion Barrier fully included.
f. Flanges on smaller end of reducers and transitions shall have a minimum of 6-in straight section to accommodate bolting, as shown for reducers in ASTM D3982 Figure 4 Standard Duct Dimensions.
g. Furnish all gaskets required. Gasket material shall be EPDM or chlorobutyl, with a shore A hardness of 60 to 70. Gaskets shall be full face, pre-punched to match flange bolt pattern plus single piece construction up to 36-in diameter and dovetail vulcanized construction for sizes greater than 36-in diameter. Minimum gasket thickness shall be 1/8-in for flanges less than or equal to 6-in, 3/16-in for flanges greater than 6-in and up to 18-in and 1/4-in for flanges equal to or greater than 20-in diameter. For rectangular flange minimum gasket thickness, the applicable minimum for round duct correlates to the longest flange leg on the rectangular duct. Gasket thickness shall be determined by the Manufacturer as a variable in their flange design. Gasket manufacturers shall be by Aero Rubber of Tinley, IL, Corley Gasket of Dallas, TX, Seal and Design of Clarence, NY or equal.
h. Furnish all fasteners required. Fastener material shall be 316 SS and properly sized to fit gasketed or non-gasketed connections. Washers shall meet SAE or ASME B18.22.1 Type A Narrow washer seat requirements.
i. Expansion joints, flexible connectors, fans, dampers, louvers, registers, hatches, covers, tank vents, vessels, condensate drain piping, instrumentation or other equipment flanges shall be full faced for proper seating with ductwork flanges.
j. Custom filler pieces or spacer rings shall not be allowed between mating flanges.
k. Coordinate FRP flange dimensions with auxiliary equipment of dissimilar material and origin of manufacture.
l. All flange bolts shall be torqued to values as recommended by Manufacturer.

B. Round Ductwork:
   1. Reinforcing Ribs:
      a. Ductwork wall thicknesses shall be suitably designed for all loads and spans with or without reinforcing ribs.
      b. Ribs utilized shall be Hand Lay-up or filament wound and formed to a suitable shape over core material. Rib core material shall impart a laminate shape suitable for stiffening ductwork consistent with design calculations submitted, not contribute to strength of material in

calculations and be non-metallic, such as half round or trapezoidal polyurethane foam. Ductwork stiffening shall rely on strength of rib laminate overlay only.

2. Fittings:
   a. Fitting thickness and laminate composition shall be equal to design of hand lay-up duct cylindrical sections meeting the design basis of this Section. Minimum thickness for reducer and transition fittings shall be the same as the wall thickness of the ductwork connecting to the larger fitting opening.
   b. Standard Round Elbows up to 48-inch diameter shall have smooth radius with a centerline radius equal to 1-1/2 times the ductwork diameter.
   c. Short radius round elbows, where the centerline radius is less than 1-1/2 times the ductwork diameter, are not permitted unless otherwise shown on contract drawings to meet dimensional restrictions.
   d. Mitered Elbows are permitted for ductwork 54-inch diameter and greater. Standard dimensions shall be as shown in ASTM D3982 Figure 4, with mitered sections as specified below:
      1) 0° to 44° elbows shall contain one (1) mitered joint and two (2) sections.
      2) 45° to 80° elbows shall have a minimum of two (2) mitered joints and three (3) sections.
      3) Elbows greater than 80° shall have a minimum of four (4) mitered joints and five (5) sections.
   e. The length of concentric and eccentric reducers shall be five (5) times the difference in diameter and not as shown in ASTM D3982 Figure 4.
3. Butt Wrap Joints:
   a. Joint thickness and laminate composition shall be equal to design of hand lay-up duct cylindrical sections meeting the design basis of this Section.
4. Flange Connections:
   a. Minimum flange thicknesses shall be 5/8-in for less than or equal to 8-in diameter and 3/4-in for 10-in to 36-in diameter. Thicknesses for flanges greater than 36-in diameter shall be determined following rules in ASME RTP-1 Non-Mandatory Appendix NM-12 FRP Flange Design, with minimum thickness of 1-1/8-in allowed. Minimum flange thickness shall be measured at bolt hole in washer seating area.

C. Rectangular Ductwork and Transitions:
   1. Filament winding is not allowed for rectangular ductwork and transitions.
   2. All rectangular ductwork, fittings, transitions and other structures shall have integrally molded corners with radiuses. Corner radii for adjoining walls of less than or equal to 24-inch shall be 1/2-inch, 1-inch for adjoining walls between 24-inch and 48-inch and 1 1/2-inch for greater than 48-inch adjoining wall lengths. In no case shall rectangular or rectangular to round components or systems be fabricated from flat panels, with or without quartered pipe sections in corners, and joined by butt wrap joints. Care shall be exercised to assure corner radii thicknesses are maintained as a minimum, with additional plies added if required.

3. Ductwork wall thicknesses shall be suitably designed for all loads and spans with or without reinforcing ribs.
4. Ribs utilized shall be constructed from hand lay-up angle, channel, tee or tube material and laminated to the ductwork. Adhesives may be used in place of laminating ribs to ductwork where ductwork Manufacturer in-house test data, design calculations and drawing details are submitted that demonstrate reliability. No pultruded, extruded, formed, milled or welded plastic, metallic or wood structural shapes or mechanical fasteners are allowed.
5. Flange Connections:
    a. Square or rectangular ductwork flange connections shall meet the same design and fabrication requirements as round flanges above as a minimum, where square or rectangular ductwork flange requirements shall correspond to those of round ductwork having the same diameter as the longest side of the square or rectangular duct when rounded up if not equal.
    b. Bolt hole location and size shall be designed by the Manufacturer, shall straddle major centerlines and not exceed 4 1/2-in space between hole centerlines.
6. Turning vanes:
    a. Square and rectangular mitered elbows shall have hand lay-up quarter round shaped turning vanes with 3:1 tapered leading edges, with a radius equal to that of the centerline radius of the elbow.
    b. Each turning vane shall be composed of an all random strand matt construction, with a C-Glass Veil on both sides of the curved vane. A sufficient number of turning vanes shall be provided such that they are spaced no greater than 6-in apart. Each turning vane shall protrude through the fitting wall on both sides a minimum of 1.5-in, with a fiberglass overlay equal in thickness to the fitting wall laid up onto the entire projecting portion of the vane and the adjoining fitting wall a minimum of 1.5-in forming a seal and reliable attachment.
    c. Turning vane thicknesses shall be determined by design calculations given all design criteria and deflection limits defined above. Calculated thickness shall then be increased by 50% and rounded up to the nearest laminate sequence following ASTM C582, where minimum vane thickness shall be 3/8-in.
    d. Duct access doors shall be provided at each elbow with turning vanes.
6. Tops of all outdoor exposed rectangular ductwork, fittings, transitions and other structures shall be sloped ¼-in per foot to shed water. Slope shall be shown on shop drawing submittal.

D. Support System:
1. Provisions shall be made for supporting all ductwork, dampers and other ductwork accessories.
2. All ductwork shall be securely hung and anchored to the building structure.
3. The support system, comprised of hangers, supports, anchors and seismic restraints, shall be designed and supplied by Contractor and coordinated by Contractor with Manufacturer's ductwork system design.

4. Support system design criteria and supply shall include the following requirements:
    a. Conform to all requirements of 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
    b. Supports shall be custom fabricated to match as built ductwork outside diameter and account for FRP thickness and steel fabrication tolerances. Support fabricator shall define fabrication and fit up tolerances on individual assembly drawings for Contractor coordination with Ductwork Manufacturer.
    c. Support system steel shall line up with shop laminated FRP buildups. Round ductwork support bearing area shall be a minimum of 180 degrees of its circumference by a minimum width of the lesser of 1/3the ductwork diameter or 4". Rectangular ductwork support bearing area shall be a full support across ductwork underside by a minimum width of the lesser of 1/3the underside dimension or 4". A 1/4-in thick EPDM sheet shall be adhered to each support to provide a fully padded interface with ductwork.
    d. All ductwork to be hung shall be supported on trapeze hangers with angles or rods. Use of strap hangers and straps is prohibited. Hanger rods shall be minimum 3/8 inch. A pair of rods shall be provided at each duct support point.
    e. Vertical runs of ductwork shall be supported by a FRP pedestal laminated to the underside of an elbow and/or steel framework with steel ring fully bearing on underside of FRP shear collar on ductwork. Riser or friction clamps are not allowed.
    f. Where ductwork movement must be restrained, steel framework with 360 degree steel ring shall be used that incorporates and fully bears on FRP shear collars on either side of ring.
    g. All hangers, rods, supports, anchors, seismic restraints, bolts, nuts, washers, inserts, and appurtenances shall be Type 316 stainless steel.
    h. Ductwork shall be supported to allow removal of inline devices without adding temporary support.
    i. Ductwork shall be supported within 12 inches of duct free end where connected to flexible connections, expansion joints or equipment.

E. Support spacing shall be 10 feet unless otherwise indicated.

F. Ductwork Materials:
    1. Laminates for all ductwork shall be Class I fire retardant per ASTM E84 with a flame spread of less than or equal to 25.
    2. Paste used to fill gaps and create a smooth transition from mating cut edges shall be formulated from the same resin formulation as used to manufacture the ductwork.

2.4 ACCESSORIES

A. Volume and Isolation Dampers:
    1. General:

a. Volume dampers shall be provided where indicated on the Drawings and as required to facilitate accurate volume control.
b. The duct of the damper shall be reinforced to prevent vibration.
c. Volume dampers specified with registers shall be installed in addition to those shown on the Drawings.
d. Dampers larger than 11 inches in any dimension shall be opposed blade type.
e. The damper blades shall be operated by a lockable dial regulator and may be set in any position. The dial regulators shall be marked so that the "opened" and "closed" positions are clearly identified. The dial regulators on insulated ductwork shall be mounted on an elevated platform which shall finish flush with the surface of the insulation.
f. Dampers shall be located at accessible points and wherever possible some distance from a duct transition or fitting.
g. Dampers shall be provided in each branch duct take off and in both ducts downstream of each trunk duct split.
h. Dampers shall be FRP construction and be flanged at both ends.
i. Splitter type dampers shall not be installed.
j. FRP damper and flanges shall be constructed of the same materials and conform to the same standards and specifications as specified within this Section for FRP ductwork. Damper flanges shall be the same thickness as the adjoining ductwork.

2. Round Fiberglass Reinforced Plastic Dampers:
   a. Rating Conditions:
      1) Velocity Through Damper: 6000 fpm maximum.
      2) Pressure Rating: 30 inches water column.
      3) Maximum Allowable Leakage: 5.25 cfm per square foot at 30-inch w.g. pressure.
   b. Materials:
      1) Bearings: Teflon.
      2) Blade: FRP, reinforced.
      3) Frame: FRP channel.
      4) Shaft: Type 316 stainless steel rods, full length of damper size as shown on the Drawings.
      5) Blade and Shaft Seals: EPDM suitable for use in a hydrogen sulfide atmosphere.
      6) Finish: FRP.
      7) Handle (manual damper): Type 316 stainless steel.
      8) Pins: Type 316 stainless steel.
      9) Bushings: Teflon.
      10) Hardware: Type 316 stainless steel.
      11) Angles: FRP.
      12) Ends: Flanged with bolt holes drilled. Flange thickness shall not vary more than 1/16 inch.
      13) Blade Stops: FRP angles with full circumference elastomer seals suitable for use in a hydrogen sulfide atmosphere.
   c. Leakage test and performance data from an AMCA approved testing laboratory shall be submitted.

d. Manufacturers: Provide products of one of the following:
   1) Swartwout, Phillips Industries, Model 914.
   2) Or approved equal.

B. Flexible Connectors and Expansion Joints:
   1. Design and Performance Criteria:
      a. Flexible connectors and expansion joints shall be tested in accordance with UL 181.
      b. Flexible connectors and expansion joints shall be listed and labeled as Class 0 or Class 1 flexible connectors.
      c. Flexible connectors and expansion joints shall meet NFPA 90A, NFPA 90B, NFPA 701, and local building codes.
      d. Maximum Design Total Static Pressure: ±3 psig (±83.0-inch W.G.).
      e. Temperature Range: -65 degrees F to 300 degrees F.
      f. Maximum Movement Capabilities:
         1) Axial Compression: 4 inches.
         2) Axial Extension: 1 inch.
         3) Lateral Offset: 3 inches.
      g. Width: Minimum 12 inches, measured from flange to flange.
   2. Product and Manufacturer: Provide one of the following:
      a. Model 945-W, as manufactured by Holz Rubber Company, Inc.
      b. Model Duct Connectors, as manufactured by Mercer Rubber Company.
      c. Or equal.
   3. Details of Construction:
      a. Material: Minimum 1/4-inch thick EPDM or Butyl, reinforced with a strong synthetic asbestos-free fabric suitable for corrosive service.
      b. Flexible connectors and expansion joints shall be fabricated with compound curve molded corners and straight sections with premolded arch. Arch shall continue throughout the corner and straight sections and shall be fully developed when in the neutral installed position. Precompression or tucking of the corner to form the arch shall not be permitted.
      c. Corners on rectangular flexible connectors and expansion joints shall be completely molded and free of splices.
      d. Provide Type 316 stainless steel flanged ends. Flanges and bolt spacing shall be coordinated with ductwork and equipment connections.
   4. Provide flexible connectors wherever ductwork crosses a building expansion joint.

C. Grilles and Registers:
   1. General:
      a. Stainless steel grilles and registers shall have a mil finish.
      b. Where registers are shown to be provided in lieu of grilles, include an integral opposed blade damper of the same construction as the grille.
      c. Dampers shown on the drawings do not represent integral dampers provided with registers. Where registers are indicated on the Drawings,

dampers shown shall be provided in addition to register integral dampers specified.

2. Supply Grilles (SG) and Supply Registers (SR):
   a. Construction: Type 316 stainless steel.
   b. Product and Manufacturer: Provide one of the following:
      1) Model SS2, as manufactured by Anemostat.
      2) Model T54SS, as manufactured by Tuttle & Bailey.
      3) Model 300RL-SS, as manufactured by Titus.
      4) Or equal.
   c. Double deflection with horizontal face bars for horizontal duct and vertical face bars for vertical duct.
   d. 3/4-inch blade spacing.
   e. For surface mounting as shown or indicated on Drawings.
3. Exhaust Grilles (EG) and Exhaust Registers (ER):
   a. Construction: Type 316 stainless steel.
   b. Type 316 stainless steel construction:
      1) Model SS3, as manufactured by Anemostat.
      2) Model T70SS, as manufactured by Tuttle & Bailey.
      3) Model RL-SS, as manufactured by Titus.
      4) Or equal.
   c. Single 0 degree deflection with horizontal face bars for horizontal duct and vertical face bars for vertical duct.
   d. 3/4-inch blade spacing.
   e. For surface mounting as shown or indicated on Drawings.

D. Wire Mesh Screens:
   1. Wire mesh screens shall be provided where shown or specified on the Drawings.
   2. Material:
      a. Type 316 stainless steel mesh and FRP frame.
   3. Mesh Size: 3/4-inch by 3/4-inch interwoven with 0.135-inch (10 gauge) diameter wire.

E. Mechanical Link Seals:
   1. Manufacturer: Provide product of one of the following:
      a. Pipeline Seal and Insulator, Inc.
      b. Thunderline Corporation.
      c. Calpico, Inc.
      d. Or equal.
   2. Provide mechanical link seals through masonry construction with adjusting bolts suitable for 20 psig of pressure.
   3. Details of Construction:
      a. Non-Fire Rated Seals:
         1) Pressure Plates: Glass reinforced nylon composite.
         2) Bolts and Nuts: Type 316 stainless steel.
         3) Sealing Element: EPDM.
      b. Fire Rated Seals:
         1) Pressure Plates: Zinc dichromate steel.

2) Bolts and Nuts: Two part zinc dichromate steel with corrosion inhibiting coating.
3) Sealing Element: Silicone.
4) 1-1/2-hour fire rating.

F. Hardware and Fasteners:
1. All hardware and fasteners shall be Type 316 stainless steel, unless noted otherwise.

G. Penetrations:
1. Where ductwork passes through masonry construction, saw cut rectangular openings and core drill round openings. Rough cut edges shall be grouted smooth.
2. Round opening shall be provided with mechanical seals except where otherwise noted.
3. Rectangular openings shall be calked water tight.

H. Flanged condensation drain nozzles shall be shop installed on ductwork by Manufacturer where shown on contract drawings and be a minimum of 2-in diameter.

2.5 FINISHING

A. Ductwork Edge Preparation and Surface Finish:
1. All cut edges shall be de-burred, chamfered and prepared with a3 to 5 mil unreinforced resin rich finish coat at the point of manufacturing and fully cured to a Barcol hardness recommended by the resin manufacturer with no acetone sensitive or otherwise tacky spots prior to pasting or shipping.
2. The Finish Coat work for all surfaces shall be free of defects such as but not limited to sharp projections, pinholes, excessive or inadequate film build, dry spots, drips, runs, sagging, and foreign inclusions. Any such defects shall be removed from the coat and the coat reapplied. The Finish Coat shall appear uniform and be of excellent workmanship.

B. Where existing walls, floors or roofs must be penetrated, Contractor shall neatly cut the required openings and patch the existing work to provide a neat and finished appearance.

2.6 IDENTIFICATION

A. Each fabricated ductwork section and field joint material packages shall be temporarily labeled with a piece number corresponding with and keyed to layout drawings for ease of storage and field assembly. Labels shall be able to withstand weather and durable enough to remain legible and stay affixed to ductwork until such time installation is complete and shown on drawing submittals.

B. Label containing Manufacturer's name, job number and date of manufacture shall be permanently laminated to each ductwork run prior to shipment. Label shall be located for ease of reference after installation and shown on drawing submittals.

C. Resin and Catalyst (hardener) shall be properly labeled with hazardous material warnings per Occupational Safety and Health (OSHA) and Department of Transportation (DOT) requirements.

D. Field trim locations shall be boldly marked on each plain end of ductwork intending to be field joined.

E. All equipment and component identification shall be provided in accordance with Section 10 14 00, Signage.

2.7 SOURCE QUALITY CONTROL

A. Fabrication Tolerances:
   1. ASTM D3982 Section 8, identified within this Article for convenience:
      a. Overall lengths are limited to plus or minus 1/4-in.
      b. Cut ends of round ductwork shall be square within plus or minus 1/8-in for less than 24-in diameter, 3/16-in for between 24-in and 48-in and 1/4-in for greater than 48-in diameter.
      c. Flanges:
         1) Face flatness plus or minus 1/32-in for less than or equal to 18-in diameter and plus or minus 1/16-in for greater than 18-in diameter.
         2) Warpage shall be plus or minus 3 degrees.
         3) Face perpendicularity to axis of duct shall be plus or minus 1/2 degree.
         4) Flange angularity plus or minus 1 degree for less than or equal to 24-in diameter, 3/4 degree for greater than 24-in to less than or equal to 48-in and 1/2 degree for greater than 48-in diameter.
         5) Offset shall be plus or minus 1/8-in.
         6) Cant shall be plus or minus 1/2 degree.
      d. Out of roundness is limit to the greater of plus or minus 1/8-in or 1% of ductwork inside diameter, not to exceed 3/4-in.
      e. Angles of all fittings shall be plus or minus 1 degree, up to and including 24-inch diameter, plus or minus 3/4 degree for greater than 24-inch to less than or equal to 48-inch and plus or minus 1/2 degree for greater than 48-inch diameter.
      f. Gap for fit-up at shop and field joint is limited to the thickness of the adjoining material, not to exceed 3/8-in.
   2. ASME RTP-1 Subpart 2C, identified within this Article for convenience:
      a. The average of four (4) spot wall thickness readings shall be not less than 95% nor more than 120% of the design laminate thickness.
   3. Other tolerance requirements:
      a. Flange thickness shall be minus 0.00-inches plus 20% of thicknesses within this Section or as designed and shown on shop drawings.
      b. Out of flatness is limited to the lesser of plus or minus 1/2-in or 1/2% of span.
      c. Out of square for rectangular ductwork is limited to 1/16-in per foot of each individual straight leg length, not to exceed 3/4-in.
   4. Square or rectangular ductwork tolerance requirements shall correspond to those of round ductwork having the same diameter as the longest side of the

square or rectangular duct when rounded up if not equal, unless otherwise specified within this Section.

5. Tolerance measurements shall take fabrication ambient temperature into consideration.

B. Shop Tests:
   1. Ductwork Inspection and Tests:
      a. All component and fabricated assemblies shall meet the dimensions and tolerances specified within this Section.
      b. All laminate quality shall be inspected and meet ASTM D2563 Table 1 Allowable Defects Visual Acceptance Level II, whereas defects referred to as Air Bubbles shall be limited to four (4) per square inch in the corrosion barrier and ten (10) per square inch of 1/16-inch maximum diameter or four (4) per square inch up to 1/8-inch diameter in the structural layer. The maximum percent repairs allowed shall be limited to 3% for the Corrosion Barrier and 10% for the Structural Layer of the components total surface area.
      c. Resin cure for all FRP ductwork shall be checked by Barcol hardness and acetone sensitivity tests. Hardness shall be within 90 percent of resin manufacturer's specification. Barcol test shall be required for inside and outside surfaces of all fiberglass fabrications and secondary overlays joining sections in accordance with ASTM D2583.
      d. Paste protrusion past ductwork inner surface shall not exceed 1/8-inch.

C. Third Party Ductwork Inspection and Tests:
   1. Submittal auditing and production run sample inspection and testing shall be conducted per FRPI SP9100, including:
      a. Submittal review for conformance with:
         1) Material design and fabrication methods specified.
         2) Drawing detail and calculation requirements.
      b. Production run product sample inspection for:
         1) Visual quality per ASTM D2563.
         2) Thickness per ASME RTP-1 Subpart 2C.
         3) Hardness per ASTM D2583.
      c. Production run product sample destructive testing verifying:
         1) Glass to resin ratio per ASTM D2584.
         2) Laminate sequence per ASTM D2584 and C582.
         3) Strengths of materials compared to design calculations per ASTM D638.
      d. Overall design basis and production quality verification.

D. Engineer’s Inspection and Tests:
   1. The Engineer reserves the right to inspect and reject any and all ductwork being manufactured that does not fully and completely meet the requirements of this Section. Fabrication and inspection records shall be made available upon request. The Owner, Owner’s Engineer and Owner’s or Engineer’s designated Agent will have adequate, open and safe access to the Manufacturer’s facility at all times during regular business hours for the purpose of inspecting equipment being manufactured for them.

2. The Manufacturer shall make any and all inspection tools readily available to parties that may participate in inspection. Such tools shall be in a good state of repair and properly calibrated for accurate measurement.
3. Final acceptance by Engineer is not in lieu of nor does is it intended to compromise Contractor's or Manufacturer's duty and warranty in any way as required by this Section.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine conditions under which materials and equipment will be installed and notify Engineer in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

B. Take field measurements where required prior to installation to ensure proper fitting of Work.

C. A thorough inspection of each piece of ductwork and installation materials for damage incurred in transit and material conformance to this Section shall be conducted by Contractor upon delivery to construction site. Any damage and non-conformance shall be immediately repaired and/or corrected by respective ductwork Manufacturer's personnel and not sales representatives.

D. Contractor shall perform continuous inspection during installation for:
   1. Butt wrap joint reinforcement materials and resin, to assure no moisture or other such contamination and proper workability.
   2. Gaps at joint fit up, surface preparation for butt wrap joints, application of all butt wrap material layers and laminate visual quality.
   3. Proper cure of field applied butt wrap joints utilizing acetone sensitivity and Barcol hardness test methods.

E. All Contractor continuous inspection during installation shall follow requirements of this Section, be document and be submitted with any corrective action reports necessitated for Engineer review and approval.

3.2 PREPARATION

A. Protection of Surrounding Areas/Surfaces:
   1. Openings and penetrations shall be capped to protect the building from outside conditions.
   2. Properly plug or cap the open ends of all ductwork at the end of each day's Work or other stopping point throughout the construction. Equipment shall be tightly covered and protected against dirt, water, and chemical or mechanical damage.

3.3 INSTALLATION

A. General:
   1. Section 01 70 00 – Execution and Closeout: Requirements for installation.
   2. Install the equipment in accordance with the Contract Documents and by manufacturer's instructions and recommendations. Obtain written interpretation from Engineer in the event of conflict between manufacturer's instructions and recommendations and the Contract Documents.
   3. Install in accordance with Laws and Regulations.
   4. Do not modify structures to facilitate installation of equipment, unless approved in writing by Engineer.
   5. Installation to conform to requirements of all local and state codes.

B. Anchorages and Base Plates:
   1. Provide anchorages in new or existing concrete, as applicable, in accordance with equipment manufacturer's recommendations and the Contract Documents. Install anchors in accordance with Section 05 05 33, Anchor Systems.
   2. Where used, pour concrete bases up to one inch below equipment baseplate or support leg as applicable. Base with equipment mounted shall then be accurately shimmed to grade and spaces between filled with non-shrink grout in accordance with Section 03 60 00, Grouting. After grout has reached its initial set, exposed edges shall be neatly cut back 1/2 inch.

C. Ductwork:
   1. All ductwork and accessories shall be installed in accordance with Manufacturer's recommendations and provide an air tight system free from leakage, deflection, pulsation, vibration, chatter or any other such condition when ductwork system is in or out of operation.
   2. Install ductwork as shown and dimensioned on contract drawings, such that it runs vertically, horizontally, parallel and perpendicular to building lines and where horizontal runs pitch towards drops or drains.
   3. Burial of Ductwork:
      a. Maintain at least 12" between ductwork and trench walls, providing enough room to accommodate compaction equipment and workers.
      b. Provide a uniform bearing surface that fully supports ductwork.
      c. If rock bedding or other such obstructions are encountered, excavate trench below sub grade and back-filled with material that is fully compacted.
      d. Utilize well rounded pea gravel 1/4" nominal size, ranging 1/8" to 3/4" diameter. The material should be clean and free flowing per ASTM C33. No stones, boulders, hard clods of earth or vegetation are allowed in fill.
      e. Compact material up to at least centerline of ductwork horizontal run and compact to a Procter density of 85% minimum.
   4. No piping, conduit or structural work shall be installed in or through any ductwork. Ductwork shall not be decreased at any point to avoid obstructions.
   5. Any and all modifications that may be necessary to suit field conditions and clear any obstruction or conflicts with other equipment shall be approved by Engineer in writing.

6. All ductwork shall be run as close as possible to structural members, walls, ceilings, overhead construction, columns or other structural and permanent enclosure elements of building, leaving sufficient access for performing field butt wrap joint and quality control work.
7. Ductwork shall be straight and smooth on inside, with neatly finished butt wrap joints
8. Install ductwork with fewest possible field joints, utilizing hangers, supports, anchors and seismic restraints as required by Contractor and Manufacturer design. All ductwork shall be securely supported and anchored to the building structure or free standing support.
9. All gaps between mating edges of ductwork and fittings shall be less than or equal to 3/8-inches per ASTM D3982 Article 9.2.4 and maximum offset of lesser of 1/4-inch or two (2) times edge thickness divided by three (3) prior to application of paste and butt wrap joint material.
10. Bracing and ties screwed to ductwork for positioning and/or to restrain movement during field butt wrap procedures shall not damage ductwork and shall be removed prior to completion of butt wrap joints.
11. FRP work performed during installation shall meet all requirements of this Section and be of Manufacturer shop quality as specified herein.
12. Fiberglass dust and styrene emissions propagated through cutting, grinding and laminating operations shall be managed per Manufacturer's instructions provided and pre-installation conference plans.
13. Test openings shall be field installed in the ductwork as directed by the testing, adjusting and balancing contractor. The openings shall be sealed by a screw cap and gasket, with cut edges of openings sealed with resin finish coat material.

3.4 FIELD QUALITY CONTROL

A. Contractor shall inspect ductwork upon receipt, verifying Manufacturer supplied laminate quality, flange thicknesses, major dimensions and tolerances meet the requirements per this Section. Any such non-conformities identified shall be immediately reported to Manufacturer and Engineer for corrective action.

B. Manufacturer's Services:
   1. Provide a qualified, factory-trained service person to perform the following:
      a. Instruct Contractor in installing equipment.
      b. At start of installation ductwork Manufacturer service person shall:
         1) Train how to apply and assist Contractor to the extent allowed by labor agreements with field butt wrap joints.
         2) Inspect Contractor butt warp joint work for conformance with this Section.
      c. During installation Manufacturer service person shall inspect Contractor butt warp joint work for conformance with this Section and provide retraining if necessary.
      d. After installation, inspect and adjust equipment, verify proper operation, and assist with field testing.
      e. Instruct operations and maintenance personnel in operation and maintenance of the equipment.

f. The Manufacturer shall provide a final inspection.

2. Ductwork Manufacturer's service person shall make visits to the Site as follows:
   a. First visit shall be for instructing Contractor in proper equipment installation, and assisting in installing equipment. Minimum number of hours on-Site: eight (8) hours or eight (8) hours per every ten (10) field butt wrap joints required to completely install ductwork, not to exceed twenty (24) hours. Contractor shall have ductwork in position, ready for first cut and surface preparation with materials staged for field butt wrap joint application prior to service person's arrival. Weather protection shall also be in place where required.
   b. Second visit shall be midway through installation for follow up inspection and re-training. Minimum number of hours on-Site: eight (8) hours or eight (8) hours per every ten (10) field butt wrap joints required to completely install ductwork, not to exceed twenty (24) hours
   c. Third visit shall be for checking completed installation. Minimum number of hours on-Site: eight (8) hours.
   d. Fourth visit shall be to instruct operations and maintenance personnel.
      1) Furnish services of manufacturer's qualified, factory-trained specialists to instruct operations and maintenance personnel in recommended operation and maintenance of equipment.
      2) Training requirements, duration of instruction, and qualifications shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
      3) Number of hours on-Site shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
   e. Technician shall revisit the Site as often as necessary until installation is acceptable.
3. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to the Site shall be included in the Contract Price.

3.5 TESTING, ADJUSTING AND BALANCING

A. Adjust all controls for proper settings.

B. Open all volume control devices in preparation for final testing and balancing.

C. Install fusible links in fire dampers and verify that dampers are in open position.

D. Start fan system and check for excessive leaks and vibration and correct.

E. Systems shall be completely tested, adjusted and balanced by a qualified and certified testing, adjusting and balancing Contractor. A complete balancing procedure shall be submitted for approval. All equipment and connections required to balance the systems shall be provided.

F. All duct systems shall be balanced in accordance with Section 23 05 93 - Testing, Adjusting and Balancing. Test and balance air volume within 5 percent of specified capacity.

G. While system is operable, balance all equipment to achieve design conditions.

3.6 CLEANING

A. Thoroughly clean all equipment and accessories prior to installation.

B. Remove all dirt, rust, dust, etc. from equipment and accessories after installation. Prior to final inspection, all surfaces shall be made clean by brushing, wiping, or with a compressed-air blast to remove all loose foreign materials.

C. Fully remove all temporary piece labels used to aid installation plus loose materials and obstructions from interior of ductwork without damaging FRP.

D. Remove and properly dispose of all unused butt and wrap joint materials and related supplies plus other debris and waste from the Site resulting from installation.

3.7 SCHEDULES

A. Ductwork associated with the following equipment shall be FRP:
   1. SF-1
   2. EF-1

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SECTION 23 34 06

NON-METALLIC HVAC FANS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install non-metallic HVAC fans complete and operational with accessories.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the non-metallic HVAC fans Work.

C. Related Sections:
   1. Section 10 14 00, Signage.
   2. Section 23 05 29, Hangers and Supports for HVAC Ductwork, Piping, and Equipment.
   3. Section 26 05 53, Identification For Electrical Systems.
   4. Section 26 28 16.33, Disconnect Switches.

1.2 REFERENCES

A. Air Movement and Control Association International, Inc. (AMCA).
   1. AMCA Standard 204 – Balance Quality and Vibration Levels for Fans.
   2. AMCA Standard 210 – Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
   3. AMCA Standard 300 – Reverberant Room Method for Sound Testing of Fans.
   4. AMCA Standard 301 – Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

B. American Bearing Manufacturers Association (ABMA).
   1. ABMA 9 – Load Ratings and Fatigue Life for Ball Bearings.
   2. ABMA 11 – Load Ratings and Fatigue Life for Roller Bearings.

C. American Society for Testing and Materials (ASTM).
   1. ASTM E84 – Standard Test Method for Burning Characteristics of Building Materials.
   2. ASTM D4167 – Standard Specification for Fiber-Reinforced Plastic Fans and Blowers.

D. National Electrical Code (NEC).

E. National Fire Protection Association (NFPA).

1. NFPA 90A – Standard for the Installation of Air-Conditioning and Ventilating Systems.
2. NFPA 91 – Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids.

F. Underwriters Laboratories Inc. (UL).

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer:
      a. Minimum of five years of experience producing substantially similar equipment and able to show evidence of at least five installations in satisfactory operation for at least five years.

B. Component Supply and Compatibility:
   1. Obtain all equipment included in this Section regardless of the component manufacturer from a single non-metallic HVAC fan manufacturer.
   2. Require the non-metallic HVAC fan manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
   3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall equipment assembly by the non-metallic HVAC fan manufacturer.

C. Regulatory Requirements:
   1. National Electrical Code (NEC).
   2. National Fire Protection Association (NFPA).
   3. Underwriters Laboratories Inc. (UL).
   4. Local and State Building Codes and Ordinances.
   5. Permits: Contractor shall obtain and pay for all required permits, fees and inspections.

D. Certifications:
   1. Non-metallic HVAC fans shall bear an approved label with all the necessary identification marks, electrical data, and any necessary cautions as required by the National Electric Code.
   2. Non-metallic HVAC fans shall be AMCA certified.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Drawings showing fabrication methods, assembly, accessories, installation details, and wiring diagrams.
      b. Setting drawings, templates, and directions for the installation of roof/equipment curbs, anchor bolts, and other anchorages.
   2. Product Data:

a. Manufacturer's literature, illustrations, specifications, weight, dimensions, required clearances, materials of construction, and performance data for all equipment.
b. Complete component list.
c. Detailed description of each component.
d. Catalog cut sheets for each component.
e. Fan performance curves with operating points.
f. Standard and custom color selection charts for finishing system.
g. Lubricant Specification: Furnish lubricant specification for type and grade required for equipment furnished.
h. Deviations from Contract Documents. Any exceptions to the Contract Documents must be clearly defined. Contractor shall be responsible for any additional expenses that may occur due to any exception made.
i. Other technical data related to specified material and equipment as requested by Engineer.

3. Testing Plans, Procedures, and Testing Limitations:
   a. Plan for performing required shop testing.
   b. Plan for performing required field testing.

B. Informational Submittals: Submit the following:
1. Certificates:
   a. Certification of painting systems, in accordance with "Finishing" Article in this Section.
   b. Independent certification reports:
      1) UL Label or equal.
      2) AMCA certification.
2. Manufacturer Instructions:
   a. Instructions and recommendations for handling, storing, protecting the equipment.
   b. Installation Data.
   c. Instructions for handling, start-up, and troubleshooting.
3. Source Quality Control Submittals:
   a. Written report presenting results of required shop testing.
   b. Factory test reports.
4. Field Quality Control Submittals:
   a. Written report presenting results of required field testing.
5. Supplier Reports:
   a. Submit written report of results of each visit to Site by Supplier's service personnel, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
6. Qualifications Statements:
   a. Manufacturer, when requested by Engineer.

C. Closeout Submittals: Submit the following:
1. Maintenance Contracts:

a. Service shall be provided by a factory-trained and certified equipment manufacturer's representative during the One Year Correction Period. The equipment manufacturer's representative shall maintain all equipment furnished under this Section during the first year of operation.
b. Service provided shall include the following:
    1) Quarterly On-Site Service: Service intervals shall be quarterly for a minimum of one day of eight hours each quarter. The service duration shall be increased, as necessary by the equipment manufacturer's representative, taking into consideration the equipment service requirements and equipment size. Equipment manufacturer's representative shall indicate the service duration and service scope. Prior to the visits, the equipment manufacturer's representative shall contact the Owner and inquire as to problems encountered with the equipment. Service visits shall be scheduled at times agreeable to the Owner at least one week in advance. The quarterly service shall include, but not limited to the following:
        a) Provide manufacturer's recommended maintenance.
        b) Check all controls and components, and recalibrate or adjust as necessary.
        c) Perform necessary cleaning and services that are scheduled on a quarterly basis in accordance with the approved Operations and Maintenance Manuals. Provide all expendable materials, as necessary.
        d) Review and provide recommendations concerning Owner's operations.
        e) Replace or repair defective controls and components.
        f) Inspect control panels. Test control panel's indication lights and replace defective lights.
        g) Provide a detailed field report to the Owner.
    2) Technical Support: Technical support shall be provided between the hours of 8:00 AM and 4:00 PM local standard time, Monday through Friday when requested by the Owner. Technical support shall include, but not limited to the following:
        a) Telephone Technical Support.
        b) On-Site Visits: If resolution of a problem is not achieved via the Telephone Technical Support, an on-site visit and field report shall be required.

2. Operations and Maintenance Data:
    a. Submit complete Installation, Operation and Maintenance Manuals, including, test reports, maintenance data and schedules, description of operation, and spare parts information.
    b. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operations and Maintenance Data.
3. Warranty Documentation:
    a. General warranty.
    b. Special warranties on materials and equipment.

D. Maintenance Material Submittals: Furnish the following:
   1. Spare Parts:
      a. Spare parts list and recommended quantities.
   2. Extra Stock Materials:
      a. Touch up paint for each unit.
   3. Tools:
      a. Two sets of special tools, if any, required for normal operation and maintenance.
   4. Spare parts, extra stock materials, and tools shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the Owner at the conclusion of the Project.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:
   1. Deliver materials to the Site to ensure uninterrupted progress of the Work.
   2. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete, in ample time to prevent delay of that Work.
   3. Comply with manufacturer's recommendations for rigging of equipment.

B. Storage and Protection:
   1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
   2. Store all equipment in covered storage off the ground and prevent condensation and in accordance with the manufacturer's recommendations for long-term storage.

C. Acceptance at Site:
   1. All boxes, crates and packages shall be inspected by Contractor upon delivery to the Site. Contractor shall notify Engineer, in writing, if any loss or damage exists to equipment or components. Replace lost equipment or components and repair damage to new condition, in accordance with manufacturer's instructions.

1.6 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive Owner of other rights or remedies Owner may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under the Contract Documents. The obligations of Contractor under the Contract Documents shall not be limited in any way by the provisions of the specified special warranty.

B. Special Warranty on Materials and Equipment:
   1. Provide manufacturer's written warranty, running to the benefit of Owner, agreeing to correct, or at option of Owner, remove or replace materials or

equipment specified in this Section found to be defective during a period of 1 year after the date of Substantial Completion.

PART 2 - PRODUCTS

2.1 EQUIPMENT PERFORMANCE

A. Design Criteria:
   1. Design conditions shall be as indicated on the Equipment Schedule.
   2. Fan bearings shall be rated for a minimum L-10 life of 100,000 hours at the fan's maximum operating speed in accordance with ABMA 9 or 11.
   3. Fans shall be balanced in accordance with AMCA Standard 204.
   4. Fiberglass reinforced plastic fan construction shall conform to ASTM D4167.

B. Performance Criteria:
   1. Minimum performance data for each unit shall be as indicated on the Equipment Schedule. Provided equipment shall not exceed scheduled total power.
   2. Fans shall be performance rated in accordance with AMCA Standards 210, 300, and 301.

2.2 DETAILS OF EQUIPMENT

A. FRP Duct Axial Fan
   1. Product and Manufacturer: Provide one of the following:
      a. Series 29, as manufactured by Hartzell Fan Inc.
      b. Or equal.
   2. Housing:
      a. All fiberglass reinforced plastic surfaces shall be constructed of Derakane 510-A epoxy vinyl ester resin to achieve Class I flame spread rate below 25 or equivalent and glass fiber.
      b. All structural parts in the air stream shall be fiberglass and resin.
      c. All internal hardware (air stream) shall be encapsulated Type 316 stainless steel.
      d. All external hardware (out of airstream) shall be Type 316 stainless steel.
      e. All air stream surfaces shall be provided with a synthetic veil and electrostatically conductive surface coating.
      f. Inspection door fastened with 316 stainless steel bot and gasketed for tight seal.
   3. Propeller:
      a. Air foiled designed.
      b. One piece construction.
      c. Cloth mat construction of solid fiberglass with aluminum insert molded into the hub for secure attachment to the shaft.
      d. Airfoil propeller shall not have an aerodynamic stall characteristic.

B. Fan Motors:

1. Motors shall be premium efficiency, totally enclosed fan cooled (TEFC) type. Where TEFC motors are not available from the manufacturer, provide open drip proof (ODP) type with a letter from the manufacturer stating TEFC is not available.
2. Motors shall have a service factor of 1.15.
3. Motors shall be normal starting torque, normal slip, squirrel cage induction type. VFD driven motors shall be compatible for variable frequency drive operation and suitable to be applied in speed varying service without overheating.
4. Motors shall be of sufficient size so that there will be no overload on the motor above rated nameplate horsepower under any condition of operation imposed by the driven equipment.
5. Motors shall have Class F insulation with Class B temperature rise and be capable of carrying nameplate full load current plus service factor continuously without an injurious temperature rise in an ambient temperature of 40 degrees C.
6. Motor thrust bearings shall be adequate to carry continuous thrust loads under all conditions of operation imposed by the driven equipment.
7. Motors shall be in accordance with all current applicable standards of NEMA, IEEE, ABMA, NEC, and ANSI.
8. Motor shall be mill and chemical duty rated.
9. Locked rotor currents shall be as specified in NEMA Standards.
10. Provide lubrication of non-hygroscopic grease or oil type.
11. Provide automatic breather and drain for TEFC motor enclosures.
12. Provide integral overload protection on all single phase motors.

C. Belts and Drives:
1. Fans shall be belt drive with adjustable sheaves or direct drive as shown on the Equipment Schedule.
2. Belts shall be oil and heat resistant, non-static type.
3. Drives shall be precision machined cast iron type, keyed and securely attached to the wheel and motor shafts. Drives shall be sized with a minimum 1.5 service factor of the installed motor horsepower.

2.3 ACCESSORIES

A. Provide fan manufacturer's vane axial guide.

B. Bird Screens:
1. For all roof mounted fans.
2. Provide 1-inch by 1-inch, 0.120-wire diameter, epoxy coated Type 316 stainless steel mesh screen securely anchored to housing.

C. Mounting Hardware:
1. Provide Type 316 stainless steel hardware for all fan installation.

D. Structural Supports:

1. Contractor shall provide and install all hangers, rods, supports, bolts, nuts, washers, inserts, and appurtenances as required to mount equipment where shown. All hangers, rods, supports, bolts, nuts, washers, inserts, and appurtenances shall conform to Section 23 05 29, Hangers and Supports for HVAC Ductwork, Piping, and Equipment.

2.4 FINISHING

A. All fiberglass surfaces shall be protected with a minimum 10 mil dry film thickness of chemical, flame, and ultraviolet resistant resin.

B. All gears, bearing surfaces, machined surfaces, and other surfaces that are to remain unpainted shall receive a heavy application of grease or other rust-resistant coating. Maintain coating during shipping and storage until equipment is placed into operation.

2.5 CONTROLS

A. SF-1 shall be controlled by an ON-OFF switch provided by electrical. SF-1 shall turned ON to operate when the wet well is occupied by personnel and shall be OFF when the wet well is not occupied.

B. EF-1 shall be interlocked to operated when SF-1 operates.

2.6 IDENTIFICATION

A. All equipment and component identification shall be provided in accordance with Section 10 14 00, Signage.

B. All electrical wiring identification shall be provided in accordance with Section 26 05 53, Identification For Electrical Systems.

C. All electrical wiring shall be color-coded and labeled for simplified identification. Power wiring shall be coded per Owner standards.

2.7 SOURCE QUALITY CONTROL

A. Shop Tests:
   1. Fan Tests:
      a. Except as described below or otherwise approved by Engineer, test one fan of each size in accordance with AMCA Standard 210. Tests are not required for standard fans for which data on previously tested units of equal design is available. Curves and other test data from units previously tested shall be submitted with shop test results prior to shipping equipment.
      b. Test each fan for minimum three hours run-time, at the manufacturer's plant with the job or test motor. Vibration and temperature measurements shall be taken to determine its mechanical integrity. Vibration level shall be limited to a maximum of 1.25 mils. Temperature of bearing housing

near the end of run time shall not exceed 215 degrees F under artificially created ambient temperature of 104 degrees F.

c. Each test shall be witnessed by a registered professional engineer, who may be an employee of fan manufacturer. The professional engineer shall certify that the required tests were performed, and sign and seal the results. Jurisdiction of professional engineer's registration, registration number, and name shall be on the seal. Equipment serial number shall also appear on test data for the fan.

2. Equipment shall be completely manufactured and pre-assembled in accordance with Reference Standards. Perform the following tests and inspections at factory before shipment:
   a. Tested and inspected for approval as a unit by Underwriters Laboratories Inc., UL Label or equal.
   b. Factory test equipment to ensure that the entire package has been properly fabricated and assembled, that all the controls function as specified herein and that the package meets the specified performance requirements including manufacturer's data report.
   c. Fan wheels and shafts shall be statically and dynamically balanced.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine conditions under which materials and equipment will be installed and notify Engineer in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

B. Take field measurements where required prior to installation to ensure proper fitting of Work.

3.2 PREPARATION

A. Protection of Surrounding Areas/Surfaces:
   1. Openings and penetrations shall be capped to protect the building from outside conditions.
   2. Equipment shall be tightly covered and protected against dirt, water, and chemical or mechanical damage.

3.3 INSTALLATION

A. General:
   1. Install the equipment in accordance with the Contract Documents and by manufacturer's instructions and recommendations. Obtain written interpretation from Engineer in the event of conflict between manufacturer's instructions and recommendations and the Contract Documents.
   2. Install in accordance with Laws and Regulations.

3. Do not modify structures to facilitate installation of equipment, unless approved in writing by Engineer.
4. Installation to conform to requirements of all local and state codes.
5. Roof curb mounted fans shall be provided with enough electrical wiring and conduit slack to allow the fan to be removed from the curb without disconnecting the electrical wiring at the fan.

3.4 FIELD QUALITY CONTROL

A. Field Tests:
   1. After equipment installation is complete, Contractor and a qualified field service representative of unit manufacturer shall perform an operating test and a sound test of each unit and associated controls, in presence of Engineer. Equipment will pass the test when each unit and its controls are demonstrated to function correctly, and sound levels do not exceed maximum limits.
   2. Running Tests:
      a. Field-test each equipment together with its controls and appurtenances. Tests shall demonstrate to Engineer that each part and all parts together function in accordance with the Contract Documents. Provide all necessary testing equipment, labor, and appurtenances.
      b. Verify that equipment operates at design point as intended, that vibration limits are not excessive and beyond manufacturer's recommendations, and that equipment operates smoothly without excessive noise, temperature rise, or other defects, across entire range of operating curve. Verify that all controls work as intended in both manual and automatic mode. Successfully test-operate each equipment for at least 24 hours.
      c. If equipment does not comply with the Contract Documents and does not pass the tests, Contractor shall adjust, modify, and retest the equipment as often as necessary until tests are successfully passed.

B. Manufacturer’s Services:
   1. Provide a qualified, factory-trained service person to perform the following:
      a. Instruct Contractor in installing equipment.
      b. After installation, inspect and adjust equipment, verify proper operation, and assist with field testing.
      c. Instruct operations and maintenance personnel in operation and maintenance of the equipment.
   2. Manufacturer’s service person shall make visits to the Site as follows:
      a. First visit shall be for instructing Contractor in proper equipment installation, and assisting in installing equipment. Minimum number of hours on-Site: 8 hours.
      b. Second visit shall be for checking completed installation, start-up of system; and performing field testing. Minimum number of hours on-Site: 8 hours.
      c. Third visit shall be to instruct operations and maintenance personnel.
         1) Furnish services of manufacturer’s qualified, factory-trained specialists to instruct operations and maintenance personnel in recommended operation and maintenance of equipment.

2) Training requirements, duration of instruction, and qualifications shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
3) Number of hours on-Site shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.

d. Technician shall revisit the Site as often as necessary until installation is acceptable.

3. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to the Site shall be included in the Contract Price.

3.5 ADJUSTING

A. Adjust all controls for proper settings.

B. While system is operable, balance all equipment to achieve design conditions.

3.6 CLEANING

A. Thoroughly clean all equipment and accessories prior to installation.

B. Remove all dirt, rust, dust, etc. from equipment and accessories after installation.

C. Remove and dispose of all debris and waste from the Site resulting from installation.

+ + END OF SECTION + +

SECTION 23 81 26

DUCTLESS SPLIT-SYSTEM HEAT PUMPS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, tools, equipment, and incidentals as shown, specified, and required to furnish and install ductless split-system heat pumps complete and operational with accessories.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the ductless split-system air-conditioners Work.

C. Related Sections:
   1. Section 03 60 00, Grouting.
   2. Section 05 05 33, Anchor Systems.
   3. Section 10 14 00, Signage.
   4. Section 23 05 29, Hangers and Supports for HVAC Ductwork, Piping, and Equipment.

1.2 REFERENCES

A. Air-Conditioning, Heating, and Refrigeration Institute (AHRI).
   1. AHRI 210/240 – Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).
   1. ASHRAE Standard 15 – Safety Standard for Refrigeration Systems.

C. American Society for Testing and Materials (ASTM).
   1. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
   2. ASTM B117 – Standard Practice for Operating Salt Spray (Fog) Apparatus.
   3. ASTM B280 – Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

D. National Electrical Code (NEC).

E. National Electrical Manufacturers Association (NEMA).

F. Underwriters Laboratories Inc. (UL).
   1. UL 1995 – Heating and Cooling Equipment.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer:
      a. Minimum of five years' experience producing substantially similar equipment and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.

B. Component Supply and Compatibility:
   1. Obtain all equipment included in this Section regardless of the component manufacturer from a single ductless split-system air-conditioner manufacturer.
   2. Require the ductless split-system air-conditioner manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
   3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall equipment assembly by the ductless split-system air-conditioner manufacturer.

C. Regulatory Requirements:
   1. National Electrical Code (NEC).
   2. National Fire Protection Association (NFPA).
   3. Underwriters Laboratories Inc. (UL).
   4. Local and State Building Codes and Ordinances.
   5. Permits: CONTRACTOR shall obtain and pay for all required permits, fees and inspections.

D. Certifications:
   1. Ductless split-system heat pumps shall bear an approved label with all the necessary identification marks, electrical data, and any necessary cautions as required by the National Electric Code.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Drawings showing fabrication methods, assembly, accessories, installation details, and wiring diagrams.
      b. Detailed drawings of each individual component's wiring diagrams.
      c. Detailed drawings of control panel layout.
      d. Detailed installation drawing of each individual component showing:
         1) Mounting requirements.
         2) Locations (panel, field, etc.).
         3) Ductwork, piping, and wiring connections, labeled and coded.
      e. Setting drawings, templates, and directions for the installation of anchor bolts and other anchorages.
   2. Product Data:
      a. Manufacturer's literature, illustrations, specifications, weight, dimensions, required clearances, materials of construction, and performance data for all equipment.

b. Complete component list.
c. Detailed description of each component.
d. Catalog cut sheets for each component.
e. Fan performance curves with operating points.
f. Deviations from Contract Documents. Any exceptions to the Contract Documents must be clearly defined. CONTRACTOR shall be responsible for any additional expenses that may occur due to any exception made.
g. Lubricant Specification: Furnish lubricant specification for type and grade required for equipment furnished.
h. Other technical data related to specified material and equipment as requested by ENGINEER.

B. Informational Submittals: Submit the following:
1. Certificates:
a. Certification of unit painting systems in accordance with "Finishing" Article in this Section.
b. Independent certification reports:
1) UL Label or equal.
2) AHRI Label.
2. Manufacturer Instructions:
a. Instructions and recommendations for handling, storing, protecting the equipment.
b. Installation Data.
c. Instructions for handling, start-up, and troubleshooting.
3. Source Quality Control Submittals:
a. Written report presenting results of required shop testing.
b. Factory test reports.
4. Field Quality Control Submittals:
a. Written report presenting results of required field testing.
5. Supplier Reports:
a. Submit written report of results of each visit to Site by Supplier's service personnel, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
6. Qualifications Statements:
a. Manufacturer, when requested by ENGINEER.

C. Closeout Submittals: Submit the following:
1. Maintenance Contracts:
a. Service shall be provided by a factory-trained and certified equipment manufacturer's representative during the One Year Correction Period. The equipment manufacturer's representative shall maintain all equipment furnished under this Section during the first year of operation.
b. Service provided shall include the following:
1) On-Site Service: Service intervals shall be quarterly for a minimum of one day of eight hours each quarter. The service duration shall be increased, as necessary by the equipment manufacturer's representative, taking into consideration the equipment service

requirements and equipment size. Equipment manufacturer's representative shall indicate the service duration and service scope. Prior to the visits, the equipment manufacturer's representative shall contact the Owner and inquire as to problems encountered with the equipment. Service visits shall be scheduled at times agreeable to the Owner at least one week in advance. The quarterly service shall include, but not limited to the following:

a) Provide manufacturer's recommended maintenance.
b) Check all controls and components and recalibrate or adjust as necessary.
c) Perform necessary cleaning and services that are scheduled on a quarterly basis in accordance with the approved Operations and Maintenance Manuals. Provide all expendable materials, as necessary.
d) Review and provide recommendations concerning Owner's operations.
e) Replace or repair defective controls and components.
f) Inspect control panels. Test control panel's indication lights and replace defective lights.
g) Provide a detailed field report to the Owner.

2) Technical Support: Technical support shall be provided between the hours of 8:00 AM and 4:00 PM local standard time, Monday through Friday when requested by the Owner. Technical support shall include, but not limited to the following:

a) Telephone Technical Support.
b) On-Site Visits: If resolution of a problem is not achieved via the Telephone Technical Support, an on-site visit and field report shall be required.

2. Operations and Maintenance Data:
   a. Submit complete Installation, Operation and Maintenance Manuals, including, test reports, maintenance data and schedules, description of operation, and spare parts information.
   b. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operations and Maintenance Data.
3. Warranty Documentation:
   a. General warranty.
   b. Special warranties on materials and equipment.

D. Maintenance Material Submittals: Furnish the following:
   1. Spare Parts:
      a. Spare parts list and recommended quantities.
      b. One set of filters for each unit.
   2. Tools:
      a. Two sets of fin combs for each fin spacing required.
   3. Spare parts, extra stock materials, and tools shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the Owner at the conclusion of the Project.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packing, Shipping, Handling, and Unloading:
   1. Deliver materials to the Site to ensure uninterrupted progress of the Work.
   2. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete, in ample time to prevent delay of the Work.
   3. Comply with manufacturer's recommendations for rigging of equipment.

B. Storage and Protection:
   1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
   2. Store all equipment in covered storage off the ground and prevent condensation and in accordance with the manufacturer's recommendations for long-term storage.

C. Acceptance at Site:
   1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if any loss or damage exists to equipment or components. Replace lost equipment or components and repair damage to new condition, in accordance with manufacturer's instructions.

1.6 WARRANTY

A. General Warranty: The special warranties specified in this Article shall not deprive OWNER of other rights or remedies OWNER may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by CONTRACTOR under the Contract Documents. The obligations of CONTRACTOR under the Contract Documents shall not be limited in any way by the provisions of the specified special warranties.

B. Special Warranties on Materials and Equipment:
   1. Provide manufacturer's written warranty, running to the benefit of OWNER, agreeing to correct, or at option of OWNER, remove or replace materials or equipment specified in this Section found to be defective during a period of years as listed below after the date of Substantial Completion.
      a. Compressors shall carry a minimum 6 year non-prorated warranty.
      b. All other components not listed above shall carry a minimum 5 year non-prorated warranty.

PART 2 - PRODUCTS

2.1 EQUIPMENT PERFORMANCE

A. Equipment Description:
   1. Units shall be completely factory assembled and tested, and internally piped and wired. Units shall consist of indoor air conditioners (indoor units) with

filters, evaporator coils, supply fans, motors, and remotely located heat pumps (outdoor units).
2. Units shall include all unit mounted controls, wiring, and accessories.
3. Indoor units and refrigerant pipes shall be purged with dry air before shipment from the factory.
4. Outdoor units shall be pre-charged with refrigerant for a minimum of 70 feet of refrigerant tubing.

B. Design Criteria:
1. Design conditions shall be as indicated on the Equipment Schedule.
2. Units shall conform and be certified to the latest editions of ASHRAE Standard 15 and UL 1995.

C. Performance Criteria:
1. Minimum performance data for each unit shall be as indicated on the Equipment Schedule. Provided equipment shall not exceed scheduled total power.
2. Units shall meet or exceed the Energy Efficiency Ratio (EER) shown on the Equipment Schedule when tested in accordance to the latest editions of AHRI Standard 210/240.
3. Outdoor units shall be capable of cooling operation down to 0 degree F ambient temperature without additional low ambient controls.
4. Outdoor units configured as heat pumps shall be capable of heating operation down to -13 degree F ambient temperature.
5. Outdoor units shall be able to operate with a maximum height difference of 100 feet between indoor and outdoor units.
6. System shall be capable of operating up to a minimum refrigerant tubing length of 100 feet between indoor and outdoor units without the need for line size changes, traps, or additional oil.

2.2 DETAILS OF EQUIPMENT

A. Ceiling-Recessed Cassette Air Conditioners:
1. Product and Manufacturer: Provide one of the following:
a. Model PLA, as manufactured by Mitsubishi Electric.
b. X Series, as manufactured by Sanyo.
c. Or equal.
2. Cabinet:
a. Cabinet shall be formed from galvanized sheet metal coated with high-density foam insulation.
b. Cabinet shall be for recessed mounting and provided with four corner mounting supports behind removable corner pockets in grille assembly allowing adjustment of mounting height from front of unit.
c. White grille assembly shall be attached to the front of the cabinet to provide supply air vanes in four directions and a center mounted return air section. Four-way grille shall allow two, three, or four-way blow.
d. Cabinet panel shall have provisions for a field installed filtered outside air intake.

e. Cabinet shall have a knock-out to provide a branch air duct for conditioning a secondary space.

3. Evaporator Coil:
   a. Coil shall be of nonferrous construction with pre-coated aluminum strake fins on copper tubing. All tube joints shall be brazed with PhosCopper or silver alloy.
   b. Coil shall be pressure tested at the factory.
   c. Coil shall be furnished with a condensate pan and drain.
   d. Unit shall include a built-in, automatic condensate lift mechanism that will be able to raise condensate 33 inches above the condensate pan. The lift mechanism shall be equipped with a positive acting liquid level sensor to shut down the indoor unit if liquid level in the drain pan reached maximum level.
4. Supply Fans:
   a. Direct drive, turbo propeller fan shall be driven by a single motor.
   b. Multi-speed fan motor shall have permanently lubricated bearings.
   c. Fan shall have a selectable AUTO fan setting that will adjust the fan speed based on the difference between controller setpoint and sensed space temperature.
5. Vanes:
   a. Motorized adjustable air outlet system shall provide two-way, three-way, or four-way airflow with switches that can be set to provide optimum airflow based on ceiling height and number of outlets used.
   b. Vane angles shall be individually adjustable from the remote controller to customize the airflow pattern for the conditioned space.
   c. Vanes shall have five fixed positions and a swing feature that shall be capable of automatically swinging the vanes up and down for uniform air distribution.
   d. Vanes shall have the selectable capability to randomly cycle the vanes up and down to evenly heat the space in the heating mode.
6. Filter:
   a. Return air shall be filtered by means of an easily removable, washable polypropylene honeycomb filter.

B. Outdoor Units:
1. Product and Manufacturer: Provide one of the following:
   a. Model PUZ, as manufactured by Mitsubishi Electric.
   b. Daikin
   c. Or equal.
2. Unit shall be configured as an air-source heat pump and shall include a four-way solenoid valve and compressor muffler.
3. Cabinet:
   a. Casing shall be fabricated of galvanized steel.
   b. Mounting feet shall be provided and shall be welded to the base of the cabinet.
   c. Removable panel sections shall allow easy access to all serviceable parts.
   d. Fan grill shall be constructed from ABS plastic.

e. Cabinet mounting and construction shall be sufficient to withstand 155 MPH wind speed conditions for use in Hurricane condition areas.

4. Condenser Fans:
   a. Direct drive fan and motor shall be configured for horizontal discharge airflow.
   b. Fan blades shall be of aerodynamic design for quiet operation and the fan motor bearings shall be permanently lubricated.
   c. Fan shall be mounted in front of the coil, pulling air across it from the rear and dispelling it through the front.
   d. Fan shall be provided with a raised guard to prevent external contact with moving parts.
5. Condenser Coil:
   a. Coil shall be of copper tubing with flat aluminum fins.
   b. Coil shall be protected with an integral metal guard.
6. Compressors:
   a. Compressor shall be hermetically sealed, variable speed, rotary or scroll type. Compressor shall be equipped with an internal thermal overload.
   b. Compressor shall be driven by inverter circuit to control compressor speed.
   c. In lieu of a crankcase heater, minimal amount of current shall be automatically and intermittently applied to the compressor motor windings to maintain sufficient heat to vaporize any refrigerant during the off cycle to prevent liquid accumulation.
   d. Compressor shall be mounted so as to avoid transmission of vibration.
7. Refrigeration System:
   a. Refrigerant flow from the condenser shall be controlled by means of an electronic linear expansion valve (LEV) metering device. The LEV shall be control by a microprocessor controlled step motor.
   b. System shall include an accumulator, high pressure safety switch, refrigerant line filter driers (strainers), Schrader type service fittings (stop valves) for liquid and suction connections, and service ports.

2.3 ACCESSORIES

A. Hangers and Supports:
   1. Hangers and supports shall be provided in accordance with Section 23 05 29, Hangers and Supports for HVAC Ductwork, Piping, and Equipment.

B. Refrigerant Piping and Insulation:
   1. All refrigerant lines between outdoor and indoor units shall be of annealed, refrigeration grade copper tubing, Type ACR, meeting ASTM B280 requirements.
   2. Refrigerant piping shall be individually insulated in twin-tube, flexible, closed-cell, CFC-free (ozone depletion potential of zero), elastomeric material.
   3. Insulation shall have a maximum thermal conductivity of 0.27 Btu-in/hr-ft^2-degree F at 75 degrees F and a maximum water vapor transmission of 0.08 perm-in.

4. Insulation shall have a maximum Flame Spread Index of 25 and a maximum Smoke Developed Index of 50 when tested in accordance with ASTM E84.

C. Weatherproof Insulation Jacketing:
   1. General: Provide for all refrigerant piping insulation exposed to the outdoor environment.
   2. Product and Manufacturer: Provide one of the following:
      a. VentureClad Plus as manufactured by VentureTape.
      b. Or equal.
   3. Material: Heavy duty multilayered laminate coated with acrylic pressure sensitive adhesive.
   4. Thickness: 24 mills.
   5. Tensile Strength: 188 Lbs/in
   6. Puncture: 80 Lbs.
   7. Emittance: 0.03
   8. Water Vapor Transmittance: 0.00 Perm
   9. Temperature Rating: -40 to 248 degrees F.
   10. Fastening: Self-adhering adhesive.
   11. Finish: Embossed Aluminum

D. Indoor units shall be provided with a condensate mini-pump by the split system manufacturer.

E. Indoor units shall be equipped with a temperature sensor kit that provides uniform temperature detection from floor to ceiling to automatically adjust the temperature setpoint.

F. Outside air temperature and humidity sensor shall be furnished with the units for field installation.

G. Outdoor units shall be provided with wind baffle for low ambient cooling operation.

2.4 FINISHING

A. Outdoor units shall be provided with a full seacoast protection package which include the following features:
   1. Casings shall be fabricated with alloyed galvanized sheet metal with thermoset polyester-resin coating on internal and external surfaces.
   2. Compressor covers shall be fabricated with galvanized-aluminum sheet metal with thermoset polyester-resin coating on internal and external surfaces.
   3. Electrical panels shall be fabricated with galvanized-aluminum sheet metal with thermoset polyester-resin coating on external surface.
   4. Fan motor supports shall be fabricated with galvanized steel with thermoset polyester-resin coating on internal and external surfaces.
   5. Printed circuit boards shall be coated with epoxy resin and polyurethane top coat on external surface.

