56 Prospect Street,
P.O. Box 270
Hartford, CT 06103

Kathleen M. Shanley
Manager – Transmission Siting
Tel: (860) 728-4527

October 22, 2020

Melanie A. Bachman
Executive Director
Connecticut Siting Council
10 Franklin Square
New Britain, CT 06051

RE: **Notice of Exempt Modification**
Eversource Site # 1384
48 Tolland Stage Road, Tolland, CT 06084
Latitude: 41-52-1.2 N / Longitude: 72-25-23.1 W

Dear Ms. Bachman:

The Connecticut Light and Power Company doing business as Eversource Energy ("Eversource") currently maintains multiple antennas and one (1) microwave dish at various mounting heights on an existing 94-foot self-support tower located at 48 Tolland Stage Road in Tolland. See Attachment A, Parcel Map and Property Card. The tower and property are owned by Eversource. Eversource plans to install one 17-foot 6-inch tall dipole antenna, to be mounted at approximately 70 feet above ground level ("AGL"), one 12-foot 7-inch tall omnidirectional antenna, to be mounted at approximately 93.5 feet AGL, and two 7/8-inch diameter coaxial cables. One existing antenna will be removed and the coaxial cable will be relocated for use by the proposed dipole antenna. There will be no changes to the area of the fenced compound or the tower. The tower and existing and proposed equipment on the tower are depicted on Attachment B, Construction Drawings, dated July 28, 2020 and Attachment C, Structural Analysis, dated July 31, 2020. The tower does not appear on the Council's data base. Eversource has owned the property since 1960 and developed its operations center there in the 1960's and 1970's. Public Act 77-218 granted jurisdiction over telecommunications towers to the Council. However, approvals for the tower (whether municipal or State through the predecessor to the Public Utilities Regulatory Authority), may have predated the transfer of jurisdiction. The tower has been in use solely by Eversource since its construction.

The proposed installation is part of Eversource's program to update the current obsolete analog voice radio communications system to a modern digital voice communications system. The new system will enable the highest level of voice communications under all operating conditions, including during critical emergency and storm restoration activities. The new radio system will also provide for remote control of distribution safety equipment.

Please accept this letter as notification pursuant to Regulations of Connecticut State Agencies ("R.C.S.A.") §16-50j-73, for construction that constitutes an exempt modification pursuant to R.C.S.A § 16-50j-72(b)(2). In accordance with R.C.S.A. § 16-50j-73, a copy of this notice is being delivered to Tammy Nuccio, Town Council Chair for the Town of Tolland, Michael Rosen, Town Manager for the Town of Tolland and Heidi Samokar, AICP, Director of Planning & Development for the Town of Tolland via private carrier. Proof of delivery is attached. See Attachment D, Proof of Delivery of Notice.

The planned modifications to the facility fall squarely within those activities explicitly provided for in R.C.S.A. § 16-50j-72(b)(2):

1. There will be no change to the height of the existing tower.
2. The proposed modifications will not require the extension of the site boundary.
3. The proposed modification will not increase noise levels at the facility by six decibels or more, or to levels that exceed state and local criteria.
4. The operation of the new antennas will not increase radio frequency emissions at the facility to a level at or above the Federal Communications Commission safety standard as shown in the attached Radio Frequency Emissions Report, dated August 31, 2020 (Attachment E – Power Density Report).
5. The proposed modifications will not cause a change or alteration in the physical or environmental characteristics of the site.
6. The existing structure and its foundation can support the proposed loading.

For the foregoing reasons, Eversource respectfully submits that the proposed modifications to the above referenced telecommunications facility constitute an exempt modification under R.C.S.A. § 16-50j-72(b)(2). One original copy of this notice has been provided via courier to the Council.

Communications regarding this Notice of Exempt Modification should be directed to Kathleen Shanley at (860) 728-4527.

By: ______________________________
Kathleen M. Shanley
Manager – Transmission Siting

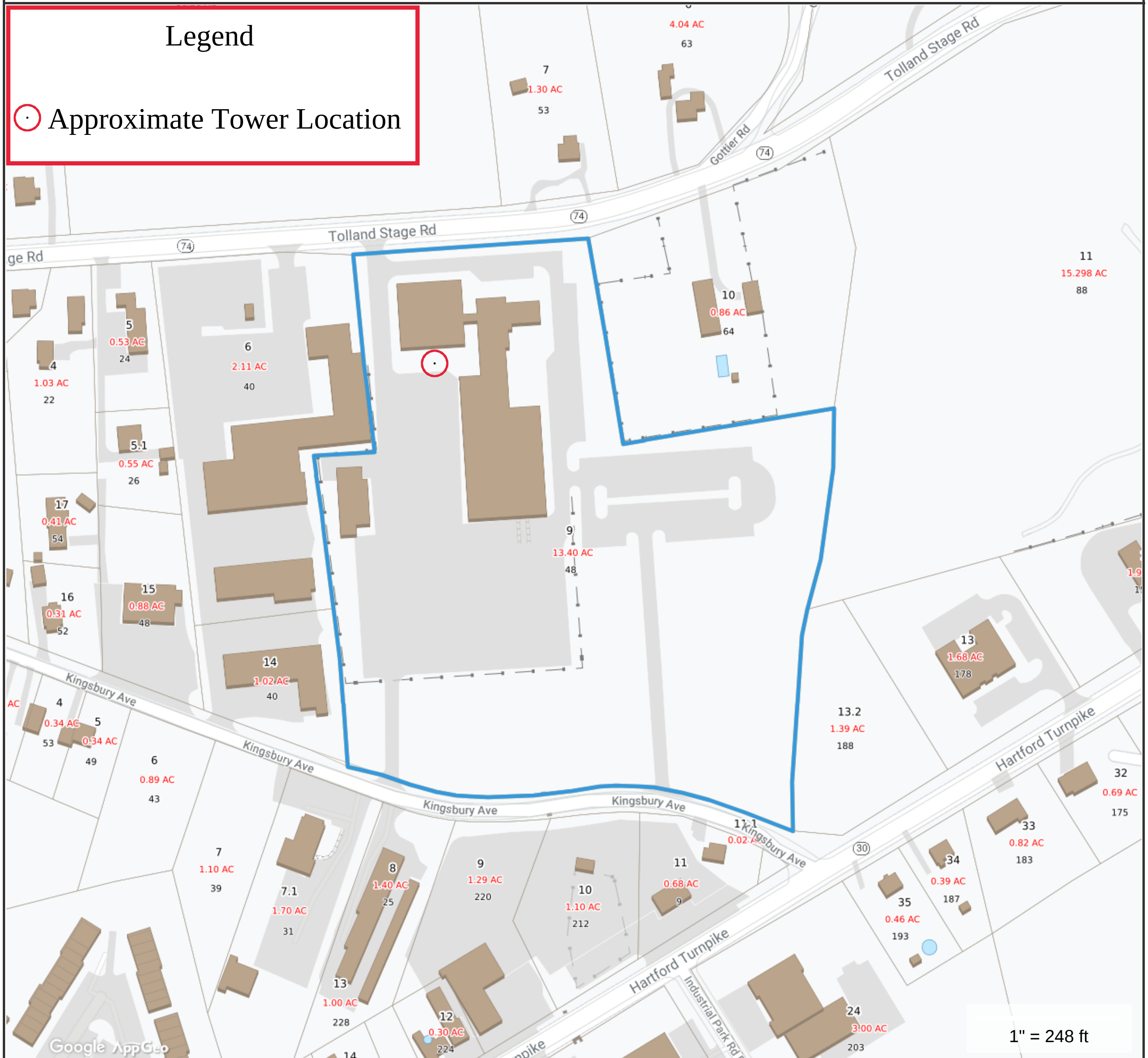
cc: Tammy Nuccio, Town Council Chair, Town of Tolland
Michael Rosen, Town Manager, Town of Tolland
Heidi Samokar, AICP, Director of Planning & Development, Town of Tolland

Attachments

A. Parcel Map and Property Card
B. Construction Drawings
C. Structural Analysis
D. Proof of Delivery of Notice
E. Power Density Report

ATTACHMENT A – PARCEL MAP AND PROPERTY CARD

ES-043 Tolland Parcel Map



Property Information

Property ID	12/C/009
Location	48 TOLLAND STAGE ROAD
Owner	CONNECTICUT LIGHT & POWER CO

MAP FOR REFERENCE ONLY
NOT A LEGAL DOCUMENT

Town of Tolland, CT makes no claims and no warranties, expressed or implied, concerning the validity or accuracy of the GIS data presented on this map.

Geometry updated 08/03/2020
Data updated 11/19/2018

48 TOLLAND STAGE ROAD

Location 48 TOLLAND STAGE ROAD

Mblu 12/ C/ 9/00 /

Acct# 1639

Owner CONNECTICUT LIGHT & POWER CO

Assessment $2,699,900

Appraisal $3,857,100

PID 1384

Building Count 2

Current Value

Appraisal			
Valuation Year	**Improvements**	**Land**	**Total**
2019	$2,870,900	$986,200	$3,857,100

Assessment			
Valuation Year	**Improvements**	**Land**	**Total**
2019	$2,009,600	$690,300	$2,699,900

Owner of Record

Owner CONNECTICUT LIGHT & POWER CO
Co-Owner
Address 107 SELDEN ST
BERLIN, CT 06037

Sale Price $1,086,096
Certificate
Book & Page 1129/ 148
Sale Date 12/29/2008
Instrument 25

Ownership History

Ownership History					
Owner	**Sale Price**	**Certificate**	**Book & Page**	**Instrument**	**Sale Date**
CONNECTICUT LIGHT & POWER CO	$1,086,096		1129/ 148	25	12/29/2008
INTERET PROPERTIES INC	$0		179/ 32	29	01/02/1900

Building Information

Building 1 : Section 1

Year Built: 1965
Living Area: 45,580
Replacement Cost: $2,637,009
Building Percent Good: 78

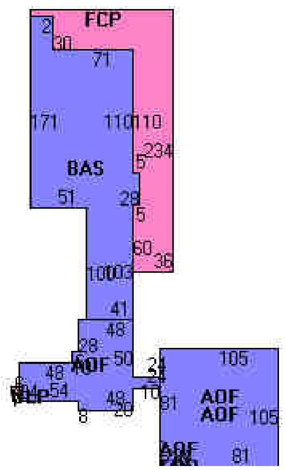
Replacement Cost
Less Depreciation: $2,056,900

Building Attributes	
Field	**Description**
STYLE	Warehouse
MODEL	Ind/Comm
Grade	Good
Stories:	1
Occupancy	1
Ext Wall 1	Pre-finsh Metl
Exterior Wall 2	Concr/Cinder
Roof Structure	Flat
Roof Cover	Tar & Gravel
Interior Wall 1	Minim/Masonry
Interior Wall 2	
Interior Floor 1	Concr Abv Grad
Interior Floor 2	Concr-Finished
Heating Fuel	Electric
Heating Type	Forced Air-Duc
AC Type	None
Bldg Use	Industrial
Total Rooms	
Total Bedrms	
Total Baths	
Solar	
1st Floor Use:	300
Heat/AC	Heat/AC Pkg
Frame Type	Masonry
Baths/Plumbing	Average
Ceiling/Wall	Sus Ceil Wall
Rooms/Prtns	Average
Wall Height	14
% Comn Wall	

Building Photo

(http://images.vgsi.com/photos/TollandCTPhotos//\00\00\79/95.jpg)

Building Layout



(http://images.vgsi.com/photos/TollandCTPhotos//Sketches/1384_1388.jpg

Building Sub-Areas (sq ft)			Legend
Code	**Description**	**Gross Area**	**Living Area**
AOF	Office	27,738	27,738
BAS	Main Floor	17,842	17,842
FCP	Carport, Paved	10,966	0
FOP	Open Porch	288	0
ULP	Loading Platform	42	0
		56,876	45,580

Building 2 : Section 1

Year Built: 1975
Living Area: 4,813
Replacement Cost: $355,480
Building Percent Good: 74
Replacement Cost
Less Depreciation: $263,100

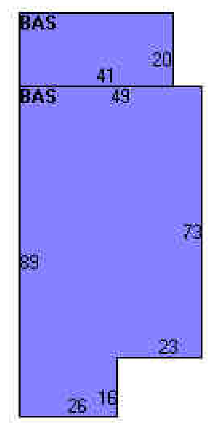
Building Attributes : Bldg 2 of 2	
Field	**Description**

STYLE	Comm Garage
MODEL	Ind/Comm
Grade	Average +20
Stories:	1
Occupancy	1
Ext Wall 1	Brick/Masonry
Exterior Wall 2	
Roof Structure	Flat
Roof Cover	Tar & Gravel
Interior Wall 1	Minim/Masonry
Interior Wall 2	
Interior Floor 1	Concr-Finished
Interior Floor 2	
Heating Fuel	Electric
Heating Type	Susp Space
AC Type	None
Bldg Use	Industrial
Total Rooms	
Total Bedrms	
Total Baths	
Solar	
1st Floor Use:	300
Heat/AC	None
Frame Type	Masonry
Baths/Plumbing	Average
Ceiling/Wall	None
Rooms/Prtns	Average
Wall Height	27
% Comn Wall	

Building Photo

(http://images.vgsi.com/photos/TollandCTPhotos//\00\00\61/87.jpg)

Building Layout



(http://images.vgsi.com/photos/TollandCTPhotos//Sketches/1384_1389.jpg

Building Sub-Areas (sq ft)			Legend
Code	**Description**	**Gross Area**	**Living Area**
BAS	Main Floor	4,813	4,813
		4,813	4,813

Extra Features

Extra Features				Legend
Code	**Description**	**Size**	**Value**	**Bldg #**
MEZ1	MEZZANINE-UNF	980 S.F.	$10,200	2
ELV	ELEVATOR	1 UNITS	$21,100	1
MEZ2	MEZZANINE-FIN	1200 S.F.	$20,600	1
A/C	AIR CONDITIONING	27738 S.F.	$43,300	1

Land

Land Use

Land Line Valuation

Use Code	300	**Size (Acres)**	13.4
Description	Industrial	**Frontage**	1139
Zone	CIZ	**Depth**	
Neighborhood	350C	**Assessed Value**	$690,300
Alt Land Appr	No	**Appraised Value**	$986,200
Category			

Outbuildings

Outbuildings						Legend
Code	**Description**	**Sub Code**	**Sub Description**	**Size**	**Value**	**Bldg #**
FN	FENCE	CL6	6' Chain Link	1220 L.F.	$7,900	1
PAV	PAVING	A	Asphalt	250000 S.F.	$200,000	1
PLS	POLES	L1	Lighting	25 UNITS	$37,500	1
FGR	GARAGE	1M	1 Stry Metal	1500 S.F.	$14,300	1
SHD	SHED	1F	1 Stry Frame	336 S.F.	$3,400	1
	SOLAR HEAT			1	$150,000	1
CNP	CANOPY	1G	Good	2128 S.F.	$42,600	1

Valuation History

Appraisal			
Valuation Year	**Improvements**	**Land**	**Total**
2018	$2,444,600	$986,200	$3,430,800
2017	$2,444,600	$986,200	$3,430,800
2015	$2,444,600	$986,200	$3,430,800

Assessment			
Valuation Year	**Improvements**	**Land**	**Total**
2018	$1,711,200	$690,300	$2,401,500
2017	$1,711,200	$690,300	$2,401,500
2015	$1,711,200	$690,300	$2,401,500

ATTACHMENT B – CONSTRUCTION DRAWINGS

EVERSOURCE ENERGY

TOLLAND AWC
48 TOLLAND STAGE ROAD
TOLLAND, CT 06084

PROJECT SUMMARY

THE GENERAL SCOPE OF WORK CONSISTS OF THE FOLLOWING:

1. INSTALL (2) NEW ANTENNAS, (1) OMIN/WHIP AT ELEVATION 104'–7 15/16"± AGL AND (1) DIPOLE ANTENNA AT ELEVATION 78'–9"± AGL
2. INSTALL (1) NEW RACK WITH DMR EQUIPMENT IN EXISTING BUILDING

GOVERNING CODES

2018 CONNECTICUT STATE BUILDING CODE (2015 IBC BASIS)
2017 NATIONAL ELECTRIC CODE
TIA–222–H

GENERAL NOTES

THE FACILITY IS UNMANNED AND NOT FOR HUMAN HABITATION. A TECHNICIAN WILL VISIT THE SITE AS REQUIRED FOR ROUTINE MAINTENANCE. THE PROJECT WILL NOT RESULT IN ANY SIGNIFICANT DISTURBANCE OR EFFECT ON DRAINAGE; NO SANITARY SEWER SERVICE, POTABLE WATER, OR TRASH DISPOSAL IS REQUIRED AND NO COMMERCIAL SIGNAGE IS PROPOSED.

SITE INFORMATION

SITE NAME:	TOLLAND AWC
SITE ID NUMBER:	#1384
SITE ADDRESS:	48 TOLLAND STAGE ROAD TOLLAND,M CT 06084
MAP:	12
BLOCK:	C
LOT:	9
ZONE:	CIZ
LATITUDE:	41° 52' 1.2" N
LONGITUDE:	72° 25' 23.1" W
ELEVATION:	557'± AMSL
FEMA/FIRM DESIGNATION:	C
ACREAGE:	13.4± AC (BOOK: 1129, PAGE: 148)

CONTACT INFORMATION

APPLICANTS:
EVERSOURCE ENERGY
107 SELDEN STREET
BERLIN, CT 06037

PROPERTY OWNER:
EVERSOURCE ENERGY
107 SELDEN STREET
BERLIN, CT 06037

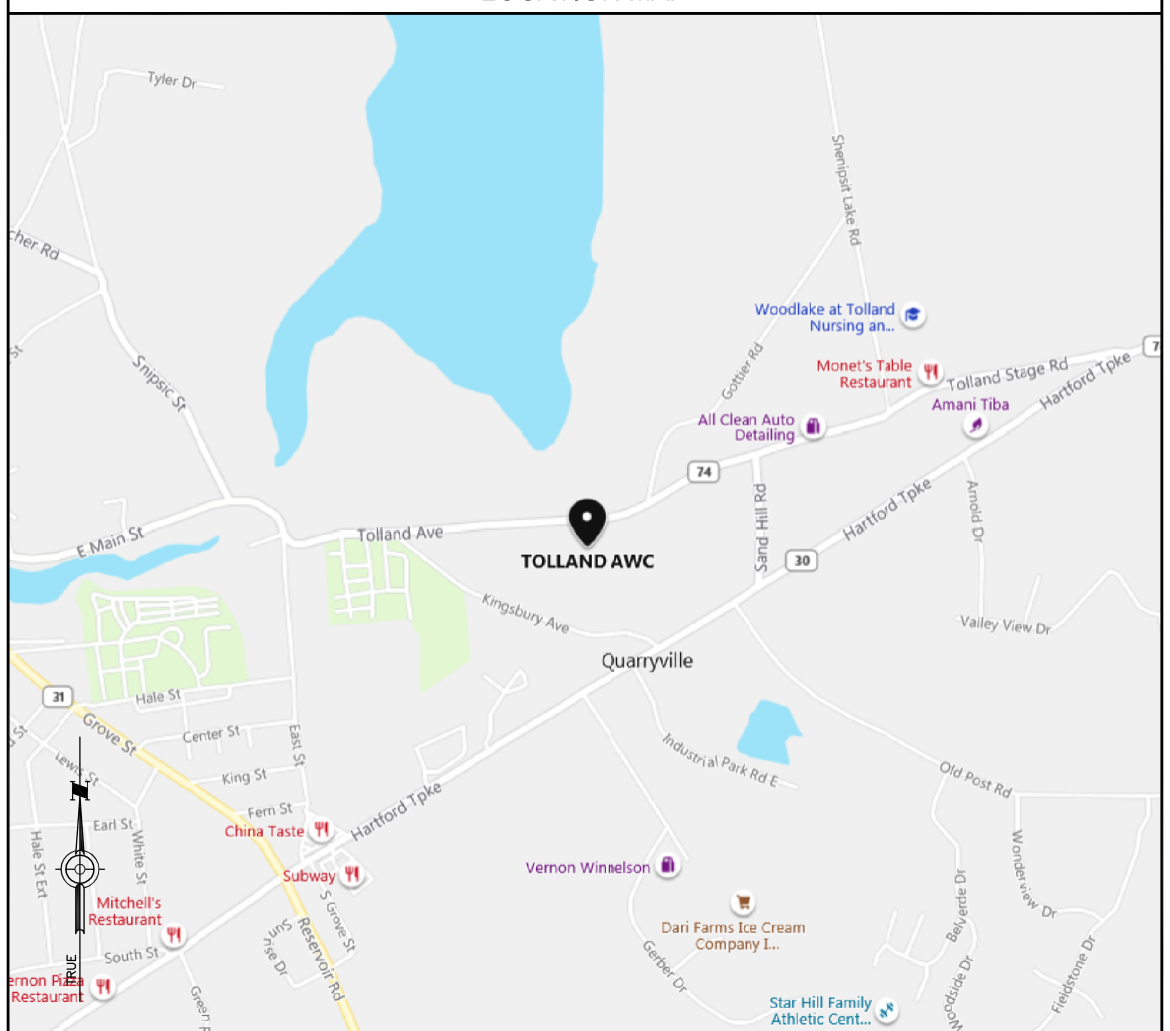
EVERSOURCE ENERGY PROJECT MANAGER:
NIKOLL PRECI
(860) 655–3079

POWER PROVIDER:
EVERSOURCE ENERGY
(800) 286–2000

TELCO PROVIDER:
FRONTIER
(800) 921–8102

CALL BEFORE YOU DIG:
(800) 922–4455

LOCATION MAP



NO SCALE

DESIGN TYPE

SITE UPGRADE
SELF–SUPPORT TOWER

DRAWING INDEX

SHEET NO:	SHEET TITLE
T–1	TITLE SHEET
C–1	SITE PLAN
C–2	TOWER ELEVATION
G–1	GROUNDING DETAILS
N–1	NOTES & SPECIFICATIONS
N–2	NOTES & SPECIFICATIONS
N–3	NOTES & SPECIFICATIONS

DO NOT SCALE DRAWINGS

SUBCONTRACTOR SHALL VERIFY ALL PLANS & EXISTING DIMENSIONS & CONDITIONS ON THE JOB SITE & SHALL IMMEDIATELY NOTIFY THE ENGINEER IN WRITING OF ANY DISCREPANCIES BEFORE PROCEEDING WITH THE WORK OR BE RESPONSIBLE FOR SAME

UNDERGROUND SERVICE ALERT
UTILITIES PROTECTION CENTER, INC.
811
48 HOURS BEFORE YOU DIG

EVERSOURCE ENERGY
107 SELDEN STREET
BERLIN, CT 06037
PHONE: (800) 286–2000

BLACK & VEATCH
6800 W 115TH ST, SUITE 2292
OVERLAND PARK, KS 66211
PHONE: (913) 458–2522

PROJECT NO:	405025
DRAWN BY:	TYW
CHECKED BY:	TH

REV	DATE	DESCRIPTION
0	07/28/20	ISSUED FOR FILING

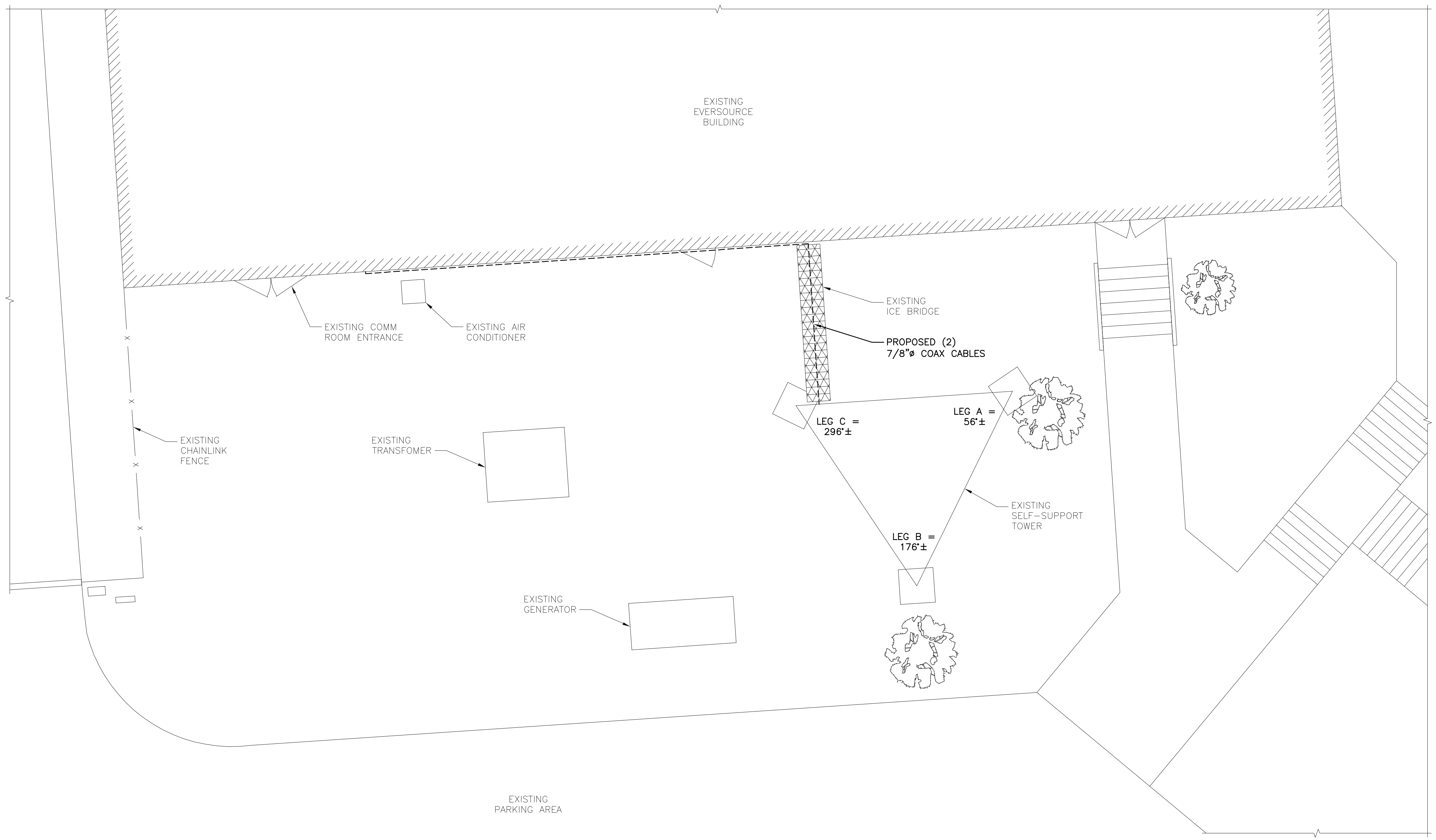
STATE OF CONNECTICUT · JOSHUA J. RILEY · 33208 · LICENSED · PROFESSIONAL ENGINEER
07/28/2020

IT IS A VIOLATION OF LAW FOR ANY PERSON, UNLESS THEY ARE ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER, TO ALTER THIS DOCUMENT.

TOLLAND AWC
48 TOLLAND STAGE ROAD
TOLLAND, CT 06084

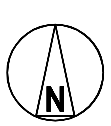
SHEET TITLE
TITLE SHEET

SHEET NUMBER
T-1



SITE PLAN

NO SCALE



EVERSOURCE
ENERGY

107 SELDEN STREET
BERLIN, CT 06037
PHONE: (800) 286–2000

BLACK & VEATCH

6800 W 115TH ST, SUITE 2292
OVERLAND PARK, KS 66211
PHONE: (913) 458–2522

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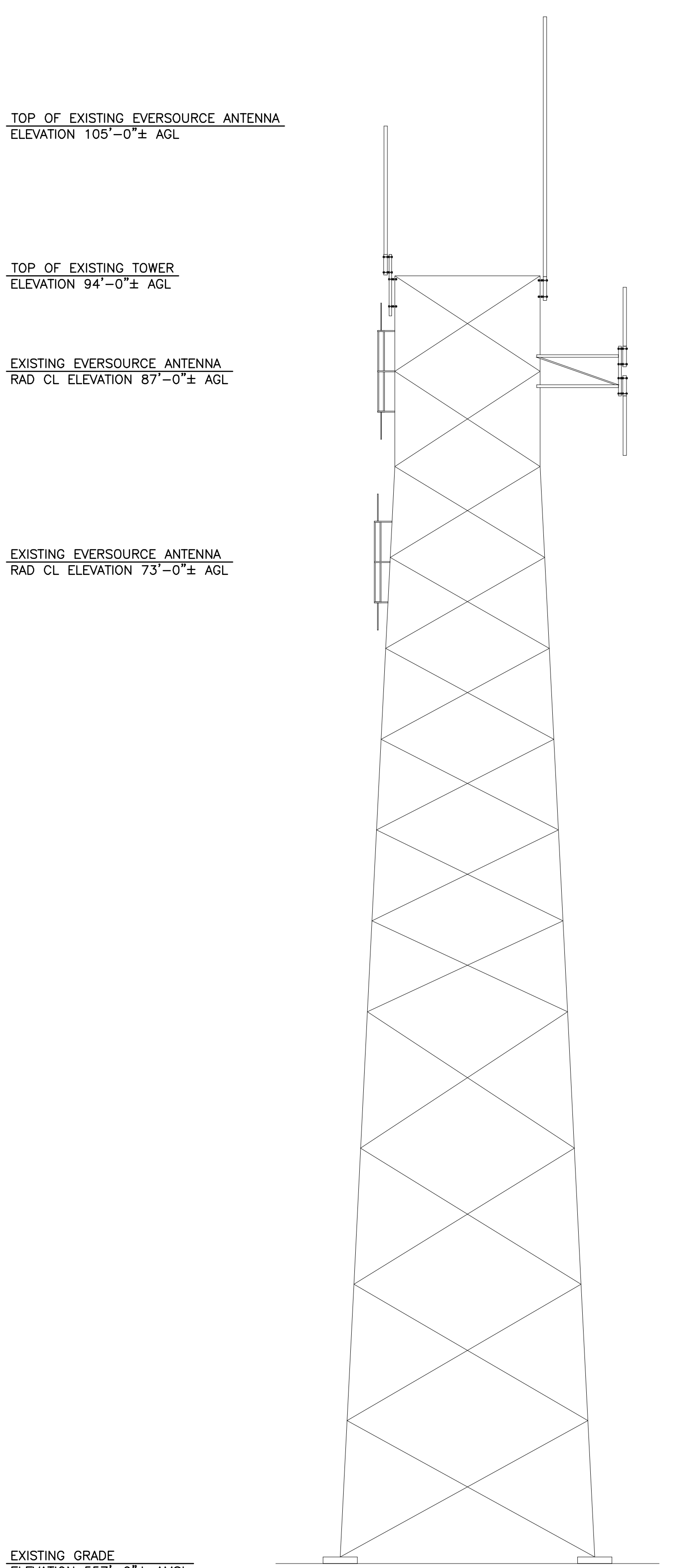
TOLLAND AWC
48 TOLLAND STAGE ROAD
TOLLAND, CT 06084