2.5 CONTROLS

A. Sequence of Operations:
   1. AC-1 thru 3 shall be controlled by a thermostat provided by the split system manufacturer set to maintain 78°F cooling and 55°F heating within the space.

B. Unit shall be completely factory wired with the necessary controls, starters, contactors and terminal blocks for power and control wiring.

C. A color-coded circuit diagram of the approved electrical drawing shall be provided with the unit.

D. All electrical components shall bear the UL label.

E. Unit shall be designed for single point electrical connection. All necessary power transformers shall be factory provided and installed.

F. The system shall be capable of satisfactory operation within voltage limits of 198 VAC to 253 VAC, 1 Phase, 60 Hz.

G. The power to the indoor unit shall be supplied from the outdoor unit. A factory provided three AWG-14 wire conductors with ground shall provide power feed and bi-directional control transmission between the outdoor and indoor units. The outdoor unit shall have Pulse Amplitude Modulation circuit to utilize 98 percent of input power supply.

H. The control system shall consist of a minimum of two microprocessors, one on each indoor and outdoor unit, interconnected by a single non-polar two-wire cable. The outdoor unit shall be controlled by the microprocessor located in the indoor unit using 24 VDC pulse control signal.

I. The indoor unit control board shall have auxiliary control contact connectors to provide:
   1. Heat Recovery Control.
   2. Back-up Heat.
   3. Remote Switch.
   4. Central Control.
   5. IP Terminal.

J. The microprocessor located in the indoor unit shall have the capability of monitoring return air temperature and indoor coil temperature, receiving and processing commands from a wireless or wired controller, providing emergency operation, and controlling the outdoor unit.

K. The system shall include a 3-minute time delay mechanism, an automatic restart function when power is restored after power interruption, and a test run switch.

L. The system shall have self-diagnostics ability, including total hours of compressor run time. Diagnostics codes for indoor and outdoor units shall be displayed on the controller panel.

M. Remote Controllers:

1. Wired, Wall Mounted:
    a. Remote controller shall be approximately 5-inch by 5-inch in size and white in color with a light-green LCD display.
    b. The control voltage from the wired controller to the indoor unit shall be 12/24 VDC.
    c. Field wiring shall run directly from the indoor unit to the wall mounted controller with no splices. Up to two wired controllers shall be able to be used to control one unit.
    d. Controller shall support a selection from multiple languages (Spanish, German, Japanese, Chinese, English, Russian, Italian, or French) for display information.
    e. Controller shall include be a built-in weekly timer with up to 8 pattern settings per day.
    f. Controller shall consist of an ON/OFF button, Increase/Decrease Set Temperature buttons, a Cool/Auto/Fan/Dry mode selector, a Timer Menu button, a Timer ON/OFF button, Set Time buttons, a Fan Speed selector, a Ventilation button, a Test Run button, and a Check Mode button.
    g. Controller shall have a built-in temperature sensor.
    h. Temperature shall be displayed in either Fahrenheit (°F) or Celsius (°C), and temperature changes shall be by increments of 1 degree F (0.5 degree C).
    i. Controller shall have the capability of controlling up to a maximum of 16 systems, as a group with the same mode and temperature setpoint for all, at a maximum developed control cable distance of 1,500 feet.
    j. Basic functions of the controller shall include:
        1) ON/OFF for run and stop operation.
        2) Operation mode for switching between Cool/Dry/Auto/Fan/Heat.
        3) Temperature setpoints:
            a) Cool/Dry: 67-87 degrees F.
            b) Heat: 63-83 degrees F.
            c) Auto: 67-83 degrees F.
        4) Fan speed settings.
        5) Air flow direction settings.
        6) Scheduling.
        7) Operating conditions and error code display.
        8) Ventilation control.
        9) Auto lock out function for setting or releasing of all buttons.

2.6 IDENTIFICATION

A. All equipment and component identification shall be provided in accordance with Section 10 14 00, Signage.

2.7 SOURCE QUALITY CONTROL

A. Shop Tests:
    1. Equipment shall be completely manufactured and pre-assembled in accordance with Reference Standards. Perform the following tests and inspections at factory before shipment:

a. Tested and inspected for approval as a unit by Underwriters Laboratories Inc., UL Label or equal.
b. Factory test equipment to ensure that the entire package has been properly fabricated and assembled, that all the controls function as specified herein and that the package meets the specified performance requirements including manufacturer's data report.
c. Fan wheels and shafts shall be statically and dynamically balanced.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine conditions under which materials and equipment will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

B. Take field measurements where required prior to installation to ensure proper fitting of Work.

3.2 PREPARATION

A. Protection of Surrounding Areas/Surfaces:
1. Openings and penetrations shall be capped to protect the building from outside conditions.
2. Equipment shall be tightly covered and protected against dirt, water, and chemical or mechanical damage.

3.3 INSTALLATION

A. General:
1. Install the equipment in accordance with the Contract Documents and by manufacturer's instructions and recommendations. Obtain written interpretation from ENGINEER in the event of conflict between manufacturer's instructions and recommendations and the Contract Documents.
2. Install in accordance with Laws and Regulations.
3. Do not modify structures to facilitate installation of equipment, unless approved in writing by ENGINEER.
4. Installation to conform to requirements of all local and state codes.

B. Concrete Pad Anchorages and Base Plates:
1. Provide anchorages in new or existing concrete, as applicable, in accordance with equipment manufacturer's recommendations and the Contract Documents. Install anchors in accordance with Section 05 05 33, Anchor Systems.

2. Where used, pour concrete bases up to one inch below equipment baseplate or support leg as applicable. Base with equipment mounted shall then be accurately shimmed to grade and spaces between filled with non-shrink grout in accordance with Section 03 60 00, Grouting. After grout has reached its initial set, exposed edges shall be neatly cut back 1/2 inch.

3.4 FIELD QUALITY CONTROL

A. Field Tests:
   1. After equipment installation is complete, CONTRACTOR and a qualified field service representative of unit manufacturer shall perform an operating test and a sound test of each unit and associated controls, in presence of ENGINEER. Equipment will pass the test when each unit and its controls are demonstrated to function correctly, and sound levels do not exceed maximum limits.
   2. Running Tests:
      a. Field-test each equipment together with its controls and appurtenances. Tests shall demonstrate to ENGINEER that each part and all parts together function in accordance with the Contract Documents. Provide all necessary testing equipment, labor, and appurtenances.
      b. Verify that equipment operates at design point as intended, that vibration limits are not excessive and beyond manufacturer's recommendations, and that equipment operates smoothly without excessive noise, temperature rise, or other defects, across entire range of operating curve. Verify that all controls work as intended in both manual and automatic mode. Successfully test-operate each equipment for at least 24 hours.
      c. If equipment does not comply with the Contract Documents and does not pass the tests, CONTRACTOR shall adjust, modify, and retest the equipment as often as necessary until tests are successfully passed.

B. Manufacturer’s Services:
   1. Provide a qualified, factory-trained service person to perform the following:
      a. Instruct CONTRACTOR in installing equipment.
      b. After installation, inspect and adjust equipment, verify proper operation, and assist with field testing.
      c. Instruct operations and maintenance personnel in operation and maintenance of the equipment.
   2. Manufacturer’s service person shall make visits to the Site as follows:
      a. First visit shall be for instructing CONTRACTOR in proper equipment installation and assisting in installing equipment. Minimum number of hours on-Site: 4 hours.
      b. Second visit shall be for checking completed installation, start-up of system; and performing field testing. Minimum number of hours on-Site: 4 hours.
      c. Third visit shall be to instruct operations and maintenance personnel.
         1) Furnish services of manufacturer’s qualified, factory-trained specialists to instruct operations and maintenance personnel in recommended operation and maintenance of equipment.

2) Training requirements, duration of instruction, and qualifications shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
3) Number of hours on-Site shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.

d. Technician shall revisit the Site as often as necessary until installation is acceptable.

3. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to the Site shall be included in the Contract Price.

3.5 ADJUSTING

A. Adjust all controls for proper settings.

B. While system is operable, balance all equipment to achieve design conditions.

3.6 CLEANING

A. Thoroughly clean all equipment and accessories prior to installation.

B. Remove all dirt, rust, dust, etc. from equipment and accessories after installation.

C. Remove and dispose of all debris and waste from the Site resulting from installation.

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SECTION 26 05 05

GENERAL PROVISIONS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to complete the electrical Work.
   2. Temporary Utilities: CONTRACTOR shall provide temporary power and lighting in accordance with Section 01 51 05, Temporary Utilities, Section 01 51 13, Temporary Electricity, and Section 01 51 26, Temporary Lighting.
   3. Demolition: Electrical demolition shall be in accordance with Section 02 41 00, Demolition.
   3. Demolition: Responsibility for electrical demolition is indicated in Section 01 12 13, Summary of Work.
   4. Utility Companies: United Illuminating
      a. Electric Utility Company: Perform the Work in connection with the electric service and utility metering in accordance with requirements of United Illuminated Company
      b. Telephone and Communications Utility Company: Perform the Work in connection with telephone service and communications services in accordance with requirements of (--2--).

B. Coordination:
   1. Review installation procedures and schedules under other Specification sections and coordinate with other trades the installation of electrical items that must be installed with or within formwork, walls, partitions, ceilings, and panels.

C. General:
   1. Interpretation of Drawings:
      a. Dimensions on Drawings related to equipment are based on equipment of certain manufacturers. Conform the dimensions of equipment furnished to space allocated to the equipment.
      b. Drawings show the principal elements of the electrical Work, and are not intended as detailed working drawings for the electrical Work. Drawings supplement and complement the Specifications relative to principal features of electrical systems.
      c. Equipment and devices furnished and installed under this Contract shall be properly connected and interconnected with other equipment and devices for successful operation of complete systems, whether or not all connections and interconnections are specifically mentioned or shown in the Contract Documents.

d. Similar products shall be from the same manufacturer for uniformity.
e. Drawings are provided for CONTRACTOR's guidance in fulfilling the operational intent of the Contract Documents CONTRACTOR shall comply with safety and electrical codes and provide equipment, appurtenances, and specialty items necessary for complete and operable systems.

D. Related Sections:
1. Section 02220, Demolitions.

1.2 QUALITY ASSURANCE

A. Permits: Refer to the General Conditions and Supplementary Conditions for responsibilities relative to obtaining and paying for CONTRACTOR's permits, licenses, and inspection fees.

B. Testing Laboratory Labels: Electrical material and equipment shall be new and bear the label of Underwriters' Laboratories, Inc. or other nationally recognized, independent testing laboratory, where standards have been established and label service applies.

C. Area Classifications:
1. Materials, equipment, and incidentals shall conform to the area classification(s) shown, specified, and required.
2. Wet Locations: Conform to NEC and NEMA requirements for wet locations. Enclosures in wet locations shall meet NEMA 4 requirements unless specified otherwise.
3. Corrosive Locations: Conform to NEC and NEMA requirements for corrosive locations. Enclosures in corrosive locations shall conform to NEMA 4X requirements unless specified otherwise.
4. Dusty Locations: Indoor areas not designated as hazardous, corrosive, or wet are dusty locations. Conform to NEC and NEMA 12 requirements unless specified otherwise.
5. Hazardous Locations: Conform to NEC and NEMA requirements for hazardous locations. Enclosures in hazardous locations shall conform to NEMA 7 requirements unless specified otherwise. Enclosure shall be suitable for wet and corrosive locations when located in areas identified as as wet and corrosive in addition to hazardous locations.requirements unless specified otherwise.

D. Wiring Coordinator:
1. Retain the services of a Wiring Coordinator who shall prepare complete point-to-point interconnection wiring diagrams. The diagrams shall identify all external interconnecting wiring associated with new or modified existing equipment.

a. Qualifications: Wiring Coordinator shall have experience in the development of diagrams of the type specified and shall have served in a similar role on a project of similar size and complexity.
   1) Present qualifications and approach for the project at the Presubmittal Conference.
   2) Prepare the items listed below for presentation at the Pre-submittal Conference. Submit copies to ENGINEER three weeks prior to the conference.
      i. List of projects where the Wiring Coordinator developed point-to-point wiring diagrams.
      ii. Samples of diagrams that were developed for the listed projects.
      iii. Example wiring diagram proposed for the Project with a preliminary list of drawings to be produced.
      iv. Plan of how information will be obtained and documented.

b. Responsibilities:
   1) Develop diagrams for performance of the Work and to document terminations. Prepare diagrams per the requirements specified under this Specification section. The diagrams are in addition to any loop diagrams specified elsewhere.
   2) Use information obtained from approved Shop Drawings, record drawings, and field inspections as required to complete the diagrams.

E.. Field Quality Control:
1. Conduct field quality control Work for the electrical installation. Field quality control shall be per the requirements specified in Article 3.3 of this Section.
2. Obtain from OWNER record drawings required to execute the Work.

F. Reference Standards:
1. ANSI.
2. ASTM.
3. ICEA.
4. IEEE.
5. ISA.
6. NEC.
7. NEMA.
8. NFPA.
9. OSHA.
10. UL.

1.3 SUBMITTALS

A.. Review of equipment submittals does not relieve CONTRACTOR of their contractual responsibility to provide complete and successfully operating systems.

B.. Shop Drawings shall include the following information to the extent applicable to the particular item:

1. Manufacturer's name and product designation or catalog number.
2. Electrical ratings.
3. Conformance to the reference standards.
4. Dimensioned plan, section, elevations, and panel layouts showing means for mounting, conduit connection, and grounding.
5. Materials and finish specifications, including paints.
6. List of components including manufacturer's names and catalog numbers.
7. Internal wiring diagram and drawings indicating all connections to components and numbered terminals for external connections.
8. Point-to point interconnection wiring diagrams.

C. Submit a written description detailing the sequence of construction staging including the steps required to complete the work. The description shall include an estimate of the shutdown time required for each step or phase. The estimate and written procedure shall be submitted to the OWNER for review 30 calendar days prior to the proposed start date of the shutdown.

D. Submit operating test procedures and results for equipment.

1.4 PROJECT CLOSE OUT

A. Record Drawings:
   1. Furnish the following record documents for the electrical Work:
      a. System Record Drawings: Include the following:
         1) One-line wiring diagram of the distribution system.
         2) Actual, in-place conduit and cable layouts with schedule of conduit sizes and number, and size of conductors.
         3) Layouts of the power and lighting arrangements and the grounding system.
         4) Control schematic diagrams, with terminal numbers and all control devices identified, for all equipment.
      b. Point-to-Point Interconnection Wiring Diagram Drawings: Include the following:
         1) External wiring for each piece of equipment, panel, instrument, and other devices and wiring to control stations, lighting panels, and motor controllers.
         2) Numbered terminal block identification for each wire termination.
         3) Identification of the assigned wire numbers for all interconnections.
         4) Identification of wiring by the conduit tag in which the wire is installed.
         5) Terminal, junction, and pull boxes through which wiring is routed.
         6) Identification of all equipment and the Shop Drawing transmittal number for equipment from which the wiring requirements and termination information was obtained.
   2. The record documents shall reflect final equipment and field installation information.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Delivery of Products: Advise Subcontractors and Suppliers of the maximum shipping sizes of equipment that can be accommodated at the Site.

1.6 JOB CONDITIONS

A. Existing Conditions:
   1. Examine the Site and existing facilities to compare them with the Contract Documents relative to the conditions of the premises, location of and connection to existing facilities, and obstructions that may affect the Work.
   2. Perform the Work with due regard to safety and in a manner that will not interfere with the existing equipment or cause interruption of the functions of the Site, unless specified otherwise.
   3. Work shall be performed with a minimum amount of disruption to the operation of the existing facilities and Site and with prior approval of OWNER. Submit for review by OWNER and ENGINEER a detailed written procedure for Work affecting operation of existing facilities and Site, a detailed procedure for modifying existing electrical equipment, and anticipated time required to complete the Work and the required shutdown time, if any.
   4. Where the Work ties in with existing installations, CONTRACTOR shall take precautions and safeguards in connecting the Work to existing operating circuits to prevent interruption to existing circuits. Connection of Work to existing circuits shall be performed in the presence of OWNER and ENGINEER. Advance written notice is required before equipment is removed from service, per the requirements of Section 01143, Coordination with Owner's Operations.

B. Demolition:
   1. Electrical demolition shall be in accordance with the requirements specified under Section 02220, Demolitions.

1.7 STAGING OF WORK

A. Where the Work requires equipment to be taken out of service, CONTRACTOR shall perform the Work with due regard to maintenance of operations and construction staging.

B. The level of service and control existing at the start of the Contract shall be maintained at all times, except as required during actual change-over to new equipment. Interruptions of existing circuits shall be coordinated with the OWNER who will determine the length of time a circuit may be de-energized to maintain the OWNER's processes in dependable and safe operation.

C. The following general staging constraints shall apply during execution of the Electrical Work:
   1. The work shall be sequenced and executed such that when equipment is taken

out of service power disruptions and plant operations are minimized.

2. When equipment is taken out of service, the work shall be executed in a continuous fashion so that the circuits are operational on the new supply within the shortest time possible. The work shall be executed consecutively daily with sufficient manpower without stopping until all work is complete and the equipment is operational.
3. Operational shall be defined to indicate that the work regarding a certain circuit or piece of equipment is complete and that it has been proven and tested and accepted by the OWNER.
4. Shutdown of the next circuit shall not proceed until the previous circuit becomes operational with the new replacement equipment.

D. The following general requirements govern the staging sequences:

1. In order to maintain the continuous plant operation desired construction sequencing as described under Section 01143, Coordination with Owner's Operations and shown on the Drawings will be required.
2. The descriptions are not intended as an exact sequence of work or a listing of priorities. However, procedural steps are presented and are intended to recommend a sequence in order to maintain the continuous operation of the plant.
3. The methods proposed are intended for guidance only, and the Contractor may request modifications to these procedures for approval by the OWNER.

1.8 ELECTRICAL EQUIPMENT

A. Electrical equipment shall be capable of operating successfully at full-rated load, without failure, with an ambient outside air temperature of 0 degrees F to 104 degrees F and an elevation of 100 feet above Mean Sea Level.

B. Unless specified otherwise, electrical equipment shall have ratings based on 75 degrees C terminations.

1.9 ELECTRICAL INSULATING MATS

A. All rooms where electrical equipment is shown shall be provided with rubber matting designed for electrical insulation as a floor covering to prevent shock around the equipment. The mats shall be ANSI/ASTM, type and class per the voltage. They shall be provided in front of all low voltage switchgear, panelboards, and motor control centers. The mats shall be three feet in width and length as required to span the entire electrical equipment footprint.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine the conditions under which Work is to be performed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with Work until unsatisfactory conditions have been corrected.

3.2 DEMONSTRATION OF EQUIPMENT

A. Demonstrate to OWNER and ENGINEER when the Work is Substantially Complete that all electrical systems and electrically operated equipment operate per the Contract Documents and as required.

B. Coordinate equipment demonstrations and tests with OWNER and ENGINEER in advance

C. Perform the following operational tests:
   1. Operate power circuits to verify proper operation and connection to equipment, including mechanical key-interlocks for circuit breakers.
   2. Remove and re-apply power supply to automatic transfer equipment to verify their operation. Activate standby power systems to verify their automatic start-up, proper de-energization, and cool down upon resumption of normal power supply.
   3. Operate control circuits including pushbuttons, indicating lights, and similar devices to verify proper connection and function. Operate all devices, such as pressure and flow switches and similar devices, to verify that shut-downs and control sequences operate as required.
   4. Operate lighting systems and receptacle devices to verify proper operation and connections.

D. Provide a report on the equipment demonstration and operating tests. The report shall include complete information on the tests performed and results.

3.3 FIELD QUALITY CONTROL

A. Provide services to interface with existing circuits. Field-determine system and equipment requirements prior to modifying existing systems.

B. Field services required shall include the following:
   1. Coordinate the interface of equipment with OWNER's personnel and field conditions.
   2. Field compare existing starter and panel control circuit terminations from record documents with the existing circuits.
   3. Field-trace existing circuits as required to interface the equipment provided.
   4. Field-identify terminations for starters and panel controls for follow function for re-connection.

C. Provide tools and equipment required to trace circuits necessary for proper execution of the Work.

D. Define and identify all wiring, circuit terminations, and equipment to be modified to ensure the proper interface of all components. The Contract Price includes all costs associated with field services specified for a complete and functional system.

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SECTION 26 05 19

600 VOLT CABLE

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install 600-volt cable.
   2. Types of cable required include:
      a. Insulated cable for installation in raceways.
      b. Cable for installation in trays.

B. Related Sections:
   1. Section 16075, Electrical Identification.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. UL 44, Thermoset-Insulated Wires and Cables.
   2. ASTM B3, Standard Specification for Soft or Annealed Copper Wire.
   3. ASTM B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft.
   4. NETA, Acceptance Testing Procedures.
   5. ICEA S-95-658, Non-Shielded Power Cables Rated 2000V or Less.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. NEC Article 300, Wiring Methods.
   2. NEC Article 310, Conductors for General Wiring.
   3. Tests by Independent Regulatory Agencies: Cable shall bear the label of the Underwriters' Laboratories, Incorporated.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Product Data:
      a. Manufacturer's literature, specifications, and engineering data for 600 volt insulated cable proposed for use.
      b. Manufacturer's literature for cable markers.

B. Informational Submittals: Submit the following:
   1. Field Quality Control Submittals: Written records of field insulation resistance test results.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Insulated Cable In Raceways:
   1. Material: Single conductor copper cable conforming to ASTM B3 and ASTM B8 with flame-retardant, moisture- and heat-resistant insulation rated for 90 degrees C in dry or wet locations, listed by UL as Type XHHW-2 conforming to UL 44..
   2. Wire Sizes: Not smaller than No. 12 AWG for power and lighting and No. 14 AWG for 120-volt control circuits.
   3. Stranding: 600-volt cable shall be stranded, except that solid cable, No. 10 and smaller may be used for lighting circuits.
   4. Manufacturers: Provide products of one of the following:
      a. Southwire.
      b. The Okonite Company.
      c. American Insulated Wire.
      d. Or equal.

B. Cable Connectors, Solderless Type:
   1. For wire sizes up to and including No. 6 AWG, use compression type. Alarm and control wire shall be terminated using forked type connectors at terminal boards.
   2. Products and Manufacturers: Provide products of one of the following:
      a. T&B Sta-Kon.
      b. Burndy Hylug.
      c. Or equal.
   3. For wire sizes No. 4 AWG and above, use either compression type or bolted type with silver-plated contact faces.
   4. For wire sizes No. 250 KCMIL and larger, use connectors with at least two cable clamping elements or compression indents and provision for at least two bolts for joining to apparatus terminal.
   5. Properly size connectors to fit fastening device and wire size. Connectors shall be rated for 90 degree C, 600 volts.

C. Cable Splices:
   1. For wire sizes No. 8 AWG and larger, splices shall be made up with compression type copper splice fittings. Splices shall be taped and covered with materials recommended by cable manufacturer to provide insulation equal to that on conductors.

2. For wire sizes No. 10 AWG and smaller, splices may be made up with compression type butt splices.
3. For wet locations, splices shall be waterproof. Compression type splices shall be waterproofed by sealant-filled, thick wall, heat shrinkable, thermosetting tubing or by pouring thermosetting resin into mold that surrounds the joined conductor. Spring connector splices shall be waterproofed with sealant filler.
4. Splices shall be suitably sized for cable, rated 90 degrees C, 600 volts.
5. Products and Manufacturers: Provide one of the following:
    a. Compression-Type Splices:
        1) Burndy Hylink.
        2) T&B Color-Keyed Compression Connectors.
        3) Or equal.
    b. Spring Connectors:
        1) Buchanan B-Cap.
        2) T&B Wire Connector.
        3) Or equal.

D. Wire and Cable Markers:
1. Provide wire and cable markers in accordance with Section 16075, Electrical Identification.

2.2 SOURCE QUALITY CONTROL

A. Factory Production Tests:
1. Factory-test wire and cable in accordance with UL standards

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install cables complete with proper terminations at both ends. Check and correct for proper phase sequence and proper motor rotation.
B. Pulling:
1. Use insulating types of pulling compounds containing no mineral oil.
2. Pulling tension shall be within limits recommended by wire and cable manufacturer.
3. Use dynamometer where mechanical means are used.
4. Cut off section subject to mechanical means.

C. Bending Radius: Limit to minimum of six times cable overall diameter.

D. Slack: Provide maximum slack at all terminal points.

E. Splices:
1. Install cable continuous, without splice, from termination to termination.

2. Where splices are shown on the drawing or where required for cable installation (pulling tension). Splices below grade, in manholes, handholes, and wet locations shall be waterproof and shall cold shrink type, hot shrink not permitted.
3. Splices are not allowed in conduits.
4. Where splices are provided due to pulling tension, Contractor shall submit calculations showing tension are exceeded for approval by Engineer before performing the splice.

F. Identification:
1. Identify conductors in accordance with Section 16075, Electrical Identification.
2. Identify power conductors by circuit number and phase at each terminal or splice location.
3. Identify control and status wiring using numeral tagging system.

G. Color code power cables as follows:
1. No. 8 AWG and Smaller: Provide colored conductors.
2. No. 6 AWG and Larger: Apply general purpose, flame retardant tape at each end, wrapped in overlapping turns to cover an area of at least two inches.
3. Colors: Match color scheme in use at the Site.
a. Power wiring shall use the following colors:

System:	Conductor:	Color:
All Systems	Equipment Grounding	Green
240/120 Volts Single-Phase, Three-Wire	Grounded Neutral One Hot Leg Other Hot Leg	White Black Red
208Y/120 Volts Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	White Black Red Blue
240/120 Volts Three-Phase, Four-Wire Delta, Center Tap Ground on Single-Phase	Grounded Neutral Phase A High (wild) Leg Phase C	White Black Orange Blue
480Y/277 Volts Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	Gray Brown Orange Yellow

b. Control wiring shall utilize the following colors:
1) AC control wiring, ungrounded: Red
2) AC control wiring, grounded: White
3) DC Control wiring, ungrounded: Blue
4) DC control wiring, grounded: White with blue stripe

5) Multi conductor control cable: see Section 16121, Instrumentation Cable
6) Intrinsically safe wiring: Light blue. This color shall not be used for any other type of wiring.

c. Control wiring provided with control panels, and not subject to this Section, shall meet the requirements specified in Section 13330, Control Panels and Panel Mounted Equipment.

3.2 FIELD QUALITY CONTROL

A. Test each electrical circuit after permanent cables are in place, to demonstrate that circuit and equipment are connected properly and will perform satisfactorily, free from improper grounds and short circuits.

B. Individually test 600-volt cable mechanical connections after installation and before they are put in service, with calibrated torque wrench. Values shall be in accordance with manufacturer's recommendations.

C. Individually test 600-volt cables for insulation resistance between phases and from each phase to ground. Test after cables are installed and before they are put in service, with Megger for one minute at voltage rating recommended by cable manufacturer or in accordance with NETA recommendations.

D. Insulation resistance for each conductor shall not be less than value recommended by cable manufacturer or in accordance with ICEA standards. Cables not meeting recommended value or that fail when tested under full load conditions shall be replaced with a new cable for full length.

E. Where existing cables are spliced to cables provided under this Contract, test existing cables prior to splicing. Test cables at 1,000 volts DC for one minute. Entire spliced cable installation shall be re-tested after splice is completed. Existing cable that fails or has value less than two megohms shall be brought to attention of ENGINEER and splicing shall not proceed until condition is acceptable.

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SECTION 16 05 23

INSTRUMENTATION AND COMMUNICATION CABLE

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install instrumentation and communication cable.
   2. Types of cable include the following:
      a. Shielded instrument cable.
      b. Ethernet Cable.
      c. Modbus Cable.
      d. Device Net Cable.

B. Related Sections:

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. UL 1581, Electrical Wires, Cables and Flexible Cords.
   2. UL 13, Power-Limited Circuit Cables.
   3. UL VW-1, Vertical Wire Flame Test.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. NEC Article 725, Class 1, Class 2, and Class 3 Remote-Control, Signaling and Power-Limited Circuits.
   2. NEC Article 727, Instrumentation Tray Cable.
   3. Tests by Independent Testing Agencies: Cable shall bear label of Underwriters' Laboratories, Inc.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Product Data: Manufacturer's technical information for instrumentation cable proposed.

PART 2 – PRODUCTS

2.1 SHIELDED INSTRUMENT CABLE

A. Single Shielded Pair Instrument Cable:
   1. Tinned copper, XLPE insulated stranded conductors, No. 16 AWG minimum, twisted pair with overall shield, stranded tinned No. 18 AWG copper drain wire and overall PVC jacket. Rated for 600 volts minimum and conforming to UL 1581.
   2. Manufacturers: Provide products of one of the following:
      a. Belden Company.
      b. Okonite Company.
      c. Dekoron Wire and Cable Company.
      d. Or equal.

B. Multi-paired Shielded Instrument Cable:
   1. Tinned copper, XLPE insulated stranded conductors, No. 16 AWG minimum, twisted pairs with shield over each pair, stranded tinned No. 18 AWG copper drain wire, and overall PVC outer jacket. Rated for 600 volts minimum and conforming to UL 1581 or UL 13.
   2. Manufacturers: Provide products of one of the following:
      a. Belden Company.
      b. Okonite Company.
      c. Dekoron Wire and Cable Company.
      d. Or equal.

C. Multi-conductor Shielded Instrument Cable:
   1. Tinned copper, XLPE insulated stranded conductors, No. 16 AWG minimum, stranded tinned No. 18 AWG copper drain wire, with overall 100 percent foil shield and overall PVC jacket. Rated for 600 volts minimum.
   2. Manufacturers: Provide products of one of the following:
      a. Belden Company.
      b. Okonite Company.
      c. Dekoron Wire and Cable Company.
      d. Or equal.

D. Multi-conductor Shielded High-Temperature Instrument Cable:
   1. Silver-plated copper, extruded Teflon insulation, stranded conductors, No. 16 AWG minimum, with overall 90 percent silver-plated copper braid shield and overall Teflon tape-wrapped jacket. Rated for 600 volts minimum and conforming to UL VW-1.
   2. Manufacturers: Provide products of one of the following:
      a. Belden Company.
      b. Okonite Company.
      c. Dekoron Wire and Cable Company.
      d. Or equal.

E. Cable Terminals:
   1. Fork type copper compression terminals with nylon insulation for termination of cable at terminal blocks.
   2. Manufacturers: Provide products of one of the following:
      a. T&B Sta-Kon.
      b. Burndy Insulug.
      c. Or equal.

2.2 ETHERNET CATEGORY 6 CABLE:

A. Ethernet 10/100/1000 BASE-T/TX CAT 6 Cable.
   1. Cable shall be 23AWG solid bare copper conductors, bonded pair, FEP insulation, FEP outer jacket, industrial grade suitable for indoor, sunlight, oil, gas resistant, sequential footage marking every two feet. Rated for 300 Volts, 150 degrees Celsius UL Temperature Rating and compliant with NEC and plenum rated.
   2. Cat 6 cables are suitable for use on Gigabit Ethernet, 100 BaseTX, 100 BaseVG ANYLAN, 155 ATM, 622 ATM, 250 MHz systems.
   3. All Base TX (RJ-45) terminations on the twisted pair cable shall be done in a professional and workman like manner. Terminations shall provide for proper strain relief on the cable jacket. Strain relief on the wire and/or wire insulation shall not be acceptable.

B. Manufacturers: Provide products of one of the following:
   1. Belden 7931A.
   2. Or equal.

2.3 MODBUS CABLE

A. Connections between field equipment as shown on the Contract Documents shall be made using Modbus cable suitable for the PLC System. An RS485-MODBUS must use a balanced pair and a third Common wire. Provide Modbus cable tagging in the same fashion as DeviceNet cable tagging.

B. Meet the following requirements:
   1. Protocol: Modbus-RTU,
   2. Medium: Shielded twisted pair cable, impedance 120 ohms or greater and a Common wire.
   3. Termination: 120 ohms, Serial Communication. Provide terminating resistors for the network.
   4. Type: Asynchronous, half-duplex RS-485,
   5. Cable: 24 AWG stranded (7x32) TC conductors, polyethylene insulation, twisted pair, overall Beldfoil® (100% coverage) + TC braid shield (90% coverage), 24 AWG stranded TC drain wire, PVC jacket.

C. Manufacturer and Product:

1. Belden 9841 cable; 1X Technologies 1XB9841EQ cable; or equal shall be provided.
2. Note: Belden 9841 Cable is the cable recommended by Allen-Bradley for connection to Modbus RTU networks.

2.4 DEVICENET CABLE:

A. Trunk Line Cable (Round Thick Cable):
   1. 15AWG and 18AWG stranded tinned copper conductors
   2. 18AWG stranded (19x30) tinned copper drain wire
   3. 100% individually foil-shielded and overall 65% tinned copper braided
   4. Nominal OD: 0.460 inch (11.68 mm)
   5. Nominal Impedance: Maximum 120 ohm
   6. Nominal Attenuation: 0.13 dB/100ft @0.125MHz, 0.25 dB/100ft @0.500MHz, 0.36 dB/100ft @1.000MHz
   7. Nominal Capacitance: Maximum 12 pF/ft (39.4 pF/ft)
   8. Color code
      a. Power pair: Red/Black
      b. Data Pair: Blue/White
      c. Conductor colors shall match at all transition points and terminations through system.
   9. UL Listed
   10. Products and Manufacturers:
      a. Belden 3082.
      b. Northwire Inc., DataCell Field.
      c. Or equal.

B. Drop Line Cable (Round Thin Cable):
   1. 22AWG and 24AWG stranded tinned copper conductors
   2. 22AWG stranded (19x30) tinned copper drain wire
   3. 100% individually foil-shielded and overall 65% tinned copper braided
   4. Nominal OD: 0.280 inch (7.11 mm)
   5. Nominal Impedance: Maximum 120 ohm
   6. Nominal Attenuation: 0.29 dB/100ft @0.125MHz, 0.50 dB/100ft @0.500MHz, 0.70 dB/100ft @1.000MHz
   7. Nominal Capacitance: Maximum 12 pF/ft (39.4 pF/ft)
   8. Color code
      a. Power pair: Red/Black
      b. Data Pair: Blue/White
      c. Conductor colors shall match at all transition points and terminations through system.
   9. UL Listed
   10. Products and Manufacturers:
      a. Belden 3084.
      b. Northwire Inc., DataCell Field.
      c. Or equal.

PART 3 – EXECUTION

3.1 INSTALLATION

A. General:
   1. Install cable complete with proper terminations at both ends.
   2. Install in conduit separate from power cables, unless specified otherwise.
   3. Ground shield on shielded cables at one end only and as recommended by instrument manufacturer.
   4. Identify conductors in accordance with Section 16075, Electrical Identification.
   5. Install and terminate Supplier-furnished cable in accordance with Supplier equipment requirements and cable manufacturer's recommendations.
   6. Install in conformance with the National Electrical Code, and Laws and Regulations.

3.2 FIELD QUALITY CONTROL

A. Site Testing:
   1. Test shielded instrumentation cable shields with an ohmmeter for continuity along full length of cable, and for shield continuity to ground.
   2. Connect shielded instrumentation cables to calibrated 4 to 20 mA DC signal transmitter and receiver. Test at four and twenty milliamp transmitter settings.
   3. Replace with new cable the full length of cable that fails a test.

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SECTION 26 05 33.13

RIGID CONDUITS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install conduit and fittings to form complete, coordinated and grounded raceway systems.
   2. When specific, detailed conduit routings for various systems within buildings and other areas are not be shown on the Drawings, CONTRACTOR shall establish routings based on single-line, riser, and interconnection diagrams and other information on the Drawings. CONTRACTOR shall provide for the proper installation of conduits in each system.
   3. Conduit types and the installation methods shall conform to the following, unless otherwise shown or indicated in the Contract Documents:
      a. Use galvanized steel conduit (rigid steel) or aluminum for exposed indoor conduit runs in non-corrosive areas for low voltage power signals.
      b. Use galvanized steel conduit (rigid steel) for exposed indoor conduit runs in non-corrosive areas for medium voltage.
      c. Use aluminum conduit for exposed interior or exterior conduit runs in hazardous, wet, and corrosive locations.
      d. Use PVC-coated rigid steel conduit for individual conduits direct-buried in the ground.
      e. Use Schedule 40 PVC or steel conduit for concrete-encased duct bank runs. PVC conduit shall be used for low voltage power and discrete signals. Rigid Steel conduits shall be used for medium voltage power and all signals identified in item 1.1.3.g below.
      f. Use galvanized steel conduit or PVC for conduit runs embedded in structural concrete slabs.
      g. Use galvanized steel conduit for plant monitoring and control (PMCS) systems, system control and data acquisition (SCADA) systems, and communication systems, regardless of the installation. Conduit shall PVC coated in wet, and corrosive locations.

B. Coordination:
   1. Conduit runs shown are diagrammatic. Coordinate conduit installation with piping, ductwork, light fixtures, and other systems and equipment and locate to avoid interferences.
   2. For conduits to be embedded in concrete slabs, confirm adequate slab thickness and coordinate location of conduits with placement of reinforcing steel, waterstops, expansion joints, and other features of the concrete slab.

C. Related Sections:
   1. Section 02315, Excavation and Backfill.
   2. Section 02576, Pavement and Resurfacing.
   3. Section 16070, Supporting Systems.
   4. Section 16075, Electrical Identification.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI/NEMA FB1, Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable.
   2. NEMA TC3, Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
   3. UL 514B, Conduit, Tubing, and Cable Fittings.
   4. UL 651, Safety Schedule 40 and 80 Rigid PVC Conduit and Fittings.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. NEC Article 344, Rigid Metal Conduit.
   2. NEC Article 352, Rigid Nonmetallic Conduit.

1.4 SUBMITTALS

A. Action Submittals: Submit the following in accordance with Section 01300, Submittals:
   1. Shop Drawings:
      a. Assembly details of conduit racks and other conduit support systems.
      b. Layout drawings showing proposed routing of exposed conduits, conduits embedded in structural concrete, and conduits directly buried in the ground. Drawings shall show locations of pull and junction boxes and penetrations in walls and floors. Shop Drawings of embedded conduits shall include cross-sections showing thickness of concrete slabs and locations of conduits relative to reinforcing steel, waterstops, and other features of the slab.
   2. Product Data: Manufacturer's catalog cuts and product data for conduit, fittings, and appurtenances.

B. Informational Submittals: Submit the following:
   1. Manufacturer's Instructions: When requested by ENGINEER, provide copies of manufacturer's recommendations for handling and installing products.
   2. Site Quality Control Submittals: When requested by ENGINEER, provide copies of results of specified Site quality control testing.

C. Closeout Submittals: Submit the following:
   1. Record Drawings: Show actual routing of exposed and concealed conduit runs in record documents.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Rigid Steel Conduit, Elbows, and Couplings:
   1. Manufacturers: Provide products of one of the following:
      a. Allied Tube and Conduit.
      b. Wheatland Tube Company.
      c. Western Tube and Conduit Corporation.
      d. Or equal.
   2. Material: Rigid, heavy-wall, mild steel, hot-dip galvanized, smooth interior, tapered threads and carefully reamed ends; 3/4-inch NPS minimum size.

B. PVC-coated Rigid Steel Conduit, Elbows, and Couplings:
   1. Manufacturers: Provide products of one of the following:
      a. Robroy Industries.
      b. Perma-Cote Industries.
      c. OCAL, Inc.
      d. Or equal.
   2. Material: Rigid, heavy-wall, mild steel, hot-dip galvanized, smooth urethane interior coating, tapered threads, carefully reamed ends, 3/4-inch NPS minimum size with factory exterior coating of 40-mil thick PVC.
   3. Color: Color of coating shall be the same on all conduit and fittings.
   4. PVC coating shall be factory applied.

C. Aluminum Conduit, Elbows, and Couplings:
   1. Material: Rigid, heavy-wall aluminum, smooth interior, tapered threads and carefully reamed ends; 3/4-inch NPS minimum size.
   2. Manufacturers: Provide products of one of the following:
      a. Allied Tube and Conduit.
      b. Wheatland Tube Company.
      c. Or equal.

D. Metallic Conduit Fittings, and Outlet Bodies:
   1. Manufacturers: Provide products of one of the following:
      a. Crouse-Hinds Company.
      b. Appleton Electric Company.
      c. Or equal.
   2. Material and Construction: Cast gray iron alloy, cast malleable iron or aluminum bodies and covers consistent with conduit material. Units shall be threaded type with five full threads. Conform to ANSI/NEMA FB1 and be

listed by UL. Do not use "LB" fittings. Use type "LBD" fittings where use of fittings is unavoidable.

3. Use: Conduits shall be gasketed and watertight in hazardous, wet, and corrosive locations.

E. PVC-coated Conduit Fittings, and Outlet Bodies:
   1. Manufacturers: Provide products of one of the following:
      a. Robroy Industries.
      b. Perma-Cote Industries.
      c. OCAL, Inc.
      d. Or equal.
   2. Material and Construction: Cast gray iron alloy, cast malleable iron bodies and covers with factory coating of 40-mil thick PVC and smooth urethane interior coating. Units shall be threaded type with five full threads. Material shall conform to ANSI/NEMA FB1 and be listed by UL. Do not use "LB" fittings. Use type "LBD" fittings where use of fittings is unavoidable.
   3. PVC coating shall be factory applied.

F. Non-metallic Conduit and Fittings:
   1. PVC Plastic Conduit:
      a. Manufacturers: Provide products of one of the following:
         1) Amoco Chemicals Corp.
         2) Carlon Electrical Products.
         3) Or equal.
      b. Material: Schedule 40 PVC, rated for 90 degrees C, conforming to NEMA TC3 and UL 514B and 651.
      c. Fittings: Form elbows, bodies, terminations, expansions, and fasteners of same material and manufacturer as base conduit. Provide cement by same manufacturer as base conduit.

G. Conduit Hubs:
   1. Manufacturers: Provide products one of the following.
      a. Myers Electrical Products Company.
      b. Cooper Industries.
      b. Or equal.
   2. Material: Threaded conduit hub, vibration-proof, weatherproof, with captive O-ring seal, zinc metal with insulated throat and bonding screw.
   3. Use: Provide for all conduit terminations to boxes, cabinets, and other enclosures in all areas except areas except where PVC coated conduit is used. In areas with PVC coated conduit use PVC coated conduit hubs.

H. PVC-coated Conduit Hubs:
   1. Manufacturers: Provide products one of the following:
      a. Robroy Industries.
      b. Perma-Cote Industries.
      c. OCAL, Inc.

d. Or equal.

2. Material: Threaded conduit hub, vibration-proof, weatherproof, with captive O-ring seal, zinc metal with insulated throat and factory coating of 40-mil thick PVC and smooth urethane interior coating.
3. Use: Provide for PVC-coated steel or aluminum conduit terminations to boxes, cabinets, and other enclosures in areas designated as corrosive location.

I. Thruwall Seals
1. For new construction through exterior subsurface walls and exterior concrete walls.
   a. Manufacturer: Provide one of the following:
      1) Type WSK and WSCS by O-Z/Gedney.
      2) Cooper Crouse-Hinds Link-Seal® with Steel Sleeve at both sides of the wall.
      3) Or equal.
2. For new construction passing through concrete floors and floor slabs.
   a. Manufacturer: Provide one of the following:
      1) Type FSK and FSCS floor seals by O-Z/Gedney.
      2) Cooper Crouse-Hinds Link-Seal® with Steel Sleeve.
      3) Or equal.
3. For conduits passing through new exterior block walls or through core-drilled holes in existing exterior subsurface walls, exterior concrete walls, floor slabs, and roof slabs, and for conduits passing through existing interior concrete walls or floors and interior block walls.
   a. Manufacturer: Provide one of the following:
      1) Type CSMI sealing bushing at the inside of the structure and Type CSMC sealing bushing at the outside of the structure by O-Z/Gedney.
      2) Cooper Crouse-Hinds Link-Seal® at both sides.
      3) Or equal.

2.2 ACCESSORIES

A. Fasteners: To the extent possible, fastener material shall be consistent with conduit material. For PVC-coated rigid steel conduit runs, fasteners shall have factory applied PVC coating or be stainless steel. Fasten raceway systems to supporting structures using the following:
1. To Wood: Wood screws.
2. To Hollow Masonry UnitsAdhesive anchors
3. To Brick Masonry: Expansion bolts by Price, or equal.
4. To Concrete: Anchor bolts or adhesive anchor
5. To Steel: Beam clamps in accordance with Section 16070, Supporting Systems.

B. Duct Sealing Compound for panels and enclosures
1. Soft, fibrous, slightly tacky, non-hardening sealing compound.
2. Remains workable at all temperatures.

3. Manufacturer:
    a. Type DUX by O-Z/Gedney.
    b. Type DS5 by Panduit
    c. Or equal.

C. Duct sealing for cables in conduit entering buildings below grade
1. Inflatable, sealed bladder of flexible, metallic laminate, high temperature sealant. Self sealing gel
2. Manufacturer
    a. Raychem RDSS Sealing System.
    b. CDC Sealing Systems.
    c. Or equal.

2.3 IDENTIFICATION

A. Conduit Labels:
1. Provide conduit labels in accordance with Section 16075, Electrical Identification.

B. Warning Tape:
1. Provide warning tape in accordance with Section 16075, Electrical Identification.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work will be performed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install in conformance with Laws and Regulations.

B. Supports:
1. Rigidly support conduits by clamps, hangers, or Unistrut-type channels. Conduit supports and accessories shall be in accordance with Section 16070, Supporting Systems.
2. Support single conduits by means of one-hole pipe clamps in combination with one-screw back plates, to raise conduits from the support surface. Support multiple runs of conduits on trapeze type hangers.

C. Fastenings: Fasten raceway systems rigidly and neatly to supporting structures using specified materials.

D. Exposed Conduit:
   1. Install parallel or perpendicular to structural members or walls.
   2. Where possible, run in groups. Provide conduit racks of suitable width, length, and height, arranged to suit field conditions. Provide support every ten feet, minimum.
   3. Install on structural members in protected locations.
   4. Locate clear of interferences.
   5. Provide six inches of clearance from hot fluid lines and 1/4-inch from walls.
   6. Install vertical runs plumb. Unsecured drop length shall not exceed 12 feet.

E. Conduit Embedded in Structural Concrete:
   1. Run embedded conduit in structural concrete in center of slabs and walls and above waterstops. Conduit connections shall be made watertight.
   2. Before placing concrete, arrange for observation of conduit installation by ENGINEER and make necessary conduit location measurements and provide required information on record documents.
   3. Confirm that concrete thickness is sufficient for embedding the quantity of conduits intended. Unless specifically shown or indicated otherwise, embedded conduits shall be in accordance with the following criteria:
      a. Minimum concrete thickness shall be as follows:
         1) For concrete 16 inches thick and less, minimum concrete thickness shall be 11.5 inches plus the depth of largest conduit assembly. Conduit assembly depth shall be from the top of uppermost conduit to bottom of lowest conduit.
         2) For concrete greater than 16 inches thick, minimum concrete thickness shall be 13.5 inches plus depth of largest conduit assembly.
         3) For concrete at foundation slabs, provide a one inch additional thickness to minimum concrete thicknesses specified.
      b. Conduit spacing shall be as follows:
         1) Two adjacent conduits shall be separated by center-to-center distance of three times the outer diameter of larger conduit
         2) When conduits cross at a point, conduits may be in direct contact and angle of cross shall be 45 degrees or greater. Conduits may also cross within the vertical spacing of multi-conduit layer assembly.
         3) When conduits cross structural expansion joint, two adjacent conduits shall be separated by center-to-center distance of three times the outer diameter of conduit fitting of the larger conduit

F. Underground Conduits:
   1. Install individual, underground conduits minimum of 30 inches below grade, unless otherwise shown or indicated.
   2. Perform excavation, bedding, backfilling, and surface restoration, including pavement replacement where required, in accordance with Section 02315, Excavation and Backfill and Section 02576, Pavement and Resurfacing.
   3. Install warning tape 12 inches below finished grade over buried conduits.

4. Provide cable duct sealing for conduits entering structure below grade to prevent water entering the structure through the conduit.

G. Empty Conduits:
   1. Install nylon pull wire in each empty conduit and cap conduits not terminating in boxes with permanent fittings designed for the purpose.
   2. Spare conduit entering below grade shall have a duct sealing removable plug installed to prevent water from entering the building through the conduit.

H. Field Bends: No indentations. Diameter of conduit shall not vary more than 15 percent at bends.

I. Joints:
   1. Apply conductive compound to joints before assembly.
   2. Make up joints tight and ground thoroughly.
   3. Use standard tapered pipe threads for conduit and fittings.
   4. Cut conduit ends square and ream to prevent damaging wire and cable.
   5. Use full threaded couplings. Split couplings are not allowed.
   6. Use strap wrenches and vises to install conduit. Replace conduit with wrench marks.
   7. Apply zinc-rich paint to exposed threads and other areas of galvanized conduit system where base metal is exposed.

J. Terminations:
   1. Install conduit hubs on conduits entering enclosures.

K. Moisture Protection:
   1. Plug or cap conduit ends at time of installation to prevent entrance of moisture and foreign materials.
   2. Underground and embedded conduit connections shall be watertight.
   3. Thruwall Seals and Conduit Sealing Bushings: Install for conduits passing through concrete slabs, floors, walls, or concrete block walls.
   4. Drainage: Conduit runs shall be fully drainable. Where possible install conduit runs to drain to one end and away from building. Avoid pockets or depressions in conduit runs.
   5. Seal conduit openings within control and instrumentation panels and distribution equipment with duct sealing compound to provide watertight seal.

L. Corrosion Protection:
   1. Conduit Curb:
      a. For conduits routed in concrete slabs or floors and stub-ups through floor, provide two inch high concrete curb, extending two inches from outer surface of conduit penetrating floor, to prevent corrosion. For floor-mounted equipment, concrete equipment base shall be in lieu of concrete curb.

b. Conduit stub-ups shall be 90-degree, PVC-coated, rigid, galvanized steel conduit elbow. PVC-coated elbow shall extend a minimum of 18-inches above top of concrete curb or equipment base. Should elbow not reach specified height, provide PVC-coated conduit extension to accommodate specified requirements. Provide coupling or fitting for transition from rigid galvanized steel conduit or PVC conduit in slab to PVC-coated elbow.

c. For conduits stubbing up and terminating at equipment enclosure mounted on concrete base, provide insulated grounding bushing on PVC-coated rigid steel elbow.

d. For conduits stubbing up and extending to boxes, cabinets, and other enclosures above the concrete curb in wet and dusty areas, provide conduit coupling/fittings between the PVC-coated rigid steel elbow and rigid steel conduit for transition between the two conduit types.

e. For conduits stubbing up and extending to boxes, cabinets, and other enclosures above the concrete curb or equipment base in corrosive areas, continue conduit system with PVC-coated rigid steel conduit

2. Dissimilar Metals:

a. Prevent occurrence of electrolytic action between dissimilar metals.

b. Do not use copper products in connection with aluminum, and do not use aluminum in locations subject to drainage of copper compounds on bare aluminum.

c. Back paint aluminum in contact with masonry or concrete with two coats of aluminum-pigmented bituminous paint.

M. Reused Existing Conduits:

1. Pull rag swab through conduits to remove water and to clean conduit prior to installing new cable.
2. Repeat swabbing until all foreign material is removed.
3. Pull mandrel through conduit, if necessary, to remove obstructions.

N. Core drill for individual conduits passing through existing concrete slabs and walls. Notify ENGINEER in writing in advance of core drilling. The Contractor shall utilize ground penetrating radar prior to making penetrations in existing surfaces, regardless of trade performing the cutting and coring.

1. Ground penetrating radar shall be used to locate existing conduit, wiring, and reinforcing bars embedded in slabs and walls at all interior and exterior penetrations prior to making penetrations.

2. Results of the ground penetration radar survey shall be submitted to the Engineer prior to making penetrations.

3. Seal spaces around conduit as indicated in Paragraph 3.2.K.3 of this Section.

O. Non-metallic Conduit:

1. Install in accordance with manufacturer's recommendations.
2. Provide manufacturer's recommended adhesives or sealants for watertight connections.
3. Provide expansion fittings for expansion and contraction to compensate for temperature variations. Fittings shall be watertight and suitable for direct burial.
4. Transition to PVC-coated rigid steel conduit before making turn up to enclosures.

P. PVC-coated Rigid Steel Conduit:
1. Install in accordance with manufacturer's recommendations.
2. Install with manufacturer's installation tools to avoid damage to PVC coating.
3. Repair damaged PVC coating with manufacturer's recommended touch-up compound.

Q. Identify conduits, including spares, in accordance with Section 16075, Electrical Identification.

3.3 SITE QUALITY CONTROL

A. Site Tests:
1. Test conduits by pulling through each conduit a cylindrical mandrel with length not less than two pipe inside diameters, having an outside diameter equal to 90 percent of conduit's inside diameter.
2. Maintain a record, by number, of all conduits successfully tested.
3. Repair or replace conduits that do not successfully pass testing, and re-test.

+ + END OF SECTION + +

SECTION 26 05 33.16

FLEXIBLE CONDUITS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install flexible metallic conduit and fittings.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the following:
   1. NEC Article 350, Liquid-Tight Flexible Metal Conduit.
   2. UL 360, Liquid-Tight Flexible Steel Conduit.

1.3 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Product Data:
      a. Manufacturer's literature and technical information for flexible conduit and fittings proposed for use.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Flexible Conduit (Non-hazardous Areas and Class 1, Division 2, Hazardous Areas):
   1. Material: Flexible galvanized steel core with smooth, abrasion-resistant, liquid-tight, polyvinyl chloride cover. Continuous copper ground built in for sizes 3/4-inch through 1.25-inch. Material shall be UL-listed.
   2. Products and Manufacturers: Provide one of the following:
      a. Anaconda Sealtite Type UA by Anamet Electrical, Inc.
      b. Liquatite Type L.A. by Electric-Flex Company.
      c. Or equal.

B. Flexible Conduit (Class 1, Group D, Division 1, Hazardous Areas):
   1. Material: Flexible brass inner core with bronze outer braid and protective neoprene plastic coating. Steel, brass, or bronze end fittings. Minimum of 12 inches long.
2. Products and Manufacturers: Provide one of the following:
      a. Type ECGJH or ECLK by Crouse Hinds Company.

b. Type EXGJH or EXLK by Appleton Electric Company.
c. Or equal.

C. Flexible Conduit Fittings:
1. Material and Construction: Malleable iron with cadmium finish. Fittings shall adapt the conduit to standard threaded connections, shall have an inside diameter not less than that of the corresponding standard conduit size and shall be UL listed.
2. Manufacturers: Provide products of one of the following:
a. Crouse-Hinds Company.
b. Appleton Electric Company.
c. Or equal.
3. Use: Provide on flexible conduit in non-hazardous and Class 1, Division 2 hazardous areas.

D. PVC-Coated Conduit Fittings:
1. Material and Construction: Malleable iron with standard finish and 40-mil PVC exterior coating. Fittings shall adapt the conduit to standard threaded connections, and shall have an inside diameter not less than that of the corresponding standard conduit size.
2. Manufacturers: Provide products of one of the following:
a. Robroy Industries.
b. Permacote Industries.
c. OCAL, Inc.
d. Or equal.
3. PVC coating shall be factory applied.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install at motors, transformers, field instruments, and equipment subject to vibration or require movement for maintenance purposes. Provide necessary reducer where equipment furnished cannot accept 3/4-inch diameter flexible conduit. Limit flexible conduit length to three feet maximum.

B. Install in conformance with the Laws and Regulations.

+ + END OF SECTION + +

SECTION 26 05 33.26

EXPANSION/DEFLECTION FITTINGS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install conduit expansion and deflection fittings.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. UL 514B, Conduit, Tubing, and Cable Fittings.
   2. UL 467, Grounding and Bonding Equipment.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the following:
   1. NEC Article 300, Wiring Methods.

1.4 SUBMITTALS

A. Action Submittals: Submit the following in accordance with Section 01300, Submittals:
   1. Shop Drawings:
      a. Listing of locations where fittings are to be installed.
   2. Product Data:
      a. Manufacturer's literature and technical information for expansion and deflection fittings proposed for use.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Products and Manufacturers: Provide one of the following:
   1. Type DX for expansion/deflection or AX for expansion only by O-Z Gedney Company.
   2. Type XD for expansion/deflection or XJ for expansion only by Crouse Hinds Company.
   3. Type DF for expansion/deflection or XJ for expansion only by Appleton Electric Company.
   4. Or equal.

B. Cast gray iron alloy or bronze end couplings, malleable iron, or hot dipped galvanized body, stainless steel clamps and tinned copper braid bonding jumper. Fitting shall be watertight, corrosion-resistant, UL-listed, and compatible with the conduit system.

C. Features:
   1. Expansion/Deflection Fittings:
      a. Axial expansion or contraction up to 3/4-inch.
      b. Angular misalignment up to 30 degrees.
      c. Parallel misalignment up to 3/4-inch.
   2. Expansion Fittings:
      a. Expansion/Contraction: Eight-inch total movement.

D. Expansion/Deflection fittings shall conform to UL 514B and UL 467.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install fittings in accordance with Laws and Regulations.

B. Provide expansion fittings on exposed conduit runs crossing structural expansion joints and where necessary to compensate for thermal expansion and contraction. Provide expansion fittings on exposed conduit runs exceeding 200 feet.

C. Provide expansion/deflection fittings on embedded conduit runs crossing structural expansion joints. Provide fittings above waterstops.

D. Unless specifically shown or indicated otherwise, when crossing structural expansion joints larger than one inch, provide expansion fitting together with expansion/ deflection fitting. Install fittings on each conduit run in accordance with manufacturer's recommendations to accommodate additional movement necessary.

E. Provide expansion/deflection fittings for underground conduit runs at penetrations of buildings, manholes, handholes, and outdoor concrete equipment pads.

F. Where required in non-metallic conduit and duct systems, provide rigid metal conduit nipples and metal rigid-to-PVC adapters for connection to fittings. Ensure that joints exposed to water or other liquid are made watertight.

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SECTION 26 05 33.33

PULL, JUNCTION AND TERMINAL BOXES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install pull, junction, and terminal boxes.

B. Related Sections:
   1. Section 16050, General Provisions.
   2. Section 16070, Supporting Systems.
   3. Section 16075, Electrical Identification

1.2 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. NEC Article 314, Outlet, Device, Pull and Junction Boxes; Conduit Bodies; Fittings; and Handhole Enclosures.

1.3 SUBMITTALS

A. Action Submittals: Submit the following: Submittals:
   1. Product Data:
      a. Supplier's technical information for pull, junction, and terminal boxes proposed for use.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Pull, Junction, and Terminal Boxes: Shall be NEMA 12 at minimum. Provide boxes appropriate for each location in accordance with NEMA requirements and as required for area classification specified in Section 16050, General Provisions.
   1. Material and Construction (Dusty Locations):
      a. Welded and galvanized sheet steel of USS gage.
      b. Oil-resistant gasket.
      c. Lift-off hinges and quick-release latches.
      d. Boxes with dimension two feet and smaller shall be 14 gage.
      e. Boxes with dimension between two and three feet shall be 12 gage.

f. Boxes with dimension of three feet or more shall be 10 gage.

2. Material and Construction (Wet, Corrosive and Hazardous Locations):
   a. Cast gray iron alloy with hot-dip galvanized finish or cast malleable iron bodies and covers.
   b. Neoprene gaskets for wet and corrosive locations. Gaskets shall be an approved type designed for the purpose. Improvised gaskets are not acceptable.
   c. Stainless steel cover bolts.
   d. External mounting lugs.
   e. Drilled and tapped conduit holes.
   f. Boxes where conduits enter a building below grade shall have 1/4-inch drain hole at the bottom of the box.
   g. Threaded connections for explosion proof boxes.
3. Large boxes not generally available in cast construction shall be fabricated of copper-free aluminum alloy or Type 316 stainless steel as required by location.
4. Boxes for areas classified as hazardous locations shall be explosion-proof and shall comply with the requirements of UL 886.
5. In corrosive locations, boxes shall be cast metal with factory-applied 40-mil PVC coating or Type 316 stainless steel,
6. For flush-mounted pullboxes in slabs or pavement, provide vehicle traffic-bearing (AASHTO H-20) covers.
7. Pull boxes embedded in concrete slabs shall be cast iron. Pull boxes in wet, corrosive, or outdoor areas shall be NEMA 4X, Type 316 stainless steel.
8. Boxes shall be identified in accordance with Section 16075, Electrical Identification.
9. Manufacturers: Provide products of one of the following:
   a. Appleton Electric Company.
   b. Crouse-Hinds Company.
   c. Hoffman Engineering Company.
   d. Or equal.

B. Terminal Blocks:
1. Material and Construction:
   a. NEMA-rated nylon modular terminal blocks.
   b. 600-volt rated.
   c. Control and alarm circuit terminals shall be screwed type with permanently affixed numeric identifiers beside each connection.
   d. Power terminals shall be copper and rated for the circuit ampacity.
2. Products and Manufacturers: Provide one of the following:
   a. Allen-Bradley Company, Bulletin, 1492.
   b. General Electric Company, CR151K.
   c. Or equal.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Mount boxes so that sufficient access and working space is provided and maintain minimum clearance of 1/2-inch from walls.

B. Securely fasten boxes to walls or other structural surfaces on which boxes are mounted. Provide independent supports that comply with Section 16070, Supporting Systems, where boxes will not be mounted on walls or other structural surface.

C. Install pull boxes where shown or indicated, and provide pull boxes in:
   1. Conduit runs containing more than three 90-degree bends.
   2. Conduit runs exceeding 200 feet in length.

D. Provide removable, flame-retardant, insulating cable supports in boxes with any dimension exceeding three feet.

E. Field-apply PVC touch-up to scratched PVC boxes damaged during installation. Touch-up work shall be in accordance with manufacturer's recommendations and instructions.

F. Size junction, pull, and terminal boxes in accordance with requirements of NEC Article 314 and other Laws and Regulations.

G. Provide terminal blocks in boxes where shown and where cable terminations or splices are required.

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SECTION 26 05 43.13

UNDERGROUND DUCTBANKS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install underground ductbanks.

B. Coordination:
   1. Duct bank routing on the Drawings is diagrammatic. Coordinate installation with piping and other Underground Facilities and locate ductbanks clear of interferences.
   2. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before underground ductbank Work.

C. Related Sections:
   1. Section 31 23 05, Excavation and Fill.
   2. Section 03 20 00, Concrete Reinforcing.
   3. Section 03 30 00, Cast-in-Place Concrete.
   4. Section 26 05 26, Grounding and Bonding for Electrical Systems.
   5. Section 26 05 53, Identification for Electrical Systems.
   6. Section 26 05 33.13, Rigid Conduits.
   7. Section 26 05 33.26, Expansion/Deflection Fittings.

1.2 SUBMITTALS

A. All files associated with shop drawings and product data shall be submitted as Adobe PDF with searchable function. This allows reviewer to search the document for keywords.

B. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Layouts showing proposed routing of ductbanks and locations of manholes, handholes, and areas of reinforcement.
      b. Profiles of ductbanks showing crossings with piping and other Underground Facilities.
      c. Typical cross sections for each ductbank.

C. Informational Submittals: Submit the following:
   1. Special Procedure Submittals:
      a. Installation procedures.
   2. Field Quality Control Submittals:

a. Field test report.

D. Closeout Submittals: Submit the following:
1. Record Drawings:
a. Include actual routing of underground ductbank runs on record documents in accordance with Section 01 78 39, Project Record Documents.

PART 2 PRODUCTS

2.1 MATERIALS

A. Duct: Provide conduit and fittings in accordance with Section 26 05 33.13, Rigid Conduits. Conduit types shall be as follows:
1. Schedule 40 PVC conduits for power circuits.
2. Rigid Galvanized Steel conduits for the following types of circuits: low voltage instrumentation analog, communication, data highway and fire alarm cable circuits.

B. Backfill: Provide backfill, including select backfill, in accordance with Section 31 23 05, Excavation and Fill.

C. Reinforcing: Provide Duct bank reinforcing in accordance with Section 03 20 00, Concrete Reinforcing.

D. Concrete: Provide duct bank concrete in accordance with Section 03 30 00, Cast-in-Place Concrete.

E. Grounding: Provide ground cable in accordance with Section 26 05 26, Grounding and Bonding for Electrical Systems.

F. Conduit Spacers: Conduit spacers shall be nonmetallic, interlocking type to maintain spacing between conduits. Provide spacers suitable for all conduit types used in multiple sizes.

G. Duct Sealing Compound:
1. Products and Manufacturers: Provide one of the following:
a. Emerson Industrial Automation 0-Z/Gedney, Appleton Group Type DUX.
b. Or equal.

H. Duct Seal Foam
1. Products and Manufacturers: Provide one of the following:
a. FST Foam Sealant by American Polywater.
b. Or equal.
2. General: Sealant is a two-part, high-expansion foam duct sealant. It keeps water, acids, gases, insects, and rodents out of the duct. Sealant expands and

hardens to a “closed cell”, rigid structure. This permanent, but removable, seal blocks both water and gas under moderate pressure.

3. Meets 2011 NEC Articles 225.27, 230.8, and 300.5(G) Raceway Seals.
4. Creates a strong, resilient, chemically resistant seal.
5. Expands, cures and seals even when water is present.
6. Seal tolerates cable movement and environment extremes.
7. Compatible with common cable and wire jackets.
8. Re-enterable – seal can be removed.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work is to be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Excavation and Backfilling:
   1. Provide excavation and backfilling for ductbank installation in accordance with Section 31 23 05 Excavation and Fill.
   2. Do not backfill with material containing large rock, paving materials, cinders, large or sharply angular substances, corrosive material, or other materials that can damage or contribute to corrosion of ducts or cables or prevent adequate compaction of backfill.

B. Duct bank Layout:
   1. Top of duct bank concrete shall be a minimum of 2.5 feet below grade, unless shown or indicated otherwise on the Drawings.
   2. Slope duct bank runs for drainage toward manholes and away from buildings with slope of approximately three inches vertical per 100 feet of run.

C. Duct bank Assembly:
   1. Assemble duct banks using non-magnetic saddles, spacers, and separators. Position separators to provide concrete separation between outer surfaces of each conduit in accordance with the detail shown on the Drawings. Provide side forms for each ductbank.
   2. Make bends with sweeps of not less than four-foot radius or five-degree angle couplings.

D. Concrete Placing:
   1. Provide concrete covering on each side, top, and bottom of concrete envelopes around conduits in accordance with the details shown on the Drawings. Concrete covering shall be as shown or indicated on the Drawings.

2. Provide red dye in concrete for easy identification during subsequent excavation; all concrete in entire ductbank, including top and bottom, shall be dyed.
3. Firmly fix conduits in place during concrete placing. Carefully place and vibrate concrete to fill spaces between conduits.

E. Conduit Transitions:
1. Conduit installations shall be watertight throughout entire length of ductbank.
2. Transition from non-metallic to rigid galvanized steel conduit where duct banks enter structure walls and slabs or extent exposed above grade.
3. Terminate conduits in insulated grounding bushings.
4. Continue conduits inside buildings in accordance with Section 26 05 33.13, Rigid Conduits, and as shown or indicated in the Contract Documents.
5. If ducts are not concrete-encased, provide expansion and deflection fittings in accordance with Section 26 05 33.26, Expansion/Deflection Fittings.
6. Plug and seal empty spare conduits entering structures. Conduits in use entering structures shall be sealed watertight with duct sealing compound.

F. Duct bank Reinforcing:
1. Provide reinforcing for all ductbanks:
2. Install duct bank reinforcement as shown or indicated on the Drawings.
3. Provide maximum clearance of 1.5 inches from bars to edge of concrete encasement.

G. Connections to Structures:
1. Firmly anchor duct banks to structure walls or slabs. Epoxy-grout ductbank rebar into structure concrete to eliminate sheer forces between ductbank and structure wall concrete.
2. Duct bank penetrations through structure walls shall be watertight.

H. Grounding:
1. Provide bare stranded copper ductbank ground cable in each duct bank envelope for medium voltage duct banks. Make ground electrically continuous throughout entire ductbank system.
2. Connect ground cable to building and station ground grid or to equipment ground buses. Also, connect ground cable to steel conduit extensions of underground ductbank system.
3. Provide ground clamp and bonding of each steel conduit extension to maintain continuity of ground system.
4. Terminate ground cable at service pole ground.

I. Detectable Underground Warning Tape:
1. Provide detectable underground warning tapes complying with Section 26 05 53, Identification for Electrical Systems, over the full length of each underground ductbank.
2. Install warning tapes approximately 12 inches below grade.

3. Provide multiple tapes across the width of each ductbank. Locate center of a warning tape above each edge of ductbank, and at intervals across top width of ductbank so that clear space between tapes does not exceed six inches.

J. Testing Ducts:
   1. Test ducts by pulling a cylindrical mandrel through each duct. Mandrel shall have length not less than two pipe inside diameters and an outside diameter equal to 90 percent of conduit's inside diameter.
   2. Pull rag swab through duct to remove water and to clean conduits prior to installing new cable.
   3. Repeat swabbing until all foreign material is removed.
   4. Pull mandrel through duct, if necessary, to remove obstructions.

END OF SECTION

SECTION 26 05 43.23

MANHOLES AND HANDHOLES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown, specified, and required to furnish and install manholes and handholes for electrical Work.

B. Coordination: Coordinate manhole and handhole installation with piping, sheeting, and other underground systems and structures and locate clear of interferences.

C. Related Sections:
   1. Div. 3
   2. Section 02315, Excavation and Backfill

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ASTM A48, Specification for Gray Iron Castings.
   2. ASTM A615, Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
   3. ASTM C478, Specification for Precast Reinforced Concrete Manhole Sections
   4. ASTM C1028, Standard Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method.
   5. ASTM D4101, Specification for Polypropylene Injection and Extrusion Materials
   6. ANSI A14.3, Safety Requirements for Fixed Ladders.
   7. ANSI/SCTE 77, Specification for Underground Enclosure Integrity.

1.3 SUBMITTALS

A. Action Submittals:
   1. Shop Drawings: Submit the following:
      a. Manholes: Plan and section drawings showing arrangement of each manhole including elevations, location of manhole wall penetrations, and Site-specific design details such as reinforcing for cast-in-place manholes.
      b. Castings: Where Site-specific castings are specified with unique lettering on the manhole cover, provide Shop Drawing for castings indicating appropriate detail to indicate conformance to the Contract Documents.
   2. Product Data: Manufacturer's technical information for manholes, handholes and accessories proposed for use.

a. Drawings showing interior and exterior dimensions and details of typical openings, jointing, inserts and typical reinforcing.
b. Fabrication and erection of all frame and cover assemblies. Include plans, elevations, and details of sections and connections. Show anchorage and accessory items. Provide setting drawings for location and installation of castings and anchorage devices.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Material and Construction:
1. Precast or cast-in-place reinforced concrete. Reinforcement shall be in accordance and cast-in-place concrete shall be per Section 03300, Cast-In-Place Concrete.
2. Minimum interior dimensions as shown. Provide a 12-inch by 12-inch by 6-inch deep sump in manhole floor.
3. Duct entrances sized and located to suit the ductbanks.
4. Precast Manholes:
   a. Except where otherwise specified precast manhole components shall consist of reinforced concrete pipe sections especially designed for manhole construction and manufactured in accordance with ASTM C 478, except as modified herein.
   b. Precast, reinforced concrete manhole bases, riser sections, flat slabs and other components shall be manufactured by wet cast methods only, using forms which will provide smooth surfaces free from irregularities, honeycombing or other imperfections.
   c. Joints between manhole components shall be the tongue and groove type employing a single, continuous rubber O-ring gasket. The circumferential and longitudinal steel reinforcement shall extend into the bell and spigot ends of the joint without breaking the continuity of the steel. Joints between the base sections, riser sections and top slabs of manholes 72 inches in diameter and less shall be rubber and concrete joints. Joints for manhole components greater than 72 inches in diameter shall be provided with steel bell and spigot rings.
   d. Precast manhole components shall be of sufficient strength to withstand the loads imposed upon them. They shall be designed for a minimum earth cover loading of 130 pounds per cubic foot, an H-20 wheel loading, and an allowance of 30 percent in roadways and 15 percent in rights-of-way for impact. Manhole bases shall have two cages of reinforcing steel in their walls, each of the area equal to that required in the riser sections. Wall thickness shall be at least five inches. Concrete top slabs shall be at least eight inches thick.
   e. Lifting holes, if used, shall be tapered, and no more than two shall be cast in each section. Tapered, solid rubber plugs shall be furnished to seal the

lifting holes. The lifting holes shall be made to be sealed by plugs driven from the outside face of the section only.

f. The point of intersection (P.I.) of the ductbank centerlines shall be marked with 1/4-inch diameter steel pin firmly enclosed in the floor of each manhole base and protruding approximately 1-inch above the finished floor of the base.

g. Mark date of manufacture and name or trademark of manufacturer on inside of the manhole barrel.

h. Barrel of manhole shall be constructed of various lengths of riser pipe manufactured in increments of one foot to provide the correct height with the fewest joints. Openings in the barrel of the manholes for ductbanks or other penetrations are not allowed closer than one foot from the nearest joint. Special manhole base or riser sections shall be provided as necessary to meet this requirement.

i. A precast or cast-in-place slab or precast eccentric cone, as shown or approved, shall be provided at the top of the manhole barrel to receive the frame and cover.

B. Accessories:

1. Frames and Covers:
   a. Material: Cast iron conforming to ASTM A48, Class 30A.
   b. Covers: Watertight, sealed type marked "ELECTRICAL" in raised 2-inch letters. Identify covers as shown.
   c. Frame shall be grouted to the manhole or handhole.
   d. Manufacturers: Provide products of one of the following:
      1) Neenah Foundry Company.
      2) Campbell Foundry Company.
      3) Or equal.
2. Pulling Irons:
   a. Material: Galvanized steel.
   b. Cast in the wall opposite to the centerline of each incoming ductbank and 12 inches below centerline of bottom line of ducts.
   c. Products and Manufacturers: Provide one of the following:
      1) Catalog No. 8119 by A.B. Chance Company.
      2) Catalog No. DU2T3 by McGraw Edison Company.
      3) Or equal.
3. Cable Racks:
   a. Material: Galvanized steel.
   b. Cable racks shall adequately support cables with space allowed for future cables.
   c. Each rack shall be a vertical assembly of 24-inch cable racks extending from within six inches of the manhole roof slab to within six inches of the manhole floor.
   d. Products and Manufacturers: Provide one of the following:
      1) Catalog No. J5125 by MacLean Power Systems.
      2) Catalog No. C203-1125 by A.B. Chance Company.

3) Or equal.

4. Cable Hooks:
   a. Material: Galvanized steel.
   b. Length: 7.5-inch minimum.
   c. Products and Manufacturers: Provide one of the following:
      1) Catalog No. J5132A by MacLean Power Systems.
      2) Catalog No. C203-1132 by A.B. Chance Company.
      3) Or equal.
5. Insulators:
   a. Material: Porcelain.
   b. Products and Manufacturers: Provide one of the following:
      1) Catalog No. J5122 by MacLean Power Systems.
      2) Catalog No. C203-1120 by A.B. Chance Company.
      3) Or equal.
6. Manhole Steps – Polypropylene
   a. Material: Polypropylene with 1/2-inch diameter Grade 60 steel reinforcing bar conforming to ASTM A615. Polypropylene to conform to ASTM D4101.
   b. Color: Black
   c. Provide manhole steps as shown. Manhole steps shall have raised treads and conform to requirements of ANSI A14.3, ASTM C478, and OSHA.
   d. Steps shall be 14.75 inches wide and, when installed, protrude from the manhole wall by 6 inches.
   e. Space steps uniformly at a maximum of 12 inches on centers, and project evenly from manhole or chamber walls.
   f. Manufacturers: Provide products of one of the following:
      1) P-14938, manufactured by Lane International.
      2) ML -13-NCR, manufactured by American Step Company
      3) Or equal.

2.2 SMALL HANDHOLES

A. Material and Construction:
   1. Precast Polymer concrete.
   2. Duct entrances sized and located to suit ductbanks.
   3. Enclosures and covers shall be UL listed.
   4. Enclosures, boxes, and covers are required to conform to test provisions of ANSI/SCTE 77 for Tier 5 applications.
   5. All covers are required to have a minimum coefficient of friction of 0.50 in accordance with ASTM C1028.
   6. Manufacturer:
      a. Strongwell Quazite
      b. Oldcastle Precast.
      c. Or equal

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work is to be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install manholes and handholes where shown and verify locations in field. Perform excavation and backfilling required for installation. Excavation and backfilling shall be per Section 02315, Excavation and Backfill.

B. Install manholes on a crushed stone foundation as shown. If not shown, crushed stone shall be select backfill at least six inches deep. Manhole bases shall be set at the proper grade and carefully leveled and aligned.

C. Precast Manholes:
   1. Set sections vertical with steps and sections in true alignment. The base of the bell or groove end at joints between components shall be buttered with 1 to 2 proportion cement-sand mortar to provide a uniform bearing between components. Joints shall be sealed with cement mortar inside and out and trowel smooth to the contour of the wall surface. Raised or rough joint finishes are not acceptable.
   2. Install sections, joints, and gaskets in accordance with manufacturer's recommendations.
   3. Lifting holes shall be sealed tight with a solid rubber plug driven into the hole from the outside of the barrel and the remaining void filled with a 1 to 2 cement-sand mortar.

D. Complete installation of manholes and handholes so that structures are watertight. Apply foam sealant to all penetrations.

E. Cable Supports in Manholes:
   1. Attach cable racks with 3-inch by 3/8-inch diameter "tamp-in" studs mounted in 1-inch holes drilled into walls of manholes in the absence of inserts. Apply PVC coating to racks.
   2. Provide cable hooks to support each cable on each rack along the cable run within the manholes. Apply PVC coating to hooks.
   3. Individually support each cable at each hook on porcelain insulators. Provide sufficient slack for each cable.
   4. Securely tie each cable in place at each insulator block to prevent excessive movement of insulators, cables, or fireproof tape. Tie cables with non-metallic 3/4-inch strapping tape as manufactured by 3M or tie down with nylon straps.

F. Grounding: Install a 3/4-inch by 10-foot copper-clad ground rod for each manhole. Bond all exposed metal manhole accessories and the concrete reinforcing rods with No.

4 AWG minimum bare copper wire and connect to the ground rod and to the ductbank ground cable.

G. Provide grade rings for manholes when required to adjust cover to proper grade. Grading ring shall be constructed on the roof slab or cone section on which the manhole frame and cover shall be placed. The height of the grading ring shall be such as is necessary to bring the frame to the proper grade and shall not exceed 12 inches in height.

H. Metal Pull Box: Install NEMA 4X stainless steel wall mounted pull box inside manholes/handholes where analog signal cables are mixed with power cables. Route conduits for analog cables directly into and out of metal pull box so that no analog cables are exposed.

3.3 GRADING AT MANHOLES

A. Manholes in unpaved areas shall be built as shown or directed by ENGINEER to a rim elevation higher than the original ground. The ground surface shall be graded to drain away from the manhole. Fill shall be placed around manholes to the level of the upper rim of the manhole frame, and the surface evenly graded on a one (vertical)-to-five (horizontal) slope to surrounding ground, unless otherwise shown or directed by ENGINEER.

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B. Manholes in paved areas shall be constructed to meet final surface grade. In paved areas on state highways, manholes shall be 1/2-inch below final wearing surfaces. Manholes shall not project above finished roadway pavements.

C. CONTRACTOR shall be solely responsible for proper height of manholes necessary to reach final grade. ENGINEER's review of Shop Drawings for manhole components is general in nature and CONTRACTOR shall provide random length precast manhole riser sections to adjust manholes to meet field conditions for final grading.

3.4 MANHOLE WATERTIGHTNESS

A. Manholes shall be free of visible leakage. Each manhole shall be inspected and leaks shall be repaired in a manner subject to ENGINEER's approval.

+ + END OF SECTION + +

SECTION 26 05 45

UTILITY SERVICES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install electric and communication services and associated equipment at the Site.
   2. CONTRACTOR shall furnish and install the following Work regarding electric and communication service:
      a. Primary circuit conduits and associated underground ductbanks.
      b. Transformer concrete pads and associated grounding, including ground rods, cables and connections.
      c. Secondary cable and terminations, conduits, and associated underground duct banks.
      d. Comcast conduit and pull boxes.
   3. Electric utility company, Illuminating Company, will furnish and install the following:
      a. Primary cable, terminations, and splices.
      b. Junction Cabinet.
      c. Transformer.
      d. Utility metering located at the XXXXXXX.
   4. Communication Company, Comcast will furnish the following:
      a. Communication conduit, High Density Polyethylene conduit two-inch size.
      b. Pull boxes.
   5. Work in connection with electric and communication services shall be in accordance with requirements of the electric utility company and the communications company.

B. Coordination:
   1. CONTRACTOR shall coordinate in advance with electric utility company and local communications company relative to electric and communication service connections and requirements. CONTRACTOR shall make all necessary arrangements with electric utility and communications company.
   2. Electric and communications services shall be obtained for the Frederick Water Treatment Plant at Hot Run Drive, Stephenson, VA 22656
   3. The following ui contact representative has been identified for coordinating the electric service requirements:
      a. XXXXXX.
      b. Tel Number xxxxx
      c. Email xxxxxxx.

4. The primary circuit duct bank routing and transformer location shall be coordinated with SEVC. Submit proposed routing and transformer location to SEVC in advance for approval prior to proceeding with installation.
5. The Lum Sum price bid shall include all costs associated with providing the necessary coordination with SVEC and local communications company to secure the services required to the Site.

1.2 QUALITY ASSURANCE

A. All work associated with the Electric and Communications services shall be performed in strict conformance with SVEC and Comcast. Obtain in advance all SVEC and Comcast standards as it pertains to the services specified.

1.3 SUBMITTALS

A. All files associated with shop drawings and product data shall be submitted as Adobe PDF with searchable function. This allows reviewer to search the document for keywords.

B. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Drawings showing proposed layout of electrical primary service duct banks and transformer location. Submit to SVEC as specified under this Section.
      b. Drawings showing proposed layout of communication service.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 INSTALLATION

A. Install electric service materials and equipment in accordance with requirements of electric utility company and install communications service materials and equipment in accordance with requirements of communications company.

B. Install all conduit seals and caps as required by SVEC.

++END OF SECTION++

SECTION 26 05 53

ELECTRICAL IDENTIFICATION

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. Provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install wire labels, wire color coding, terminal block labels, conduit identification, legend plates, nameplates and other identification for electrical apparatus.

B. Related Sections:
1. Section 16131, Rigid Conduits.
2. Section 16137, Underground Ductbanks.

1.2 SUBMITTALS

A. Shop drawings shall include the following information:
1. Nameplate schedules.
2. Product data sheets and catalog numbers for materials furnished specifically for this project.
3. Samples of conduit, wire and cable labels shall be submitted and shall include both applied and unapplied label samples. These samples shall be used as quality standards for the wire and cable labeling required by this Section. These samples shall be of material specified in this Section and shall include wire and cable designators meeting the requirements of this Section.

B. Point to point connection diagrams:
1. Provide detailed point-to-point interconnection wiring diagrams to supplement manufacturer's shop drawings for all equipment furnished under other Divisions requiring an electrical connection; either control, signal, or power, as indicated. Data and communication system wiring shall be included.
2. Point-to-point connection diagrams shall be produced with AutoCAD software. A separate drawing shall be provided for each diagram. One complete diagram shall be included on a drawing.
3. The diagrams shall include the following information:
   a. Circuit origin, destination and wire numbers.
   b. Field wiring terminal strip names and numbers.

c. Each point-to-point interconnection diagram shall be unique with diagram number, wire numbers, device numbers, equipment numbers and location designations.

4. Identifying numbers for equipment shall be coordinated with the Drawings.

C. Project Record Documents:
1. Submit record document information in accordance with Section 01720.
2. Submit the following information for record purposes:
a. "As Built" point-to-point interconnection wiring diagrams with updated wire and terminal numbers.
b. "As Built" conduit schedules.
c. "As Built" nameplate schedules.
d. All spreadsheets and databases used in creating labels.

1.3 REFERENCES

A. Standards referenced in this Section are:
1. ANSI Z535 Safety Alerting Standards.
2. Applicable requirements of NEMA Standard No. WC-1 and WC-2, pertaining to identification of power and control conductors.
3. OSHA 1910.303 pertaining to the proper identification and marketing of arc flash and other electrical hazards.
4. Applicable requirements of UL Standard No. 969, "Marking and Labeling Systems," pertaining to electrical identification systems.
5. NFPA 70 - National Electrical Code.
6. NFPA 70E - Standard for Electrical Safety in the Workplace.
7. ISO 9001 & 9002.

B. Where reference is made to one of the above standards, the revision in effect at the time of the bid shall apply.

1.4 QUALITY ASSURANCE

A. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 (NEC) unless more stringent requirements are specified or indicated.

B. The manufacturer shall maintain a documented ISO 9001 or 9002 quality assurance program implementing suitable procedures and controls to monitor all aspects of production and testing.

1.5 PROJECT/SITE REQUIREMENTS

A. Labeling materials shall withstand the following environmental conditions without damage or degradation of operating characteristics or life:
1. Wastewater treatment plant subject to corrosive vapors, chemicals, sewage,

sludge and dirt. Materials shall be suitable for indoor or outdoor use.
2. Ambient Temperature: 0 degrees C to 50 degrees C maximum.
3. Relative Humidity: 0 to 95%, non-condensing.

PART 2 – PRODUCTS

2.1 GENERAL

A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired

B. Products of the following manufacturers are acceptable, except where otherwise noted.
   1. Brady.
   2. Panduit.
   3. 3M Corp.
   4. Or equal.

C. Like items of materials/equipment shall be the end products of one manufacturer in order to provide standardization for appearance, operation, maintenance, and manufacturer's service.

2.2 EQUIPMENT IDENTIFICATION

A. Engraved Plastic Nameplates:
   1. Nameplates shall be laminated plastic with engraved white letters on a black background. Nameplates for emergency equipment shall be laminated plastic with engraved white letters on a red background.
   2. Embossed plastic adhesive tape labels will not be accepted in lieu of engraved nameplates.
   3. Unless noted otherwise, the minimum letter height on engraved nameplates shall be:
      a. For Equipment Designation:
         1) Switchgear and Motor Control Centers: ½ inch.
         2) Panelboards: ¼ inch.
         3) Voltage, Bus Ampacity, Feeder Source, and Circuit Number: 1/8 inch.
      b. Individual Circuit Breakers and/or Motor Starters in Motor Control Centers:
         1) For Equipment Designation and Section Number: ¼ inch.
         2) Load Served and Location of Load: 1/8 inch.
      c. Individual Breakers in Switchgear:
         1) Breaker Number and Equipment Designation: ¼ inch.
         2) Breaker Frame Size: 1/8 inch.
      d. Individual Circuit Breaker and Spaces in Panelboards: Numbers (Section Number) ¼ inch.
      e. Individual Circuit Breakers in Distribution Panelboards: ¼ inch for panel

being fed and 1/8 inch for its location.

f. Individual Remote Indicating Lights, Meters, Instruments and Control Switches:
   1) Manufacturer standard lithographed nameplate or engraved plastic nameplate as shown on the Drawings.
   2) Indicate unit, equipment, or fire detector being monitored and condition indicated by illumination.

g. Individual Switches and Pilots:
   1) Manufacturer standard lithographed nameplate or engraved plastic nameplate as shown on the Drawings.
   2) Identify mechanical unit being served.

h. Disconnects, Relay Panels, Lighting Contactors:
   1) ¼ inch for unit designation.
   2) 1/8 inch for voltage and source circuit number.

4. All junction boxes and pull boxes shall be labeled with an engraved plastic nameplate.

2.3 LABELING SYSTEMS

A. Conduit Labeling System
   1. Provide machine printed Ultra Aggressive_Polyester permanent adhesive backed labels with black lettering on white or colored background as specified. Labels shall be custom printed with using thermal printer specified herein.
   2. Printable area shall be 1.9-inch height, with minimum character height 12 pt., with width as necessary to accommodate all lines of text. Adjust description as necessary to accommodate three lines of text. Labels shall not contain uncommon abbreviations in the text.
   3. Identify specialty conduit systems with a color band or black lettering on a colored background label per Table 16075-A. Label material shall be vinyl.
   4. Products of the following manufacturers are acceptable, except where otherwise noted.
      a. TLS 2200®/TLS PC Link™ BradyBondz™, suitable for use with the specified Brady thermal printing system.
      b. Duralabel PremiumVinyl Tape suitable for use with the specified Graphic Products, Inc. thermal printing system.
      c. Vinyl Continuous Tapes suitable for use with the specified Panduit thermal printing system.
      d. Or equal.

B. Heat Shrinkable Wire and Cable Labeling System
   1. White heat-shrinkable irradiated polyolefin shrink-on sleeves. Labels shall be at least 2 inches in width.
   2. Products of the following manufacturers are acceptable, except where otherwise noted.
      a. Brady PermaSleeve® suitable for use with the specified Brady thermal printing system.

b. Duralabel Shrink Tubing suitable for use with the specified Graphic Products, Inc. thermal printing system.
c. Heat Shrink Polyolefin (F1) suitable for use with the specified Panduit thermal printing system.

C. Wrap-Around Wire and Cable Labeling Systems
1. Self laminating white/transparent self extinguishing vinyl strips, suitable for use with the specified thermal printing systems. Length shall be sufficient to provide at least two and one half wraps. Labels shall be thermally printed. Labels shall be at least 2 inches in width.

D. Thermal Printing System
1. Printing system shall utilize a thermal transfer process to create non-smearing labels and markers. Labels shall be created using either or both of the following methods:
a. Portable printer:
1) TLS 2200® Thermal Transfer Printer by Brady.
2) Duralabel Pro 300 by Graphic Products Inc.
3) Viper LS6 Portable Thermal Printer by Panduit.
b. Desktop Software:
1) LabelMark™ Label Design Software by Brady.
2) Viperlink™ Label Design Software by Panduit.
3) DuraSuite Label Design Software by Graphic Products Inc.

2.4 CONDUIT IDENTIFICATION:

A. All labels shall have at least three lines, and as many as five lines, of text as follows:
1. Line 1: conduit number per Table 16075-A.
2. Line 2: Source (i.e. "S: MCC-1")
3. Line 3: Destination (i.e. "BLCP-1")
4. Line 4: If applicable, route components including intermediate stops between source and destination (i.e. "Via: Junction Box in Tunnel")
5. Line 5: If applicable, optional information (additional information such as building and/or room separations between source and destination; or in the case of a conduit for feeders with multiple parallel runs, or multiple sources or destinations)

B. The conduit number shall be developed as follows:
1. **Conduit** as "C"
2. **Type** as MV, LV, FO, IC, TEL, PA, FA, or SC which stands for medium voltage, low voltage, fiber, instrumentation, telephone, paging, fire, and security, respectfully. **Area** as AT and BB which stand for aeration tank and blower building, respectfully. In the case of aeration tanks, numbering 1 through 3 (i.e. AT1) designates which tank the label corresponds to. Other areas should be labeled in coordination with the District, keeping two or three letters/digits in length whenever possible.

3. **Number** as a 4-digit number, see table for assignments of 0001-1000, 1001-3000, etc. Note specific start points have been assigned for the various systems.

TABLE 16075-A CONDUIT LABELING GUIDELINES			
System	**Label Color (background – lettering)**	**Line 1 C-Type-Area-Number**	**4-digit Numbering**
Medium Voltage (above 600 V)	Yellow/Black	C-MV-XXX-####	0001-1000
Low Voltage (600 V or less)	White/Black	C-XXX-####	1001-3000
Fiber	Orange/Black	C-FO-XXX-####	3001-4000
Instrumentation (4-20mA and low voltage DC signal conduits, PLC I/O wiring, Data highway conduits)	Green/Black	C-IC-XXX-####	4001-5000
Communication (Telephone, Paging)	Blue/Black	C-COM-XXX-####	5001-6000
Fire	Red/Black	C-FA-XXX-####	6001-7000
Security (cameras, door access card system, etc)	Silver or Gray/Black	C-SC-XXX-####	7001-8000
Spares	White/Black, or if designated for specific system, match that color	C-SPARE-XXX-####	8001-9000

2.5 CABLE IDENTIFICATION

A. Power Wiring:
   1. Wires/Cables No. 6 AWG and Smaller: Black on white, machine printed, heat shrink markers with cable number.
   2. Wires/Cables No. 4 AWG and Larger: Heat-shrink sleeving or colored tapes shall be used for phase color-coding, with numbered markers to show circuit identification.

B. Multi-Conductor Power Cables:
   1. Outer Jacket: Black on white, machine printed heat shrink marker with cable number.
   2. Individual Wires: Same as individual power wiring requirements.

C. Control Wiring:
   1. Labeling for individual control wiring shall be as shown on the Contract Documents and coordinated with the approved shop drawings. I/O wiring shall be numbered with rack number, slot number, and point number as specified in Division 13, Special Construction.
   2. Spares shall be labeled.

D. Multi-Conductor Control Cables:
   1. Outer Jacket: Black on white, machine printed heat shrink marker with cable number.

2. Individual Wires: Same as individual control wiring requirements.

E. Single Pair or Single Triad:
   1. Single pair or single triad cables shall be used for 24VDC and 4-20mA analog signals.
   2. Outer Jacket: Black on white, machine printed heat shrink marker with cable number.
   3. Individual Wires in pair or triad: Black on white, machine printed heat shrink marker with loop identifier information as shown on the drawings.

F. Multi Pair or Multi Triad:
   1. Individual pairs or triads in a multi cable shall be used for 24VDC and 4-20mA analog signals.
   2. Outer Jacket: Black on white, machine printed heat shrink marker with cable number.
      Individual Wires in pair or triad: Black on white, machine printed heat shrink marker with loop identifier information as shown on the drawings.
   3.

2.6 SAFETY SIGNS AND VOLTAGE MARKERS

A. Provide self-adhesive procedural or cautionary signage as required or as recommended by manufacturer or as required for proper identification and operation/maintenance of electrical systems and equipment.
   1. Provide permanent electrical hazard warning signs marked per OSHA requirements.
   2. Manufacturer's standard preprinted or partially preprinted accident-prevention and operational tags.
   3. Appropriate preprinted words including large-size primary words: e.g., DANGER, CAUTION, DO NOT OPERATE.

2.7 UNDERGROUND LINE MARKER

A. Detectable warning tape shall be minimum 4-in. width, 5 mil thick, five-ply ultra-high molecular weight virgin polyethylene; acid, alkaline and corrosion resistant; with 150 pounds of tensile break strength.

B. Printing which most accurately indicates type of service is required on tape.

C. The top side of the tracer tape shall be color banded red for electrical and high voltage lines, and orange for signal, communication, telephone and fire alarm lines. Tracer tape shall be 4-in wide with four color bands. The tape shall be inscribed with the warning message for the utility such as "CAUTION – ELECTRICAL LINED BURIED BELOW".

D. Tape shall be as manufactured by the following manufacturers:
   1. Mutual Industries, Inc.; Terra Tape, Div. of Reef Industries Inc.
   2. Seton.

3. Rhino Marking and Protection Systems.
4. Or equal.

2.8 ARC-FLASH SAFETY SIGNS

A. Arc-flash Safety Signs:
   1. Products and Manufacturers: Provide one of the following:
      a. Brady.
      b. Panduit
      c. Or equal.
   2. Warning signs shall be adhesive-backed polyester.
   3. Warning signs shall read, "Warning – Arc Flash and Shock Hazard. Appropriate PPE Required." Arc flash warning signs shall indicate the flash protection boundary, incident energy in calories per square centimeter, hazard level, description of required protective clothing, shock hazard, limited approach boundary, restricted approach boundary, prohibited approach boundary, and equipment name.

PART 3 – EXECUTION

3.1 GENERAL

A. Install labels as specified and as shown on the Drawings in accordance with manufacturer's instructions and approved shop drawings.

3.2 INSTALLATION

A. Equipment Identification
   1. Provide engraved laminated plastic nameplates to identify all electrical equipment, unit load description, and each control or indicating device, such as meters and control switches. Nomenclature shall be as shown on the Drawings or as directed.
   2. Provide blank nameplates for useable spaces and spaces indicated on the Drawings for future devices.
   3. Permanent nameplates shall be attached with adhesive and a minimum of two stainless-steel, self-tapping machine screws. Where drilling the enclosure would violate the UL listing or the integrity of the enclosure, nameplates shall be attached with adhesive only. Double sided foam tape is not an acceptable method for adhesion.
   4. NEMA 7 explosion proof enclosures shall not be modified in the field. Permanent nameplates shall be attached with adhesive only.
   5. Identify each unit of the following categories of electrical work:
      a. Switchboards, panelboards, electrical cabinets, and enclosures.
      b. Access panel/doors to electrical facilities.
      c. Major electrical switchgear

d. Disconnect switches.
e. Push buttons, selector switches, indicating lights, and LEDs.
f. Power Transfer Equipment: Contactors and transfer switches.
g. Transformers.
h. Battery racks and chargers.
i. Power generating units.
j. Fire alarm panels.
k. Uninterruptible power supplies.
l. Relays.
m. Lighting contactors.
n. Individual distribution circuit breakers.

6. All branch circuit panelboards shall have a typed panel schedule indicating the type of equipment served and its location.

B. Safety Signs and Voltage Markers

1. Safety signs and voltage markers shall be provided on and around electrical equipment as specified and as required by authorities having jurisdiction.
   a. Rigid safety signs shall be installed using stainless steel fasteners.
   b. Surfaces shall be cleaned before application of pressure sensitive signs and markers.
2. High Voltage safety signs shall be mounted on all equipment doors providing access to uninsulated conductors terminals or buss bar greater than 600 volts.
3. Low voltage safety signs shall be mounted on all equipment doors providing access to uninsulated 480 volt conductors terminals or buss bar.
4. Low voltage markers shall be installed on each terminal box, safety disconnect switch and panelboard installed, modified or relocated and containing 120/208 volt conductors.
5. Wherever required to ensure safe and efficient operation and maintenance of electrical systems, electrically connected mechanical systems, and general systems and equipment (including prevention of misuse of electrical facilities by unauthorized personnel), provide self-adhesive plastic signs or similar equivalent identification, instruction, or warnings on switches, outlets, and other controls, devices, and covers of electrical enclosures. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for intended purposes.

C. Conduit Labels

1. All conduits shall be identified with permanent conduit labels in the field unless otherwise specified. The following conduit systems shall be labeled: Power conduits (all voltage levels), control wiring conduits, 120 Volt lighting and receptacle conduits, 4-20mA and low voltage DC signal conduits, data highway conduits, telephone conduits, conduits containing power limited circuits per the NEC (paging/FA/security), and all spares. The Contractor shall assign unique conduit numbers per this guideline and record this information on the record drawings.
2. Flexible conduit shall not be labeled.

3. Labels are not required at light fixtures, light switches, conduit bodies and fittings used for pulling or change of direction.
4. Exposed single conduit runs of less than 10 feet between local disconnect switches and the equipment they operate shall not be labeled.
5. Conduit labels shall be installed at the following locations:
    a. Where conduit enters or exits walls, ceilings, floors or slabs.
    b. Where conduit enters or exits boxes, cabinets, consoles, panels, enclosures, or equipment, except pull boxes and conduit bodies used for pull boxes.
6. Conduit labels shall be oriented so as to be readable.
7. Identify medium/high voltage conduits within buildings and electrical rooms by the following:
    a. Conduit ID label as specified at each end.
    b. Pre-printed voltage identification labels (i.e. "4160 VOLTS") in nominal 2-inch black letters on yellow background.
    c. Voltage identification labels to be placed once in each room and at a minimum of every 50 feet. Place where convenient for tracing.
    d. Exception: Conduit ID labels not required if conduit does not exit room and has readily identifiable terminations within the same room.
8. Feeder and branch circuit conduits
    a. In accessible ceiling spaces and exposed in unfinished areas, label conduit at each side of wall penetrations and connections to all panels, junction boxes, and equipment served. Define briefly, but accurately, nature of connected load.
    b. Exception: Labels not required if conduit does not exit room and has readily identifiable terminations within the same room.
9. Empty conduits
    a. Provide labels as specified.
10. Conduit abandoned as a result of this contract: Re-label as spare conduit if suitable for future use. Note accurately on as-built drawings.
11. Cardboard or plastic handwritten tags are not permissible, except for temporary markings. Remove all temporary markings where possible. Where markings cannot be removed, repaint trims, housing, etc. to cover markings.

D. Wire and Cable Identification
1. Wire and Cable Labels shall be provided as follows:
    a. All insulated conductors shall be labeled.
    b. Bare, un-insulated conductors shall not be labeled unless otherwise shown or specified.
    c. Wire and cable terminations shall be labeled.
        1) Wire labels shall be applied between half an inch and one inch of the completed termination.
        2) Cable labels shall be applied between half an inch and one inch of cable breakout into individual conductors. Individual conductors in a cable shall be labeled after the breakout as specified for wires.
    d. Wire or cable exiting cabinets, consoles, panels, terminal boxes and enclosures shall be labeled.

1) Wires or cables shall be labeled within two inches of the entrance to the conduit.

e. Wire or cable in junction boxes and pull boxes shall be labeled
   1) Wires or cables shall be labeled within two inches of the entrance to the conduit.

f. Wire and cable installed in cable tray shall be labeled.
   1) Wire and cable shall have labels applied at 20 foot maximum intervals.

g. Wire and cable installed without termination in electrical manholes shall be labeled.
   1) Wire and cable shall have wrap-around labels applied within one foot of exiting the manhole.

h. Wire and cable labels shall be installed after the wire or cable is pulled and prior to termination of the conductors where possible.
   1) Self-laminating wrap-around wire markers may be used either before or after termination, however the preferred method is before.
   2) Self-laminating wrap-around wire markers shall be used to identify existing wiring that is already terminated.
   3) Heat shrinkable sleeve markers shall be installed before termination.

E. Terminal Strip Labeling
   1. The panel side of the terminal shall be labeled to match the panel wire number.
   2. The field side of the terminal shall be labeled to match the field wire number. The terminal number shall not include the contract number.

F. Underground Warning Tape
   1. Each duct bank section shall be marked by means of a detectable warning tape (tracer tape) as shown on the Drawings. The detectable warning tape shall be capable of being detected or located by either conductive or inductive location techniques.
   2. Where trench exceeds 24-in width, provide additional detectable tape runs to mark each side of the duct bank in addition to the one in the center.

3.3 CLEANING

A. Remove grease, oil, dirt, dust, and concrete spatter from surfaces prior to applying labels.

B. Labels that do not adhere properly shall be re-made.

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SECTION 26 05 73

POWER DISTRIBUTION SYSTEM STUDY

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, professional services, and incidentals required to perform power distribution system studies and protective device field testing.
   2. Motor starting and transformer information used in the power distribution system studies shall be based on equipment provided by CONTRACTOR and, where applicable, existing equipment ratings and settings.

B. Power distribution system studies shall include the following, as specified in this Section:
   1. Short-circuit study.
   2. Protective device evaluation study.
   3. Protective device coordination study.
   4. Arc flash analysis.

C. Related Sections:
   1. Section 16075, Electrical Identification.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI/IEEE C37.91, Guide for Protective Relay Applications to Power Transformers
   2. ANSI/NCSL Z540.3 Requirements for the Calibration of Measuring and Test Equipment.
   3 IEEE 141, Recommended Practice for Electric Power Distribution in Industrial Plants.
   4. IEEE 242, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
   5. IEEE 399, Recommended Practice for Power System Analysis.
   6. IEEE 1584, Guide for Performing Arc-Flash Hazard Calculations.
   7. NFPA 70E (2015) , Electrical Safety in the Workplace.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Professional Engineer:
      a. Engage a registered professional engineer legally qualified to practice in the jurisdiction where the Project is located and experienced in

providing engineering services of the kind indicated. Professional engineer may be employed by independent consulting firm or manufacturer of power distribution equipment.

b. Professional engineer shall have at least five years of experience performing power distribution system studies similar in scope and size to the studies required for the Project.

c. Submit qualifications data.

d. Responsibilities include but are not necessarily limited to:

1) Performing or supervising the performance of power distribution system studies and related field services.

2) Preparing or supervising the preparation of test plans and test reports, and interpretation and engineering analysis of test data. Test reports shall bear the seal and signature of the professional engineer. State of licensure, license number, and professional engineer's name shall be clearly legible on the seal.

3) Certifying that tests performed and results achieved conform to the Contract Documents.

2. Field Engineer:

a. Field engineer performing protective device testing shall be experienced in type of testing required and testing equipment used on the Project.

b. Field engineer may be an employee of the protective device equipment manufacturer.

B. Test equipment and instrument calibration shall comply with accuracy standards of NIST and ANSI/NCSL Z540.3.

1.4 SUBMITTALS

A. Informational Submittals: Submit the following:

1. Test and Evaluation Reports:

a. Calculations and results of the short-circuit study, protective device evaluation, and coordination studies in report format. Report shall be sealed and signed by the professional engineer retained for the studies. Submit preliminary reports (when specified) and final reports.

b. Time current curves for protective devices included within the power system studies.

c. Results of field testing.

d. Calculations and results of arc flash analysis in report format stamped and signed by professional engineer retained for the studies. Submit preliminary reports (when specified) and final reports.

3. Qualifications Statements:

a. Professional engineer.

b. Field engineer, when required by ENGINEER.

1.6 POWER DISTRIBUTION SYSTEM STUDIES

A. General:
   1. Perform a current and complete short-circuit study, protective device evaluation study, and protective device coordination study to evaluate electrical equipment provided under this contract, and include recommendations on required adjustments. Studies shall also account for all existing equipment that is connected to the new electrical system provided under this contract. Studies shall include both the normal utility supply and the standby generator dedicated to the blower building. Studies shall be performed in accordance with IEEE 141, IEEE 242, and IEEE 399.
   2. Promptly bring to attention of ENGINEER and OWNER problem areas and inadequacies in equipment.

B. Short-circuit Study:
   1. Perform short-circuit evaluation using computer software specifically designed for such use.
   2. Input data shall include electric utility company's short-circuit, single-, and three-phase contributions, with reactance/resistance (X/R) ratio, resistance and reactance components of each branch impedance, motor and generator contributions, base quantities selected, and other applicable circuit parameters.
   3. Calculate short-circuit momentary duties and interrupting duties on the basis of maximum available fault current at each switchgear bus, switchboard, motor control center, distribution panelboard, pertinent branch circuit panelboards, and other significant locations through the system.
   4. Short-circuit tabulations shall include symmetrical fault currents and X/R ratios. For each fault location, total duty on the bus and individual contribution from each connected branch, including motor back electro-motive force (EMF) current contributions, shall be listed with its associated X/R ratio.

C. Protective Device Evaluation Study:
   1. Determine adequacy of circuit breakers, controllers, surge arresters, busways, switches, and fuses by tabulating and comparing short-circuit ratings of these devices with the available fault currents.
   2. Apply appropriate multiplying factors based upon system X/R ratios and protective device rating standards.

D. Protective Device Coordination Study:
   1. Perform study to select or to check selections of power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated voltage and current transformers, and low-voltage breaker trip characteristics and setting.
   2. Over-current device settings estimated in the protective device coordination study shall provide complete, 100 percent selectivity. Selectively coordinate system such that only the device nearest a fault will operate to

remove the faulted circuit. System selectively shall be based on both the magnitude and duration of a fault current.

3. Study shall include all voltage classes of equipment starting at electric utility's incoming line protective device, down to and including medium- and low-voltage equipment. Phase and ground over-current and phase and ground fault protection shall be included, and settings for other adjustable protective devices.
4. Plot time-current characteristics of installed protective devices on appropriate log-log paper. Maintain reasonable coordination intervals and separation of characteristic curves. Provide coordination plots for phase and ground protective devices for complete system. Use sufficient curves to clearly indicate selective coordination achieved through electric utility's main breaker, power distribution feeder breakers, and over-current devices at each major load center.
5. Show maximum of eight protective devices per plot. Appropriately title each plot and include the following information as required for the circuits shown:
    a. Representative one-line diagram, legends, and types of protective devices selected.
    b. Power company's relays or fuse characteristics.
    c. Significant motor starting characteristics.
    d. Parameters of transformers, magnetizing inrush and withstand curves in accordance with ANSI C37.91.
    e. Operating bands of low-voltage circuit breaker trip curves, and fuse curves.
    f. Relay taps, time dial and instantaneous trip settings.
    g. Cable damage curves.
    h. Symmetrical and asymmetrical fault currents.
6. Provide selection and settings of protective devices separately in tabular format listing circuit identification, IEEE device number, current transformer ratios, manufacturer, type, range of adjustment, and recommended settings. Provide a tabulation of recommended power fuse selection for all fuses in system.

E. Arc Flash Analysis:
1. Conduct arc flash analysis after acceptance by ENGINEER of short-circuit study and coordination study. Perform arc flash analysis for each operating mode of the system, in accordance with IEEE 1584 and NFPA 70E.
2. Document the protection and calculation procedures and coordination review in testing report. Present analysis results in tabular format showing the following:
    a. Bus and protection device name.
    b. Bolted and arcing fault values.
    c. Protective device trip times.
    d. Arc flash boundary, working distance, and incident energy.
    e. Required protective flame-resistant (FR) clothing class.

1.7 STUDY REPORT

A. Summarize results of power distribution system studies in a typewritten report that includes the following:
   1. Description, purpose, basis, written scope, and single-line diagram of power distribution systems evaluated.
   2. Tabulations of circuit breaker, fuses, and other equipment ratings versus calculated short-circuit duties. Evaluation of short-circuit calculations and identification of underrated equipment.
   3. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, and fuse selection. Include an evaluation and discussion of logical compromises for proposed protection.
   4. Fault current tabulation including definition of terms and guide for interpretation.
   5. Tabulation of appropriate tap settings for relay seal-in units.
   6. Tabulation of equipment survey information.

B. Power distribution system studies shall include a separate section addressing arc flash analysis. In addition to protection and calculation procedures, and coordination review and analysis results, report shall include protective device evaluation for each high-incident energy case to determine if adjustments can improve system performance relative to arc flash hazard level.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 PREPARATION

A. General:
   1. Coordinate with professional engineer performing the studies and assist professional engineer with collecting information necessary to complete the specified studies.

3.2 FIELD SERVICES

A. CONTRACTOR's professional engineer shall conduct an equipment survey of devices and information necessary for power distribution system studies.

B. To the extent applicable, survey shall include the following information:
   1. Manufacturer, type, and size of each power fuse.
   2. Manufacturer, type, model, and settings for each protective relay, trip unit, and circuit breaker.
   3. Current transformer ratios for each protective relay.
   4. Appropriate data for motors and transformers included with the study.

C. CONTRACTOR's professional engineer shall confirm and establish proper settings for protective devices. Professional engineer shall collect data and coordinate with equipment Suppliers to establish proper settings for the devices provided. Document in the study, all devices and settings.

3.3 FIELD TESTING

A. Provide protective device field testing in accordance with manufacturers' recommendations. Field testing shall be by CONTRACTOR's field engineer, after submittal of and ENGINEER's acceptance of power distribution system studies. Field testing results shall be documented in a report that shall include final settings of protective devices.

B. Field engineer shall provide necessary tools and equipment and adjust, set, calibrate, and test protective devices. Protective relays and meters shall be set, adjusted, calibrated, and tested in accordance with manufacturers' recommendations and the coordination study. Provide minor adjustments, repairs, and lubrication necessary for proper operation.

C. Solid state and multi-function trip devices shall be set, including required programming necessary for the protection required. Devices shall be checked, configured, and tested for setting and proper operation.

3.4 MAINTENANCE OF OPERATIONS

A. Field testing may require that certain equipment be temporarily taken out of service. CONTRACTOR shall perform the Work with due regard to the need of OWNER for continuance of operations and in accordance with sequencing required in the Contract Documents, and in accordance with Section 01143, Coordination with Owner's Operations. Submit testing procedures and schedules and obtain acceptance by ENGINEER prior to starting testing and related Work.

3.5 INSTALLATION

A. Provide personnel protective equipment labels in accordance with Section 16075, Electrical Identification.

+ + END OF SECTION + +

SECTION 26 22 14

DRY TYPE TRANSFORMERS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified, and required to furnish and install dry type transformers.

B. Related Sections:
   1. Section 16050, General Provisions.
   2. Section 16061, Grounding Systems.
   3. Section 16075, Electrical Identification.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. NEMA ST-20, Dry Type Transformers for General Applications.
   2. NEMA TP-1, Guide for Determining Energy Efficiency for Distribution Transformers.
   3. NEMA TP-2, Standard Test Method for Measuring the Energy Consumption for Distribution Transformers.
   4. UL 1561, Dry Type General Purpose and Power Transformers.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. NEC Article 450, Transformers and Transformer Vault (Including Secondary Ties).

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Product Data: Supplier's technical information for transformers proposed for use, including pad layout, materials, and dimensions
   2. Listing of transformers to be furnished with ratings and proposed locations for each.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Dry Type Two-Winding Transformer:
   1. Type: Dry type, air cooled, low temperature rise. Transformers 15 kVA and larger shall be energy efficient, complying with NEMA TP-1 Class 1 efficiency levels. Transformers less than 15 kVA shall be general purpose.
   2. Rating: KVA, primary voltage and connection, secondary voltage and connection, frequency and number of phases shall be as shown on the Drawings.
   3. Insulation: Insulation and average winding temperature rise (in a 40 degree C maximum ambient) for rated kVA per the following table. Energy efficient transformers shall be capable of 15 percent continuous overload at 150 degrees C temperature rise.

kVA Rating	Insulation Class (degrees C)	Temperature Rise (degrees C)
1 to 15 kVA	185	115
25 to 500 kVA	220	115

   4. Winding Taps, Transformers 15 kVA and Less: Two 5-percent below rated voltage, full capacity taps on primary winding.
   5. Winding Taps, Transformers 25 kVA and Larger: Two 2-1/2-percent above rated voltage and four 2-1/2+ percent below rated voltage, full capacity taps on primary.
   6. Basic impulse level shall be 10 kV.
   7. Sound Level: NEMA ST-20 standard.
   8. Enclosure: UL listed for the application.
   9. Identification: Identify transformers in accordance with Section 16075, Electrical Identification, with the transformer number and voltages, connection data, kVA ratings, impedance, and overload capacity.
   10. Transformers shall comply with NEMA ST-20, NEMA TP-1, NEMA TP-2, and UL 1561.
   11. Transformers shall bear the label of the Underwriters' Laboratories, Inc.
   12. Transformer windings shall be copper.

B. Manufacturers: Provide products of one of the following:
   1. Eaton.
   2. Schneider Electric/Square D Company.
   3. Or equal.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine the conditions under which the dry type transformers are to be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install transformers on walls or floors at locations shown. Install floor mounted transformers on raised concrete bases. Provide sufficient access and working space for convenient and safe operation and maintenance.

B. Mount transformers so that vibrations are not transmitted to the building structural parts and other equipment. Make connections to transformers with flexible conduit.

C. Adjust tap settings to provide proper voltage at panelboards.

D. Install dry type transformers in conformance with governing codes and manufacturer's instructions and recommendations, and the Contract Documents.

+ + END OF SECTION + +

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SECTION 26 24 13

SWITCHBOARDS

PART 1 GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, services, and incidentals as shown, specified, and required to furnish and install switchboards.

B. Related Sections:
   1. Section 40 05 96, Vibration, Seismic and Wind Controls.
   2. Section 26 05 53, Identification for Electrical Systems.
   3. Section 26 05 73, Electrical Power Distribution System Studies.
   4. Section 26 43 00, Surge Protective Devices.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. NEMA PB2, Dead-Front Distribution Switchboards.
   2. UL 891, Dead-Front Switchboards.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer: Shall have not less than five years experience manufacturing and servicing materials and equipment substantially similar to those required and upon request shall submit documentation of not less than five installations in satisfactory operation for at least five years each.
   2. Manufacturer shall manufacture circuit protective devices within the assembly.

B. Component Supply and Compatibility:
   1. Obtain all materials and equipment included in this Section regardless of component manufacturer from a single switchboard manufacturer.
   2. Switchboard manufacturer shall review and approve or prepare all Shop Drawings and other submittals for all components furnished under this Section.
   3. Components shall be suitable for the specified service conditions and shall be integrated into overall assembly by switchboard manufacturer.

C. Regulatory Requirements: Comply with the following:
   1. NEC Article 408, Switchboards and Panelboards.

D. Seismic Requirements: The Work shall comply with seismic (--1--) requirements in Section 40 05 96, Vibration, Seismic, and Wind Controls.

1.4 SUBMITTALS

A. All files associated with shop drawings and product data shall be submitted as Adobe PDF with searchable function. This allows reviewer to search the document for keywords.

B. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Three-line diagrams.
      b. Dimensional information including front view elevation and plan view.
      c. Construction details of enclosures with conduit entry locations and connection details between assemblies.
      d. Components list and nameplate schedule.
      e. Summary sheets with schedules of equipment.
      f. Key interlock scheme and sequence of operation.
   2. Product Data:
      a. Manufacturer's technical information, including catalog information.
      b. Manufacturer's technical specifications with assembly and component ratings.
      c. Time current curves for protective devices.
   3. Testing Plans, Procedures, and Testing Limitations:
      a. At least thirty days prior to factory testing, submit description of proposed factory testing methods, procedures, and apparatus.
      b. At least thirty days prior to field testing, submit description of proposed testing methods, procedures, and apparatus.

C. Informational Submittals: Submit the following:
   1. Certificates:
      a. Certifications required in this Section, including seismic requirements.
   2. Source Quality Control Submittals:
      a. Report of results of testing and inspections performed at manufacturer's shop.
   3. Site Quality Control Submittals:
      a. Report of results of field testing.
   4. Supplier Reports:
      a. Submit written report of results of each visit to Site by Supplier's service technician, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
   5. Qualifications Statements:
      a. Manufacture, when requested by ENGINEER.

D. Closeout Submittals: Submit the following:
   1. Operations and Maintenance Data:
      a. Submit in accordance with Section 01 78 23, Operations and Maintenance Data.
      b. Include acceptable test reports, maintenance data and schedules, description of operation, wiring diagrams, and list of spare parts recommended for one year of operation with current price list.
      c. Include record drawings of control schematics, with point-to-point wiring diagrams.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Delivery:
   1. Upon delivery, check for evidence of water that may have entered equipment during transit.

B. Handle equipment in accordance with manufacturer's instructions. One copy of these instructions shall be furnished with equipment at time of delivery.

C. Storage:
   1. 1. Store switchboards equipment in a clean, dry location with controls for uniform temperature and humidity. Protect equipment with coverings and maintain environmental controls.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Provide equipment of one of the following:
   1. Eaton/Cutler-Hammer.
   2. General Electric.
   3. Schneider Electric/Square D Company.
   4. Or equal.

2.2 SWITCHBOARD EQUIPMENT

A. Ratings:
   1. Switchboard shall be 600-volt class, suitable for operation on three-phase, 60-Hertz system.
   2. System operating voltage, number of wires, bus ampacity, and short circuit withstand capability and interrupting rating shall be as shown on the Drawings, or as otherwise indicated in the Contract Documents.

B. General:
   1. Switchboards shall be dead-front type with individual and group-mounted devices, front-accessible.
   2. Arrange switchboards with number of sections and compartments required for distribution arrangement shown.
   3. Provide switchboard in accordance with the arrangement shown on the Drawings. Switchboard shall consist of bus system, structure, circuit breakers, metering, surge protective device (SPD), and enclosure.
   4. Switchboards shall be in accordance with NEMA PB2, UL 891, and NEC Article 408.
   5. Switchboard shall be service entrance type and UL-labeled as such. Equip service entrance switchboards with bonding jumper to bond enclosure and ground bus to the neutral bus, and a barrier to isolate service bus bars and terminals.

C. Bus Bars:
   1. Switchboard bus bars shall be tin-plated copper, supported with high-

impact, non-tracking insulating material. Secure bus joints with Belleville type washers, and braced bus joints for mechanical forces exerted during short circuit conditions. Mount main horizontal bus bars with all three phases arranged in the same vertical plane.

2. Bus bar sizes shall be based upon a maximum temperature rise of 65 degrees C over a 40-degree C ambient in accordance with NEMA PB2 and UL 891.
3. Provide copper ground bus, minimum size of 1/4-inch by two inches, secured to each vertical section and extending entire length of equipment. Ground bus current capacity shall equal one-half the capacity of main power bus.
4. Conductor hardware shall be high-tensile strength and zinc-plated. Provide bus joints with conical spring-type washers.

D. Structure:
1. Equipment structure shall be completely self-supporting and shall include required number of vertical sections bolted together to form a single metal-enclosed enclosure.
2. Enclosure shall be rated NEMA 1.
3. Enclosure structure frame shall be die-formed, 12-gauge steel bolted together and reinforced.
4. Equipment shall have identifying nameplates in accordance with Section 26 05 53, Identification for Electrical Systems. Provide nameplates for each breaker circuit and provide typewritten directory of circuits.
5. Cover sides and rear of enclosure with removable, bolt-on covers. Edges of front covers or hinged front panels shall be formed. Provide adequate ventilation within enclosure.
6. Sections of switchboard shall be front- and rear-aligned with depth as shown on the Drawings. Devices shall be front-removable and load connections shall be front-accessible.
7. Provide assembly with adequate lifting means so that assembly is capable of being moved to its installation position.
8. Conduit entry and exit shall be bottom entry and coordinated by CONTRACTOR.
9. 9Quantity of conduits and cables associated with each feeder shall be as shown or indicated on the Drawings.

E. Circuit Breakers:
1. Circuit breakers shall be insulated case or molded case type with quantity of poles, voltage, and current ratings shown.
2. Breakers shall be manually-operated thermal magnetic type, including inverse-time overload and instantaneous short-circuit protection. Contacts shall be non-welding silver alloy and arc extinction shall be accomplished by arc chutes.
3. Breakers shall be operated by a toggle-type handle and shall have quick-make/quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of breakers shall be clearly indicated by handle position.
4. Where shown or required due to capacity, breakers shall be insulated case type. Insulated case breakers shall be manually-operated with stored energy mechanisms. Breakers shall include open-close

pushbuttons, five-cycle close time, and rotary operated stored energy handle mechanism providing quick make/quick-break protection.

5. Breakers shall have 100-amp frames, minimum. Provide overload protection on all poles, with trip settings as shown. Breakers with frame sizes 250 amps and below shall have thermal-magnetic trip units and inverse time-current characteristics, or equal.
6. Provide breakers 400-amp frame and larger with an electronic solid state programmable trip unit. For four-wire power systems and circuits, provide a neutral current transformer, and trip unit shall be suitable to accept neutral input. Provide push-to-trip button on front of circuit breaker to provide local manual means of exercising trip mechanism. Electronic trip system shall include:
   a. Plug-in protection programmer, flux shift trip device, and current sensor package. Construct programmer, sensor, and flux-shifting trip device as integral elements of breaker, requiring no externally mounted assemblies for proper operation.
   b. Solid state, microprocessor-based, nine-function programmer shall provide true RMS current sensing and include adjustable continuous and instantaneous current elements with adjustable long time, short time, zero sequence ground fault pickup and delay and zone selective interlocking. Main, tie and feeder circuit breakers shall be connected for zone selective interlocking to allow instantaneous bus protection.
7. Where shown, provide breakers with shunt trips, bell alarms, and auxiliary devices.
8. Type 1 Microprocessor-based Monitoring Device:
   a. Device shall provide complete electrical metering in one package. Device shall include self-contained potential transformers and self-protected internal fuses.
   b. Mount device on compartment door to allow personnel access to meter menu and display.
   c. Device shall include trend analysis, event logging, and recording. Device shall include the following direct reading metered values:
      1) Volts: 0.2 percent accuracy
      2) Amperes: 0.2 percent accuracy
      3) Watts, Vars, and VA: 0.5 percent accuracy
      4) Power Factor: 1.0 percent accuracy
      5) Frequency: 0.05 percent accuracy
      6) Watts, and VA Hours: 0.5 percent accuracy
      7) Var Hours: 1.0 percent accuracy
      8) Watts, Var, and VA Demand: 0.4 percent accuracy
      9) THD-Voltage: 50th harmonic
      10) THD-Current: 50th harmonic
      11) Individual Ampere Harmonics: 50th harmonic
      12) Individual Voltage Harmonics: 50th harmonic
   d. Metering device shall have the following additional features:
      1) Trend analysis that shall display minimum and maximum values for each metered parameter with date and time of each occurrence.
      2) Input range of device shall accommodate external current transformers with ranges from 100/5 to 5000/5 and potential

transformers from a ratio of 120:120 to 500,000:120. Three current transformers suitably rated shall be included.

3) Alarm contacts rated five amps at 120 vac.
4) Three analog outputs programmable to reflect the metered parameters, except kilowatt hours and kilovar hours.
5) Communication capability, using RS-485, Modbus RTU Protocol or Ethernet as indicated on the Drawings

9. Type 2 Microprocessor-based Monitoring Device:
   a. Device shall provide complete electrical metering in one package. Device shall include self-contained potential transformers and self-protected internal fuses.
   b. Mount device on compartment door to allow operator access to meter menu and display.
   c. Device shall include trend analysis, event logging, and recording. Device shall include the following direct reading metered values:
      1) Volts: 0.2 percent accuracy
      2) Amperes: 0.2 percent accuracy
10. Control power shall be drawn from the monitored incoming AC line. Device shall have non-volatile memory and not require battery backup. During power failure, device shall retain preset parameters.

F. Wiring/Terminations:
   1. Provide small wiring, necessary fuse blocks, and terminal blocks in switchboard as required. Control components mounted in assembly, such as fuse blocks, relays, pushbuttons, switches, and other components, shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.
   2. Provide mechanical-type terminals for all line and load terminations suitable for copper or aluminum cable rated for 75 degrees C of size indicated on the Drawings.
   3. Provide lugs in incoming line section for connection of main grounding conductor. Provide additional lugs for connection of other grounding conductors as indicated on Drawings.
   4. Control wire shall be Type SIS, bundled and secured with nylon ties. Provide insulated locking spade terminals for all control connections, except where saddle type terminals are provided integral to a device. Current transformer secondary leads shall first be connected to conveniently accessible short-circuit terminal blocks before connecting to another device. Provide groups of control wires leaving switchboard with terminal blocks with suitable numbering strips. Provide wire markers at each end of all control wiring.

G. Accessories:
   1. Provide a surge protective device in accordance with Section 26 43 00, Surge Protective Devices, for each switchboard bus shown or indicated on the Drawings. Each surge protective device shall be included and factory-mounted within switchboard-by-switchboard manufacturer. Surge protective device monitoring and display shall be visible from switchboard front.
   2. Provide thermostatically-controlled space heater to prevent moisture condensation.

H. Miscellaneous Devices:
   1. Provide control power transformers with primary and secondary protection, as indicated on the Drawings or as required for proper operation of equipment.

I. Finishing:
   1. Exterior and interior steel surfaces of switchboard shall be properly cleaned and provided with rust-inhibiting phosphatized coating by switchboard manufacturer. Color and finish of switchboard shall be light gray.

2.3 SOURCE QUALITY CONTROL

A. Tests:
   1. Factory-test switchboards in accordance with NEMA PB2 and UL 891
   2. Perform factory tests on equipment prior to shipment. Tests shall consist of the manufacturer's standard tests, and shall include:
      a. Physical inspection and checking of all components.
      b. Operation and device function tests under simulated service conditions to verify accuracy of wiring and functioning of all equipment.
      c. Primary, control, and secondary wiring hi-pot tests.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine conditions under which materials and equipment will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install equipment so that sufficient access and working space is provided for ready and safe operation and maintenance.