SHEET TITLE

SITE PLAN

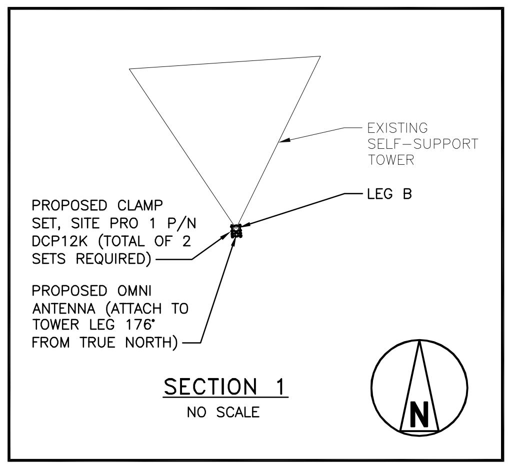
SHEET NUMBER

C-1



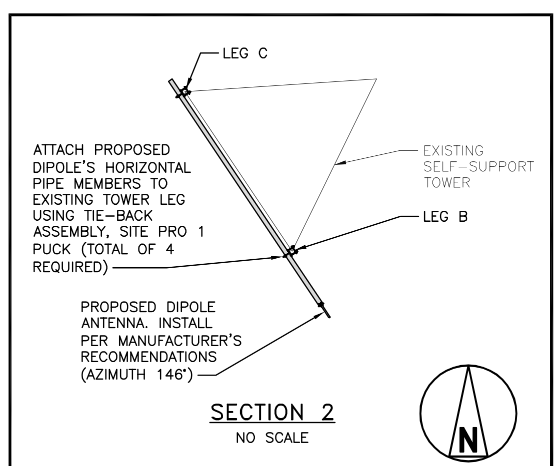
TOWER ELEVATION FACE AC

NO SCALE



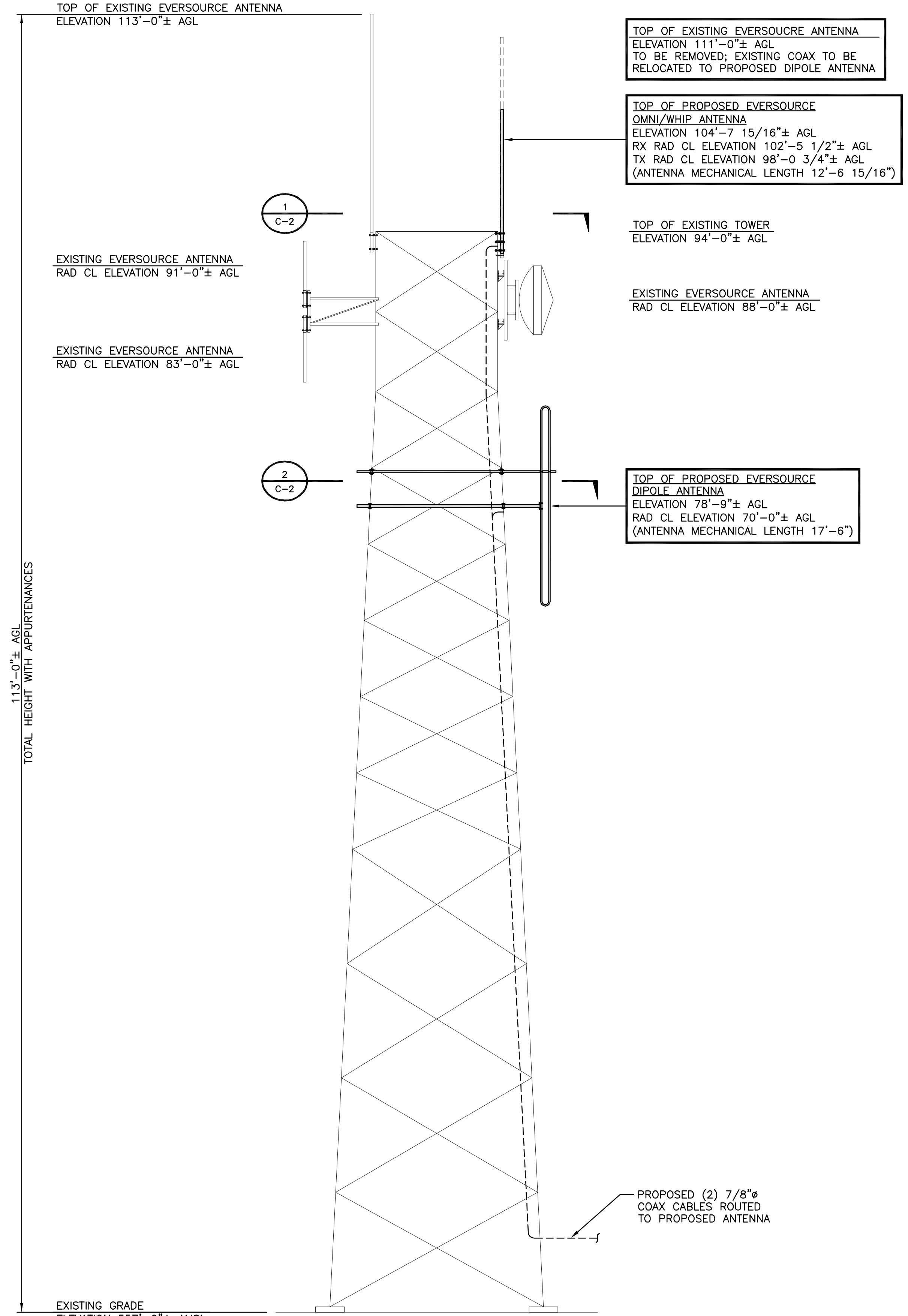
SECTION 1

NO SCALE



SECTION 2

NO SCALE



TOWER ELEVATION FACE CB

NO SCALE

EVERSOURCE ENERGY
107 SELDEN STREET
BERLIN, CT 06037
PHONE: (800) 286-2000

BLACK & VEATCH
6800 W 115TH ST, SUITE 2292
OVERLAND PARK, KS 66211
PHONE: (913) 458-2522

PROJECT NO:	405025
DRAWN BY:	TYW
CHECKED BY:	TH

REV	DATE	DESCRIPTION
0	07/28/20	ISSUED FOR FILING

STATE OF CONNECTICUT · JOSHUA J. RILEY · 33208 · LICENSED PROFESSIONAL ENGINEER

07/28/2020

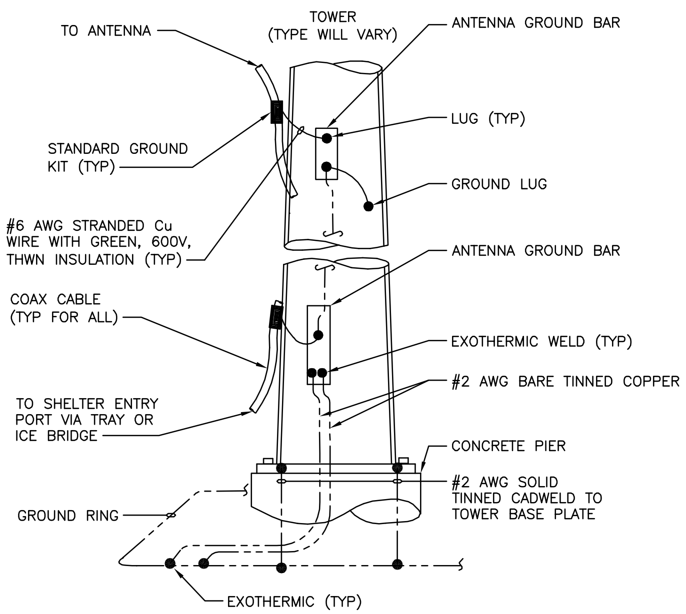
TOLLAND AWC
48 TOLLAND STAGE ROAD
TOLLAND, CT 06084

SHEET TITLE

TOWER ELEVATION & ANTENNA EQUIPMENT

SHEET NUMBER

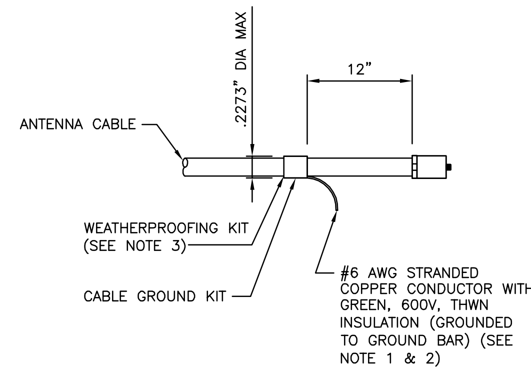
C-2



NOTE

1. NUMBER OF GROUND BARS MAY VARY DEPENDING ON THE TYPE OF TOWER, ANTENNA LOCATION AND CONNECTION ORIENTATION. PROVIDE AS REQUIRED.

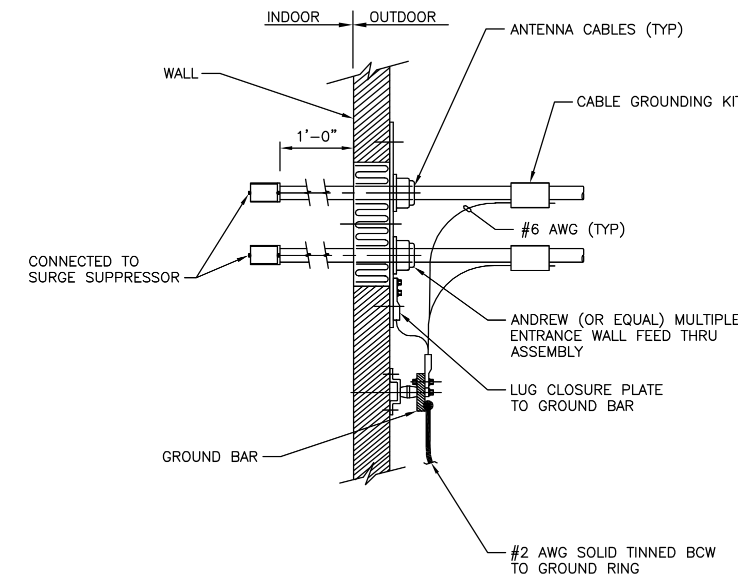
ANTENNA CABLE GROUNDING
NO SCALE



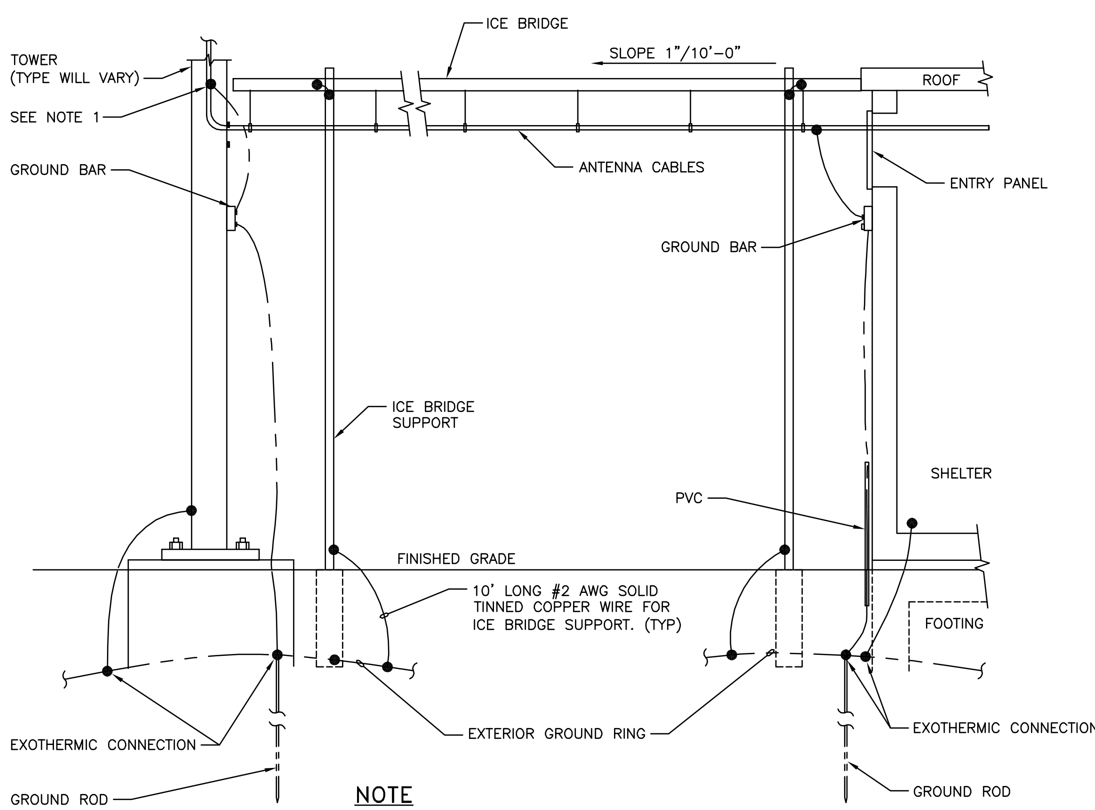
NOTES

1. DO NOT INSTALL CABLE GROUND KIT AT A BEND AND ALWAYS DIRECT GROUND WIRE DOWN TO GROUND BAR.
2. GROUNDING KIT SHALL BE TYPE AND PART NUMBER AS SUPPLIED OR RECOMMENDED BY CABLE MANUFACTURER.
3. WEATHER PROOFING SHALL BE TYPE AND PART NUMBER AS SUPPLIED OR RECOMMENDED BY CABLE MANUFACTURER.

CONNECTION OF CABLE GROUND KIT TO ANTENNA CABLE
NO SCALE



CABLE INSTALLATION WITH WALL FEED THRU ASSEMBLY
NO SCALE



NOTE

1. PROVIDE GROUND KIT 6" BEFORE TURN

ICE BRIDGE AND ANTENNA CABLE DETAIL
NO SCALE

EVERSOURCE ENERGY
107 SELDEN STREET
BERLIN, CT 06037
PHONE: (800) 286-2000

BLACK & VEATCH
6800 W 115TH ST, SUITE 2292
OVERLAND PARK, KS 66211
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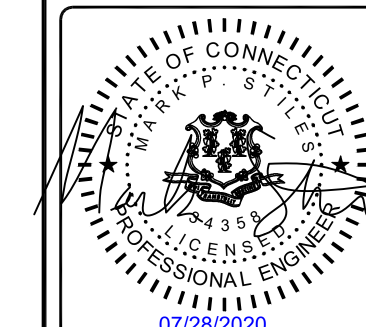

TOLLAND AWC
48 TOLLAND STAGE ROAD
TOLLAND, CT 06084

SHEET TITLE
GROUNDING DETAILS

SHEET NUMBER
G-1

DESIGN BASIS

1. GOVERNING CODE: 2018 CONNECTICUT STATE BUILDING CODE (2015 IBC BASIS).

GENERAL CONDITIONS

1. IT IS THE CONTRACTOR'S SOLE RESPONSIBILITY TO COMPLY WITH ALL APPLICABLE FEDERAL, STATE, AND LOCAL BUILDING CODES, PERMIT CONDITIONS AND SAFETY CODES DURING CONSTRUCTION.
2. THE ENGINEER IS NOT: A GUARANTOR OF THE INSTALLING CONTRACTOR'S WORK; RESPONSIBLE FOR SAFETY IN, ON OR ABOUT THE WORK SITE; IN CONTROL OF THE SAFETY OR ADEQUACY OF ANY BUILDING COMPONENT, SCAFFOLDING OR SUPERINTENDING THE WORK.
3. THE CONTRACTOR IS RESPONSIBLE FOR PROVIDING ALL PERMITS, INSPECTIONS, TESTING AND CERTIFICATES NEEDED FOR LEGAL OCCUPANCY OF THE FINISHED PROJECT.
4. THE CONTRACTOR IS RESPONSIBLE TO REVIEW THIS COMPLETE PLAN SET AND VERIFY THE EXISTING CONDITIONS SHOWN IN THESE PLANS AS THEY RELATE TO THE WORK PRIOR TO SUBMITTING PRICE. SIGNIFICANT DEVIATIONS FROM WHAT IS SHOWN AFFECTING THE WORK SHALL BE REPORTED IMMEDIATELY TO THE CONSTRUCTION MANAGER.
5. DETAILS INCLUDED IN THIS PLAN SET ARE TYPICAL AND APPLY TO SIMILAR CONDITIONS.
6. EXISTING ELECTRICAL AND MECHANICAL FIXTURES, PIPING, WIRING, AND EQUIPMENT OBSTRUCTING THE WORK SHALL BE REMOVED AND/OR RELOCATED AS DIRECTED BY THE CONSTRUCTION MANAGER. TEMPORARY SERVICE INTERRUPTIONS MUST BE COORDINATED WITH OWNER.
7. THE CONTRACTOR SHALL DILIGENTLY PROTECT THE EXISTING BUILDING/SITE CONDITIONS AND THOSE OF ANY ADJOINING BUILDING/SITES AND RESTORE ANY DAMAGE CAUSED BY HIS ACTIVITIES TO THE PRE-CONSTRUCTION CONDITION.
8. THE CONTRACTOR SHALL SAFEGUARD AGAINST: CREATING A FIRE HAZARD, AFFECTING TENANT EGRESS OR COMPROMISING BUILDING SITE SECURITY MEASURES.
9. THE CONTRACTOR SHALL REMOVE ALL DEBRIS AND CONSTRUCTION WASTE FROM THE SITE EACH DAY. WORK AREAS SHALL BE SWEPT AND MADE CLEAN AT THE END OF EACH WORK DAY.
10. THE CONTRACTOR'S HOURS OF WORK SHALL BE IN ACCORDANCE WITH LOCAL CODES AND ORDINANCES AND BE APPROVED BY OWNER.
11. THE CONTRACTOR SHALL IMMEDIATELY NOTIFY THE CONSTRUCTION MANAGER IF ASBESTOS IS ENCOUNTERED DURING THE EXECUTION OF HIS WORK. THE CONTRACTOR SHALL CEASE ALL ACTIVITIES WHERE THE ASBESTOS MATERIAL IS FOUND UNTIL NOTIFIED BY THE CONSTRUCTION MANAGER TO RESUME OPERATIONS.

THERMAL & MOISTURE PROTECTION

1. FIRE-STOP ALL PENETRATIONS FOR ELECTRICAL CONDUITS OR WAVEGUIDE CABLING THROUGH BUILDING WALLS, FLOORS, AND CEILINGS SHALL BE FIRESTOPPED WITH ACCEPTED MATERIALS TO MAINTAIN THE FIRE RATING OF THE EXISTING ASSEMBLY. ALL FILL MATERIAL SHALL BE SHAPED, FITTED, AND PERMANENTLY SECURED IN PLACE. FIRESTOPPING SHALL BE INSTALLED IN ACCORDANCE WITH ASTM E814.
2. HILTI CP620 FIRE FOAM OR 3M FIRE BARRIER FILL, VOID OR CAVITY MATERIAL OR ACCEPTED EQUAL SHALL BE APPLIED IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS AND ASSOCIATED UNDERWRITERS LABORATORIES (UL) SYSTEM NUMBER.
3. FIRESTOPPING SHALL BE APPLIED AS SOON AS PRACTICABLE AFTER PENETRATIONS ARE MADE AND EQUIPMENT INSTALLED.
4. FIRESTOPPED PENETRATIONS SHALL BE LEFT EXPOSED AND MADE AVAILABLE FOR INSPECTION BEFORE CONCEALING SUCH PENETRATIONS. FIRESTOPPING MATERIAL CERTIFICATES SHALL BE MADE AVAILABLE AT THE TIME OF INSPECTION.
5. ANY BUILDING ROOF PENETRATION AND/OR RESTORATION SHALL BE PERFORMED SO THAT THE ROOF WARRANTY IN PLACE IS NOT COMPROMISED. CONTRACTOR SHALL ARRANGE FOR OWNER'S ROOFING CONTRACTOR TO PERFORM ANY AND ALL ROOFING WORK IF SO REQUIRED BY EXISTING ROOF WARRANTY. OTHERWISE, ROOF SHALL BE MADE WATERTIGHT WITH LIKE CONSTRUCTION AS SOON AS PRACTICABLE AND AT COMPLETION OF CONSTRUCTION.
6. ALL PENETRATIONS INTO AND/OR THROUGH BUILDING EXTERIOR WALLS SHALL BE SEALED WITH SILICONE SEALER.
7. WHERE CONDUIT AND CABLES PENETRATES FIRE RATED WALLS AND FLOORS, FIRE GROUT ALL PENETRATIONS IN ORDER TO MAINTAIN THE FIRE RATING USING A LISTED FIRE SEALING DEVICE OR GROUT.
8. CONTRACTOR TO REMOVE AND RE-INSTALL ALL FIRE PROOFING AS REQUIRED DURING CONSTRUCTION.

SUBMITTALS

1. CONTRACTOR TO SUBMIT SHOP DRAWINGS TO ENGINEER FOR REVIEW PRIOR TO FABRICATION.
2. CONTRACTOR TO NOTIFY ENGINEER FOR INSPECTION PRIOR TO CLOSING PENETRATIONS.
3. CONTRACTORS SHALL VERIFY ALL DIMENSIONS AND CONDITIONS IN THE FIELD PRIOR TO FABRICATION AND ERECTION OF ANY MATERIAL. THE ENGINEER SHALL BE NOTIFIED OF ANY CONDITIONS WHICH PRECLUDE COMPLETION OF THE WORK IN ACCORDANCE WITH THE CONTRACT DOCUMENTS.
4. ALL STEEL MATERIAL EXPOSED TO WEATHER SHALL BE GALVANIZED AFTER FABRICATION IN ACCORDANCE WITH ASTM A123 " ZINC (HOT-DIPPED GALVANIZED) COATINGS" ON IRON AND STEEL PRODUCTS.
5. THE ENGINEER SHALL BE NOTIFIED OF ANY INCORRECTLY FABRICATED, DAMAGED OR OTHERWISE MISFITTING OR NONCONFORMING MATERIALS OR CONDITIONS FOR REMEDIAL OR CORRECTIVE ACTION. ANY SUCH ACTION SHALL REQUIRE ENGINEER REVIEW.

CONCRETE

1. ALL CONCRETE CONSTRUCTION SHALL BE DONE IN ACCORDANCE WITH THE AMERICAN CONCRETE INSTITUTE (ACI) CODES 301 & 318, LATEST REVISION.
2. FOUNDATION WORK SHALL BE IN ACCORDANCE WITH THE MANUFACTURER'S DESIGNS AND SPECIFICATIONS.
3. ALL CONCRETE USED SHALL BE 4000 PSI (28 DAY COMPRESSIVE STRENGTH) UNLESS NOTED OTHERWISE. THE CONCRETE MIX DESIGN SHALL USE THE FOLLOWING MATERIALS AND PARAMETERS:

   PORTLAND CEMENT: ASTM C150, TYPE 1
   AGGREGATE: ASTM C33, 1 INCH MIX
   WATER: POTABLE
   ADMIXTURE: NON-CHLORIDE
   AIR: 6%*
   SLUMP: 4 INCH UNLESS NOTED OTHERWISE

   *ALL CONCRETE EXPOSED TO FREEZING WEATHER SHALL CONTAIN ENTRAINED AIR PER ACI 211 TABLE 4.2.1 OF ACI 318-05.
4. ALL REINFORCING STEEL SHALL BE ASTM A615, GR 60 (DEFORMED) UNLESS NOTED OTHERWISE. WELDED WIRE FABRIC SHALL CONFORM TO ASTM A185 WELDED STEEL WIRE FABRIC UNLESS NOTED OTHERWISE. SPLICES SHALL BE CLASS 'B' AND ALL HOOKS SHALL BE ACI STANDARD UNLESS NOTED OTHERWISE. REINFORCING BARS SHALL BE COLD BENT WHERE REQUIRED AND TIES (NOT WELDED).
5. THE FOLLOWING MINIMUM CONCRETE COVER SHALL BE PROVIDED FOR REINFORCING STEEL UNLESS SHOWN OTHERWISE ON DRAWINGS:

   CONCRETE CAST AGAINST EARTH = 3 INCHES
   CONCRETE EXPOSED TO EARTH OR WEATHER:
   #6 AND LARGER = 2 INCHES
   #5 AND SMALLER AND WWF = 1 1/2 INCHES
   CONCRETE NOT EXPOSED TO EARTH OR WEATHER OR NOT CAST AGAINST THE GROUND:
   SLAB AND WALL = 3/4 INCHES
   BEAMS AND COLUMNS = 1 1/2 INCHES
6. A 3/4 INCH CHAMFER SHALL BE PROVIDED AT ALL EXPOSED EDGES OF CONCRETE, UNLESS NOTED OTHERWISE, IN ACCORDANCE WITH ACI 301 SECTION 4.2.4.
7. CONCRETE SHALL REPLACED IN A UNIFORM MANNER AND CONSOLIDATED IN PLACE.
8. CONCRETE FOOTINGS SHALL BE CAST AGAINST LEVEL, COMPACTED, NON-FROZEN BASE SOIL FREE OF STANDING WATER.

STEEL

1. MATERIAL:

   WIDE FLANGE: ASTM A572, GR 50
   TUBING: ASTM A500, GR C
   PIPE: ASTM A53, GR B AND ASTM 572, GR 50
   ANGLE: ASTM A570, GR 50 AND ASTM A36
   BOLTS: ASTM A325
   GRATING: TYPE GW-2 (1"x3/16" BARS)
   MISC. MATERIAL: ASTM A36

   ALL STEEL SHAPES SHALL BE HOT-DIPPED GALVANIZED IN ACCORDANCE WITH ASTM A123 WITH A COATING WEIGHT OF 2 OZ/SF.
2. DAMAGED GALVANIZED SURFACES SHALL BE CLEANED WITH A WIRE BRUSH AND PAINTED WITH TWO COATS OF COLD ZINC, "GALVANOX", "DRY GALV", "ZINC IT", OR APPROVED EQUIVALENT, IN ACCORDANCE WITH MANUFACTURER'S GUIDELINES. TOUCH UP DAMAGED NON GALVANIZED STEEL WITH SAME PAINT IN SHOP OR FIELD.
3. DESIGN, FABRICATION AND ERECTION OF STRUCTURAL STEEL SHALL CONFORM TO THE AISC "MANUAL OF STEEL CONSTRUCTION" 13TH EDITION.
4. THE STEEL STRUCTURE IS DESIGNED TO BE SELF-SUPPORTING AND STABLE AFTER COMPLETION. IT IS THE CONTRACTOR'S SOLE RESPONSIBILITY TO DETERMINE ERECTION PROCEDURE AND SEQUENCE AND TO INSURE THE SAFETY OF THE BUILDING AND ITS COMPONENT PARTS DURING ERECTION.
5. ALL STEEL ELEMENTS SHALL BE INSTALLED PLUMB AND LEVEL.
6. TOWER MANUFACTURER'S DESIGNS SHALL PREVAIL FOR TOWER.

CONNECTIONS

1. CONNECTIONS SHALL BE DESIGNED BY THE FABRICATOR AND CONSTRUCTED IN ACCORDANCE WITH THE AISC "MANUAL OF STEEL CONSTRUCTION" 13TH EDITION. CONNECTIONS SHALL BE PROVIDED TO CONFORM TO THE REQUIREMENTS OF TYPE 2 CONSTRUCTION UNLESS OTHERWISE DETAILED. ALL WELDING SHALL BE PERFORMED BY AWS CERTIFIED WELDERS.
2. DESIGN CONNECTIONS AT BEAM ENDS FOR 10 KIPS (MIN).
3. ALL BUILDING CONNECTION POINTS ARE TO BE CENTERED OVER BEARING WALLS
4. CONNECTIONS SHALL BE MADE USING ASTM A325 BOLTS (SNUG TIGHT OR SLIP CRITICAL) OR WELDS. IF TENSION CONTROL BOLTS ARE USED, CONNECTIONS SHALL BE DESIGNED FOR SLIP CRITICAL BOLT ALLOWABLE LOAD VALUES.
5. NUT LOCKING DEVICES ARE REQUIRED FOR ALL BOLT ASSEMBLIES.
6. GRATING SHALL BE ATTACHED USING FOR GRATING CLAMPS OR 1/4 INCH FILLET WELDS. NON-STRUCTURAL CONNECTIONS FOR STEEL GRATING MAY BE 5/8" DIAMETER GALVANIZED ASTM A307 BOLTS UNLESS OTHERWISE NOTED.
7. ALL BOLTS, ANCHORS, AND MISCELLANEOUS HARDWARE EXPOSED TO WEATHER SHALL BE GALVANIZED IN ACCORDANCE WITH ASTM A153 "ZINC COATING (HOT-DIP) ON IRON AND STEEL HARDWARE."
8. CONTRACTOR SHALL COMPLY WITH AWS CODE FOR PROCEDURES, APPEARANCE AND QUALITY OF WELDS, AND WELDING PROCESSES SHALL BE QUALIFIED IN ACCORDANCE WITH AWS "STANDARD QUALIFICATION PROCEDURES". UPON COMPLETION OF WELDING, ALL DAMAGE TO GALVANIZED COATING SHALL BE REPAIRED. SEE NOTE ABOVE.
9. USE THE LARGER OF 1/4 INCH FILLET WELDS OR MINIMUM SIZE PER AISC REQUIREMENTS WHERE NO WELD SIZE IS SHOWN ON THE DRAWINGS.
10. ALL ARC AND GAS WELDING SHALL BE DONE BY LICENSED AND CERTIFIED WELDER IN ACCORDANCE WITH AMERICAN WELDING SOCIETY.
11. ALL WELDING SHALL BE DONE USING E70XX ELECTRODES AND WELDING SHALL CONFORM TO AISC AND AWS D1.1. UPON THE COMPLETION OF WELDING, ALL DAMAGE TO GALVANIZED COATINGS SHALL REPAIRED.
12. USE PRECAUTIONS AND PROCEDURES PER AWS D1.1 WHEN WELDING GALVANIZED METALS.

SITE GENERAL

1. CONTRACTOR SHALL FOLLOW CONDITIONS OF ALL APPLICABLE PERMITS AND WORK IN ACCORDANCE WITH OSHA REGULATIONS.
2. THESE PLANS DEPICT KNOWN UNDERGROUND STRUCTURES, CONDUITS, AND/OR PIPELINES. THE LOCATIONS FOR THESE ELEMENTS ARE BASED UPON THE VARIOUS RECORD DRAWINGS AVAILABLE. THE CONTRACTOR IS HEREBY ADVISED THAT THESE DRAWINGS MAY NOT ACCURATELY DEPICT AS-BUILT LOCATIONS AND OTHER UNKNOWN STRUCTURES. THE CONTRACTOR SHALL THEREFORE DETERMINE THE EXACT LOCATION OF EXISTING UNDERGROUND ELEMENTS AND EXCAVATE WITH CARE AFTER CALLING MARKOUT SERVICE AT 1-800-272-4480 48 HOURS BEFORE DIGGING, DRILLING OR BLASTING.
3. ALL EXISTING ACTIVE SEWER, WATER, GAS, ELECTRIC, FIBER OPTIC, AND OTHER UTILITIES WHERE ENCOUNTERED, SHALL BE PROTECTED AT ALL TIMES, AND WHERE REQUIRED FOR THE PROPER EXECUTION, SHALL BE RELOCATED AS DIRECTED BY ENGINEER. EXTREME CAUTION SHOULD BE USED BY THE CONTRACTOR WHEN EXCAVATING OR PIER DRILLING AROUND OR NEAR UTILITIES. CONTRACTOR SHALL HAND DIG UTILITIES AS NEEDED. CONTRACTOR SHALL PROVIDE, BUT IS NOT LIMITED TO, APPROPRIATE A) FALL PROTECTION, B) CONFINED SPACE ENTRY, C) ELECTRICAL SAFETY, AND D) TRENCHING AND EXCAVATION.
4. IF NECESSARY, RUBBISH, STUMPS, DEBRIS, STICKS, STONES, AND OTHER REFUSE SHALL BE REMOVED FROM THE SITE AND DISPOSED OF LEGALLY.
5. ALL EXISTING INACTIVE SEWER, WATER, GAS, ELECTRIC, FIBER OPTIC, OR OTHER UTILITIES, WHICH INTERFERE WITH THE EXECUTION OF THE WORK, SHALL BE REMOVED, AND/OR CAPPED, PLUGGED OR OTHERWISE DISCONTINUED AT THE POINTS WHICH WILL NOT INTERFERE WITH THE EXECUTION OF THE WORK, SUBJECT TO THE APPROVAL OF THE CONSTRUCTION MANAGER.
6. CONTRACTOR IS RESPONSIBLE FOR REPAIRING OR REPLACING STRUCTURES OR UTILITIES DAMAGED DURING CONSTRUCTION.
7. CONTRACTOR SHALL PROTECT EXISTING PAVED AND GRAVEL SURFACES, CURBS, LANDSCAPE AND STRUCTURES AND RESTORE SITE OR PRE-CONSTRUCTION CONDITION WITH AS GOOD, OR BETTER, MATERIALS. NEW MATERIALS SHALL MATCH EXISTING THICKNESS AND TYPE.
8. THE CONTRACTOR SHALL SHORE ALL TRENCH EXCAVATIONS GREATER THAN 5 FEET IN DEPTH OR LESS WHERE SOIL CONDITIONS ARE DEEMED UNSTABLE. ALL SHEETING AND/OR SHORING METHODS SHALL BE DESIGNED BY A PROFESSIONAL ENGINEER.
9. THE CONTRACTOR IS RESPONSIBLE FOR MANAGING GROUNDWATER LEVELS IN THE VICINITY OF EXCAVATIONS TO PROTECT ADJACENT PROPERTIES AND NEW WORK. GROUNDWATER SHALL BE DRAINED IN ACCORDANCE WITH LOCAL SEDIMENTATION AND EROSION CONTROL GUIDELINES.

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STATE OF CONNECTICUT
JOSHUA J. RILEY
33208
LICENSED PROFESSIONAL ENGINEER
07/28/2020

IT IS A VIOLATION OF LAW FOR ANY PERSON, UNLESS THEY ARE ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER, TO ALTER THIS DOCUMENT.