B. Install equipment on concrete pad, as shown. Coordinate pad dimensions to fit equipment furnished.

C. Install in accordance with Laws and Regulations, manufacturer's recommendations, and the Contract Documents. Do not energize equipment without permission of OWNER.

3.3 FIELD QUALITY CONTROL

A. Site Tests:
   1. After installation, inspect and perform field testing of each switchboard. Testing and inspections shall by Supplier's factory-trained representative, in accordance with manufacturer's recommendations. Inform OWNER

and ENGINEER when Supplier's representative indicates that equipment is correctly installed.

2. Perform the following tests and checks before energizing equipment:
   a. Verify proper installation.
   b. Inspect all mechanical and electrical devices for proper operation.
   c. Check tightness of bolted connections.
   d. Measure insulation resistance of each bus section, phase-to-phase and phase-to-ground.
   e. Measure insulation resistance of each circuit breaker, pole-to-pole and from pole-to-ground.
   f. Check for proper anchorage, required area clearances, physical damage, and proper alignment.
   g. Clean and lubricate as required.
   h. Perform other tests and adjustments recommended by equipment manufacturer.

B. Manufacturer's Services: Provide services of qualified, factory-trained serviceman to perform the following:
   1. Instruct CONTRACTOR in installing equipment.
   2. Inspect and adjust equipment after installation and ensure proper operation.
   3. Instruct operations and maintenance personnel in operation and maintenance of the equipment.
   4. Manufacturer's technician shall make visits to the Site as follows:
      a. First visit shall be for instructing CONTRACTOR in proper equipment installation, and assisting in installing equipment. Minimum number of hours on-Site: (--1--) hours.
      b. Second visit shall be for checking completed installation, start-up of system; and performing field quality control testing. Minimum number of hours on-Site: (--2--) hours.
      c. Third visit shall be to instruct operations and maintenance personnel.
         1) Furnish services of manufacturer's qualified, factory-trained specialists to instruct OWNER's operations and maintenance personnel in recommended operation and maintenance of equipment.
         2) Training requirements, duration of instruction and qualifications shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
         3) Number of hours on-Site shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
      d. Technician shall revisit the Site as often as necessary until installation is acceptable.
   5. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to the Site shall be included in the Contract Price.

3.4 ADJUSTING

A. Calibrate, set and program protective devices. Coordinate the protective devices furnished under this Section and provide proper settings of devices per the results of the study specified in Section 26 05 73, Electrical Power Distribution System Studies.

END OF SECTION

SECTION 26 24 13

PANELBOARDS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install lighting and distribution panelboards.

B. Related Sections:
   1. Section 16050, General Provisions.
   2. Section 16075, Electrical Identification.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. NEMA PB1, Panelboards.
   2. UL 67, Panelboards.

1.3 SUBMITTALS

A. Shop Drawings: Submit the following:
   1. Manufacturer's technical information for panelboards proposed.
   2. Listing of panelboards to be furnished with identification of their proposed location, and all electrical characteristics, including number and rating of branch circuit breakers and enclosure type.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements
   1. NEC Article 408, Switchboards and Panelboards.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery:
   1. Deliver materials to the Site to ensure uninterrupted progress of the Work.
   2. Inspect equipment for shipping damage or loose parts upon delivery. Check for evidence of water that may have entered equipment during transit.
   3. Notify ENGINEER of loss or damage to equipment or components. Replace loss and repair damage to new condition per manufacturer's instructions.

B. Equipment shall be handled in accordance with manufacturer's instructions.

C. Storage:
   1. Store panelboards equipment in a clean, dry location with controls for uniform temperature and humidity. Protect equipment with coverings and maintain environmental controls.
   2. Store materials for easy access for inspection and identification. Keep all materials off the ground, using pallets, platforms or other supports. Protect equipment from corrosion and deterioration.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Panelboards:
   1. Manufacturers: Provide products of one of the following:
      a. Eaton.
      b. Schneider Electric/Square D Company.
      d. Or equal.
   2. Rating: Voltage rating, current rating, number of phases, number of wires and number of poles as indicated on Drawings.
   3. Circuit Breakers: Molded case, bolt-in thermal magnetic type with number of poles and trip ratings as shown. Where indicated on Drawings, circuit breakers shall be ground fault circuit interrupting type equipped with solid state sensing and five-milliamp sensitivity.
   4. Circuit breakers for 480-volt panelboards shall have a minimum interrupting rating of 65,000 ampere RMS symmetrical,. Circuit breakers for other panelboards shall have a minimum interrupting rating of 22,000 ampere RMS symmetrical, unless otherwise noted on Drawings.
   5. Bus Bars: All bus bars shall be 98 percent conductivity copper. Four-wire panelboards shall have a solid neutral bar. All panels shall have a ground bus bar.
   6. Main: Panelboards shall have a main circuit breaker, unless Drawings specifically call for main lugs only. .
   7. Branch circuit breakers shall be connected for sequence phasing.
      a. Enclosures: Panel enclosures shall be as required for the area classifications specified in Section 16050, General Provisions, unless otherwise noted on Drawings.
   8. Construction: Code grade steel, ample gutter space, flush door, flush snap latch and lock. Panelboards shall meet the requirements of NEMA PB1 and UL 67.
   9. Trim: Surface or flush as required.
   10. Directory: Typed card, with transparent protective cover in frame on back of door giving circuit numbers and area or equipment served.
   11. Identification: Identify all panelboards in accordance with Section 16075, Electrical Identification. Include the panel number and voltage.

B. Integrated Panelboard and Transformer:
   1. Products and Manufacturers: Provide products of one of the following:
      a. Mini-Power Zone by Schneider Electric/Square D Company.
      b. Mini-Power Center by Eaton/Cutler-Hammer.
      c. Panel Tran by Acme Electric Corporation.
      d. Or equal.
   2. General: Unit shall consist of encapsulated dry-type transformer, primary and secondary main circuit breakers, and secondary panelboard all in one enclosure.
   3. Transformer Rating: Transformer portion shall comply with Section 26 22 14, Dry-type Low-Voltage Distribution Transformers. KVA, primary voltage, secondary voltage, frequency and number of phases shall be as shown or indicated on the Drawings.
   4. Branch Circuits: Molded case circuit breakers, plug-in thermal magnetic type with number of poles and trip ratings as shown or indicated on the Drawings.
   5. Enclosure: Enclosures shall be as required for the area classifications indicated in Section 26 05 05, General Provisions for Electrical Systems, unless otherwise indicated on the Drawings.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work is to be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Mounting: Install panelboards at locations shown. Set cabinets so that top branch circuit breaker is not over six feet above grade.

B. Directory: Complete typewritten directory indicating items controlled by each circuit breaker and the size of feeder serving the panel.

C. Arrange circuits to balance the loads on the panelboards.

D. Identify panelboard in accordance with Section 16075, Electrical Identification.

E. Install in accordance with governing codes, manufacturer's recommendations, and the Contract Documents. Verify proper installation prior to energizing panelboards.

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SECTION 26 29 23

LOW-VOLTAGE VARIABLE FREQUENCY DRIVES

PART 1 GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, services, and incidentals as shown, specified, and required to furnish and install low-voltage variable frequency drives, complete and operational.
   2. Variable frequency drives required under this Section are low-voltage, voltage source inverter type. Variable frequency drives shall be customized for the control functionality specified.
   3. Low-voltage variable frequency drive types required which are included in this Section are associated with the following equipment:
      a. Storm water Pumps
   4. Section 26 05 53, Identification for Electrical Systems.
   5. Section 43 31 13.13, End Centrifugal Pumps Wet-Pit

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. IEEE 519, Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.
   2. ISO 9000, Quality Management Systems, Fundamentals and Vocabulary.
   3. ISO 9001, Quality Management Systems, Requirements.
   4. ISO 9002, Quality Systems, Model for Quality Assurance in Production, Installation and Servicing.
   5. NEMA ICS 2, Controllers, Contactors and Overload Relays Rated 600 Volts.
   6. NEMA ICS 7, Industrial Control and Systems Adjustable Speed Drives.
   7. NEMA MG 1, Motor and Generators.
   8. UL 489, Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures.
   9. UL 508, Industrial Control Equipment.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer:
      a. Low-voltage variable frequency drive manufacturer shall have not less than five years of experience designing and regularly manufacturing and servicing substantially similar equipment to that required, and upon ENGINEER's request shall submit documentation of not less than five installations in satisfactory operation for not less than five years each.
      b. Manufacturer shall be certified under ISO 9000, ISO 9001, or ISO 9002 for materials and equipment specified.
      c. For all required factory tests, low-voltage variable frequency drive manufacturer shall use a factory test facility that has calibrated its testing

apparatus in the previous twelve months, and is staffed by qualified, experienced technicians.

B. Component Supply and Compatibility
   1. Drives under this Section shall employ a transistor-based active front end input rectifier that utilizes a selective harmonic elimination algorithm. The drive harmonic mitigation shall be enough to meet IEEE-519 without the need for multi-pulse rectifiers and transformers. Total current harmonic distortion shall be 5 percent or less at the VFD input terminals under all load conditions.
   2. Drives specified under this Section shall employ a low switching frequency or pattern to minimize instantaneous rate of voltage change over time (dv/dt), and the adverse effects of potential bearing currents. Where alternate manufacturers are proposed, obtain manufacturer recommendations regarding bearing currents and provide equipment required at no additional cost to the Owner.
   3. Each low-voltage variable frequency drive shall be fully compatible with associated driven equipment and motors. Variable frequency drives shall be matched to specific load requirements for each system. Operation of variable frequency drive shall not overstress motor insulation.
   4. To centralize responsibility and to ensure that all equipment is properly coordinated, variable drives specified under this Section shall be obtained from the Supplier of the associated driven equipment.
   5. Similar components of drives associated with each system shall be products of a single manufacturer.

1.4 SUBMITTALS

A. All files associated with shop drawings and product data shall be submitted as Adobe PDF with searchable function. This allows reviewer to search the document for keywords.

B. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Dimensional information and construction details of enclosures. Enclosure details shall consist of exterior and interior front door with nameplate legends, interior door front and rear views, and terminal block layout.
      b. Three-line power and control schematic diagrams.
      c. Wiring diagrams showing the interconnection of conductors to all devices with terminal assignments for remote devices.
      d. Functional description of system operation.
      e. VFD heat dissipation at full load, including heat rejection/cooling system.
      f. Certification of VFD IEEE 519 compliance.
   2. Product Data:
      a. Manufacturer's technical specifications.
      b. Manufacturer's catalog cuts and product literature.
   3. Testing Plans:
      a. Not less than thirty days prior to source quality control testing, submit descriptions of proposed shop testing methods, procedures, apparatus, and limitations.
      b. Not less than thirty days prior to field quality control testing, submit descriptions of proposed field testing methods, procedures, and apparatus.

C. Informational Submittals: Submit the following:
   1. Certificates:

a. Certification letters from low-voltage variable frequency drive manufacturer and motor manufacturer that the approved driven equipment has been reviewed and that variable frequency drive units and motors are compatible and shall be provided in accordance with the Contract Documents and requirements of the driven equipment.

2. Source Quality Control Submittals:
   a. Within five days of completing source quality control tests and inspections, submit test results with indication of whether all criteria of the Contract Documents for the specified equipment were met.
3. Field Quality Control Submittals:
   a. Within five days of completing field quality control tests and inspections, submit test results with indication of whether all criteria of the Contract Documents for the specified equipment were met.
4. Manufacturer Reports:
   a. Within five days of each visit to the Site by manufacturer's representative, submit written report of reason for visit, problems encountered, solutions implemented, and remaining work.
5. Qualifications Statements:
   a. Manufacturer, when requested by ENGINEER.

D. Closeout Submittals: Submit the following:
   1. Operation and Maintenance Data:
      a. Submit complete installation, operation and maintenance manuals including test reports, maintenance data and schedules, description of operation, list of recommended spare parts, and spare parts ordering information.
      b. Manuals shall include record drawings of control schematics, including point-to-point wiring diagrams.
      c. Include a listing of all programmable drive parameters and their settings at Substantial Completion. Submit parameters as both printed pages in the operations and maintenance manual and in electronic format on compact disc that can be directly uploaded to the drive-in event of drive replacement or repair.
      d. Comply with Section 01 78 23, Operations and Maintenance Data.

E. Maintenance Materials Submittals: Submit the following:
   1. Spare Parts and Extra Stock Materials:
      a. Furnish, tag, and box for shipment and long-term storage spare parts and special tools for low-voltage variable frequency drives. Each set of spare parts and tools shall include manufacturer's recommended spare parts inventory for one year and include, at minimum, the following:

Item	Quantity per Four VFDs per HP Rating
1) Transistor and diode modules with accessories	One set
2) Power supply module	One
3) Fans	One set
4) Power fuses	One set of each size and type used
5) Control power fuses	Two sets of each size and type used
6) Pilot lights	Two per ten of each type used

b. Furnish a list of recommended spare parts for an operating period of one year. Describe each part, the quantity recommended, and current unit price.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packing, Shipping, Handling, and Unloading:
   1. Packing:
      a. Inspect prior to packing to ensure that assemblies and components are complete and undamaged.
      b. Protect mating connections.
      c. Cover all openings into enclosures with-vapor inhibiting, water-repellent material.
      d. Indoor containers shall be bolted to skids.
   2. Upon delivery, check materials and equipment for evidence of water that may have entered equipment during transit.
   3. Handling:
      a. Lift, roll or jack low-voltage variable frequency drive equipment into locations shown.
      b. Variable frequency drives shall be equipped for handling required for installation. Handle equipment in accordance with manufacturer's requirements.

B. Storage and Protection:
   1. Store low-voltage variable frequency drive equipment in a clean, dry location with controls for uniform temperature and humidity. Protect equipment with coverings and maintain environmental controls.

PART 2 PRODUCTS

2.1 EQUIPMENT PERFORMANCE

A. System Performance:
   1. Driven equipment to be controlled by a low-voltage variable frequency drive shall be provided with a customized variable frequency drive. Each drive unit shall include an adjustable frequency controller with associated controls for continuous speed adjustment and protection of the driven equipment. Output speed control of motor shall be continuous throughout speed range of two to 60 Hertz under variable torque load or constant torque as specified for the driven equipment.
   2. Low-voltage variable frequency drives associated with each set of driven equipment shall be similar to each other.
   3. Variable frequency drives shall be UL-listed or ETL-listed and designed, built, and tested in accordance with UL 489, NEMA ICS 2, NEMA ICS 7, and UL 508.

2.2 MANUFACTURERS

A. Provide low-voltage variable frequency drives by one of the following:
   1. Rockwell Automation Allen Bradley.
   2. Siemens.
   3. ABB.
   4. Or equal.

2.3 VARIABLE FREQUENCY DRIVE CABLE

Refer to Specification 26 05 19 for special requirements for VFD Cables.

2.4 ENCLOSURE

A. Provide each low-voltage variable frequency drive with freestanding, front-access, NEMA 1, filtered and gasketed enclosure. Enclosure shall house all components required for the associated variable frequency drive.

B. Enclosure shall provide adequate cooling for components within and include positive ventilation.

C. Enclosure shall include circuit breaker disconnect switch. Circuit breakers shall be in accordance with UL 489. Switch handle shall be suitable for padlocking and be through-the-door type with handle height not exceeding six feet. Operation of switch shall remove the service supply from all internal components. Power devices shall be suitable for interrupting capacity of 65,000 RMS symmetrical amperes. Include current limiting semi-conductor fuses where required for protection of solid state components.

D. Enclosure door shall include an operator interface for access to controller's digital keypad and display.

E. Equip enclosure front with nameplates for identification of equipment and operating functions. Nameplates shall be in accordance with Section 26 05 53, Identification for Electrical Systems.

F. Equip enclosure with phenolic type terminal blocks suitably labeled for all internal and remote wiring requirements, plus twenty percent spare.

2.5 ADJUSTABLE FREQUENCY CONTROLLER

A. General:
   1. Adjustable frequency controller shall be design, suitable for operation on a 480-volt, three-phase supply. Controller shall produce an adjustable AC voltage/frequency output to vary speed of driven equipment.
   2. Controller specified as low harmonic type:
      a. Microprocessor-based inverter and converter logic isolated from power circuits.
      b. Switched Insulated Gate Bi-Polar Transistor (IGBT) bridge inverter and converter, input section (Active Front End).
   3. Controller switching frequency shall be adjustable and allow operation at 5,000 Hertz or less. Controller technology shall include a switching scheme that reduces the dv/dt of output supply.
   4. Controller shall include an LCL filter suitable for reducing EMI/RFI emissions.
   5. Controller shall include MOV protection, phase to phase and phase to ground.
   6. Overload rating of 110 percent variable torque, 150 percent constant torque for one minute.
   7. RMS harmonic content of output current shall be less than five percent of fundamental current.
   8. Able to withstand output terminal line-to-line short circuits without component failure.

B. Operating Criteria:
   1. Operating criteria shall be in accordance with the following:
      a. Ambient temperature range of zero to 40 degrees C.
      b. Operational humidity of up to 90 percent non-condensing.
      c. Altitude up to 3,300 feet above sea level.
      d. Nominal voltage of 480-volts plus or minus ten percent, three-phase, three-wire. Include an under-voltage feature to allow trip-free operation down to 20 percent undervoltage.
      e. Nominal frequency of 60 Hertz plus or minus three Hertz.
      f. Input power factor of 97 percent displacement power factor at all operating speeds.
      g. Efficiency of 96 percent at full speed and full load.

C. Features:
   1. Controller shall have the following features:
      a. Digital keypad and display module shall provide parameter setting, adjustments, and monitoring of control functions and faults. Display messages shall be in English.
      b. Controllers shall be equipped with a built-in dual port EtherNet/IP interface with capability of communicating at a minimum EtherNet/IP for remote monitoring at the PLC located within the process control panel. Contractor shall ensure that the manufacturer can communicate with the remote PLC provided under this Contract.
      c. HMI interface with integral LCD display, operating and programming keys.
      d. Independent acceleration/deceleration rates shall provide two to 600 seconds minimum. When called to stop, motor shall decelerate to minimum speed before stopping.
      e. Power loss feature shall allow five cycle ride through capability for input supply interruptions.
      f. Time delay automatic restart shall allow restart after controller fault conditions with programmable attempts.
      g. Coasting motor restart shall allow controller to restart into a coasting motor without damage or tripping.
      h. Isolated control inputs and outputs.

D. Protection:
   1. Controller shall have electronic protective functions as follows:
      a. Power loss.
      b. Over-current phase to phase and phase to ground.
      c. Inverse time overload protection with thermal memory retention.
      d. Over-temperature.
      e. Current limit trip protection.
      f. Over and under-voltage.

2.6 OUTPUT FILTER

A. General:
   1. Provide output filter to prevent overstressing motor insulation system. Provide output filter with each low-voltage variable frequency drive, when cable length between motor and variable frequency drive exceeds the following based on noted switching frequencies.
      a. One KHZ switching frequency, 200 feet cable length.
      b. Three KHZ switching frequency, 175 feet cable length.

2. Provide output filters in all other cases, based on recommendations of low-voltage variable frequency drive and motor manufacturers, when actual voltage peaks at motor terminals exceed NEMA MG 1 limits.

B. Features and Criteria:
   1. Filter shall be three-phase, 600-volt class motor-protecting type consisting of suitable values of inductance, capacitance and resistance to form a damped, low pass filter.
   2. Filter shall be low-loss type specifically designed to reduce voltage wave form dv/dt. Filter shall allow cable lengths at minimum exceeding actual application distances with waveform resulting in voltage spikes at motor terminal that are within NEMA MG 1 Part 31 voltage stress levels.
   3. Filter shall be suitable for mounting within low-voltage variable frequency drive enclosure.

2.7 CONTROLS

A. General:
   1. Equip each low-voltage variable frequency drive control system with relays, switches, fuses, indicating lights, and components required for a complete, functional system.
   2. Variable frequency drive control shall be powered from a suitably sized and protected control power transformer.
   3. Variable frequency drive control shall include status indicators, controller, and system fault condition displays and operating controls. Provide status indicators and operating controls associated with drive control on front door of enclosure.
   4. Control arrangement shall be such that variable frequency drive internal electronic supply voltage is isolated from field wiring.

B. Control and Pilot Devices:
   1. Relays shall be electrically operated, electrically held type, and pneumatic or solid-state time delay type. Provide relays with contacts rated ten amps, quantity as required.
   2. Pilot devices shall be heavy duty type, rated 10 amps continuous. Indicating lights shall be push-to-test transformer LED type with 12-volt secondaries.

C. Operation: **UPDATE WHEN CONTROLS FINALIZED**
   1. Stop/Start and Speed Control for all drives, unless specifically noted otherwise: Drives shall respond to drive-mounted Local-Off-Remote selector switch and a Local-Off-Remote local control station switch mounted near the motor. With drive switch in “REMOTE” position, stop/start and speed control shall be based on a remote stop/start contact and a four- to 20-mADC speed signal from remote process control panel. With drive switch in “LOCAL” position and local control station switch in “Remote” stop/start and speed control shall be from the HMI located at the Drive. With the local control station switch in “LOCAL” postion stop/start and speed control shall be based on a remote stop/start pushbuttons and a four- to 20-mADC speed signal from the local control station.
   2. Auxiliary Controls for all pumping units shall include the following, unless specifically noted otherwise:
      a. Emergency Stop Control: Emergency stop control shall include a drive mounted stop pushbutton and a remote field mounted stop pushbutton

located adjacent to driven equipment. When activated driven equipment shall stop immediately in all operating modes.

b. Motor Vibration Shutdown, Finished Water: Motor vibration control shall respond to remote contacts from motor mounted vibration electronic switches that activate on motor high vibration. When high vibration is detected, from any one of the vibration switches driven equipment shall stop. Include provisions to remotely supply 120-volt power to the vibration control switches located at motor. The Finished Water Pumps are equipped with five separate vibration switches.

c. Motor Vibration Start Command, Finished Water: When the drive is started a normally open dry contact shall be provided which shall close to initiate a startup delay command to remote mounted vibration switches. Five separate contacts are required for the Finished Water Pumps, one contact for each switch.

d. Discharge No Flow Shutdown, Finished Water: No flow control shall respond to a remote flow switch. Upon pump start the no flow switch shall be bypassed for an adjustable time delay. When the startup delay times out, if no flow is detected, pump shall stop after an adjustable time delay. Include provisions to remotely supply 120-volt power to the flow switch located at pump.

e. Low Suction Level, Finished Water Pumps Only: Low suction level control logic will be derived at the remote process control panel. Drive will accept a low level remote dry contact normally open which shall be used as a permissive to start. A low level On-Off selector switch shall be provided to manually bypass the low suction level permissive to start contact. The On-Off low level selector shall be mounted behind the drive door and shall not be accessible front the front door.

3. Auxiliary Pump Motor Temperature Monitoring:

a. The Finished Water Pumps shall include motor temperature relays, for each pump motor. Temperature relays shall be multi-functional, microprocessor based suitable for monitoring motor winding RTDs, 2 per phase. The relays shall provide temperature monitoring and protection in a single draw-out case. The relays shall include keypad and local display for programming set points and temperature data retrieval and motor shutdown on high temperature.

b. The Quarry Return Pumps and Membrane Feed Pumps shall respond to a remote motor thermistor relay contact that activates on motor over-temperature. When over-temperature is detected, pump shall stop. Provide 120 Volt supply to power the motor thermistor relay.

c. Reverse Filtration Pumps Motor Thermostat Over-temperature Shutdown: Motor over-temperature control shall respond to remote normally closed contacts that activates on motor over-temperature. When over-temperature is detected, driven equipment shall stop.

D. Status Lights and Contact Outputs:

1. Provide the following separate drive mounted status pilot lights for each drive, unless specifically noted otherwise:

a. Motor run (red). include provisions to supply a second pilot light located in remote control station that activates when motor runs.

b. Motor stop (green). include provisions to supply a second pilot light located in remote control station that activates when motor stops.

2. Provide the following separate drive mounted shutdown pilot lights, (amber) for each drive. Arrange shutdown indication circuitry so that, when activated, indicator requires manual reset.
   a. Over-temperature.
   b. Finished Water, no flow.
   c. Finished, high vibration.
   d. Finished Water, low level.
3. Provide the following dry contact outputs for remote indication of each drive:
   a. Motor high temperature.
   b. Motor run.
   c. VFD fault.
   d. Emergency stop activated. Provide relay to repeat contact for remote indication.
   e. Local-Off-Remote switch not in remote. Provide relay to repeat contact for remote indication.
   f. Finished Water Pumps, no flow.
   g. Finished Water Pumps high vibration.
4. Speed Output: Provide a speed output four- to 20-mADC signal for remote indication of motor speed.

E. Wiring and Device Identification:
   1. Provide control wiring and device identification for each low-voltage variable frequency drive:
      a. Identify all control conductors with permanent type wire markers. Each wire shall be identified by a unique number and shall be attached to wire at each termination point.
      b. Identify each control device with permanent type marker. Each device shall be identified by a unique number and shall be attached to each device.
      c. Numbering system for each wire and control device shall be identified on wiring diagrams and shall reflect actual designations used in the Work.

2.8 SOURCE QUALITY CONTROL

A. Tests:
   1. Perform factory tests on each low-voltage variable frequency drive prior to shipping. Tests shall consist of simulating expected load to be driven by operating load through speed ranges specified for driven equipment, for minimum of two hours per drive unit.
   2. Provide factory control and alarm tests on each drive unit by simulating each control signal and each alarm function to verify proper and correct drive unit action.
   3. Perform specified tests in addition to standard factory tests typically performed.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install equipment in accordance with manufacturer's recommendations and instructions and in conformance with Laws and Regulations, and the Contract Documents.

B. Install equipment with sufficient access and working space provided for ready and safe operation and maintenance.

C. For installations against masonry walls, provide an insulation board, 1/4-inch minimum thickness, between equipment and wall for corrosion protection. Trim board neatly within outline of equipment.

D. Install all terminations, lugs, and required appurtenances necessary to properly terminate power supplies.

E. Install control wiring terminations and appurtenances necessary to complete installing control and monitoring devices.

F. Immediately prior to Substantial Completion, replace all enclosure filters and frames provided under this Contract with new filters and frames, except expanded metal filter types. Immediately prior to Substantial Completion, clean expanded metal filters.

3.3 FIELD QUALITY CONTROL

A. Site Tests:
   1. After installation, inspect, adjust, and test each low-voltage variable frequency drive at the Site. Testing and inspection shall be in accordance with manufacturer's recommendations and be performed by manufacturer's factory-trained representative. Through CONTRACTOR, manufacturer's factory-trained representative shall inform OWNER and ENGINEER when equipment is correctly installed and ready to be energized. Do not energize equipment without permission of ENGINEER.
   2. Perform the following equipment inspection and testing and provide reports documenting procedures and results.
      a. Verify all device settings and drive adjustments.
      b. Inspect all mechanical and electrical interlocks and controls for proper operation.
      c. Test each drive through specified speed ranges and loads for a minimum of two hours per drive unit.
      d. Test each drive by using actual control signal for remote and local operation.
      e. Test each drive alarm function and field devices.
      f. Verify signals and communication functions with the process control panel.
      g. Perform other tests recommended by equipment manufacturer.

B. Manufacturer Services:
   1. Unloading and Installation: Manufacturer's factory-trained representative shall be present during unloading of equipment and installation at equipment's final location. Representative shall train installing personnel in advance in the proper handling and rigging of equipment.
   2. Post-installation Check: Manufacturer's factory-trained representative shall check and approve the installed equipment before initial operation. Manufacturer shall calibrate, set and program low-voltage variable frequency drives provided.
   3. Manufacturer's factory-trained representative shall test the system as specified in Paragraph 3.3.A of this Section. Representative shall operate and test the system

in presence of ENGINEER and verify that equipment is in conformance with the Contract Documents.

4. Representative shall revisit the Site as often as necessary until all deficiencies are corrected, prior to readiness for final payment.
5. Provide services of manufacturer's factory-trained representatives to correct defective Work within 72 hours of notification by OWNER during the correction period specified in the General Conditions as may be amended by the Supplementary Conditions.
6. Replacement parts or equipment provided during the correction period shall be equal to or better than original.
7. Training: Provide services of qualified factory trained specialists from manufacturer to instruct OWNER's operations and maintenance personnel in recommended operation and maintenance of equipment. Training requirements, duration of instruction, and other qualifications shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.

3.4 ADJUSTING

A. Immediately prior to Substantial Completion, when testing is acceptably completed and low-voltage variable frequency drives are operating, manufacturer's representative shall return to the Site and make final adjustments as required to each variable frequency drive furnished under this Section.

END OF SECTION

SECTION 26 29 33

CONTROL STATIONS

PART 1 GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install control stations, including pushbuttons, selector switches, and other control stations elements.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before control stations Work.

C. Related Sections:
   1. Section 26 05 05, General Provisions for Electrical Systems.
   2. Section 26 05 29, Hangers and Supports for Electrical Systems.
   3. Section 26 05 53, Identification for Electrical Systems.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. NEMA ICS 2, Controllers, Contactors and Overload Relays Rated 600 Volts.
   2. NEMA ICS 5, Industrial Control and Systems: Control-Circuits and Pilot Devices.
   3. NEMA ICS 6, Industrial Control and Systems Enclosures.
   4. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   5. UL 508, Industrial Control Equipment.

1.3 QUALITY ASSURANCE

A. Component Supply and Compatibility:
   1. Obtain all control stations furnished under this Section from a single control station manufacturer.
   2. Components shall be suitable for the specified application and shall be integrated into the overall assembly by control station manufacturer.

1.4 SUBMITTALS

A. All files associated with shop drawings and product data shall be submitted as Adobe PDF with searchable function. This allows reviewer to search the document for keywords.

B. Action Submittals: Submit the following:

1. Shop Drawings:
    a. Listing of control stations to be furnished with their location, rating, and NEMA enclosure type for each.
2. Product Data:
    a. Manufacturer's technical information and specifications for control stations proposed for use.

PART 2 PRODUCTS

2.1 MATERIALS

A. Control Stations:
1. Manufacturers: Provide products of one of the following:
    a. Eaton Cutler-Hammer.
    b. General Electric Company.
    c. Rockwell Automation, Allen Bradley Company.
    d. Schneider Electric, Square-D Company.
    e. Or equal.
2. Control stations shall comply with NEMA ICS 2, NEMA ICS 5, and UL 508, and shall bear the UL label.
3. Type: 30.5 mm industrial, heavy duty, oil-tight construction with clearly-marked legend plates.
4. Emergency Stop or Lockout Stop: Lockout stop pushbuttons shall be two-position, push-pull type with maintained contact and mushroom head. Provide control stations with padlocking attachment and legend plate reading "PUSH-TO-STOP, PULL-TO-START".
5. Pushbuttons: Momentary or maintained types, NEMA A600 contact rating.
6. Selector Switches: Rotary type with round or oval handles and positioning device to securely hold switch in selected position for maintained type and for spring return from left, right, or both left and right to maintained position.
7. Indicating lights shall be transformer type with six Volt, LED push-to test type Lens color shall be in accordance with Section 26 05 53, Identification for Electrical Systems.
8. Enclosures: As required for area classifications specified in Section 26 05 05, General Provisions for Electrical Systems, and complying with NEMA 250 and NEMA ICS 6.
9. Identification: Identify enclosures in accordance with Section 26 05 53, Identification for Electrical Systems. Devices shall include front-mounted nameplates identifying function and equipment controlled, if not readily apparent.
10. Control stations for the Finished Water and Backwash Pumps and the HVAC supply and exhaust fans shall be emergency stop with lockout feature.
11. Control stations for the flocculators shall include:
    a. Emergency stop with lockout feature.
    b. Local-Off-Remote selector switch with additional auxiliary contact for remote indication of not in remote.

c. Stop and start pushbuttons.
d. Motor run, Red indicating light.
e. Motor off, Green indicating light.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install equipment as shown and provide sufficient access and working space for ready and safe operation and maintenance.

B. Securely fasten equipment to walls or other surfaces on which equipment is mounted. Provide independent supports where no wall or other surface exists, in accordance with Section 26 05 29, Hangers and Supports for Electrical Systems.

END OF SECTION

SECTION 26 29 36

MANUAL MOTOR STARTERS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install manual motor starters.

B. Related Sections:
   1. Section 16050, General Provisions.
   2. Section 16075, Electrical Identification.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. NEMA ICS 2-110, General Standards for Manual and Magnetic Controllers.
   2. UL 508, Industrial Control Equipment

1.3 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the following:
   1. NEC Article 430, Motors, Motor Circuits, and Controllers.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Listing of manual motor starters to be furnished, with identification of location of each, NEMA enclosure type, and equipment to be controlled.
   2. Product Data:
      a. Manufacturer's technical information for manual motor starters proposed.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Provide products of one of the following:
   1. Eaton.
   2. Schneider Electric/Square D Company.
   3. Allen Bradley Company.

4. Or equal.

2.2 MATERIALS

A. Manual Motor Starters:
   1. Type: Toggle-operated, horsepower-rated, with thermal overload protection.
      a. Where shown or indicated on the Drawings, provide manual motor starters rated 600-volt, three-pole, 20-amp without overload protection for use as disconnects.
   2. Provide starters rated for 600-volt, three-pole; 240-volt, two-pole; or 120-volt, single-pole with amperage and horsepower rating as required for load to be controlled.
   3. Enclosure: As required for area classifications specified in Section 16050, General Provisions.
   4. Identification: Identify starters in accordance with Section 16075, Electrical Identification. Identify per the equipment controlled.
   5. Starter shall comply with NEMA ICS 2-110 and UL 508.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install equipment so that sufficient access and working space is provided for ready and safe operation and maintenance.

B. Securely fasten equipment to walls or other surfaces on which equipment is to be mounted. Provide suitable 1/4-inch spacers to so that enclosure is not installed directly against walls. Provide independent supports where no wall or surface capable of supporting equipment exists.

C. Install in conformance with Laws and Regulations, the Contract Documents, and manufacturer recommendations.

+ + END OF SECTION + +

SECTION 26 32 13

ENGINE GENERATORS

PART 1 GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals as shown specified and required to furnish and install a standby power generator system with appurtenances for complete and operational system.
   2. The following generator is included in this Section:
      a. A single outdoor diesel engine generator located in a walk-in sound attenuated enclosure shall supply an emergency-standby power source for the plant.
      b. The generator shall be rated xxxxx KW, xxxxx KVA, 0.8 power factor, 480 volts, 3 phase, 3 wires, solidly grounded.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate installation of items that must be installed with or before engine generator Work.
   2. Notify other trades in advance of installing engine generator set to provide sufficient time for installing related items included that must be installed with or before engine generator Work.

C. Related Sections:
   1. Section 05 05 33, Anchor Systems.

1.2 REFERENCES

A. Standards referenced in this section are:
   1. International Standards Organization (ISO), ISO 8528, Reciprocating Internal Combustion Engine Driven Alternating Current Generator Sets.
   2. ISO 9001, Quality Management Systems – Requirements.
   3. NEMA MG-1, Motors and Generators.
   4. NFPA 30, Flammable and Combustible Liquids Code.
   5. NFPA 37, Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines.
   6. NFPA 70E, Electrical Safety in the Workplace.
   7. NFPA 110, Standard for Emergency and Standby Power Systems.
   8. UL 142, Steel Aboveground Tanks for Flammable and Combustible Liquids.
   9. UL 508, Safety Standard for Industrial Control Equipment.
   10. UL 2200, Standard for Safety Stationary Engine Generator Assemblies (rated 600 volts or less)

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer:
      a. Shall have minimum of five years of experience of producing substantially similar equipment to that specified and shall document at least five installations in satisfactory operation for at least five years.
      b. Shall possess valid ISO 9001 certification.
      c. Supplier shall have complete parts and service facilities, factory-trained service staff available for 24-hour emergency service, and be authorized to administer the warranty for all components of engine generator systems.

B. Component Supply and Compatibility:
   1. Obtain all equipment included in this Section regardless of component manufacturer from a single generator set manufacturer. Materials, equipment, and parts shall be new, of current production of a firm that manufactures the generator set as a matched system. Manufacturer shall have full responsibility for engine generator performance. Generator set manufacturer shall prepare or approve all Shop Drawings and other submittals for all components furnished under this Section.
   2. Engine generator shall be factory-assembled and factory tested. Verify in the factory that system is free from electrical and mechanical defects and conforms to the Contract Documents.

C. Regulatory Requirements: Comply with applicable provisions of authorities having jurisdiction, including the following:
   1. Code of Federal Regulations (CFR), Title 40, Part 89, Control of Emissions from New and In-Use Nonroad Compression Ignition Engines, Subpart D Emission Test Equipment Provisions
   2. Comply with the State of New Jersey, local and federal codes and regulations for standby diesel generators.
   3. Local Ordinances: Systems shall conform to Laws and Regulations relative to noise control and emissions.
   4. Local and State Building Codes: Installations shall conform to applicable codes including requirements of local fire marshals.
   5. Permits: Obtain and pay for required permits, fees, and inspections by authorities having jurisdiction

1.4 SUBMITTALS

A. All files associated with shop drawings and product data shall be submitted as Adobe PDF with searchable function. This allows reviewer to search the document for keywords.

B. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Installation drawings specific to the Project.

b. Bill of material for all equipment and spare parts.
c. Electrical wiring and interconnection diagrams with all external connections identified.
d. Control panel data shall include:
    1) Description of control features.
    2) Operator panel control switches and functions.
    3) Alarm and status displays.
    4) Provisions for remote start signal and remote status and alarm.
    5) Compliance with UL 508.
e. Enclosure data shall include the following:
    1) Plan and elevation drawings showing overall dimensions, interior equipment arrangement, and working spaces.
    2) Construction details and hardware specifications.
    3) Exhaust piping and silencer mounting arrangement.
    4) Sound attenuation provisions and decibel levels.
f. Fuel storage system data shall include:
    1) Day tank and storage tank arrangements.
    2) Storage capacity and hours of operation at rated load and 3/4 load.
    3) Alarm devices.
    4) Construction details including secondary containment provisions for fuel tank.
    5) Piping arrangements and details.
    6) Compliance with UL 142 and local codes.
g. Provide the following relative to installation:
    1) Vibration isolators and anchor bolt requirements.
    2) Seismic restraint requirements.
    3) Provisions for fuel piping, electrical conduits, and other external connection requirements.

2. Product Data:
    a. Manufacturer's literature, specifications, engineering data sheets, and standard drawings, necessary to fully describe the engine generator sets and appurtenances, and substantiate compliance with the Contract Documents. Information shall be annotated to clearly indicate ratings, features, and options specific to the Project.
    b. Generator data shall include:
        1) Listed to UL 2200.
        2) Heat rejection to room
        3) Combustion air requirements.
        4) Factory painting specifications.
    c. Engine data shall include:
        1) Fuel flow at rated load.
        2) Fuel consumption at 1/4, 1/2, 3/4, and full load.
        3) Engine Type: Naturally aspirated or turbocharged and after-cooled.
        4) Maximum exhaust backpressure.
        5) Silencer attenuation rating.
        6) Jacket water heater system.

7) Gaseous emissions data measurements for hydrocarbons, carbon monoxide, particulate matter, and NOx conforming to 40 CFR 89, Subpart D.

d. Alternator data shall include:
   1) Winding insulation class and temperature rise in accordance with NEMA MG-1-1.65
   2) Standby and continuous KW/KVA ratings.
   3) Motor starting KVA at 90 percent sustained voltage.
   4) Surge KW capacity.
   5) Machine reactances and time constants.

e. Starting system data shall include:
   1) Battery system.
   2) Battery charger.
   3) Cycle cranking configuration.

f. Submit emissions data measurements for hydrocarbons (HC), carbon monoxide (CO), particulate matter (PM) and oxides of nitrogen (NOx) conforming to USEPA test procedures. Include USEPA not-to-exceed requirements for each pollutant.

3. Testing Procedures:
   a. Source Quality Control Testing Procedures: For Units 501 kW and larger, provide factory testing procedures and dates at least thirty days prior to testing.
   b. Site Quality Control Testing Procedures: Testing procedures, provided at least thirty days prior to scheduled start of testing.

C. Informational Submittals: Submit the following:
   1. Manufacturer's Instructions:
      a. Manufacturer's unloading, rigging, installing, testing, and startup instructions. Information shall be specific to and indicate options for the Project
   2. Source Quality Control Submittals:
      a. For Units 500 kW and Smaller: Prototype testing certification.
      b. For Units 501 kW and Larger: Provide factory testing results within seven days of completing factory test.
   3. Site Quality Control Submittals:
      a. Services to be performed by Supplier's representative, provided at least thirty days prior to start of Site testing.
      b. Report on results of testing at the Site, provided within seven days of completion of testing.
   4. Manufacturer Reports: Reports of visits to Site by Supplier's representative, including purpose of visit, problems encountered, and resolutions.
   5. Qualifications Statements:
      a. Manufacturer: When requested by ENGINEER, submit data documenting compliance with qualifications requirements of the Contract Documents.

D. Closeout Submittals:

1. Operation and Maintenance Manuals: Provide in accordance with Section 01 78 23, Operations and Maintenance Data. Include the following information:
    a. Operating Instructions: Instructions for starting, stopping, protection of circuits, automatic controls, battery charging and safety considerations. Methods for adjusting speed, output voltage, and control timers.
    b. Performance Parameters: Provide nominal values and acceptable limits for output voltage, frequency, load, engine temperature, and oil pressure Include circuit drawings with component identifications for reference .
    c. Maintenance Instructions: Procedures for daily, weekly, monthly, and annual basis, or on an hours-run basis. Include guidance for selecting fuel oil, lubricating oil, use of water treatment additives, and anti-freeze.

2. Warranty Documentation.

E. Maintenance Materials:
1. Provide the following spare parts for each generator set:
    a. Two sets of primary and secondary fuel filters.
    b. One set of air filters.
    c. Two control circuit fuses of each size used.
    d. Two sets of lube oil filters.
    e. One set of fan belts.

1.5 WARRANTY

A. General Warranty: Special warranty specified in this Article shall not deprive OWNER of other rights or remedies OWNER may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by CONTRACTOR under the Contract Documents. Obligations of CONTRACTOR under the Contract Documents shall not be limited by provisions of the specified special warranty.

B. Special Warranty:
1. Provide manufacturer's written warranty, running to the benefit of OWNER, agreeing to correct or, at option of OWNER remove or replace materials or equipment specified in this Section found to be defective during a period of five years after date of Substantial Completion or 3,000 hours of operation.
2. Products supplied under this Section shall be covered by a single warranty for the coverage period. Warranty shall provide for free replacement or repair of parts for five years or 3,000 hours of operation, and free labor for the first two years.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Delivery:
1. Cover all generator air and exhaust openings with vapor inhibiting and water repellent material.

2. Deliver anchorage devices that are to be embedded in cast-in-place concrete in ample time to prevent delaying the Work.
3. Inspect equipment for shipping damage or loose parts upon delivery. Check for evidence of water that may have entered equipment during transit.
4. Notify ENGINEER of loss or damage to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

B. Handle equipment in accordance with manufacturer's instructions. Furnish at least one copy of instructions with equipment at time of shipment.

C. Storage:
1. Store equipment in a clean, dry location with controls for uniform temperature and humidity. Protect equipment with coverings and maintain environmental controls.
2. Store materials for easy access for inspection and identification. Keep all materials off the ground, using pallets, platforms or other supports. Protect equipment from corrosion and deterioration.

PART 2 PRODUCTS

2.1 SYSTEM REQUIREMENTS

A. Quantity and ratings of the systems shall be as indicated in Paragraph 1.1.A.2 of this Section.

B. Generator shall be emergency emissions rated for operation and duration of normal utility outages as defined by ISO 8528 for limited time operation. Generators shall be standby rated capable of operating for up to 500 hours per year, of which maximum of 300 hours is continuous running, and no overload is allowed.

C. Generator assemblies shall be UL 2200-listed, control panels shall be UL 508-listed and above-ground fuel tanks shall be UL 142-listed.

D. Generators shall be rated for the specified KW, without overload, at the following Site conditions:
1. Maximum Ambient Temperature: 40 degrees C.
2. Altitude: 2000 feet above mean sea level.

2.2 MANUFACTURERS

A. Provide generator systems of one of the following:
1. Caterpillar
2. Cummins/ONAN
3. Or equal.

2.3 ENGINE

A. Engine Type: Four-cycle compression ignition, water cooled diesel 1800 RPM. Two-cycle engines are not acceptable.

B. Engine Construction:
   1. Steel-backed bearings.
   2. Crank Case: Reinforced cast iron.
   3. Crank Shaft: Forged alloy steel with hardened journals, finished and dynamically balanced.
   4. Cylinder Head: Cast iron.
   5. Pistons: Aluminum alloy with chrome faced rings.
   6. Replaceable cylinder liners and valve seat inserts for engines rated over 200 horsepower.
   7. Single-block construction. Bolted, multiple blocks are not acceptable.

C. Cooling System:
   1. Radiator: Engine-mounted with engine-driven blower fan capable of cooling the engine under full load conditions in an ambient temperature of 104 degrees F without de-rating.
   2. Thermostatic valve in jacket water outlet between radiator and engine to maintain proper jacket water temperature. Engine-driven pump to circulate water through cooling system.
   3. Coolant: Fill system with 50 percent solution of ethylene glycol with additives as recommended by engine manufacturer.
   4. Coolant water temperature gauge.
   5. High engine temperature shutdown.
   6. Loss of coolant shutdown.
   7. Fan guard.
   8. Radiator face duct connection.
   9. Engine coolant heaters, thermostatically controlled, capable of keeping jacket water at temperature not less than 90 degrees F in compliance with NFPA 110. Coolant heaters shall operate at 208 volts, single phase. House contactor for controlling heater in NEMA 4X stainless steel enclosure mounted on unit.
   10. Extend radiator drain hose to shutoff valve located on the exterior of the generator enclosure.
   11. Provide shutoff valves so that the engine coolant heater can be removed without draining the engine coolant.

D. Lubrication System: Positive displacement, mechanical, full pressure lube pump, full flow and bypass lubrication filters with replaceable spin-on canister elements, oil drain line with valves and dipstick oil level indicator.

E. Fuel System: Suitable for operation on No. 2 diesel fuel oil. System to include primary and secondary fuel filters, fuel/water separator, fuel priming pump, flexible fuel lines and fuel pressure gauge.

F. Governor: Woodward 2301E load sharing and speed control system complete with software. Electronic system to provide automatic isochronous frequency regulation. System dynamic capabilities to be controlled as function of engine temperature for fast stable operation at varying engine operating conditions. System to actively control fuel rate and excitation. Fuel rate to be regulated as function of starting, accelerating to start, disconnect speed, accelerating to rated speed, and operating in various isochronous states.

G. Fuel Oil Sub-Base Tank
   1. Construction: Heavy-gage steel primary storage tank sub-base mounted with welded steel secondary containment sized to contain 110 percent of primary tank capacity. Rust inhibitor coating inside and prime- and finish-coated outside, color to match generator set exterior paint.
   2. Storage sub-base tank capacity in gallons shall be sufficient for 24 hours of run time at 2000 KW.
   3. Comply with the following:
      a. UL142-listed and labeled.
      b. NFPA 30, NFPA 37, and NFPA 110.
   4. Fittings: NPT for fuel supply and return; two-inch diameter NPT for normal vent, manual fill and level alarm; NPT for emergency vents, level gauge, basin drain, and leak detection alarm.
   5. Fuel level gauge and leak detector switch shall be monitored by and displayed on the generator control panel. Generator control panel shall provide output contacts for low fuel level and fuel leak from for remote monitoring.
   6. Mushroom-type cap and screen for normal vent openings and pressure relief-type caps for emergency vent openings.
   7. Manufacturers: Provide sub-base tank of one of the following:
      a. Pryco, Inc.
      b. Tramont Corp.
      c. Or equal.

H. Air Supply/Exhaust Systems:
   1. Heavy duty air cleaner with service indicator.
   2. Flexible stainless steel exhaust connector.
   3. Critical grade silencer with condensate drain ports.
   4. Schedule 40 stainless steel piping. Insulate indoor piping to limit surface temperature to 50 degrees C.

I. Air Emissions:
   1. Comply with United States Environmental Protection Agency (USEPA) standards for non-road engines and with state and local requirements.
   2. Submit emissions data measurements for hydrocarbons (HC), carbon monoxide (CO), particulate matter (PM) and oxides of nitrogen (NOx) conforming to USEPA test procedures. Include USEPA not-to-exceed requirements for each pollutant.

J. Starting System: DC system complete with engine mounted batteries, locally mounted charger and connecting cables between batteries and engine and between charger and batteries.
   1. Batteries: Lead-acid or calcium/lead antimony, engine cranking type, rated in accordance with engine manufacturer's requirements for minimum of three 15-second cranking cycles at firing speeds without recharging, and to accommodate DC power requirements of control panel and other accessories requiring DC power.
   2. Battery racks, cables, connectors, and disconnect switch.
   3. Engine-mounted battery charging alternator and solid-state voltage regulator.
   4. Battery Charger:
      a. UL-listed, voltage regulated and equipped with float, taper and equalize charge settings.
      b. Automatic charge rate compensation based on ambient temperature at the batteries.
      c. Analog DC ammeter and voltmeter; 12-hour equalize timer; AC and DC fuses.
      d. Loss of AC power, low battery voltage and high battery voltage alarm lights and contacts for remote annunciation; power on light.

2.4 ALTERNATOR

A. Construction: Synchronous generator, four-pole, 2/3 pitch, revolving field, self ventilated, drip-proof construction, single bearing, dynamically balanced rotor with amortisseur windings to minimize voltage deviations and heating effects under unbalanced load conditions. Rotor directly connected to engine flywheel housing to ensure permanent alignment. Rotor connected to engine flywheel via flexible coupling to ensure permanent alignment.

B. Winding Insulation Systems: Class H in accordance with NEMA MG-1. Temperature rise not to exceed 130 degrees C over 40 degrees C ambient at rated load. Epoxy coating for fungus resistance and abrasion protection.

C. Excitation System: Brushless construction. Excitation support system, permanent magnet type, to sustain 300 percent rated current for up to 10 seconds under short circuit conditions. Provide surge suppressors to protect against voltage spikes.

D. Voltage Regulator: Automatic solid-state system to maintain generator output voltage within plus or minus 0.5 percent from no load to full load. Control voltage buildup, provide volts per Hertz regulation, protect from over-excitation, limit voltage overshoot on startup, and be environmentally sealed. The regulator shall be 3-phase true RMS sensing, full wave rectified, and provide a pulse-width modulated output to the alternator field. It shall be immune to mis-operation due to voltage waveform distortion. The voltage regulator shall include current monitoring capability to provide regulated current output on any fault condition.

E. Provide anti-condensation heater to maintain temperature approximately five degrees Fahrenheit above ambient when generator is idle.

2.5 CONTROL PANEL

A. Controls shall be in accordance with NFPA 110, Level 1, and control panel shall conform to the following:
   1. Install control panel on vibration isolators or isolated from engine and alternator.
   2. Engine generator controller shall be microprocessor based and provide automatic starting, monitoring, protection and control functions for the unit. The control system shall be designed and manufactured by the generator set manufacturer.
   3. Controls shall be UL 508-listed and microprocessor-based with programmable adjustments. Control power from starting battery system.
   4. Controller shall include the following minimum protective functions to self-protect the generator:
      a. Phase sequence.
      b. Under/overvoltage, 27/59
      c. Over/under frequency, 81O/U.
      d. Overcurrent, 50/51.
   5. Controller shall include the following monitoring, control and protective functions:
      a. Emergency stop pushbutton with provisions for accepting the remote stops specified.
      b. Generator Monitoring: KW, KVA, KVAR, power factor, current and voltage metering.
      c. Engine Monitoring: Coolant temperature, oil pressure, engine speed, battery voltage and run time readouts.
      d. Control: Run, auto, stop control, speed and voltage adjust, remote start-stop and cycle cranking.
      e. Engine Protection: High coolant temperature, alarm and shutdown, low coolant temperature and level alarm, high engine oil temperature, alarm and shutdown, overspeed, over-crank and high, low and weak battery voltage.
   6. Communications: The controller shall be able to communicate remotely via RS-485 to remote annunciator.
   7. Provide output dry contacts for remote monitoring and control for the following:
      a. Generator running
      b. Generator common warning alarm.
      c. Generator common shutdown alarm.
      d. Switch not in auto.
      e. Low tank fuel (warning alarm).
      f. Liquid leak in containments areas, including tank, double walled piping, and other fuel supply components (warning alarm).
   8. Reset Control: There shall be no manual or remote restarts. Alarm lamps shall remain in alarm state until manual reset is accomplished even if alarm condition has been corrected.
   9. Provide control panel anti-condensation space heater.

B. Remote Annunciator: Provide remote annunciator with LED indicators for displaying generator system NFPA 110 alarm conditions and status indicators. The annunciator shall communicate with the generator control panel on the RS-485 communication network.

C. Remote emergency stop station: Provide two remote stop stations wired to the control panel to immediately stop the generator. Stations shall be maintained, mushroom type, red colored, push to stop. The first stop station shall be located outdoors mounted externally on the generator enclosure. The second stop station shall be located indoors in the electrical room.

2.6 CIRCUIT BREAKERS

A. General: Provide main and exciter circuit breakers, sized for protecting the engine- generator.

B. Type: UL-listed, molded case breaker with electronic RMS type trip unit. Trip unit shall be adjustable and shall include long-time, short-time and instantaneous phase and ground protection. Provide NEMA 1 enclosed units and mount on engine generator.

2.7 ENCLOSURE

A. Provide engine-generator system with a custom designed outdoor weatherproof walk-in type sound attenuated enclosure.

B. Enclosure shall be constructed of minimum14-gauge, reinforced sheet steel and shall attach directly to engine-generator base or sub-base fuel tank. Enclosure shall be factory assembled structure with key-lockable access doors for performing normal maintenance operations. Hardware and fasteners shall be stainless steel. Lube oil and coolant drains shall be extended to exterior of enclosure and terminated with drain valves, capped with pipe nipples on flanged connections.

C. The enclosure shall be provided with galvanized steel platform and steps with rail system at both sides of the generator set to allow access for operation and maintenance.

D. Sound Attenuation: Engine-generator enclosure shall be sound-attenuated to reduce noise levels. The sound attenuation shall achieve a reduction of 25 dBA at point twenty-three feet from engine-generator in free air environment, while operating at full load.

E. The enclosure shall be completely wired with the following equipment:
   1. 480 Volt disconnect and 30 KVA transformer, 120/208 Volt, three Phase, supplied from a 480 Volt, three phase remote source.
   2. 208 Volt, three phase jacket water heater and contactor control.
   3. 120/208-volt, three-phase load center panelboard with circuit breakers for all 120/208 Volt power requirements including lighting, convenience receptacle,

battery charger, day tank, generator jacket and space heaters, heating and ventilation fans.

4. Interior vapor-tight LED type lighting fixtures with snap switch at entrance door.
5. Exterior weatherproof wall pack LED type lighting fixture one over each personnel door. Exterior light fixtures shall include an integral motion sensor.
6. Battery-powered dual head emergency lighting fixtures positioned to light engine starting controls.
7. Interior duplex receptacles.
8. Heaters thermostatically control for enclosure heating.
9. Ventilation fans to operate when temperature exceeds 40 degrees C.

2.8 ACCESSORIES

A. Engine Generator Mounting:
   1. Vibration Isolators: Steel springs in combination with rubber pads.
   2. Vibration Isolation: Provide flexible connections between engine-generator set and fuel lines, exhaust system, electrical conduits, and other externally connected support systems.
   3. Anchor Bolts: Type 316 stainless steel, conforming to Section 05 05 33, Anchor Systems.
   4. Template shall be furnished by manufacturer for setting anchorages devices, pipe sleeves, and nuts for mounting spring-type isolators to concrete foundation. Provide bolts and nuts for bolting isolators to channel frame base of engine-generator set.

2.9 FINISHING

A. Engine generator ferrous metal surfaces shall be prime-coated for corrosion protection and finish-painted in accordance with manufacturer's standard painting system.

B. Color of finish paint to be selected by ENGINEER from manufacturer's standard colors.

2.10 SOURCE QUALITY CONTROL

A. Factory Tests
   1. Following assembly, perform at the factory standard production tests to verify proper operation and performance. Tests shall include two-hour load test.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the conditions under which the Work is to be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely

completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install engine generator system in accordance with the Contract Documents, approved Shop Drawings, and manufacturer's recommendations.

B. Make all connections to generator with flexible conduits

3.3 SITE QUALITY CONTROL

A. Site Testing: Test engine-generator set in accordance with NFPA 110. Provide all materials and equipment, including load banks, fuel, lubricants and material required for Site testing. Completely fill fuel tank at conclusion of testing.

B. Manufacturer's Services: Provide qualified, factory-trained serviceman to perform the following:
   1. Supervise unloading and installation of equipment.
   2. Instruct CONTRACTOR in the installation of equipment.
   3. Inspect and adjust equipment after installation and ensure that equipment operates properly.
   4. Instruct OWNER's personnel in operating and maintaining the equipment.

C. Service representative shall make a minimum of four separate 8 hour site visits for the following:
   1. First visit shall be for unloading supervision and instruction of CONTRACTOR in installing equipment.
   2. Second visit shall be for assistance in installation of equipment and to perform inspection, checking and adjustments.
   3. Third visit shall be for performing testing and start-up of system;
   4. Fourth visit shall be to instruct operations and maintenance personnel. Representative shall revisit the Site as often as necessary until installation is acceptable.

END OF SECTION

SECTION 26 36 23

AUTOMATIC TRANSFER SWITCHES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install automatic transfer switches.
   2. Switches specified under this Section include enclosed types.

B. Related Sections:
   1. Section 16075, Electrical Identification.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. IEEE 472, Guide for Surge Withstand Capability Tests.
   2. IEEE 446, Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications.
   3. IEEE C62.41, Recommended Practice for Surge Voltages in Low Voltage AC Power Circuits.
   4. NEMA ICS1 109, Tests and Procedures.
   5. NEMA ICS10, AC Automatic Transfer Switches.
   6. UL 1008, Transfer Switch Equipment.
   7. UL 508, Industrial Control Equipment
   8. UL 61010B-1 (previously UL 3111-1), Electrical Measuring and Test Equipment; Part 1: General Requirements.
   9. ANSI C37.90a, Surge Withstand Capability Test (formerly IEEE Standard 472-1974) – Ring Wave Test.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. NEC Article 702, Optional Standby Systems.

1.4 SUBMITTALS

A. Action Submittals:
   1. Shop Drawings: Submit the following:
      a. Listing of transfer switches to be provided, including ratings and location of each.

b. Manufacturer's technical information for products proposed, including catalog cuts, dimensions, and construction details of enclosures with conduit entry locations.

2. Test Procedures: At least thirty days prior to actual factory and field testing, submit proposed testing procedures, methods and apparatus.

B. Informational Submittals:
1. Source Quality Control Submittals: Submit reports of completed factory tests, including test results and procedures used for testing.
2. Field Quality Control Submittals: Submit reports of completed field tests, including test results and procedures used for testing.
3. Manufacturer's written instructions for transporting, handling, storing, and installing the products.
4. Manufacturer's Reports: Written report of each visit to Site by manufacturer's service representative.
5. List of spare parts recommended by the manufacturer. The list shall describe each part, the quantity recommended and unit price of each part.

C. Closeout Submittals
1. Operation and Maintenance Data:
a. Submit complete installation, operation and maintenance manuals including test reports, maintenance data and schedules, description of operation, and spare parts information.
b. Manuals shall include record drawings of control schematics, including point-to-point wiring diagrams.
c. Furnish operation and maintenance manuals.
2. Spare Parts and Extra Stock Materials: Provide as specified in this Section.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver products to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices to be embedded in cast-in-place concrete in time to prevent delay of the Work.

B. Shipping sections shall be designed to be shipped by truck, rail, and ship. Indoor sections shall be bolted to skids.

C. Equipment shall be equipped to be handled by crane. Where cranes are not available equipment shall be suitable for skidding in place on rollers using jacks to raise and lower the sections.

PART 2 – PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Provide automatic transfer switches as specified for transferring loads from one power source to another.

2.2 MANUFACTURERS

A. Manufacturers: Provide products of one of the following:
   1. Russelectric, Inc.
   2. Cummins

2.3 SWITCH

A. Ratings:
   1. Switches shall be capable of switching all classes of loads and rated for continuous duty when installed in a non-ventilated enclosure.
   2. Switches shall be rated with continuous ampere rating, number of poles and voltage as shown on Drawings.
   3. Switches shall be rated to withstand the magnitude of fault current available without welding of contacts in compliance with ANSI C37.90a and IEEE C62.41.

B. Standards and Performance:
   1. Switches shall comply with UL Standard 1008, NEMA Standard ICS10, and applicable requirements of NEC Article 700, IEEE 446, IEEE C62.41, UL 508, and UL 61010B-1. Switches shall be UL labeled with performance meeting or exceed the following:
      a. Temperature Rise: Measurements shall be made after overload and endurance tests.
      b. Withstand: UL listed to withstand magnitude of fault current available at switch terminals when coordinated with respective protective devices shown on Drawings at an X/R ratio of 6.6 or less. Main contacts shall not trip open or weld when subjected to fault currents.
         1) As a condition for approval, manufacturer of automatic transfer switches shall verify that switches are listed by Underwriters Laboratories, Inc., Standard UL-1008 with three-cycle short circuit closing and withstand as follows:

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RMS Symmetrical Amperes at 480 VAC	
Amperes:	3 Cycle Closing & Withstand:
100 to 400	42,000
600 to 800	65,000
1000 to 1200	85,000
1600 to 4000	100,000

2) During three-cycle closing and withstand tests, there shall be no contact welding or damage. Three-cycle tests shall be performed without using current limiting fuses, and oscillograph traces across main contacts shall be furnished to verify that contact separation has not occurred, and there is contact continuity across all phases after completion of testing. Test procedures shall be in accordance with UL-1008, and testing shall be certified by UL.
3) When conducting temperature rise tests to UL-1008, Supplier shall include post-endurance temperature rise tests to verify ability of transfer switch to carry full rated current after completing overload and endurance tests.

c. Dielectric: Measurements shall be made at 1960 VAC RMS minimum following the withstand current rating test.
d. Transient Withstand: Control panel shall pass the voltage surge withstand test per IEEE Standard 472 and voltage impulse withstand test per NEMA ICS1 109.

C. Construction:
1. Switch shall be double throw actuated by non-fused, momentarily energized operating mechanism(s).
2. Accomplish mechanical locking of main contacts in each direction without aid of latching solenoids, toggle mechanisms, or gear arrangements.
3. An overload or short-circuit shall not cause switch to go to a neutral position.
4. All transfer switch sizes shall use only one type of main operator for ease of maintenance and commonality of parts.
5. Switch shall be positively locked and unaffected by momentary outages, so that contact pressure is maintained at a constant value and contact temperature rise is minimized for maximum reliability and operating life.
6. Main contacts shall be silver-tungsten composition. Switches shall have segmented, blow-on construction for high withstand and close-on capability and be protected by separate arcing contacts.
7. Inspection of contacts shall be possible from front of switch without disassembly of operating linkages and without disconnecting power conductors. Switches rated 600 amps and higher shall have front-removable and -replaceable contacts. All stationary and moveable contacts shall be replaceable without removing power conductors or bus bars.
8. Transfer switch shall be equipped with a safe manual operator designed to prevent injury to operating personnel. Manual operator shall provide same contact-to-contact transfer speed as electrical operator to prevent a flash-over

from switching main contacts slowly. Manual operation shall be safe even if electrical operator becomes energized and shall not require prior disconnection of operators or control wiring. Safe manual transfer shall be possible under all load conditions, energized or non-energized. Manual operator shall be an external type, operable through door of transfer switch enclosure. Operating personnel shall not be required to open transfer switch door to facilitate manual transfer. Manual operator shall be functional at all times, regardless of switch position or status. Manually initiated electrical operation does not meet intent of this requirement. Manual operator is not required on closed transition type switches.

D. Enclosure: Enclosed switches shall be NEMA 12 at minimum.
   1. Standard and optional door-mounted switches and pilot lights shall be 30.5-mm industrial grade type or equivalent.
   2. Provide door controls on a separate, removable plate that can be supplied loose for open type units.

E. Identification: Identify switches per Section 16075, Electrical Identification.

2.4 TRANSFER SWITCHING FEATURES

A. Delay Transition (Open): Provide automatic delayed open transition transfer for each switch. Switch shall transfer load in delayed transition (break-before-make) mode. Transfer shall be accomplished with a user-defined interruption period in both directions adjustable from one second to five minutes in at least 15 increments.

2.5 SEQUENCE OF OPERATION

A. Switch shall operate between two sources. Souce #1 is utility based and acceptable for long term operation. The normal source shall be Source #1

B. When voltage on any phase of source 1 is outside of specified parameters and after a programmable time delay period to allow for momentary dips the switch shall transfer to source 2 (assuming source 2 is within specified parameters).

C. After restoration of source 1 supply on all phases to within specified parameters, Source #2 shall switch back to Source #1.

D. Should transfer to emergency source be initiated by test switch rather than an actual source failure, transfer from normal to emergency shall be as described above.

2.6 MICROPROCESSOR CONTROLLER

A. Each switch shall include a microprocessor controller for operation of the switch. Equip controller with the following:
   1. Provide controller's sensing and logic by a built-in microprocessor with ability to communicate serially through an optional serial communication module.

2. Controller shall provide a minimum of five selectable nominal voltages. Voltage sensing shall be true RMS type and be accurate to plus/minus one percent of nominal voltage. Frequency sensing shall be accurate to plus/minus 0.2 percent. Controller shall be capable of operating over a temperature range of -20 to +60 degrees C and storage from -55 to +85 degrees C.
3. Connect controller to transfer switch by an interconnecting wiring harness that shall include a keyed disconnect plug to enable controller to be disconnected from transfer switch for routine maintenance. Interfacing relays shall be industrial grade plug-in type with dust covers. Enclose controller with a protective cover. Mount controller internally but separately from transfer switch.
4. Customer connections shall be wired to a common terminal block.

B. Controller Display and Keypad:
1. Display and keypad shall be an integral part of controller for viewing available data and setting desired operational parameters. Operational parameters shall also be available for viewing and limited control through serial communications input port. The following parameters shall be adjustable:
   a. Nominal line voltage and frequency
   b. Single- or three-phase sensing
   c. Operating parameter protection
   d. Transfer operating mode configuration: Open transition, closed transition or delayed transition
2. Instructions and controller settings shall be easily accessible, readable, and accomplished without using codes, calculations, or instruction manuals.

C. Controller Voltage, Frequency and Phase Rotation Sensing:
1. Voltage and frequency on both the normal and emergency sources shall be continuously monitored, with the following pickup, dropout, and trip setting capabilities values shown as a percent nominal unless otherwise specified:

Parameter:	Sources:	Dropout/Trip:	Pickup/Reset:
Under-voltage	Normal and Emergency, three-phase	70 to 98%	85 to 100%
Over-voltage	Normal and Emergency, three-phase	102 to 115%	2% below trip
Under-frequency	Normal and Emergency	85 to 98%	90 to 100%
Over-frequency	Normal and Emergency	102 to 110%	2% below trip
Voltage Unbalance	Normal and Emergency	5 to 20%	1% below dropout

2. Repetitive accuracy of all settings shall be within plus/minus 0.5 percent over an operating temperature range of -20 degrees C to +60 degrees C.
3. Voltage and frequency settings shall be field adjustable in one percent increments, either locally with the display and keypad or remotely via serial communications port access.
4. When activated by keypad or through serial port, controller shall be capable of sensing phase rotation of both normal and emergency sources. Source will be unacceptable if phase rotation is not preferred rotation selected (ABC or CBA).

5. Source status screens shall be provided for both normal and emergency to provide digital readout of voltage on all three phases, frequency, and phase rotation.

D. Controller Time Delays:
   1. Provide controller with time delays below. Time delay settings shall be adjustable over a range of zero to 9999 seconds (factory set at three seconds) unless specified otherwise.
      a. Normal source failure, for engine starting.
      b. Transfer to emergency on availability of emergency source.
      c. Emergency source failure, retransfer on availability of normal source.
      d. Engine cool down following retransfer to normal.
      e. Time delay to control contact transition time during open transition transfer to either source.
      f. All timers can be bypassed via operation on processor's keypad.
   2. Provide adjustable time-delay on retransfer to normal. Time delay shall be automatically bypassed if emergency source fails and normal source is acceptable.
   3. Provide a time delay activated output signal to drive external relays for selective load disconnect control. Controller shall have the ability to activate an adjustable zero to five minute time delay for one of the following modes:
      a. Prior to transfer only.
      b. Prior to and after transfer.
   4. Time delay and sensing functions shall be field adjustable and operate with drift that does not exceed plus/minus one percent of set frequency, plus/minus two percent of set voltage, and plus/minus ten percent of set time delay, over the temperature range of -20 degrees C to +70 degrees C.
   5. Time delays shall be adjustable in one-second increments, except extended parallel time, that shall be adjustable in 0.01 second increments.
   6. Time delays shall be adjustable by using display and keypad or with a remote device connected to serial communications port. Time delay value displayed shall be time remaining until next event occurs.
   7. For (open) delay transition transfer switches controller shall include the following built-in time delays for delayed transition operation:
      a. Zero to five minute time delay for load disconnect position for delayed transition operation.

2.7 ACCESSORY FEATURES:

A. Provide each switch with the following:
   1. A two-position maintained-type test switch for test/automatic/ modes. Test position shall simulate a normal source failure.
   2. A SPDT silver-tungsten contact, rated five amps at 30 VDC, for a low-voltage engine start signal. Start signal shall prevent dry cranking of engine by requiring generator set to reach proper output and run for duration of cool down setting regardless of whether normal source restores before load is transferred.

3. Auxiliary contacts, rated ten amps at 250 VAC, consisting of one contact, closed when switch is connected to normal source and one contact closed when switch is connected to emergency source.
4. LED indicating lights (30.5 mm, industrial heavy duty, oil-tight, NEMA rated to match automatic transfer switch enclosure, push-to-test). One shall indicate when switch is connected to normal source (green) and one to indicate when the switch is connected to emergency source (red).
5. LED indicating lights (30.5 mm, industrial heavy duty, oil-tight, NEMA rated to match automatic transfer switch enclosure, push-to-test), energized by controller outputs. Lights shall provide true source availability of normal and emergency sources as determined by voltage sensing trip and reset settings for each source.
6. Provide the following built-in to controller, capable of being activated through keypad programming no serial port or manual adjustment of dip switches are acceptable.:
    a. Provide ability to select "commit/no commit to transfer" to determine whether load should be transferred to standby generator if normal source restores before generator is ready to accept load.
    b. Provide terminals for a remote contact that opens to signal switch to transfer to emergency, and for remote contacts that open to inhibit transfer to emergency or retransfer to normal. Provide ability to activate both inhibit signals through keypad or serial port.
    c. Controller shall be capable of accepting a normally open contact that will allow transfer switch to function in a non-automatic mode using an external control device.
7. System Status: Controller display shall include a "System Status" screen that shall be readily accessible from all points in the menu by a maximum of two key strokes. System status screen shall display a clear description of active operating sequence and switch position.
8. Self-Diagnostics: Controller shall contain a diagnostic screen for detecting system errors. Screen shall provide information on status input signals to controller that may be preventing completion of load transfer commands.
9. Communications Interface: Controller shall be capable of interfacing, through an optional full-duplex RS 485 serial communication module, with a network of transfer switches, within 4,000 feet (locally) and remotely through modem serial communications. Standard software specific for transfer switch applications shall be available from transfer switch manufacturer. Software shall include monitoring, control, and setup of parameters.
10. Data Logging: Controller shall have ability to log data and to maintain last 99 events, even during total power loss. The following events shall be time and date stamped and maintained in a non-volatile memory:
    a. Event Logging
        1) Date and time and reason for transfer normal to emergency.
        2) Date and time and reason for transfer emergency to normal.
        3) Date and time emergency source available.
    b. Statistical Data
        1) Total number of transfers.
        2) Last ten numbers of transfers due to source failure.

3) Total number of hours both normal and emergency sources are available.

11. Terminate control wires with crimp lugs and identify with sleeve type markers. Provide suitable copper connector lugs for each service and load connections.

2.8 DATA MONITOR

A. Provide a data monitor for each switch to monitor all functions specified. Flush-mount monitor on switch enclosure and equip monitor with continuous duty, long-life, lit display.

B. Data monitors shall be rated for an operating temperature range of -20 degrees C to +60 degrees C.

C. Data monitor shall be accurate to one percent measured, two percent computed values and display resolution to 0.1 percent. Voltage and current for all phases shall be sampled simultaneously to assure high accuracy in conditions of low power factor or large waveform distortions (harmonics).

D. Data monitor shall be capable of operating without modification at nominal frequencies of 45 to 66 Hertz and over a control power input range of 20 to 32 VDC.

E. Data monitor shall accept inputs from industry standard instrument transformers, including five-amp secondary current transformers. Direct-phase voltage connections, 600 VAC and under, shall be possible without using potential transformers.

F. Data monitor shall be applied in single, three-phase, or three- and four-wire circuits.

G. Setup parameters required by data monitors shall be stored in non-volatile memory and retained during control power interruption.

H. Metered readings listed below shall be available from display and transmitted remotely by serial communications module. Transmit data in format compatible with plant monitoring and control system.
   1. Current, per phase RMS.
   2. Current unbalance percentage
   3. Voltage, phase-to-phase, and phase-to-neutral
   4. Voltage unbalance percentage
   5. Real power (KW), per phase and three-phase total
   6. Apparent power (KVA), per phase and three-phase total
   7. Reactive power (KVAR), per phase and three-phase total
   8. Power factor, three-phase total and per phase
   9. Frequency.
   10. Accumulated energy, (MWH, MVAH, and MVARH)

I. The following energy readings shall be communicated by data monitor:
   1. Accumulated real energy (KWH)
   2. Accumulated reactive energy (KVAH)
   3. Accumulated apparent energy (KVARH)
   4. Real and reactive energy reported values for the load circuit.

J. Provide menu scroll buttons to display data monitor quantities.

K. Display shall remain continuously on, without detrimental effect on life of data monitor.

L. Setup for system requirements shall be via the front of data monitor. Setup provisions shall include:
   1. CT Rating: Five ampere secondary and primary rating equal to automatic transfer switch rating.
   2. System Type: Single, three-phase; three- and four-wire.
   3. Communication parameters

M. Provide capability to reset the following electrical parameters front of data monitor:
   1. Real energy (MWH), apparent energy (MVAH), and reactive energy (MVARH).
   2. All reset and setup functions shall have a means for protection against unauthorized and accidental changes.

2.9 SOURCE QUALITY CONTROL

A. Perform manufacturer's standard factory tests that shall include:
   1. Physical inspection and checking of components.
   2. Mechanical operation and device functional tests.
   3. Control operation and functionality tests.
   4. Primary, control, and secondary wiring hi-pot tests.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which Work is to be performed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install equipment so that sufficient access and working space is provided for ready and safe operation and maintenance.

B. Install equipment in accordance with Contract Documents and manufacturer recommendations.

C. Securely fasten equipment to floors, walls, or other surfaces on which equipment will be mounted. Install freestanding switches on raised concrete pad at locations shown on Drawings. Install in accordance with manufacturer's recommendations.

3.3 FIELD QUALITY CONTROL

A. Perform field testing and inspection of each automatic transfer switch. Testing and inspection shall be in accordance with manufacturer's recommendations and be performed by manufacturer's factory-trained representative, who shall inform OWNER and ENGINEER when equipment has been correctly installed. Do not energize equipment without permission of OWNER.

3.4 MANUFACTURER SERVICES

A. Manufacturer Services:
   1. Unloading and Installation: Manufacturer's factory-trained representative shall be present during unloading of equipment and installation at equipment's final location. In advance of installation, representative shall train installing personnel in proper handling and rigging of equipment, for at least one eight-hour day at the Site.
   2. Manufacturer's factory-trained representative shall test the system as specified in Article 3.3 of this Section. Representative shall operate and test system in the presence of ENGINEER and verify that equipment conforms to requirements. These services shall be at least one eight-hour day at the Site.
   3. Manufacturer's factory-trained representative shall adjust the system to initial settings specified in Article 2.6 of this Section.
   4. Representative shall revisit the Site as often as necessary until all deficiencies are corrected, prior to readiness for final payment.
   5. Provide services of manufacturer's factory-trained representatives to correct defective Work within 72 hours of notification by OWNER during the Correction Period specified in the General Conditions as amended by the Supplementary Conditions.
   6. Replacement parts or equipment installed during the Correction Period shall be equal to or better than the original.

B. Training: Furnish services of qualified factory trained specialists from manufacturer to instruct OWNER's operations and maintenance personnel in recommended operation and maintenance of the products.

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SECTION 26 41 13

LIGHTNING PROTECTION FOR STRUCTURES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, services, and incidentals shown, specified, and required to furnish and install and Underwriters Laboratories listed Master Label Lightning Protection Systems.
   2. Provide a lightning protection system for each building, and structure, including tanks shown on the Drawings. Each system shall consist of air terminals, interconnecting conductors, fittings, connectors and auxiliary devices for a complete protection system.

B. Coordination:
   1. Review installation procedures included under other Sections and coordinate installation of items to be installed with or before lightning protection systems.
   2. Review the buildings and structures features and equipment requirements in advance. Lightning protection layouts are not shown on the Drawings, CONTRACTOR shall provide lightning protection systems that satisfies the protection requirements of each building and structure.

C. Related Sections:
   1. Section 26 05 26, Grounding and Bonding for Electrical Systems.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. LPI 175, Standard of Practice.
   2. LPI 176, Standard of Materials.
   3. NFPA 70, National Electrical Code.
   4. NFPA 780, Standard for the Installation of Lightning Protection Systems.
   5. UL 96A, Installation Requirements for Lightning Protection Systems.
   6. UL 651, Schedule 40 and 80 PVC Conduit.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Lightning Protection System Subcontractor:
      a. Retain services of lightning protection Subcontractor regularly engaged in providing Master Labeled lightning protection systems.

2. Subcontractor shall be LPI-certified Master Installer or Inspector.
3. Subcontractor shall be listed with UL.

B. Component Supply and Compatibility:
1. Obtain all materials equipment included in this Section regardless of component manufacturer from a single lightning protection system manufacturer.
2. Lightning protection system manufacturer shall review and approve or prepare all Shop Drawings and other submittals for all components furnished under this Section.
3. All components shall be specifically constructed for specified service conditions and shall be integrated into the overall system by lighting protection system manufacturer.

1.5 SUBMITTALS

A. Action Submittals: Submit the following:
1. Shop Drawings:
a. Complete scaled drawings showing proposed routing and layout of lightning protection system with installation details. Drawings shall include equipment connection details and downlead details.
2. Product Data:
a. Manufacturer's catalog cuts and technical information.
b. Technical specifications.

B. Informational Submittals: Submit the following:
1. Certificates:
a. Certificates of LPI code compliance provided by manufacturer, together with UL Master Label certificate or letter of finding.
2. Field Quality Control Submittals:
a. Master Installer or Inspector's final inspection report following installation.
3. Qualifications Statements:
a. Lightning protection system Subcontractor.

1.6 GUARANTEE

A. Guarantee:
1. Lightning protection system shall be guaranteed by lightning protection system manufacturer against defective parts and installation for one year from date of Substantial Completion.

PART 2 – PRODUCTS

2.1 SYSTEM PERFORMANCE

A. System Description:
   1. Each lightning protection system shall consist of a complete cable network on the building roofs or top of structures involving all air terminals, splices, and bonds with cable downleads routed concealed either directly in the building construction or in conduit to ground, and ground rods all connected together in an appropriate manner and certified by LPI to provide a zone of protection to entire building against lightning strikes, in accordance with NFPA 780.
   2. Provide complete, certified lightning protection system. Provide bonding connections and miscellaneous items for complete system.

2.2 MANUFACTURERS

A. Manufacturers: Provide products of one of the following:
   1. Heary Brothers Lightning Protection Company.
   2. Thompson Lightning Protection, Inc.
   3. Or equal.

2.3 MATERIALS

A. General:
   1. Size materials in accordance with NFPA 780, UL 96A, and LPI 176.
   2. Materials and equipment shall be labeled or listed by UL for use in Master Labeled lightning protection systems. Completed system shall conform to NFPA 70, NFPA 780, LPI 175, LPI 176, and UL96A.
   3. Materials shall comply in weight, size, and composition for class of structure to be protected in accordance with the following:
      a. Use Class I materials for systems on structures not exceeding 75 feet in height.
      b. Use Class II materials for systems on structures exceeding 75 feet above grade.
   4. Materials shall be corrosion-resistant, heavy-duty type. Unless otherwise specified, materials shall be Type 316 stainless steel, copper, or high copper-content bronze castings. Bolts, screws, and hardware shall be Type 316 stainless steel.
   5. Use aluminum materials in locations where system components are mounted on aluminum surfaces to avoid electrolytic corrosion of dissimilar metals.
   6. Provide fittings, mounting bases, couplings, connectors, fasteners, and other system devices required for complete system.

B. Ground Rods: Comply with Section 26 05 26, Grounding and Bonding for Electrical Systems.

C. Ground Cables:
   1. Ground cables shall be tinned copper, except in connections to aluminum surfaces as required to prevent dissimilar metals reaction.

2. Ground cable stranding, number and size shall be suitable for classification of structure to be protected.
3. Exposed ground cable shall be corrosion resistant.

D. Air Terminals:
1. Air terminals shall be stainless steel 5/8-inch diameter and maximum of 18 inches long based on FAA restrictions at the facility.
2. Air terminals shall include a cast bronze point protector, stainless steel adapter, and copper base.

E. Non-Metallic Conduit and Fittings:
1. Non-metallic conduit shall be Schedule 80 PVC plastic, rated for 90 degrees C, conforming to UL 651.
2. Non-metallic fittings shall be of same material and manufacturer as base conduit. Provide cement for joining fittings to conduit. Fittings shall be by same manufacturer as base conduit.
3. Use non-metallic conduit wherever ground cables are concealed within conduits.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine the conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install main conductors to provide two-way path from each air terminal horizontally or downward to connections with ground terminals.

B. Install conductors free of excessive splices and sharp bends. Conductor bends shall form an included angle of not less than 90 degrees and shall not have bend radius less than eight inches. Secure conductors to structure at intervals not exceeding three feet.

C. Conceal down conductors where possible in exterior wall construction. Space down conductors at intervals averaging not more than 100 feet around perimeter of structure. Provide at least two down conductors for each protected structure.

D. For structural steel frame construction, down conductors at upper and lower extremities and at intervals not exceeding 200 feet shall be connected to structural

steel. Make connections to steel frame with bonding plates having eight square inches of contact, or by exothermic weld connections.

E. Provide air terminals at intervals not exceeding 20 feet along ridges and around perimeter of flat or gently-sloping roofs. Air terminals shall project a minimum of 10 inches above the area protected.

F. Protect flat or gently-sloping roofs exceeding 50 feet in width, by providing additional air terminals at intervals not exceeding 50 feet on flat or gently-sloping area. Locate air terminals within two feet of roof edges and outside corners of protected areas. Air terminal spacing exceeding these dimensions will be allowed if the area protected is within a "zone of protection" from lightning strikes.

G. Provide air terminals for stacks, flues, mechanical equipment, and other objects, having metal thickness less than 3/16-inch and not located within a "zone of protection". Connect objects having metal thickness 3/16-inch or greater to lightning protection system.

H. Do not connect copper equipment to aluminum surfaces, except using bimetal transition fitting. Lead coating is unacceptable for bimetal transition.

I. Install roof penetrations using through-roof assemblies with solid bars and appropriate roof flashing. Conductors shall not pass directly through roof.

J. Grounded metal bodies shall be bonded to the system using bonding connections and fittings. When ground conductors are installed in conduit, conduit shall be non-metallic.

K. Bond building ground systems including electrical, communication, and telephone services and arresters.

L. Bond metal pipes and roof mounted metal structure to the roof ground loop or to downlead cables.

M. Provide ground electrodes for each down conductor dedicated for lightning protection system and bond electrodes to building or structure grounding system. Connect down conductor to ground rod using high-strength, removable ground clamp. Provide bronze ground rod clamp having at least 1.5 inches of contact between rod and conductor, measured parallel to the axis of the rod, at ground test wells.

3.3 FIELD QUALITY CONTROL

A. Inspection:

1. During installation, lightning protection system shall be inspected by Master Installer or Inspector at several stages during installation in accordance with LPI requirements.
2. Do not conceal system components until inspection has been completed and successfully inspected, and observed by ENGINEER.
3. Upon completion of lightning protection system, arrange for final lightning system inspection and submit final inspection report to ENGINEER. Final lightning system inspection shall be performed by Master Installer or Inspector in accordance with LPI requirements.

END OF SECTION

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SECTION 26 43 00

SURGE PROTECTIVE DEVICES

PART 1 GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install surge protective devices (SPD).
   2. SPDs furnished under this Section shall be ANSI/UL 1449 Type 2 integrating both surge suppression and high-frequency noise filtering suitable for use on low-voltage distribution systems.

B. Related Sections:
   1. Section 26 05 05, General Provisions for Electrical Systems.
   2. Section 26 24 13, Switchboards.
   3. Section 26 24 16, Panelboards.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI/UL 1449, Surge Protective Devices.
   2. IEEE C62.11, Metal-Oxide Surge Arresters for AC Power Circuits (>1 kV)
   3. IEEE C62.41, Recommended Practice on Surge Voltages in Low-voltage AC Power Circuits.
   4. IEEE C62.45, Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1,000 V and Less) AC Power Circuits.
   5. UL 1283, Electromagnetic Interference Filters.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer: Shall have at least five years experience manufacturing and servicing products substantially similar to those required and shall be able to submit documentation of at least five installations in satisfactory operation for at least five years each.

B. Component Supply and Compatibility:
   1. Obtain all products included in this Section regardless of component manufacturer from a single SPD manufacturer.
   2. SPD manufacturer shall review and approve or prepare all Shop Drawings and other submittals for all components furnished under this Section.

3. Components shall be suitable for the specified service conditions and shall be integrated into overall assembly by SPD manufacturer.

C. Regulatory Requirements: Comply with the following:
   1. NEC 110.9, Requirements for Electrical Installations, Interrupting Rating.
   2. NEC 240.21, Overcurrent Protection, Location in Circuit.

1.4 SUBMITTALS

A. All files associated with shop drawings and product data shall be submitted as Adobe PDF with searchable function. This allows reviewer to search the document for keywords.

B. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Electrical and mechanical drawings for each type of unit, showing electrical ratings, dimensions, mounting provisions, connection details, and layout diagrams.
      b. Components list and nameplate schedule.
      c. Summary sheets with schedules of equipment.
   2. Product Data:
      a. Manufacturer's technical information, including catalog information.
      b. Manufacturer's technical specifications with assembly and component ratings.

C. Informational Submittals: Submit the following:
   1. Certifications:
      a. Certification that SPD devices comply with standards referenced in this Section.
   2. Source Quality Control Submittals:
      a. Report of results of testing and inspections performed at manufacturer's shop.
   3. Supplier Reports:
      a. Submit written report of results of each visit to Site by Supplier's service technician, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
   4. Qualifications Statements:
      a. Manufacture, when requested by ENGINEER.

D. Closeout Submittals: Submit the Following
   1. Operations and Maintenance Data:
      a. Submit in accordance with Section 01 78 23, Operations and Maintenance Data.

b. Include acceptable test reports, maintenance data and schedules, description of operation, wiring diagrams, and list of spare parts recommended for one year of operation with current price list.

2. Warranty Documentation: Submit example warranty at time of shipment of the equipment. Include final warranty accepted by ENGINEER in the operations and maintenance manual for the equipment.

1.5 DELIVERY, STORAGE, AND HANDLING.

A. Delivery:
   1. Upon delivery, check for evidence of water that may have entered equipment during transit.

B. Storage:
   1. Store SPD equipment in a clean, dry location with controls for uniform temperature and humidity. Protect equipment with coverings and maintain environmental controls.
   2. Protect equipment from corrosion and deterioration.

1.6 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive OWNER of other rights or remedies OWNER may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by CONTRACTOR under the Contract Documents. The obligations of CONTRACTOR under the Contract Documents shall not be limited in any way by the provisions of the specified special warranty.

B. Special Warranty on Materials and Equipment:
   1. Provide manufacturer's written warranty, running to the benefit of OWNER, agreeing to correct, or at option of OWNER, remove or replace materials or equipment specified in this Section found to be defective during a period of five years after the date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Provide equipment of one of the following:
   1. General Electric.
   2. Schneider Electric/Square-D Company.
   3. Eaton/Cutler-Hammer.
   4. Or equal.

2.2 EQUIPMENT

A. General:
   1. SPD shall be modular, high-energy, parallel design with fast-acting transient voltage suppression using metal oxide varistors. Equipment shall provide noise attenuation with electromagnetic interference filter.
   2. SPD shall comply with requirements of the following:
      a. ANSI/UL 1449.
      b. UL 1283.
      c. IEEE C62.11, IEEE C62.41 and IEEE C62.45.
   3. SPD shall be suitable for operation under the following environmental conditions:
      a. Relative Humidity: Zero to 95 percent, non-condensing.
      b. Frequency: 47 to 63 Hertz.
      c. Temperature: Zero to 149 degrees F.
   4. SPD operating voltage and IEEE C62.41 and IEEE C62.45 Category A, B, and C application environments shall be suitable for the associated SPD location(s) shown or indicated on the Drawings.
   5. SPD shall be suitable for internal mounting. Where shown on the Drawings, SPD shall be factory-mounted and integrated into distribution equipment specified under the following Sections:
      a. Section 26 24 13, Switchboards.
      b. Section 26 24 16, Panelboards.

B. SPD shall include a surge suppression path for each mode as required for the system configuration shown on the Drawings. Each mode shall be individually fused and equipped with thermal cutouts. SPD short-circuit rating shall be 200 kA. Protection modes shall include, to the extent applicable, the following:
   1. Line-to-line.
   2. Line-to-neutral.
   3. Line-to-ground.
   4. Neutral-to-ground.

C. SPD shall include electromagnetic interference/radio frequency interference (EMI/RFI) noise rejection filter with attenuation up to 30 dB from 10 kHz to 100 MHz.

D. SPDs and components in the operating path shall have maximum continuous operating voltage greater than 115 percent of nominal system operating voltage.

E. ANSI/UL 1449 minimum withstand rating shall be 20 kA per pole, and ANSI/UL 1449 voltage protection rating for SPD shall not exceed the following:

Modes	208Y/120	480Y/277
L-N,L-G, N-G	800	1200
L-L	1200	2000

F. SPD surge capacity based upon IEEE C62.41 location category shall, as a minimum, be the following:

Category	Application	Per Phase	Per Mode
C	Service entrance	240 kA	120 kA
B	High exposure locations (distribution equipment)	160 kA	80 kA
A	Branch locations	120 kA	60 kA

2.3 ACCESSORIES

A. Provide SPD equipped with the following accessories:
   1. Surge counter with display for indicating the number of surges detected.
   2. LED indicators for monitoring device status.
   3. Audible alarm and silence switch for indicating an inoperative condition.
   4. Dry contacts, "Form C", for remote annunciation of unit status.
   5. Indicators, counter, alarm, and silence switch shall be visible and accessible from front of the SPD. When SPD is integral to distribution equipment, indicators, counter, alarm, and silence switch shall be visible and accessible from front of the equipment in which the SPD is installed.

2.4 SOURCE QUALITY CONTROL

A. Perform manufacturer's standard factory tests on equipment. Tests shall be in accordance with IEEE C62.45 and ANSI/UL 1449.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine conditions under which materials and equipment will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install SPD at locations shown on the Drawings in accordance with equipment manufacturer's recommendations, Laws, and Regulations, and the Contract Documents.

B. Conductor length between suppressor and connection point shall be as short and as straight as possible.

END OF SECTION

SECTION 33 05 05

BUILDING PIPING INSTALLATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to install and test all buried piping, fittings, and specials. The Work includes the following:
      a. All types and sizes of buried piping, except where buried piping installations are specified under other Sections or other contracts.
      b. Unless otherwise shown or specified, this Section includes all buried piping Work required, beginning at the outside face of structures or structure foundations, including piping beneath structures, and extending away from structures.
      c. Work on or affecting existing buried piping.
      d. Installation of all jointing and gasket materials, specials, flexible couplings, mechanical couplings, harnessed and flanged adapters, sleeves, tie rods, cathodic protection, and other Work required for a complete, buried piping installation.
      e. Supports, restraints, and thrust blocks.
      f. Pipe encasements, with the exception of piping embedded in concrete within a structure or foundation specified under Section 40 05 05, Exposed Piping Installation.
      g. Field quality control, including testing.
      h. Cleaning and disinfecting.
      i. Incorporation of valves, meters, and special items shown or specified into piping systems in accordance with the Contract Documents and as required.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before buried piping Work.
   2. Coordinate with appropriate piping Sections of Division 40, Process Integration.
   3. Notify other contractors in advance of installing buried piping to provide them with sufficient time for installing items included in their contracts to be installed with or before buried piping installation Work.

C. Related Sections:
   1. Section 31 20 00, Earth Moving.
   2. Section 03 30 00, Cast-In-Place Concrete.
   3. Section 09 91 00, Painting.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ASME Boiler and Pressure Vessel Code.
   2. ASME B31.3, Process Piping.
   3. American Society for Non-Destructive Testing (ASNT), ASNT-TC-1A, Recommended Practice, Personnel Qualification, and Certification in Non-destructive Testing.
   4. AWWA M41, Ductile-Iron Pipe and Fittings.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Comply with requirements and recommendations of authorities having jurisdiction over the Work.
   2. Obtain required permits for Work in roads, rights-of-way, railroads, and other areas of the Work.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Details of piping, specials, joints, harnessing and thrust blocks, and connections to piping, structures, equipment, and appurtenances.
   2. Product Data:
      a. Manufacturer's literature and specifications, as applicable, for products specified in this Section.
   3. Testing Procedures:
      a. Submit proposed testing procedures, methods, apparatus, and sequencing. Obtain ENGINEER's approval prior to commencing testing.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. Certificate signed by manufacturer of each product certifying that product conforms to applicable referenced standards.
   2. Field Quality Control Submittals:
      a. Results of each specified field quality control test.

C. Closeout Submittals: Submit the following:
   1. Record Documentation:
      a. Maintain accurate and up-to-date record documents showing modifications made in the field, in accordance with approved submittals, and other Contract modifications relative to buried piping Work. Submittal shall show actual location of all piping Work and appurtenances at same scale as the Drawings.
      b. Show piping with elevations referenced to Project datum and dimensions from permanent structures. For each horizontal bend in piping, include

dimensions to at least three permanent structures, when possible. For straight runs of piping provide offset dimensions as required to document piping location.

c. Include profile drawings with buried piping record documents when the Contract Documents include piping profile drawings.

d. Conform to Section 01 78 39, Project Record Documents.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Delivery:

1. Deliver materials to the Site to ensure uninterrupted progress of the Work.
2. Upon delivery inspect pipe and appurtenances for cracking, gouging, chipping, denting, and other damage and immediately remove from Site and replace with acceptable material.

B. Storage:

1. Store materials to allow convenient access for inspection and identification. Store material off ground using pallets, platforms, or other supports. Protect packaged materials from corrosion and deterioration.
2. Pipe and fittings other than PVC and CPVC may be stored outdoors without cover. Cover PVC and CPVC pipe and fittings stored outdoors.

C. Handling:

1. Handle pipe, fittings, specials, and accessories carefully in accordance with pipe manufacturer's recommendations. Do not drop or roll material off trucks. Do not drop, roll or skid piping.
2. Avoid unnecessary handling of pipe.
3. Keep pipe interiors free from dirt and foreign matter.
4. Protect interior linings and exterior coatings of pipe and fittings from damage. Replace pipe and fittings with damaged lining regardless of cause of damage.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Piping materials are specified in the Buried Piping Schedule at end of this Section. Piping materials shall conform to Specifications for each type of pipe and piping appurtenances in applicable Sections of Division 40, Process Integration.

B. General:

1. Pipe Markings:
   a. Manufacturer shall cast or paint on each length of pipe and each fitting pipe material, diameter, and pressure or thickness class.

2.2 BURIED PIPING IDENTIFICATION

A. Polyethylene Underground Warning Tape for Metallic Pipelines:

1. Tracer tape shall be of inert, acid- and alkali-resistant, polyethylene, four mils thick, six inches wide, suitable for direct burial. Tape shall be capable of stretching to twice its original length.
2. Message shall read, "CAUTION [insert customized name of pipe service, i.e., "POTABLE WATER", "SANITARY SEWER", "CHLORINE GAS", or other service as appropriate, as indicated in the Buried Pipe Schedule at the end of this Section] PIPE BURIED BELOW", with bold letters approximately two inches high. Messages shall be printed at maximum intervals of two feet. Tape shall be custom colored the same as pipeline colors specified for associated pipe service in Section 09 91 00, Painting.
3. Manufacturer: Provide products of one of the following:
    a. Brady Corporation
    b. Seton Identification Products
    c. Marking Services, Inc.
    d. Or equal.

B. Detectable Underground Warning Tape for Non-Metallic Pipelines:
1. Tape shall be of inert, acid- and alkali-resistant, polyethylene, five mils thick, six inches wide, with aluminum backing, and have 15,000 psi tensile strength and 80 percent elongation capability. Tape shall be suitable for direct burial.
2. Message shall read, "CAUTION [insert customized name of pipe service, i.e., "POTABLE WATER", "SANITARY SEWER", "CHLORINE GAS", or other appropriate service, as indicated in the Buried Pipe Schedule at the end of this Section] PIPE BURIED BELOW" with bold letters approximately two inches high. Messages shall be printed at maximum intervals of two feet. Tape shall be custom colored the same as the pipeline colors as specified for the associated pipe service in Section 09 91 00, Painting.
3. Manufacturer: Provide products of one of the following:
    a. Brady Corporation
    b. Seton Identification Products
    c. Marking Services, Inc.
    d. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
1. Install piping as shown, specified, and as recommended by pipe and fittings manufacturer.
2. In event of conflict between manufacturer's recommendations and the Contract Documents, request interpretation from ENGINEER before proceeding.
3. ENGINEER will observe excavations and bedding prior to laying pipe by CONTRACTOR. Notify ENGINEER in advance of excavating, bedding, pipe
4. Minimum cover over buried piping shall be as shown on the Contract Drawings.
5. Earthwork is specified in Section 31 20 00, Earth Moving.

6. Excavation in excess of that required or shown, and that is not authorized by ENGINEER shall be filled at CONTRACTOR's expense with granular material furnished, placed, and compacted in accordance with Section 31 05 16, Aggregates for Earthwork.
7. Comply with NFPA 24 for "Outside Protection", where applicable to water piping systems used for fire protection.

B. Separation of Sewers and Potable Water Piping:
   1. Horizontal Separation:
      a. Where possible, existing and proposed potable water mains and service lines, and sanitary, combined, and storm sewers shall be separated horizontally by clear distance of at least ten feet.
      b. If local conditions preclude the specified clear horizontal separation, installation will be allowed if potable water main is in separate trench or on undistributed earth shelf on one side of sewer and with bottom of potable water main at least 18 inches above top of sewer.
      c. Exception:
         1) Where it is not possible to provide minimum horizontal separation described above, construct potable water main of cement-lined ductile iron pipe with restrained push-on joint or restrained mechanical joint pipe complying with public water supply design standards of authority having jurisdiction. Hydrostatically test water main and sewer as specified in this Section prior to backfilling. Hydrostatic test pressure at crossing shall be at least 150 psi.
   2. Vertical Separation:
      a. Provide minimum vertical distance of 18 inches between outside of potable water main and outside of sewer when sewer crosses over potable water main.
      b. Center a section of potable water main pipe at least 17.5 feet long over sewer so that sewer joints are equidistant from potable water main joints.
      c. Provide adequate structural support where potable water main crosses under sewer. At minimum, provide compacted select backfill for ten feet on each side of crossing.
      d. Exceptions:
         1) Where it is not possible to provide minimum vertical separation described above, construct potable water main of cement-lined ductile iron pipe with restrained push-on joint or restrained mechanical joint pipe. Hydrostatically test water main and sewer as specified in this Section, prior to backfilling. Hydrostatic test pressure at crossing shall be at least 150 psi.
         2) Encase either potable water main or sewer in watertight carrier pipe extending ten feet on each side of crossing, measured perpendicular to potable water main.

C. Plugs:
   1. Temporarily plug installed pipe at end of each day of work or other interruption of pipe installation to prevent entry of animals, liquids, and persons into pipe, and entrance or insertion of deleterious materials into pipe.
   2. Install standard plugs in bells at dead ends, tees, and crosses. Cap spigot and plain ends.
   3. Fully secure and block plugs, caps, and bulkheads installed for testing to withstand specified test pressure.
   4. Where plugging is required for phasing of the Work or subsequent connection of piping, install watertight, permanent type plugs, caps, or bulkhead acceptable to ENGINEER.

E. Bedding Pipe: Bed pipe as specified and in accordance with details on the Drawings.
   1. Trench excavation and backfill, and bedding materials shall conform to Section 31 20 00, Earth Moving, as applicable.
   2. Where ENGINEER deems existing bedding material unsuitable, remove and replace existing bedding with approved granular material furnished, placed, and compacted in accordance with Section 31 20 00, Earth Moving. Payment for additional excavation and providing granular material will be made under the unit price payment items in the Contract.
   3. Excavate trenches below bottom of pipe by amount shown and indicated in the Contract Documents. Remove loose and unsuitable material from bottom of trench.
   4. Carefully and thoroughly compact pipe bedding with hand held pneumatic compactors.
   5. Do not lay pipe until ENGINEER approves bedding condition.
   6. Do not bring pipe into position until preceding length of pipe has been bedded and secured in its final position.

F. Laying Pipe:
   1. Conform to manufacturer's instructions and requirements of standards and manuals listed below, as applicable:
      a. Ductile Iron Pipe: ANSI/AWWA C600, ANSI/AWWA C105, AWWA M41.
   2. Install pipe accurately to line and grade shown and indicated in the Contract Documents, unless otherwise approved by ENGINEER. Remove and reinstall pipes that are not installed correctly.
   3. Slope piping uniformly between elevations shown.
   4. Keep groundwater level in trench at least 24 inches below bottom of pipe before laying pipe. Do not lay pipe in water. Maintain dry trench conditions until jointing and backfilling are complete. Keep clean and protect interiors of pipe, fittings, valves, and appurtenances.
   5. Start laying pipe at lowest point and proceed towards higher elevations, unless otherwise approved by ENGINEER.
   6. Excavate around joints in bedding and lay pipe so that pipe barrel bears uniformly on trench bottom.
   7. Deflections at joints shall not exceed 75 percent of amount allowed by pipe manufacturer, unless otherwise approved by ENGINEER.

8. Carefully examine pipe, fittings, valves, and specials for cracks, damage, and other defects while suspended above trench before installation. Immediately remove defective materials from the Site and replace with acceptable products.
9. Inspect interior of all pipe, fittings, valves, and specials and completely remove all dirt, gravel, sand, debris, and other foreign material from pipe interior and joint recesses before pipe and appurtenances are moved into excavation.
10. Field cut pipe, where required, with machine specially designed for cutting the type of pipe being installed. Make cuts carefully, without damage to pipe, coating or lining, and with smooth end at right angles to axis of pipe. Do not flame-cut pipe.
11. Do not place blocking under pipe, unless specifically approved by ENGINEER for special conditions.
12. Touch up protective coatings in manner satisfactory to ENGINEER prior to backfilling.
13. Notify ENGINEER in advance of backfilling operations.
14. Thrust Restraint: Where required, provide thrust restraint conforming to Article 3.3 of this Section.
15. Exercise care to avoid flotation when installing pipe in cast-in-place concrete, and in locations with high groundwater.

H. Jointing Pipe:
1. Ductile Iron Mechanical Joint Pipe:
   a. Immediately before making joint, wipe clean the socket, plain end, and adjacent areas. Taper cut ends and file off sharp edges to provide smooth surface.
   b. Lubricate plain ends and gasket with soapy water or manufacturer's recommended pipe lubricant, in accordance with ANSI/AWWA C111, just prior to slipping gasket onto plain end of the joint assembly.
   c. Place gland on plain end with lip extension toward the plain end, followed by gasket with narrow edge of gasket toward plain end.
   d. Insert plain end of pipe into socket and press gasket firmly and evenly into gasket recess. Keep joint straight during assembly.
   e. Push gland toward socket and center gland around pipe with gland lip against gasket.
   f. Insert bolts and hand-tighten nuts.
   g. If deflection is required, make deflection after joint assembly and prior to tightening bolts. Alternately tighten bolts approximately 180 degrees apart to seat gasket evenly. Bolt torque shall be as follows:

Pipe Diameter (inches)	Bolt Diameter (inches)	Range of Torque (ft-lbs)
3	5/8	45 to 60
4 to 24	3/4	75 to 90
30 to 36	1	100 to 120
42 to 48	1.25	120 to 150

h. Bolts and nuts, except those of stainless steel, shall be coated with two coats, minimum dry film thickness of eight mils each, of high build solids epoxy or bituminous coating manufactured by Tnemec, or equal.

i. Restrained mechanical joints shall be in accordance with Section 40 05 19, Ductile Iron Process Pipe.

I. Backfilling:

1. Conform to applicable requirements of Section 31 20 00, Earth Moving.
2. Place backfill as Work progresses. Backfill by hand and use power tampers until pipe is covered by at least one foot of backfill.

J. Connections to Valves and Hydrants:

1. Install valves and hydrants as shown and indicated in the Contract Documents.
2. Provide suitable adapters when valves or hydrants and piping have different joint types.
3. Provide thrust restraint at all hydrants and at valves located at pipeline terminations.

K. Closures:

1. Provide closure pieces shown or required to complete the Work.

3.2 TRACER TAPE INSTALLATION

A. Polyethylene Underground Warning Tape for Metallic Pipelines:

1. Provide polyethylene tracer tape for buried metallic piping, which includes pipe that is steel, ductile iron, cast iron, concrete, copper, and corrugated metal.
2. Provide tracer tape 12 to 18 inches below finished grade, above and parallel to buried pipe.
3. For pipelines buried eight feet or greater below finished grade, provide second line of magnetic tracer tape 2.5 feet above crown of buried pipe, aligned along pipe centerline.
4. Tape shall be spread flat with message side up before backfilling.

3.3 THRUST RESTRAINT

A. Provide thrust restraint on pressure piping systems where shown or indicated in the Contract Documents.

B. Thrust restraint may be accomplished by using restrained pipe joints, concrete thrust blocks, or harnessing buried pipe. Thrust restraints shall be designed for axial thrust exerted by test pressure specified in the Buried Piping Schedule at the end of this Section.

C. Place concrete thrust blocks against undisturbed soil. Where undisturbed soil does not exist, or for projects where the Site consists of backfill material, thrust restraint shall be provided by restrained pipe joints.

D. Restrained Pipe Joints:
   1. Pipe joints shall be restrained by means suitable for the type of pipe being installed.
      a. Ductile Iron Mechanical Joints: Restrain with proprietary restrained joint system as specified in Section 40 05 19, Ductile Iron Process Pipe; lugs and tie rods; or other joint restraint systems approved by ENGINEER.

E. Concrete Thrust Blocks:
   1. Provide concrete thrust blocks on pressure piping at changes in alignment of 15 degrees or more, at tees, plugs and caps, and where shown or indicated in the Contract Documents. Construct thrust blocks of Class B concrete, conforming to 03 30 00, Cast-In-Place Concrete.
   2. Install thrust blocks against undisturbed soil. Place concrete so that pipe and fitting joints are accessible for repair.
   3. Concrete thrust block size shall be as shown on the Drawings or as approved by ENGINEER.

3.5 FIELD QUALITY CONTROL

A. General:
   1. Test all piping, except as exempted in the Buried Piping Schedule in this Section.
   2. When authorities having jurisdiction are to witness tests, notify ENGINEER and authorities having jurisdiction in writing at least 48 hours in advance of testing.
   3. Conduct all tests in presence of ENGINEER.
   4. Remove or protect pipeline-mounted devices that could be damaged by testing.
   5. Provide all apparatus and services required for testing, including:
      a. Test pumps, compressors, hoses, calibrated gages, meters, test containers, valves, fittings, and temporary pumping systems required to maintain OWNER's operations.
      b. Temporary bulkheads, bracing, blocking, and thrust restraints.
   6. Unless otherwise specified, OWNER will provide fluid required for hydrostatic testing. CONTRACTOR shall provide means to convey fluid for hydrostatic testing into piping being tested. CONTRACTOR shall provide fluid for other types of testing required.
   7. Repair observed leaks and repair pipe that fails to meet acceptance criteria. Retest after repair.

B. Test Schedule:
   1. Refer to the Buried Piping Schedule in this Section for type of test required and required test pressure.
   2. Unless otherwise specified, required test pressures are at lowest elevation of pipeline segment being tested.
   3. For piping not listed in Buried Piping Schedule in this Section:
      a. Hydrostatically test pipe that will convey liquid at a pressure greater than five psig. Provide process air pipe test for pipe that will convey air or gas

under pressure or vacuum, except chlorine gas, which requires separate test.

4. Test Pressure:
   a. Use test pressures listed in Buried Piping Schedule in this Section.
   b. If test pressure is not listed in Buried Piping Schedule, or if test is required for piping not listed in the Buried Piping Schedule, test pressure will be determined by ENGINEER based on maximum anticipated sustained operating pressure and methods described in applicable ANSI/AWWA manual or standard that applies to the piping system.

C. Hydrostatic Testing:
   1. Preparation for Testing:
      a. For thermoplastic pipe and fiberglass pipe, follow procedures described in Section 7 of ANSI/AWWA Standard C605.
      b. For HDPE pipe, follow procedures described in ASTM F2164. Test duration, including time to pressurize, time for initial expansion, time at test pressure, and time to depressurize, shall not exceed eight hours. If re-testing of a test section or pipeline is required, at least eight hours shall elapse between tests.
      c. For steel pipe, follow procedures described in ANSI/AWWA Manual M11. Wetting period is not required for pipe that is not cement-lined.
      d. For other piping follow procedures described in ANSI/AWWA Manual M9, except that minimum wetting period required immediately prior to testing for asbestos cement pipe shall be 24 hours rather than the 48 hours prescribed for concrete pipe. Wetting period is not required for pipe that is not cement mortar-lined.
      e. Prior to testing, ensure that adequate thrust protection is in place and joints are properly installed.
   2. Test Procedure:
      a. Fill pipeline slowly to minimize air entrapment and surge pressures. Fill rate shall not exceed one foot of pipe length per second in pipe being tested.
      b. Expel air from pipe as required. Obtain approval of ENGINEER prior to tapping pipe for expelling air.
      c. Examine exposed joints and valves, and make repairs to eliminate visible leakage.
      d. After specified wetting period, add fluid as required to pressurize line to required test pressure. Maintain test pressure for a stabilization period of ten minutes before beginning test.
      e. HDPE Pipe: After filling pipeline, gradually pressurize pipe to test pressure and maintain required test pressure for three hours for pipe to expand. During expansion, add fluid to maintain required test pressure. Begin timed test period after expansion period and other requirements are met.
      f. Timed test period shall not begin until after pipe has been filled, exposed to required wetting period, air has been expelled, and pressure stabilized.
      g. Timed Test Period: After stabilization period, maintain test pressure for at least two hours. During timed testing period, add fluid as required to

maintain pressure within five psig of required test pressure. For HDPE pipe, after three hour expansion phase, reduce test pressure by ten psig and do not add liquid. Test pressure shall then remain steady for one hour, indicating no leakage.

h. Pump from test container to maintain test pressure. Measure volume of fluid pumped from test container and record on test report. Record pressure at test pump at 15 minute intervals for duration of test.

3. Allowable Leakage Rates: Leakage is defined as the quantity of fluid supplied to pipe segment being tested to maintain pressure within five psi of test pressure during timed test period. Allowable leakage rates for piping are:
   a. No Leakage: Pipe with flanged, welded, fused, threaded, soldered, or brazed joints.
   b. Rates based on formula or table in ANSI/AWWA Manual M41:
      1) Metal and fiberglass pipe joined with rubber gaskets as sealing members, including the following joint types:
         a) Mechanical joints.

3.6 CLEANING

A. Cleaning, General: Clean pipe systems as follows:
   1. Thoroughly clean all piping, including flushing with water, dry air, or inert gas as required, in manner approved by ENGINEER, prior to placing in service. Flush chlorine solution and sodium hypochlorite piping with water.
   2. Piping 24-inch diameter and larger shall be inspected from inside and debris, dirt and foreign matter removed.

3.8 SCHEDULES

A. Schedules listed below, following the "End of Section" designation, are part of this Specification section.
   1. Table 33 05 05-A, Buried Piping Schedule.

+ + END OF SECTION + +

TABLE 33 05 05-A, BURIED PIPING SCHEDULE

Service	Diameter (inch)	Material	Interior Lining	Exterior Coating	Pressure Class/ Thickness	Joint	Test	Remarks
PSD	6-36	DI	CL	-	350	MJ	HYD (50)	

The following abbreviations are used in the Buried Piping Schedule.

A. Service Abbreviations

Service	Abbrev
Pump Station Discharge	PSD

B. Material Abbreviations

Material	Abbrev
Ductile Iron	DI

C. Lining/Coating Abbreviations

Lining	Abbrev
Cement Mortar Lined	CL

D. Joint Abbreviations

Joint Type	Abbrev
Mechanical Joint	MJ

E. Test Abbreviations

Test	Abbrev
Hydrostatic Test (test pressure in psig)	HYD ( )

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SECTION 40 05 05

EXPOSED PIPING INSTALLATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified, and required to install and test all exposed piping, fittings, and specials. The Work includes the following:
      a. All types and sizes of exposed piping, except where exposed piping installations are specified under other Sections or other contracts.
      b. Unless otherwise shown or specified, this Section includes all piping beginning at the outside face of structures or structure foundations and extending into the structure. Piping embedded in concrete within a structure or foundation shall be considered as exposed and is included herein. Piping that is permanently or intermittently submerged, or installed in sub-aqueous environments, is considered as exposed and is included in this Section.
      c. Work on or affecting existing exposed piping.
      d. Installation of all jointing and gasket materials, specials, flexible couplings, mechanical couplings, harnessed and flanged adapters, sleeves, tie rods, and all Work required for a complete exposed piping installation.
      e. Supports, restraints, and other anchors.
      f. Field quality control, including testing.
      g. Cleaning and disinfecting.
      h. Incorporation of valves, meters, and special items shown or specified into the piping systems per the Contract Documents and as required

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before exposed piping Work.
   2. Coordinate with appropriate piping Sections of Division 40, Mechanical.
   3. Notify other contractors in advance of installation of exposed piping to provide them with sufficient time for installation of items included in their contracts that must be installed with or before exposed piping Work.

C. Related Sections:
   1. Section 09 91 00, Painting.
   2. Section 10 14 00, Signage.
   3. Section 40 05 07, Pipe Hangers and Supports.
   4. Section 40 05 06, Couplings, Adapters, and Specials for Process Piping.
   5. Section 40 05 08, Wall Pipes, Floor Pipes and Pipe Sleeves.

6. Section 40 05 96, Vibration, Seismic, and Wind Controls.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI B16.1, Cast Iron Pipe Flanges and Flanged Fittings
   2. ASME Boiler and Pressure Vessel Code.
   3. ASME B31.3, Process Piping.
   4. American Society for Non-Destructive Testing (ASNT), ASNT-TC-1A, Recommended Practice, Personnel Qualification, and Certification in Non-destructive Testing.
   5. ASTM A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
   6. ANSI/AWWA C111, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   7. AWWA M41, Ductile-Iron Pipe and Fittings.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Comply with requirements and recommendations of authorities having jurisdiction over the Work.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Detailed drawings in plan and, as applicable, section.
      b. Details of piping, valves, supports, accessories, specials, joints, harnessing, and main anchor supports, and connections to existing piping, structures, equipment, and appurtenances.
   2. Testing Plans, Procedures, and Testing Limitations
      a. Submit description of proposed testing methods, procedures, and apparatus, and obtain ENGINEER's approval prior to testing.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. Submit a certificate, signed by manufacturer of each product, certifying that product complies with applicable referenced standards.
      b. Welder's certificate in compliance with Paragraph 3.1.E.7.c of this Section.
   2. Source Quality Control Submittals:
      a. Submit copies of testing report for each test.
   3. Site Quality Control Reports:
      a. Submit copies of testing report for each test.

C. Closeout Submittals: Submit the following:

1. Record Documentation:
    a. Maintain accurate and up-to-date record documents showing field and Shop Drawing modifications. Record documents for exposed piping Work shall show actual location of all piping and appurtenances on a copy of the Drawings, unless otherwise approved by ENGINEER.
    b. Record documents shall show piping with elevations referenced to the project datum and dimensions from permanent structures. For straight runs of pipe provide offset dimensions as required to document pipe location.
    c. Include section drawings with exposed piping record documents when the Contract Documents include section Drawings.
    d. Conform to Section 01 78 39, Project Record Documents.

1.5 DELIVERY, STORAGE AND HANDLING

A. Delivery:
1. Deliver products to Site to ensure uninterrupted progress of the Work.
2. Upon delivery, inspect pipe and appurtenances for cracked, gouged, chipped, dented, and other damage and immediately remove damaged products from Site.
3. Conform to requirements of Section 01 65 00, Product Delivery Requirements.

B. Storage:
1. Store products for convenient access for inspection and identification. Store products off the ground using pallets, platforms, or other supports. Protect packaged products from corrosion and deterioration.
2. Pipe and fittings other than thermoplastic materials may be stored outdoors without cover. Thermoplastic pipe and fittings stored outdoors shall be covered.
3. Conform to requirements of Section 01 66 00, Product Storage and Handling Requirements.

C. Handling:
1. Handle pipe, fittings, specials, and accessories carefully with approved handling devices. Do not drop or roll material of delivery vehicles. Do not otherwise drop, roll, or skid piping.
2. Avoid unnecessary handling of pipe.
3. Keep pipe interiors free of dirt and foreign matter.
4. Protect interior linings and exterior coatings of pipe and fittings from damage. Replace pipe and fittings with damaged lining regardless of cause of damage. Repair damaged coatings.
5. Conform to requirements of Section 01 65 00, Product Delivery Requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Piping materials are specified in the Exposed Piping Schedule at the end of this Section. Piping materials shall conform to Specification for each type of pipe and piping appurtenances in applicable sections of Division 40, Process Integration.

B. Markings and Identification:
   1. Pipe Markings:
      a. Clearly mark each piece of pipe or fitting with a designation conforming to that shown on the approved Shop Drawings.
      b. Manufacturer shall cast or paint on each length of pipe and each fitting the pipe material, diameter, and pressure or thickness class.
   2. Pipe Identification Markers and Arrows: Refer to Section 10 14 00, Signage.

C. Appurtenances: Provide products that comply with:
   1. Section 40 05 07, Pipe Hangers and Supports.
   2. Section 40 05 06, Couplings, Adapters, and Specials for Process Piping.
   3. Section 40 05 08, Wall Pipes, Floor Pipes and Pipe Sleeves.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work is to be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General:
   1. Install piping as shown, specified and as recommended by the pipe and fittings manufacturer.
   2. If there is a conflict between manufacturer's recommendations and the Contract Documents, request in writing instructions from ENGINEER before proceeding.
   3. Provide pipe manufacturer’s installation specialist at Site as specified on this Section.

B. Temporary Blind Flanges, Plugs, Caps, and Bulkheads:
   1. Temporarily plug installed pipe at the end of each day of work or other interruption of pipe installation to prevent entry of animals, liquids, and persons into pipe, and entrance or insertion of deleterious materials into pipe.
   2. Install standard plugs in all bells at dead ends, tees, and crosses. Cap all spigot and plain ends.

3. Fully secure and block blind flanges, plugs, caps, and bulkheads installed for testing, designed to withstand specified test pressure.
4. Where plugging is required for phasing of Work or subsequent connection of piping, install watertight, permanent type blind flanges, plugs, caps, or bulkhead acceptable to ENGINEER.

C. Piping Installation:
1. Conform to manufacturer's instructions and requirements of standards and manuals listed in this Section, as applicable:
   a. Ductile Iron Pipe: ANSI/AWWA C600, AWWA M41.
2. Install straight runs true to line and elevation.
3. Install vertical pipe truly plumb in all directions.
4. Install piping parallel or perpendicular to walls of structures. Piping at angles and 45 degree runs across corners of structures will not be accepted unless specifically shown on the Contract Documents or approved by the ENGINEER.
5. Cutting: Cut pipe from measurements verified at Site. Field cut pipe, where required, with a machine specially designed for cutting type of pipe being installed. Make cuts carefully without damage to pipe, coating, or lining, and with a smooth end at right angles to axis of pipe. Cut ends of push-on joint type pipe shall be tapered and sharp edges filed off smooth. Do not flame-cut pipe.
6. Deflections at joints shall not exceed 75 percent of amount allowed by pipe manufacturer, unless otherwise approved by the Engineer.

D. Jointing Pipe:
1. General:
   a. Make joints in accordance with pipe manufacturer's recommendations and Contract Documents.
   b. Cut piping accurately and squarely and install without forcing or springing.
   c. Ream out pipes and tubing to full inside diameter after cutting. Remove all sharp edges on end cuts.
   d. Remove all cuttings and foreign matter from inside of pipe and tubing before installation. Thoroughly clean all pipe, fittings, valves, specials, and accessories before installing.
2. Ductile Iron Flanged Joints:
   a. Assemble flanged joints using ring-type gaskets, with thickness as recommended by pipe manufacturer but not less than 1/8-inch thick, for raised-face flanges. Use full-face gaskets for flat-face flanges, unless otherwise approved by ENGINEER or recommended by pipe manufacturer. Gaskets shall be suitable for the service intended in accordance with the manufacturer's ratings and instructions. Gaskets shall be properly centered.
   b. Tighten bolts in a sequence that provides equal distribution of bolt loads.
   c. Length of bolts shall be uniform. Bolts shall not project beyond the nut more than 1/4-inch or fall short of the nut when fully taken up. Machine-cut ends of bolts to be neatly rounded. Do not use washers.

d. Prior to assembly of flanged joints, lubricate bolt threads and gasket faces.
e. Alternately tighten bolts 180 degrees apart to compress the gasket evenly.
f. After assembly, coat all bolts and nuts, except stainless steel bolts and nuts, with same coating specified in Section 09 91 00, Painting, for material of pipe and fittings being joined.

E. Installing Valves and Accessories:
1. Provide supports for large valves, flow meters, and other heavy items as shown or required to prevent strain on adjoining piping.
2. Position flow measuring devices in pipe lines so that they have the amount of straight upstream and downstream runs recommended by the flow measuring device manufacturer, unless specific location dimensions are shown.
3. Position swing check valves so that they do not conflict with upstream and downstream elements of the piping system.

F. Closures:
1. Provide closure pieces, such as blind flanges and caps, shown or required to complete the Work.

3.2 THRUST RESTRAINT

A. Provide thrust restraint on all pressure piping systems and where otherwise shown or specified.

B. Thrust restraints shall be designed for axial thrust exerted by test pressure specified in the Exposed Piping Schedule at end of this Section.

C. Restrained Pipe Joints:
1. Pipe joints shall be restrained by means suitable for the type of pipe being installed.
a. Prestressed Concrete Cylinder Pipe Joints: Restrain utilizing clamp type restrained joint, snap ring-type restrained joint, or by welding. Concrete pipe requiring restraint shall have sufficient longitudinal steel reinforcement provided to handle the thrust forces at a maximum design stress of 12,500 psi. Thrust forces in the longitudinals must be transmitted directly to steel joint bands using welded connections sufficient to carry stresses involved. No allowance for concrete to handle tensile forces is allowed. Thrust restraint shall be in accordance with ANSI/AWWA Manual M-9.
c. Ductile Iron, Push-on Joints and Mechanical Joints: Restrain with a proprietary restrained joint system as specified in Section 40 05 19. Ductile iron pipe, lugs, and tie rods, or other joint restraint systems approved by ENGINEER. Restrain ductile iron pipe connected by flexible couplings or flanged coupling adapters by harnessing across the coupling or adapter using tie rods or extended bolts connecting between flanges.

d. Steel Pipe Joints: Provide butt-welded joints, lap welded joints, flanged joints, or mechanical coupling connections as shown and specified in Exposed Piping Schedule. Provide tie rods connected to lugs welded to the steel pipe for restraint at mechanical couplings.

e. Thermoplastic, FRP and HDPE Joints: Where bell and spigot-type or other non-restrained joints are utilized, provide tie rods across the joint or other suitable joint restraint system, subject to approval of ENGINEER.

3.3 PAINTING

A. Field painting shall conform to Section 09 91 00, Painting.

3.5 FIELD QUALITY CONTROL

A. Testing, General:
   1. Test all piping, except as exempted in the Exposed Piping Schedule.
   2. Notification:
      a. Notify ENGINEER at least 48 hours prior to testing.
      b. When authorities having jurisdiction are to witness tests, notify ENGINEER and authorities having jurisdiction in writing at least 48 hours in advance of testing.
   3. Conduct all tests in presence of ENGINEER.
   4. Remove or protect pipeline-mounted devices that could be damaged by testing.
   5. Provide all apparatus and services required for testing, including:
      a. Test pumps, compressors, hoses, calibrated gages, meters, test containers, valves, fittings, and temporary pumping systems required to maintain OWNER's operations.
      b. Temporary bulkheads, bracing, blocking, and thrust restraints.
   6. Unless otherwise specified, OWNER will provide fluid required for hydrostatic testing. CONTRACTOR shall provide means to convey fluid for hydrostatic testing into the pipe being tested. CONTRACTOR shall provide fluid for other types of testing required.
   7. Repair observed leaks and repair pipe that fails to meet acceptance criteria. Retest after repair.
   8. Unless otherwise specified, testing shall include existing piping systems that connect with new piping system. Test existing pipe to nearest valve. Piping not installed by CONTRACTOR and that fails the test shall be repaired upon authorization of ENGINEER or OWNER. Repair of existing piping will be paid as extra work unless otherwise specified.

B. Test Schedule:
   1. Refer to the Exposed Piping Schedule for type of test required and required test pressure.
   2. Unless otherwise specified, the required test pressures are at lowest elevation of pipeline segment being tested.
   3. For piping not listed in Exposed Piping Schedule:
      a. Hydrostatically test pipe that will convey liquid at a pressure greater than five psig. Provide process air pipe test for pipe that will convey air or gas

under pressure or vacuum, except chlorine gas, which requires a separate test.

b. Disinfect for bacteriological testing piping that conveys potable water.

4. Test Pressure:
   a. Use test pressures listed in Exposed Piping Schedule.
   b. If test pressure is not listed in Exposed Piping Schedule, or if a test is required for piping not listed in the Exposed Piping Schedule, test pressure will be determined by the ENGINEER based on the maximum anticipated sustained operating pressure and the methods described in the applicable ANSI/AWWA manual or standard that applies to the piping system.