TOLLAND AWC
48 TOLLAND STAGE ROAD
TOLLAND, CT 06084

SHEET TITLE
NOTES & SPECIFICATIONS

SHEET NUMBER
N-1

EXCAVATION

1. CONTRACTOR SHALL GRADE ONLY AREAS SHOWN TO BE MODIFIED HEREIN AND ONLY TO THE EXTENT REQUIRED TO SHED OVERLAND WATER FLOW AWAY FROM SITE. SLOPES SHALL NOT BE STEEPER THAN 3:1 (HORIZONTAL:VERITICAL), UNLESS NOTED OTHERWISE. SEDIMENTATION AND EROSION CONTROLS SHOWN AND SPECIFIED SHALL BE ESTABLISHED BEFORE STRIPPING EXISTING VEGETATION.
2. ORGANIC MATERIAL AND DEBRIS SHALL BE STRIPPED AND STOCKPILED BEFORE ADDING FILL MATERIAL.
3. NO FILL OR EMBANKMENT MATERIAL SHALL BE PLACED ON FROZEN GROUND. FROZEN MATERIALS, SNOW OR ICE SHALL NOT BE PLACED IN ANY FILL OR EMBANKMENT.
4. ALL FILL SHALL BE PLACED IN ONE FOOT LIFTS AND COMPACTED IN PLACE. STRUCTURAL FILL SHALL BE COMPACTED TO 95% OF ITS MAXIMUM DRY UNIT WEIGHT TESTED IN ACCORDANCE WITH ASTM D1557.
5. EXCAVATIONS FOR FOOTINGS SHALL BE CUT LEVEL TO THE REQUIRED DEPTH AND TO UNDISTURBED SOIL. REPORT UNSUITABLE SOIL CONDITIONS TO THE CONSTRUCTION MANAGER.
6. TRENCH EXCAVATIONS SHALL BE BACKFILLED AT THE END OF EACH DAY.
7. SURPLUS MATERIAL SHALL BE REMOVED FROM THE SITE.
8. TOWER FOUNDATION EXCAVATION, BACKFILL AND COMPACTION SHALL BE IN ACCORDANCE WITH THE TOWER MANUFACTURER'S DESIGNS AND SPECIFICATIONS.

MATERIAL

1. NATIVE GENERAL MATERIAL MAY BE USED FOR TRENCH BACKFILL WHERE SELECT MATERIAL IS NOT SPECIFIED. GRAVEL MATERIAL FOR CONDUIT TRENCH BACKFILL SHALL NOT CONTAIN ROCK GREATER THAN 2 INCHES IN DIAMETER.
2. BANK OR CRUSHED GRAVEL SHALL CONSIST OF TOUGH, DURABLE PARTICLES OF CRUSHED OR UNCRUSHED GRAVEL FREE OF SOFT, THIN, ELONGATED OR LAMINATED PIECES AND MEET THE GRADATION REQUIREMENTS.
3. PROCESSED AGGREGATE BASE SHALL CONSIST OF COURSE AND FINE AGGREGATES COMBINED AND MIXED SO THAT THE RESULTING MATERIAL CONFORMS TO THE GRADATION REQUIREMENTS. COURSE AGGREGATE SHALL BE EITHER GRAVEL OR BROKEN STONE AND FINE AGGREGATE SHALL CONSIST OF SAND.

SQUARE MESH SIEVES	PERCENT PASSING BY WEIGHT		
	BANK GRAVEL FILL	BANK GRAVEL BASE	PROCESSED AGG BASE
SIEVES		100	
PASS 5"		100	90–100
PASS 3 1/2"		100	
PASS 2 1/4"		95–100	
PASS 2"		55–100	
PASS 1 1/2"			
PASS 1"			
PASS 3/4"			50–75
PASS 1/4"	25–60	25–60	25–45
PASS #10	15–45	15–45	
PASS #40	2–25	5–25	5–20
PASS #100	0–10	0–10	2–12
PASS #200	0–5	0–5	

4. FILL MATERIAL SHALL BE FREE OR ORGANIC MATERIAL, ICE, TRASH AND DEBRIS.
5. REFER TO MOST CURRENT GEOTECHNICAL ENGINEERING REPORT FOR ALL FILL MATERIAL REQUIREMENTS.

ELECTRICAL

1. CONTRACTOR SHALL VERIFY EXISTING ELECTRIC SERVICE TYPE AND CAPACITY AND ORDER NEW ELECTRIC SERVICE FROM LOCAL ELECTRIC UTILITY, WHERE APPLICABLE.
2. ALL ELECTRICAL WORK SHALL BE IN ACCORDANCE WITH ALL APPLICABLE CODES, AND SHALL BE ACCEPTABLE TO ALL AUTHORITIES HAVING JURISDICTION. WHERE A CONFLICT EXISTS BETWEEN CODES, PLAN AND SPECIFICATIONS, OR AUTHORITIES HAVING JURISDICTION, THE MORE STRINGENT AUTHORITIES SHALL APPLY.
3. CONTRACTOR SHALL PROVIDE ALL LABOR, MATERIALS, INSURANCE, EQUIPMENT, INSTALLATION, CONSTRUCTION TOOLS, TRANSPORTATION, ETC, FOR A COMPLETE AND PROPERLY OPERATIVE SYSTEM ENERGIZED THROUGHOUT AND AS INDICATED ON THE DRAWINGS AND AS SPECIFIED HEREIN AND/OR OTHERWISE REQUIRED.
4. ALL ELECTRICAL CONDUCTORS SHALL BE 100% COPPER AND SHALL HAVE TYPE THHN INSULATION UNLESS INDICATED OTHERWISE.
5. CONDUIT SHALL BE THREADED RIGID GALVANIZED STEEL OR EMT WITH ONLY COMPRESSION TYPE COUPLINGS AND CONNECTORS, ALL MADE UP WRENCH TIGHT.
6. ALL BURIED CONDUIT SHALL BE MINIMUM SCH 40 PVC UNLESS NOTED OTHERWISE, OR AS PER LOCAL CODE REQUIREMENTS.
7. PROVIDE FLEXIBLE STEEL CONDUIT OR LIQUID TIGHT FLEXIBLE STEEL CONDUIT TO ALL VIBRATING EQUIPMENT, INCLUDING HVAC UNITS, TRANSFORMERS, MOTORS, ETC, OR WHERE EQUIPMENT IS PLACED UPON A SLAB ON GRADE.
8. ALL BRANCH CIRCUITS AND FEEDERS SHALL HAVE A SEPARATE GREEN INSULATED EQUIPMENT GROUNDING CONDUCTOR BONDED TO ALL ENCLOSURES, PULLBOXES, ETC.
9. CONDUIT AND CABLE WITHIN CORRIDORS SHALL BE CONCEALED AND EXPOSED ELSEWHERE, UNLESS NOTED OTHERWISE.
10. ELECTRICAL MATERIALS INSTALLED ON ROOFTOP SHALL BE LISTED FOR NEMA 3R USE. –AND ALL WIRING WITHIN A VENTILATION DUCT SHALL BE LISTED FOR SUCH USE. IN GENERAL WIRING METHODS WITHIN A DUCT SHALL BE AN MC CABLE WITH SMOOTH OR CORRUGATED METAL JACKET AND HAVE NO OUTER COVERING OVER THE METAL JACKET. INTERLOCKED ARMOR TYPE OF MC CABLE IS NOT ACCEPTABLE FOR THIS APPLICATION. CONTRACTOR CAN ALSO USE TYPE MI CABLE IN THE VENTILATION DUCT PROVIDED IT DOES NOT HAVE ANY OUTER COVERINGS OVER THE METAL EXTERIOR.
11. WIRING DEVICES SHALL BE SPECIFICATION GRADE, AND WIRING DEVICE COVER PLATES SHALL BE PLASTIC WITH ENGRAVING AS SPECIFIED.
12. GROUNDING SYSTEM RESISTANCE SHALL BE MEASURED, RECORDED, AND DATED USING MEGGER DET14 OR SIMILAR INSTRUMENT. GROUND RESISTANCE SHALL NOT EXCEED 5 OHMS. IF THE RESISTANCE VALUE IS EXCEEDED, NOTIFY CONSTRUCTION MANAGER FOR FURTHER INSTRUCTION.
13. COORDINATE WITH BUILDING MANAGEMENT BEFORE PERFORMING ANY WORK INVOLVING EXISTING SYSTEMS OR EQUIPMENT IN ORDER TO DETERMINE THE EFFECT, IF ANY, ON OTHER TENANTS WITHIN THE BUILDING, AND TO DETERMINE THE APPROPRIATE TIME FOR PERFORMING THIS WORK.
14. THE CONTRACTOR SHALL BE REQUIRED TO VISIT THE SITE PRIOR TO SUBMITTING BID IN ORDER TO DETERMINE THE EXTENT OF THE EXISTING CONDITIONS.
15. ALL CONDUCTOR ENDS SHALL BE TAGGED AND ELECTRICAL EQUIPMENT LABELED WITH ENGRAVED IDENTIFICATION PLATES.
16. CONTRACTOR IS RESPONSIBLE FOR ALL CONTROL WIRING AND ALARM TIE–INS.

GROUNDING

1. #6 THWN SHALL BE STRANDED #6 COPPER WITH GREEN THWN INSULATION SUITABLE FOR WET INSTALLATIONS.
2. #2 THWN SHALL BE STRANDED #2 COPPER WITH THWN INSULATION SUITABLE FOR WET INSTALLATIONS.
3. #2 BARE TINNED SHALL BE SOLID COPPER TINNED. ALL BURIED WIRE SHALL MEET THIS CRITERIA.
4. ALL LUGS SHALL BE 2–HOLE, LONG BARREL, TINNED SOLID COPPER UNLESS OTHERWISE SPECIFIED, LUGS SHALL BE THOMAS AND BETTS SERIES 548##BE OR EQUIVALENT (IE #2 THWN – 54856BE, #2 SOLID – 54856BE, AND #6 THWN – 54852BE).
5. ALL HARDWARE, BOLTS, NUTS, AND WASHERS SHALL BE 18–8 STAINLESS STEEL. EVERY CONNECTION SHALL BE BOLT–FLAT WASHER–BUSS–LUG–FLAT WASHER–BELLEVILLE WASHER–NUT IN THAT EXACT ORDER. BACK–TO–BACK LUGGING, BOLT–FLAT WASHER–LUG–BUSS–LUG–FLAT WASHER–BELLEVILLE WASHER–NUT, IN THAT EXACT ORDER, IS ACCEPTED WHERE NECESSARY TO CONNECT MANY LUGS TO A BUSS BAR. STACKING OF LUGS, BUSS–LUG–LUG, IS NOT ACCEPTABLE.
6. WHERE CONNECTIONS ARE MADE TO STEEL OR DISSIMILAR METALS, A THOMAS AND BETTS DRAGON TOOTH WASHER MODEL DTWXXX SHALL BE USED BETWEEN THE LUG AND THE STEEL, BOLT–FLAT WASHER–STEEL–DRAGON TOOTH WASHER–LUG–FLAT WASHER–BELEVILE WASHER–NUT.
7. ALL CONNECTIONS, INTERIOR AND EXTERIOR, SHALL BE MADE WITH THOMAS AND BETTS KPOR–SHIELD. COAT ALL WIRES BEFORE LUGGING AND COAT ALL SURFACES BEFORE CONNECTING.
8. THE MINIMUM BEND RADIUS SHALL BE 8 INCHES FOR #6 WIRE AND SMALLER AND 12 INCHES FOR WIRE LARGER THAN #6.
9. ALL CONNECTIONS TO THE GROUND RING SHALL BE EXOTHERMIC WELD.
10. BOND THE FENCE TO THE GROUND RING AT EACH CORNER, AND AT EACH GATE POST WITH #2 SOLID TINNED WIRE. EXOTHERMIC WELD BOTH ENDS.
11. GROUND KITS SHALL BE SOLID COPPER STRAP WITH #6 WIRE 2–HOLE COMPRESSION CRIMPED LUGS AND SHALL BE SEALED ACCORDING TO MANUFACTURER INSTRUCTIONS.
12. FERROUS METAL CLIPS WHICH COMPLETELY SURROUND THE GROUNDING CONDUCTOR SHALL BE USED.
13. GROUND BARS SHALL BE FURNISHED AND INSTALLED WITH PRE–DRILLED HOLE DIAMETERS AND SPACINGS. GROUND BARS SHALL NEITHER BE FIELD FABRICATED NOR NEW HOLES DRILLED. GROUND LUGS SHALL MATCH THE SPACING ON THE BAR. HARDWARE DIAMETER SHALL BE MINIMUM 3.8 INCH.
14. MGB GROUND CONNECTION SHALL BE EXOTHERMIC WELDED TO THE GROUND SYSTEM.
15. ALL CABLE TRAY AND/OR PLATFORM STEEL SHALL BE BONDED TOGETHER WITH JUMPERS (#6 IN EQUIPMENT ROOM, #2 ELSEWHERE AND HOMERUN).

CABLE TRAY

1. CABLE TRAY SHALL BE MADE OF EITHER CORROSION RESISTANT METAL OR WITH A CORROSION RESISTANT FINISH.
2. CABLE TRAY SHALL BE OF LADDER TRAY TYPE WITH FLAT COVER CLAMPED TO SIDE RAILS.
3. CABLE LADDER SHALL BE SIZED TO FIT ALL CABLES IN ACCORD WITH NEC AND NEMA 11–15–84.
4. CABLE LADDER TRAYS SHALL BE NEMA CLASS 12A BY PW INDUSTRIES, INC OR EQUAL.
5. CABLE LADDER TRAY SHALL BE SUPPORTED IN ACCORDANCE WITH MANUFACTURER'S SPECIFICATIONS.
6. ALL WORKMANSHIP SHALL CONFORM TO THESE REQUIREMENTS AND ALL LOCAL CODES AND STANDARDS TO ENSURE SAFE AND ADEQUATE GROUNDING SYSTEM.

ANTENNA & CABLE NOTES

1. THE CONTRACTOR SHALL FURNISH AND INSTALL ALL TRANSMISSION CABLES, JUMPERS, CONNECTORS, GROUNDING STRAPS, ANTENNAS, MOUNTS AND HARDWARE. ALL MATERIALS SHALL BE INSPECTED BY THE CONTRACTOR FOR DAMAGE UPON DELIVERY. JUMPERS SHALL BE SUPPLIED AT ANTENNAS AND EQUIPMENT INSIDE SHELTER COORDINATE LENGTH OF JUMP CABLES WITH EVERSOURCE. COORDINATE AND VERIFY ALL OF THE MATERIALS TO BE PROVIDED WITH EVERSOURCE PRIOR TO SUBMITTING BID AND ORDERING MATERIALS.
2. AFTER INSTALLATION, THE TRANSMISSION LINE SYSTEM SHALL BE PIM/SWEEP TESTED FOR PROPER INSTALLATION AND DAMAGE WITH ANTENNAS CONNECTED. CONTRACTOR TO OBTAIN LATEST TESTING PROCEDURES FROM EVERSOURCE PRIOR TO BIDDING.
3. ANTENNA CABLES SHALL BE COLOR CODED AT THE FOLLOWING LOCATIONS:
   – AT THE ANTENNAS.
   – AT THE WAVEGUIDE ENTRY PLATE ON BOTH SIDES OF THE EQUIPMENT SHELTER WALL.
   – JUMPER CABLES AT THE EQUIPMENT ENTER.
4. SYSTEM INSTALLATION:
   THE CONTRACTOR SHALL INSTALL ALL CABLES AND ANTENNAS TO THE MANUFACTURER'S SPECIFICATIONS. THE CONTRACTOR IS RESPONSIBLE FOR THE PROCUREMENT AND INSTALLATION OF THE FOLLOWING:
   – ALL CONNECTORS, ASSOCIATED CABLE MOUNTING, AND GROUNDING HARDWARE.
   – WALL MOUNTS, STANDOFFS, AND ASSOCIATED HARDWARE.
   – 1/2 INCH HELIAX ANTENNA JUMPERS OF APPROPRIATE LENGTHS.
5. MINIMUM BENDING RADIUS FOR COAXIAL CABLES:
   – 7/8 INCH, RMIN = 15 INCHES
   – 1 5/8 INCH, RMIN = 25 INCHES
6. CABLE SHALL BE INSTALLED WITH A MINIMUM NUMBER OF BENDS WHERE POSSIBLE. CABLE SHALL NOT BE LEFT UNTERMINATED AND SHALL BE SEALED IMMEDIATELY AFTER BEING INSTALLED.
7. ALL CABLE CONNECTIONS OUTSIDE SHALL BE COVERED WITH WATERPROOF SPLICING KIT.
8. CONTRACTOR SHALL VERIFY EXACT LENGTH AND DIRECTION OF TRAVEL IN FIELD PRIOR TO CONSTRUCTION.
9. CABLE SHALL BE FURNISHED WITHOUT SPLICES AND WITH CONNECTORS AT EACH END.

TYPICAL WOVEN WIRE FENCING NOTES

1. INSTALL FENCING PER ASTM F567, SWING GATES PER ASTM F900.
2. GATE POST, CORNER, TERMINAL OR PULL POST 2 1/2 INCH DIAMETER SCHEDULE 40 FOR GATE WIDTHS UP THROUGH 6 FEET OR 12 FEET DOUBLE SWING GATE PER ASTM F1083.
3. LINE POST: 2 INCH DIAMETER SCHEDULE 40 PIPE PER ASTM F1083.
4. GATE FRAME: 1 1/2 INCH DIAMETER SCHEDULE 40 PIPE PER ASTM F1083.
5. TOP RAIL AND BRACE RAIL: 1 1/2 DIAMETER SCHEDULE 40 PIPE PER ASTM F1083.
6. FABRIC: 12 GA CORE WIRE SIZE 2 INCH MESH, CONFORMING TO ASTM A392.
7. TIE WIRE: MINIMUM 11 GA GALVANIZED STEEL POSTS AND RAILS. A SINGLE WRAP OF FABRIC TIE AND AT TENSION WIRE BY HOG RINGS SPACED MAX 24 INCH INTERVALS.
8. TENSION WIRE: 7 GA GALVANIZED STEEL.
9. BARBED WIRE: DOUBLE STRAND 12 – 1/2 INCH OUTSIDE DIAMETER TWISTED WIRE TO MATCH WITH FABRIC 12 GA, 4 POINT BARBS SPACED ON APPROXIMATELY 5 INCH CENTERS.
10. GATE LATCH: DROP DOWN LOCKABLE FORK LATCH AND LOCK, KEYED ALIKE FOR ALL SITES.
11. LOCAL ORDINANCE OF BARBED WIRE PERMIT REQUIREMENT SHALL BE COMPLIED IF REQUIRED.
12. HEIGHT = 6 FEET VERTICAL + 1 FOOT BARBED WIRE VERTICAL DIMENSION.

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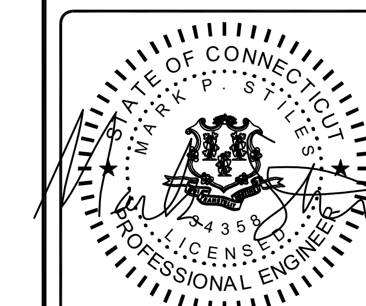


07/28/2020

TOLLAND AWC
48 TOLLAND STAGE ROAD
TOLLAND, CT 06084

SHEET TITLE
NOTES & SPECIFICATIONS

SHEET NUMBER
N-2

SYMBOLS

●	EXOTHERMIC CONNECTION
■	COMPRESSION CONNECTION
	5/8"ø x10–'0" COPPER CLAD STEEL GROUND ROD.
	TEST GROUND ROD WITH INSPECTION SLEEVE
— — — —	GROUNDING CONDUCTOR
(A)	KEY NOTES

CHAINLINK FENCE	—— X —— X —— X —— X —— X ——
WOOD FENCE	—□—□—□—□—□—□—□—
LEASE AREA	— — — — — — — — — — — — — — — —
ICE BRIDGE	
CABLE TRAY	
GAS LINE	—— G —— G —— G —— G —— G ——
UNDERGROUND ELECTRICAL/TELCO	—— E/T —— E/T —— E/T —— E/T ——
UNDERGROUND ELECTRICAL/CONTROL	—— E/C —— E/C —— E/C —— E/C ——
UNDERGROUND ELECTRICAL	—— E —— E —— E —— E —— E ——
UNDERGROUND TELCO	—— T —— T —— T —— T —— T ——
PROPERTY LINE (PL)	—— — — —— — — —— — — —— — — ——

ABBREVIATIONS

AC	ALTERNATING CURRENT	MGB	MASTER GROUNDING BAR
AIC	AMPERAGE INTERRUPTION CAPACITY	MIN	MINIMUM
ANI	AUXILIARY NETWORK INTERFACE	MW	MICROWAVE
ATM	ASYNCHRONOUS TRANSFER MODE	MTS	MANUAL TRANSFER SWITCH
ATS	AUTOMATIC TRANSFER SWITCH	NEC	NATIONAL ELECTRICAL CODE
AWG	AMERICAN WIRE GAUGE	OC	ON CENTER
AWS	ADVANCED WIRELESS SERVICES	PP	POLARIZING PRESERVING
BATT	BATTERY	PCU	PRIMARY CONTROL UNIT
BBU	BASEBAND UNIT	PDU	PROTOCOL DATA UNIT
BTC	BARE TINNED COPPER CONDUCTOR	PWR	POWER
BTS	BASE TRANSCEIVER STATION	RECT	RECTIFIER
CCU	CLIMATE CONTROL UNIT	RET	REMOTE ELECTRICAL TILT
CDMA	CODE DIVISION MULTIPLE ACCESS	RMC	RIGID METALLIC CONDUIT
CHG	CHARGING	RF	RADIO FREQUENCY
CLU	CLIMATE UNIT	RUC	RACK USER COMMISSIONING
COMM	COMMON	RRH	REMOTE RADIO HEAD
DC	DIRECT CURRENT	RRU	REMOTE RADIO UNIT
DIA	DIAMETER	RWY	RACEWAY
DWG	DRAWING	SFP	SMALL FORM–FACTOR PLUGGABLE
EC	ELECTRICAL CONDUCTOR	SIAD	SMART INTEGRATED ACCESS DEVICE
EMT	ELECTRICAL METALLIC TUBING	SSC	SITE SOLUTIONS CABINET
FIF	FACILITY INTERFACE FRAME	T1	1544KBPS DIGITAL LINE
GEN	GENERATOR	TDMA	TIME–DIVISION MULTIPLE ACCESS
GPS	GLOBAL POSITIONING SYSTEM	TMA	TOWER MOUNT AMPLIFIER
GSM	GLOBAL SYSTEM FOR MOBILE	TVSS	TRANSIENT VOLTAGE SUPPRESSION SYSTEM
HVAC	HEAT/VENTILATION/AIR CONDITIONING	TYP	TYPICAL
ICF	INTERCONNECTION FRAME	UMTS	UNIVERSAL MOBILE TELECOMMUNICATION SYSTEM
IGR	INTERIOR GROUNDING RING (HALO)	UPS	UNINTERRUPTIBLE POWER SUPPLY (DC POWER PLANT)
LTE	LONG TERM EVOLUTION		

EVERSOURCE ENERGY

107 SELDEN STREET
BERLIN, CT 06037
PHONE: (800) 286–2000

BLACK & VEATCH

6800 W 115TH ST, SUITE 2292
OVERLAND PARK, KS 66211
PHONE: (913) 458–2522

PROJECT NO:	405025
DRAWN BY:	TYW
CHECKED BY:	TH

REV	DATE	DESCRIPTION
0	07/28/20	ISSUED FOR FILING

07/28/2020

IT IS A VIOLATION OF LAW FOR ANY PERSON, UNLESS THEY ARE ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER, TO ALTER THIS DOCUMENT.

TOLLAND AWC
48 TOLLAND STAGE ROAD
TOLLAND, CT 06084

SHEET TITLE

NOTES & SPECIFICATIONS

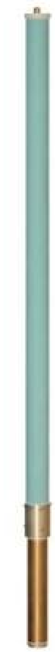
SHEET NUMBER

N-3

REFERENCE CUTSHEETS

VHF Omni Antennas (160-222 MHz)

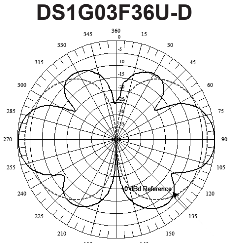
		160-174 MHz						217-222 MHz									
	Model Number	DS1G03F36U-N	DS1G03F36U-D	DS1G06F36U-N	DS1G06F36U-D	DS1G03F36D-N	DS1G03F36D-D	DS2C00F36U-N	DS2C00F36U-D	DS2C03F36U-N	DS2C03F36U-D	DS2C06F36U-N	DS2C06F36U-D	DS2C00F36D-N	DS2C00F36D-D	DS2C03F36D-N	DS2C03F36D-D
	Input Connector	N(F)	7/16 DIN	N(F)	7/16 DIN	N(F)	7/16 DIN	N(F)	7/16 DIN	N(F)	7/16 DIN	N(F)	7/16 DIN	N(F)	7/16 DIN	N(F)	7/16 DIN
	Type	Single		Single		Dual		Single		Single		Single		Dual		Dual	
ELECTRICAL	**Bandwidth**, MHz	14		14		14		5		5		5		5		5	
ELECTRICAL	**Power**, Watts	500		500		350		500		500		500		350		350	
ELECTRICAL	**Gain**, dBd	3		6		3		0		3		6		0		3	
ELECTRICAL	**Horizontal Beamwidth**, degrees	360		360		360		360		360		360		360		360	
ELECTRICAL	**Vertical Beamwidth**, degrees	30		16		30		60		30		16		60		30	
ELECTRICAL	**Beam Tilt**, degrees	0		0		0		0		0		0		0		0	
ELECTRICAL	**Isolation (minimum)**, dB	N/A		N/A		30		N/A		N/A		N/A		30		30	
MECHANICAL	**Number of Connectors**	1		1		2		1		1		1		2		2	
MECHANICAL	**Flat Plate Area**, ft^2	2.10		3.63		3.69		1.28		1.64		2.58		2.09		3.08	
MECHANICAL	**Lateral Windload Thrust**, lbf	88		152		155		54		69		109		88		129	
MECHANICAL	**Wind Speed Rating without ice**, mph	190		150		150		250		225		175		190		160	
MECHANICAL	**Mounting Hardware** included	DSH3V3R		DSH3V3N		DSH3V3N		DSH2V3R		DSH2V3R		DSH3V3N		DSH3V3R		DSH3V3N	
DIMENSIONS	**Length**, ft(m)	12.7 (3.9)		21.9 (6.7)		22.3 (6.8)		7.7 (2.3)		9.9 (3)		15.6 (4.8)		12.6 (3.8)		18.6 (5.7)	
DIMENSIONS	**Radome O.D.**, in(cm)	3 (7.6)		3 (7.6)		3 (7.6)		3 (7.6)		3 (7.6)		3 (7.6)		3 (7.6)		3 (7.6)	
DIMENSIONS	**Mast O.D.**, in(cm)	2.5 (6.4)		2.5 (6.4)		2.5 (6.4)		2.5 (6.4)		2.5 (6.4)		2.5 (6.4)		2.5 (6.4)		2.5 (6.4)	
DIMENSIONS	**Net Weight** w/o bracket, lb(kg)	37 (16.8)		60 (27.2)		63 (28.6)		19 (8.6)		26 (11.8)		47 (21.3)		40 (18.1)		70 (31.8)	
DIMENSIONS	**Shipping Weight**, lb(kg)	67 (30.4)		90 (40.8)		93 (42.2)		39 (17.7)		56 (25.4)		77 (34.9)		70 (31.8)		100 (45.4)	



DS2C00F36D-D

VERTICAL PATTERNS

DS1G03F36U-N
DS1G03F36U-D



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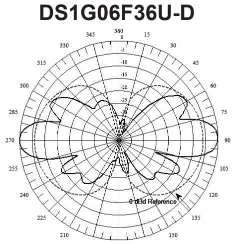

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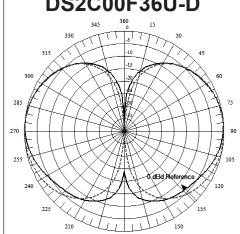

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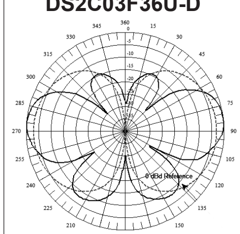
DS2C03F36U-D



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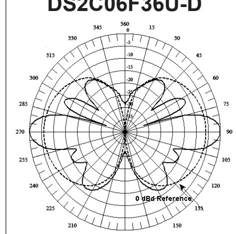

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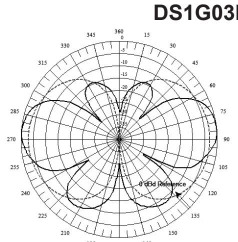
DS1G03F36D-D



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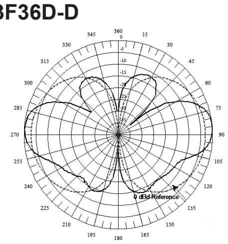

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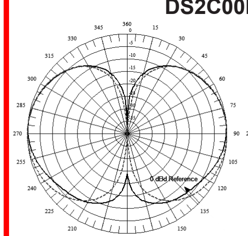
DS2C00F36D-N
DS2C00F36D-D



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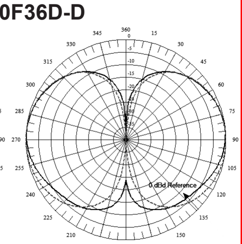

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DS2C03F36D-N
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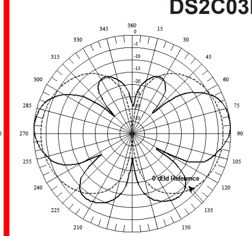

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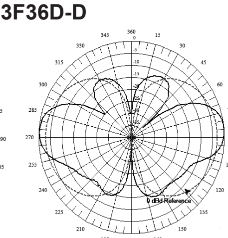


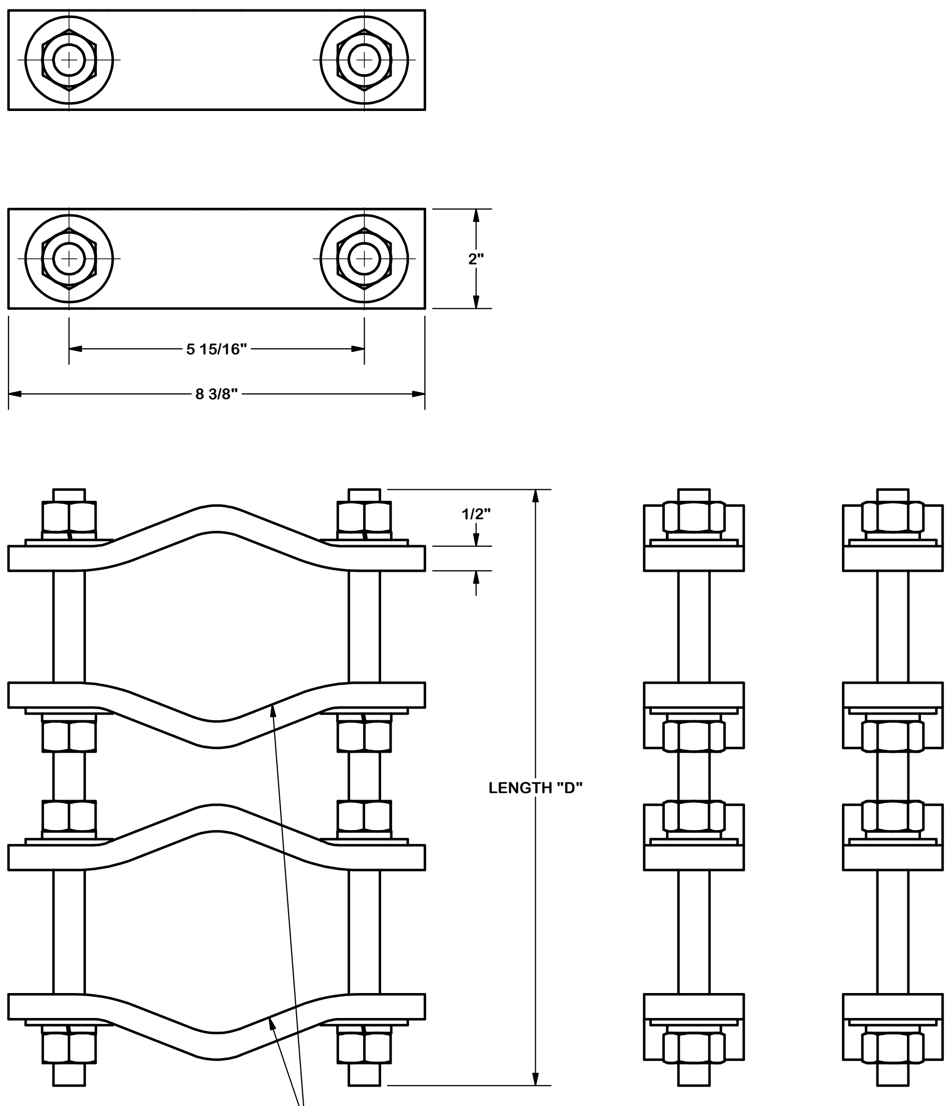
Bottom

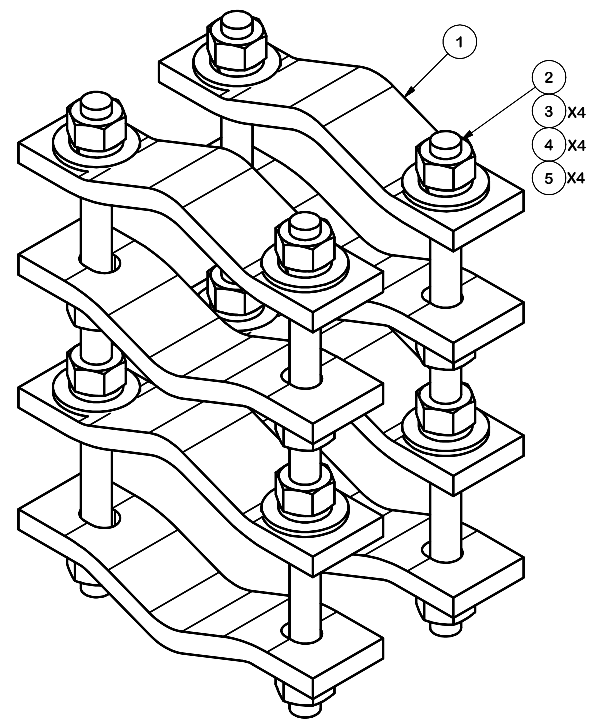
Specifications are subject to change • **www.dbspectra.com** • 1590 E Hwy 121 Bus, Ste A100, Lewisville, TX 75056 • P(469)322-0080 • F(469)322-0079 • ISO 9001:2015 • 096000-030.E • © 07/2019

TOTAL OF (2) REQUIRED.
TOWER/MAST SIZE AT PROPOSED ANTENNA ATTACHMENT = 2.875" ± DIAMETER.