C. Hydrostatic Testing:
   1. Preparation for Testing:
      a. For thermoplastic pipe and FRP pipe, follow procedures described in Section 7 of ANSI/AWWA Standard C605.
      b. For HDPE pipe, follow procedures described in ASTM F2164. Test duration, including time to pressurize, time for initial expansion, time at test pressure, and time to depressurize, shall not exceed eight hours. If re-testing of a test section or pipeline is required, at least eight hours shall elapse between tests.
      c. For steel pipe, follow procedures described in AWWA Manual M11. Wetting period is not required for pipe that is not cement-lined.
      d. For other piping follow procedures described in AWWA Manual M9. A wetting period is not required for pipe that is not cement mortar-lined.
      e. Prior to testing, ensure that adequate thrust protection is in place and all joints are properly installed.
   2. Test Procedure:
      a. Fill pipeline slowly to minimize air entrapment and surge pressures. Fill rate shall not exceed one foot of pipe length per second in the pipe being tested.
      b. Expel air from pipe as required. Obtain approval of ENGINEER prior to tapping pipe for expelling air.
      c. Examine joints and valves, and make repairs to eliminate visible leakage.
      d. After specified wetting period, add fluid as required to pressurize line to required test pressure. Maintain test pressure for a stabilization period of ten minutes before beginning test.
      e. HDPE Pipe: After filling pipeline, gradually pressurize pipe to test pressure and maintain required test pressure for three hours for pipe to expand. During expansion, add fluid to maintain required test pressure. Begin timed test period after expansion period and other requirements are met.
      f. Timed test period shall not begin until after the pipe has been filled, exposed to the required wetting period, air has been expelled, and pressure stabilized.
      g. Timed Test Period: After the stabilization period, maintain test pressure for at least two hours. During timed testing period, add fluid as required to maintain pressure within five psig of required test pressure. For HDPE

pipe, after three hour expansion phase, reduce test pressure by ten psig and do not add liquid. The test pressure shall then remain steady for one hour, indicating no leakage.

h. Pump from a test container to maintain test pressure. Measure volume of fluid pumped from test container and record on test report. Record pressure at test pump at fifteen minute intervals for duration of test.

3. Allowable Leakage Rates: Leakage is defined as the quantity of fluid supplied to pipe segment being tested to maintain pressure within five psi of the test pressure during timed test period. Allowable leakage rates for piping are:
   a. No Leakage: Pipe with flanged, welded, fused, threaded, soldered, or brazed joints.

3.6 CLEANING

A. Cleaning, General: Clean pipe systems as follows:
   1. Thoroughly clean all piping, including flushing with water, dry air, or inert gas as required, in a manner approved by ENGINEER, prior to placing in service. Flush chlorine solution and sodium hypochlorite piping with water.
   2. Piping 24-inch diameter and larger shall be inspected from inside and debris, dirt and foreign matter removed.

3.7 EXPOSED PIPING SCHEDULE

A. The schedules listed below, following the "End of Section" designation, are a part of this Specification section.
   1. Table 40 05 05-A, Exposed Piping Schedule.

+ + END OF SECTION + +

TABLE
40 05 05-A, EXPOSED PIPING SCHEDULE

Service	Diameter (inch)	Material	Interior Lining	Exterior Coating	Pressure Class/ Thickness	Joint	Test	Remarks
	8-30	DI	CL	P	350	FLG	HYD (150)	

The following abbreviations are used in the Exposed Piping Schedule.

A. Service Abbreviations

Service	Abbrev.
Pump Station Discharge	PSD

B. Material Abbreviations

Material	Abbrev
Ductile Iron	DI

C. Lining/Coating Abbreviations

Lining	Abbrev
Cement Mortar Lined	CL
Painted	P

D. Joint Abbreviations

Joint Type	Abbrev
Flanged	Flg

E. Test Abbreviations

Test	Abbrev
Hydrostatic Test (test pressure in psig)	HYD ( )

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SECTION 40 05 06

COUPLINGS, ADAPTERS, AND SPECIALS FOR PROCESS PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install all couplings, adapters, and specials for process piping.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before couplings, adapters, and specials for process piping Work.
   2. Notify other contractors in advance of the installation of couplings, adapters, and specials for process piping to provide them with sufficient time for installing items included in their contracts that must be installed with or before couplings, adapters, and specials for process piping Work.

C. Related Sections:
   1. Section 09 91 00, Painting.
   2. Section 33 05 05, Buried Piping Installation
   3. Section 40 05 05, Exposed Piping Installation.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI B16.1, Cast-Iron Pipe Flanges and Flanged Fittings.
   2. ANSI B16.39, Malleable Iron Threaded Pipe Unions.
   3. ASME B31, Standards of Pressure Piping.
   4. ASTM A53/A53M, Specification for Pipe, Steel, Black and Hot-dipped, Zinc-Coated, Welded and Seamless.
   5. ASTM A105/A105M, Specification for Carbon Steel Forgings and Piping Applications.
   6. ASTM B169/B169M Specification for Aluminum Bronze Sheet, Strip, and Rolled Bar.
   7. ASTM B650, Specification for Electro-Deposited Engineering Chromium Coatings of Ferrous Substrates.
   8. ASTM F593, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
   9. AWWA C606, Grooved and Shouldered Joints.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer shall have at least five years experience producing substantial similar products to those specified and shall be able to provide documentation of at least five installations in satisfactory operation for at least five years each.

B. Component Supply and Compatibility:
   1. Obtain each type of coupling, adapter, and special for process piping product included in this Section, regardless of component manufacturer, from a single couplings, adapters, and specials manufacturer.
   2. Supplier shall prepare, or review, and approve all submittals for components furnished under this Section.
   3. Components shall be suitable for specified service conditions and be integrated into overall assembly by the Supplier.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Submit piping layout Shop Drawings in accordance with Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.
   2. Product Data:
      a. Submit product data on each type of coupling, expansion joint, and other piping specialties and accessories, including gaskets, hardware, and appurtenances sufficient to demonstrate compliance with the Contract Documents.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. When requested by ENGINEER submit certificate attesting to compliance with standards referenced in this Section, signed by manufacturer.
   2. Manufacturer's Instructions:
      a. Provide instructions for handling, storing, installing, and adjusting of products.
   3. Source Quality Control:
      a. When requested by ENGINEER, submit results of source quality control tests.
   4. Qualifications Statements:
      a. Submit qualifications of manufacturer when requested by ENGINEER.

1.5 DELIVERY, STORAGE AND HANDLING

A. Refer to Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

PART 2 – PRODUCTS

2.1 COUPLINGS

A. Sleeve-type, Flexible Couplings:
   1. Pressure and Service: Same as connected piping.
   2. Products and Manufacturers: Provide products of one of the following:
      a. Style 253, as manufactured by Dresser Piping Specialties, part of Dresser, Inc.
      b. Style 441, by Smith Blair, Inc.
      c. Or equal.
   3. Material: Ductile Iron.
   4. Gaskets: Suitable for specified service, as recommended by manufacturer .
   5. Bolts and Nuts: Alloy steel, corrosion-resistant, primer-coated. For buried or submerged applications, provide stainless steel bolts complete with washers complying with ASTM F593, AISI Type 316 and with nitrided stainless nuts.
   6. Harnessing:
      a. Harness couplings to restrain pressure piping. For pipelines that will be under pressure, test pressures are specified in piping schedules in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.
      b. Tie adjacent flanges with bolts of corrosion-resistant alloy steel. Provide flange-mounted stretcher bolt plates to be designed by manufacturer, unless otherwise approved. For buried or submerged applications, provide external bolting and other hardware of Type 316 stainless steel, including tie bolts, bolt plates, lugs, nuts, and washers.
      c. On plain-end piping, for harnessing couplings, provide anchor restraint system such as Dresser Piping Specialties STAR Anchor Style 443, or equal.
      d. Conform to dimensions, size, spacing, and materials for lugs, bolts, washers, and nuts as recommended by manufacturer and approved by ENGINEER for pipe size, wall thickness, and test pressure required. Provide minimum 5/8-inch diameter bolts.
   7. Remove pipe stop(s) if used, unless otherwise shown or specified.

B. Flanged Coupling Adapters:
   1. Description: One end of adapter shall be flanged and opposite end shall have sleeve-type flexible coupling.
   2. Products and Manufacturers: Provide one of the following:
      a. Style 227, as manufactured by Dresser Piping Specialties, part of Dresser, Inc.
      b. Style 912, by Smith Blair, Inc.
      c. Or equal.
   3. Pressure and Service: Same as connected piping.
   4. Material: Ductile iron.
   5. Gasket: Recommended by the manufacturer.

6. Bolts and Nuts: Alloy steel, corrosion-resistant, primer-coated. For buried or submerged applications, provide stainless steel bolts complete with washers complying with ASTM F593, AISI Type 316 and nitrided stainless nuts.
7. Harnessing:
    a. Harness adapters to restrain pressure piping. For pressure pipelines, test pressures are included in piping schedules in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.
    b. For flanged adapters 12-inch diameter and smaller, provide 1/2-inch diameter (minimum) Type 316 stainless steel anchor studs installed in pressure-tight anchor boss. For buried or submerged applications, provide external bolting and other hardware of Type 316 stainless steel, including tie bolts, bolt plates, lugs, nuts, and washers. Provide number of studs required to restrain test pressure and service conditions. Harness shall be as designed and recommended by flanged adapter manufacturer. Provide the following minimum anchor studs unless otherwise approved by ENGINEER.
        1) Six-inch Diameter and Smaller: Two
        2) Eight-inch Diameter and Smaller: Four
        3) Ten-inch Diameter and Smaller: Six
        4) Twelve-inch Diameter and Smaller: Eight
    c. For adapters larger than 12-inch diameter, provide split-ring harness clamps with minimum of four corrosion-resistant alloy steel bolts. For buried or submerged applications, provide external bolting and other hardware of Type 316 stainless steel, including tie bolts, bolt plates, lugs, nuts, and washers. Harness assembly shall be as designed and recommended by flanged adapter manufacturer. Dimensions, sizes, spacing and materials shall be suitable for service and conditions encountered and shall be approved by ENGINEER.

2.2 PAINTING

A. Shop Painting:
    1. Clean and prime-coat ferrous metal surfaces of products in the manufacturer's shop in accordance with Section 09 91 00, Painting, unless otherwise specified in this Section
    2. Coat machined, polished and non-ferrous surfaces bearing surfaces and similar unpainted surfaces with corrosion prevention compound that shall be maintained during storage and until products are placed into operation.

B. Field painting shall conform to Section 09 91 00, Painting.

PART 3 - EXECUTION

3.1 INSPECTION

A. Inspect materials for defects in material and workmanship. Verify compatibility of products with pipe, fittings, valves, and appurtenances.

3.2 INSTALLATION

A. Installation:
   1. Install piping specialties in accordance with the Contract Documents and manufacturer's instructions.
   2. For buried installations, refer to Section 33 05 05, Buried Piping Installation.
   3. For exposed installations, refer to Section 40 05 05, Exposed Piping Installation.

B. Adjust expansion joints as required to ensure that expansion joints will be fully extended when ambient temperature is at minimum operating temperature, and fully compressed at maximum operating temperature for the system in which expansion joints are installed.

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SECTION 40 05 07

PIPE HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified and required to design, furnish, and install all hangers, supports and appurtenances necessary to complete the Work.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the pipe hangers and supports Work.
   2. Notify other contractors in advance of the installation of the pipe hangers and supports to provide them with sufficient time for the installation of items included in their contracts that must be installed before the pipe hangers and supports Work.

C. Related Sections:
   1. Section 03 30 00, Cast-In-Place Concrete.
   2. Section 05 50 13, Miscellaneous Metal Fabrications.
   3. Section 09 91 00, Painting.
   4. Section 40 05 06, Couplers, Adapters, and Specials for Process Piping.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
   1. American Society for Testing and Materials, (ASTM).
      a. ASTM A 575, Specification for Steel Bars Carbon, Merchant Quality, M-Grades.
      b. ASTM E 84, Test Method for Surface Burning Characteristics of Building Materials.
   2. Federal Specification, (FS).
      a. FS A-A-1192, Hangers, Pipe.
   3. Manufacturers Standardization Society of the Valve and Fittings Industry, (MSS).
      a. MSS SP 58, Pipe Hangers and Supports-Materials, Design and Manufacture.
      b. MSS SP 69, Pipe Hangers and Supports - Selection and Application.
   4. Underwriters' Laboratories, Inc., (UL).
      a. UL 203, Pipe Hanger Equipment for Fire Protection Service.

1.3 QUALITY ASSURANCE

A. Each type of pipe hanger or support shall be the product of one manufacturer.

B. Component Supply and Compatibility:
   1. Obtain all equipment included in this Section regardless of the component manufacturer from a single pipe hangers and supports manufacturer.
   2. The pipe hangers and supports equipment manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
   3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the pipe hangers and supports equipment manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Detailed drawings showing all hangers and supports for each piping system specified. Shop Drawings shall show location, installation, material, loads or forces, and deflection of all hangers and supports.
      b. Each pipe system shall be analyzed for all loads and forces on the hangers and supports. Provide calculations of reaction forces to the structure to which they are fastened. Provide confirmation that hanger systems comply with support requirements and codes.
      c. Submit and coordinate these with Shop Drawings required for all piping systems.
   2. Product Data:
      a. Submit manufacturers' catalogs, literature, and engineering data on all hangers and supports. Load ratings, materials and installation shall be consistent with the recommendations of the MSS SP 58, MSS SP 69 and Federal Specification A-A-1192.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:
   1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of that Work.

B. Storage and Protection:
   1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
   2. Store materials in covered storage off the ground and prevent condensation.

C. Acceptance at Site:
   1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 GENERAL

A. Hangers and supports shall meet with the following requirements:
   1. Standard and fabricated hangers and supports shall be furnished complete with necessary inserts, bolts, nuts, rods, washers, and other accessories.
   2. Generally, run piping in groups where practicable and parallel to building wall. Provide minimum clearance of 1-inch between pipe and other work.
   3. Install hangers or supports at all locations where pipe changes direction.
   4. All hangers and supports shall be capable of adjustment after placement of piping.
   5. Different types of hangers or supports shall be kept to a minimum.
   6. All suspended or supported ductile iron pipe shall have a hanger or support adjacent to each hub.
   7. Support vertical piping at each floor and between floors by stays or braces to prevent rattling and vibration.
   8. Hanger rods shall be straight and vertical. Chain, wire, strap or perforated bar hangers shall not be used. Hangers shall not be suspended from piping.
   9. Maximum support spacing unless otherwise shown or approved for standard weight steel pipe shall be as follows:

Pipe Size (inches)	Maximum Pipe Span [1] (feet)			
	Steel	Copper	Plastic [2]	Cast/Ductile Iron [4]
3/8 to 3/4	5	6	Cont. [3]	-
1	6	6	5	-
1-1/4	6	6	5	-
1-1/2	6	6	5	-
2	10	10	5	-
2-1/2	10	10	5	-
3	10	10	5	-
4	12	12	5	12 feet for pressure pipe
6	12	12	5	
8	12	12	5	
10	12	-	5	
12	12	-	10	
14	12	-	-	
16	12	-	-	

18	12	-	-	10 feet for soil pipe
20	12	-	-	
24	12	-	-	

[1]Pipe shall not have pockets formed in the span due to sagging of the pipe between supports caused by the weight of the pipe, medium in the pipe, insulation, valves and fittings.

[2]Span shown is for Schedule 80 CPVC pipe at 100°F. Spans for other plastics, other CPVC pipe Schedules and pipes at higher temperatures shall be shortened in accordance with the pipe manufacturer's recommendations.

[3]Continuous means pipe shall be in unistrut or similar channel.

[4] Pipe hanger and support selection shall be as shown and in this Section.

10. Maximum support spacing, unless otherwise shown for plastic pipe at ambient temperature, shall be one-half of the values specified for steel pipe.
11. Plastic pipe at temperature greater than 130ºF shall be continuously supported in a metal cradle or tray.
12. Where proper hanger or support spacing does not correspond with joist or rib spacing, structural steel channels may be attached to joists or ribs and pipes suspended there from.
13. Prevent contact between dissimilar metals when supporting copper tubing, by use of copper plated, rubber or vinyl coated, or stainless steel hangers or supports.
14. Isolate thin walled stainless steel piping from carbon steel by use of plastic coated hangers or supports or by taping at points of contact with PVC or vinyl.
15. Supports and hangers shall be of a material that is compatible with the fluid being conveyed in such pipe being supported.
16. Anchors for pipe support systems shall be compatible or protected by a coating system which is compatible with the fluid being conveyed in such pipe being supported.

B. Expansion compensation shall be designed for individual exposed piping systems with the following Design Criteria:
   1. $\Delta L = L \times \Delta T \times \alpha$
      a. Where ΔL = pipe length change (inches).
      b. L = pipe length between anchors (inches).
      c. ΔT = 100 (F).
      d. α = coefficient of thermal expansion (inches/inches/F).
   2. Expansion compensation shall be designed as an integral part of the piping hanger, support and anchorage system.
   3. Expansion compensation shall be achieved via expansion joints specified in Section 40 05 06, Couplers, Adapters, and Specials for Process Piping.

2.2 HANGERS AND SUPPORTS

A. Hangers and supports where shown shall be in accordance with detail drawings. Hangers and supports not shown shall be in accordance with MSS SP 58.

B. Products and Manufacturers: Provide one of the following manufacturers:
   1. Anvil International, Inc.
   2. Elcen.
   3. B-Line.
   4. Unistrut Corporation.
   5. Or equal.

2.3 ACCESSORIES

A. Hanger rods shall be made from ASTM A 575, with square head nut on top and running thread on bottom end.

B. Concrete Inserts:
   1. Concrete inserts shall be MSS SP 58 malleable Type 18.
   2. Manufacturers: Provide products of one of the following:
      a. Unistrut Corporation, Wayne, Michigan.
      b. Elcan Metal Products, Company, Franklin Park, Illinois.
      c. B-Line.
      d. Anvil International, Inc.
      e. Or equal.

C. Steel Beam Clamps:
   1. Steel beam clamps shall be of malleable iron and conform to MSS SP 58 .

D. Inserts for Pipe Insulation:
   1. Insulated pipe, larger than 1-1/2-inches in diameter, shall be supported by a rigid insert to protect the insulation. A steel metal saddle of sufficient gauge to carry the weight of the pipe and its fluid without deforming shall extend 2-inches minimum on each side of the rigid insert. The joints between insert and insulation shall be sealed before saddle is installed. Sizes up to 6-inches IPS shall be MSS SP 58, Type 40, and for sizes over 10-inches shall be MSS SP 58, Type 39.

E. Brackets:
   1. Brackets for wall mounting shall conform to MSS SP 58 Type 33.

f. Fabricated Pipe Rack:
   1. Pipes shall be supported and anchored to the fabricated pipe rack as shown. Clamps, rollers, and supports for piping shall conform to the general requirements of MSS SP 69.

2.4 PAINTING

A. Clean and prime ferrous metal surfaces in the shop in accordance with the requirements of Section 09 91 00, Painting.

B. Field painting shall conform to the requirements of Section 09 91 00, Painting.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Locate hangers, supports, and accessories to support piping, valves, and at all concentrated loads.

B. Locate hangers, supports, and accessories within maximum span lengths specified to support continuous pipeline runs unaffected by concentrated loadings.

C. Locate hanger, supports to prevent vibration or swaying and to provide for expansion and contraction.
   1. Temperature differential specified in this Section.
   2. Support piping independently so that equipment is not stressed by piping weight or expansion.
   3. For Uninsulated Copper Pipe or Tubing: Clamps and supports, electroplated copper finish. Instrumentation tubing shall be supported in steel or aluminum troughs with covers. All tubing layout and connections shall be as approved by the manufacturer of the equipment.
   4. Uncoated Hangers, Rods and Supports: Dip in zinc chromate primer before installation.
   5. Maximum spacing for horizontal piping:
      a. Steel 1-Inch and Smaller: Seven feet.
      b. Steel 1-1/2-Inch and Larger: Ten feet.
      c. Brass or Copper 3-Inch and Smaller: Seven feet.
      d. Brass or Copper 4-Inch and Larger: Ten feet.
      e. Additional supports at:
         1) Change in direction.
         2) Branch piping and runouts over five feet.
         3) Concentrated loads due to valves, strainers or other similar items.
      f. Maximum support spacing for plastic pipe at ambient temperature shall be one-half the above values.
   6. Hanger types for horizontal piping, except as noted and shown:
      a. Forged steel adjustable clevis type, rod support for all services.
      b. Slide Bases:
         1) Pipe stand, brackets, trapeze or other equivalent structural support.
         2) For piping 2-inches or larger.
      c. For pipe and covering provide:
         1) Saddles for rollers or slide bases.
         2) Protective shields or saddles for all other types of supports.
      d. Threaded Steel Rods:
         1) Two inch vertical adjustment with two nuts each end for positioning and locking.
         2) Size hanger rods according to the schedule below, unless otherwise noted:

Nominal Pipe (Inches)	Rod Diameter (Inches)
2 and less	3/8
2-1/2 to 3-1/2	1/2
4	5/8
6	3/4
8 through 12	7/8
14 through 18	1
20 through 30	1-1/4

3) For Double Rod Hangers: One size smaller than above.
4) Connection to Structure for Piping to 2-Inches: Concrete inserts, or expansion shields in shear into sides of beams.
5) Connection to Structure for Piping 2-1/2-Inch or Larger: Concrete inserts, beam clamps or suitable bridging.

7. Vertical Piping:
   a. Base Support: Base elbow or welded equivalent.
      1) Bearing plate on structural support.
   b. Guides not to exceed:
      1) 25 feet for piping to 2-inches.
      2) 36 feet for piping 2-1/2-inches or larger.
   c. Top Support:
      1) Special hanger or saddle in horizontal connection.
      2) Provisions for expansion.
   d. Intermediate Supports: Steel pipe clamp at floor.
      1) Bolted and welded to pipe.
      2) Extension ends bearing on structural steel or bearing plates.
   e. For Multiple Pipes: Coordinate guides, bearing plates and accessory steel.
8. Insulated Piping:
   a. Horizontal Pipe Shields at Supports:
      1) Minimum 120 degree arc.
      2) Length equal to diameter of insulation 12-inch minimum.
      3) To 6-Inch Pipe Size: No. 18 USSG galvanized steel.
   b. Vertical Pipe Shields at Guides:
      1) Full 360 degree arc, securely banded.
      2) Length equal to diameter of insulation, 12-inch minimum.
      3) To 6-Inch Pipe Size: No. 18 USSG galvanized steel.

D. Install items to be embedded before concrete placement.

E. Fasten embedded items securely to prevent movement during concrete placement.

F. Install hangers and support units on piping systems in accordance with manufacturer's recommendations.

G. Adjust hangers and supports and place grout for concrete supports to bring pipelines to specified elevations.

H. Bring all pipe systems up to operating pressures and temperatures. Cycle systems to duplicate operating conditions. Correct all support malfunctions.

+ + END OF SECTION + +

SECTION 40 05 08

WALL PIPES, FLOOR PIPES, AND PIPE SLEEVES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all floor pipes, pipe sleeves, wall pipes, other wall pieces and escutcheons to complete the general construction Work.

B. Coordination:
   1. Review installation procedures under other contracts and coordinate with other contractors the installation of floor pipes, pipe sleeves, wall pipes, other wall pieces and escutcheons that must be installed with or within formwork, walls, partitions, ceilings and panels constructed by such other contractors.
      a. Provide other contractors with detailed plans or sketches of the locations of the floor pipes, pipe sleeves, wall pipes, other wall pieces and escutcheons as may be required.
      b. Keep informed of the construction where floor pipes, pipe sleeves, wall pipes, other wall pieces and escutcheons are to be installed. Install the floor pipes, pipe sleeves, wall pipes, other wall pieces and escutcheons in such a manner and within such time periods as will not delay the work of the other contractors.

C. Related Sections:

   1. Section 03 30 00, Cast-In-Place Concrete.
   2. Section 07 92 00, Joint Sealants.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
   1. American National Standards Institute, (ANSI).
      a. ANSI B16.1, Cast-Iron Pipe Flanges and Flanged Fittings.
      b. ANSI B16.4, Gray-Iron Threaded Fittings.
   2. American Water Works Association, (AWWA).
      a. AWWA C104 (ANSI A21.4), Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
      b. AWWA C110 (ANSI A21.10), Ductile-Iron and Gray-Iron Fittings, for Water.

c. AWWA C111 (ANSI A21.11), Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
d. AWWA C115 (ANSI A21.15), Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
e. AWWA C151 (ANSI A21.51), Ductile-Iron Pipe, Centrifugally Cast, for Water.
f. AWWA C200, Steel Water Pipe 6-Inches and Larger.

1.3 QUALITY ASSURANCE

A. Component Supply and Compatibility:
1. Obtain all equipment included in this Section regardless of the component manufacturer from a single wall pipes, floor pipes and pipe sleeves manufacturer.
2. The wall pipes, floor pipes and pipe sleeves manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the wall pipes, floor pipes and pipe sleeves manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
1. Shop Drawings:
a. Detailed drawings and data on all wall and floor pipe, and pipe sleeves. Submit and coordinate these with Shop Drawings required for all piping systems.

1.5 DELIVERY, STORAGE AND HANDLING

A. Comply with the requirements of Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Wall and Floor Pipes:
1. Material: Same as specified for the piping connected to wall or floor pipe, unless otherwise approved by ENGINEER.
2. End Connections: As shown.
3. Thickness: Same as specified for the piping connected to wall or floor pipe.
4. Collars: Provide collars at mid-point of wall for anchorage and watertightness.
5. Pipes ends shall be flush with wall face, unless otherwise shown.

6. Drill and tap flanged ends and mechanical joint bells for studs. Provide studs of same material as connected piping, except submerged and buried studs shall be of Type 316 stainless steel.

B. Pipe Sleeves:
   1. Ferrous and Plastic Pipe: Use standard weight galvanized steel pipe, unless otherwise shown.
   2. Copper Pipe: Use Type K hard drawn copper pipe, unless otherwise shown.

C. Cast Wall Sleeves:
   1. Material: Ductile iron furnished with integral wall collar.
   2. Dimensions: As required for mechanical joint pipe to pass through sleeve. Length as required.

D. Link Seals: Provide link type mechanical seals suitable for 20 psi working pressure, corrosive service and accessible from one side, with glass-reinforced nylon pressure plate and stainless steel bolts and nuts.
   1. Products and Manufacturers: Provide one of the following:
      a. Link-Seal, as manufactured by Thunderline Corporation.
      b. Or equal.

E. Wall and Ceiling Plates:
   1. Bare pipes passing through walls and ceilings in finished rooms: Provide escutcheon plates of cast brass or cast-iron nickel plated, clevis or split ring and hinged with set screws.
   2. Provide plated escutcheon plates of 18-gauge steel for insulated pipes passing through walls and ceilings in finished rooms.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Wall and Floor Pipes: Install as shown and in accordance with approved Shop Drawings.

B. Pipe Sleeves:
   1. Use sleeves wherever pipes pass through walls, partitions, floors, and roofs, unless otherwise shown.
   2. Extend all sleeves through floor slabs a minimum of 2-inches above finished floor.
   3. Anchor sleeves to concrete and masonry walls as shown or otherwise approved.
   4. All sleeves through walls shall be flush with wall face.
   5. All pipe joints and annular spaces in exterior walls or walls subjected to hydrostatic pressure shall be completely watertight.

6. Use link type seals to seal sleeve against hydrostatic pressure. Size sleeves to provide annular space required to suit the link type mechanical seals that are used.
7. Do not install sleeves and pipes through structural members, unless specifically shown and approved by ENGINEER.
8. Size sleeves to provide annular space as follows:

Pipe Size	Sleeve ID Minus Pipe Or Insulation OD
Less than 2-inches	1/2-inches to 3/4-inches
2-inches to 4-inches	3/4 inches to 1-1/4-inches.
6-inches to 12-inches	1-1/4 inches to 2-inches
Over 12-inches	2-inches to 3-inches

C. Install wall and ceiling plates in accordance with the manufacturer's recommendations and approved Shop Drawings.

+ + END OF SECTION + +

SECTION 40 05 19

DUCTILE IRON PROCESS PIPE

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish ductile iron pipe and fittings.
   2. Extent of piping is shown on the Drawings. Piping schedules in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation, specify pipe service, diameter, material, lining, coating, pressure rating, joint type, and testing required.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before ductile iron pipe Work.
   2. Notify other contractors in advance of installation of ductile iron pipe to provide other contractors with sufficient time to install items included in their contracts that will be installed with or before ductile iron pipe Work.

C. Related Sections:
   1. Section 09 91 00, Painting.
   2. Section 31 20 00, Earth Moving
   3. Section 33 05 05, Buried Piping Installation.
   4. Section 40 05 05, Exposed Piping Installation.
   5. Section 40 05 06, Couplers, Adapters, and Specials for Process Piping.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI B18.2.1, Square and Hex Bolts and Screws Inch Series.
   2. ANSI B18.2.2, Square and Hex Nuts. (Inch Series).
   3. ASTM A193, Alloy Steel and Stainless Steel Bolting Materials for High-Temperature Service.
   4. ASTM A194, Specification for Carbon Steel and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both.
   5. ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
   6. ASTM A354, Specification for Quenched and Tempered Alloy Steel Bolts, Studs and Other Externally Threaded Fasteners.
   7. ASTM A563, Specification for Carbon and Alloy Steel Nuts.
   8. ASTM B117, Practice for Operating Salt Spray (Fog) Apparatus.
   9. ASTM C283, Test Methods for Resistance of Porcelain Enameled Utensils to

Boiling Acid.

10. ASTM D714, Test Method for Evaluating Degree of Blistering of Paints.
11. ASTM D792, Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
12. ASTM D5162, Discontinuity (Holiday) Testing of Non-Conductive Protective Coating on Metallic Substrates.
13. ASTM E96, Test Methods for Water Vapor Transmission of Materials.
14. ASTM G14, Test Method for Impact Resistance of Pipeline Coatings (Falling Weight Test).
15. ASTM G62, Test Methods for Holiday Detection in Pipeline Coatings.
16. ASTM G95, Test Methods for Cathodic Disbondment Test of Pipeline Coatings (Attached Cell Method).
17. ANSI/AWWA C104, Cement-Mortar Lining for Ductile Iron Pipe and Fittings for Water.
18. ANSI/AWWA C110, Ductile Iron and Gray Iron Fittings for Water.
19. ANSI/AWWA C111, Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings.
20. ANSI/AWWA C115, Flanged Ductile Iron Pipe with Ductile Iron or Gray Iron Threaded Flanges.
21. ANSI/AWWA C116, Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile Iron and Gray Iron Fittings for Water Service.
22. ANSI/AWWA C151, Ductile Iron Pipe, Centrifugally Cast, for Water.
23. ANSI/AWWA C153, Ductile Iron Compact Fittings, 3 inch through 24 inch and 54 inch through 64 inch for Water Service.
24. ANSI/AWWA C606, Grooved and Shouldered Type Joints.
25. European Standard (EN), EN 598: Ductile Iron Pipe, Fittings, Accessories and Their Joints for Sewerage Applications.
26. MSS-SP 60, Connecting Flange Joint Between Tapping Sleeves and Tapping Valves.
27. NACE RP0188, Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
28. NAPF 500-03, Surface Preparation Standard for Ductile Iron Pipe and Fittings Receiving Special External Coatings and/or Special Internal Linings.
29. NSF/ANSI 61, Drinking Water System Components - Health Effects.
30. SSPC PA 2, Measurement of Dry Coating Thickness with Magnetic Gages.
31. SSPC Painting Manual, Volume 1, Para. XIV.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer:
      a. Manufacturer shall have a minimum of five years successful experience producing ductile iron pipe and fittings and shall be able to show evidence of at least five installations in satisfactory operation in the United States that are similar applications to the specified service.
      b. Lining and coating products shall be manufactured by a firm with a minimum of five years successful experience in protecting pipelines

exposed to the specified service conditions , and shall be able to show evidence of at least five installations in satisfactory operation in the United States that are similar applications to the specified service.

c. When not applied by the manufacturer, lining and coating Subcontractor shall have a minimum of five years successful experience in the application of the specified linings and coatings for similar applications for the specified service, and shall be able to show evidence of at least five installations in satisfactory operation in the United States.

B. Supply and Compatibility:
   1. Unless otherwise approved, obtain all pipe, fittings, and appurtenances included in this Section from a single ductile iron pipe manufacturer.
   2. Ductile iron pipe manufacturer shall review and approve or prepare all Shop Drawings and other submittals for pipe, fittings, and appurtenances furnished under this Section.
   3. Pipe, fittings, and appurtenances shall be suitable for the specified service and shall be integrated into overall piping system by ductile iron pipe manufacturer.
   4. Ductile iron pipe manufacturer shall be responsible for all products and all factory-applied linings and coatings, whether installed at pipe manufacturer's facility or at manufacturer's Supplier's facility.

C. Regulatory Requirements:
   1. Pipe and fittings, including linings and coatings, that will convey potable water or water that will be treated to become potable, shall be certified by an accredited organization in accordance with NSF/ANSI 61 as being suitable for contact with potable water, and shall comply with requirements of authorities having jurisdiction at Site.

1.4 SUBMITTALS

A. Action Submittals: Submit the following with Shop Drawings required under Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation:
   1. Shop Drawings:
      a. Detailed drawings and data for pipe, fittings, gaskets, appurtenances, linings, and coatings.

   2. Product Data:
      a. Surface preparation and application reports and procedures as required for lining and coating of pipe and fittings. Ductile iron pipe and fitting manufacturer and manufacturer and applicator of lining and coating, as specified, shall mutually determine recommended surface preparation and application methods, and provide written verification of mutually selected method in the submittals.
   3. Test Procedures: For linings and coatings in pipe and fittings.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. Submit certificate signed by manufacturer of each product that product conforms to applicable referenced standards and the Contract Documents.
   2. Source Quality Control Submittals:
      a. Submit results of specified shop tests for pipe, fittings, linings, and coatings.
      b. Lining and coating test coupons.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

PART 2 – PRODUCTS

2.1 MATERIALS

A. General:
   1. Piping systems shall be suitable for their intended use.
   2. Joints shall be as specified in Section 33 05 05, Buried Piping Installation and Section 40 05 05, Exposed Piping Installation. If not specified, provide flanged joints for exposed piping and push-on or mechanical joints for buried piping. Provide couplings on pipe with plain or grooved ends where shown or where approved by ENGINEER.

B. Ductile Iron Pipe, Joints, and Fittings:
   1. Flanged Pipe: Fabricate in accordance with ANSI/AWWA C115.
      a. Pressure Rating: As specified in piping schedule in Section 40 05 05, Exposed Piping Installation. If not otherwise specified, use Special Thickness Class 53 for three-inch to 54-inch diameter pipe and Pressure Class 350 for 60-inch and 64-inch diameter pipe.
   2. Non-Flanged Pipe: Conform to ANSI/AWWA C151 for material, pressure, dimensions, tolerances, tests, markings, and other requirements.
      a. Pressure Class: As specified in piping schedules in Section 33 05 05, Buried Piping Installation and Section 40 05 05, Exposed Piping Installation.
      b. Special Thickness Class: As specified in piping schedules in Section 33 05 05, Buried Piping Installation and Section 40 05 05, Exposed Piping Installation.
   3. Pipe Joints:
      a. Flanged Joints: Conform to ANSI/AWWA C110 and ANSI/AWWA C111 capable of meeting the pressure rating or special thickness class, and test pressure specified in piping schedule in Section 40 05 05, Exposed Piping Installation.
         1) Gaskets: Unless otherwise specified, gaskets shall be at least 1/8-inch thick, ring or full-face as required for the pipe, of synthetic rubber

compound containing not less than 50 percent by volume nitrile or neoprene, and shall be free from factice, reclaimed rubber, and other deleterious substances. Gaskets shall be suitable for the service conditions specified, specifically designed for use with ductile iron pipe and fittings.

2) Bolts: Comply with ANSI B18.2.1.
   a) Exposed: ASTM A307, Grade B.
   b) Buried or Submerged: ASTM A193, Grade B8M, Class 2, Heavy hex, Type 316 stainless steel.
3) Nuts: Comply with ANSI B18.2.2.
   a) Exposed: ASTM A563, Grade A, Heavy hex.
   b) Buried or Submerged: ASTM A194, Grade B8M, Heavy hex, Type 316 stainless steel.

b. Mechanical Joints: Comply with ANSI/AWWA C111 and ANSI/AWWA C151, capable of meeting pressure rating or special thickness class, and test pressure specified in piping schedules in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.
   1) Glands: Ductile iron.
   2) Gaskets: Plain tip.
   3) Bolts and Nuts: High strength, low alloy steel.
   4) Manufacturers: Provide products of one of the following:
      a) Clow Water Systems Company
      b) Atlantic States Cast Iron Pipe Company
      c) Canada Pipe Company, Ltd.
      d) McWane Cast Iron Pipe Company
      e) Pacific States Cast Iron Pipe Company
      f) Griffin Pipe Products Co.
      g) American Cast Iron Pipe Co.
      h) U.S. Pipe and Foundry Co.
      i) Or equal.

4. Flanged Joint Fittings: Comply with ANSI/AWWA C110 and ANSI/AWWA C111.
   a. Material: Ductile iron.
   b. Pressure rating, gaskets, bolts, and nuts shall be as specified for flanged joints. Pressure rating of fittings shall meet, but not exceed, specified pressure rating or special thickness class of the connected pipe.
5. Mechanical Joint Fittings: Comply with ANSI/AWWA C110 and ANSI/AWWA C111.
   a. Material: Ductile iron.
   b. Glands: Ductile iron.
   c. Pressure rating, gaskets, bolts, and nuts shall be as specified for mechanical joints. Pressure rating of fittings shall meet, but not exceed, specified pressure rating or special thickness class of connected pipe.

C. Cement-mortar Lining:
1. Where specified in piping schedules included with Section 33 05 05, Buried Piping Installation and Section 40 05 05, Exposed Piping Installation, pipe and fittings shall be lined with bituminous seal coated cement-mortar lining in

accordance with ANSI/AWWA C104.

E. Couplings:
   1. Refer to Section 40 05 06, Couplings, Adapters, and Specials for Process Piping.

I. Specials:
   1. Taps:
      a. Provide taps where shown or required for small-diameter piping or instrumentation connections.
      b. Provide corporation stops where shown or required.
      c. Where pipe wall thickness or tap diameter will not allow engagement of three full threads, provide tapping saddle with outlet joints conforming to requirements of Paragraph 2.1.B.3.a of this Section for four-inch through 12-inch diameter pipe, and Paragraph 2.1.B.3.b. for 14-inch through 54-inch diameter pipe.
      d. For flanged connections on tapping saddle outlet branch, counterbore flange in accordance with MSS SP-60 dimensions. Inside diameter of outlet shall be 1/4-inch greater than nominal diameter.
   3. Tangential Outlets:
      a. Provide tangential outlet fittings where shown or indicated.
      b. Weld-on fittings are acceptable.
      c. Flanged and grooved end joints are not allowed.

2.2 MARKING FOR IDENTIFICATION

A. In addition to identification markings specified in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation, also stamp, mark, and identify push-on joint and mechanical joint pipe with:
   1. Name or trademark of manufacturer.
   2. Weight, class or nominal thickness, and casting period.
   3. Country where cast.
   4. Year the pipe was produced.
   5. Letters “DI” or “Ductile” shall be cast or metal stamped

B. In addition to identification markings specified in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation, also stamp, mark, and identify flanged pipe with:
   1. Flange manufacturer’s mark, size, and letters “DI” cast or stamped on the flanges.
   2. Fabricator’s mark if other than flange manufacturer.
   3. Length and weight.

C. In addition to identification markings specified in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation, also stamp, mark, and identify fittings with:
   1. Manufacturer’s identification.
   2. Pressure rating.

3. Nominal diameters of openings.
4. Country where cast.
5. Number of degrees or fraction of the circle on bends.
6. Letters "DI" or "Ductile" cast on them.

2.3 EXTERIOR SURFACE PREPARATION AND COATINGS

A. General Coating Requirements:
   1. Coating types are specified in piping schedules in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

B. Exposed Pipe and Fittings:
   1. Surface Preparation:
      a. Initial Surface Inspection: Pipe and fitting manufacturer and coating applicator shall inspect surface to be coated and mutually determine recommended NAPF 500-03 surface preparation method.
      b. Surface Preparation: Prepare surface in accordance with recommended NAPF 500-03 method.
      c. Finished Surface Inspection: Prepared surfaces shall be inspected by coating applicator prior to application to determine acceptability of finished surface. If surface is unacceptable, repeat surface preparation and re-application as necessary.
   2. After recommended surface preparation, prime coat exterior ferrous metal surfaces of pipe and fittings in the shop in accordance with Section 09 91 00, Painting.
   3. Field painting shall comply with Section 09 91 00, Painting.

C. Buried Pipe and Fittings:
   1. Asphaltic Coating: Where specified in piping schedule in Section 33 05 05, Buried Piping Installation, coat pipe and fittings with an asphaltic coating approximately one-mil thick, in accordance with ANSI/AWWA C151, ANSI/AWWA C115, ANSI/AWWA C110, and ANSI/AWWA C153, as applicable.

PART 3 – EXECUTION

3.1 INSPECTION

A. Inspect piping to assure that piping is free from defects in material and workmanship. Verify compatibility of pipe, fittings, gaskets, linings, and coatings.

3.2 INSTALLATION AND FIELD QUALITY CONTROL

A. For buried piping installation and testing, refer to Section 33 05 05, Buried Piping Installation.

B. For exposed piping installation and testing, refer to Section 40 05 05, Exposed Piping

Installation.

+ + END OF SECTION + +

SECTION 40 05 53

PROCESS VALVES, FOUR-INCH DIAMETER AND LARGER

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install process valves, four-inch diameter and larger, and appurtenances, complete and operational.
   2. Valves for digester gas and air have been specifically identified. All other valves are for liquid service.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before process valves Work.
   2. Notify other contractors in advance of the installation of process valves and appurtenances to provide them with sufficient time for installing items included in their contracts that must be installed with or before process valves Work.

C. Related Sections:
   1. Section 05 05 33, Anchor Systems.
   2. Section 09 91 00, Painting.
   3. Section 33 05 05, Buried Piping Installation.
   4. Section 40 05 05, Exposed Piping Installation.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
   1. American Bearing Manufacturers Association (ABMA).
   2. ANSI B16.1, Cast-Iron Pipe Flanges and Flanged Fittings.
   3. ANSI B16.34, Valves-Flanged, Threaded and Welding end. (ASME B16.34).
   4. API STD 594, Check Valves, Flanged Lug, Wafer and Butt-Welding.
   5. API STD 598, Valve Inspection and Testing.
   6. API STD 609, Butterfly Valves: Double Flanged, Lug-Type and Wafer-Type.
   7. ASTM A194/A194M, Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service, or Both.
   8. ASTM A276, Specification for Stainless Steel Bars and Shapes.

9. ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
10. ASTM A351/A351M, Specification for Castings, Austenitic, Austenitic-Ferritic (Duplex), for Pressure-Containing Parts.
11. ASTM A380, Practice for Cleaning, Descaling and Passivation of Stainless Steel Parts, Equipment and Systems.
12. ASTM A536, Specification for Ductile Iron Castings.
13. ASTM A564/A564M, Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.
14. ASTM A743/A743 M, Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
15. ASTM B62, Specification for Composition Bronze or Ounce Metal Castings.
16. ASTM B98/B98M, Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.
17. ASTM B138/B138M, Specification for Manganese Bronze Rod, Bar and Shapes.
18. ASTM B265, Specification for Titanium and Titanium Alloy Strip, Sheet and Plate.
19. ASTM B584, Specification for Copper Alloy Sand Castings for General Applications.
20. ASTM D429, Test Methods for Rubber Property - Adhesion to Rigid Substrates.
21. AWWA C500, Metal-Seated Gate Valves for Water Supply Service.
22. AWWA C504, Rubber-Seated Butterfly Valves.
23. AWWA C508, Swing-Check Valves for Waterworks Service, 2-inch through 24-inch NPS.
24. AWWA C509, Resilient-Seated Gate Valves for Water Supply Service.
25. AWWA C540, Power-Actuating Devices for Valve and Slide Gates.
26. AWWA C550, Protective Interior Coatings for Valves and Hydrants.
27. AWWA Manual M49, Butterfly Valves: Torque, Head Loss, and Cavitation Analysis.
28. FS TT-C-494, Coating Compound, Bituminous, Solvent Type, Acid-Resistant.
29. NEMA MG 1, Motors and Generators.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have minimum of five years of experience producing substantially similar materials and equipment to that required and be able to provide evidence of at least five installations in satisfactory operation for at least five years.

B. Component Supply and Compatibility:
   1. Obtain each type of equipment and appurtenances included in this Section, regardless of the component manufacturer, from a single manufacturer of

the type of process valve. For each type of valve, do not furnish valves of more than one manufacturer.

2. Supplier of each type of equipment specified shall review and approve or prepare all Shop Drawings and other submittals for all components associated with the type of process valve Supplier is furnishing.
3. Components shall be suitable for use in the specified service conditions. Components shall be integrated into the overall assembly by the process valve manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Installation drawings showing orientation of valve in both plan and elevation view. Drawings shall clearly identify valve and its appurtenances, including controls, actuators, valve stems, and other components. Show dimensions of valves and appurtenances in relation to piping and structural and architectural components, where applicable.
      b. Controls for and control characteristics of modulating valves.
      c. Power and control wiring diagrams, including terminals numbers for electric-motor actuators.
      d. Calculations for sizing of electric actuators.
      e. Calculations for sizing of operating mechanism with extension stems.
      f. Calculations for sizing of gear actuators.
   2. Product Data:
      a. Product data sheets.
      b. Complete catalog information, including dimensions, weight, specifications, and identification of materials of construction of all parts.
      c. Corrosion resistance information to confirm suitability of valve materials for the application. Furnish information on chemical resistance of elastomers from elastomer manufacturer.
      d. Cv values and hydraulic headloss curves.
   3. Testing Plans:
      a. Submit plan for shop testing of each valve for which shop testing is specified, including testing plan's and test facility's limitations proposed.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. Certificates of compliance with referenced standards, where applicable, including those of AWWA, NSF, and others required by ENGINEER.
   2. Manufacturer Instructions:
      a. Submit manufacturer's instructions for handling, storing, and installing valves and appurtenances. Provide templates and setting drawings for

valves and appurtenances that require anchor bolts or similar anchorages.

4. Source Quality Control Submittals:
   a. Submit copies of shop test results and inspection data, certified by manufacturer.
5. Field Quality Control Submittals:
   a. Submit results of field tests required.
6. Supplier's Reports:
   a. When requested by ENGINEER, submit written report of results of each visit to Site by Supplier's serviceman, including purpose and time of visit, tasks performed and results obtained.
7. Qualifications Statements:
   a. When requested by ENGINEER, submit manufacturer's qualifications demonstrating compliance with the Specifications, including list of existing installations with contact names and telephone number(s) for each.

C. Closeout Submittals: Submit the following:
   1. Operations and Maintenance Data:
      a. Furnish operation and maintenance manuals in accordance with Section 01 78 23, Operations and Maintenance Data.
      b. Furnish in operations and maintenance manuals complete nameplate data for each valve and electric actuator.

D. Maintenance Material Submittals: Submit the following:
   1. Spare Parts, Extra Stock Materials, and Tools:
      a. Spare Parts and Extra Stock Materials: Furnish as specified for each valve type.
      b. Tools: Furnish two sets of special tools (excluding metric tools, if applicable) for each size and type of valve furnished.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling, and Unloading:
   1. Deliver materials and equipment to Site to ensure uninterrupted progress of the Work. Deliver anchorage products that are to be embedded in concrete in ample time to prevent delaying the Work.
   2. Inspect boxes, crates, and packages upon delivery to Site and notify ENGINEER in writing of loss or damage to materials and equipment. Promptly remedy loss and damage to new condition in accordance with manufacturer's instructions.
   3. Conform to Section 01 65 00, Product Delivery Requirements.

B. Storage and Protection:
   1. Keep products off ground using pallets, platforms, or other supports. Store equipment in covered storage and prevent condensation and damage by extreme temperatures. Store in accordance with manufacturer's

recommendations. Protect steel, packaged materials, and electronics from corrosion and deterioration.

2. Conform to Section 01 66 00, Product Storage and Handling Requirements.

PART 2 - PRODUCTS

2.1 GENERAL

A. Valves, General:
   1. Provide each valve with manufacturer's name and rated pressure cast in raised letters on valve body.
   2. Provide valves with brass or Type 316 stainless steel nameplate attached with Type 316 stainless steel screws. Nameplates shall have engraved letters displaying the following minimum information:
      a. Valve size.
      b. Pressure and temperature ratings.
      c. Application (other than water and wastewater).
      d. Date of manufacture.
      e. Manufacturer's name.
   3. Provide valves to turn clockwise to close, unless otherwise specified.
   4. Provide valves with permanent markings for direction to open.
   5. Manually operated valves, with or without extension stems, shall require not more than 40-pound pull on manual operator to open or close valve against specified criteria. Gear actuator and valve components shall be able to withstand minimum pull of 200 pounds on manual operator and input torque of 300-foot pounds to actuator nut. Manual operators include handwheel, chainwheel, crank, lever, and T-handle wrench.

B. Valve Materials:
   1. Valve materials shall be suitable for the associated valve's service or application, as shown.
   2. Protect wetted parts from galvanic corrosion caused by contact of different metals.
   3. Wetted components and wetted surfaces of valves used with potable water or water that will be treated to become potable shall conform to ANSI/NSF 61.
   4. Clean and descale fabricated stainless steel items in accordance with ASTM A380 and the following:
      a. Passivate all stainless steel welded fabricated items after manufacture by immersing in pickling solution of six percent nitric acid and three percent hydrofluoric acid. Temperature and detention time shall be sufficient for removing oxidation and ferrous contamination without etching surface. Perform complete neutralizing operation by immersing in trisodium phosphate rinse followed by clean water wash.
      b. Scrub welds with same pickling solution or pickling paste and clean with stainless steel wire brushes or by grinding with non-metallic

abrasive tools to remove weld discoloration, and then neutralize and wash clean.

C. Valve Joints:
   1. Exposed Valves: Unless otherwise specified, provide with flanged ends conforming to ANSI B16.1. Pressure class of flanges shall be equal to or greater than specified pressure rating of the associated valve.
   2. Buried Valves: Unless otherwise specified, provide with mechanical or push-on joints, restrained or unrestrained, as required by piping with which valve is installed.
   3. For stainless steel bolting, except where nitrided nuts are required, use graphite-free anti-seize compound to prevent galling. Strength of joint shall not be affected by using anti-seize compound.

2.2 ECCENTRIC PLUG VALVES

A. Manufacturers: Provide products of one of the following:
   1. DeZurik.
   2. Or equal.

B. General:
   1. Provide eccentric-type plug valves each with rectangular ports.
   2. Minimum Rated Working Pressure:
   a. Valves 12-inch Diameter and Smaller: 175 psig.
   b. Valves 14-inch through 72-inch Diameter: 150 psig.
   3. Maximum Fluid Temperature: 180 degrees F.
   4. Minimum Port Area:
      a. Valves 20-inch Diameter and Smaller: 80 percent of nominal pipe area.
      b. Valves Larger than 20-inch Diameter: 70 percent of nominal pipe area.
   5. Packing and packing gland shall be externally adjustable and accessible without disassembling valve and without removing the actuator.
   6. Valves shall provide drip-tight, bi-directional shutoff at rated pressures.
   7. Plug shall have cylindrical seating surface eccentrically offset from center of plug shaft. Interface between plug face and body seat, with plug in closed position, shall be externally adjustable in the field with valve in the line while under pressure.
   8. Plug shall be supported to top bearing by using spring that is externally adjustable.
   9. For sludge service, plug valves shall allow pigging of the piping with line-size pigs.

C. Materials of Construction:
   1. Body: Cast Iron ASTM A126 Class B, or Ductile-iron ASTM A536 Grade 65-45-12.
   2. Plug:
      a. Core: Cast Iron ASTM A126 Class B, or Ductile-iron, ASTM A536 Grade 65-45-12.

b. Plug Facing: Neoprene.
c. For valves up to eight-inch diameter, plugs shall be fully encapsulated with rubber. For valves larger than eight-inch diameter, provide plugs with rubber facing. Minimum thickness of rubber lining shall be 1/8-inch. Rubber hardness shall be a minimum of 70 (Shore A) durometer. Rubber-to-metal bond shall withstand minimum 75-pound pull conforming to ASTM D429 Method B.

3. Seats: Minimum 1/8-inch welded overlay of minimum 90 percent pure nickel on surfaces contacting plug face. Seats shall provide contact area of at least 1/2-inch width all around.
4. Stem Bearings: Sintered, oil impregnated, permanently lubricated of Type 316 stainless steel.
5. Stem Seal: Multiple neoprene V-ring type.
6. All internal and external bolting and other hardware including pins, set screws, plug, studs, bolts, nuts and washers shall be Type 316 stainless steel.

D. Interior Coating and Lining:
1. Valves shall be coated inside. Steel, cast-iron, and ductile iron surfaces, except machined surfaces, shall be epoxy-coated in accordance with AWWA C550.

E. Shop Testing:
1. Operational Tests:
a. To demonstrate that complete assembly is workable, successfully operate each valve (with actuator mounted directly on valve) three times from fully closed to fully open position and reverse under no-flow condition.
2. Leakage Tests:
a. Test each valve for leaks while valve is in closed position.
b. Test valves at rated pressures. During test, valves shall be drip-tight. Test duration shall be at least five minutes for valves up to 20-inch diameter and ten minutes for valves larger than 20-inch diameter. Tests shall be repeated successfully with pressure in the unseating direction.
3. Hydrostatic Test: Test valves to an internal hydrostatic pressure equivalent to twice rated pressure of valve. During hydrostatic test, there shall be no leakage through metal, end joints, and shaft seal, nor shall any part be permanently deformed. Duration of hydrostatic test shall be sufficient to allow visual examination for leakage. Test duration shall be at least one minute for valves eight-inch diameter and smaller, three minutes for valves 10-inch through 20-inch diameter, and ten minutes for valves 24-inch diameter and larger.

F. Gear Actuators for Manually-operated Valves:
1. Provide gear actuators on buried and exposed valves, except valves four-inch diameter and smaller located less than five feet above operating floor. Gas service valves shall be provided with worm gear actuators.

2. Size gear actuators for valves eight-inch diameter and smaller for 175 psig differential pressure.
3. Size gear actuators for valves larger than eight-inch diameter in accordance with manufacturers recommendation.
4. Provide actuators capable of holding associated valves in any intermediate position without creeping or vibrating.
5. Provide valve position indicator on each actuator. Provide stop-limiting devices for open and closed position. For buried and submerged service actuators, provide position indicators in valve box.
6. Provide adjustable stop to adjust seating pressure.
7. Make packing accessible for adjustment without requiring removal of actuator from valve, except for valves in buried and submerged service.
8. Diameter ratio of handwheel or chainwheel and gear sector shall be less than two.
9. For buried and submerged valves, gear actuator shall be grease-packed and designed to withstand submersion, and shall be drip-tight in water 20 feet deep, with self-adjusting packing.
10. Provide each actuator with gearing totally enclosed.
11. Operator shaft and gear sector shall be supported on permanently lubricated bronze or stainless steel bearings.
12. Provide metal-encased spring loaded seals in top and bottom covers of gear housing.
13. Actuators shall be provided to produce indicated torque with maximum pull of 40 pounds on handwheel or chainwheel and maximum input of 150-foot pounds on operating nuts, for both seating and unseating heads equal to maximum differential pressure rating of valve.
14. Actuator components between input and stops shall be designed to withstand, without damage, a pull of 200 pounds for handwheel or chainwheel actuators and input torque of 300-foot pound for operating nuts when operating against stops.
15. Materials of Construction:
    a. Housing: Cast-iron, ASTM A126 Class B.
    b. Gear Sector: Cast-iron ASTM A126 Class B, or ductile iron ASTM A536.
    c. Worm Shaft: Steel, AISI 1144, hardened and tempered to an average Rc 40 and within range of Rc 35-45.
    d. Bearings: Bronze oil-impregnated, or stainless steel.

    Type 316 stainless steel.

2.3 SWING CHECK VALVES

A. Manufacturers: Provide products of one of the following:
   1. APCO Willamette Valve & Primer Corp.
   2. Crispin Valve
   3. G.A. Industries.

B. General:
   1. Provide valves conforming to AWWA C508 and as specified herein.

2. Type: Resilient-seated.
3. Rated Working Pressure:
4. Smaller than 12-inch Diameter: 175 psig.
5. 12-inch Diameter and Larger: 150 psig.
6. Provide valves suitable for horizontal or vertical mounting.
7. Check valves shall have clear waterway with full-open area equal to nominal pipe size.
8. Provide check valves with outside adjustable weight and lever.
9. Provide valves larger than six-inch diameter with adjustable air cushion chambers.
10. Valve seats shall be mechanically attached and shall be field replaceable.

C. Materials of Construction: All materials of construction shall conform to AWWA C508 and shall be as follows:
1. Body, Disc, Cover and Gland: Cast-iron or ductile iron.
2. Disc Arm: Ductile iron.
3. Hinge Shaft: Type 316 stainless steel.
4. Hinge Shaft Bushings: Bronze, or Type 316 stainless steel for sewage service.
5. Shaft End Plate: Type 316 stainless steel.
6. Body Seat: Type 316 stainless steel.
7. Follower Ring for Rubber Seat on Disc: Type 316 stainless steel.
8. Disc Center Pin Assembly: Type 316 stainless steel.
9. Air Cushion Chamber:
    a. Chamber and Plunger: Bronze.
    b. Linkages and Pins: Type 316 stainless steel.
    c. Air Check Valve and Tubing: Brass or stainless steel.
10. Rubber Items:
    a. Applications Up to 180-degree F Fluid Temperature: Buna-N or other synthetic rubber suitable for the application.
    b. Applications 180-degrees F and Greater Fluid Temperature: Viton, or other synthetic rubber suitable for the application.
11. Internal and external bolting and other hardware; including pins, set screws, studs, bolts, nuts, and washers shall be Type 316 stainless steel.
12. Gland Packing: Graphite and Kevlar.

D. Interior Coating:
1. Valves shall be coated inside. Steel, cast-iron and ductile iron surfaces, except machined surfaces, shall be epoxy coated in accordance with AWWA C550.

E. Testing:
1. Test each valve in manufacturer's shop in accordance with AWWA C508.
2. Allowable Leakage at Rated Pressures: Zero.

2.4 ELECTRIC ACTUATORS (OPEN/CLOSE)

A. Manufacturers: Provide products of one of the following:
   1. Limitorque.
   2. Rotork.
   3. Or equal.

B. Application Criteria:
   1. Ambient Temperature Rating: -20 to +158 degrees F.
   2. Ambient Humidity: 100 percent.
   3. Maximum Differential Pressures Across Closed Valves: Refer to Schedule of Valves with Electric Actuators at the end of this Section.
   4. Maximum Flows Through Full-Open Valves: Refer to Schedule of Valves with Electric Actuators located at end of this Section.
   5. Power Supply: 480-volt, three-phase, 60 Hertz.
   6. Control Voltage: 120 VAC, single phase, 60 Hertz.
   7. Torques: As determined by valve manufacturer.
   8. Duty Cycle: Sixty starts per hour, minimum.

C. General:
   1. Conform to AWWA C540 and this Section.
   2. Provide actuator operable with handwheel or chainwheel, even after disengaging and removing electric motor.
   3. Provide valves with electric actuators that are located more than five feet above operating floor with separate control panels installed so that panel controls and indicators are approximately five feet above operating floor, at location approved by ENGINEER. Modify electrical wiring as required for remote location of control panels.
   4. Coordinate sizing of each electric actuator with valve manufacturer, who shall furnish valve and associated electric actuator and appurtenances as a unit.
   5. Electric actuators shall be suitable for valve orientation as shown.

D. Electric Motor:
   1. General:
      a. Provide motors suitable for "open/close" service, with high torque characteristics and minimum 70 degree C temperature rating.
   2. Motor Construction:
      a. Enclosure: NEMA 6.
      b. Insulation: Class F.
      c. Service Factor: 1.15.
      d. Power Supply: 480V.
      e. Motor Size: 1/2 horsepower.
      f. Provide winding thermostats for overcurrent protection.
      g. Efficiency: High-efficiency conforming to NEMA MG 1.
      h. Bearings: Anti-friction with minimum B-10 life of 100,000 hours, lifetime pre-lubricated and sealed.

E. Actuator Gearing:
   1. Housing: Die-cast aluminum or cast-iron.
   2. Close-coupled to electric motor.
   3. Input Shaft Gearing: Spur or bevel gear assembly.
   4. Output Shaft Gearing: Self-locking worm gears with minimum gear backlash to prevent valve disc chatter or vibration.
   5. Gearing shall be of hardened alloy steel or combination of hardened alloy steel and alloy bronze, accurately cut by hobbing machine.
   6. Lubrication: Grease or oil bath.
   7. Bearings: Ball or roller with minimum B-10 life of 100,000 hours, lifetime pre-lubricated and sealed.
   8. Input Shaft: Hardened alloy steel.
   9. Provide mechanical stops adjustable to plus-or-minus five degrees at each end of travel.

F. Limit Switches:
   1. Provide each actuator with "end of travel" limit switches to allow control of desired end position for each direction of travel.
   2. Provide open and close limit switches geared to drive mechanism and in step at all times, whether unit is operated electrically or manually, and whether or not actuator is powered by electric power supply. Friction devices or set-screw arrangements shall not be used to maintain the setting.
   3. Limit switch gearing shall be appropriately lubricated.
   4. Provide driven mechanism totally enclosed to prevent entrance of foreign matter and loss of lubricant.
   5. Provide each limit switch with four auxiliary contacts. Two contacts shall close and two contacts shall open at a desired end position for each direction of travel.
   6. Switches shall be rated five amperes at 120 volts.

G. Torque Switches:
   1. Provide adjustable torque switches with each valve actuator. Torque switches shall operate during complete valve cycle without using auxiliary relays, linkages, latches, or other devices.
   2. Wire torque switches to de-energize valve actuator motor when excessive torque is developed during each direction of travel.
   3. It shall be possible to select the torque switches to control open and close limit positions in each direction of valve travel.
   4. Provide dry contacts (five-amp, 120 VAC) for remote high torque alarm.

H. Handwheel and Chainwheel Operation:
   1. Provide actuator with handwheel (or chainwheel as required) for manual operation, so connected that operation by motor will not cause handwheel or chainwheel to rotate.
   2. Should electric power be returned to motor while handwheel or chainwheel is in use, unit shall prevent transmission of motor torque to handwheel or chainwheel.

3. Handwheel or chainwheel shall require no more than 80-pound effort on rim for seating or unseating load, and no more than 60 pounds on running load.
4. Handwheel or chainwheel shall have an arrow and the word "OPEN" or "CLOSE" indicating required rotation. Handwheel or chainwheel shall operate in clockwise direction to close.
5. Chain Operators:
    a. Valves more than five feet above operating floor level shall be equipped with chain operators.
6. Handwheels and chain operators shall be as specified in Article 2.23 of this Section.
7. Provide stem covers for rising stem gate valves as specified in Article 2.23 of this Section.

I. Controls:
1. Provide the following controls in separate compartment integral with actuator.
2. Enclosure: NEMA 6.
3. Starter: Combination reversing magnetic starter with circuit breaker and disconnect switch.
4. Control Power Transformer: Provide transformer to transform rated three-phase, 60 Hertz power to 120 volts, single-phase. Transformer shall be complete with grounded and fused secondary and dual primary fuses.
5. Provide "LOCAL/OFF/REMOTE" selector switch. In "LOCAL" position actuator shall be operated by "OPEN/CLOSE/STOP" pushbuttons. In "OFF" position, actuator shall be disabled from local and remote operation. In "REMOTE" position, "open/close/stop" control from remote source shall be enabled.
6. Provide "OPEN/CLOSE/STOP" pushbuttons with hold-to-run or momentary contact selection.
7. Provide "OPEN/CLOSE/STOP" indicating lights and zero-to-100 percent position indication in liquid crystal display window.
8. Provide thermal overload and single-phasing protection of motor.
9. Provide set of dry contacts to remotely indicate that actuator is available for remote operation.
10. Actuator circuit boards shall be rated for high temperature service, minimum 55 degrees C.
11. Provide electrical interlocks as shown.
12. Provide 120 VAC space heater to maintain internal housing temperature at 20 degrees C.

J. Remote-mounted Control Stations:
1. Where required by valve location or as indicated, provide remote control panels.
2. Enclosure: NEMA 4X, Type 316 stainless steel.
3. Provide "LOCAL/OFF/REMOTE" selector switch. In "LOCAL" position actuator shall be operated by "OPEN/CLOSE/STOP" pushbuttons. In "OFF" position, actuator shall be disabled from local and remote operation. In "REMOTE" position, "open/close/stop" control from remote source shall

be enabled Provide contact when switch is in "REMOTE" position for remote indication.

4. Provide "OPEN/CLOSE/STOP" pushbuttons with hold-to-run or momentary contact selection.
5. Provide "OPEN/CLOSE/STOP" indicating lights and zero-to-100 percent position indication with liquid crystal display.

K. Testing:
1. Test each actuator in manufacturer's shop in conformance with AWWA C540.

2.5 APPURTENANCES FOR EXPOSED METALLIC VALVES

A. General:
1. For valves located less than five feet above operating floor, provide levers on four-inch diameter quarter-turn valves, and provide handwheels on all other valves, unless otherwise shown or specified.
2. For valves located five feet or more above operating floor, provide chain operators.
3. Where indicated, provide extension stems and floorstands.

B. Handwheels:
1. Conform to applicable AWWA standards.
2. Material of Construction: Ductile iron, or cast aluminum.
3. Arrow indicating direction of opening and word "OPEN" shall be cast on trim of handwheel.
4. Maximum Handwheel Diameter: 2.5 feet.

C. Chain Operators:
1. Chains shall extend to three feet above operating floor.
2. Provide 1/2-inch stainless steel hook bolt to keep chain out of walking area.
3. Materials of Construction:
   a. Chain: Type 316L stainless steel.
   b. Chainwheel: Recessed groove type made out of Type 316 stainless steel.
   c. Guards and Guides: Type 316L stainless steel.
4. Chain Construction:
   a. Chain shall be of welded link type with smooth finish. Chain that is crimped or has links with exposed ends is unacceptable.
5. Provide geared operators where required to position chainwheels in vertical position.

D. Extension Stems and Floor Stands for Gate Valves:
1. Conform to the applicable requirements of AWWA C501 for sizing of complete lifting mechanism.
2. Bench and Pedestal Floor Stands:

a. For valves requiring extension stems, provide bench or pedestal floor stands with handwheel or crank as indicated. Provide provisions for using portable electric actuator for opening and closing of valves.
b. Type: Heavy-duty with tapered roller bearings enclosed in a weatherproof housing, provided with positive mechanical seals around lift nut and pinion shaft to prevent loss of lubrication and to prevent moisture from entering housing. Provide lubrication fitting for grease. For valves conveying water that is potable or that will be treated to become potable, grease shall be food-grade and ANSI/NSF 61-listed. Base shall be machined.
c. Materials of Construction:
1) Housing: Cast-iron, ASTM A126, Class B.
2) Lift Nut: Cast bronze, ASTM B98/B98M.
3) Grease Fitting: Stainless steel.
4) Bolting: Type 316 stainless steel.

3. Wall brackets for floor stands shall be Type 316L stainless steel construction.
4. Extension Stems:
a. Materials of Stems and Stem Couplings: Type 316 stainless steel.
b. Maximum Slenderness Ratio (L/R): 100.
c. Minimum Diameter: 1.5-inch.
d. Threads: Acme.
e. Provide stem couplings where stems are furnished in more than one piece. Couplings shall be threaded and keyed or threaded and bolted and shall be of greater strength than the stem.
f. Weld to bottom of extension stem a Type 316 stainless steel cap suitable for square end of valve stem.
5. Bottom Couplings: Ductile iron with Type 316 stainless steel pin and set screw.
6. Stem Guides:
a. Material: Type 316 cast stainless steel with bronze bushing for stem. For submerged service, Type 316 cast stainless steel with stainless steel bushing for stem.
b. Maximum Stem Length Between Guides: Seven feet.
c. Stem guides shall be adjustable in two directions.
7. Furnish stem cover of clear butyrate plastic or Grade 153 Lexan with cast adapter for mounting cover to bench and floor stands. Provide stem cover with gasketing and breathers to eliminate water intrusion into operator and condensation within cover. Provide stem cover with mylar tape with legible markings showing valve position at one-inch intervals and open and close limits of valve.

F. Floor Boxes: Provide cast-iron floor boxes for valves that are to be operated from floor above valve. Boxes shall be equal in depth to floor slab. Boxes shall have cast-iron covers and be fitted with bronze bushing.

2.6 APPURTENANCES FOR BURIED METALLIC VALVES

A. Wrench Nuts:
   1. Provide wrench nuts on buried valves of nominal two-inch size, in accordance with AWWA C500.
   2. Arrow indicating direction of opening the valve shall be cast on the nut along with the word "OPEN".
   3. Material: Ductile iron or cast-iron.
   4. Secure nut to stem by mechanical means.

B. Extension Stems for Non-Rising Stem Gate Valves and Quarter-turn Buried Valves:
   1. Provide extension stems to bring operating nut to six inches below valve box cover.
   2. Materials of Stems and Stem Couplings: Type 316 stainless steel.
   3. Maximum Slenderness Ratio (L/R): 100

   4. Provide top nut and bottom coupling of ductile iron or cast-iron with pins and set screws of Type 316 stainless steel.

C. Valve Boxes:
   1. Valve boxes shall be as indicated and as required.
   2. Type: Heavy-duty, suitable for highway loading, two-piece telescopic, and adjustable. Lower section shall enclose valve operating nut and stuffing box and rest on valve bonnet.
   3. Material: Cast-iron or ductile iron.
   4. Coating: Two coats of asphalt varnish conforming to FS TT-C-494.
   5. Marking: As required for service.

2.7 ANCHORAGES AND MOUNTING HARDWARE

A. General:
   1. Comply with Section 05 05 33, Anchor Systems, except as modified in this Section.
   2. Obtain bolts, nuts, and washers for connection of valve and appurtenances to concrete structure or other structural members from valve Supplier.
   3. Bolts, nuts, and washers shall be of ample size and strength for purpose intended. Anchorages in concrete shall be at least 5/8-inch diameter.
   4. Provide stem guide anchorages of required strength to prevent twisting and sagging of guides under load.
   5. Materials: Provide bolts and washers of Type 316 stainless steel and nitrided nuts. Bolts shall have rolled threads. Bolts and nuts shall be electropolished to remove burrs.

2.8 TOOLS, LUBRICANTS, AND SPARE PARTS

A. Lubricants: For valves, actuators, and appurtenances requiring lubricants, provide suitable lubricants for initial operation and for first year of use following

Substantial Completion. Lubricants for equipment associated with conveying potable water or water that will be treated to become potable shall be food-grade and ANSI/NSF 61-listed.

B. Tools, spare parts, and maintenance materials shall conform with Section 01 78 43, Spare Parts and Extra Materials.

2.27 PAINTING OF EXPOSED VALVES, HYDRANTS, AND APPURTENANCES

A. Exterior steel, cast-iron, and ductile iron surfaces, except machined surfaces of exposed valves and appurtenances, shall be finish painted in manufacturer's shop. Surface preparation, priming, finish painting, and field touch-up painting shall conform to Section 09 91 00, Painting.

2.28 PAINTING OF BURIED VALVES

A. Exterior steel, cast-iron, and ductile iron surfaces, except machined or bearing surfaces of buried valves, shall be painted in valve manufacturer's shop with two coats of asphalt varnish conforming to FS TT-C 494.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine conditions under which materials and equipment are to be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General:
   1. Install valves and appurtenances in accordance with:
      a. Supplier's instructions and the Contract Documents.
      b. Requirements of applicable AWWA standards.
      c. Applicable requirements of Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.
   2. Install valves plumb and level. Install all valves to be free from distortion and strain caused by misaligned piping, equipment, and other causes.
   3. Position swing check valves and butterfly valves so that, when valve is fully open, valve disc does not conflict with piping system elements upstream and downstream of valve.

B. Exposed Valves:
   1. Provide supports for large or heavy valves and appurtenances as shown or required to prevent strain on adjoining piping.
   2. Operators:

a. Install valves so that operating handwheels or levers can be conveniently turned from operating floor without interfering with access to other valves, piping, structure, and equipment, and as approved by ENGINEER.
b. Avoid placing operators at angles to floors or walls.
c. Orient chain operators out of way of walking areas.
d. Install valves so that indicator arrows are visible from floor level.
e. For motor-operated valves located lower than five feet above operating floor, orient motor actuator to allow convenient access to pushbuttons and handwheel.

3. Floor Stands and Stems:
a. Install floor stands as shown and as recommended by manufacturer.
b. Provide lateral restraints for extension bonnets and extension stems as shown and as recommended by manufacturer.
c. Provide sleeves where operating stems pass through floor. Extend sleeves two inches above floor.

C. Buried Valves:
1. Install valve boxes plumb and centered, with soil carefully tamped to a lateral distance of four feet on all sides of box, or to undisturbed trench face if less than four feet.
2. Provide flexible coupling next to each buried valve.

D. Plug Valves:
1. Install plug valves that are in horizontal liquid piping with stem horizontal and plugs on top when valve is open. Plug shall be on upstream end when valve is closed.
2. Install plug valves that are in vertical liquid piping with plug at top when closed or as recommended by valve Supplier.
3. Supplier shall tag or mark plug valves to indicate proper mounting position.

3.3 FIELD QUALITY CONTROL

A. Field Tests:
1. Adjust all parts and components as required to provide correct operation of valves.
2. Conduct functional field test on each valve in presence of ENGINEER to demonstrate that each valve operates correctly.
3. Verify satisfactory operation and controls of motor operated valves.
4. Demonstrate satisfactory opening and closing of valves at specified criteria requiring not more than 40 pounds effort on manual actuators.
5. Test ten percent of valves of each type by applying 200 pounds effort on manual operators. There shall be no damage to gear actuator or valve.

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SECTION 40 05 93

COMMON MOTOR REQUIREMENTS
FOR PROCESS EQUIPMENT

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Electric motors and accessories to be furnished under other equipment Sections shall comply with this Section, unless specified otherwise in the Section for the associated driven equipment.
   2. Motor horsepower and voltage ratings, speed, enclosure type, and unusual service conditions (such as ambient temperatures above 40 degrees C, corrosive areas requiring severe duty motors, and variable frequency drive applications requiring inverter duty motors), and requirements for witnessing shop tests shall be as specified in the Sections for the associated driven equipment. Specific accessories and construction features may also be required by the Sections on the associated driven equipment.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ASTM A48/A48M, Specification for Gray Iron Castings.
   2. ASTM B117, Practice for Operating Salt Spray (Fog) Apparatus.
   3. IEEE 112, Test Procedure for Polyphase Induction Motors and Generators.
   4. IEEE 522, Guide for Testing Turn-to-Turn Insulation on Form-Wound Stator Coils for Alternating Current Electric Machines.
   5. IEEE 841, Petroleum and Chemical Industry - Premium-Efficiency, Severe-Duty, Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors – Up to and Including 370 KW (500 HP).
   6. IEEE 1043, Recommended Practice for Voltage Endurance Testing of Form-Wound Bars and Coils.
   7. NEMA MG 1, Motors and Generators. (This Section's references to NEMA MG 1 followed by a hyphen and number, such as “NEMA MG 1-20.14”, indicate the associated NEMA MG 1 paragraph reference.)
   8. ANSI/NETA ATS, Acceptance Testing Specifications for Electrical Power Equipment and Systems
   9. UL 674, Electric Motors and Generators, for Use in Division 1 Hazardous (Classified) Locations.
   10. UL 1004, Electric Motors.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer:
      a. Manufacturer shall have not less than five years experience producing equipment substantially similar to that required and shall be able to submit documentation of at least five installations in satisfactory operation for at least five years each.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Data sheets indicating nameplate data for fractional-horsepower motors.
      b. Outline drawing or data sheet indicating complete motor dimensions for motors rated greater than 1/3-hp. Several motors of the same type and rating for the same application may be covered by an appropriate single drawing or data sheet. Drawings and data sheets shall have complete identifying data including frame size, speed, horsepower ratings, and application for each particular motor.
      c. Details of motor heaters, winding thermal protection, and other accessories.
      d. Copies of motor characteristic curves and data inputs when required for programming motor protection and management relays.
   2. Product Data:
      a. Submit motor test data sheets for each motor rated one horsepower or greater. Values indicated on test data sheets shall be from tests of a previously manufactured, electrically duplicate motor or calculated data. Mark each test data sheet to indicate the Project motor application location, manufacturer, type, frame size, horsepower, voltage, speed, bearing type, lubrication medium and enclosure type. Test data sheet shall also include:
         1) Winding resistances.
         2) Torques.
         3) Efficiencies.
         4) Power factors.
         5) Slip.
         6) Full load amperes.
         7) Locked rotor and no load amperes.
         8) Nameplate temperature and results of dielectric tests.
   3. Testing Plans and Procedures:
      a. When witnessed source quality control testing is required in the Section for associated driven equipment, submit description of proposed shop testing methods, procedures, and testing apparatus with calibration dates, together with proposed testing schedule and proposed travel and logistical plans for testing.

B. Informational Submittals: Submit the following:
   1. Manufacturer's Instructions:
      a. Instructions and recommendations for handling, storing, protecting the motors.
      b. Installation data for motors, including setting drawings, templates, and directions and tolerances for installing anchorage devices.
   2. Source Quality Control Submittals:
      a. Written reports presenting results of required shop testing. Shop test reports shall be dated and signed by motor manufacturer.
      b. When witnessed shop tests are required, shop test results shall be signed by and shall bear the seal of registered professional engineer. Name on seal, registration or license number, and jurisdiction or registration of license shall be legible.
   3. Field Quality Control Submittals:
      a. Written reports presenting results of required field testing and inspections. Field testing reports shall be dated and signed by CONTRACTOR.
   4. Supplier Reports:
      a. Submit written report of results of each visit to Site by Supplier's service personnel, including purpose and time of visit, persons contacted, problems encountered and resolved, tasks performed, results obtained, and other pertinent information. Submit within two days of completion of visit to the Site.
   5. Qualifications Statements:
      a. Submit manufacturer's qualifications data when requested by ENGINEER.

C. Closeout Submittals: Submit the following:
   1. Operation and Maintenance Data:
      a. Furnish operation and maintenance data for motors as part of the operations and maintenance data for the associated driven equipment.
      b. Comply with Section 01 78 23, Operations and Maintenance Data.

D. Maintenance Material Submittals: Submit the following:
   1. Spare Parts and Extra Stock Materials: For each motor size and type, furnish spare parts in accordance with motor manufacturer's recommendations, including the following for three-phase motors:
      a. One set of fans and guards for each set of three or fewer motors, for each size of totally-enclosed fan-cooled motor.
      b. One set of bearing liners, or renewable ball or roller bearings, for each set of three or fewer motors, for each type and size of motor.
      c. One set of oil rings, for each sleeve bearing motor.
      d. One set of bearing temperature detectors, for each set of three or fewer motors, of each type of motor.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling, and Unloading:
   1. Ship motors with openings sealed.

B. Storage and Protection:
   1. Protect materials and equipment from corrosion and deterioration.

PART 2 – PRODUCTS

2.1 EQUIPMENT PERFORMANCE

A. Equipment Description:
   1. Comply with motor requirements specified in the Sections for the associated driven equipment.
   2. Motors shall be suitable for continuous operation at an elevation of up to 3,300 feet above mean sea level, at ambient temperatures ranging from -25 degrees C to 40 degrees C, unless specified otherwise in the Section for the associated driven equipment.

2.2 CONSTRUCTION – GENERAL

A. Unless specified otherwise in Sections on the associated driven equipment, motors shall have the following features of construction and operation:
   1. Successfully operate under power supply variations in accordance with NEMA MG 1-14.30 and NEMA MG 1-20.14.
   2. NEMA Design B with torque and starting currents in accordance with NEMA MG 1, except in special high-torque applications, as specified in the Section for the associated driven equipment, which may require NEMA Design C.
   3. Motors shall operate within their full load rating without applying the service factor, unless specified otherwise in Section for the associated driven equipment.
   4. Speed and horsepower specified or required to properly operate the associated driven equipment and torque characteristics required by the drive load and suitable for direct coupling or V-belt drive, as specified in the Section for the associated driven equipment.
   5. Constructed for full-voltage starting.
   6. Fabricated steel or cast-iron frames with integrally cast feet or bases, cast-iron end bells, cast iron or steel conduit boxes and covers and bases with precision machined bearing fits, ASTM A48/A48M, Class 25 or better. For each TEFC motor, provide UL-approved automatic stainless steel breather drains in lowest part of front and back brackets to allow drainage of condensation.
   7. Stator core assembly shall consist of stacked lamination made from specially selected electrical sheet silicon steel.

8. Rotor cages shall be die-cast or fabricated aluminum or fabricated copper or copper alloy. Shafts shall be carbon steel unless specified otherwise in this Section or in the Section on the associated driven equipment.
9. Rotors on frames 213T and larger shall be keyed shrunk or welded to shaft and rotating assembly, dynamically balanced to NEMA limits. Use rivets to secure balance weights, if required, to rotor resistance ring or fan blades. Machine screws and nuts are unacceptable. Coat entire rotating assembly between bearing inner caps with corrosion-resistant epoxy.
10. Bolt and cap screws shall be high-strength, SAE Grade 5 zinc-plated and chromatic steel. Screwdriver slot fasteners are unacceptable.
11. Motors shall be shop-painted at the motor fabrication facility. Finish coat shall be the same color as the associated driven equipment. Final paint finish shall be corrosive resistant and capable of passing ASTM B117 250-hour salt spray test. Motors that will be located outdoors shall have coating resistant to degradation or chalking in sunlight.

2.3 SINGLE-PHASE AC MOTORS

A. Motors shall be rated 115-, 200-, or 230-volt, 60 Hertz.

B. Bearings shall be grease-lubricated ball type with grease fittings or with lubrication for 10 years of normal operation.

C. Motors shall be totally enclosed except fractional-horsepower motors may be open type if motor is suitably protected from moisture, dripping water, and airborne particulates accumulation. Motor features shall be in accordance with the following:
1. Open motors shall be split-phase or capacitor start in accordance with torque requirements, with service factor of not less than 1.25, 40 degrees C ambient rating, and Class B insulation.
2. Enclosed motors shall be capacitor start, with service factor of not less than 1.15, 40 degrees C ambient rating, and Class F insulation. Motors shall be fan-cooled or non-ventilated.
3. Severe duty type motors shall be designed to withstand chemical corrosion and equipped with cast iron end shields, neoprene gaskets, stainless steel shaft, heavy pressed steel fan cover and provision for threaded conduit connection.
4. Provide direct drive fan motors with conduit fittings and leads to allow external connection.
5. Explosion-proof motors shall comply with UL 674.

2.4 THREE-PHASE AC MOTORS

A. General: Unless specified otherwise in the Sections for the associated driven equipment, provide three-phase motors with the following features:
1. Premium, energy-efficient construction complying with NEMA MG 1.
2. Motor efficiency determined in accordance with NEMA MG 1-12.58.
3. Minimum and nominal full-load efficiencies not less than those listed in: NEMA MG 1 Table 12-12 for motors rated 600 volts and smaller, and NEMA

MG 1 Table 12-13 for motors rated larger than 600 volts and equal to or less than 5,000 volts.

4. Motors shall be constructed for operation on three-phase, 60 Hertz, alternating current system. Motor voltage and variable frequency operation, where required, shall be as specified in the Sections for the associated driven equipment. Voltage ratings shall be 200 volts for operation on 208-volt systems, 230 volts for 240-volt systems, 460 volts for 480-volt systems, 2300 volts for 2400-volt systems, and 4000 volts for 4160-volt systems.
5. Unless otherwise required by the load, motors shall be NEMA Design B, normal starting torque. Locked rotor KVA/HP shall not exceed NEMA Code Letter G for motors 20 hp and larger.
6. Motor frame shall be a rigid structure, constructed to maintain the lamination in correct alignment, and shall not depend on lamination or bolts for rigidity.
7. Severe-duty totally-enclosed motors shall comply with IEEE 841.

B. Bearings:

1. Provide horizontal motors with rolling element (anti-friction) or sliding element (sleeve) type bearings. Use anti-friction type bearings for NEMA frame motors. Use sleeve type bearings when specified in the Section for the associated driven equipment.
2. Insulate the bearings for motors larger than 200 hp and for inverter-duty motors 100 hp and larger, to prevent shaft currents and related bearing damage.
3. Bearings for open drip-proof, TEFC, and explosion-proof motors shall be grease lubricated, ball type, unless specified otherwise in the Section for the associated driven equipment. Bearings shall have inlet fittings and outlet plugs. Protect bearings and grease reservoirs from entry of contaminants. Provide suitable fittings to allow convenient positive purging of old grease during re-greasing.
4. For horizontal motors with ratings up to and including 500 hp, or for motors with speeds up to and including 3600 rpm, and where both conditions apply, anti-friction bearings furnished shall have a minimum L-10 bearing life of 100,000 hours, as defined by the ABMA, for direct-connected motors, and L-10 bearing life of 50,000 hours for belted motors.
5. Sleeve bearings shall be ring-oiled with adequate, integral self-cooled oil reservoir. Bearing sleeves shall be lined with high tin content babbitt to minimize oil contamination. Close running shaft seals shall prevent oil leakage as well as prevent entrance of foreign material such as water and dirt into the bearing area. Provide oil level sight gauges with permanently-marked easily-discernible oil level. Provide inspection openings to observe the oil rings.
6. When specified in Section for the associated driven equipment or required by motor speed and bearing size, provision shall be made for forced lubrication. Provide oil rings and an adequate oil reservoir in bearing housings to allow orderly shutdown of motor in the event of failure of forced feed lubrication system.
7. Provide vertical motors with thrust bearings adequate for all thrusts to which motor can be subjected. Rated minimum L-10 life of the thrust bearings shall be at least 15,000 hours when operated at rated speed and full load thrust.

Manufacturers of the associated driven equipment shall furnish motor manufacturer with speed and thrust conditions required by the associated driven equipment.

C. Insulation:
   1. Insulation systems shall be rated Class F, with a service factor of 1.15 times motor's nameplate horsepower rating when operated on a sine wave power supply, and a service factor of 1.00 on an adjustable frequency power supply. Temperature rise shall be limited to Class B insulation system when motor is operated continuously at rated horsepower with ambient temperature not exceeding 40 degrees C, unless specified otherwise in the Section for the associated driven equipment.
   2. Windings shall be epoxy-coated. Treat windings with insulating compound suitable for protecting against moisture, salt air, and slightly acidic and alkaline conditions. Insulation system for enclosed motors shall be upgraded to increase moisture resistance.
   3. Motors for outdoor service and all motors larger than 200 hp shall have vacuum/pressure-impregnated epoxy insulation (VPI) for moisture resistance. Motors shall be preheated before VPI and baked in temperature-controlled oven.
   4. Stator windings and end turn connections shall be fully brazed to withstand full voltage starting, regardless of the starting method indicated in the Section for the associated driven equipment. Bracing system shall essentially eliminate coil vibration under the high-current conditions of starting as well as during normal operation. When a tied system is used, system shall be such that no tie depends on the integrity of another tie within the system.
   5. Motors larger than 200 hp shall be form wound. Form wound coils with micaceous ground wall insulation shall have additional insulation and hot-pressed to provide sealed system. Complete stator shall be vacuum/ pressure-impregnated.

D. Enclosures:
   1. Motor enclosure type shall be as specified in the Section for the associated driven equipment. Enclosure types shall comply with the following:
      a. Open Drip Proof: Motors shall have a steel or cast-iron frame, cast-iron end brackets, and steel conduit box. Provide vertical motors of the open type with drip hoods. When the drip hood is too heavy to be easily removed, provide access for testing. Provide stainless steel corrosion-resistant screens over air openings in accordance with NEMA requirements for guarded machines.
      b. Weather Protected Type I and Type II: Weather-protected motor shall be an open drip proof guarded machine with ventilating passages constructed to minimize entrance of rain, snow, and airborne particles to motor's electric parts complying with NEMA MG 1-1.25.8
      c. Totally enclosed fan cooled and non-ventilated motors shall have cast-iron frame, cast-iron end brackets, and cast-iron conduit box. Provide drain holes on each end of motor.

d. Explosion-proof motors shall comply with NEMA MG 1-1.26.10 and UL 674.

2. Motor conduit box shall be split from top to bottom, shall be capable of being rotated to four positions 90 degrees apart, and shall comply with the following:
   a. Box shall be gasketed with rubber-like gaskets between frame and conduit box and between conduit box and conduit box cover.
   b. Provide box or opening in motor housing with conduit hub type fitting to allow threaded conduit connections.
   c. Box sizes shall be in accordance with code requirements and shall accommodate medium-voltage terminations or stress cones, when required.
   d. Protective and auxiliary devices shall terminate in auxiliary conduit boxes.
   e. Terminal leads shall be flexible and of sufficient length to extend for distance of not less than ten inches beyond face of terminal box. Terminal leads shall be fitted with solderless lugs suitable for attachment to lugs installed on external wiring. Leads shall be sealed with non-wicking, non-hygroscopic insulating material, or insulating "wrap-cap" as manufactured by Ideal Industries, or equal.
   f. Provisions for terminal box size, length of leads, size of conduit openings, and type of terminal lugs shall be complied with irrespective of other standards or practice.
   g. Provide motor frame grounding stud inside conduit box. Stud shall include a drilled and tapped hole.

E. Motors for Use with Variable Frequency Drives:
   1. Motors shall be compatible with characteristics of the intended variable frequency inverters.
   2. Motors shall comply with the performance standards of NEMA MG 1-31.

F. Vertical Motors:
   1. Vertical motors shall have Type P base specifically constructed for vertical installation. Universal position motors are unacceptable.
   2. Vertical motors shall have solid shafts, unless otherwise specified in Section for the associated driven equipment.

G. Lifting Eyes: Motors weighing more than 50 pounds shall include at least one lifting eye or lifting lug. Construct motor and lifting eyes or lifting lugs to bear motor's full weight.

2.5 ACCESSORIES

A. General:
   1. Provide motor accessories in accordance with this Section unless specified otherwise in the Section for the associated driven equipment.

2. Provide space heaters in motors five horsepower and larger installed outdoors, and in enclosed motors five horsepower and larger installed indoors in unheated spaces.
3. Provide thermostat type winding thermal protection for motors in accordance with the following:
    a. Variable speed motors up to and including 25 hp.
    b. Constant speed motors when specified in Section for the associated driven equipment.
4. Provide thermistor type winding thermal protection for motors in accordance with the following:
    a. Constant speed motors 50 hp and larger up to and including 200 hp.
    b. Variable speed motors 30 hp and larger up to and including 200 hp.
5. Provide resistance temperature detector (RTD) type winding thermal protection for all motors larger than 200 hp.
6. Provide stator and bearing temperature detectors for each motor 250 hp and larger.

B. Space Heaters:
1. Space heaters for condensation prevention shall operate at 120 volts and shall be sized to provide approximately 10 degrees C temperature rise above ambient.
2. Heaters shall be low-density type for low surface temperature and long life.

C. Winding Thermal Protection:
1. Thermostats shall be bi-metal disk or rod type embedded in the stator windings. Thermostat contacts shall be normally-closed, automatic-reset type, rated 120 vac, five amps minimum, opening on excessive temperature. Provide three thermostats, one in each phase, wired to motor junction box.
2. Thermistors embedded in each stator phase winding shall be in direct contact with the winding conductors. Each thermistor circuit shall be factory-wired to 120-volt solid-state control module mounted at the motor in box rated NEMA 4X. Control module contacts shall be automatic-reset type, rated 120 vac, five amps minimum, opening on excessive temperature. Provide normally-closed isolated contact for motor shutdown.
3. Resistance temperature detectors (RTD) shall be 100-ohm platinum three-lead type with calibrated resistance-temperature characteristics. Position detectors, two per phase for non-explosion proof motors and one per phase for explosion proof motors, to detect highest winding temperature and located between coil sides in stator slots. Detector leads shall be wired to a separate terminal box.

D. Bearing Temperature Protection: When specified in Section for the associated driven equipment, provide motor bearing temperature detectors, RTD type similar to the winding detectors specified in this Article, on each bearing for horizontal motors and on the thrust bearing for vertical motors.

E. Vibration Protection: When specified in Section for associated driven equipment, provide accommodations for mounting sensors for monitoring bearing or casing vibration.

F. Medium-Voltage Auxiliary Devices: When specified in Section for the associated driven equipment with medium voltage motors, provide lightning arrestors and surge capacitors, located in motor conduit box.

G. Single-Phase Motors: Single-phase motors requiring auxiliary starting resistors, capacitors or reactors and switching devices shall be provided as combination units with such auxiliaries either incorporated within motor housings or housed in suitable enclosures mounted on motor frames. Each combination unit shall be mounted on a single base and be provided with a single conduit box.

2.6 IDENTIFICATION

A. Nameplates:
   1. Nameplates shall be Type 316 stainless steel with embossed or pre-printed lettering and fastened to the motor frame with Type 316 stainless steel pins.
   2. Nameplates shall have stamped on them the motor manufacturer's name, voltage, number of Hertz and phases, horsepower rating, amperes and temperature rise at rated load, full load speed, locked rotor amperes or code letter, service factor, NEMA nominal efficiency, model number, insulation class, bearing number, serial number and maintenance manual number.
   3. Name plates for explosion proof motors shall indicate the Division, Class and Group of the hazardous location in which the motor is intended for use.
   4. Dual-voltage motor nameplates shall include connection diagrams.
   5. Nameplate markings shall be in accordance with NEMA MG 1-10.

2.7 SOURCE QUALITY CONTROL

A. Shop Tests:
   1. Perform shop testing on the motors at the manufacturer's facility. Shop test shall be in accordance with NEMA MG 1, UL 674, and UL 1004 and shall demonstrate that the motors tested comply with the Contract Documents.
   2. Submit shop test reports identifying tests performed and results obtained.
   3. Motors shall be given Routine Test in accordance with NEMA MG 1-12.55 and IEEE 112. Test shall include the following:
      a. Measurement of winding resistance.
      b. No-load readings of current and speed at normal voltage and frequency.
      c. Current input at rated frequency with rotor at standstill for squirrel-cage motors (locked rotor amperes).
      d. High-potential test.
      e. Bearing inspection.
   4. Motors rated 200 hp and larger shall be given a "Complete Test" in accordance with IEEE 112 consisting of a "Routine Test" and a full-load heat run. When "Complete Tests" are required for a group of the same type, rating and

horsepower for the same application, each motor of the group shall be given a "Complete Test", unless specified otherwise in the Section for the associated driven equipment. Testing shall document the following:

a. Percent **s**lip.
b. No-**l**oad **s**peed, **v**oltage, **c**urrent, and losses at rated frequency.
c. Full-**l**oad **c**urrent.
d. Locked-rotor **t**orque.
e. Locked-rotor **c**urrent.
f. Breakdown **t**orque (**c**alculated).
g. Starting **t**orque (squirrel-cage).
h. Winding **r**esistance.
i. Sound pressure level at no-load.
j. Vibration levels.
k. Efficiency current, and power factor at 100, 75, and 50 percent of full load and at service factor load.
l. Stabilized full load temperature rise.

5. Motors with stator windings rated greater than six kV shall have the following additional tests:
   a. Voltage endurance test of the ground-wall insulation system in accordance with IEEE 1043.
   b. Partial discharge testing of the stator coils to insure proper impregnation and clearances. Acceptance criteria shall be based on manufacturer's quality assurance data base.
   c. Voltage surge test on multi-turn stator coils in accordance with IEEE 522.

B. Witnessed Shop Testing:
   1. When witnessed motor shop testing, which may also be referred to as witnessed source quality control motor testing, is specified in the Section for associated driven equipment, shop tests shall be witnessed at the motor manufacturer's testing and production facility. The number of attendees shall as indicated in the Sections for the associated driven equipment.
   2. Dates of witnessed testing shall be acceptable to OWNER and ENGINEER and shall be agreed upon in writing at least 45 days prior to the actual test. Perform all witnessed tests at motor manufacturer's facility in one day or on consecutive days to minimize the time required to witness the tests.
   3. OWNER will be responsible for cost of OWNER's and ENGINEER's time for first test on each motor, and for time to travel to and from motor manufacturer's facility once. Responsibility for cost of lodging, meals, and travel expenses shall be as indicated in the Section for the associated driven equipment.
   4. If re-testing is required, all labor and expense costs incurred by OWNER and ENGINEER will be deducted from the Contract Price via a Change Order. If tests are not performed on agreed-upon date as a result of CONTRACTOR's or motor manufacturer's action or inaction and OWNER or ENGINEER incurs lost time or expense as a result of such action or inaction, the associated costs will be deducted from the Contract Price via a Change Order.

5. Not less than the number of days prior to the scheduled witnessed motor test specified in Paragraph B.2 of this Article, submit to ENGINEER the proposed witness testing plans and procedures.

PART 3 – EXECUTION

3.1 INSTALLATION

A. General:
   1. Install motors in accordance with the Contract Documents and manufacturer's instructions and recommendations. Obtain written interpretation from ENGINEER in the event of conflict between manufacturer's instructions and recommendations and the Contract Documents.
   2. Install in accordance with Laws and Regulations.
   3. Do not modify structures to facilitate installation of motors, unless approved in writing by ENGINEER.
   4. Carefully and properly align motors with the driven equipment.
   5. Secure motors to mounting surfaces with anchorage devices complying with manufacturer's recommendations that are of sufficient size and quantity to secure motor to equipment.
   6. Until start-up and operation, tightly cover and protect motors from dirt, water, and chemical and mechanical damage.

3.2 FIELD QUALITY CONTROL

A. Site Tests:
   1. Inspect motors prior to supplying electricity to (energizing) equipment. Do not energize equipment without ENGINEER's permission. Inspections shall include the following:
      a. Inspect motor and equipment for physical damage.
      b. Inspect motor for proper anchorage, mounting, grounding, connection, and lubrication.
      c. Check for unusual noise and indications of overheating during initial or test operation.
   2. Perform testing at the Site for motors larger than 200 hp, as follows:
      a. Testing shall be witnessed by ENGINEER.
      b. Initial inspections and testing shall include the following:
         1) Electrical and grounding connections.
         2) Shaft alignment, proper mounting and lubrication.
         3) Check ventilating air passageways for blockage.
         4) Excessive noise.
         5) Overheating.
         6) Correct rotation.
         7) Protective detectors operation.
         8) Excessive vibration.
         9) Space heater operation.

c. Electrical testing shall include the following:
   1) Insulation resistance test.
   2) Surge comparison test.
   3) Vibration test.
   4) Bearing insulation resistance test on insulated bearings.
   5) Running current and voltage measurements and evaluations relative to load conditions over full range of operations and nameplate full-load amperes.
   6) High-potential test.
   7) For wound rotor motors, additional testing at minimum and normal operating load points and at ring short.
   8) Motor operation with the driven equipment for not less than 48 continuous hours per motor, with checks for overheating and vibration during operation.

d. Tests and values shall be in accordance with motor manufacturer's recommendations and ANSI/NETA ATS.

e. Prepare and submit field testing report in accordance with ANSI/NETA ATS.

B. Manufacturer's Services:
   1. For motors larger than 200 hp, furnish services of motor manufacturer's qualified service representative to assist with installing motors, checking installed motors before initial operation, assisting in performing field quality control tests and inspections, observing and assisting initial operations, and training operations and maintenance personnel in caring for, operating, and maintaining motors.
   2. Preparing and submitting manufacturer's field report for each visit to the Site.

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SECTION 40 60 05

INSTRUMENTATION AND CONTROL FOR PROCESS SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish, install, calibrate, test, start-up, and place in satisfactory operation a complete and operating Instrumentation and Control system for the Pump Station. The Instrumentation and Control system shall be designated as Pump Station Control System (PSCS).
   2. Major components of the PSCS include:
      a. Pump Station Control Panel.
      b. Programmable Logic Controller (PLC) housed in the control panel and software.
      c. Operator Interface Terminals (OIT) mounted on the face of the control panel and human-machine interface (HMI) software.
      d. Field instruments.
      e. Network Switch
      f. Uninterruptible power supply.

B. Coordination:
   1. Instrumentation and Controls:
      a. Instrumentation and Control Equipment shown and specified herein is expected to be furnished, installed, and placed into satisfactory operation by an Instrumentation and Controls (I&C) Subcontractor. Programming of control logic and configuration of HMI software is not part of the Work and is by OWNER assigned Programmer. Programming of the PLC and configuration of the HMI software on the OIT are not part of this contract. It will be performed by an OWNER assigned Programmer.
      b. Some panels and equipment are furnished under other Specification Sections under this Contract. CONTRACTOR shall coordinate with Suppliers of these panels and equipment to provide fully functional system in accordance with the Contract Documents and that interfaces with PSCS.
   2. To centralize responsibility, materials and equipment provided under this Section shall be furnished by a single I&C Subcontractor.
   3. With CONTRACTOR, I&C Subcontractor shall assume the responsibility for adequacy and performance of materials and equipment provided under this Section.
   4. To the greatest extent possible, provide materials and equipment from a single manufacturer.
   5. I&C Subcontractor's Responsibilities:

a. Preparing all instrumentation and control equipment submittals in accordance with the Contract Documents.
b. Proper interfacing of instrumentation and control equipment with field equipment, instruments, devices, and panels, including required interfacing with packaged control systems furnished by other equipment Suppliers, and required interfacing with the Site's electrical system.
c. Review and coordination with manufacturers, Suppliers, and other I&C Subcontractor submittals for equipment, valves, piping, and appurtenances for ensuring proper interfacing of hardware, and locations and installation requirements of inline devices and instrument taps.
d. Direct, detailed oversight of installation of instruments, panels, consoles, cabinets, wiring and other components, and related wiring and piping connections.
e. Calibrating, source quality control, field quality control, and start-up of the system.
f. Responsibility for correction period obligations for the PSCS.
g. Training of operations and maintenance personnel in operation and maintenance (including calibration and troubleshooting) of the instrumentation and control system.
h. Handling of all warranty obligations for the PSCS components.

C. Related Sections:
1. Section 26 29 37, Low Voltage Combination Magnetic Motor Starters
2. Section 26 32 13, Engine Generators.
3. Section 43 21 39, Submersible Axial Flow Pumps
4. Section 46 21 16, Flexible Rake Bar Screens

1.2 REFERENCES

A. Standards referenced in this Section are:
1. IEEE 802.1 LAN/MAN Bridging & Management
2. IEEE 802.1X, Port Based Network Access Control.
3. IEEE 802.3, Standards Defining Physical Layer and Data Link Layer Media Access Control (MAC) Sublayer of Wired Ethernet
4. ISA 5.1, Instrumentation Symbols and Identification.
5. ISA 5.4, Instrument Loop Diagrams.
6. ISA 20, Specification Forms for Process Measurement & Control Instruments, Primary Elements & Control Valves.
7 ISO 8802-3, Information Technology - Telecommunications and Information Exchange Between Systems - Local and Metropolitan Area Networks - Specific Requirements - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications.
8. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
9. NFPA 70 (NEC), Article 770, Optical Fiber Cables and Raceways.

10. NFPA 79, Electrical Standard for Industrial Machinery.
11. UL 50, Safety Enclosures for Electrical Equipment, Non-Environmental Considerations.
12. UL 508A, Industrial Control Panels.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. I&C Subcontractor:
      a. Shall be financially sound with at least five years continuous experience in designing, implementing, supplying, and supporting instrumentation and control systems for municipal pump stations comparable to the instrumentation and control systems required for the Project, relative to hardware, software, cost, complexity, and size.
      b. Shall have record of successful instrumentation and control system equipment installations. Upon ENGINEER's request, submit record of experience listing for each project: project name, owner name and contact information, name and contact information for contractor, name and contact information for engineer or architect, approximate contract value of instrumentation and controls Work for which Supplier was responsible.
      c. Shall have at time of Bid experienced engineering and technical staff capable of designing, supplying, implementing, and supporting the instrumentation and control system and complying with submittal and training requirements of the Contract Documents.
      d. Shall provide system hardware components of fully developed, field proven standardized designs, and therefore shall furnish a system that is not a highly unique, custom one-of-a-kind system.
      e. Shall have a minimum of five years' experience in application of PLC based control systems.
      f. Shall have a system of traceability of the manufactured units and purchased components through production, assembly, and testing.
      g. Shall have a demonstrated record of prompt response to field failures.
      h. Shall be capable of training operations and maintenance personnel in instrumentation and control applications, and in operating, and maintaining the control system and equipment.
      i. Shall have UL-approved panel shop.
      j. Possess a thorough, working knowledge of stormwater or wastewater pump stations and control philosophy in accordance with standard practices of the water and wastewater treatment industry.

2. Manufacturer: Manufacturers of instrumentation and control equipment furnished under this Section shall be experienced producing similar equipment and shall have the following qualifications:
    a. Shall manufacture instrumentation and control system components that are fully-developed, field-proven, and of standardized designs.
    b. Shall have system of traceability of manufactured unit through production and testing in accordance with ANSI/ASQ Z1.4.
    c. Shall have guaranteed availability clause (99.99 percent, minimum for one year) for microprocessor-based components and appurtenances.
    d. Shall have documented product safety policy relevant to products proposed for the Work.

B. Pre-Construction Conference
    1. Comply with the requirements of Division 1, Project Meetings and the requirements listed below.
    2. Prepare items listed below for presentation at pre-construction conference. Submit information to ENGINEER two weeks prior to pre-construction conference.
        a. List of materials and equipment required for PSCS, and brand and model proposed for each item.
        b. List of proposed exceptions to the Contract Documents along with brief explanation of each.
        c. General outline of types of tests to be performed to verify that all sensors and transducers, instruments, and digital processing equipment are functioning properly.
        d. Submittal numbering, submittal protocol, and correspondence requirements.
        e. Discussion of items listed under 1.4.B and C of this Section.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
    1. Shop Drawings:
        a. Field Instruments:
            1) Manufacturer's product name and complete model number of devices proposed for use, including manufacturer's name and address.
            2) Instrument tag number in accordance with the Contract Documents.
            3) Data sheets and manufacturer's catalog literature. Provide data sheets in accordance with ISA 20 and annotated for features proposed for use. For instruments not included in ISA 20, submit data sheets using a format similar to ISA 20.
            4) Description of construction features.
            5) Performance and operation data.
            6) Installation, mounting, and calibration details; instructions and recommendations.

7) Service requirements.
8) Range of each device and calibration information
9) Descriptions of materials of construction and listing of NEMA ratings for equipment

b. Panels, Consoles, and Cabinets:
1) Layout drawings that include:
a) Front, rear, and internal panel views to scale.
b) Tag number and functional name of components mounted in and on panel, console, or cabinet, as applicable.
c) Product information on panel components.
d) Nameplate location and legend including text, letter size and colors to be used.
e) Location of anchorage connections.
f) Location of external wiring and piping connections.
g) Mounting and installation details, coordinated with actual application.
h) Proposed layouts and sizes of operator interface graphic display panels.
i) Calculations for heating and cooling of panels
j) Subpanel layouts and mounting details for items located inside control panels.
2) Product information on panel components including:
a) Manufacturer's product name and complete model number of devices being provided, including manufacturer's name and address.
b) Instrument tag number in accordance with the Contract Documents.
c) Data sheets and catalog literature. Submit data sheets as shown in ISA 20 and annotated for features proposed for use. For instruments not included in ISA 20, submit data sheets with format similar to ISA 20.
d) Description of construction features.
e) Performance and operation data.
f) Installation, mounting, and calibration details; instructions and recommendations.
g) Service requirements
3) Wiring and piping diagrams, including the following:
a) Name of each panel, console, or cabinet.
b) Wire sizes and types.
c) Terminal strip and terminal numbers.
d) Wire color coding.
e) Functional name and manufacturer's designation for components to which wiring and piping are connected.
f) Lightning and surge protection grounding.
4) Electrical control schematics in accordance with NFPA 79. Drawings shall be in accordance with convention indicated in Annex D of the NFPA 79. Typical wiring diagrams that do not

accurately reflect actual wiring to be furnished are unacceptable. Tables or charts for describing wire numbers are unacceptable.

5) Stock list or bill of materials for each panel including tag number, functional name, manufacturer's name, model number and quantity for components mounted in or on the panel or enclosure.
6) Detail showing anchorage plan of wire bundles between subpanels and front panel mounted devices.

c. Field wiring and piping diagrams, include the following:
   1) Wire and pipe sizes and types.
   2) Terminal numbers at field devices and in panels.
   3) Fiber optic termination designations in the field and in panels.
   4) Color coding.
   5) Conduit numbers in which wiring will be located.
   6) Locations, functional names, and manufacturer's designations of items to which wiring or piping are connected.

d. Pump Station Control System:
   1) Hardware:
      a) Layout drawings showing front, rear, end and plan views to scale of equipment, I/O components, power supplies, and peripheral devices.
      b) Equipment ventilation requirements.
      c) Interconnection diagrams, including termination details, cable identification list, and cable length.
      d) Drawings showing equipment layout.
      e) Installation requirements, instructions, and recommendations.
   2) Software:
      a) Licensing agreement with name of licensee, renewal requirements, release and versions, expiration dates (if any) and upcoming releases scheduled before Project completion. When upcoming releases are expected, provide descriptions, when available, of features that differ from the proposed release.
   3) System I/O Loop Wiring Diagrams: Prepare Shop Drawings on module-by-module basis and include the following information:
      a) Rack numbers, module type and slot number, and module terminal point numbers. Include location and identification of intermediate panel and field terminal blocks and terminal numbers to which I/O wiring and power supply wiring is connected. Identify power supply circuits with designation numbers and ratings.
      b) Wiring types, wire numbers, and color coding.
      c) Designation of conduits in which field I/O wiring will be installed.
      d) Location, functional name, tag numbers and manufacturer's module numbers of panel and field devices and instruments to which I/O wiring will be connected.
      e) Prepare loop wiring diagrams in accordance with ISA 5.4.

e. Complete point-to-point interconnection wiring diagrams of field wiring associated with the system. Diagrams shall include the following:
   1) Field wiring between each equipment item, panel, instruments, and other devices, and wiring to control stations, panelboards, and motor starters. Some of this equipment may be specified in other Divisions, CONTRACTOR is responsible for providing complete point-to-point interconnection wiring diagrams for control and monitoring of that equipment.
   2) Numbered terminal block and terminal identification for each wire termination.
   3) Identification of assigned wire numbers for interconnections. Assign each wire a unique number.
   4) Schedule showing the wiring numbers and the conduit number in which the numbered wire is installed.
   5) Junction and pull boxes through which wiring will be routed.
   6) Identification of equipment in accordance with the Contract Documents.

2. Product Data:
   a. Product data for field instruments in accordance with requirements for Shop Drawings in this Section.
   b. Product data for panels, consoles, and cabinets in accordance with requirements for Shop Drawings in this Section.
   c. Product data for field wiring provided for instrumentation and control service and not included under other Sections or contracts.
   d. Product data for PSCS, including software and hardware.
3. Samples:
   a. Color charts for finish paint for panels. Provide full range of paint manufacturer's standard and custom colors. Color selection will be by ENGINEER.
   b. Color charts for FRP panels. Provide full range of panel manufacturer's standard and custom colors. Color selection will be by ENGINEER.
4. Factory Acceptance Test Procedure: Submit factory testing procedures that will be performed to fulfill requirements of the Contract Documents. Test procedure shall include the following:
   a. Visual inspection of components and assembly.
   b. Description of hardware operational testing.
   c. Description of testing equipment to be used.
   d. Sign-off sheets to be used at time of testing.

B. Informational Submittals: Submit the following:
1. Documents to be submitted prior to pre-submittal conference, in accordance with Article 1.3 of this specification.
2. Manufacturer's Instructions:
   a. Shipping, handling, storage, installation, and start-up instructions.
3. Source Quality Control Submittals:

a. Factory test reports and results.

4. Special Procedure Submittals:
   a. Submit notification to OWNER and ENGINEER at least 14 days before readiness to begin system checkout. Schedule system checkout on dates agreed to by OWNER and ENGINEER.
   b. Submit written procedure for system checkout to ENGINEER three months prior to starting system checkout. Three months prior to starting system checkout submit written procedure for start-up to ENGINEER.
5. Field Quality Control Submittals:
   a. Submit the following prior to commencing system checkout and start-up.
      1) Completed calibration sheets for each installed instrument showing five-point calibration (0, 25, 50, 75, 100 percent of span), signed by factory-authorized serviceman.
   b. Field calibration reports
   c. Field testing reports.
6. I&C Subcontractor's Reports:
   a. Installation inspection and check-out report.
   b. Submit written report of results of each visit to Site by Supplier's service technician, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
7. Qualifications Statements:
   a. I&C Subcontractor
   b. Manufacturer, when required by ENGINEER.

C. Closeout Submittals: Submit the following:
   1. Operations and Maintenance Data:
      a. Submit in accordance with Division 1, Operations, Maintenance and Warranty Manuals.
      b. Include acceptable test reports, maintenance data and schedules, description of operation, wiring diagrams, and list of spare parts recommended for one year of operation with current price list.
   2. Record Documentation:
      a. Prepare and submit record documents in accordance with Division 1, As-Built Documentation.
      b. Revise all system Shop Drawing submittals to reflect as-built conditions in accordance with the following.
         1) Two copies of each revised Shop Drawings and documentation to replace outdated drawings and documentation contained in operation and maintenance manuals. Submit half-size black line drawings for each drawing larger than 11 inches by 17 inches. Include specific instructions for outdated drawing removal and replacement with record documents submittal.

2) Half-size black line prints of wiring diagrams applicable to each control panel shall be placed in clear plastic envelopes and stored in a suitable print pocket or container inside each control panel.
3) Submit CADD drawings of the point-to-point interconnection wiring diagrams updated to reflect final as-built equipment information and as-installed field installation information.

D. Maintenance Materials Submittals: Submit the following:
1. Spare Parts and Test Equipment
a. General
1) For process sensors and other analog instruments, Supplier shall submit a separate quotation for recommended list of spare parts and test equipment. Separately list and price each item recommended. Spare parts quotation shall include a statement that prices quoted are valid for a period of one year from date of equipment installation and that Supplier understands that OWNER reserves the right to purchase none, any, or all parts quoted.

1.5 STORAGE AND HANDLING

A. Prior to packaging, each manufacturer or Supplier shall securely attach tag number and instructions for proper field handling and installation to each instrument.

B. Comply with Division 1, Materials and Equipment.

PART 2 – PRODUCTS

2.1 SYSTEM REQUIREMENTS

A. Power Supplies:
1. Electrically powered equipment and devices shall be suitable for operation on 115-volt plus-or-minus 10 percent, single-phase, 60 Hertz plus-or-minus two Hertz, power supply. If different voltage or closer regulation is required, provide suitable regulator or transformer at no additional cost to OWNER.
2. Provide appropriate power supplies for field instruments requiring power source less than 115 volts. Power supplies shall be mounted in control panels or enclosures installed near associated instrument or in field panels.
3. Power supplies shall be capable of minimum of 130 percent of maximum simultaneous current draw.
4. Provide power on-off switch or air circuit breaker for each item provided under this Section that requires electric power.

B. Signal Requirements:
   1. Control system shall use 4 to 20 mA DC analog signals, unless otherwise shown or indicated.
   2. Provide signal converters and repeaters where required. Adequately size power supplies for signal converters and repeater loads.
   3. Analog signals shall be isolated from ground.
   4. Signals transient DC voltage shall not exceed 300 volts over one millisecond and shall not have a DC component over 300 volts.
   5. Discrete signals shall use 120 VAC.

C. Surge Protection Requirements:
   1. Provide surge protection to protect electronic instrumentation and control systems from surges propagating along signal and power supply cabling. Protection systems shall be such that the protection level shall not interfere with normal operation, but shall be lower than instrument surge withstand level, and be maintenance-free and self-restoring.
   2. Provide instruments in suitable metallic cases, properly grounded. Ground wires for surge protectors shall be connected to good earth ground and, where practical, run each ground wire individually and insulated from other wires. Mount protectors within instrument enclosure or in separate junction box compatible with the area designation coupled to the enclosure.

D. Miscellaneous:
   1. General:
      a. Instrumentation components shall be heavy-duty types, constructed for continuous service.
      b. System shall consist of equipment models currently in production.
      c. Materials and equipment, including cabling and interconnections, shall be in accordance with Division 16, Electrical, and manufacturer's recommendations, unless indicated otherwise in the Contract Documents.
      d. Materials and equipment shall, where applicable, be in accordance with UL standards and be so marked and labeled.
   2. Logic and control loops shall be fail-safe. Instrumentation components shall return automatically to accurate measurement within 15 seconds upon restoration of power after power failure and when transferred to standby power supply.
   3. Provide surge protection for instruments and other control system components that could be damaged by electrical surges. Provide lightning arresters on both ends of communication lines, except for fiber optic cabling, external to buildings or structures, including leased telephone lines and similar communication lines.
   4. Field-mounted instruments and system components shall be constructed for use in humid and corrosive service conditions. Field-mounted instrument enclosures, junction boxes and appurtenances shall have NEMA rating appropriate for hazardous rating requirements shown or indicated on

Electrical Drawings, instrument data sheets, and elsewhere in the Contract Documents.

5. Miscellaneous hardware such as fittings, fasteners, and screws, shall be Type 316 stainless steel or other appropriate material to prevent galvanic reactions, and shall be suitable for service intended. Piping stands shall be provided for fastening instruments as required. Provide threaded pipe stands with flange bolted to slab. Use carbon steel piping and flanges painted in accordance with Section 09 91 00, Painting.
6. Data processing equipment and relays with interconnections to field devices shall be wired through field wiring terminal blocks in the panel. Terminating field wiring directly to terminals on relay base is unacceptable.
7. Arrange panel-mounted instruments, switches, and other devices ergonomically for functional use and ease of maintenance. Similar types of panel-mounted devices shall be by one same manufacturer and of the same model line.
8. Equipment furnished shall be of modular construction and be capable of field expansion through installation of plug-in circuit cards and additional cabinets as necessary.
9. Field- and panel-mounted instruments shall be tagged with equipment number and nomenclature indicated in the Contract Documents; if not so indicated, tag in accordance with approved Shop Drawings.
10. Coordinate ranges and scales specified in the Contract Documents with manufacturer of the equipment actuallyfurnished for operability over the intended range. Complete the coordination prior to submitting Shop Drawings to ENGINEER.
11. Treat field-mounted devices with anti-fungus spray.
12. Protect field-mounted devices from exposure to high and freezing temperatures to provide complete operability under the environmental conditions indicated in the Contract Documents.

E. Programmable Logic Controller (PLC)
1. The PLC will be programmed by the OWNER assigned Programmer to perform functions shown and specified.
2. The programming format shall be IEC 1131-3 compliant Ladder Diagram, Function Block Diagram, Sequential Function Chart, and Structured Text languages. The ladder diagram format shall contain a complete cross reference with each coil referred to in logic and identified as normally open or normally closed. Mnemonic information shall be added to each coil and to both real and internal I/O points. Alphanumeric titles and descriptions shall appear on the screen.
3. The controller mainframe shall be arranged in modular type design. All inputs, outputs, and communication modules (cards) can be easily removed for replacement or restructuring the hardware arrangement. Shut down of the processor control logic (halting of program scan) shall not occur when remote I/O modules are removed.
4. In the event of a power failure or malfunction of the hardware, the controller shall provide dry, Form C contact closures for remote and local indication

and alarming.

5. A self-diagnostics package to determine proper processor operation shall be included. Diagnostic LED shall be provided in clear view on the front of the PLC enclosure.
6. Changing on-line control logic shall not necessitate halting of the processor.
7. Processor and I/O modules shall be capable of withstanding temperatures of 32°F to 120°F at a relative humidity of 5 to 95 percent (non-condensing) in system manufacturer's standard enclosures.
8. Burn-in for all printed circuit boards and modules shall be performed at the factory.
9. The primary interface to the process equipment and field devices shall be provided by the I/O system consisting of I/O modules installed in mounting racks. The I/O system hardware shall be designed with the following features:
    a. Noise immunity and filtering.
    b. IEEE surge withstand rating to IEEE 472.
    c. Optical isolation for all inputs and outputs to provide hardware and controller protection.
    d. No on-board pots requiring adjustment or maintenance.
    e. Front-of-module LED status indicators for each individual input and output point to indicate when power is applied at I/O terminals.
    f. For outputs to motor contactors and other load relays, provide transient and inrush surge suppressor connected across the output contact terminal and the neutral-common terminal inside the control center to suppress the switching surge transient to lower than the continuous rating of the output contacts.
    g. The following types of I/O modules shall be provided for use with the supplied PLC System:
        1) Analog Inputs (16 bits, minimum): 4 to 20mA DC with isolated points (250 ohms maximum impedance).
        2) Analog Outputs (16 bits minimum): 4 to 20mA DC with isolated points (load of 750 ohms minimum).
        3) Discrete Inputs: 120VAC in both isolated and common circuit types.
        4) Discrete Outputs: Form C Relay Contacts.
10. Functions to be performed by the PLC include, but are not necessarily limited to, the following:
    a. Generate alarms based on inactive and active input and output and based on analog values.
    b. PID control and arithmetic functions.
    c. Interlock and sequential logic control of processes and equipment operations.
    d. Collection and transmission of data and control parameters to and from other PLC's and workstations with Human Machine Interface (HMI) software.
    e. User program executions.
11. The manipulative functions shall have the capability of being rearranged

into any desired format while the controller is performing other control tasks.

12. The control programs and applications memory of the PLC shall be capable of being remotely (off-line) and locally (on-line) monitored, programmed, modified, and displayed by use of a personal computer and documentation software which shall be provided as part of this contract.
13. Construction: Modular printed circuit boards.
14. Memory: The CPU shall be a microprocessor with onboard Dynamic Random Access memory (DRAM) and flash memory for read/write functions and storage of configured data without battery backup. The microprocessor shall have:
    a. Minimum of 4 M Bytes of User Memory
    b. Flash memory with minimum 128 M bytes of memory.
15. Provide type and quantity of I/O required performing the operations and functions shown and specified plus 20 percent spare for each type of I/O module used. Spare points shall be mounted and wired ready for use and shall require only field wiring connections and software configuration to place the point in service.
16. Internal Functions: Relays, timers, counters, latches, internal storage registers, and other functions as required to perform specified functional requirements, plus 20 percent spare capacity.
17. A minimum of 20 percent spare rack space shall be provided for future card additions.
18. Operating Temperature: 32°F to 140°F.
19. Storage Temperature: Minus 40°F to 160°F.
20. Power Supply: 120 V AC, with fuse or circuit breaker protection. Power Supplies shall be sized for a minimum of 130 percent of maximum simultaneous current. Power Supplies shall incorporate full power factor correction, AC input filtering, and a 40 millisecond hold up item.
21. Clock: Real time battery-backed clock with typical variation of 2 seconds in 6 months to provide time reference for processor and system operation. Also provide timer for monitoring system software operations to detect hardware malfunction or a non-productive loop (stall condition).
22. Current Input Module
    a. 4-20 mA DC
    b. Maximum of 8 isolated input channels per module.
23. Current Output Module
    a. 4-20 mA DC
    b. Maximum of 8 isolated output channels per module.
24. Discrete Digital Input Module
    a. 120V AC voltage monitor.
    b. Maximum of 16 individually isolated input channels per module.
25. Discrete Digital Dry Contact Output Module
    a. Relay output (NO contacts, 120 V AC 2A minimum).
    b. Maximum of 8 individually isolated output channels per module.
26. Ethernet Interface Module:
    a. Standard Ethernet media (10baseT, 100baseT, and fiber).

b. RJ-45 interface.
c. Standard TCP/IP communications.
d. Subnet masking.

27. I/O Chassis:
    a. Number of slots as needed.
28. Power Supply (PS):
    a. 120 VAC input voltage
    b. Minimum current output as required to power all local PLC modules.
29. Product and Manufacturer:
    a. ControlLogix Series with 1756 – L81EK manufactured by Allen Bradley.
    b. No Substitutions

F. PLC Spare Parts:
1. See item J below for required spare parts.

G. PLC Programming Software:
1. Software shall support the development of the PLC ladder logic derived from process control strategies as specified herein. Software shall be IEC 1131-3 compliant Ladder Diagram as well as modular, function block type of control elements, which are familiar to control system programmers and engineers, instrumentation technicians and electricians. The function blocks shall be computational blocks for performing arithmetic, operational blocks for performing such functions as move and convert values, file to file operations, communication blocks for communicating with other PLC's and system resources, special algorithm blocks for advanced control procedures such as shift register, and PID functions. The PID shall use traditional strategies such as Proportional Integral Derivative (PID) controllers, feed forward, cascaded controllers, etc. shall be provided. Tuning constants shall be easily set from operator consoles. For each analog loop, software to allow provision of status of the manual backup control to be monitored and an alarm generated when switch is not in automatic mode.
2. Software shall allow configuration of internal diagnostics alarms for the PLC hardware. Alarms shall be suitable to verify proper operation and to alert operators when alarm conditions occur. This includes, but is not limited to annunciation blown fuse indication for all I/O, watchdogs for communications failure with any system processor or I/O address, and communications failure with existing third party equipment.

3. The PLC software shall use intuitive, menu-driven environment and base package platform. These easy-to-use Graphical User Interface (GUI) packages shall perform configuration and maintenance operations.
4. The PLC software shall be compatible with Windows 10.
5. The PLC software shall be fully compatible with all furnished PLC hardware.
6. Product and Manufacturer:
    a. Studio (RSLogix) 5000 Designer, Professional Edition as manufactured by Allen Bradley. Provide latest service pack.
    b. No Substitutions.

H. Operator Interface Terminal (OIT):
1. Provide a programmable Operator Interface Terminal (OIT) to enable Operator to control and monitor field equipment. The OIT unit shall be flush panel mounted on the front of the panel. OIT unit shall be provided with all necessary hardware, cables, and software to accomplish the interface as specified herein and shown on the Contract Drawings.
2. Performance Requirements:
    a. The OIT shall be designed to display directly connected to the remote I/O or Ethernet network and shall be able to transfer up to twenty-two 64 word blocks each way.
    b. The OIT shall be provided with off-line development software which allows development of graphic picture files, touch screen key files, alarm files, trend files, system configurations, variables, and screen definitions. Provision shall be made to store commonly used symbols and screen definitions. Software license shall be for an unlimited time for use on hardware provided as part of the Contract or their successors. All licenses shall be in the name of the OWNER and turned over to the OWNER on the conclusion of Contract.
3. Each OIT shall be provided with the following minimum requirements:
    a. Display: 12-inch Color touch screen.
    b. Field replaceable Backlight.
    c. Memory: Available Flash: 64MB; RAM: 64MB.
    d. Communication: Ethernet TCP/IP communication port.
    e. Input Voltage: 120 VAC.
    f. Hot-swappable secure digital (SD) card. One per unit.
    g. Operating Temperature: 0 – 45 degrees Celsius.
    h. Humidity: 5 - 90% without condensation.
    i. Rating: NEMA 4X, UL-listed.
4. Product and Manufacturer: Provide one of the following:
    a. PanelView Plus 7 as manufactured by Allen Bradley with FactoryTalk View Software and license.
    b. No Substitutions.

I. Environmental Conditions:
1. Provide control system suitable for continuous operation under the following conditions:
    a. Indoor Instruments:

1) Ambient Temperature: Zero degrees F to 120 degrees F.
2) Relative Humidity: 100 percent, maximum.

b. Outdoor Instruments
1) Ambient Temperature: -15 degrees F to 120 degrees F.
2) Relative Humidity: 100 percent, maximum.

2. Protect outdoor-mounted field instruments from direct sunlight by providing sunshade for instruments. Construct sunshade out of non-corrosive material. Sunshade shall withstand wind velocity of 130 miles per hour.