PARTS LIST						
ITEM	QTY	PART NO.	PART DESCRIPTION	LENGTH	UNIT WT.	NET WT.
1	8	DCP	CLAMP HALF, 1/2" THICK, 8-3/8"		2.40	19.20
2	B	C	5/8" THREADED ROD	D	E	F
3	16	G58NUT	5/8" HDG HEAVY 2H HEX NUT		0.13	2.08
4	16	G58LW	5/8" HDG LOCKWASHER		0.03	0.42
5	16	G58FW	5/8" HDG USS FLATWASHER		0.07	1.13

VARIABLE PARTS TABLE						
ASSEMBLY "A"	QTY "B"	PART "C"	LENGTH "D"	UNIT WT. "E"	NET WT. "F"	TOTAL WEIGHT
DCP12K	4	G58R-12	12"	1.05	4.18	27.01
DCP18K	4	G58R-18	18"	1.57	6.27	29.10





TOLERANCE NOTES

TOLERANCES ON DIMENSIONS, UNLESS OTHERWISE NOTED ARE:
SAWED, SHEARED AND GAS CUT EDGES *(± 0.030")*
DRILLED AND GAS CUT HOLES *(± 0.030")* - NO CONING OF HOLES
LASER CUT EDGES AND HOLES *(± 0.010")* - NO CONING OF HOLES
BENDS ARE ± 1/2 DEGREE
ALL OTHER MACHINING *(± 0.030")*
ALL OTHER ASSEMBLY *(± 0.060")*

DESCRIPTION
PIPE TO PIPE CLAMP SET
1-1/2" TO 5" PIPE
1/2" THICK CLAMP

SITE PRO 1 — A valmont COMPANY

Engineering Support Team:
1-888-753-7446

Locations:
New York, NY
Atlanta, GA
Los Angeles, CA
Plymouth, IN
Salem, OR
Dallas, TX

CPD NO.		DRAWN BY	ENG. APPROVAL	PART NO.
		KC8 8/21/2012		SEE ASSEMBLY "A"
CLASS	SUB	DRAWING USAGE	CHECKED BY	DWG. NO.
81	01	CUSTOMER	CEK 1/22/2013	DCPxxK

ORDER WITH N CONNECTOR
Part # 531-70*4 (36-38 MHz) 12' Face Tower (Item No. F-33483)

LOW BAND EXPOSED DIPOLE ANTEN

The antenna length @ 37.74 MHz is 210" (17.5'), according to Comprod and will stand off approximately 39" from the tower.

530 Series Low Band Exposed Dipole Antenna

The Low Band Exposed Dipole Antenna Series are available in our standard or heavy-duty construction. These exposed dipole antennas come in both single and dual configurations, depending on the gain required. They are constructed from high strength, corrosion resistant aluminum alloy, hot galvanized steel mounting hardware, and use unique PVC off-set support arms. Our heavy-duty versions have dual support braces and use a superior anti-torque support. All components are oversized.

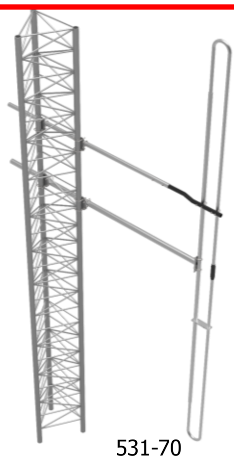
- Each antenna has a rugged design to withstand the most extreme environmental conditions.
- Supplied with anti-torque supports.
- DC ground for lightning protection.
- Can be black anodized coating for enhanced anti-corrosion and de-icing properties

Electrical Specifications	531-70	531-70-HD	532-70	532-70-HD
Frequency Range, MHz (in splits)	30-76	30-76	30-76	30-76
Nominal Gain, dBd	2.5	2.5	5.5	5.5
Bandwidth 1.5:1 VSWR, MHz	7%	7%	7%	7%
Polarization	Vertical	Vertical	Vertical	Vertical
Pattern	Offset	Offset	Offset	Offset
Power Rating, Watts	300	300	300	300
Nominal Impedance, Ohms	50	50	50	50
Lightning Protection	DC Ground	DC Ground	DC Ground	DC Ground
Standard Termination	Type N Male	Type N Male	Type N Male	Type N Male
Mechanical Specifications	**531-70**	**531-70-HD**	**532-70**	**532-70-HD**
Length @ 30 MHz, in (mm)	189 (4800)	189 (4800)	472 (11989)	472 (11989)
Width, in (mm)	87 (2210)	87 (2210)	87 (2210)	87 (2210)
Weight, lbs. (kg)	37 (17)	43 (19.5)	79 (36)	91 (41)
Rated Wind Velocity, No Ice, mph (km/h)	143 (230)	200 (322)	143 (230)	200 (322)
Rated Wind Velocity, 0.5" (13mm) ice, mph (km/h)	98 (158)	160 (258)	98 (158)	160 (258)
Lateral Thrust @ 100 mph, wind, lbs. (kg)	133 (60.8)	160 (72.3)	266 (121.6)	320 (144.6)
Projected Area, ft² (m²)	4.98 (0.46)	5.94 (0.55)	9.96 (0.92)	11.88 (1.10)
Mounting Information Mast O.D., mm (number of clamps needed)	1.25"-2.38" (4)	1.25"-2.38" (6)	1.25"-2.38" (8)	1.25"-2.38" (12)

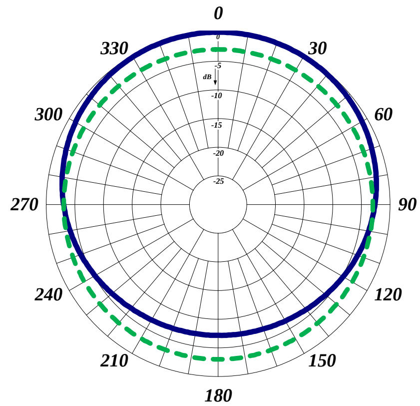
* See next page for ordering information of different frequency splits (page 3) *

COMPROD
Simplifying RF Solutions
www.comprodcom.com
Tel: US 1.877.825.2007 / CAN 1.800.603.1454
Email: sales@comprodcom.com
Fax: 1.800.554.1033

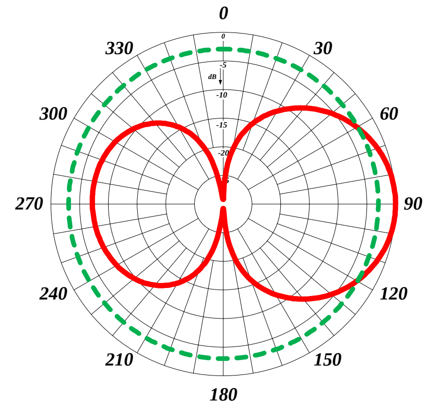
LOW BAND EXPOSED DIPOLE ANTENNA 30-76 MHz



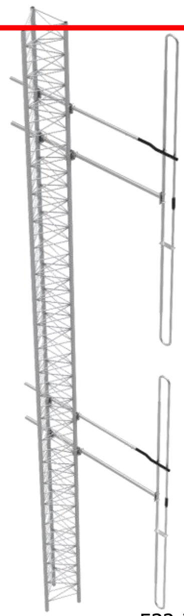
531-70



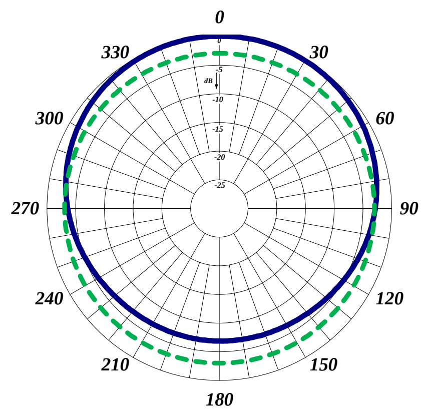
Horizontal Pattern



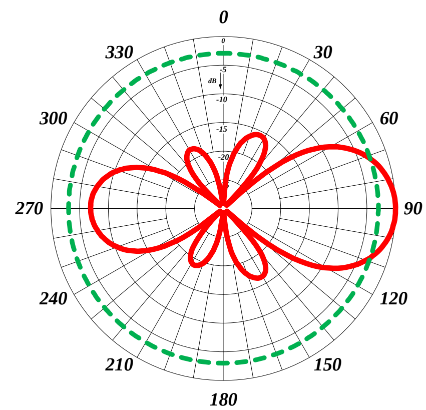
Vertical Pattern



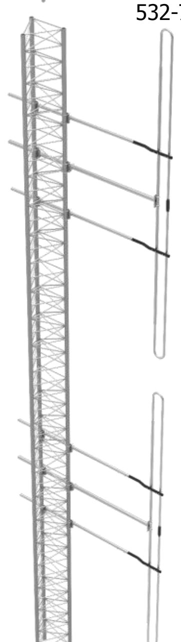
532-70



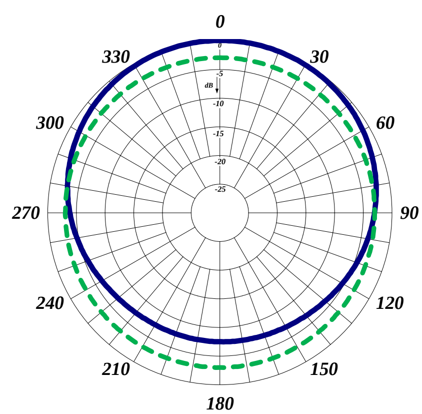
Horizontal Pattern



Vertical Pattern



532-70-HD



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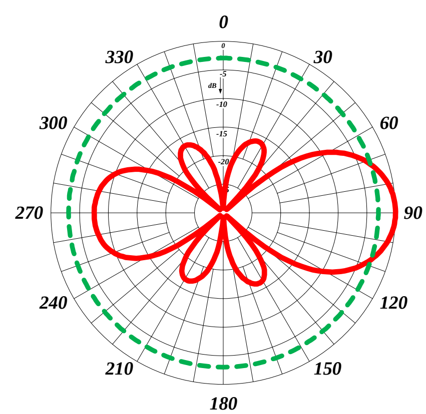


Vertical Pattern

Tel: US 1.877.825.2007 / CAN 1.800.603.1454
www.comprodcom.com
Email: sales@comprodcom.com
Fax: 1.800.554.1033

LOW BAND EXPOSED DIPOLE ANTENNA 30-76 MHz

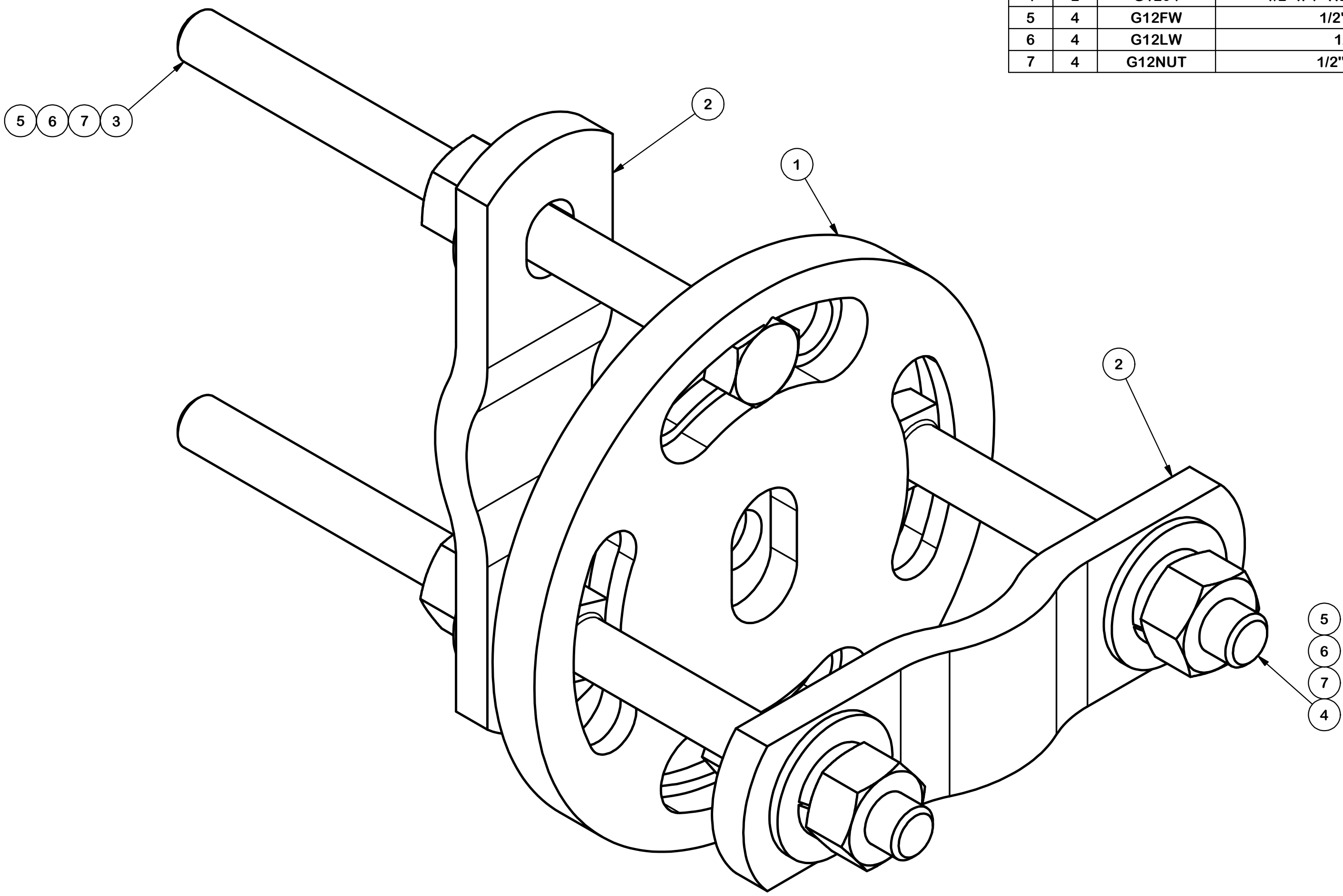
Order Information	30-32 MHz	32-34 MHz	34-36 MHz	36-38 MHz	38-41 MHz	41-44 MHz	44-47 MHz	47-50 MHz
531-70	531-70*1	531-70*2	531-70*3	531-70*4	531-70*5	531-70*6	531-70*7	531-70*8
532-70	532-70*1	532-70*2	532-70*3	532-70*4	532-70*5	532-70*6	532-70*7	532-70*8
531-70-HD	531-70-HD*1	531-70-HD*2	531-70-HD*3	531-70-HD*4	531-70-HD*5	531-70-HD*6	531-70-HD*7	531-70-HD*8
532-70-HD	532-70-HD*1	532-70-HD*2	532-70-HD*3	532-70-HD*4	532-70-HD*5	532-70-HD*6	532-70-HD*7	532-70-HD*8

Tel: US 1.877.825.2007 / CAN 1.800.603.1454
Email: sales@comprodcom.com
Fax: 1.800.554.1033

TOTAL OF (4) REQUIRED.
TOWER/MAST SIZE AT PROPOSED ANTENNA ATTACHMENT = 2.875" ± DIAMETER.

PARTS LIST

ITEM	QTY	PART NO.	PART DESCRIPTION	LENGTH	UNIT WT.	NET WT.
1	1	X-127594	FLAT DISK CLAMP PLATE 4" CENTERS (GALVANIZED)		2.48	2.48
2	2	X-100064	CLAMP (S) (4" V-CLAMP) GALVANIZED		0.91	1.83
3	2	G12065	1/2" x 6-1/2" HDG HEX BOLT GR5 FULL THREAD	6 1/2 in	0.41	0.82
4	2	G1204	1/2" x 4" HDG HEX BOLT GR5 FULL THREAD	4 in	0.27	0.54
5	4	G12FW	1/2" HDG USS FLATWASHER		0.03	0.14
6	4	G12LW	1/2" HDG LOCKWASHER		0.01	0.06
7	4	G12NUT	1/2" HDG HEAVY 2H HEX NUT		0.07	0.29
					TOTAL WT. #	6.16



TOLERANCE NOTES

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DRILLED AND GAS CUT HOLES *(± 0.030")* - NO CONING OF HOLES
LASER CUT EDGES AND HOLES *(± 0.010")* - NO CONING OF HOLES
BENDS ARE ± 1/2 DEGREE
ALL OTHER MACHINING *(± 0.030")*
ALL OTHER ASSEMBLY *(± 0.060")*

DESCRIPTION
ADJUSTABLE CLAMP PLATE
TIE-BACK ASSEMBLY

SITE PRO 1
A valmont COMPANY
Engineering Support Team:
1-888-753-7446
Locations:
New York, NY
Atlanta, GA
Los Angeles, CA
Plymouth, IN
Salem, OR
Dallas, TX

CPD NO.	DRAWN BY	ENG. APPROVAL	PART NO.
	CEK 8/30/2010		PUCK

CLASS	SUB	DRAWING USAGE	CHECKED BY	DWG. NO.
81	01	CUSTOMER	BMC 9/1/2010	PUCK

ATTACHMENT C – STRUCTURAL ANALYSIS REPORT

Date: **July 31, 2020**

Black & Veatch Corp.
6800 W. 115th St., Suite 2292
Overland Park, KS 66211
(913) 458-2522

Subject:	**Structural Analysis Report**	
Eversource Designation:	**Site Number:** **Site Name:**	ES-043 TollandAWC
Engineering Firm Designation:	**Black & Veatch Corp. Project Number:**	405025
Site Data:	**48 Tolland Stage Road, Tolland, Tolland County CT** **Latitude *41° 52' 1.2"*, Longitude *-72° 25' 23.1"*** **94 Foot - Self Support Tower**	

Black & Veatch Corp. is pleased to submit this **"Structural Analysis Report"** to determine the structural integrity of the above mentioned tower.

The purpose of the analysis is to determine acceptability of the tower stress level. Based on our analysis we have determined the tower stress level for the structure and foundation, under the following load case, to be:

LC1: Proposed Equipment Configuration **Sufficient Capacity – 47.4%**

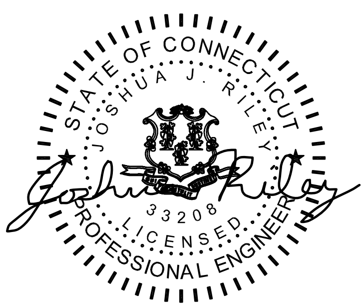
This analysis utilizes an ultimate 3-second gust wind speed of 135 mph as required by the 2018 Connecticut State building Code. Applicable standard references and design criteria are listed in Section 2 - Analysis Criteria.

Structural analysis prepared by: Aditya Kulkarni/Changzhi Zang

Respectfully submitted by:

Joshua J. Riley, P.E.

Professional Engineer



07/31/2020

TABLE OF CONTENTS

1) INTRODUCTION

This tower is a 94 ft Self Support tower designed and manufactured by Rohn.

2) ANALYSIS CRITERIA

TIA-222 Revision:	TIA-222-H
Risk Category:	III
Wind Speed:	135 mph
Exposure Category:	C
Topographic Factor:	1
Ice Thickness:	2 in
Wind Speed with Ice:	50 mph
Seismic Ss:	0.176
Seismic S1:	0.064
Service Wind Speed:	60 mph

Table 1 - Proposed Equipment Configuration

Mounting Level (ft)	Center Line Elevation (ft)	Number of Antennas	Antenna Manufacturer	Antenna Model	Number of Feed Lines	Feed Line Size (in)	Note
93.5	98.5	1	dbspectra	DS2C00F36D-D	2	7/8	-
	93.5	2	site pro 1	DCP12K Clamp Set			
70.0	70.0	1	comprod	531-70 Dipole Antenna w/ Mounting Equipment	-	-	1,2

Note:
1) Will use relocated coax cable from the antenna being removed, see notes in Table 2.
2) Antenna comes with its own standoff mounting pipes.

Table 2 - Other Considered Equipment

Mounting Level (ft)	Center Line Elevation (ft)	Number of Antennas	Antenna Manufacturer	Antenna Model	Number of Feed Lines	Feed Line Size (in)	Note
93.0	103.0	1	antennae	3" Dia 20' Omni	1	7/8	1
	102.0	1	antennae	3" Dia 18' Omni	1	7/8	2
	98.0	1	antennae	3" Dia 10' Omni	1	7/8	1
88.0	88.0	1	rfs celwave	PAD6-W59BC	1	WE65	1
		1	tower mounts	6' x 3" Mount Pipe			
87.0	91.0	1	decibel	DB586-Y	2 1	7/8 1/2	1
	87.0	1	tower mounts	Side Arm Mount [SO 308-1]			
		1	unknown	15"x8"x3" TMA			
	83.0	1	decibel	DB586-Y			
87.0	87.0	1	unknown	5' Dipole Antenna	1	7/8	1
73.0	73.0	1	unknown	5' Dipole Antenna	1	1/2	1

Note:
1) Existing Equipment
2) Antenna and it's mounting clamps to be removed. Its coax will be relocated down to the proposed dipole antenna at 70'.

3) ANALYSIS PROCEDURE

Table 3 - Documents Provided

Document	Remarks	Reference	Source
GEOTECHNICAL REPORT	Delta Oaks Group, Dated 02/26/2019	Geotechnial Investigation Report	Eversource
TOWER FOUNDATION DRAWING	Northeast Utilities Service Co., Dated 03/15/1979	Tower Foundation Details	Eversource
TOWER STRUCTURAL ANALYSIS REPORT	Centek Engineering, Inc., Dated 10/26/2011	Tower geometry and reserved loading	Eversource

3.1) Analysis Method

tnxTower (version 8.0.5.0), a commercially available analysis software package, was used to create a three-dimensional model of the tower and calculate member stresses for various loading cases. Selected output from the analysis is included in Appendix.

3.2) Assumptions

1) Tower and structures were built and maintained in accordance with the manufacturer's specifications.
2) The configuration of antennas, transmission cables, mounts and other appurtenances are as specified in Tables 1 and 2 and the referenced drawings.
3) The existing baseplate grout was considered in this analysis. Grout must be maintained and inspected periodically and must be replaced if damaged or cracked.
4) This analysis was performed under the assumption that all information provided to Black & Veatch is current and correct. This is to include site data, appurtenance loading, tower/foundation details, and geotechnical data.
5) Tower loading is based on 2018 drone mapping photos and previous Centek structural analyses.

This analysis may be affected if any assumptions are not valid or have been made in error. Black & Veatch Corp. should be notified to determine the effect on the structural integrity of the tower.

Table 4 - Section Capacity (Summary)

Section No.	Elevation (ft)	Component Type	Size	Critical Element	P (K)	SF*P_allow (K)	% Capacity	Pass / Fail
T1	94 - 80	Leg	ROHN 2.5 EH	2	-3.72	58.19	6.4	Pass
T2	80 - 60	Leg	ROHN 2.5 EH	20	-12.31	61.44	20.0	Pass
T3	60 - 40	Leg	ROHN 3 EH	42	-24.77	99.06	25.0	Pass
T4	40 - 20	Leg	ROHN 3.5 EH	63	-37.68	93.61	40.2	Pass
T5	20 - 0	Leg	ROHN 4 EH	78	-52.74	128.29	41.1	Pass
T1	94 - 80	Diagonal	L1 3/4x1 3/4x3/16	7	-1.64	4.06	40.3	Pass
T2	80 - 60	Diagonal	L2x2x3/16	22	-2.27	4.78	47.4	Pass
T3	60 - 40	Diagonal	L2 1/2x2 1/2x3/16	43	-2.94	7.53	39.0 44.9 (b)	Pass
T4	40 - 20	Diagonal	L3x3x3/16	64	-3.81	8.98	42.5 45.8 (b)	Pass
T5	20 - 0	Diagonal	L 3x3x1/4	80	-4.27	9.88	43.3	Pass
T1	94 - 80	Top Girt	L3 1/2x3 /12x1/4	5	-0.15	16.22	0.9 1.6 (b)	Pass
							Summary	

Section No.	Elevation (ft)	Component Type	Size	Critical Element	P (K)	SF*P_allow (K)	% Capacity	Pass / Fail
						Leg (T5)	41.1	Pass
						Diagonal (T2)	47.4	Pass
						Top Girt (T1)	1.6	Pass
						Bolt Checks	45.8	Pass
						RATING =	47.4	Pass

Table 5 - Tower Component Stresses vs. Capacity - LC1

Notes	Component	Elevation (ft)	% Capacity	Pass / Fail
1	Anchor Rods	0	29.1	Pass
1	Base Foundation	0	30.4	Pass
1	Base Foundation Soil Interaction		26.4	Pass

Structure Rating (max from all components) =	47.4%

Note:
1) See additional documentation in “Appendix C – Additional Calculations” for calculations supporting the % capacity consumed. Rating per TIA-222-H Section 15.5.

4.1) Recommendations

The tower has sufficient capacity to carry the proposed load configuration. No modifications are required at this time.

Maximum Tower Deflections - Service Wind

Section No.	*Elevation ft*	*Horz. Deflection in*	*Gov. Load Comb.*	*Tilt °*	*Twist °*	*Check**
T1	94 - 80	0.356	47	0.025	0.006	OK
T2	80 - 60	0.279	47	0.025	0.005	OK
T3	60 - 40	0.173	47	0.021	0.004	OK
T4	40 - 20	0.086	47	0.015	0.002	OK
T5	20 - 0	0.027	39	0.008	0.001	OK

*Limit State Deformation (TIA-222-H Section 2.8.2)

1) Maximum Rotation = 4 Degrees

2) Maximum Deflection = 0.03 * Tower Height = 34 in.

Critical Deflections of Tower at the MW Dish Elevations - Service Wind

Elevation (ft)	*MW Dish*	*Tilt (°)*	*Twist (°)*	*Diameter, D (ft)*	*Frequency, α (GHz)*	*Decibel Points*	*Deformation Limit (θ)**	*Deformation Limit Exceeded?*
88	PAD6-W59BC	0.025	0.006	6.583333	10	10 dB	0.807	Not Exceeded

*Limit per TIA-222-H Annex D

Maximum Tower Deflections - Design Wind

Section No.	*Elevation* *ft*	*Horz. Deflection* *in*	*Gov. Load Comb.*	*Tilt* °	*Twist* °	*Combined Max*	*Check**
T1	94 - 80	1.08	39	0.075	0.019	0.077	OK
T2	80 - 60	0.849	39	0.074	0.016	0.076	OK
T3	60 - 40	0.531	39	0.063	0.011	0.064	OK
T4	40 - 20	0.265	39	0.045	0.007	0.046	OK
T5	20 - 0	0.083	39	0.023	0.003	0.023	OK

*Up to 0.5 degree is considered acceptable per SUB090 Section 7

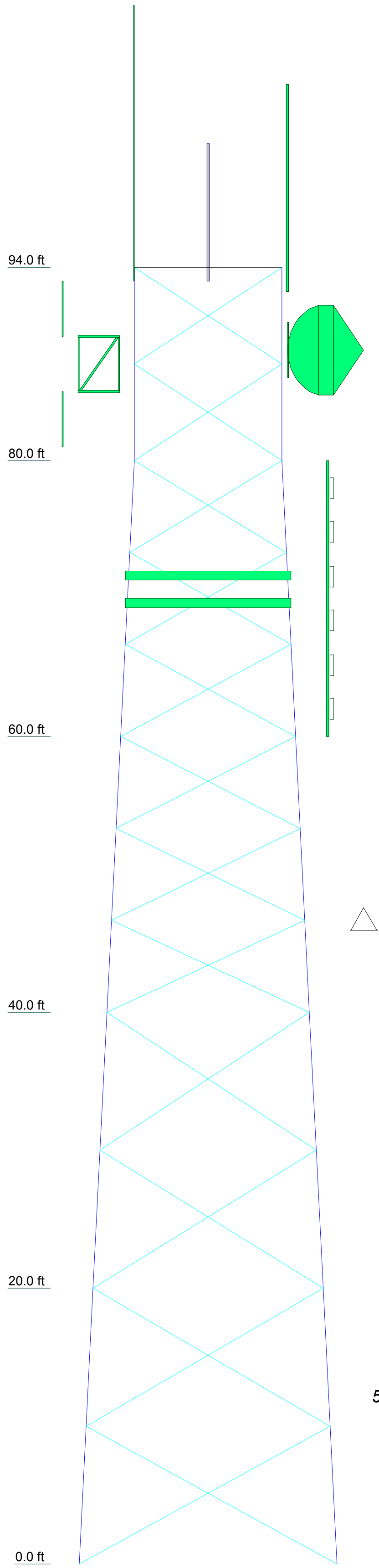
Critical Deflections of Tower at the MW Dish Elevations - Design Wind

Elevation *ft*	*Appurtenance*	*Gov. Load Comb.*	*Deflection* *in*	*Tilt* °	*Twist* °	*Radius of Curvature* *ft*
88	PAD6-W59BC	39	0.981	0.075	0.017	Inf

APPENDIX A

TNXTOWER OUTPUT

Section	Legs	Leg Grade	Diagonals	Diagonal Grade	Top Girts	Face Width (ft)	# Panels @ (ft)	Weight (K)
T1	ROHN 2.5 EH	A572-50	L1 3/4x1 3/4x3/16	A36	L3 1/2x3 /12x1/4	10.67	2 @ 7	0.9
T2			L2x2x3/16		N.A.	12.67	6 @ 6.66667	1.1
T3	ROHN 3 EH		L2 1/2x2 1/2x3/16			14.67		1.5
T4	ROHN 3.5 EH		L3x3x3/16			16.67	4 @ 10	1.7
T5	ROHN 4 EH		L 3x3x1/4	A572-50		18.67		2.2
								7.4



DESIGNED APPURTENANCE LOADING

TYPE	ELEVATION	TYPE	ELEVATION
DS2C00F36D-D w/ DCP12K Clamp Sets	93.5	5' Dipole Antenna	87
		Side Arm Mount [SO 308-1]	87
3" Dia 20' Omni	93	DB586-Y	87
3" Dia 10' Omni	93	5' Dipole Antenna	73
6'x3" Mount Pipe	88	15'x2.5" Horizontal Pipe	70
PAD6-W59BC	88	15'x2.5" Horizontal Pipe	70
15"x8"x3" TMA	87	531-70 Dipole Antenna w/ Mounting Equipment	70
DB586-Y	87		

MATERIAL STRENGTH

GRADE	Fy	Fu	GRADE	Fy	Fu
A572-50	50 ksi	65 ksi	A36	36 ksi	58 ksi

TOWER DESIGN NOTES

1. Tower is located in Tolland County, Connecticut.
2. Tower designed for Exposure C to the TIA-222-H Standard.
3. Tower designed for a 135 mph basic wind in accordance with the TIA-222-H Standard.
4. Tower is also designed for a 50 mph basic wind with 2.00 in ice. Ice is considered to increase in thickness with height.
5. Deflections are based upon a 60 mph wind.
6. Tower Risk Category III.
7. Topographic Category 1 with Crest Height of 0.00 ft
8. TOWER RATING: 47.4%

ALL REACTIONS ARE FACTORED

MAX. CORNER REACTIONS AT BASE:
DOWN: 57 K
SHEAR: 9 K

UPLIFT: -45 K
SHEAR: 8 K

AXIAL 44 K
SHEAR 5 K
MOMENT 301 kip-ft
TORQUE 5 kip-ft
50 mph WIND - 2.000 in ICE

AXIAL 11 K
SHEAR 16 K
MOMENT 858 kip-ft
TORQUE 10 kip-ft
REACTIONS - 135 mph WIND

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Job: **ES-043 TollandAWC**		
Project: **405025**		
Client: Eversource	Drawn by: TH	App'd:
Code: TIA-222-H	Date: 07/21/20	Scale: NTS
Path: C:\Users\hal92311\OneDrive - Black & Veatch\My Desktop\Rev. H\ES-043 TollandAWC Structural Analysis.eri		Dwg No. E-1

Tower Input Data

The main tower is a 3x free standing tower with an overall height of 94.00 ft above the ground line.
The base of the tower is set at an elevation of 0.00 ft above the ground line.
The face width of the tower is 10.67 ft at the top and 18.67 ft at the base.
This tower is designed using the TIA-222-H standard.
The following design criteria apply:

1. Tower is located in Tolland County, Connecticut.
2. Tower base elevation above sea level: 557.00 ft.
3. Basic wind speed of 135 mph.
4. Risk Category III.
5. Exposure Category C.
6. Simplified Topographic Factor Procedure for wind speed-up calculations is used.
7. Topographic Category: 1.
8. Crest Height: 0.00 ft.
9. Nominal ice thickness of 2.000 in.
10. Ice thickness is considered to increase with height.
11. Ice density of 56 pcf.
12. A wind speed of 50 mph is used in combination with ice.
13. Temperature drop of 50 °F.
14. Deflections calculated using a wind speed of 60 mph.
15. Pressures are calculated at each section.
16. Stress ratio used in tower member design is 1.05.
17. Local bending stresses due to climbing loads, feed line supports, and appurtenance mounts are not considered.

Options

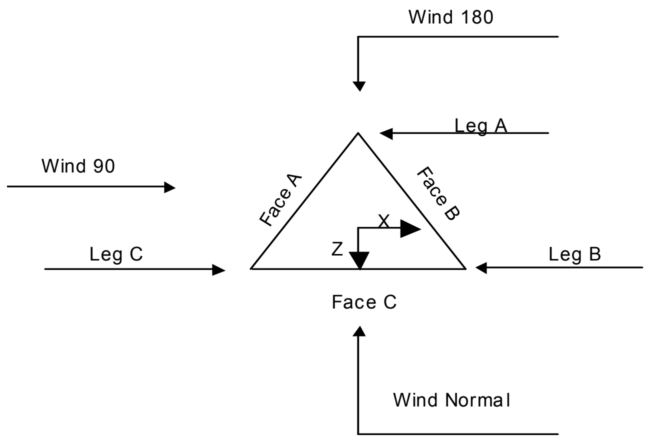
Consider Moments - Legs
Consider Moments - Horizontals
Consider Moments - Diagonals
Use Moment Magnification
Use Code Stress Ratios
Use Code Safety Factors - Guys
Escalate Ice
Always Use Max Kz
Use Special Wind Profile
√ Include Bolts In Member Capacity
Leg Bolts Are At Top Of Section
√ Secondary Horizontal Braces Leg
Use Diamond Inner Bracing (4 Sided)
SR Members Have Cut Ends
SR Members Are Concentric

Distribute Leg Loads As Uniform
Assume Legs Pinned
√ Assume Rigid Index Plate
√ Use Clear Spans For Wind Area
√ Use Clear Spans For KL/r
Retension Guys To Initial Tension
√ Bypass Mast Stability Checks
√ Use Azimuth Dish Coefficients
√ Project Wind Area of Appurt.
Autocalc Torque Arm Areas
Add IBC .6D+W Combination
√ Sort Capacity Reports By Component
Triangulate Diamond Inner Bracing
Treat Feed Line Bundles As Cylinder
Ignore KL/ry For 60 Deg. Angle Legs

Use ASCE 10 X-Brace Ly Rules
√ Calculate Redundant Bracing Forces
Ignore Redundant Members in FEA
SR Leg Bolts Resist Compression
All Leg Panels Have Same Allowable
Offset Girt At Foundation
√ Consider Feed Line Torque
√ Include Angle Block Shear Check
Use TIA-222-H Bracing Resist. Exemption
Use TIA-222-H Tension Splice Exemption

Poles

Include Shear-Torsion Interaction
Always Use Sub-Critical Flow
Use Top Mounted Sockets
Pole Without Linear Attachments
Pole With Shroud Or No Appurtenances
Outside and Inside Corner Radii Are Known



Triangular Tower

Tower Section Geometry

Tower Section	*Tower Elevation* ft	*Assembly Database*	*Description*	*Section Width* ft	*Number of Sections*	*Section Length* ft
T1	94.00-80.00			10.67	1	14.00
T2	80.00-60.00			10.67	1	20.00
T3	60.00-40.00			12.67	1	20.00
T4	40.00-20.00			14.67	1	20.00
T5	20.00-0.00			16.67	1	20.00

Tower Section Geometry *(cont'd)*

Tower Section	*Tower Elevation* ft	*Diagonal Spacing* ft	*Bracing Type*	*Has K Brace End Panels*	*Has Horizontals*	*Top Girt Offset* in	*Bottom Girt Offset* in
T1	94.00-80.00	7.00	X Brace	No	No	0.000	0.000
T2	80.00-60.00	6.67	X Brace	No	No	0.000	0.000
T3	60.00-40.00	6.67	X Brace	No	No	0.000	0.000
T4	40.00-20.00	10.00	X Brace	No	No	0.000	0.000
T5	20.00-0.00	10.00	X Brace	No	No	0.000	0.000

Tower Section Geometry *(cont'd)*

Tower Elevation ft	*Leg Type*	*Leg Size*	*Leg Grade*	*Diagonal Type*	*Diagonal Size*	*Diagonal Grade*
T1 94.00-80.00	Pipe	ROHN 2.5 EH	A572-50 (50 ksi)	Single Angle	L1 3/4x1 3/4x3/16	A36 (36 ksi)
T2 80.00-60.00	Pipe	ROHN 2.5 EH	A572-50 (50 ksi)	Single Angle	L2x2x3/16	A36 (36 ksi)

Tower Elevation ft	Leg Type	Leg Size	Leg Grade	Diagonal Type	Diagonal Size	Diagonal Grade
T3 60.00-40.00	Pipe	ROHN 3 EH	A572-50 (50 ksi)	Single Angle	L2 1/2x2 1/2x3/16	A36 (36 ksi)
T4 40.00-20.00	Pipe	ROHN 3.5 EH	A572-50 (50 ksi)	Single Angle	L3x3x3/16	A36 (36 ksi)
T5 20.00-0.00	Pipe	ROHN 4 EH	A572-50 (50 ksi)	Single Angle	L 3x3x1/4	A572-50 (50 ksi)

Tower Section Geometry *(cont'd)*

Tower Elevation ft	Top Girt Type	Top Girt Size	Top Girt Grade	Bottom Girt Type	Bottom Girt Size	Bottom Girt Grade
T1 94.00-80.00	Single Angle	L3 1/2x3 /12x1/4	A572-50 (50 ksi)	Solid Round		A36 (36 ksi)

Tower Section Geometry *(cont'd)*

Tower Elevation ft	Gusset Area (per face) ft^2	Gusset Thickness in	Gusset Grade	Adjust. Factor A_f	Adjust. Factor A_r	Weight Mult.	Double Angle Stitch Bolt Spacing Diagonals in	Double Angle Stitch Bolt Spacing Horizontals in	Double Angle Stitch Bolt Spacing Redundants in
T1 94.00-80.00	0.00	0.000	A36 (36 ksi)	1.05	1	1.05	36.000	36.000	36.000
T2 80.00-60.00	0.00	0.000	A36 (36 ksi)	1.05	1	1.05	36.000	36.000	36.000
T3 60.00-40.00	0.00	0.000	A36 (36 ksi)	1.05	1	1.05	36.000	36.000	36.000
T4 40.00-20.00	0.00	0.000	A36 (36 ksi)	1.05	1	1.05	36.000	36.000	36.000
T5 20.00-0.00	0.00	0.000	A36 (36 ksi)	1.05	1	1.05	36.000	36.000	36.000

Tower Section Geometry *(cont'd)*

			K Factors[1]							
Tower Elevation ft	Calc K Single Angles	Calc K Solid Rounds	Legs	X Brace Diags X Y	K Brace Diags X Y	Single Diags X Y	Girts X Y	Horiz. X Y	Sec. Horiz. X Y	Inner Brace X Y
T1 94.00-80.00	Yes	Yes	1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
T2 80.00-60.00	Yes	Yes	1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
T3 60.00-40.00	Yes	Yes	1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
T4 40.00-20.00	Yes	Yes	1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
T5 20.00-0.00	Yes	Yes	1	1 1	1 1	1 1	1 1	1 1	1 1	1 1

[1]Note: K factors are applied to member segment lengths. K-braces without inner supporting members will have the K factor in the out-of-plane direction applied to the overall length.

Tower Section Geometry *(cont'd)*

Tower Elevation ft	*Leg*		*Diagonal*		*Top Girt*		*Bottom Girt*		*Mid Girt*		*Long Horizontal*		*Short Horizontal*	
	Net Width Deduct in	*U*	*Net Width Deduct in*	*U*	*Net Width Deduct in*	*U*	*Net Width Deduct in*	*U*	*Net Width Deduct in*	*U*	*Net Width Deduct in*	*U*	*Net Width Deduct in*	*U*
T1 94.00-80.00	0.000	1	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75
T2 80.00-60.00	0.000	1	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75
T3 60.00-40.00	0.000	1	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75
T4 40.00-20.00	0.000	1	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75
T5 20.00-0.00	0.000	1	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75

Tower Section Geometry *(cont'd)*

Tower Elevation ft	*Leg Connection Type*	*Leg*		*Diagonal*		*Top Girt*		*Bottom Girt*		*Mid Girt*		*Long Horizontal*		*Short Horizontal*	
		Bolt Size in	*No.*	*Bolt Size in*	*No.*	*Bolt Size in*	*No.*	*Bolt Size in*	*No.*	*Bolt Size in*	*No.*	*Bolt Size in*	*No.*	*Bolt Size in*	*No.*
T1 94.00-80.00	Flange	0.625 A325N	4	0.500 A325N	1	0.500 A325N	1	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0
T2 80.00-60.00	Flange	0.750 A325N	4	0.500 A325N	1	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0
T3 60.00-40.00	Flange	0.875 A325N	4	0.500 A325N	1	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0
T4 40.00-20.00	Flange	0.875 A325N	4	0.625 A325N	1	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0
T5 20.00-0.00	Flange	0.875 A354-BC	0	0.625 A325N	1	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0

Feed Line/Linear Appurtenances - Entered As Round Or Flat

Description	*Face or Leg*	*Allow Shield*	*Exclude From Torque Calculation*	*Component Type*	*Placement ft*	*Face Offset in*	*Lateral Offset (Frac FW)*	*#*	*# Per Row*	*Clear Spacing in*	*Width or Diameter in*	*Perimeter in*	*Weight plf*
T-Brackets (Af)	C	No	No	Af (CaAa)	87.00 - 16.00	0.000	0.47	1	1	3.000	1.500		8.40
LDF5-50A(7/8)	C	No	No	Ar (CaAa)	93.00 - 87.00	0.000	0.46	2	2	0.500	1.030		0.33
LDF5-50A(7/8)	C	No	No	Ar (CaAa)	87.00 - 12.00	0.000	0.46	6	3	0.500	1.030		0.33
WE65(ELLIPTICAL)	C	No	No	Ar (CaAa)	87.00 - 12.00	0.000	0.48	1	1	0.500	2.030		0.53
LDF4-50A(1/2")	C	No	No	Ar (CaAa)	87.00 - 73.00	0.000	0.44	1	1	0.500	0.630		0.15
LDF4-50A(1/2") ***proposed***	C	No	No	Ar (CaAa)	73.00 - 12.00	0.000	0.44	2	1	0.500	0.630		0.15
LCF78-50JA(7/8) **	C	No	No	Ar (CaAa)	93.50 - 0.00	0.000	-0.49	2	2	0.500	1.090		0.32
LDF5-50A(7/8)	C	No	No	Ar (CaAa)	70.00 - 12.00	0.000	0.465	1	1	0.500	1.030		0.33

Feed Line/Linear Appurtenances Section Areas

Tower Section	Tower Elevation ft	Face	A_R ft^2	A_F ft^2	C_AA_A In Face ft^2	C_AA_A Out Face ft^2	Weight K
T1	94.00-80.00	A	0.000	0.000	0.000	0.000	0.00
		B	0.000	0.000	0.000	0.000	0.00
		C	0.000	0.000	12.117	0.000	0.09
T2	80.00-60.00	A	0.000	0.000	0.000	0.000	0.00
		B	0.000	0.000	0.000	0.000	0.00
		C	0.000	0.000	28.889	0.000	0.24
T3	60.00-40.00	A	0.000	0.000	0.000	0.000	0.00
		B	0.000	0.000	0.000	0.000	0.00
		C	0.000	0.000	30.360	0.000	0.24
T4	40.00-20.00	A	0.000	0.000	0.000	0.000	0.00
		B	0.000	0.000	0.000	0.000	0.00
		C	0.000	0.000	30.360	0.000	0.24
T5	20.00-0.00	A	0.000	0.000	0.000	0.000	0.00
		B	0.000	0.000	0.000	0.000	0.00
		C	0.000	0.000	13.760	0.000	0.07

Feed Line/Linear Appurtenances Section Areas - With Ice

Tower Section	Tower Elevation ft	Face or Leg	Ice Thickness in	A_R ft^2	A_F ft^2	C_AA_A In Face ft^2	C_AA_A Out Face ft^2	Weight K
T1	94.00-80.00	A	2.534	0.000	0.000	0.000	0.000	0.00
		B		0.000	0.000	0.000	0.000	0.00
		C		0.000	0.000	48.711	0.000	0.80
T2	80.00-60.00	A	2.480	0.000	0.000	0.000	0.000	0.00
		B		0.000	0.000	0.000	0.000	0.00
		C		0.000	0.000	106.776	0.000	1.94
T3	60.00-40.00	A	2.398	0.000	0.000	0.000	0.000	0.00
		B		0.000	0.000	0.000	0.000	0.00
		C		0.000	0.000	113.784	0.000	2.02
T4	40.00-20.00	A	2.278	0.000	0.000	0.000	0.000	0.00
		B		0.000	0.000	0.000	0.000	0.00
		C		0.000	0.000	109.832	0.000	1.89
T5	20.00-0.00	A	2.041	0.000	0.000	0.000	0.000	0.00
		B		0.000	0.000	0.000	0.000	0.00
		C		0.000	0.000	50.934	0.000	0.71

Feed Line Center of Pressure

Section	Elevation ft	CP_X in	CP_Z in	CP_X Ice in	CP_Z Ice in
T1	94.00-80.00	-3.549	4.277	-4.684	8.071
T2	80.00-60.00	-8.653	7.918	-11.792	13.128
T3	60.00-40.00	-8.519	7.756	-13.401	14.357
T4	40.00-20.00	-9.562	8.652	-15.293	16.400
T5	20.00-0.00	-1.926	4.201	-2.085	8.966

Shielding Factor Ka

Tower Section	Feed Line Record No.	Description	Feed Line Segment Elev.	K_a No Ice	K_a Ice
T1	1	T-Brackets (Af)	80.00 - 87.00	0.6000	0.6000
T1	2	LDF5-50A(7/8)	87.00 - 93.00	0.6000	0.6000
T1	4	LDF5-50A(7/8)	80.00 - 87.00	0.6000	0.6000
T1	5	WE65(ELLIPTICAL)	80.00 - 87.00	0.6000	0.6000
T1	6	LDF4-50A(1/2")	80.00 - 87.00	0.6000	0.6000
T1	9	LCF78-50JA(7/8)	80.00 - 93.50	0.6000	0.6000
T2	1	T-Brackets (Af)	60.00 - 80.00	0.6000	0.6000
T2	4	LDF5-50A(7/8)	60.00 - 80.00	0.6000	0.6000
T2	5	WE65(ELLIPTICAL)	60.00 - 80.00	0.6000	0.6000
T2	6	LDF4-50A(1/2")	73.00 - 80.00	0.6000	0.6000
T2	7	LDF4-50A(1/2")	60.00 - 73.00	0.6000	0.6000
T2	9	LCF78-50JA(7/8)	60.00 - 80.00	0.6000	0.6000
T2	11	LDF5-50A(7/8)	60.00 - 70.00	0.6000	0.6000
T3	1	T-Brackets (Af)	40.00 - 60.00	0.6000	0.6000
T3	4	LDF5-50A(7/8)	40.00 - 60.00	0.6000	0.6000
T3	5	WE65(ELLIPTICAL)	40.00 - 60.00	0.6000	0.6000
T3	7	LDF4-50A(1/2")	40.00 - 60.00	0.6000	0.6000
T3	9	LCF78-50JA(7/8)	40.00 - 60.00	0.6000	0.6000
T3	11	LDF5-50A(7/8)	40.00 - 60.00	0.6000	0.6000
T4	1	T-Brackets (Af)	20.00 - 40.00	0.6000	0.6000
T4	4	LDF5-50A(7/8)	20.00 - 40.00	0.6000	0.6000
T4	5	WE65(ELLIPTICAL)	20.00 - 40.00	0.6000	0.6000
T4	7	LDF4-50A(1/2")	20.00 - 40.00	0.6000	0.6000
T4	9	LCF78-50JA(7/8)	20.00 - 40.00	0.6000	0.6000
T4	11	LDF5-50A(7/8)	20.00 - 40.00	0.6000	0.6000
T5	1	T-Brackets (Af)	16.00 - 20.00	0.6000	0.6000
T5	4	LDF5-50A(7/8)	12.00 - 20.00	0.6000	0.6000
T5	5	WE65(ELLIPTICAL)	12.00 - 20.00	0.6000	0.6000
T5	7	LDF4-50A(1/2")	12.00 - 20.00	0.6000	0.6000
T5	9	LCF78-50JA(7/8)	0.00 - 20.00	0.6000	0.6000
T5	11	LDF5-50A(7/8)	12.00 - 20.00	0.6000	0.6000

Discrete Tower Loads

Description	Face or Leg	Offset Type	Offsets: Horz Lateral Vert ft ft ft	Azimuth Adjustment °	Placement ft		C_AA_A Front ft^2	C_AA_A Side ft^2	Weight K
3" Dia 10' Omni	A	From Leg	0.00	0.000	93.00	No Ice	3.00	3.00	0.08
			0.00			1/2"	4.03	4.03	0.10
			5.00			Ice	5.03	5.03	0.13
						1" Ice	6.26	6.26	0.20
						2" Ice			
3" Dia 20' Omni	C	From Leg	0.00	0.000	93.00	No Ice	4.00	4.00	0.06
			0.00			1/2"	6.00	6.00	0.10
			10.00			Ice	8.00	8.00	0.14
						1" Ice	12.00	12.00	0.23
						2" Ice			
Side Arm Mount [SO 308-1]	C	From Leg	3.00	0.000	87.00	No Ice	0.98	3.03	0.05
			0.00			1/2"	1.70	5.22	0.08
			0.00			Ice	2.42	7.41	0.10
						1" Ice	3.86	11.79	0.16
						2" Ice			
DB586-Y	C	From Leg	6.00	0.000	87.00	No Ice	1.01	1.01	0.01
			0.00			1/2"	1.28	1.28	0.02
			4.00			Ice	1.56	1.56	0.03
						1" Ice	2.14	2.14	0.06
						2" Ice			
DB586-Y	C	From Leg	6.00	0.000	87.00	No Ice	1.01	1.01	0.01
			0.00			1/2"	1.28	1.28	0.02
			-4.00			Ice	1.56	1.56	0.03
						1" Ice	2.14	2.14	0.06
						2" Ice			
15"x8"x3" TMA	C	From Leg	3.00	0.000	87.00	No Ice	1.00	0.41	0.01
			0.00			1/2"	1.13	0.51	0.02
			0.00			Ice	1.27	0.62	0.03
						1" Ice	1.57	0.85	0.05
						2" Ice			
6'x3" Mount Pipe	B	From Leg	0.50	0.000	88.00	No Ice	1.76	1.76	0.05
			0.00			1/2"	2.29	2.29	0.06
			0.00			Ice	2.67	2.67	0.08
						1" Ice	3.44	3.44	0.13
						2" Ice			
5' Dipole Antenna	A	From Leg	0.50	0.000	87.00	No Ice	1.58	5.98	0.04
			0.00			1/2"	2.68	10.20	0.05
			0.00			Ice	3.80	14.40	0.06
						1" Ice	6.04	22.90	0.09
						2" Ice			
5' Dipole Antenna	A	From Leg	0.50	0.000	73.00	No Ice	1.58	5.98	0.04
			0.00			1/2"	2.68	10.20	0.05
			0.00			Ice	3.80	14.40	0.06
						1" Ice	6.04	22.90	0.09
						2" Ice			
67									
56									
93.5									
DS2C00F36D-D w/ DCP12K Clamp Sets	B	From Leg	0.50	0.000	93.50	No Ice	3.78	3.78	0.04
			0.00			1/2"	5.07	5.07	0.07
			6.29			Ice	6.38	6.38	0.10
						1" Ice	8.58	8.58	0.20
						2" Ice			
***									
70									
531-70 Dipole Antenna w/ Mounting Equipment	B	From Leg	3.25	0.000	70.00	No Ice	1.73	6.53	0.05
			0.00			1/2"	2.94	11.22	0.05
			0.00			Ice	4.16	15.91	0.06
						1" Ice	6.58	25.28	0.07
						2" Ice			
15'x2.5" Horizontal Pipe	C	From Face	0.50	0.000	70.00	No Ice	4.31	0.01	0.09
			3.25			1/2"	5.84	0.08	0.12
			0.00			Ice	7.39	0.15	0.16
						1" Ice	10.54	0.29	0.27

Description	*Face or Leg*	*Offset Type*	*Offsets: Horz Lateral Vert*	*Azimuth Adjustment*	*Placement*		*C_AA_A Front*	*C_AA_A Side*	*Weight*
			ft *ft* *ft*	*°*	*ft*		*ft²*	*ft²*	*K*
						2" Ice			
15'x2.5'' Horizontal Pipe	C	From Face	0.50 3.25 2.00	0.000	70.00	No Ice	4.31	0.01	0.09
						1/2"	5.84	0.08	0.12
						Ice	7.39	0.15	0.16
						1" Ice	10.54	0.29	0.27
						2" Ice			

Dishes

Description	*Face or Leg*	*Dish Type*	*Offset Type*	*Offsets: Horz Lateral Vert*	*Azimuth Adjustment*	*3 dB Beam Width*	*Elevation*	*Outside Diameter*		*Aperture Area*	*Weight*
				ft	*°*	*°*	*ft*	*ft*		*ft²*	*K*
PAD6-W59BC	B	Paraboloid w/Radome	From Leg	0.50 0.00 0.00	10.000		88.00	6.58	No Ice	34.04	0.14
									1/2" Ice	34.91	0.29
									1" Ice	35.77	0.47
									2" Ice	37.51	0.83

Load Combinations

Comb. No.	*Description*
1	Dead Only
2	1.2 Dead+1.0 Wind 0 deg - No Ice
3	0.9 Dead+1.0 Wind 0 deg - No Ice
4	1.2 Dead+1.0 Wind 30 deg - No Ice
5	0.9 Dead+1.0 Wind 30 deg - No Ice
6	1.2 Dead+1.0 Wind 60 deg - No Ice
7	0.9 Dead+1.0 Wind 60 deg - No Ice
8	1.2 Dead+1.0 Wind 90 deg - No Ice
9	0.9 Dead+1.0 Wind 90 deg - No Ice
10	1.2 Dead+1.0 Wind 120 deg - No Ice
11	0.9 Dead+1.0 Wind 120 deg - No Ice
12	1.2 Dead+1.0 Wind 150 deg - No Ice
13	0.9 Dead+1.0 Wind 150 deg - No Ice
14	1.2 Dead+1.0 Wind 180 deg - No Ice
15	0.9 Dead+1.0 Wind 180 deg - No Ice
16	1.2 Dead+1.0 Wind 210 deg - No Ice
17	0.9 Dead+1.0 Wind 210 deg - No Ice
18	1.2 Dead+1.0 Wind 240 deg - No Ice
19	0.9 Dead+1.0 Wind 240 deg - No Ice
20	1.2 Dead+1.0 Wind 270 deg - No Ice
21	0.9 Dead+1.0 Wind 270 deg - No Ice
22	1.2 Dead+1.0 Wind 300 deg - No Ice
23	0.9 Dead+1.0 Wind 300 deg - No Ice
24	1.2 Dead+1.0 Wind 330 deg - No Ice
25	0.9 Dead+1.0 Wind 330 deg - No Ice
26	1.2 Dead+1.0 Ice+1.0 Temp
27	1.2 Dead+1.0 Wind 0 deg+1.0 Ice+1.0 Temp
28	1.2 Dead+1.0 Wind 30 deg+1.0 Ice+1.0 Temp
29	1.2 Dead+1.0 Wind 60 deg+1.0 Ice+1.0 Temp
30	1.2 Dead+1.0 Wind 90 deg+1.0 Ice+1.0 Temp
31	1.2 Dead+1.0 Wind 120 deg+1.0 Ice+1.0 Temp
32	1.2 Dead+1.0 Wind 150 deg+1.0 Ice+1.0 Temp
33	1.2 Dead+1.0 Wind 180 deg+1.0 Ice+1.0 Temp

Comb. No.	Description
34	1.2 Dead+1.0 Wind 210 deg+1.0 Ice+1.0 Temp
35	1.2 Dead+1.0 Wind 240 deg+1.0 Ice+1.0 Temp
36	1.2 Dead+1.0 Wind 270 deg+1.0 Ice+1.0 Temp
37	1.2 Dead+1.0 Wind 300 deg+1.0 Ice+1.0 Temp
38	1.2 Dead+1.0 Wind 330 deg+1.0 Ice+1.0 Temp
39	Dead+Wind 0 deg - Service
40	Dead+Wind 30 deg - Service
41	Dead+Wind 60 deg - Service
42	Dead+Wind 90 deg - Service
43	Dead+Wind 120 deg - Service
44	Dead+Wind 150 deg - Service
45	Dead+Wind 180 deg - Service
46	Dead+Wind 210 deg - Service
47	Dead+Wind 240 deg - Service
48	Dead+Wind 270 deg - Service
49	Dead+Wind 300 deg - Service
50	Dead+Wind 330 deg - Service

Maximum Member Forces

Section No.	Elevation ft	Component Type	Condition	Gov. Load Comb.	Axial K	Major Axis Moment kip-ft	Minor Axis Moment kip-ft
T1	94 - 80	Leg	Max Tension	23	1.85	0.25	0.14
			Max. Compression	31	-3.72	0.01	0.02
			Max. Mx	20	-0.07	0.31	-0.04
			Max. My	2	0.64	-0.03	0.35
			Max. Vy	20	-0.53	0.31	-0.04
			Max. Vx	2	-0.66	-0.03	0.35
		Diagonal	Max Tension	20	1.62	0.00	0.00
			Max. Compression	20	-1.64	0.00	0.00
			Max. Mx	38	0.44	0.08	0.00
			Max. My	20	1.61	0.01	0.00
			Max. Vy	38	-0.06	0.08	0.00
			Max. Vx	20	0.00	0.01	0.00
		Top Girt	Max Tension	23	0.13	0.00	0.00
			Max. Compression	20	-0.15	0.00	0.00
			Max. Mx	26	-0.07	-0.43	0.00
			Max. Vy	26	0.16	0.00	0.00
T2	80 - 60	Leg	Max Tension	23	10.19	-0.07	0.01
			Max. Compression	10	-12.31	0.07	-0.02
			Max. Mx	2	-8.52	-0.22	-0.00
			Max. My	17	-0.44	0.02	-0.30
			Max. Vy	6	-0.16	-0.14	-0.01
			Max. Vx	8	0.17	0.01	0.03
		Diagonal	Max Tension	20	2.23	0.00	0.00
			Max. Compression	20	-2.27	0.00	0.00
			Max. Mx	33	0.20	0.11	-0.01
			Max. My	36	-0.03	0.11	0.01
			Max. Vy	33	0.08	0.11	-0.01
			Max. Vx	36	-0.00	0.00	0.00
T3	60 - 40	Leg	Max Tension	23	20.32	-0.06	0.02
			Max. Compression	2	-24.77	0.17	0.02
			Max. Mx	29	-4.38	-0.30	-0.01
			Max. My	24	-2.20	-0.00	0.13
			Max. Vy	29	0.10	-0.30	-0.01
			Max. Vx	24	-0.08	-0.01	0.10
		Diagonal	Max Tension	20	2.92	0.00	0.00
			Max. Compression	20	-2.94	0.00	0.00
			Max. Mx	33	0.16	0.15	-0.02
			Max. My	31	0.67	0.14	-0.02
			Max. Vy	33	0.10	0.14	0.02
			Max. Vx	31	0.00	0.00	0.00
T4	40 - 20	Leg	Max Tension	23	30.70	-0.15	0.05
			Max. Compression	2	-37.68	0.23	0.02
			Max. Mx	29	-4.59	-0.43	-0.00
			Max. My	25	-1.99	-0.02	0.29

Section No.	Elevation ft	Component Type	Condition	Gov. Load Comb.	Axial K	Major Axis Moment kip-ft	Minor Axis Moment kip-ft
			Max. Vy	29	0.10	-0.43	-0.00
			Max. Vx	25	0.12	-0.02	0.29
		Diagonal	Max Tension	20	3.76	0.00	0.00
			Max. Compression	20	-3.81	0.00	0.00
			Max. Mx	33	0.20	0.23	-0.03
			Max. My	31	0.91	0.21	-0.03
			Max. Vy	34	0.12	0.21	0.03
			Max. Vx	31	0.01	0.00	0.00
T5	20 - 0	Leg	Max Tension	23	42.50	-0.21	0.01
			Max. Compression	2	-52.74	0.00	-0.00
			Max. Mx	29	-2.65	-0.43	-0.00
			Max. My	25	-2.46	-0.02	0.34
			Max. Vy	29	-0.10	-0.43	-0.00
			Max. Vx	25	0.12	-0.02	0.34
		Diagonal	Max Tension	20	4.22	0.00	0.00
			Max. Compression	10	-4.27	0.00	0.00
			Max. Mx	34	-0.22	0.28	-0.03
			Max. My	32	1.26	0.23	-0.04
			Max. Vy	34	0.12	0.23	0.03
			Max. Vx	32	0.01	0.00	0.00

Maximum Reactions

Location	Condition	Gov. Load Comb.	Vertical K	Horizontal, X K	Horizontal, Z K
Leg C	Max. Vert	18	54.94	7.94	-4.34
	Max. H_x	18	54.94	7.94	-4.34
	Max. H_z	5	-37.47	-5.39	3.98
	Min. Vert	7	-41.61	-6.47	3.50
	Min. H_x	7	-41.61	-6.47	3.50
	Min. H_z	18	54.94	7.94	-4.34
Leg B	Max. Vert	10	54.97	-8.04	-4.26
	Max. H_x	23	-45.47	6.82	3.62
	Max. H_z	25	-40.69	5.73	3.98
	Min. Vert	23	-45.47	6.82	3.62
	Min. H_x	10	54.97	-8.04	-4.26
	Min. H_z	10	54.97	-8.04	-4.26
Leg A	Max. Vert	2	56.57	-0.09	9.36
	Max. H_x	21	2.62	1.29	0.27
	Max. H_z	2	56.57	-0.09	9.36
	Min. Vert	15	-43.52	0.11	-7.56
	Min. H_x	8	3.22	-1.26	0.35
	Min. H_z	15	-43.52	0.11	-7.56

Tower Mast Reaction Summary

Load Combination	Vertical K	$Shear_x$ K	$Shear_z$ K	Overturning Moment, M_x kip-ft	Overturning Moment, M_z kip-ft	Torque kip-ft
Dead Only	8.99	0.00	0.00	4.82	4.68	0.00
1.2 Dead+1.0 Wind 0 deg - No Ice	10.79	-0.05	-16.20	-856.44	11.65	-2.94
0.9 Dead+1.0 Wind 0 deg - No Ice	8.09	-0.05	-16.20	-857.89	10.24	-2.94
1.2 Dead+1.0 Wind 30 deg - No Ice	10.79	7.06	-12.68	-667.76	-362.16	2.34
0.9 Dead+1.0 Wind 30 deg - No Ice	8.09	7.06	-12.68	-669.20	-363.56	2.34
1.2 Dead+1.0 Wind 60 deg - No Ice	10.79	11.77	-6.99	-365.37	-614.02	7.22