J. Spare Parts
1. General:
a. Furnish the spare parts as indicated below, identical to and interchangeable with similar equipment provided under this Section.
b. Provide source quality control for spare parts as part of factory testing prior to shipment of instrumentation and control equipment.
2. Furnish the following PLC Spare Parts:
a. One spare digital input module of each type utilized.
b. One spare digital output module of each type utilized.
c. One spare analog input module of each type utilized.
d. One spare analog output module of each type utilized.
e. One spare power supply assembly of each size utilized.
f. One spare Ethernet interface module.
g. One CPU of each type furnished.
3. Furnish the following spare parts:
a. Five of each type of input/output relay for each quantity of forty or fraction thereof provided under the Contract.
b. One replacement power supply for each type and size provided under the Contract.
c. One-year supply of all expendable or consumable materials.
d. One per quantity of ten of fraction thereof provided, per range of field instruments including insertion type instruments. No spares are required for inline instruments such as magnetic flow meters and flumes or venturis that include flow tubes through which flow is conveyed.
e. Twelve of each type and size of fuse used in instruments and in control panels.

2.2 PANELS

A. General Provisions:
1. Provide electrical components and devices, support hardware, fasteners, and interconnecting wiring and piping required to provide control panels complete and operational.
2. Locate and provide hardware so that connections can be easily made and there is ample room for servicing each item.
3. Prevent movement by adequately supporting and restraining devices and components mounted on or within panel.

4. Provide panels with sub-panels for installation of all internally mounted hardware.
5. Provide numbered terminal strips for terminating field wiring and wiring from other panels, unless otherwise shown or indicated.
6. Provide copper grounding studs for hardware requiring grounding.
7. Provide the following convenience accessories inside each panel:
    a. One 120 vac, 20-amp duplex, grounding type receptacle.
    b. One 120 vac fluorescent service light fixture with 20-watt lamp and protective plastic shield or appropriate wattage incandescent bulb for panels two feet by two feet and smaller.
    c. One 120 vac snap switch, to turn on service light, mounted in outlet box with cover and located so that switch is easily accessible from access door.
    d. Service light with switch and duplex receptacle shall have a dedicated circuit breaker.
8. Control of Environment (Except NEMA 7 Panels):
    a. Provide 120 vac thermostatically controlled fan-driven heater units to maintain stable temperature within enclosure to protect equipment from harmful effects of condensation, corrosion, and low temperatures inside panels.
    b. Provide automatically controlled closed-loop heat exchangers or closed-loop air conditioners to maintain temperature inside each enclosure at optimum operating temperature rating of components inside the enclosure.
    c. Each heat exchanger or air conditioner shall have a dedicated, properly sized and -rated circuit breaker within the panel.
    d. Submit supporting calculations as part of panel Shop Drawing submittal if panel equipment to comply with specified environmental requirements is proposed to be deleted as unnecessary.
    e. The fan-driven heater unit, closed-loop heat exchangers or closed-loop air conditioners, duplex utility receptacle, and fluorescent service light shall have a one dedicated 120-volt ac service from the source, separate from the 120-volt service from the source for the process control hardware within the panel.
9. Panels to be located in non-hazardous (non-classified) environments shall comply with UL 50 and UL 508A.
10. Panels to be located in hazardous (classified) environments shall comply with UL 698A and UL 2062.
11. CONTRACTOR is responsible for detailed layout and design of panels, in accordance with the Contract Documents. Base cutouts and design on instrument manufacturers' requirements.
12. Lower 12 inches of free-standing panels shall be free of devices, including Wire trays and terminal strips, for ease of installation and maintenance.
13. For front-opening panels, install no device less than three feet above operating floor level, unless otherwise shown or indicated. For rear-opening panels, install no devices on the door.
14. Wire bundles between subpanels and front panel-mounted devices shall be anchored and protected from damage by opening and closing of panel door.

15. Do not locate front panel-mounted devices requiring manipulation by operating personnel, such as pushbuttons, hand switches, controllers, and similar devices, higher than 5.5 feet above finished floor.
16. Wire trays located on either side of terminal strips shall have minimum clearance of 1.5 inches between wire trays and terminal strip.
17. Provide three-inch high channel base assembly, drilled to mate panel to floor pad.
18. Provide easily accessible pocket built into panel door to enclose "as built" panel wiring diagrams.
19. Panels shall be UL-listed.

B. Identification:
1. Provide laminated plastic nameplate for identification of panels. Use self-tapping stainless-steel screws for fastening nameplates to panels. When self-tapping screws may degrade panel's NEMA rating, retain NEMA rating intact by using gaskets on each side of panel surface and use retaining plate on the panel back that is same size as nameplate. When gaskets and retaining plate are used, use full-penetration screws with nuts.
2. Panel identification nameplates shall have 1/2-inch-high engraved letters.
3. Identify front panel-mounted devices with nameplates engraved with functional description of the device. Nameplate engraving shall be in accordance with the identification provided in the Drawings.
4. Tag electric components and devices mounted within panels with high adhesive labels.
5. Identify terminal strips with nameplate engraved as "TB-XX" where "XX' is the numerical identification of terminal strip.
6. Identify terminals within each terminal strip with sequential numbers and wire numbers.
7. Internal panel wiring shall be color-coded and numerically identified with unique wire numbers affixed at each end of each wire. Color coding shall be in accordance with panel wiring color code table, below:

Panel Wiring Color Code Table

Description	Color
110 vac panel power before fuses or breakers	Black
Controlled 110 vac power (e.g., after relay contacts, selector switch contacts, and similar equipment.)	Red
110 vac power source from devices external to panel	Yellow
110 vac neutral	White
24 vdc positive power from power supplies	Brown
24 vdc negative power from power supplies	Manufacturer choice
Controlled 24 vdc power (e.g., after PLC output contacts, relay contacts, and similar)	Blue
24 vdc positive power from devices external to panel	Orange
24 vdc negative power from devices external to panel	Manufacturer choice
24 vdc four to 20 mA DC signal cable	Grey sheath with red positive, clear negative

Grounding wire	Green

C. Panel Construction Features:

1. Panels located inside control or electric room areas shall be rated NEMA 12 with the following features:
   a. Fabricate enclosures using minimum 14-gage steel for wall- or frame-mounted enclosures and minimum 12-gage for free standing enclosures. Steel shall be free of pitting and surface blemishes.
   b. Continuously weld exterior seams and grind smooth. Surface grind panel to completely remove corrosion, burrs, sharp edges, and mill scale.
   c. Reinforce sheet steel with steel angles where required to adequately support devices and equipment and ensure rigidity and to preclude resonant vibrations.
   d. Panel shall be flat within tolerance of 1/16-inch over two-foot by two-foot area, or flat within tolerance of 1/8-inch for larger surface area. Acceptable out-of-flatness shall be gradual, in one direction only, and shall not consist of obvious depressions or a series of wavy sections.
   e. Use pan type construction for doors. Door widths shall not exceed three feet.
   f. Mount doors with full-length heavy-duty piano hinge with stainless steel hinge pins.
   g. Provide oil resistant gasket completely around each door or opening.
   h. Provide handle-operated, oil-tight, key-lockable three-point stainless steel latching system with rollers on latch-rods for easy door closing.
   i. Use stainless steel fasteners throughout.
   j. Provide interior mounting panels and shelves constructed of minimum 12-gage steel with white enamel finish.
   k. For prints, provide steel pocket with white enamel finish.
   l. Provide enclosure mounting supports as required for floor, frame, or wall mounting as required.
   m. Completely clean interior and exterior surfaces so surfaces are free of corrosive residue, oil, grease, and dirt. Zinc phosphatize for corrosion protection.
   n. Provide one coat of primer paint to interior and exterior surfaces immediately after applying corrosion protection, in accordance with coating manufacturers' instructions. Provide surface preparation in accordance with coating manufacturer's requirements.
   o. Paint interior surfaces with two coats of semi-gloss white polyurethane enamel.
   p. Paint exterior surfaces with minimum of three finish coats of polyurethane enamel to produce a finish that is smooth and free of imperfections. Color shall be selected by ENGINEER from complete selection of standard and custom color charts furnished by manufacturer.
   q. Primer and finish paint shall be compatible and shall be low-VOC, high-solids polyurethane enamel.
2. Control panels located in non-environmentally controlled areas and outdoor

areas shall be rated NEMA 4X and with the following features:

a. Panels shall be Type 316L stainless steel construction with minimum thickness of 12-gage for all surfaces, except areas requiring reinforcing, with a smooth-brushed finish.
b. Stainless steel screw clamp assemblies on three sides of each door.
c. Rolled lip around three sides of door and along top of enclosure opening.
d. Hasp and staple for padlocking.
e. Provide clear-plastic, gasketed lockable hinged door to encompass non-NEMA 4X front-of-panel devices.

3. Control Panels Located in Hazardous Rated Areas (NEMA 7):
   a. General: Provide explosion-proof enclosures, suitable for use in NEC Class 1, Groups C and D or Class II, Groups E, F and G applications and comply with UL 2062.
   b. Required Features:
      1) Lightweight and corrosion-resistant copper-free aluminum.
      2) Integral, cast-on mounting lugs.
      3) Left side door hinges.
      4) Viewing windows sized to suit internally mounted components.
      5) Stainless steel cover bolts.
      6) Cadmium-plated steel mounting pans.
      7) Enclosed heat-generating devices shall not cause external surfaces to reach temperatures capable of igniting explosive gas-air mixtures in surrounding atmosphere.
      8) Mark panels with appropriate class and group(s) for which panel is qualified. Panels shall comply with features and test criteria of NEMA 250.

D. Electrical Systems:
   1. Power Source and Internal Power Distribution:
      a. Provide in the panel, near where incoming power is terminated, nameplate with panel power supply source, type, voltage, and circuit number.
      b. Protect incoming 120 vac power feeds to power the panel by providing lightning and surge arrestors, properly connected to grounds.
      c. Provide panels with internal 120 vac power distribution system with properly sized and -rated circuit breakers to distribute power. Power not more than three devices from a single breaker. When power supplies are included in the panel, not more than two power supplies shall be powered from a single breaker. The PLC shall have its own dedicated circuit breaker. Convenience receptacles and interior panel lights shall have their own breakers. When one or more field instruments require 120 VAC power from the panel, power not more than three instruments from a given breaker.
      d. Provide space for a minimum of two spare breakers in each panel.

2. Wiring:
   a. Internal wiring shall be Type MTW and THW stranded copper wire with thermoplastic insulation rated for 600 volts at 85 degrees C for single conductors, color-coded and labeled with wire identification.
   b. For DC signal wiring, use shielded cable with 18-gage conductors. DC field signal wiring terminal strips shall be capable of handling wires up and including No. 12 size.
   c. For AC power wiring, use No. 12 minimum AWG. For AC signal and control wiring, use No. 16 minimum AWG. For wiring carrying more than 15 amps, use sizes required by the NEC (NFPA 70).
   d. Inside of panels, route DC signal wiring separately from power wiring with minimum separation distance of six inches.
   e. Use covered wire trays to route internal panel cables and wiring. wire trays in each section of panel shall be appropriately sized to accommodate the quantity of wires to be routed with a spare capacity of 40 percent.
   f. Install wire troughs inside panels along horizontal or vertical routes to present a neat appearance. Angled runs are unacceptable.
   g. Wiring that is routed without wire trays shall be adequately supported and restrained to prevent sagging or other movement. Use of adhesive anchors to support or restrain wiring is unacceptable.
   h. Terminate internal panel wiring using ferret tip, insulated, crimp-on connectors; soldered connectors are unacceptable. Provide panels with 600-volt rated barrier type terminal strips mounted on Din rails. Identify terminal strips as indicated in this Section. Identification devices shall be self-stick, plastic tape strips with permanent, machine- printed numbers.
   i. Terminal blocks for 4-20 mA signals shall be fused and knife disconnect type. Fused terminal blocks shall have LED blown fuse indication.
   j. Wiring in panels shall be installed such that, if wires are removed from any one device, power will not be disrupted to other devices.
   k. Provide spare terminals equal in number to 20 percent of terminals used for each type of wiring (e.g., DC signal and AC power).
   l. Provide ground terminals to terminate the shield wire of shielded cables. Termination of more than two shielded wires on a single ground terminal is unacceptable.
   m. Provide a single copper bus bar with 5/16-inch diameter copper grounding stud to connect the panel to external ground. Panel's internal grounds shall be terminated to the bus bar.
   n. Where wires pass through panel walls, provide suitable bushings to prevent cutting or abrading of insulation.
   o. When DC power or low voltage AC power is required, furnish and install in the panel required power supplies and transformers.
   p. Provide complete wiring diagram of "as-built" circuitry enclosed in transparent plastic.

2.3 DATA SHEETS –PRIMARY SENSORS AND FIELD INSTRUMENTS

A. General:
   1. Primary sensors and field instruments shall be in accordance with the "data sheets" included in Part 3 of this specification.

2.4 PANEL INSTRUMENTS AND DEVICES

A. General: Do not fabricate, ship, or assemble instruments and devices in panels until required Shop Drawings and other submittals required for fabrication are approved or accepted as required.

B. Uninterruptible Power System (Single Phase)
   1. General: Uninterruptible Power System (UPS) shall be furnished to provide a reliable source of uninterruptible power for PSCP with no break in AC output power during a complete or partial interruption of incoming line power. UPS shall include audio/visual alarms. UPS shall be UL listed.
   2. Description: On line dual track power conditioner and true (0 ms transfer time) uninterruptible power supply providing isolation, line regulation and conditioning, using sealed 48 VDC maintenance free batteries and switch mode power supply for uninterrupted power with 0.5 to 0.7 power factor and 2.7 to 3.5 crest factor.
   3. Features:
      a. Unit shall provide uninterrupted conditioned power, under fully loaded conditions, for 20 minutes. Unit shall be sized to accommodate power requirements for all equipment it is to power for the required length of time and shall provide ten percent spare output capacity at minimum.
      b. Rating: 1.4 KVA/1.0 KW minimum
      c. Lighting and Surge Protection: Inherent 2000: One spike attenuation.
      d. Regulation: One to three percent load regulation with less than 2 pF effective coupling capacitance for line to load.
      e. Output Waveform: Computer grade sine wave with three percent maximum single harmonic and five percent maximum total harmonic distortion.
      f. Output Frequency: 60 Hz ±0.5 Hz.
      g. Operating Temperature: 1°C to 40°C.
      h. Relative Humidity: Five to 90 percent non-condensing.
      i. Normally Closed contact output for Battery Low alarm to be connected to a PLC discrete input.
      j. Computer Interface: USB Port
      k. Input Protection: Independent battery charger fuse and DC fuses.
      l. Output Protection: Inherently current limited ferro-resonant transformer.
      m. Battery Charger: Two-step charger, 8A and 2A.
      n. AC Input: 120 VAC. 60 Hz, single phase, +3 percent, -3 percent.
      o. AC Output: 120 VAC, 60 Hz, single phase, +3 percent, -3 percent.
   4. Products:

a. Eaton.
b. APC.
c. Or Equal.

C. Managed Ethernet Switch
1. General:
a. Managed type Ethernet switches shall have a full set of management features, including SNMP agent, and web interface. In addition, managed switches shall have features to manipulate configurations, such as the ability to display, modify, backup and restore configurations.
b. Input Power: 18 to 60 VDC.
c. Provide DIN Rail mounted power expansion module that supports 100-240 V AC Input, and provides 24 VDC Output.
d. Provide all necessary items for installation, including mounting brackets, interconnecting cables, hardware and appurtenances.
e. Quantity shall be as shown.
2. Features:
a. Type: Managed, Industrial grade Ethernet switch.
b. Connectivity:
1) Eight (8) Ethernet ports; Ethernet ports shall be expanded as needed to interconnect all system components. Ethernet ports shall be type RJ-45 supporting 100Base-TX transmission over Category 6 cable.
2) Two (2) dual-purpose uplinks (each dual-purpose uplink port either 10/100/1000 copper or SFP fiber)
c. Support for up to 2 expansion modules.
d. Alarm relay contacts for external alert system.
e. Switch shall comply with the following:
1) IEEE 802.3u compliant, minimum.
2) 100 Mbps baseband CSMA/CD (Carrier Sense Multiple Access / Collision Detection) standard.
3) ISO 8802/3.
f. Management features shall include:
1) Ability to turn particular port range on or off.
2) Link speed and duplex settings.
3) Prioritize settings for ports.
4) MAC filtering and "port security" features to prevent MAC flooding.
5) Spanning Tree Protocol.
6) SNMP monitoring of device and link health.
7) Port mirroring.
8) Link aggregation.
9) VLAN settings.
10) 802.1X network access control.
11) IGMP snooping and query.

3. Products and Manufacturers: Provide one of the following:
    a. Cisco IE 3000 Series
    b. No Substitutions

D. Power Supplies
1. General: Single unit and multiple unit power supplies, located in remote terminal units and field panels as required.
2. Single Unit Required Features:
    a. Solid state circuitry.
    b. Surface mounting.
    c. Input Power: 120 VAC ±10 percent, 60 Hz.
    d. Output Power: 24 VDC or as required.
    e. Line/Load Regulation: ±0.005 percent.
    f. Ripple: 0.25 mV RMS.
    g. Polarity: Floating output.
    h. Ambient Temperature: -20°C to +71°C.
    i. Response Time: <20µS.
    j. Overload Protection: Internal preset.
    k. Include mounting brackets, fuse, and mating connector for AC power plug.
3. Multiple Unit Required Features:
    a. Solid state circuitry.
    b. Standard 19-inch RETMA (EIA) rail mounting.
    c. Input Power: 120 VAC ±10 percent, 60 Hz.
    d. Output Power: 24 VDC or as required.
    e. Polarity: Floating output.
    f. Ambient Temperature: -20°C to +71°C.
    g. Response Time: <20µS.
    h. Include over-voltage protection, output current limiting protection, provisions for paralleling power supplies and front panel mounted indicating fuses.
    i. If the power supplies are connected in parallel, provide isolation diodes in series with the positive lead of each of the parallel connected power supplies.
    j. Connections:
        1) Twist-lock AC power connector.
        2) DC power terminal strip.
4. Products and Manufacturers: Provide one of the following:
    a. Acopian Corporation, Gold Box Series A.
    b. Or Equal.

E. Main and Branch Circuit Breaker
1. General:
    a. Circuit breakers shall be furnished and installed in control panels to provide automatically operated switch protection in an electrical circuit from damage caused by an overload or short circuit.

b. Branch circuit breakers shall be approved for branch circuit applications in the United States.

2. Features:
   a. Type: High Density Circuit Breaker.
   b. Provide Single Pole 120/240V breakers within the control panels.
   c. Rating: Provide breakers with proper amp rating to protect the circuit it serves. Normal operating load of each circuit shall be noted on the panel power distribution wiring drawing.
   d. Insulation Resistance: 100M-ohm at 500VDC.
   e. Terminal Type: Tubular screw with self-lifting box lug.
   f. Push-to-set mechanism for circuit actuation.
   g. Manual trip button.
   h. DIN rail mounted.
   i. Status on/off indicator lights.
   j. Compliance: UL 1077 Listed, CSA C22.2 No. 235, EN/IEC 60934
3. Products and Manufacturers: Provide one of the following:
   a. Allen Bradley.
   b. Or Equal.

F. Selector Switches, Pushbuttons, and Indicating Lights
1. General:
   a. Selector switches, pushbuttons and indicating lights shall be supplied by one manufacturer and be of the same series or model type.
   b. Type: Heavy duty, oil tight.
   c. Provide legend plate for indication of switch, pushbutton or light function (e.g., "OPEN-CLOSED", "HAND-OFF-AUTO").
   d. Mounting: Flush mounted on control panel front, unless otherwise noted.
   e. NEMA rated to match panel in which mounted.
2. Selector Switches:
   a. Type: Provide selector switches with number of positions as required to perform intended functions as shown and specified.
   b. Contacts:
      1) Provide number and arrangement of contacts as required to perform intended functions specified, but not less than one single pole, double throw contact.
      2) Type: Double break, silver contacts with movable contact blade providing scrubbing action.
      3) Rating: Compatible with AC or DC current with devices simultaneously operated by the switch contacts, but not less than 10 A resistive at 120 VAC or DC continuous.
   c. Switch Operator: Standard black knob.
3. Pushbuttons (Standard or Illuminated):
   a. Type: Provide momentary lighted and/or unlighted, single and/or dual type pushbuttons as required to perform intended functions specified and shown.

b. Contacts: Comply with the requirements specified for selector switches.

4. Indicating Lights:
   a. Type: Light-Emitting Diode (LED).
   b. Lamps: 2.2 volt, long life (20,000 hours minimum).
5. Button and Lens Colors:
   a. Red for indication of open, on, or running.
   b. Green for indication of closed, off (ready), or stopped.
   c. Amber for indication of equipment malfunction, process trouble and alarms (e.g., "HIGH LEVEL", "LOW LEVEL", etc.).
   d. White for indication of electrical control power on.
   e. Blue for indication of remote.
6. Products and Manufacturers: Provide one of the following:
   a. Eaton Corp.
   b. Allen Bradley.
   c. Or Equal.

E. Control Relay
1. Type: General purpose, plug-in type rated for continuous duty.
2. Construction Features:
   a. Coil Voltages: 24 VDC or 120 VAC, as required.
   b. Contacts:
      1) Silver cadmium oxide rated not less than 5 A resistive at 120 VAC or 24 VDC continuous.
      2) For switching low energy circuits (less than 200 mA) fine silver, gold flashed contacts rated not less than 3 A resistive at 120 VAC or 28 VDC continuous shall be provided.
   c. Relays to have clear plastic dust cover.
   d. Relays to have pilot light to show energized coil.
   e. Relays to be UL recognized.
3. Products and Manufacturers: Provide one of the following:
   a. Square D Company, Type R and/or Type K.
   b. IDEC, RU Series.
   c. Or Equal.

2.5 IDENTIFICATION

A. Instrument Tagging
1. Headings on the instrument index in the Contract Documents have the following meaning:
   a. "TAG" is divided into two sections. The first seven to nine alphanumeric characters represent the OWNER's equipment number, and the remaining characters comply with ISA Standard S5.1.
   b. "DESCRIPTION/LOCATION" is an explanation of instrument function and location.

c. "RANGE/SET POINT" is the limit for the specified units of the instrument and set point is the precise value within the instrument's range.
d. "SPEC REF" is the paragraph reference in the Specifications where the instrument's requirements are specified.
e. "DRAWING NO." indicates the Drawing where the device is shown or indicated.
f. "REMARKS" contains specific notes relative to the instrument.

B. Input/Output List Identification
1. I/O point list contains information required to configure PLC I/O interface hardware, and to indicate range conversion or signal functions.
2. "POINT NUMBER" is an alphanumeric character string. For example, for the point "MP-FI-806-0123" the following apply:
a. The first two characters (MP) refer to the specific plant area (MP = Main Pump, for example).
b. The third character is the functional identifier and conforms with ANSI/ISA S5.1. In the example, "F" represents flow.
c. The fourth (and sometimes fourth and fifth) alphabetical character (I) is the function identifier. In the example, the "I" represent indication input.
d. The first three-digit number (806) identifies the P&ID number.
e. The next four-digit number (0123) identifies the loop or field device.
f. Suffix, where required, is used for distinguishing between similar variables.
3. "DESCRIPTION" is an alphanumeric character string up to 40 characters in length. Points described as "SPARE" indicate pre-wired I/O.
4. "SIGNAL TYPE" is one of the following:
a. AI indicates analog input.
b. DI indicates discrete input.
c. PI indicates pulse input.
d. AO indicates analog output.
e. DO indicates momentary, maintained or latched discrete output.
f. FB indicates foundation field bus.
g. PB indicates profi bus.
h. MB indicates Modbus.
i. DN indicates device net.

C. ISA Identification
1. A = Analytical.
2. B = Burner, Combustion.
3. C = Cooling (Cooling Condenser).
4. D = Dissolved.
5. E = Voltage.
6. F = Flow.
7. G = Intrusion.
8. H = Hand.

9. I = Current.
10. J = Power.
11. K = Time.
12. L = Level.
13. M = Manual.
14. N = UNDEFINED.
15. O = Overload.
16. P = Pressure.
17. Q = Communication.
18. R = Reverse.
19. S = Speed, Frequency.
20. T = Temperature.
21. U = Universal (Common).
22. V = Vibration.
23. W = Torque (Weight or Force).
24. X = Critical (Emergency).
25. Y = Event, State or Presence.
26. Z = Position, Dimension.

D. Function Identifier:
1. A = Alarm
2. B = UNDEFINED.
3. C = Control.
4. D = Differential.
5. E = Element.
6. F = Failure.
7. G = UNDEFINED.
8. H = High.
9. I = Indication.
10. J = UNDEFINED.
11. K = Factor.
12. L = Low.
13. M = Mode.
14. N = Normal.
15. O = Oxygen.
16. P = UNDEFINED.
17. Q = Quantity.
18. R = Rotation.
19. S = Switch.
20. T = Timer
21. U = UNDEFINED.
22. V = Slow (output)
23. W = Slow (input)
24. X = Selector Switch (input)

2.6 PROCESS CONTROL DESCRIPTIONS

A. Process Control Descriptions provided below are the general description for programming control logic in the PLC and configuring the HMI software that runs on the OIT. The control logic in the PLC and the configured OIT software shall be modified, finetuned, and customized as directed by the OWNER/ENGINEER during the factory acceptance test and during field start-up of the system. Expect a 10% rework to the PLC program and a 15% rework to the OIT software during the factory acceptance test and field start-up. This rework shall be provided at no additional cost to the OWNER.

B. Pump Station Level Monitoring: The pump station shall have four level monitors as specified and shown on the drawings. The level monitors shall be installed at the following locations.

1. LIT-101: Hydrostatic Pressure Transmitter; pump 3 sump in wet well 1, against the wall in a stilling well.
2. LIT-102: Hydrostatic Pressure Transmitter; pump 4 sump in wet well 2, against the wall in a stilling well.
3. LIT-103: Hydrostatic Pressure Transmitter; in wet well 1, against the wall in a stilling well.
4. LIT-104: Radar Level Indicating Transmitter; in the influent channel, upstream of the bar screen. The PLC program shall cross check the LIT-104 reading against the active pump control level sensor to generate the differential level across the bar screen. The PLC program shall activate a high differential level alarm when the differential level is at or above an operator adjustable set point.
5. Under normal conditions, for controlling the pumps, the three level sensors in the wet wells shall operate as per the below assignment:
   a. Active Sensor: LIT-101
   b. Backup Sensor: LIT-102
   c. Standby Sensor: LIT-103
6. The OIT shall display all four level readings, active sensor selection for pump control, and level sensor control mode, locally at the pump station and remotely on the SCADA HMI at the ---------- treatment plant. The selection between Auto or Manual level sensor control modes can only be made locally at the pump station (control panel OIT). Control modes shall be programmed as per the following strategy:
   a. In Manual mode, the operator shall have the ability to manually select any of the three (3) level transmitters as the active sensor.
   b. In Manual mode, the PLC shall not automatically switch the active sensor in the case of a signal failure for the selected sensor, such failures include a false reading, an out of range 4 to 20 mA signal, and the loss of the 4 to 20 mA signal.
   c. In Auto mode, the PLC shall continually check for level sensor related alarms and take the corrective action as described below:
      1) Alarm for level deviation between three hydrostatic sensors (LIT-101, LIT-102 and LIT 103):
         a) Sensor False Data alarm shall be generated when the three hydrostatic sensor readings deviate from one another by a difference setpoint (initial value: 6 inches) for a period of two (2) minutes.
         b) Once this alarm is generated, the PLC shall check which of the three are reading closer to each other and identify the one reading higher than the deviation set point as the faulty sensor. PLC shall then automatically pick one of the two good sensors reading closer to each other for controlling the pumps.
         c) The three-sensor deviation monitoring program shall be automatically disabled when the LIT-103 reading is below two (2) feet depth (-13.00 Elevation).

d) When the LIT-101 and 102 readings are below two (2) feet depth (measured from tank bottom at -15.00' Elevation), the two-sensor deviation monitoring shall be activated. A sensor False Data alarm shall be generated when the two (2) level sensor readings deviate from one another by a difference setpoint (initial value: 6 inches) for a period of two (2) minutes. Identifying the faulty sensor and selecting the sensor with the correct reading as the active sensor will be performed by the operator.

2) Level sensor failure shall be generated for each sensor when the signal goes out of range (4-20 mA).
   a) If active sensor LIT-101 goes out of range, the PLC shall automatically switch to backup sensor LIT-102.
   b) If active sensor LIT-102 goes out of range, the PLC shall automatically switch to standby sensor LIT-103. When LIT-103 is the active sensor, pumps 3 and 4 (small pumps) shall shut off when the level reading goes below 1.5' (EL-13'.6") measured from the bottom of wet well.

3) Stuck Signal sensor malfunction:
   a) If all 3 hydrostatic level sensor signals flatline (within a set tolerance), that is considered an actual stagnant level condition in the wells.
   b) If 2 hydrostatic level sensor signals flatline, but the third does not, the PLC shall determine that the third sensor has deviated and has a false reading.
   c) If only one hydrostatic level sensor signal flatlines, and two sensor readings are varying, PLC automatically determines that the level sensor flatlining has failed.
   d) In scenarios b and c above, if the active sensor is the one identified as the faulty one, the PLC shall automatically switch to the next sensor in line as the active sensor for control.

4) The Sensor Deviation Alarm indication for level deviation between sensors shall be de-activated if Sensor False Data alarm is also active to help cut down nuisance alarming.

7. When level sensor control is in Auto mode, if the gate on wet well 1 and 2 dividing wall is closed, wet well 1 influent gate is open, and wet well 2 influent gate is closed, the PLC shall select LIT-101 as the active level for pump control.
8. When level sensor control is in Auto mode, if the gate on wet well 1 and 2 dividing wall is closed, wet well 2 influent gate is open, and wet well 1 influent gate is closed, the PLC shall select LIT-102 as the active level for pump control.

C. Pump Control (Reference Drawing: I-02)

1. The pump control system consists of two wet wells with three (3) level sensors, five (5) submersible pumps, each pump's variable speed drive (VFD), a Pump Station Control Panel (PSCP), and associated instrumentation. Each pump VFD shall be equipped with a Local/Off/Remote selector switch, Start/Stop pushbuttons, an E-Stop pushbutton, potentiometer for speed control, speed indication, and a Run indicating light. Pump 1, 2, and 5, each have a pumping capacity of 40 cfs. Pump 3 and 4, each have a pumping capacity of 5 cfs.
2. All level setpoints described in the pump controls below shall be continually active for a minimum of 30 seconds before the PLC executes the function(s) related to corresponding level setpoint.
3. Ramp up time for pump to reach minimum speed and start pumping shall be set to five (5) seconds in all five (5) VFDs.
4. When the Local/Off/Remote selector switch on the VFD is in the Local position, the start/stop pushbuttons and the potentiometer on the VFD shall control the pump. When the

Local/Off/Remote selector switch on the VFD is in the Off position, the corresponding pump shall not operate manually from the VFD or remotely from the PSCP. When the Local/Off/Remote selector switch on the VFD is in the Remote position, the corresponding pump control shall be based on the control signals received from the PSCP. Operation of the pumps under normal conditions shall be automatic by the PLC in the PSCP. When in Remote, soft controls shall be available to the operator at the OIT located on the PSCP and at the remote SCADA HMI at the---------- treatment plant.

5. When Local/Off/Remote selector switches on the VFDs for pumps 3 and 4 are in the Remote position, pumps 3 and 4 shall operate as follows:
   a. The OIT on the PSCP shall have a soft Auto/Manual selector switch for each pump. In Manual mode, start/stop control of the pump shall be by the soft pushbuttons and speed control shall be by the speed settings on the OIT. Manual control is intended for maintenance and emergency operation only. In Auto mode, the pumps shall be controlled as follows:
      1) Pumps 3 and 4 shall operate in a Lead/Lag configuration. The operator shall be able to select the Lead and Lag pumps manually or select "Auto Alternation" mode based on pump runtimes.
      2) The pump selected as Lead shall start when the level rises to an operator adjustable start setpoint. The adjustable setpoint range for pump start shall be 4' to 5' (EL. -11'.0" to EL. -10'.0") measured from the bottom of the wet well. Use 4' (EL. -11'.0') for the initial startup setpoint.
      3) If the Lead pump fails to start or trips while running, the Lag pump shall start immediately and take the place of the Lead pump. A pump failure alarm shall be generated for the failed pump and displayed on the OIT and on the remote SCADA HMI.
      4) When pump speed reaches its minimum speed setpoint and the five (5) second ramp up time has elapsed, the VFD shall continually vary the pump speed based on the speed control signal received from the PSCP to maintain an operator adjustable wet well level. The adjustable level setpoint shall have a range between 2.5' to 3.5' (EL. -11'.6" to EL. -12'.6") measured from the bottom of the wet well. Use 3' (EL. -12'.0') for the initial startup setpoint. When the wet well level rises above the setpoint, pump speed shall rise proportionally and when the wet well level drops below the setpoint, pump speed shall decrease proportionally to maintain the selected level in the wet well.
      5) If wet well level does not fall below the pump start setpoint (described in item 2 above) within two (3) minutes after the Lead pump has started and is running at full speed, the Lag pump shall start.
      6) If the Lead pump is running at full speed and the wet well level cannot be maintained at the level setpoint described in item 4 above and continues to rise above the pump start setpoint (setpoint described in item 2 above), the Lag pump shall start.
      7) When the Lag pump speed reaches its minimum speed setpoint and the five (5) second ramp up time has elapsed, the PLC shall increase the Lag pump speed in increments of 10% every ten (10) seconds until the Lag pump speed matches the Lead pump speed. When the Lag pump speed matches the Lead pump, the PLC shall deactivate incremental speed control and vary both pump speeds together to maintain the selected wet well level setpoint, described in item 4 above.
      8) When both pumps 3 and 4 (Lead and Lag) are running at minimum speed and the wet well level drops below Lag pump off set point, the Lag pump shall shut down. The non-operator adjustable level setpoint for Lag pump off shall be 1.5' (EL. -13'.6") measured from the bottom of the wet well.
      9) When the Lead pump is running at its minimum speed and the wet well level drops below the Lead pump off set point, the Lead pump shall shut down. The

non-operator adjustable level setpoint for Lead pump off shall be 3.5' (EL. -15'.6") measured from the bottom of the Lead pump sump pit.

6. When the Local/Off/Remote selector switches on the VFDs for pumps 1, 2, and 5 are in the Remote position, pumps 1, 2, and 5 shall operate as follows:
   a. The OIT on the PSCP shall have a soft Auto/Manual selector switch for each pump. In Manual mode, start/stop control of the pump shall be by the soft pushbuttons and speed control shall be by the speed settings on the OIT. Manual control is intended for maintenance and emergency operation only. In Auto mode, the pumps shall be controlled as follows:
      1) Pumps 1, 2, and 5 shall operate in a Lead/Lag-1/Lag-2 configuration. The operator shall be able to select Lead, Lag-1, and Lag-2 pumps manually or select "Auto Alternation" mode based on pump runtimes.
      2) The pump selected as Lead shall start when the level rises to an operator adjustable start setpoint. The adjustable setpoint range for pump start shall be 11' to 13' (EL. -4'.0" to EL. -2'.0") measured from the bottom of the wet well. Use 12' (EL. -3'.0') for the initial startup setpoint.
      3) If Lead pump fail to start or trips while running, the Lag-1 pump shall start immediately and take the place of the Lead pump. A pump failure alarm shall be generated for the failed pump and displayed on the OIT and remote SCADA HMI. If the Lag-1 pump fails to start or trips while running, the Lag-2 pump shall start immediately and take the place of the failed pump. A pump failure alarm shall be generated for the failed pump and displayed on the OIT and on the remote SCADA HMI.
      4) When pump speed reaches its minimum speed setpoint and the five (5) second ramp up time has elapsed, the VFD shall continually vary the pump speed based on the speed control signal received from the PSCP to maintain an operator adjustable wet well level. The adjustable level setpoint shall have a range between 8' to 10' (EL. -7'.0" to EL. -5'.0") measured from the bottom of the wet well. Use 9' (EL. -6'.0') for the initial startup setpoint. When the wet well level rises above the setpoint, pump speed shall rise proportionally and when the wet well level falls below the setpoint, pump speed shall decrease proportionally to maintain the selected level in the wet well.
      5) If the wet well level does not fall below the pump start setpoint (described in item 2 above) within three (3) minutes after the Lead pump has started and is running at full speed, the Lag-1 pump shall start.
      6) If the Lead pump is running at its full speed and the wet well level cannot be maintained at the level setpoint described in item 4 above and continues to rise above the pump start setpoint (setpoint described in item 2 above), the Lag-1 pump shall start.
      7) When the Lag-1 pump speed reaches its minimum speed setpoint and the five (5) second ramp up time has elapsed, the PLC shall increase Lag-1 pump speed in increments of 10% every ten (10) seconds until the Lag-1 pump speed matches the Lead pump speed. When the Lag-1 pump speed matches the Lead pump, the PLC shall deactivate incremental speed control and vary both pump speeds together to maintain the selected wet well level setpoint, described in item 4 above.
      8) If the Lead and Lag-1 pumps are running at full speed and the wet well level cannot be maintained at the level setpoint described in item 4 above and continues to rise above the pump start setpoint described in item 2 above, the Lag-2 pump shall start.
      9) When Lag-2 pump speed reaches its minimum speed setpoint and the five (5) second ramp up time has elapsed, the PLC shall increase the Lag-2 pump speed

in increments of 10% every ten (10) seconds until the Lag-2 pump speed matches the Lead and Lag-1 pump speed. When the Lag-2 pump speed matches the Lead and Lag-1 pump speed, the PLC shall deactivate incremental speed control and vary all three pumps' speeds together to maintain the selected wet well level setpoint, described in item 4 above.

10) When all 3 pumps are running at minimum speed and the wet well level drops below the Lag-2 pump off set point, the Lag-2 pump shall shut down. The non-operator adjustable level setpoint for Lag-2 pump off shall be 7' (EL. -8'.0") measured from the bottom of the wet well.
11) When the Lead and Lag-1 pumps are running at minimum speed and the wet well level drops below the Lag-1 pump off set point, the Lag-1 pump shall shut down. The non-operator adjustable level setpoint for Lag-1 pump off shall be 6' (EL. -9'.0") measured from the bottom of the wet well.
12) When the Lead pump is running at minimum speed and the wet well level drops below the Lead pump off set point, the Lead pump shall shut down. The non-operator adjustable level setpoint for Lead pump off shall be 5' (EL. -10'.0") measured from the bottom of the wet well.
13) Pumps 3 and 4 shall continue to operate as described in article C.5 above.

7. Interlocks and Alarms:
   a. In any mode of operation if the following conditions occur, the pump shall shut down, and an alarm shall be generated:
      1) Motor Winding High Temperature
      2) Motor Housing Leakage
      3) Motor Overload
      4) Ground Wire Fail
   b. In any mode of operation, if the emergency stop pushbutton is pressed, the pump shall stop, and an alarm shall be generated.
   c. Individual wet well level high level alarm for wet well 1 and 2.
   d. An alarm shall be generated upon high differential level across the upstream and downstream of the bar screen.

2.7 SOURCE QUALITY CONTROL

A. General:
   1. Factory Test:

a. Representatives of OWNER, OWNER assigned Programmer, and ENGINEER will witness factory test at testing facility during operational test of equipment, either for individual units or as an integrated system. Give minimum of 30 days' notice to ENGINEER prior to the proposed testing date so that arrangements for test witnessing can be made. Presence of OWNER and ENGINEER during testing does not relieve CONTRACTOR from complying with the Contract Documents and shall not imply acceptance of equipment. When factory tests have been successfully completed, a submit factory test report to ENGINEER.

2. OWNER assigned Programmer will upload the PLC Program and HMI Software prior to the start of the Factory Test.
3. Factory test results will be acceptable when all components within tested control panel or system being tested successfully operate and meet its intended function, and are so certified by the testing entity.
4. Do not ship the equipment until obtaining ENGINEER's acceptance of factory test results.

B. Factory Inspection:
1. Inspect each panel, console, device, and cabinet before testing and before shipping. Inspection shall include, but not be limited to the following:
   a. Verify all "Approved as Corrected" comments on Shop Drawings were implemented.
   b. Verify presence of and accuracy of nameplates and tags.
   c. Verify that wire sizes and color-coding comply with the Contract Documents.
   d. Verify presence of terminal blocks, terminal block numbers, and required quantity of spares.
   e. Verify annunciator window engravings and quantity of spare windows comply with the Contract Documents.
   f. Verify proper wiring practices and grounding.
   g. Verify enclosure flatness, finish, and color.
   h. Verify anchoring of wire bundles between subpanels and front panel-mounted devices.
   i. Verify presence of applicable items specified in this Section.
   j. Check and verify software licenses for latest release and license types.

C. Panel Operational Testing:
1. Test all input/output components to verify that internal panel wiring is properly terminated at correct locations. Verify initial ranges and settings.
2. Test all system hardware and software to verify proper operation as stand-alone units. Test shall include, but not be limited to, the following:
   a. Power distribution and breaker ratings to match approved Shop Drawings.
   b. Power fail/restart tests.
   c. Diagnostics checks.

d. Demonstrate that all specified equipment functional capabilities are working properly.
e. Check and verify process displays are in accordance with approved Shop Drawings.

3. Test components and devices requiring data transmission to verify that communication between such components is working properly. Verify communication by using the same media required for the completed system at the Site as indicated in the Contract Documents.
4. Test system performance using simulated inputs. Signal generators shall be appropriately sized and calibrated for full range of use and shall have a power source to accommodate not less than a full day of testing.
5. Simulation devices shall be of suitable quality to not mask control panel defects.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Environmental Requirements:
1. Do not install instruments in areas where construction may cause instrument to be damaged, without providing adequate protection for said instrument.

B. Installation of Instrumentation:
1. Secure field-mounted instruments to stands or brackets in accordance with manufacturer's recommendations, approved or accepted (as applicable) submittals, and the Contract Documents.
2. Locate sensors where shown on the Drawings. Confirm exact locations in the field with ENGINEER.
3. Install all devices so that devices are readily accessible for service and do not cause potential hazards.

C. Services and Operator Instructions:
1. Provide repairs or replacement of defective materials, equipment or workmanship, including with respect to equipment, the services of factory-trained servicemen.
2. In addition to the calibration required for check-out, provide two additional calibrations on all instruments. The first re-calibration shall be approximately six months after acceptance of the system, and the second shall be approximately eleven months after acceptance. As part of each

calibration, provide two copies of the calibration sheets, a detailed list of deficiencies (should any be found), and a statement that the entire system is in proper operation and condition (except for the deficiencies noted) and shall be turned over to the OWNER.

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections: Field-verify calibration and performance of each instrument prior to start-up of the associated equipment, and document on a separate sheet for each.
   1. For each calibration certification sheet, include the following information:
      a. Project name.
      b. Tag number and description.
      c. Manufacturer.
      d. Model and serial number.
      e. Date, time and person who performed calibration.
      f. Calibration data to include.
         1) Input, output, and error at 0, 25, 75, and 100 percent of span for analog instruments.
         2) Switch setting, contact action and deadband, if applicable, for discrete elements.
      g. Space for comments.
      h. Signature and date.
   2. System Check-Out and Start-Up Responsibilities:
      a. CONTRACTOR shall retain the services of the I&C Subcontractor to supervise and/or perform check-out and start-up of all system components. As part of these services, the I&C Subcontractor shall include for those equipment items not manufactured by him the services of an authorized manufacturer's representative to check the equipment installation and place the equipment in operation. The manufacturer's representative shall be thoroughly knowledgeable about the installation, operation and maintenance of the equipment.
      b. Check and approve the installation of all instrumentation and control system components and all cable and wiring connections between the various system components prior to placing the various processes and equipment into operation.
      c. Conduct a complete system checkout and adjustment, including calibration of all instruments, tuning of control loops, and checking operation functions. When there are future operational functions included in the Work, they should be included in the system checkout. All problems encountered shall be promptly corrected to prevent any delays in start-up of the various unit processes.
      d. CONTRACTOR shall provide all test equipment necessary to perform the testing during system checkout and start-up.
      e. CONTRACTOR shall furnish to the ENGINEER certified calibration reports for field instruments and panel mounted devices specified in this Section as soon as calibration is completed.

f. CONTRACTOR shall furnish ENGINEER an Installation Inspection Report certifying that all equipment has been installed correctly and is operating properly. The report shall be signed by authorized representatives of both CONTRACTOR and the I&C Subcontractor.

g. Instrumentation and Control System Field Test:

1) Following demonstration of all system functions, the instrumentation and control system, including field sensors/transducers and instruments, and telemetry system shall be running and fully operational for a continuous 48 hour period.

3.4 MANUFACTURER'S SERVICES

A. General:

1. CONTRACTOR shall retain the services of the I&C Subcontractor to provide operation and maintenance training for all instrumentation and control system equipment as specified herein.
2. For equipment items not manufactured by the I&C Subcontractor, he shall provide for on-Site training by an authorized representative of the equipment manufacturer as part of his services. The manufacturer's representative shall be fully knowledgeable in the operation and maintenance of the equipment.
3. CONTRACTOR shall be responsible for all costs associated with training and shall provide all required materials, texts and required supplies.
4. Training shall conform to the requirements of Division 1, Equipment Demonstration / Instruction.

B. On-Site Training:

1. General:
   a. Provide on-site operation and maintenance training by I&C Subcontractor and the equipment manufacturer representatives prior to placing the equipment in continuous operation.
   b. Training courses shall include time for students to develop and demonstrate understanding of training concepts. Testing shall include hands on training with equipment.
   c. At the conclusion of each course students shall be tested on course material. Testing shall include exercises where students must demonstrate proper response to normal operational needs, emergencies and maintenance tasks. Every student shall be tested individually.
   d. Training shall accomplish the following:
      1) Provide instruction covering use and operation of the equipment to perform the intended functions.
      2) Provide instruction covering procedures for routine, preventive and troubleshooting maintenance, including equipment calibration.
      3) Explain procedures for placing the equipment in and out of operation and explain necessary actions and precautions to be taken regarding the overall plant monitoring and control system.

4) Provide classes and field training as to how to change process control and alarm set points in all microprocessor based controllers and transmitters. Maintenance personnel shall be trained to enter passwords, programming or configuration data, etc.

3.5 SUPPLEMENTS

A. The supplements listed below, following the "End of Section" designation, are part of this Specification section.

B. Data Sheets – Primary Sensors and Field Instruments

C. Input/Output List

+ + END OF SECTION + +

SECTION 43 26 23

STAINLESS STEEL SLIDE GATES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install stainless steel slide gates and appurtenances complete and operational.
   2. Included are stainless steel slide gates, anchorage systems and all appurtenances.
   3. Extent of the equipment is shown on the Stainless Steel Slide Gate Schedule located at the end of this Section.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before the stainless steel slide gates Work.
   2. Notify other contractors in advance of the installation of the stainless steal slide gates to provide them with sufficient time for the installation of items included in their contracts that must be installed with, or before, the stainless steel slide gates Work.

C. Related Sections:
   1. Section 03 30 00, Cast-In-Place Concrete.
   2. Section 03 60 00, Grouting.
   3. Section 05 05 33, Anchor Systems.
   4. Section 09 91 00, Painting. (Specifications for Surface Preparation and Shop Painting required under Section 43 26 23, Stainless Steel Slide Gates, are under Section 09 91 00, Painting.)

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
   1. American Society for Testing and Materials, (ASTM).
      a. ASTM A 276, Specification for Stainless Steel Bars and Shapes.
      b. ASTM B 584, Specification for Copper Alloy Sand Castings for General Applications
   2. National Electrical Code, (NEC).
   3. National Electrical Manufacturers' Association, (NEMA).

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have a minimum of five years of experience of producing substantially similar equipment and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.
   2. Stainless steel slide gates shall be the product of one manufacturer.

B. Component Supply and Compatibility:
   1. Obtain all equipment included in this Section regardless of the component manufacturer from a single stainless steel slide gate manufacturer.
   2. The stainless steel slide gate equipment manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
   3. All components shall be specifically designed for the specified service and shall be integrated into the overall assembly by the stainless steel slide gate equipment manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Fabrication, assembly and installation diagrams.
      b. Setting drawings, templates, and directions for the installation of anchor bolts and other anchorages.
      c. Wiring diagrams for electric motor operators.
   2. Product Data:
      a. Manufacturer's literature, illustrations, specifications and engineering data.
      b. Deviations from the Contract Documents.
      c. Lubricant Specification: Furnish a lubricant specification for the type and grade necessary to meet the requirements of the equipment.

B. Informational Submittals: Submit the following:
   1. Support Design Information:
      a. Submit for record purposes only the weight of each slide gate and expected opening and closing thrust loads on the supporting structure.
   2. Shop Test Results:
      a. Submit results of required shop tests.
   3. Field Test Results:
      a. Submit a written report giving the results of the field tests required.

C. Closeout Submittals:
   1. Operation and Maintenance Manuals:
      a. Submit complete Installation, Operation and Maintenance Manuals including, test reports, maintenance data and schedules, description of operation and spare parts information.

b. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operations and Maintenance Data.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:
   1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of that Work.
   2. Handle all stainless steel slide gates and appurtenances properly, in accordance with manufacturer's recommendations. Stainless steel slide gates, which are distorted or otherwise damaged, will not be acceptable. Protect all bolt threads and ends from damage.

B. Storage and Protection:
   1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
   2. Store all mechanical equipment in covered storage off the ground and prevent condensation.

C. Acceptance at Site:
   1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. General:
   1. Design stainless steel slide gates to safely withstand conditions listed in Stainless Steel Slide Gate Schedule, located at the end of the Section.
   2. Stainless steel slide gates shall be substantially watertight with leakage less than 0.5 gpm per foot of seating perimeter at design head.
   3. Manual operators shall turn right to close, unless otherwise specified. Operators shall indicate the direction of operation.
   4. Bolts, studs, cap screws, and adjusting screws shall be of ample section to withstand the force created by operation of the gate under a full head of water.

2.2 MANUFACTURERS

A. Manufacturers: Provide equipment of one of the following:
   1. RW Gate Company
   2. Whipps, Inc.
   3. Or equal.

2.3 FABRICATION

A. Description:
   1. Comply with AWWA C561 or as modified herein.
   2. Self-contained stainless-steel slide gate, with extended frame, yoke, lifting stem attached to yoke, lift and lift support, stem, stem guide, and stem block.
   3. Non-self-contained stainless-steel slide gate, with limited frame, lifting stem, lift and lift support, stem, stem guide, and stem block.
   4. Size: See Stainless Steel Slide Gate Schedule at the end of this section.
   5. Operating Head: See Stainless Steel Slide Gate Schedule at the end of this section.
   6. Closure: See Stainless Steel Slide Gate Schedule at the end of this section.
   7. Opening: See Stainless Steel Slide Gate Schedule at the end of this section.
   8. Actuator: See Stainless Steel Slide Gate Schedule at the end of this section.
   9. Gear Box: Provided by manufacturer as required to eliminate a conflict between the actuator and the adjacent wall when mounting surface extends above the actuator.

B. Gates: Type 316 stainless steel, with disc arranged to lower or raise to open and with guides designed to mount on the face of or embedded in concrete.
   1. Disc or Sliding Member: Type 316 and the stainless-steel plate reinforced with stainless steel structural members welded to the plate not more than 16 inches apart.
      a. Deflection: Not greater than 1/360 of span of the gate, or 1/16-inch, whichever is less, under the design head.
      b. Reinforcing Ribs: Extend into guides so they overlap seating surface of the guide.
      c. The portion of the disc that engages the guide shall have a minimum thickness of 1/2- inch.
      d. A Specially Extruded Resilient Seal:
         1) Mounted on the invert member with stainless-steel attachment bolts to provide flush bottom closure.
         2) Seal Shape: Produce a seating surface with minimum width of 3/4 inch.
         3) Vertical Seal Face: In contact with seating surface of guide providing a proper seal at the corners.
      e. Reinforcements, Retainer and Bolts: Same material as disc.
   2. Configuration: Removable.

C. Guides: Type 316 stainless-steel construction, designed for maximum rigidity, weighing a minimum of 13 lbs. per foot for face mounted frames and 6.5 lbs. per foot for embedded or in-channel mounted frames.
   1. The structural members for the guide and guide extensions are to be formed into a one-piece shape for rigidity.
   2. Holes for anchor bolts to be provided at a distance of every 18 inches for face mounted units or embedding keyways for embedded units or are to be spaced as required to handle the design pressure for the application, whichever is less.

3. Centerline of anchor holes to be located 7" from the wall opening or exterior of the wall pipe. Manufacturer to utilize three sided guide frame and increase size of slide to meet anchor location requirement.
4. The portion of the face-mounted frame, where the anchor bolts penetrate, will have a minimum thickness of 1/2-inch.
5. Guides to extend beneath opening a sufficient amount to support the disc in fully down or open position for downward opening gates.
6. Guides extensions to be "C" shaped stainless-steel members, or similar, for rigidity, weighing a minimum of 6.5 lbs. per foot.
7. The gate frame may require a spliced connection for disassembly when installing inside an existing building. Contractor to coordinate with gate manufacturer.

D. Gate Seal:

1. Gate to be sealed with UV stabilized, self-adjusting UHMWPE material with a nitrile compression cord.
2. Seal to be placed in a stainless-steel channel, welded to the guides of the gate.
3. Seals to be provided on the sides of gate, and along the top seal member.
4. Deflection: Arrange seal to have a minimum deflection of 1/16-inch.
5. Attachment hardware to be same material as the guides.

E. Yokes: Type 316 stainless-steel construction with the yoke supporting the operating benchstand.
1. Formed by welding two "C" channels to the top of the guides to provide a single piece rigid frame.
2. Arrangement: Disc and stem to be removable without disconnecting the yoke.
3. Top of yoke height: Minimum – 42".
4. Off-set yoke maybe utilize to accommodate slide travel.

F. Lifting Nut: Brass.
1. Grease fitting on manual operators.
2. Roller bearings or ball bearings above and below lifting nut.

G. Lifting Stem: Type 316 stainless steel for the entire length.
1. Tensile Strength: 60,000 psi.
2. Diameter: Of sufficient size at base of thread to lift the weight of the gate, offset the resistance of the gate to the maximum unbalanced head fully allow for starting impact, and withstand at least twice the rated output of the actuator. Minimum diameter is 1-1/2-inches.
3. Slenderness Ratio (l/r): Less than 200.
4. Non-rising stems shall have a bronze nut mounted on the slide. Equip stems with adjustable bronze stop collars above and below the lift nut preventing over opening or over closing the gate. Stops on the frame and disc are also acceptable.
5. Stem Guides: Type 316 stainless steel, UHMWPE bushed, mounted in a Type 316 stainless-steel bracket. Adjustable in two directions and spaced at sufficient intervals to adequately support the stem.

6. For non-rising stems and off-set yoke configurations, stem may connect to the downstream side of the slide.
7. Configuration: Removable.
8. Thread: Full depth machine rolled, Acme type, double lead threads.
9. Finish: 16 micro inch or better
10. Stem Covers: Provide rising stem gates with clear fracture resistant butyrate plastic covers.
    a. Will not discolor or become opaque for a minimum of 5 years after installation.
    b. Capped, vented, and of a length to allow full travel of gate.
    c. Bottom end mounted in a housing or adapter plate for easy field mounting.
    d. Indicator markings showing gate position.

H. Gate actuator location: Center to be a maximum of 5 feet above operating level.

2.4 FINISHES

A. Stainless-Steel Surfaces: Mill finish.

B. Welds to be passivated in accordance with ASTM A380. If bead blasting is utilized, the entire slide, frame and stop log shall be blasted for a uniform finish.

2.4 APPURTENANCES

A. Hardware: Type 316 stainless steel. Conform to ASTM A276 or A193/A194 and F593/F594 unless otherwise specified.

B. Attaching Bolts and Anchor Bolts: Type 316 stainless steel. Furnished by manufacturer.

C. Nameplates: Each gate and stop log is to be provided with a nameplate that includes the manufacturer's name, opening size and maximum head rating, as a minimum. Nameplate to be mounted on the gate yoke or pedestal, or on each stop log.

D. Manual Operators:
1. Manual operation shall be by handwheel or crank operated floorstand or benchstand as shown and specified.
2. Handwheel-operated type shall be without gear reduction and crank-operated type will have either a single or double gear reduction, as required. Each type shall be provided with a threaded cast manganese bronze lift nut to engage the operating stem.
3. Provide anti-friction bearings to properly support both opening and closing thrusts.
4. Stands shall operate the gates under the specified operating head with not greater than a 40-pound pull on the crank or handwheel.
5. All components shall be totally enclosed in a cast-iron weather-proof housing. Provide positive mechanical seals to exclude moisture and dirt and prevent leakage of lubricant out of the unit.

6. Provide lubricating fittings for all gears and bearings.
7. Stands shall include a cast-iron pedestal designed to position the input shaft approximately 36-inches above the operating floor. An arrow with the word "OPEN" shall be permanently attached or cast on the floorstand indicating the direction of rotation to open the stainless steel slide gate.
8. Removable cranks shall be cast-iron with a revolving brass grip. Removable handwheel shall be fabricated steel designed for rough treatment and minimum weight.
9. For self-contained type stainless steel slide gates, the distance between handwheel or crank operator and the operating floor shall be 36-inches minimum and 48-inches maximum.
10. Crank-operated gates shall be provided with nut-operator drives as noted on Stainless Steel Slide Gate Schedule.
11. Operators shall be furnished with a limit switch to indicate fully closed position, where shown.
12. Provide mechanical stops adjustable ±five degrees at each end of travel.

E. Electric Operators:
1. Electric motor operators shall be furnished for continuous duty, open-close operation.
2. Electric motor operator shall be capable of providing not less than 1-1/2 times the required operator torque for opening and closing of the stainless steel slide gate.
3. Operator shall be of NEMA 4X construction and furnished with a handwheel for manual operation.
4. Operator gear reducer shall be provided with a pair of limit switches and torque switches and a reversing contactor. The torque switches shall be adjustable.
5. Limit switches furnished for all stainless steel slide gates shall be equipped with 16 contacts (four rotors with four contacts each). Contacts shall open and close as shown.
6. Reversing starter, limit switches, and torque switches shall be supplied in NEMA 4X enclosures, furnished and mounted on the operators.
7. Where shown, furnish a resistance-to-current converter for remote position indication.
8. Electric motor shall be totally enclosed, sized to open or close the stainless steel slide gate full cycle in approximately 30 seconds, and suitable for operation on 480 volt, 3 phase, 60 Hz power. All electrical equipment, which is mounted on the operator, shall be housed in NEMA 4X enclosures.
9. Starter shall include an adequately sized, fused, control power transformer, 480 volt primary and 120 volt secondary.
10. Manufacturer shall comply with all requirements of the electrical control schematic diagrams as shown.
11. The stainless steel slide gates shall be controlled as shown.
12. Where shown or specified, provide electric operator for modulating continuous duty service.
13. Provide mechanical stops adjustable ±five degrees at each end of travel.
14. Electric motor operator shall include a thermostatically controlled space heater.

15. A handwheel shall be provided for manual operation. It shall not rotate during motor operation. The change from motor operation to handwheel operation shall be accomplished by a positive declutching device, which shall disengage the motor and motor gearing mechanically, but not electrically. Hand operation shall not require more than 80 pounds of rim effort at maximum required torque.
16. Each stainless steel slide gate actuator shall be provided with an integral dial-type disc position indicator.
17. Manufacturers: Provide equipment of one of the following:
    a. AUMA.
    b. EIM.
    c. Or equal.

F. Identification: Identify each stainless steel slide gate with a stainless steel nameplate stamped with the approved designation as shown in the Stainless Steel Slide Gate Schedule, located at the end of this Section. Nameplate shall be permanently fastened to the gate at the factory.

2.5 SURFACE PREPARATION AND PAINTING

A. Clean, prime coat, and finish coat ferrous metal surfaces of equipment in the shop in accordance with the requirements of Section 09 91 00, Painting.

B. Coat machined, polished and non-ferrous surfaces bearing surfaces and similar unpainted surfaces with corrosion prevention compound, which shall be maintained during storage, and until equipment begins operation.

C. CONTRACTOR shall certify, in writing, that the shop primer and coating system conforms to the requirements of Section 09 91 00, Painting.

2.6 SOURCE QUALITY CONTROL

A. Shop Tests:
1. Test each stainless steel slide gate fully assembled in the vertical position for proper seating.
2. Fully open and close gate disc in its guide system to ensure that it operates freely.
3. Operate and test floor stands, bench stands and motor operators to ensure proper assembly and operation.

2.7 SLIDE GATE SCHEDULE

A. The Stainless Steel Slide Gate Schedule is located at the end of this Section. Conform to type, size, operation and other data specified, unless otherwise approved by ENGINEER.

B. Provide all stainless steel slide gates as shown and listed in the schedule.

C. Schedule Abbreviation:
   1. Type:
      a. SM - Surface Mounted Frame.
   2. Operator Type:
      a. MO - Motor Operated.

D. The seating and unseating design head as stated in the Stainless Steel Slide Gate Schedule is based on the head measured to the centerline of the gate in its closed position.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install stainless steel slide gate equipment in accordance with manufacturer's instructions and recommendations.

B. Brace guides and frames during placement of concrete.

C. Set anchor bolts in accordance with approved Shop Drawings and manufacturer's recommendations.

D. Provide minimum of 1-inch of non-shrink grout below all floorstands.

E. Adjust all parts and components as required to provide correct operation.

3.2 START-UP AND FIELD TESTS

A. After CONTRACTOR and ENGINEER have mutually agreed that the equipment installation is complete and ready for continuous operation, CONTRACTOR and a qualified field service representative of the manufacturer shall conduct a functional field test and a leakage test of each stainless steel slide gate in the presence of ENGINEER to demonstrate that each stainless steel slide gate furnished will function correctly and that maximum permissible leakage is not exceeded.
   1. Functional Tests:
      a. Each stainless steel slide gate with appurtenances shall be field-tested. Tests shall demonstrate to ENGINEER that each part and all parts together function in the manner intended. All necessary testing equipment and manpower shall be provided by CONTRACTOR at their expense. OWNER will furnish all power, and incidental material and labor required for the tests.
   2. Leakage Tests:
      a. Maximum permissible leakage shall be in accordance with the requirements of Paragraph 2.1, above. Excess leakage shall be reduced to meet specified requirements by adjusting the gate, or replacement will be required.
   3. In the event that the manufacturer is unable to demonstrate to ENGINEER that

their equipment meets the requirements of the tests, the deficient equipment will be rejected and CONTRACTOR shall adjust and/or modify and retest the equipment as often as necessary to meet the specified requirements. No separate payments shall be made for adjustments and/or modifications.

3.3 MANUFACTURER'S SERVICES

A. A factory trained representative shall be provided for installation supervision, start-up and test services and operation and maintenance personnel training services. The representative shall make a minimum of two visits, minimum 8 hours on-Site for each visit, to the Site. The first visit shall be for assistance in the installation of equipment. Subsequent visits shall be for checking the completed installation, start-up and training of the system. Manufacturer's representative shall test operate the system in the presence of the ENGINEER and verify that the equipment conforms to the requirements. Representative shall revisit the Site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.

B. All costs, including travel, lodging, meals and incidentals, for additional visits shall be at no additional cost to the OWNER.

STAINLESS STEEL SLIDE GATE SCHEDULE								
Gate ID	**Location**	**Type**	**Opening Size (W x H)**	**Mounting**	**Gate Invert Elevation**	**Floor Mounting Elevation**	**Design Head (Seating/ Unseating)[1]**	**Operator**
SG-1	Inlet Channel	Slide	4'x4'	SM	-12.5	6.75	9	MO
SG-2	Inlet Channel	Slide	4'x4'	SM	-12.5	6.75	9	MO
SG-3	Wetwell	Slide	4'x4'	SM	-11.5	NA	8	MO

Note 1: Design head measured from invert of gate.

+ + END OF SECTION + +

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