Load Combination	Vertical K	$Shear_x$ K	$Shear_z$ K	Overturning Moment, M_x kip-ft	Overturning Moment, M_z kip-ft	Torque kip-ft
0.9 Dead+1.0 Wind 60 deg - No Ice	8.09	11.77	-6.99	-366.81	-615.42	7.22
1.2 Dead+1.0 Wind 90 deg - No Ice	10.79	14.05	-0.01	6.06	-739.85	9.43
0.9 Dead+1.0 Wind 90 deg - No Ice	8.09	14.05	-0.01	4.61	-741.26	9.43
1.2 Dead+1.0 Wind 120 deg - No Ice	10.79	13.62	7.83	418.94	-717.20	10.42
0.9 Dead+1.0 Wind 120 deg - No Ice	8.09	13.62	7.83	417.49	-718.60	10.42
1.2 Dead+1.0 Wind 150 deg - No Ice	10.79	7.25	12.73	685.60	-381.55	7.73
0.9 Dead+1.0 Wind 150 deg - No Ice	8.09	7.25	12.73	684.15	-382.95	7.73
1.2 Dead+1.0 Wind 180 deg - No Ice	10.79	-0.03	14.04	748.79	6.77	3.59
0.9 Dead+1.0 Wind 180 deg - No Ice	8.09	-0.03	14.04	747.34	5.36	3.59
1.2 Dead+1.0 Wind 210 deg - No Ice	10.79	-7.29	12.40	654.74	393.79	-2.09
0.9 Dead+1.0 Wind 210 deg - No Ice	8.09	-7.29	12.40	653.29	392.39	-2.09
1.2 Dead+1.0 Wind 240 deg - No Ice	10.79	-13.59	7.71	405.84	724.23	-6.60
0.9 Dead+1.0 Wind 240 deg - No Ice	8.09	-13.59	7.71	404.40	722.82	-6.60
1.2 Dead+1.0 Wind 270 deg - No Ice	10.79	-14.49	-0.02	2.76	789.19	-9.14
0.9 Dead+1.0 Wind 270 deg - No Ice	8.09	-14.49	-0.02	1.31	787.78	-9.14
1.2 Dead+1.0 Wind 300 deg - No Ice	10.79	-12.36	-7.16	-383.49	678.45	-9.29
0.9 Dead+1.0 Wind 300 deg - No Ice	8.09	-12.36	-7.16	-384.93	677.05	-9.29
1.2 Dead+1.0 Wind 330 deg - No Ice	10.79	-7.42	-13.00	-697.74	407.70	-7.98
0.9 Dead+1.0 Wind 330 deg - No Ice	8.09	-7.42	-13.00	-699.19	406.30	-7.98
1.2 Dead+1.0 Ice+1.0 Temp	44.24	0.00	-0.00	38.38	30.01	0.00
1.2 Dead+1.0 Wind 0 deg+1.0 Ice+1.0 Temp	44.24	0.01	-4.65	-220.18	29.73	-2.49
1.2 Dead+1.0 Wind 30 deg+1.0 Ice+1.0 Temp	44.24	2.22	-3.87	-176.65	-93.43	-0.27
1.2 Dead+1.0 Wind 60 deg+1.0 Ice+1.0 Temp	44.24	3.77	-2.20	-83.99	-180.35	2.03
1.2 Dead+1.0 Wind 90 deg+1.0 Ice+1.0 Temp	44.24	4.40	-0.02	37.22	-216.31	3.88
1.2 Dead+1.0 Wind 120 deg+1.0 Ice+1.0 Temp	44.24	3.97	2.26	163.32	-191.84	4.83
1.2 Dead+1.0 Wind 150 deg+1.0 Ice+1.0 Temp	44.24	2.22	3.86	253.16	-94.31	4.24
1.2 Dead+1.0 Wind 180 deg+1.0 Ice+1.0 Temp	44.24	-0.03	4.40	282.28	31.38	2.59
1.2 Dead+1.0 Wind 210 deg+1.0 Ice+1.0 Temp	44.24	-2.26	3.83	249.65	156.55	0.31
1.2 Dead+1.0 Wind 240 deg+1.0 Ice+1.0 Temp	44.24	-3.99	2.28	163.39	252.41	-1.93
1.2 Dead+1.0 Wind 270 deg+1.0 Ice+1.0 Temp	44.24	-4.47	0.02	39.11	282.14	-3.84
1.2 Dead+1.0 Wind 300 deg+1.0 Ice+1.0 Temp	44.24	-3.84	-2.19	-84.69	247.29	-4.66
1.2 Dead+1.0 Wind 330 deg+1.0 Ice+1.0 Temp	44.24	-2.24	-3.90	-180.03	156.60	-4.28
Dead+Wind 0 deg - Service	8.99	-0.01	-3.20	-165.50	5.87	-0.58
Dead+Wind 30 deg - Service	8.99	1.40	-2.50	-128.23	-67.97	0.46
Dead+Wind 60 deg - Service	8.99	2.33	-1.38	-68.50	-117.72	1.43
Dead+Wind 90 deg - Service	8.99	2.78	-0.00	4.87	-142.57	1.86
Dead+Wind 120 deg - Service	8.99	2.69	1.55	86.43	-138.10	2.06

Load Combination	Vertical K	$Shear_x$ K	$Shear_z$ K	Overturning Moment, M_x kip-ft	Overturning Moment, M_z kip-ft	Torque kip-ft
Dead+Wind 150 deg - Service	8.99	1.43	2.51	139.10	-71.80	1.53
Dead+Wind 180 deg - Service	8.99	-0.01	2.77	151.58	4.91	0.71
Dead+Wind 210 deg - Service	8.99	-1.44	2.45	133.01	81.36	-0.41
Dead+Wind 240 deg - Service	8.99	-2.68	1.52	83.84	146.63	-1.30
Dead+Wind 270 deg - Service	8.99	-2.86	-0.00	4.22	159.46	-1.80
Dead+Wind 300 deg - Service	8.99	-2.44	-1.42	-72.08	137.58	-1.83
Dead+Wind 330 deg - Service	8.99	-1.47	-2.57	-134.15	84.10	-1.58

Solution Summary

	Sum of Applied Forces			Sum of Reactions			
Load Comb.	PX K	PY K	PZ K	PX K	PY K	PZ K	% Error
1	0.00	-8.99	0.00	0.00	8.99	0.00	0.000%
2	-0.05	-10.79	-16.20	0.05	10.79	16.20	0.000%
3	-0.05	-8.09	-16.20	0.05	8.09	16.20	0.000%
4	7.06	-10.79	-12.68	-7.06	10.79	12.68	0.000%
5	7.06	-8.09	-12.68	-7.06	8.09	12.68	0.000%
6	11.77	-10.79	-6.99	-11.77	10.79	6.99	0.000%
7	11.77	-8.09	-6.99	-11.77	8.09	6.99	0.000%
8	14.05	-10.79	-0.01	-14.05	10.79	0.01	0.000%
9	14.05	-8.09	-0.01	-14.05	8.09	0.01	0.000%
10	13.62	-10.79	7.83	-13.62	10.79	-7.83	0.000%
11	13.62	-8.09	7.83	-13.62	8.09	-7.83	0.000%
12	7.25	-10.79	12.73	-7.25	10.79	-12.73	0.000%
13	7.25	-8.09	12.73	-7.25	8.09	-12.73	0.000%
14	-0.03	-10.79	14.04	0.03	10.79	-14.04	0.000%
15	-0.03	-8.09	14.04	0.03	8.09	-14.04	0.000%
16	-7.29	-10.79	12.40	7.29	10.79	-12.40	0.000%
17	-7.29	-8.09	12.40	7.29	8.09	-12.40	0.000%
18	-13.59	-10.79	7.71	13.59	10.79	-7.71	0.000%
19	-13.59	-8.09	7.71	13.59	8.09	-7.71	0.000%
20	-14.49	-10.79	-0.02	14.49	10.79	0.02	0.000%
21	-14.49	-8.09	-0.02	14.49	8.09	0.02	0.000%
22	-12.36	-10.79	-7.16	12.36	10.79	7.16	0.000%
23	-12.36	-8.09	-7.16	12.36	8.09	7.16	0.000%
24	-7.42	-10.79	-13.00	7.42	10.79	13.00	0.000%
25	-7.42	-8.09	-13.00	7.42	8.09	13.00	0.000%
26	0.00	-44.24	0.00	-0.00	44.24	0.00	0.000%
27	0.01	-44.24	-4.65	-0.01	44.24	4.65	0.000%
28	2.22	-44.24	-3.87	-2.22	44.24	3.87	0.000%
29	3.77	-44.24	-2.20	-3.77	44.24	2.20	0.000%
30	4.40	-44.24	-0.02	-4.40	44.24	0.02	0.000%
31	3.97	-44.24	2.26	-3.97	44.24	-2.26	0.000%
32	2.22	-44.24	3.86	-2.22	44.24	-3.86	0.000%
33	-0.03	-44.24	4.40	0.03	44.24	-4.40	0.000%
34	-2.26	-44.24	3.83	2.26	44.24	-3.83	0.000%
35	-3.99	-44.24	2.28	3.99	44.24	-2.28	0.000%
36	-4.47	-44.24	0.02	4.47	44.24	-0.02	0.000%
37	-3.84	-44.24	-2.19	3.84	44.24	2.19	0.000%
38	-2.24	-44.24	-3.90	2.24	44.24	3.90	0.000%
39	-0.01	-8.99	-3.20	0.01	8.99	3.20	0.000%
40	1.40	-8.99	-2.50	-1.40	8.99	2.50	0.000%
41	2.33	-8.99	-1.38	-2.33	8.99	1.38	0.000%
42	2.78	-8.99	-0.00	-2.78	8.99	0.00	0.000%
43	2.69	-8.99	1.55	-2.69	8.99	-1.55	0.000%
44	1.43	-8.99	2.51	-1.43	8.99	-2.51	0.000%
45	-0.01	-8.99	2.77	0.01	8.99	-2.77	0.000%
46	-1.44	-8.99	2.45	1.44	8.99	-2.45	0.000%

	Sum of Applied Forces			Sum of Reactions			
Load Comb.	PX K	PY K	PZ K	PX K	PY K	PZ K	% Error
47	-2.68	-8.99	1.52	2.68	8.99	-1.52	0.000%
48	-2.86	-8.99	-0.00	2.86	8.99	0.00	0.000%
49	-2.44	-8.99	-1.42	2.44	8.99	1.42	0.000%
50	-1.47	-8.99	-2.57	1.47	8.99	2.57	0.000%

Maximum Tower Deflections - Service Wind

Section No.	Elevation ft	Horz. Deflection in	Gov. Load Comb.	Tilt °	Twist °
T1	94 - 80	0.356	47	0.025	0.006
T2	80 - 60	0.279	47	0.025	0.005
T3	60 - 40	0.173	47	0.021	0.004
T4	40 - 20	0.086	47	0.015	0.002
T5	20 - 0	0.027	39	0.008	0.001

Critical Deflections and Radius of Curvature - Service Wind

Elevation ft	Appurtenance	Gov. Load Comb.	Deflection in	Tilt °	Twist °	Radius of Curvature ft
93.50	DS2C00F36D-D w/ DCP12K Clamp Sets	47	0.354	0.025	0.006	Inf
93.00	3'' Dia 10' Omni	47	0.351	0.025	0.006	Inf
88.00	PAD6-W59BC	47	0.323	0.025	0.006	Inf
87.00	Side Arm Mount [SO 308-1]	47	0.318	0.025	0.006	Inf
73.00	5' Dipole Antenna	47	0.241	0.024	0.005	558206
70.00	531-70 Dipole Antenna w/ Mounting Equipment	47	0.225	0.023	0.004	420463

Maximum Tower Deflections - Design Wind

Section No.	Elevation ft	Horz. Deflection in	Gov. Load Comb.	Tilt °	Twist °
T1	94 - 80	1.796	3	0.125	0.031
T2	80 - 60	1.412	3	0.123	0.026
T3	60 - 40	0.882	3	0.104	0.018
T4	40 - 20	0.440	3	0.075	0.011
T5	20 - 0	0.138	3	0.039	0.005

Critical Deflections and Radius of Curvature - Design Wind

Elevation ft	Appurtenance	Gov. Load Comb.	Deflection in	Tilt °	Twist °	Radius of Curvature ft
93.50	DS2C00F36D-D w/ DCP12K Clamp Sets	3	1.782	0.125	0.031	Inf
93.00	3'' Dia 10' Omni	3	1.768	0.125	0.031	Inf
88.00	PAD6-W59BC	3	1.631	0.125	0.029	839701
87.00	Side Arm Mount [SO 308-1]	3	1.604	0.125	0.029	719728
73.00	5' Dipole Antenna	3	1.221	0.118	0.023	116019

Elevation ft	Appurtenance	Gov. Load Comb.	Deflection in	Tilt °	Twist °	Radius of Curvature ft
70.00	531-70 Dipole Antenna w/ Mounting Equipment	3	1.140	0.115	0.022	87388

Bolt Design Data

Section No.	Elevation ft	Component Type	Bolt Grade	Bolt Size in	Number Of Bolts	Maximum Load per Bolt K	Allowable Load per Bolt K	Ratio Load / Allowable	Allowable Ratio	Criteria
T1	94	Leg	A325N	0.625	4	0.47	20.34	0.023	1.05	Bolt Tension
		Diagonal	A325N	0.500	1	1.62	6.20	0.262	1.05	Member Bearing
		Top Girt	A325N	0.500	1	0.15	8.84	0.017	1.05	Bolt Shear
T2	80	Leg	A325N	0.750	4	2.55	30.10	0.085	1.05	Bolt Tension
		Diagonal	A325N	0.500	1	2.23	6.20	0.361	1.05	Member Bearing
T3	60	Leg	A325N	0.875	4	5.08	41.56	0.122	1.05	Bolt Tension
		Diagonal	A325N	0.500	1	2.92	6.20	0.471	1.05	Member Bearing
T4	40	Leg	A325N	0.875	4	7.68	41.56	0.185	1.05	Bolt Tension
		Diagonal	A325N	0.625	1	3.76	7.83	0.481	1.05	Member Bearing
T5	20	Diagonal	A325N	0.625	1	4.22	11.70	0.361	1.05	Member Bearing

Compression Checks

Leg Design Data (Compression)

Section No.	Elevation ft	Size	L ft	L_u ft	Kl/r	A in^2	P_u K	ϕP_n K	Ratio $\frac{P_u}{\phi P_n}$
T1	94 - 80	ROHN 2.5 EH	14.00	7.00	90.9 K=1.00	2.254	-3.72	55.42	0.067 [1]
T2	80 - 60	ROHN 2.5 EH	20.03	6.68	86.7 K=1.00	2.254	-12.31	58.52	0.210 [1]
T3	60 - 40	ROHN 3 EH	20.03	6.68	70.5 K=1.00	3.016	-24.77	94.35	0.263 [1]
T4	40 - 20	ROHN 3.5 EH	20.03	10.02	92.0 K=1.00	3.678	-37.68	89.16	0.423 [1]
T5	20 - 0	ROHN 4 EH	20.03	10.02	81.4 K=1.00	4.407	-52.74	122.18	0.432 [1]

[1] P_u / ϕP_n controls

Diagonal Design Data (Compression)

Section No.	Elevation ft	Size	L ft	L_u ft	Kl/r	A in^2	P_u K	ϕP_n K	Ratio $\frac{P_u}{\phi P_n}$
T1	94 - 80	L1 3/4x1 3/4x3/16	12.76	6.13	214.3 K=1.00	0.621	-1.64	3.87	0.423 [1]

Section No.	Elevation ft	Size	L ft	L_u ft	Kl/r	A in^2	P_u K	ϕP_n K	Ratio $\frac{P_u}{\phi P_n}$
		KL/R > 200 (C) - 7							
T2	80 - 60	L2x2x3/16	14.02	6.96	212.0 K=1.00	0.715	-2.27	4.55	0.498 [1]
		KL/R > 200 (C) - 22							
T3	60 - 40	L2 1/2x2 1/2x3/16	15.81	7.82	189.7 K=1.00	0.902	-2.94	7.17	0.409 [1]
T4	40 - 20	L3x3x3/16	19.01	9.49	191.0 K=1.00	1.090	-3.81	8.55	0.446 [1]
T5	20 - 0	L 3x3x1/4	20.74	10.32	209.1 K=1.00	1.438	-4.27	9.41	0.454 [1]
		KL/R > 200 (C) - 80							

[1] P_u / ϕP_n controls

Top Girt Design Data (Compression)

Section No.	Elevation ft	Size	L ft	L_u ft	Kl/r	A in^2	P_u K	ϕP_n K	Ratio $\frac{P_u}{\phi P_n}$
T1	94 - 80	L3 1/2x3 /12x1/4	10.67	10.22	176.8 K=1.00	1.688	-0.15	15.44	0.010 [1]

[1] P_u / ϕP_n controls

Tension Checks

Leg Design Data (Tension)

Section No.	Elevation ft	Size	L ft	L_u ft	Kl/r	A in^2	P_u K	ϕP_n K	Ratio $\frac{P_u}{\phi P_n}$
T1	94 - 80	ROHN 2.5 EH	14.00	7.00	90.9	2.254	1.86	101.41	0.018 [1]
T2	80 - 60	ROHN 2.5 EH	20.03	6.68	86.7	2.254	10.19	101.41	0.100 [1]
T3	60 - 40	ROHN 3 EH	20.03	6.68	70.5	3.016	20.32	135.72	0.150 [1]
T4	40 - 20	ROHN 3.5 EH	20.03	10.02	92.0	3.678	30.70	165.53	0.185 [1]
T5	20 - 0	ROHN 4 EH	20.03	10.02	81.4	4.407	42.50	198.34	0.214 [1]

[1] P_u / ϕP_n controls

Diagonal Design Data (Tension)

Section No.	Elevation ft	Size	L ft	L_u ft	Kl/r	A in^2	P_u K	ϕP_n K	Ratio $\frac{P_u}{\phi P_n}$
T1	94 - 80	L1 3/4x1 3/4x3/16	12.76	6.13	139.4	0.378	1.62	16.44	0.099 [1]
T2	80 - 60	L2x2x3/16	14.02	6.96	137.4	0.448	2.23	19.50	0.115 [1]
T3	60 - 40	L2 1/2x2 1/2x3/16	15.81	7.82	122.3	0.589	2.92	25.60	0.114 [1]
T4	40 - 20	L3x3x3/16	19.01	9.49	122.8	0.712	3.76	30.97	0.122 [1]
T5	20 - 0	L 3x3x1/4	20.74	10.32	134.7	0.938	4.22	45.70	0.092 [1]

[1] P_u / ϕP_n controls

Top Girt Design Data (Tension)

Section No.	Elevation ft	Size	L ft	L_u ft	Kl/r	A in^2	P_u K	ϕP_n K	Ratio $\frac{P_u}{\phi P_n}$
T1	94 - 80	L3 1/2x3 /12x1/4	10.67	10.22	114.7	1.148	0.13	55.99	0.002 [1]

[1] P_u / ϕP_n controls

Section Capacity Table

Section No.	Elevation ft	Component Type	Size	Critical Element	P K	$øP_{allow}$ K	% Capacity	Pass Fail
T1	94 - 80	Leg	ROHN 2.5 EH	2	-3.72	58.19	6.4	Pass
T2	80 - 60	Leg	ROHN 2.5 EH	20	-12.31	61.44	20.0	Pass
T3	60 - 40	Leg	ROHN 3 EH	42	-24.77	99.06	25.0	Pass
T4	40 - 20	Leg	ROHN 3.5 EH	63	-37.68	93.61	40.2	Pass
T5	20 - 0	Leg	ROHN 4 EH	78	-52.74	128.29	41.1	Pass
T1	94 - 80	Diagonal	L1 3/4x1 3/4x3/16	7	-1.64	4.06	40.3	Pass
T2	80 - 60	Diagonal	L2x2x3/16	22	-2.27	4.78	47.4	Pass
T3	60 - 40	Diagonal	L2 1/2x2 1/2x3/16	43	-2.94	7.53	39.0 44.9 (b)	Pass
T4	40 - 20	Diagonal	L3x3x3/16	64	-3.81	8.98	42.5 45.8 (b)	Pass
T5	20 - 0	Diagonal	L 3x3x1/4	80	-4.27	9.88	43.3	Pass
T1	94 - 80	Top Girt	L3 1/2x3 /12x1/4	5	-0.15	16.22	0.9 1.6 (b)	Pass
							Summary	
						Leg (T5)	41.1	Pass
						Diagonal (T2)	47.4	Pass
						Top Girt (T1)	1.6	Pass
						Bolt Checks	45.8	Pass
						RATING =	**47.4**	**Pass**

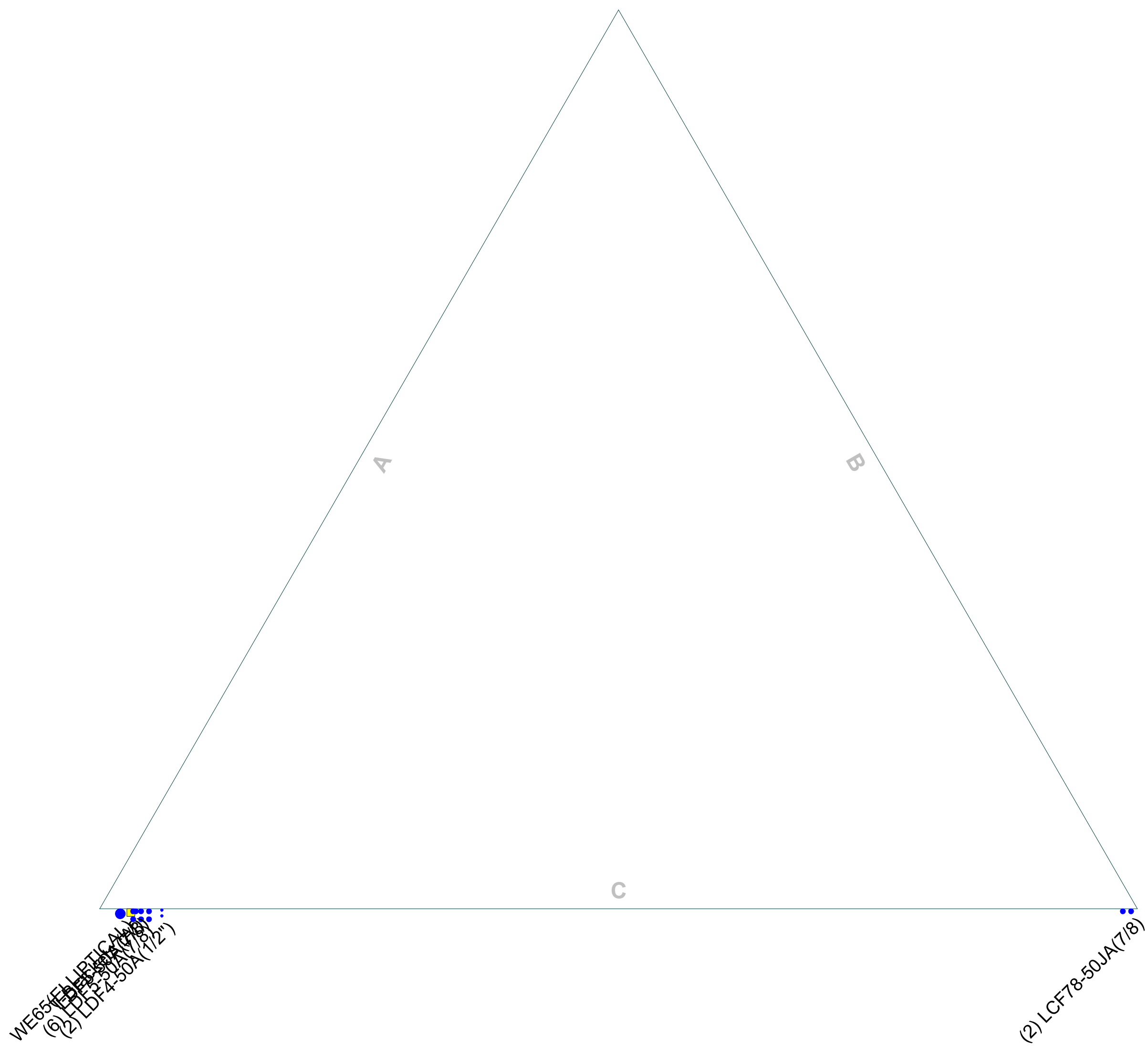
APPENDIX B

BASE LEVEL DRAWING

Feed Line Plan
20'

Round | Flat | App In Face | App Out Face

Section @ 20'



BLACK & VEATCH Building a world of difference.	*Black & Veatch Corp.* 6800 W. 115th St., Suite 2292 Overland Park, KS 66211 Phone: FAX:	Job: ***ES-043 TollandAWC***	
		Project: ***405025***	
		Client: Eversource	Drawn by: TH	App'd:
		Code: TIA-222-H	Date: 07/21/20	Scale: NTS
		Path: C:\Users\hal92311\OneDrive - Black & Veatch\My Desktop\TOLLANDAWC\ES-043 TollandAWC Structural Analysis.eri		Dwg No. E-7

APPENDIX C

ADDITIONAL CALCULATIONS

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ANCHOR ROD ANALYSIS

Project Information

Site Name:ES-043 TollandAWC

TIA Revision: Rev-G / Rev-H (selected: Rev-H)

TIA-222-G 105% Allowable? No / Yes (selected: No)

Apply TIA-222-H Section 15.5? No / Yes (selected: Yes)

Max Leg Reactions

Compression

$Axial\_C := 57 \cdot kip$

$Shear\_C := 9 \cdot kip$

Uplift

$Axial\_U := 45 \cdot kip$

$Shear\_U := 8 \cdot kip$

Anchor Rod Data

Diameter of Anchor Rod: $D := 0.875 \cdot in$

Number of Anchor Rods: $N := 4$

Length from top of concrete to bottom of anchor rod leveling nut: $lar := 2 \cdot in$

Anchor Rod Grade: F1554-105, A687, A354-BC (selected), A354-BD, A449, A572-42, A572-50, A572-55, A572-60, A572-65, A588-42, A588-46, A588-50, A36M-42, A36M-45, A36M-50, A36M-55, A500-50, A514-GR100, A53-B-35, A53-B-42, A607-60, A607-65, S-128, S-22

Threads in Shear Plane?: Yes (selected) / No

Thread Series: Coarse (selected) / Fine / 8-Thread

Consider Base Plate Grout? Yes (selected) / No

Grout Factor η: 0.90 / 0.70 / 0.55 (selected) / 0.50

Threads per Inch: $n = 9$ (Thread selection invalid if n = 0)

Rod Ultimate Strength: $Fu = 125 \cdot ksi$

Rod Yield Strength: $Fy = 109 \cdot ksi$

Anchor Rod Plastic Section Modulus: (based on tension root diameter)

$$Z := \frac{1}{6} \cdot \left(D - \frac{0.9743in}{n}\right)^3 = 0.075 \cdot in^3$$

Radius of Gyration:

$$r := \left(\frac{1}{4}\right) \cdot \left(D - \frac{0.9743in}{n}\right) = 0.192 \cdot in$$

Net Area of Anchor Rod:

$$An := \frac{\pi}{4} \cdot \left(D - \frac{0.9743in}{n}\right)^2 = 0.462 \cdot in^2$$

TIA-222-G/H Section 4.9.6.1

Nominal Unthreaded Area of Anchor Rod:

$$Ab := \frac{\pi}{4} \cdot (D)^2 = 0.601 \cdot in^2$$

Anchor Rod Design Capacities

Design Tension Strength: TIA-222-G/H Section 4.9.6.1

$Rnt := Fu \cdot An = 57.717 \cdot kip$

$\phi t = 0.75$

$\phi Rnt := \phi t \cdot Rnt = 43.287 \cdot kip$

Design Compression Strength:

$Rnc := Fy \cdot An = 50.329 \cdot kip$

$\phi c = 1$

$\phi Rnc := \phi c \cdot Rnc = 50.329 \cdot kip$

Design Buckling Strength: TIA-222-H Section 4.5.4.2

$K_0 := 1.2$

$Fcr = 106.31 \cdot ksi$

$Fe = 1.826 \times 10^3 \cdot ksi$

$Rnb := Fcr \cdot An = 49.087 \cdot kip$

$\phi c = 1$

$\phi Rnb := \phi c \cdot Rnb = 49.087 \cdot kip$

Design Shear Strength: TIA-222-G/H Section 4.9.6.3

$$Rnv := \left| \begin{array}{l} 0.55 \cdot Fu \cdot Ab \ \text{ if } Thread\_Type = \text{"No"} \wedge TIA = \text{"Rev-G"} \\ 0.45 \cdot Fu \cdot Ab \ \text{ if } Thread\_Type = \text{"Yes"} \wedge TIA = \text{"Rev-G"} \\ 0.625 \cdot Fu \cdot Ab \ \text{ if } Thread\_Type = \text{"No"} \wedge TIA = \text{"Rev-H"} \\ 0.5 \cdot Fu \cdot Ab \ \text{ if } Thread\_Type = \text{"Yes"} \wedge TIA = \text{"Rev-H"} \end{array} \right.$$

$Rnv = 37.583 \cdot kip$

$Rnvc := 0.6 \cdot Fy \cdot 0.5 \cdot An = 15.099 \cdot kip$ TIA-222-H Section 4.9.9

$\phi v = 0.75$ $\quad \phi c = 1$

$\phi Rnv := \phi v \cdot Rnv = 28.187 \cdot kip$ $\quad \phi Rnvc := \phi c \cdot Rnvc = 15.099 \cdot kip$

Design Flexural Strength: TIA-222-G/H Section 4.7.1

$Rmn := Fy \cdot Z = 8.189 \cdot kip \cdot in$

$\phi f = 0.9$

$\phi Rmn := \phi f \cdot Rmn = 7.37 \cdot kip \cdot in$

Anchor Rod Loading Demands

Tension Demand:

$$Put := \frac{Axial\_U}{N} = 11.25 \cdot kip$$

Compression Demand:

$$Puc := \frac{Axial\_C}{N} = 14.25 \cdot kip$$

Shear Demand:

$$Vut := \frac{Shear\_U}{N} = 2 \cdot kip$$

$$Vuc := \frac{Shear\_C}{N} = 2.25 \cdot kip$$

Moment Demand:

$$Mut := 0.65 \cdot lar \cdot Vut = 2.6 \cdot kip \cdot in$$

$$Muc := 0.65 \cdot lar \cdot Vuc = 2.925 \cdot kip \cdot in$$

Anchor Rod Interaction Check

TIA-222-G Section 4.9.9

$$SR\_g := \begin{cases} \dfrac{Put + \dfrac{Vut}{\eta}}{\phi Rnt} & \text{if } \eta > 0.50 \\ \dfrac{Put + \dfrac{Vut}{\eta}}{\phi Rnt} & \text{if } \eta = 0.50 \wedge lar \le D \wedge Put > Puc \\ \dfrac{Puc + \dfrac{Vuc}{\eta}}{\phi Rnt} & \text{if } \eta = 0.50 \wedge lar \le D \wedge Put < Puc \\ \left(\dfrac{Vut}{\phi Rnv}\right)^2 + \left(\dfrac{Put}{\phi Rnt} + \dfrac{Mut}{\phi Rmn}\right)^2 & \text{if } \eta = 0.5 \wedge lar > D \wedge Put > Puc \\ \left(\dfrac{Vuc}{\phi Rnv}\right)^2 + \left(\dfrac{Puc}{\phi Rnt} + \dfrac{Muc}{\phi Rmn}\right)^2 & \text{if } \eta = 0.5 \wedge lar > D \wedge Put < Puc \end{cases}$$

$$SR\_g = 0.344$$

Anchor Rod Interaction Check

TIA-222-H Section 4.9.9

$$SR\_Pt := \begin{cases} \left(\frac{Put}{\phi Rnt}\right)^2 + \left(\frac{Vut}{\phi Rnv}\right)^2 & \text{if } lar \le D \\ \left(\frac{Put}{\phi Rnt}\right)^2 + \left(\frac{Vut}{\phi Rnv}\right)^2 & \text{if } D < lar \le 3\cdot in \wedge Grout = \text{"Yes"} \\ \left(\frac{Put}{\phi Rnt} + \frac{Mut}{\phi Rmn}\right)^2 + \left(\frac{Vut}{\phi Rnv}\right)^2 & \text{if } 3\cdot in < lar \wedge Grout = \text{"Yes"} \\ \left(\frac{Put}{\phi Rnt} + \frac{Mut}{\phi Rmn}\right)^2 + \left(\frac{Vut}{\phi Rnv}\right)^2 & \text{if } D < lar \wedge Grout = \text{"No"} \end{cases}$$

$SR\_Pt = 0.073$

$$SR\_Pc := \begin{cases} \left(\frac{Puc}{\phi Rnc}\right) + \left(\frac{Vuc}{\phi Rnvc}\right)^2 & \text{if } lar \le D \\ \left(\frac{Puc}{\phi Rnc}\right) + \left(\frac{Vuc}{\phi Rnvc}\right)^2 & \text{if } D < lar \le 3\cdot in \wedge Grout = \text{"Yes"} \\ \left(\frac{Puc}{\phi Rnc} + \frac{Muc}{\phi Rmn}\right) + \left(\frac{Vuc}{\phi Rnvc}\right)^2 & \text{if } 3\cdot in < lar \wedge Grout = \text{"Yes"} \\ \left(\frac{Puc}{\phi Rnc} + \frac{Muc}{\phi Rmn}\right) + \left(\frac{Vuc}{\phi Rnvc}\right)^2 & \text{if } D < lar \le 4\cdot D \wedge Grout = \text{"No"} \\ \left(\frac{Puc}{\phi Rnb} + \frac{Muc}{\phi Rmn}\right) + \left(\frac{Vuc}{\phi Rnvc}\right)^2 & \text{if } lar > 4\cdot D \wedge Grout = \text{"No"} \end{cases}$$

$SR\_Pc = 0.305$

$$SR := \begin{cases} SR\_g & \text{if } TIA = \text{"Rev-G"} \\ \max(SR\_Pt, SR\_Pc) & \text{if } TIA = \text{"Rev-H"} \wedge S15 = \text{"No"} \\ \frac{\max(SR\_Pt, SR\_Pc)}{1.05} & \text{if } TIA = \text{"Rev-H"} \wedge S15 = \text{"Yes"} \end{cases} = 0.291$$

$$Check_{SR} := \begin{cases} \text{"Passing"} & \text{if } SR \le 1.00 \wedge TIA = \text{"Rev-G"} \wedge S105 = \text{"Yes"} \\ \text{"Acceptable"} & \text{if } 1.00 < SR \le 1.05 \wedge TIA = \text{"Rev-G"} \wedge S105 = \text{"Yes"} \\ \text{"Failing"} & \text{if } SR > 1.05 \wedge TIA = \text{"Rev-G"} \wedge S105 = \text{"Yes"} \\ \text{"Passing"} & \text{if } SR \le 1.00 \wedge TIA = \text{"Rev-G"} \wedge S105 = \text{"No"} \\ \text{"Failing"} & \text{if } SR > 1.00 \wedge TIA = \text{"Rev-G"} \wedge S105 = \text{"No"} \\ \text{"Passing"} & \text{if } SR \le 1.0 \wedge TIA = \text{"Rev-H"} \\ \text{"Failing"} & \text{if } SR > 1.0 \wedge TIA = \text{"Rev-H"} \end{cases} = \text{"Passing"}$$

Anchor Rod Results

Axial Tension Demand:	$Put = 11.25 \cdot kip$
Axial Tension Capacity:	$\phi Rnt = 43.287 \cdot kip$
Axial Compression Demand:	$Puc = 14.25 \cdot kip$
Axial Compression Capacity:	$\phi Rnc = 50.329 \cdot kip$
Shear Tension Demand:	$Vut = 2 \cdot kip$
Tension Shear Capacity:	$\phi Rnv = 28.187 \cdot kip$
Shear Compression Demand:	$Vuc = 2.25 \cdot kip$
Compresison Shear Capacity:	$\phi R_{nvc} = 15.099 \cdot kip$
Moment Tension Demand:	$M_{ut} = 2.6 \cdot kip \cdot in$
Moment Compression Demand:	$M_{uc} = 2.925 \cdot kip \cdot in$
Moment Capacity:	$\phi R_{mn} = 7.37 \cdot kip \cdot in$

Governing Stress Ratio

$SR = 29.08 \cdot \%$

$Check_{SR} = $ "Passing"

Pier and Pad Foundation

ES-043
TollandAWC

TIA-222 Revision:	H
Tower Type:	Self Support

Top & Bot. Pad Rein. Different?:	☐
Block Foundation?:	☐

Superstructure Analysis Reactions		
Compression, P_{comp}:	57	kips
Compression Shear, Vu_comp:	9	kips
Uplift, P_{uplift}:	45	kips
Uplift Shear, V_{u_uplift}:	8	kips
Tower Height, **H**:	94	ft
Base Face Width, **BW**:	18.67	ft
BP Dist. Above Fdn, bp_{dist}:	3.5	in

Foundation Analysis Checks	Capacity	Demand	Rating*	Check
Uplift (kips)	162.48	45.00	**26.4%**	**Pass**
Lateral (Sliding) (kips)	72.50	8.00	**10.5%**	**Pass**
Bearing Pressure (ksf)	23.53	3.36	**13.6%**	**Pass**
*Pier Flexure (Comp.) (kip*ft)*	312.61	85.50	**26.0%**	**Pass**
*Pier Flexure (Tension) (kip*ft)*	238.46	76.00	**30.4%**	**Pass**
Pier Compression (kip)	1548.87	67.69	**4.2%**	**Pass**
*Pad Flexure (kip*ft)*	108.44	15.12	**13.3%**	**Pass**
Pad Shear - 1-way (kips)	129.38	0.62	**0.5%**	**Pass**
Pad Shear - 2-way (Comp) (ksi)	0.177	0.009	**4.8%**	**Pass**
*Flexural 2-way (Comp) (kip*ft)*	216.88	51.30	**22.5%**	**Pass**
Pad Shear - 2-way (Uplift) (ksi)	0.177	0.019	**10.1%**	**Pass**
*Flexural 2-way (Tension) (kip*ft)*	216.88	45.60	**20.0%**	**Pass**

**Rating per TIA-222-H Section 15.5*

Soil Rating*:	**26.4%**
Structural Rating*:	**30.4%**

Pier Properties		
Pier Shape:	Square	
Pier Diameter, **dpier**:	2.5	ft
Ext. Above Grade, **E**:	0.5	ft
Pier Rebar Size, **Sc**:	6	
Pier Rebar Quantity, **mc**:	12	
Pier Tie/Spiral Size, **St**:	3	
Pier Tie/Spiral Quantity, **mt**:	9	
Pier Reinforcement Type:	Tie	
Pier Clear Cover, cc_{pier}:	3	in

Pad Properties		
Depth, **D**:	11	ft
Pad Width, **W**:	6	ft
Pad Thickness, **T**:	2	ft
Pad Rebar Size (Bottom), **Sp**:	4	
Pad Rebar Quantity (Bottom), **mp**:	6	
Pad Clear Cover, cc_{pad}:	3	in

Material Properties		
Rebar Grade, **Fy**:	60	ksi
Concrete Compressive Strength, **F'c**:	3.5	ksi
Dry Concrete Density, δ**c**:	150	pcf

Soil Properties			
Total Soil Unit Weight, γ:	125	pcf	
Ultimate Net Bearing, Qnet:	30.000	ksf	<--Toggle between Gross and Net
Cohesion, **Cu**:	0.000	ksf	
Friction Angle, φ:	35	degrees	
SPT Blow Count, N_{blows}:	19		
Base Friction, μ:	0.35		
Neglected Depth, **N**:	3.33	ft	
Foundation Bearing on Rock?	No		
Groundwater Depth, **gw**:	16	ft	

Version 3.3.2

TIA-222- H **ACI : 2014**

PHYSICAL PARAMETERS

Pier Height Above Water Table:	h_{pier_above} = (MIN(gw,D-T) + E)	h_{pier_above} =	9.5	ft
Pier Height Below Water Table:	h_{pier_below} = ((D-T) - MIN(gw,D-T))	h_{pier_below} =	0	ft
Buoyant Weight of Pier:	W_{pier} = (dpier^2) * hpier_above * δc / 1000 + (dpier^2) * hpier_below * (δc-62.4) /1000	W_{pier} =	8.91	kips
Pad Height Above Water Table:	h_{pad_above} = IF(gw<=D-T,0,IF(gw>D,T,T-(D-gw)))	h_{pad_above} =	2	ft
Pad Height Below Water Table:	h_{pad_below} = (T-IF(gw<=D-T,0,IF(gw>D,T,T-(D-gw))))	h_{pad_below} =	0	ft
Buoyant Weight of Pad:	W_{pad} = (W^2) * hpad_above * δc / 1000 + (W^2) * hpad_below * (δc-62.4) / 1000	W_{pad} =	10.80	kips
Concrete weight:	W_c = V * δc	W_c =	19.7	kips
Soil weight:	W_s = (D - T) * (W² - dpier²) * γ	W_s =	33.5	kips
EIA/TIA-222 Load Factor:	LF = 1	LF =	1.00	

UPLIFT RESISTANCE

Soil Weight

Soil Height Below Water Table:	h_1 = MAX((D-T) - gw , 0)	h_1 =	0	ft
Soil Height Above Water Table:	h_2 = MIN(gw,D-T)	h_2 =	9	ft
Soil Wedge Width 1:	W'_1 = W + 2 * (h_1 * IF(φ>25,TAN(φ*°),IF(AND(Co=0,φ>0),TAN(φ*°),0)))	W'_1 =	6.00	ft
Soil Wedge Width 2:	W'_2 = W\1 + 2 * (h_2 * IF(φ>25,TAN(φ*°),IF(AND(Co=0,φ>0),TAN(φ*°),0)))	W'_2 =	18.60	ft
Volume of Soil Truncated Pyramid 1 (Below Water Table):	V'_1 = (h_1/3)*(W^2+W*W1\+W1\^2) - ((dpier^2) * h_1))	V'_1 =	0.00	ft³
Volume of Soil Truncated Pyramid 2 (Above Water Table):	V'_2 = (h_2/3)*(W^2+W*W1\+W1\^2) - ((dpier^2) * h_2))	V'_2 =	1424.91	ft³
Soil Weight of V'_1 (Below Water Table):	$W_s'_1$ = V'_1 * (γ-γ_w)	$W_s'_1$ =	0.00	kips
Soil Weight of V'_2 (Above Water Table):	$W_s'_2$ = V'_2 * γ	$W_s'_2$ =	178.11	kips
Total Weight of Soil:	W_{s_uplift} = $W_s'_1$ + $W_s'_2$	W_{s_uplift} =	178.11	kips

Soil Cohesion

Pad Perimeter:	P_o = 4*W	P_o =	24	ft
Depth to Mid-Layer of Soil:	$H_{\_shear}$ = ((D - T) - N) / 2 + N	$H_{\_shear}$ =	6.17	ft
Cohesion at Mid-Layer of Soil:	S_u = 0	S_u =	0.00	ksf
Soil Shear:	$Shear_{soil}$ = (Su/2) * Po * (D-T - MIN(N,D-T))	$Shear_{soil}$ =	0.00	kips

Skin Friction / Adhesion Applied to Pad

Adhesion Factor:	α = 0	α =	0.00	
Soil Depth from Top of Pad to Mid. Layer (Cohesionless Soil):	$H_{cohesionless}$ = T / 2	$H_{cohesionless}$ =	1.00	ft
Beta Factor:	β = = (MIN(N_blows,15)/15)*(1.5-0.135*SQRT(H_pad))	β =	1.37	
Pad Side Area:	A_s = Po * T	A_s =	48.00	ft²
Effective Soil Unit Weight at H_{pad}:	γ_{eff} = γ	γ_{eff} =	0.125	kcf
Soil Depth from Grade to Mid. Layer (Silty Soil):	H_{silty} = (D-T)+T/2	H_{silty} =	10.00	ft
Cohesion at Mid-Layer of Pad:	S_{u_pad} = 0	S_{u_pad} =	0.000	ksf
Ultimate Skin Friction / Adhesion:	f_s = β * γeff * Hpad	f_s =	0.171	ksf
Skin Friction / Adhesion Resistance:	F_s = fs * As	F_s =	8.19	kips

Uplift Resistance

Nominal Uplift Resistance:	R_n = Wc + $W_s'_1$ + $W_s'_2$ + $Soil_{shear}$ + F_s	R_n =	206.01	kips
Factored Uplift Resistance:	Ra = φD * (Wc + Ws) + φsu * (Soil_shear + F_s + Ws_uplift -Ws)	Ra =	162.48	kips

Check	**Ra =**	**162.48**	**kips**	**>=**	**P_{uplift} =**	**45.00**	**kips**	**RATING:**	**27.70%**	**OK**

LATERAL RESISTANCE

Total Nominal Pp Resistance:	P_{p_total} = Pp_pier *Ap_pier + Pp_pad * Ap_pad	P_{p_total} =	95.66	kips
Factored Total Weight for Compression:	$P_{factored\_comp}$ = φD * (Wc + Ws + Pcomp / 1.2)	$P_{factored\_comp}$ =	90.61	kips
Factored Total Weight for Uplift:	$P_{factored\_uplift}$ = MAX(φD * (Wc + Ws) - Puplift , 0)	$P_{factored\_uplift}$ =	2.86	kips
Nominal Base Friction Resistance (Comp):	R_{s_comp} = P * μ	R_{s_comp} =	31.71	kips
Nominal Base Friction Resistance (Uplift):	R_{s_uplift} = P * μ	R_{s_uplift} =	1.00	kips
Lateral Resistance (Comp):	Va_comp = Φs * (Pp_total + Rs_comp)	Va_comp =	95.53	kips
Lateral Resistance (Uplift):	Va_uplift = Φs * (Pp_total + Rs_uplift)	Va_uplift =	72.50	kips

Check **Va_comp = 72.50 kips >= Vu_uplift = 8.00 kips** **RATING: 11.03% OK**

PIER REINFORCEMENT

Pier / Column Compression

Pier Cross-Sectional Area:	A_1 = dpier^2	A_1 =	900.00	in²
Support Area (2H:1V Slope):	A_2 = (MIN(W, dpier + 4 * T))²	A_2 =	5184.00	in²
Compressive Resistance (H/D < 3):	$ΦP_{n1}$ = 0.65*0.85 * F'c * A1 * MIN(√(A2/A1),2)	$ΦP_{n1}$ =	3480.75	kips
Rebar:	$s_{\_pier}$ = 6 $m_{\_pier}$ = 12	d_{b_pier} = 0.75 in A_{b_pier} = 0.44 in^2		
Provided area of steel:	A_{s_pier} = Ab_pier * m_pier	A_{s_pier} =	5.28	in^2
Compressive Resistance (H/D >= 3):	$ΦP_{n2}$ = 0.65 * 0.8 * (0.85 * (F\c) * (A_1 - As_pier) + ((Fy) * As_pier))	$ΦP_{n2}$ =	1548.87	kips
	H/D = (D - T + E) / dpier	H/D =	3.80	
Utilized Compressive Resistance:	$ΦP_n$ = Pn2	$ΦP_n$ =	1548.87	kips
Applied Compressive Force:	P_u = Pcomp + 1.2 * Wpier	P_u =	67.69	kips

Check **$ΦP_n$ = 1548.87 kips >= P_u = 67.69 kips** **RATING: 4.37% OK**

Pier Flexure

Cross-sectional area:	A_g = dpier²	A_g =	900.00	in^2
Min. area of steel (pier):	A_{smin_pier} = Ag * 0.005	A_{smin_pier} =	4.50	in^2
Cage Width:	d_o = dpier - 2 * cc - 2 * tie - d_b	d_o =	22.50	in

Check **A_{s_pier} = 5.28 in^2 >= A_{smin_pier} = 4.50 in^2** **OK**

Applied Moment to DSMC (Compression):	M_{u_comp} = (D - T + E) * Vu + Mu	M_{u_comp} =	85.50	ft-kips
Pier Moment Capacity (Compression):	$ΦM_{n\_comp}$ = *from DSMC*	$ΦM_{n\_comp}$ =	312.61	ft-kips

Check **M_{u_comp} = 85.50 ft-kips >= $ΦM_{n\_comp}$ = 312.61 ft-kips** **RATING: 27.35% OK**

Applied Moment to DSMC (Tension):	$M_{u\_tension}$ = (D - T + E) * Vu + Mu	$M_{u\_tension}$ =	76.00	ft-kips
Pier Moment Capacity (Tension):	$ΦM_{n\_tension}$ = *from DSMC*	$ΦM_{n\_tension}$ =	238.46	ft-kips

Check **$M_{u\_tension}$ = 76.00 ft-kips >= $ΦM_{n\_tension}$ = 238.46 ft-kips**

PAD REINFORCEMENT

Elastic Bearing Pressure for Soil Checks

Overturning Moment:	Mo = 0	Mo =	0.00	ft-kips	
Compressive Load for Bearing:	$P_{bearing}$ = Wc + Ws + Pcomp / 1.2	$P_{bearing}$ =	100.68	kips	
*Load Eccentricity (0.9*D LC):*	ec_0.9 = Mo / 0.9*Pbearing	ec_0.9 =	0.00	ft	e <= L/6
*Load Eccentricity (1.2*D LC):*	ec_1.2 = Mo / 1.2*Pbearing	ec_1.2 =	0.00	ft	e <= L/6
Elastic Section Modulus:	S = W³ / 6	S =	36.00	ft³	
*Positive Pressure 0.9*D LC):*	Ppos_0.9 = 0.9*Pbearing / Area + Mo / S	$P_{pos\_st\_0.9}$ =	2.52	ksf	
*Positive Pressure (1.2*D LC):*	Ppos_1.2 = 1.2*Pbearing / Area + Mo / S	$P_{pos\_st\_1.2}$ =	3.36	ksf	
*Negative Pressure (0.9*D LC):*	Pneg_0.9 = 0.9*Pbearing / Area - Mo / S Note: The resultant stress is within the kern. No adjustment is required.	$P_{neg\_st\_0.9}$ =	2.52	ksf	
*Negative Pressure (1.2*D LC):*	Pneg_1.2 = 1.2*Pbearing / Area - Mo / S Note: The resultant stress is within the kern. No adjustment is required.	$P_{neg\_st\_1.2}$ =	3.36	ksf	
*Adjusted Pressure (0.9*D LC):*	Padj_0.9 = 2*0.9*Pbearing/(3*W*(W/2-ec_0.9))	$P_{adj\_0.9}$ =	3.36	ksf	
*Adjusted Pressure (1.2*D LC):*	Padj_1.2 = 2*1.2*Pbearing/(3*W*(W/2-ec_0.9))	$P_{adj\_1.2}$ =	4.47	ksf	
*Maximum Pressure (0.9*D LC):*	$q_{u1\_0.9}$ = IF(Pneg ≥ 0, Ppos , Padj)	$q_{u\_st\_0.9}$ =	2.52	ksf	
*Maximum Pressure (1.2*D LC):*	$q_{u1\_1.2}$ = IF(Pneg ≥ 0, Ppos , Padj)	$q_{u\_st\_1.2}$ =	3.36	ksf	

One-Way Shear

Rebar:	$s_{\_pad}$ = 4	*Equally spaced;*	d_{b_pad} =	0.5	in
	$m_{\_pad}$ = 6	*bottom layer in one direction*	A_{b_pad} =	0.2	in^2

Effective depth:	d_c = T - cc - 1.5 * db	d_c =	20.3	in
Distance from Edge of Pad to Column Face:	d' = W / 2 - dpier / 2	d' =	1.8	ft
Distance from Edge of Pad to dc from Column Face:	d'' = d' - d_c / 12	d'' =	0.06	ft
Distance to qs (0.9D LC):	L' _0.9 = (W / 2 - ec_0.9) * 3	L' _0.9 =	6.00	ft
Distance to qs (1.2D LC):	L' _1.2 = (W / 2 - ec_1.2) * 3	L' _1.2 =	6.00	ft
*Slope of qs (0.9*D LC):*	sqs_0.9 = IF(L' > W, (Ppos - Pneg) / W, qu / L')	sqs_0.9 =	0.00	kcf
*Slope of qs (1.2*D LC):*	sqs_1.2 = IF(L' > W, (Ppos - Pneg) / W, qu / L')	sqs_1.2 =	0.00	kcf
Nominal Shear Strength:	V_{n1} = 2 * W * √(F'c*1000) * dc	V_{n1} =	172.51	kips
Shear Reduction Factor:	φ_{shear} = 0.75	φ_{shear} =	0.75	
Design Shear Strength:	φV_{n1} = φshear * V_{n1}	φV_{n1} =	129.38	kips

Resisting Weight above Critical Section:

	Thickness (ft)	Unit Weight (kcf)	Weight (kip) (0.9*D LC)	Weight (kip) (1.2*D LC)
Soil Above Water Table:	9	0.125	0.38	0.51
Soil Below Water Table:	0	0.063	0.00	0.00
Pad Above Water Table:	2	0.150	0.10	0.14
Pad Below Water Table:	0	0.088	0.00	0.00
Total:			0.48	0.64

*Applied Shear (0.9*D LC):*	$V_{u1\_0.9}$ = sqs_0.9 * MIN(L'_0.9,d'') * (W / 2 - dpier / 2 - dc) * W	$V_{u1\_0.9}$ =	0.46	kips
*Applied Shear (1.2*D LC):*	$V_{u1\_1.2}$ = sqs_1.2 * MIN(L'_1.2,d'') * (W / 2 - dpier / 2 - dc) * W	$V_{u1\_1.2}$ =	0.62	kips

Check **φV_{n1} = 129.38 kips >= V_{u1} = 0.62 kips** **RATING: 0.48% OK**

Two-Way Shear (Compression)

Pier Shape:	Pier Shape: Square	Pier Shape:	Square	
Pier Diameter:	d_{pier1} = d_{pier} * 12 in / ft	d_{pier1} =	30.00	in
Equivalent Square Pier Diameter:	d_{pier_sq} = dpier	d_{pier_sq} =	30.00	in
Avg. Effective Depth for Punching Shear:	d_{c_2} = T - cc_{pad} - AVERAGE(0.5 * $_{db\_pad}$, 1.5 * d_{b_pad})	d_{c_2} =	20.50	in
Area of Concrete in Shear:	A_c = (4 * (dpier1 + dc_2)) * dc_2)	A_c =	4141.00	in^2
Eq. Square Area of Concrete in Shear:	A_{c_sq} = (4*(dpier_sq+dc_2))*dc_2	A_{c_sq} =	4141.00	in^2
Factor of transfer of Moment:	Y_f = 1/(1+(2/3)*√(dpier1/dpier1))	Y_f =	0.60	
Factor of transfer of eccentricity of Shear:	Y_v = 1 - Y_f	Y_v =	0.40	
Moment applied at base of Pier:	M_v = M_{u_comp} * 12 in / ft	M_v =	1026.00	kip*in
Polar Moment of Inertia at assumed Critical Section:	J_{c_1} = (dc_2*(dpier1+dc_2)^3)/6 + ((dpier1+dc_2)*(dc_2^3))/6 + (dc_2*(dpier1+dc_2)*(dpier1+dc_2)^2)/2	J_{c_1} =	1832608.18	in^4
Eq. Square Polar Moment of Inertia at assumed Critical Section:	J_{c_sq} = (dc_2*(dpier_sq+dc_2)^3)/6 + ((dpier_sq+dc_2)*(dc_2^3))/6 + (dc_2*(dpier_sq+dc_2)*(dpier_sq+dc_2)^2)/2	J_{c_sq} =	1832608.18	in^4
*Net Bearing Resistance at front of Pier (1.2*D LC):*	$q_{u\_AB\_1.2}$ = MAX((qu_st_1.2 - sqs_1.2*(W/2 - (dpier1/12+dc_2/12)/2) - 1.2*(Wpad+Ws)/Area)/144,0)	$q_{u\_AB\_1.2}$ =	0.01	ksi
*Net Bearing Resistance at rear of Pier (1.2*D LC):*	$q_{u\_CD\_1.2}$ = MAX((qu_st_1.2 - sqs_1.2*(W/2 + (dpier1/12+dc_2/12)/2) - 1.2*(Wpad+Ws)/Area)/144,0)	$q_{u\_CD\_1.2}$ =	0.01	ksi
*Net Bearing Resistance at front of Pier_sq (1.2*D LC):*	$q_{u\_AB\_1.2\_sq}$ = MAX((qu_st_1.2 - sqs_1.2*(W/2 - (dpier_sq/12+MIN(dc_2,(T*12)*3)/12)/2) - 1.2*(Wpad+Ws)/Area)/144,0)	$q_{u\_AB\_1.2\_sq}$ =	0.01	ksi
*Net Bearing Resistance at rear of Pier_sq (1.2*D LC):*	$q_{u\_CD\_1.2\_sq}$ = MAX((qu_st_1.2 - sqs_1.2*(W/2 + (dpier_sq/12+dc_2/12)/2) - 1.2*(Wpad+Ws)/Area)/144,0)	$q_{u\_CD\_1.2\_sq}$ =	0.01	ksi
*Applied Shear Force (1.2*D LC):*	$V_{u\_1.2}$ = 1.2*Wpier + 1.2 * IF(OR($B$1="G",$B$1="H"), Pcomp / 1.2, Pcomp)	$V_{u\_1.2}$ =	67.69	kip
*Controlling Shear Stress (1.2*D LC):*	$v_{u\_1.2\_controlling}$ = MAX(0,IF(L_0.9 <= W/2 + dpier/2 + (dc_2/12)/2, 0, Vu_0.9/Ac + (Yv * Mv * (dpier1 + dc_2)/2) / Jc_1 - MIN(qu_AB_0.9,qu_CD_0.9)))	$v_{u\_1.2\_controlling}$ =	0.009	ksi
*Eq. Sq. Controlling Shear Stress (1.2*D LC):*	$v_{u\_1.2\_controlling\_sq}$ = MAX(0,Vu_1.2/Ac_sq + (Yv * Mv * (dpier_sq + dc_2)/2) / Jc_sq - MIN(qu_AB_1.2_sq,qu_CD_1.2_sq))	$v_{u\_1.2\_controlling\_sq}$ =	0.009	ksi
Shear Stress Capacity:	Φv_n = φs * 4 * (√F'c*1000) / 1000	Φv_n =	0.177	ksi

Check **Φv_n = 0.177 ksi >= v_{u_demand} = 0.009 ksi** **RATING: 5.04% OK**

Two-Way Shear (Compression, Flexural Component) [BOTTOM REINFORCEMENT]

Effective Pad Width:	$b_{\_pad}$ = MIN(dpier+3*T,W)	$b_{\_pad}$ =	6	ft
Bar Spacing:	B_{s_pad} = Bs_pad (see design checks below)	B_{s_pad} =	13.10	in
Fraction of Bars in Effective Width:	$m_{\_effective}$ = IF(b_pad=W,mp,12*b_pad/Bs_pad)	$m_{\_effective}$ =	6.00	
Area of Steel in Effective Width:	$A_{s\_effective}$ = VLOOKUP(Sp,Ref!$A$2:$C$12,3,0)*m_effective	$A_{s\_effective}$ =	1.20	in²
Depth of Equivalent Rectangular Stress Block:	$a_{\_effective} = A_{s\_effective}$ * Fy / (0.85 * F'c * b_{slab}*12)	$a_{\_effective}$ =	0.34	in
	$\beta_{pad} = \beta_{pad}$ (see design checks below)	β_{pad} =	0.85	
Distance from Top to Nuetral Axis:	$c_{\_effective} = a_{\_effective} / \beta_{pad}$	$c_{\_effective}$ =	0.40	
Effective depth:	dc = dc (see One-Way Shear check above)	dc =	20.25	in
Modulus of Elasticity of Steel:	E_s = 29000 ksi	E_s =	29000	ksi
Strain in Steel:	$\varepsilon_{s\_effective}$ = 0.003 * (dc-c) / c	$\varepsilon_{s\_effective}$ =	0.15062	in/in
Compression-Controlled Strain Limit::	$\varepsilon_c = F_y / E_s$	ε_c =	0.00207	in/in
Tension-Controlled Strain Limit::	ε_t = 0.005	ε_t =	0.00500	in/in
Flexure Strength Reduction Factor:	$\varphi flex_{\_effective}$ = IF(εs>=εt,0.9,IF(εs<=εc,0.65,0.65+(0.9-0.65)*((εs-εc)/(εt-εc))))	$\varphi flex_{\_effective}$ =	0.9	
Nominal Flexural Strength:	$M_{n\_effective} = A_{s\_effective} * (F_y) * (dc - a_{\_effective} / 2) * (1/12)$	$M_{n\_effective}$ =	120.49	ft-kips
Design Flexural Strength:	$\varphi M_{n\_effective}$ = φflex_effective * Mn_effective	$\varphi M_{n\_effective}$ =	108.44	ft-kips

Two-Way Shear (Compression, Flexural Component) [TOP REINFORCEMENT]

Bar Spacing:	$B_{s\_pad\_top}$ = (W*12 - 2 * ccpad - VLOOKUP(sptop,Ref!$A$2:$C$12,2,0)) / (mptop - 1)	$B_{s\_pad\_top}$ =	6.00	in
Fraction of Bars in Effective Width:	$m_{\_effective\_top}$ = IF(b_pad=W,mptop,12*b_pad/Bs_pad_top)	$m_{\_effective\_top}$ =	6.00	
Area of Steel in Effective Width:	$A_{s\_effective\_top}$ = VLOOKUP(sptop,Ref!$A$2:$C$12,3,0)*m_effective_top	$A_{s\_effective\_top}$ =	1.20	in²
Depth of Equivalent Rectangular Stress Block:	$a_{\_effective\_top} = A_{s\_effective\_top}$ * Fy / (0.85 * F'c * b_{slab}*12)	$a_{\_effective\_top}$ =	0.34	in
Distance from Top to Nuetral Axis:	$c_{\_effective\_top} = a_{\_effective\_top} / \beta_{pad}$	$c_{\_effective\_top}$ =	0.40	
Effective depth:	d_{c_top} = T *12 - ccpad - 1.5 * VLOOKUP(sptop,Ref!$A$2:$C$12,2,0)	d_{c_top} =	20.25	in
Strain in Steel:	$\varepsilon_{s\_effective\_top}$ = 0.003 * (dc_top - c_effective_top) / c_effective_top	$\varepsilon_{s\_effective\_top}$ =	0.15062	in/in
Flexure Strength Reduction Factor:	$\varphi flex_{\_effective\_top}$ = IF(εs_top>=εt,0.9,IF(εs_top<=εc,0.65,0.65+(0.9-0.65)*((εs_top-εc)/(εt-εc))))	$\varphi flex_{\_effective\_top}$ =	0.9	
Nominal Flexural Strength:	$M_{n\_effective\_top} = A_{s\_effective\_top} * (F_y) * (dc\_top - a_{\_effective\_top} / 2) * (1/12)$	$M_{n\_effective\_top}$ =	120.49	ft-kips
Design Flexural Strength:	$\varphi M_{n\_effective\_top}$ = φflex_effective * Mn_effective	$\varphi M_{n\_effective\_top}$ =	108.44	ft-kips
Applied Moment:	$Yf*M_{u\_comp} = Yf*M_{u\_comp}$	$Yf*M_{u\_comp}$ =	51.3	ft-kips

Check	**$\varphi M_{n\_effective}$ =**	**216.88**	**ksi**	**>=**	**$Yf*M_{u\_comp}$ =**	**51.30**	**ksi**	**RATING: 23.65% OK**

Two-Way Shear (Uplift)

Moment applied at base of Pier:	$M_{v\_tension}$ = IF(T>D,E+T,(D - T + E)) * Vu_uplift * 12	$M_{v\_tension}$ =	912.00	kip*in
Diameter of Longitudinal Rebar Cage:	$d_{\_cage}$ = dpier*12-2*(ccpier+VLOOKUP(St,Ref!$A$2:$C$12,2,0))-VLOOKUP(Sc,Ref!$A$2:$C$12,2,0)	$d_{\_cage}$ =	22.50	in
Eq. Square Dia. of Longitudinal Rebar Cage:	$d_{\_cage\_sq}$ = SQRT(PI())/2*d_cage	$d_{\_cage\_sq}$ =	19.94	in
Steel Embedment Length:	L_{embed} = dc_2	L_{embed} =	20.50	in
Area of Concrete in Shear:	$A_{c\_tension}$ = Lembed*(d_cage+Lembed)*PI()	$A_{c\_tension}$ =	2769.31	in²
Eq. Square Area of Concrete in Shear:	$A_{c\_tension\_sq}$ = Lembed*(d_cage_sq+Lembed)*4	$A_{c\_tension\_sq}$ =	3316.09	in²
Polar Moment of Inertia at assumed Critical Section:	$J_{c\_\_tension}$ = (Lembed*(d_cage+Lembed)^3)/6 + ((d_cage+Lembed)*(Lembed^3))/6 + (Lembed*(d_cage+Lembed)*(d_cage+Lembed)^2)/2	$J_{c\_tension}$ =	1148337.40	in⁴
Eq. Square Polar Moment of Inertia at assumed Critical Section:	$J_{c\_\_tension\_sq}$ = (Lembed*(d_cage_sq+Lembed)^3)/6 + ((d_cage_sq+Lembed)*(Lembed^3))/6 + (Lembed*(d_cage_sq+Lembed)*(d_cage_sq+Lembed)^2)/2	$J_{c\_tension\_sq}$ =	961922.52	in⁴
*Applied Shear Force (0.9*D LC):*	$V_{u\_0.9\_tension}$ = MAX(0.9 * IF(OR($B$1="G",$B$1="H"), Puplift / 0.9, Puplift) - 0.9*Wpier,0)	$V_{u\_0.9\_tension}$ =	36.98	kip
*Controlling Shear Stress (0.9*D LC):*	$v_{u\_0.9\_controlling\_tension}$ = Vu_0.9_tension/Ac_tension+(Yv*Mv_tension*(d_cage+Lembed)/2)/Jc_tension	$v_{u\_0.9\_controlling\_tension}$ =	0.020	ksi
*Eq. Sq. Controlling Shear Stress (0.9*D LC):*	$v_{u\_0.9\_tension\_sq}$ = Vu_0.9_tension/Ac_tension_sq+(Yv*Mv_tension*(d_cage_sq+Lembed)/2)/Jc_tension_sq	$v_{u\_0.9\_tension\_sq}$ =	0.019	ksi
Shear Stress Capacity:	$\Phi v_{n\_tension}$ = φs * 4 * (√F'c*1000)/1000	$\Phi v_{n\_tension}$ =	0.177	ksi

Check	**Φv_n =**	**0.177**	**ksi**	**>=**	**v_{u_demand} =**	**0.019**	**ksi**	**RATING: 10.60% OK**

Two-Way Shear (Uplift, Flexural Component)

Applied Moment:	$Yf*M_{u\_tension}$ = $Yf*M_{u\_tension}$	$Yf*M_{u\_tension}$ = 45.6	ft-kips

Check $\varphi M_{n\_effective}$ = **216.88 ksi** >= $Yf*M_{u\_tension}$ = **45.60 ksi** **RATING: 21.02% OK**

Pad Flexure (Net Bearing Pressure)

	β_{pad} =	IF(F'c <= 4, 0.85, IF(F'c >= 8, 0.65, 0.85 - (F'c - 4) * 0.05))	β_{pad} = 0.85	
Provided Steel:	A_{s_pad} =	A_{b_pad} * m_pad	A_{s_pad} = 1.20	in^2
Depth of Equivalent Rectangular Stress Block:	a =	A_{s_pad} * Fy / (0.85 * F'c * W)	a = 0.34	in
Distance from Top to Nuetral Axis:	c =	a / β_{pad}	c = 0.40	in
Modulus of Elasticity of Steel:	E_s =	29000 ksi	E_s = 29000	ksi
Strain in Steel:	ε_s =	0.003 * (dc-c) / c	ε_s = 0.15062	in/in
Compression-Controlled Strain Limit::	ε_c =	F_y / E_s	ε_c = 0.00207	in/in
Tension-Controlled Strain Limit::	ε_t =	0.005	ε_t = 0.00500	in/in
Flexure Strength Reduction Factor:	φflex =	IF(εs>=εt,0.9,IF(εs<=εc,0.65,0.65+(0.9-0.65)*((εs-εc)/(εt-εc))))	φflex = 0.9	
Nominal Flexural Strength:	M_n =	$As_{\_pad}$ * (F_y) * (dc - a / 2) * (1/12)	M_n = 120.49	ft-kips
Design Flexural Strength:	φM_n =	φflex * Mn	φM_n = 108.44	ft-kips
*Bearing Press. at Crit. Section (0.9*D LC):*	qmid_0.9 =	qu_st_0.9 - sqs_0.9 * d'	qmid_0.9 = 2.52	ksf
*Bearing Press. at Crit. Section (1.2*D LC):*	qmid_1.2 =	qu_st_1.2 - sqs_1.2 * d'	qmid_1.2 = 3.36	ksf

Resisting Weight above Critical Section:

	Thickness (ft)	Unit Weight (kcf)	Weight (kip) (0.9*D LC)	Weight (kip) (1.2*D LC)	Moment Arm (ft)	Resisting Moment (ft-kips) (0.9*D LC)	Resisting Moment (ft-kips) (1.2*D LC)
Soil Above Water Table:	9	0.125	10.63	14.18	0.875	9.30	12.403125
Soil Below Water Table:	0	0.063	0.00	0.00	0.875	0.00	0
Pad Above Water Table:	2	0.150	2.84	3.78	0.875	2.48	3.3075
Pad Below Water Table:	0	0.088	0.00	0.00	0.875	0.00	0
Total:			13.47	17.96		11.78	15.71

*Factored Bending Moment (0.9*D LC):*	Mu_pad_0.9 =	((0.5*(qu_0.9-qmid_0.9))*(d\^2)*(2/3)+(0.5*qmid_0.9*(d\^2))-(0.5*Wg_0.9*(d\^2)))*W	Mu_pad_0.9 = 11.34	ft-kips
*Factored Bending Moment (1.2*D LC):*	Mu_pad_1.2 =	((0.5*(qu_1.2-qmid_1.2))*(d\^2)*(2/3)+(0.5*qmid_1.2*(d\^2))-(0.5*Wg_1.2*(d\^2)))*W	Mu_pad_1.2 = 15.12	ft-kips

Check φM_n = **108.44 ft-kips** >= M_{u_pad} = **15.12 ft-kips** **RATING: 13.94% OK**

PIER DESIGN CHECKS

Minimum Steel

Min. area of steel (pier):	A_{st_c} =	Ag * 0.005	A_{st_c} = 4.50	in^2

Check A_{s_pier} = **5.28 in²** >= A_{st_c} = **4.50 in²**

Bar Spacing

Bar separation:	B_{s_pier} =	(do * π) / m_pier - db_pier	B_{s_pier} = 5.14	in

Check **18.00 in** >= B_{s_pier} = **5.14 in** **RATING: 28.56% OK**

Vertical Rebar Development Length

Reinforcement location:	α_c =	if space under bar > 12", 1.3, else use 1.0	α_c = 1.3	
Epoxy coating:	β_c =	for non- epoxy coated, use 1.0	β_c = 1.0	
Max term:	$\alpha\beta_c$ =	product of α x β not to exceed 1.7	$\alpha\beta_c$ = 1.3	
Reinforcement size:	γ_c =	if bar size is 6 or less, 0.8, else use 1.0	γ_c = 0.8	
Light weight concrete:	λ_c =	1.0	λ_c = 1.0	
Spacing/cover:	$c_{\_c}$ =	use smaller of half of bar spacing or concrete cover	$c_{\_c}$ = 2.9	in
Transverse bars:	k_{tr_c} =	0 in (per simplification)	k_{tr_c} = 0	in
Max term:	c_c' =	MIN(2.5, (c_c + ktr_c) / db_c)	c_c' = 2.500	
Excess reinforcement:	R_c =	Ast_c / As_c	R_c = 0.85	
Development (tensile):	$L_{dt}'_{\_c}$ =	(3 / 40) * (Fy*1000 / √(F'c*1000)) * αβ_c * γ_c * λ_c * R_c * db_c / c_c'	$L_{dt}'_{\_c}$ = 20.23	in
Minimum length:	L_{d_min} =	12 inches	L_{d_min} = 12.0	in
Development length:	L_{dt_c} =	MAX(Ld_min, Ldt'_c)	L_{dt_c} = 20.23	in
Development (comp.):	$L_{dc}'_{\_c}$ =	0.02 * db_c * Fy*1000 / √(F'c*1000)	$L_{dc}'_{\_c}$ = 15.21	in
	$L_{dc}''_{\_c}$ =	0.0003 * db_c * Fy*1000	$L_{dc}''_{\_c}$ = 13.50	in
Development length:	L_{dc_c} =	MAX(8, Ldc'_c, Ldc''_c)	L_{dc_c} = 15.21	in
Length available in pier:	L_{vc} =	D - T + E - cc	L_{vc} = 111.0	in

Check	L_{vc} = **111.00** **in**	**>=**	L_{dt_c} = **20.23** **in**					**OK**
Check	L_{vc} = **111.00** **in**	**>=**	L_{dc_c} = **15.21** **in**					**OK**
	Length available in pad:	L_{vp} = T - ccpad			L_{vp} =	21.0	in	
Check	L_{vp} = **21.00** **in**	**>=**	L_{dt_c} = **20.23** **in**					**OK**
Check	L_{vp} = **21.00** **in**	**>=**	L_{dc_c} = **15.21** **in**					**OK**

Vertical Rebar Hook Ending

	Bar size & clear cover:	α_h = =if bar <= 11, and cc >= 2.5", use 0.7, else use 1.0			α_h =	0.7		
	Epoxy coating:	β_h = for non- epoxy coated, use 1.0			β_h =	1.0		
	Light weight concrete:	λ_h = 1.0			λ_h =	1.0		
	Development (hook):	L_{dh}' = 0.02 * αh * βh * λh * Fy*1000 / √(F'c*1000) * db_c			L_{dh}' =	10.6	in	
	Minimum length:	L_{dh_min} = the larger of: 8 * d_b or 6 in			L_{dh_min} =	6.0	in	
	Development length:	L_{dh} = MAX(Ldh_min, Ldh')			L_{dh} =	10.6	in	
Check	L_{vp} = **21.00** **in**	**>=**	L_{dh} = **10.65** **in**					**OK**
	Hook tail length:	L_{h_tail} = 12 * db beyond the bend radius			L_{h_tail} =	12.0	in	
	Length available in pad:	L_{h_pad} = (W - dpier) / 2 + ccpier - ccpad			L_{h_pad} =	21	in	
Check	L_{h_pad} = **21.00** **in**	**>=**	L_{dh_tail} = **12.00** **in**					**OK**

Pier Ties

	Minimum size: [ACI 7.10.5.1]	$s_{\_t\_min}$ =IF(s_c <= 10, 3, 4)			$s_{\_t\_min}$ =	3		
	z factor:	z_seismic = 0.5 if the SDC is A, B, or C, else 1.0			z_seismic =	0.5		
	Tie parameters:	$s_{\_t}$ = 3 $m_{\_t}$ = 9		d_{b_t} = 0.375 in A_{b_t} = 0.11 in^2				
	Allowable tie spacing per vertical rebar:	$B_{s\_t\_max1}$ = 8 / z * db_c			$B_{s\_t\_max1}$ =	12	in	
	per tie size:	$B_{s\_t\_max2}$ = 24 / z * db_t			$B_{s\_t\_max2}$ =	18	in	
	per pier diameter:	$B_{s\_t\_max3}$ = di / (4 * z²)			$B_{s\_t\_max3}$ =	30	in	
	per seismic zone:	$B_{s\_t\_max4}$ = 12" in active seismic zones, else 18"			$B_{s\_t\_max4}$ =	18	in	
	Maximum tie spacing:	$B_{s\_t\_max}$ = MIN(Bs_t_max1, Bs_t_max2, Bs_t_max3, Bs_t_max4)			$B_{s\_t\_max}$ =	12	in	
	Minimum required ties:	$m_{\_t\_min}$ = (D - T + E) / Bs_t_max + 2			$m_{\_t\_min}$ =	12.00		
Check	$m_{\_t}$ = **9.00**	**>=**	$m_{\_t\_min}$ = **12.00**					

PAD DESIGN CHECKS

Minimum Steel Required for Shrinkage

Shrinkage:	ρ_{sh} = IF(Fy*1000 >= 60000, 0.0018, 0.002)	ρ_{sh} =	0.0018	
Min. Required Shrinkage Steel:	$A_{st\_p\_sh}$ = ρsh * W * T	$A_{st\_p\_sh}$ =	3.110	in^2

Check **A_{s_p} = 1.20 in^2 >= A_{st_p} = 3.11 in^2**

Bar Separation

Bar separation:	B_{s_pad} = (W - 2 * cc - db) / (m - 1)	B_{s_pad} =	13.10	in

Check **18" >= B_{s_p} = 13.10 in >= 2"** **OK**

Pad Development Length

Reinforcement location:	α_p = if space under bar > 12", 1.3, else use 1.0	α_p =	1.3	
Epoxy coating:	β_p = for non- epoxy coated, use 1.0	β_p =	1.0	
Max term:	$\alpha\beta_p$ = product of α x β not to exceed 1.7	$\alpha\beta_p$ =	1.3	
Reinforcement size:	γ_p = if bar size is 6 or less, 0.8, else use 1.0	γ_p =	0.8	
Light weight concrete:	λ_p = 1.0	λ_p =	1.0	
Spacing/cover:	c_p = use smaller of half of bar spacing or concrete cover	c_p =	3.25	in
Transverse bars:	k_{tr_p} = 0 in (simplification)	k_{tr_p} =	0	in
Max term:	c_p' = MIN(2.5, (c + ktr) / db)	c_p' =	2.500	
Required moment (φt = 0.9):	M_{nr} = Mu_pad / φflex	M_{nr} =	16.8	ft-kips
Steel estimate:	A_{st_p}' = Mn / (φt * Fy * dc)	A_{st_p}' =	0.184	in^2
	a_p = Ast' * Fy / (β * F'c * W)	a_p =	0.05	in
Required steel:	$A_{st\_p\_st}$ = M_{nr} / (Fy * (dc - ap / 2))	$A_{st\_p\_st}$ =	0.166	in^2
Excess reinforcement:	R_p = Ast_p / As_p	R_p =	2.59	
Development (tensile):	L_d = (3 / 40) * (Fy*1000 / √(F'c*1000)) * αβ * γ * λ * R * db / c'	L_d =	41.01	in
Minimum length:	L_{d_min} = 12 inches	L_{d_min} =	12.0	in
Development length:	L_{dp} = MAX(Ld_min, Ldp')	L_{dp} =	41.01	in
Length available in pad:	L_{pad} = W / 2 - dpier / 2 - ccpad	L_{pad} =	18.00	in

Check **L_{pad} = 18.00 in >= L_{dp} = 41.01 in**

Moment Capacity of Drilled Concrete Shaft (Caisson) for TIA Rev F, G, or H

Note: **Shaft assumed to have ties, not spiral, transverse reinforcing**

Site Data

ES-043
TollandAWC

Maximum Shaft Superimposed Forces		
TIA Revision:	H	
Max. Factored Shaft Mu:	76	ft-kips (* Note)
Max. Factored Shaft Pu:	45	kips
Max Axial Force Type:	Tension	

(*) Note: Max Shaft Superimposed Moment does not necessarily equal to the shaft top reaction moment

Loads Already Factored		
For M (WL):	1.00	
For P (DL):	1.00	

Load Factor	Shaft Factored Loads		
1.00	Mu:	76	ft-kips
1.00	Pu:	45	kips

Pier Properties		
Concrete:		
Pier Diameter =	2.5	ft
Concrete Area =	706.9	in^2
Reinforcement:		
Clear Cover to **Tie**=	3.00	in
Horiz. **Tie** Bar Size=	3	
Vert. Cage Diameter =	1.88	ft
Vert. Cage Diameter =	22.50	in
Vertical Bar Size =	6	
Bar Diameter =	0.75	in
Bar Area =	0.44	in^2
Number of Bars =	12	
As Total=	5.28	in^2
A s/ Aconc, Rho:	0.0075	0.75%

Material Properties		
Concrete Comp. strength, f'c =	3500	psi
Reinforcement yield strength, Fy =	60	ksi
Reinforcing Modulus of Elasticity, E =	29000	ksi
Reinforcement yield strain =	0.00207	
Limiting compressive strain =	0.003	
ACI 318 Code		
Select Analysis ACI Code=	2014	

SOLVE <-- Press Upon Completing All Input

ACI 10.5 , ACI 21.10.4, and IBC 1810.

Min As for Flexural, Tension Controlled, Shafts:

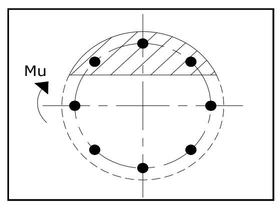
(3)*(Sqrt(f'c)/Fy:	0.0030
200 / Fy:	0.0033

Minimum Rho Check:

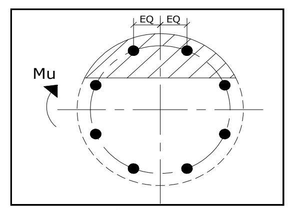
Assumed Min. Rho:	0.50%	
Provided Rho:	0.75%	**OK**

Results:

Governing Orientation Case: **1**



Case 1



Case 2

Dist. From Edge to Neutral Axis:	**5.06**	in
Extreme Steel Strain, εt:	**0.0123**	
	εt > 0.0050, Tension Controlled	
Reduction Factor,φ:	**0.900**	

Output Note: Negative Pu=Tension

For Axial Compression, φ Pn = Pu:	-40.50	kips
Drilled Shaft Moment Capacity, φMn:	**238.46**	ft-kips
Drilled Shaft Superimposed Mu:	**76.00**	ft-kips

Ref. Shaft Max Axial Capacities, ϕ Max(Pn or Tn):		
Max Pu = (φ=0.65) Pn. Pn per ACI 318 (10-2)	1250.08	kips
at Mu=(ϕ=0.65)Mn=	260.15	ft-kips
Max Tu, (φ=0.9) Tn =	285.12	kips
at Mu=ϕ=(0.90)Mn=	0.00	ft-kips

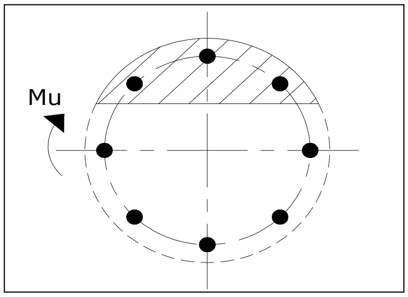
Maximum Allowable Moment of a Circular Pier

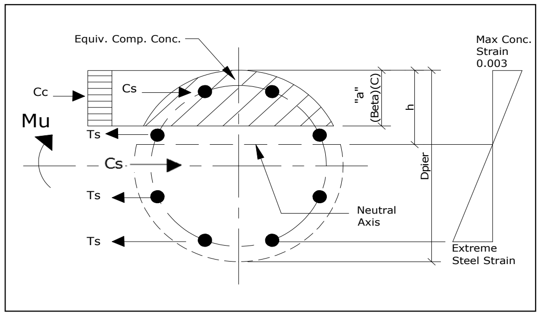
Pu: 45 kips (from Results Tab)
Axial Force type: Tension (from Results Tab)

For Internal Calculations:
Axial Load (Negative for Compression) = 45.00 kips

	Case 1	Case 2
Reduction factor, ϕ2002 =	0.9	0.9
Reduction factor, ϕ2005 =	0.9	0.9
Reduction factor, ϕ2014 =	0.9	0.9
I ACI code:	0.9	0.9

Case 1: Single Bar Near the Extreme Fiber





General Sketch (Variables) for both cases

Neutral Axis

Distance from extreme edge to neutral axis, h = 5.08 in
Equivalent compression zone factor = 0.85
Distance from extreme edge to equivalent compression zone factor, a = 4.32 in
Distance from centroid to neutral axis = 9.92 in

Compression Zone

Area of steel in compression zone, Asc = 0.44 in^2
Angle from centroid of pier to intersection of equivalent compression zone and edge of pier = 44.61 deg <-- 1/2 of total angle
Area of concrete in compression, Acc = 62.68 in^2
Force in concrete = 0.85 * f`c * Acc, Fc = 186.48 kips <-- ϕ Not Involved = Concrete Pn
Total reinforcement forces, Fs = -231.48 kips <-- ϕ Not Involved = Total Steel Pn
Case 1, φ= 0.900
Axial (comp=negative), Pu = 45.00 kips <-- Pu
Balance Force in concrete, Fs+Fu = -186.48 kips
Shaft Comp. Capacity, ϕPn= **-40.50** kips <--φ Pn=Pu

Sum of the axial forces in the shaft = 0.00 kips **OK**

Maximum Moment

First moment of the concrete area in compression about the centoid = 779.20 in^3
Distance between centroid of concrete in compression and centroid of pier = 12.43 in
Moment of concrete in compression = 2318.12 in-kips 193.1769 ft-kips
Total reinforcement moment = 884.17 in-kips 73.68098 ft-kips
Nominal Moment strength of Drilled Shaft Mn = 3202.29 in-kips
Moment Capacity of Drilled Shaft, ϕMn = 2882.06 in-kips 240.1721 ft-kips

Case 1, φMn = 240.17 ft-kips

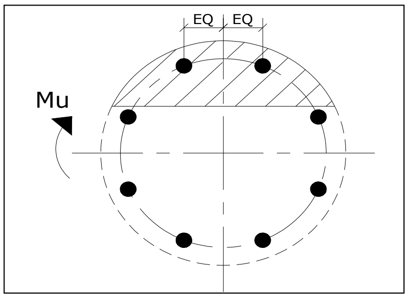
Final Results		
Governing Orientation Case=	**2**	
phi, φ=	0.900	
Shaft ϕ*Mn=	**238.46**	ft-kips
Distance from Edge of Shaft to N.A.=	5.06	in
Shaft Beta=	0.85	
Maximum Tensile Strain=	-0.01235	<------------
Shaft Tension Cap., φTn= (φ=0.9)*(Total As)(Fy)=	285.12	kips
Shaft Max Comp, (φ=0.65)(0.80)[0.85*f'c*(Ag-Ast)+Ast*Fy]=	1250.08	kips

Individual Bars

Bar #	Angle from first bar (deg)	Distance to center of shaft (in)	Distance to neutral axis (in)	Distance to equivalent comp. zone (in)	Strain	Area of steel in compression (in^2)	Stress (ksi)	Axial force (kips)	Moment (in-kips)
1	0.00	11.25	1.33	0.57	0.00079	0.44	22.82	8.73	98.24
2	30.00	9.74	-0.17	-0.94	-0.00010	0.00	-2.97	-1.31	-12.74
3	60.00	5.63	-4.29	-5.05	-0.00253	0.00	-60.00	-26.40	-148.50
4	90.00	0.00	-9.92	-10.68	-0.00585	0.00	-60.00	-26.40	0.00
5	120.00	-5.63	-15.54	-16.30	-0.00917	0.00	-60.00	-26.40	148.50
6	150.00	-9.74	-19.66	-20.42	-0.01160	0.00	-60.00	-26.40	257.21
7	180.00	-11.25	-21.17	-21.93	-0.01249	0.00	-60.00	-26.40	297.00
8	210.00	-9.74	-19.66	-20.42	-0.01160	0.00	-60.00	-26.40	257.21
9	240.00	-5.63	-15.54	-16.30	-0.00917	0.00	-60.00	-26.40	148.50
10	270.00	0.00	-9.92	-10.68	-0.00585	0.00	-60.00	-26.40	0.00
11	300.00	5.63	-4.29	-5.05	-0.00253	0.00	-60.00	-26.40	-148.50
12	330.00	9.74	-0.17	-0.94	-0.00010	0.00	-2.97	-1.31	-12.74
				Min-->	-0.01249	0.44		-231.48	884.17
									73.68098

<-- ϕ based on ACI 318 2002, Section 9.3.2.2 and corresponding comentaries. Transition zone equation for ties: φ=0.48+83(ϵt). Transition zone equation for sp
<-- ϕ based on ACI 318 2005, Section 9.3.2.2 and corresponding comentaries. Transition zone equation for ties: φ=0.65+((ϵt)-0.002)(250/3). Transition zone eq
<-- ϕ based on ACI 318 2014, Section 21.2 and corresponding comentaries. Transition zone equation for ties: φ=0.65+0.25((ϵt-ϵty)/(0.005-ϵty). Transition zone

Case 2: (2) Equidistant Bars Near the Extreme Fiber



Neutral Axis

Distance from extreme edge to neutral axis, h =	5.06	in
Equivalent compression zone factor =	0.85	
Distance from extreme edge to equivalent compression zone factor, a =	4.30	in
Distance from centroid to neutral axis =	9.94	in

Compression Zone

Area of steel in compression zone, Asc =	0.88	in^2	
Angle from centroid of pier to intersection of equivalent compression zone and edge of pier =	44.48	deg	<-- 1/2 of total angle
Area of concrete in compression, Acc =	62.18	in^2	
Force in concrete = 0.85 * f'c * Acc, Fc =	184.99	kips	<-- ϕ Not Involved = Concrete Pn
Total reinforcement forces, Fs =	-229.99	kips	<-- ϕ Not Involved = Total Steel Pn
Case 2, φ=	0.900		
Axial (comp=negative), Pu =	45.00	kips	<-- Pu
Balance Force in concrete, Fs+Fu =	-184.99	kips	
Shaft Comp. Capacity, ϕPn=	**-40.50**	kips	<--φ Pn=Pu
Sum of the axial forces in concrete in the shaft=	0.00	kips	**OK**

Magr

Maximum Moment

First moment of the concrete area in compression about the centoid =	773.82	in^3	
Distance between centroid of concrete in compression and centroid of pier =	12.44	in	
Moment of concrete in compression =	2302.12	in-kips	191.8435 ft-kips
Total reinforcement moment =	877.37	in-kips	73.11428 ft-kips
Nominal Moment strength of Drilled Shaft Mn =	3179.49	in-kips	
Moment Capacity of Drilled Shaft, ϕMn =	2861.54	in-kips	238.462 ft-kips

Case 2, φMn = **238.46** **ft-kips**

ϵt > 0.0050, Tension Controlled   TC

Bar #	Angle from first bar (deg)	Distance to center of shaft (in)	Distance to neutral axis (in)	Distance to equivalent comp. zone (in)	Strain	Area of steel in compression (in^2)	Stress (ksi)	Axial force (kips)	Moment (in-kips)
1	15.00	10.87	0.92	0.16	0.00055	0.44	15.87	5.67	61.64
2	45.00	7.95	-1.99	-2.75	-0.00118	0.00	-34.24	-15.07	-119.85
3	75.00	2.91	-7.03	-7.79	-0.00417	0.00	-60.00	-26.40	-76.87
4	105.00	-2.91	-12.86	-13.61	-0.00763	0.00	-60.00	-26.40	76.87
5	135.00	-7.95	-17.90	-18.66	-0.01062	0.00	-60.00	-26.40	210.01
6	165.00	-10.87	-20.81	-21.57	-0.01235	0.00	-60.00	-26.40	286.88
7	195.00	-10.87	-20.81	-21.57	-0.01235	0.00	-60.00	-26.40	286.88
8	225.00	-7.95	-17.90	-18.66	-0.01062	0.00	-60.00	-26.40	210.01
9	255.00	-2.91	-12.86	-13.61	-0.00763	0.00	-60.00	-26.40	76.87
10	285.00	2.91	-7.03	-7.79	-0.00417	0.00	-60.00	-26.40	-76.87
11	315.00	7.95	-1.99	-2.75	-0.00118	0.00	-34.24	-15.07	-119.85
12	345.00	10.87	0.92	0.16	0.00055	0.44	15.87	5.67	61.64
				Min-->	-0.01235	0.88		-229.99	877.37
									73.11428

irals: φ=0.57+67(εt).
uation for spirals: φ=0.70+((εt)-0.002)(200/3).
equation for spirals: φ=0.75+0.15((εt-εty)/(0.005-εty).

Case 3: = Case 1, but Pu set at Max Axial Compression per ACI 318 (10-2) and phi=0.65.

Neutral Axis

Distance from extreme edge to neutral axis, h =	27.28	in	
Equivalent compression zone factor =	0.85		
Distance from extreme edge to equivalent compression zone factor, a =	23.18	in	
Distance from centroid to neutral axis =	-12.28	in	

Compression Zone

Area of steel in compression zone, Asc =	3.96	in^2	
Angle from centroid of pier to intersection of equivalent compression zone and edge of pier =	123.07	deg	<-- 1/2 of total angle
Area of concrete in compression, Acc =	586.17	in^2	
Force in concrete = 0.85 * f`c * Acc, Fc =	1743.86	kips	<-- ϕ Not Involved = Concrete Pn
Total reinforcement forces, Fs =	179.34	kips	<-- ϕ Not Involved = Total Steel Pn
φ=	0.65		
ıified, Max Axial Comp, Pn, per ACI 318 (10-2)/(ϕ=0.65)=	-1923.20	kips	<-- (Pn per ACI 10-2)/ϕ
Balance Force in concrete, Fs+Fu =	-1743.86	kips	
Shaft Comp. Capacity, (ϕ=0.65)Pn=	**1250.08**	kips	<--φ Pn=Pu
Sum of the axial forces in the shaft =	0.00	kips	**OK**

Maximum Moment

First moment of the concrete area in compression about the centoid =	1324.18	in^3	
Distance between centroid of concrete in compression and centroid of pier =	2.26	in	
Moment of concrete in compression =	3939.45	in-kips	328.2873 ft-kips
Total reinforcement moment =	863.34	in-kips	71.94471 ft-kips
Nominal Moment strength of Drilled Shaft Mn =	4802.78	in-kips	
Moment Capacity of Drilled Shaft, (ϕ=0.65)Mn =	3121.81	in-kips	260.1508 ft-kips

Case 3, at Pmax, (φ=0.65)Mn = 260.15 ft-kips

Individual Bars

Bar #	Angle from first bar (deg)	Distance to center of shaft (in)	Distance to neutral axis (in)	Distance to equivalent comp. zone (in)	Strain	Area of steel in compression (in^2)	Stress (ksi)	Axial force (kips)	Moment (in-kips)
1	0.00	11.25	23.53	19.43	0.00259	0.44	60.00	25.09	282.27
2	30.00	9.74	22.02	17.93	0.00242	0.44	60.00	25.09	244.46
3	60.00	5.63	17.90	13.81	0.00197	0.44	57.10	23.81	133.95
4	90.00	0.00	12.28	8.18	0.00135	0.44	39.16	15.92	0.00
5	120.00	-5.63	6.65	2.56	0.00073	0.44	21.21	8.03	-45.14
6	150.00	-9.74	2.53	-1.56	0.00028	0.00	8.08	3.56	-34.64
7	180.00	-11.25	1.03	-3.07	0.00011	0.00	3.27	1.44	-16.20
8	210.00	-9.74	2.53	-1.56	0.00028	0.00	8.08	3.56	-34.64
9	240.00	-5.63	6.65	2.56	0.00073	0.44	21.21	8.03	-45.14
10	270.00	0.00	12.28	8.18	0.00135	0.44	39.16	15.92	0.00
11	300.00	5.63	17.90	13.81	0.00197	0.44	57.10	23.81	133.95
12	330.00	9.74	22.02	17.93	0.00242	0.44	60.00	25.09	244.46
				Min-->	0.00011	3.96		179.34	863.34
									71.94471

TIA-222- H

FACTORED LOADS

Axial Load 0.9D:	$P_{\_0.9D}$ = 0.9 * Pcomp / 1.2	$P_{\_0.9D}$ =	42.75	kip	
Axial Load 1.2D:	$P_{\_1.2D}$ = 1.2 * Pcomp / 1.2	$P_{\_1.2D}$ =	57.00	kip	
Shear Load:	V_u = Vu_comp	V_u =	9.00	kip	
Moment:	M_u = Mu	M_u =	0.00	kip*ft	

PASSIVE PRESSURE RESISTANCE (ORTHOGONAL DIRECTION)

Force of Pp Applied on Pier:	$Force_{pier}$ = MIN(Vu,Sum(Pp!M2:M7))	$Force_{pier}$ =	9.00	kip	
Moment Arm of Pp on Pier:	M_{arm_pier} = D-T-Pp!O2 + T	M_{arm_pier} =	4.40	ft	
Force of Pp Applied on Pad:	$Force_{pad}$ = MIN(Vu-$Force_{pier}$,SUM(Pp!M8:M13))	$Force_{pad}$ =	0.00	kip	
Moment Arm of Pp on Pad:	M_{arm_pad} = D-Pp!O8	M_{arm_pad} =	0.97	ft	
Unfactored Moment Resistance due to Passive Pressure:	$M_{R\_Pp} = Force_{pier}*M_{arm\_pier}+Force_{pad}*M_{arm\_pad}$	M_{R_Pp} =	39.60	kip*ft	
Factored Moment Resistance due to Passive Pressure:	$\Phi M_{R\_Pp} = \Phi_s*M_{R\_Pp}$	ΦM_{R_Pp} =	29.70	kip*ft	

PLASTIC BEARING PRESSURE & OVERTURNING MOMENT (ORTHOGONAL DIRECTION)

*Compressive Load for Bearing (0.9*D LC):*	$P_{bearing\_0.9}$ = P_0.9D+0.9*(Ws+Wc)+0.75*Wwedges_0.9_bearing	$P_{bearing\_0.9}$ =	90.61	kip	
*Compressive Load for Bearing (1.2*D LC):*	$P_{bearing\_1.2}$ = P_1.2D+1.2*(Ws+Wc)+0.75*Wwedges_1.2_bearing	$P_{bearing\_1.2}$ =	120.81	kip	
Factored Overturning Moment:	$M_{overturning} = M_u + V_u * (MAX(T,D)+E+bp_{dist}/12)$	$M_{overturning}$ =	0.00	kip*ft	
Area of Pad:	Area = W^2	Area =	36.00	ft^2	
Plastic Section Modulus of Pad:	Z = W^3 / 4	Z =	54.00	ft^3	
*Preliminary Load Eccentricity (0.9*D LC):*	$pre\_ec_{\_0.9\_p} = M_{overturning}/P_{bearing\_0.9}$	$pre\_ec_{\_0.9\_p}$ =	0.00	ft	
*Preliminary Load Eccentricity (1.2*D LC):*	$pre\_ec_{\_1.2\_p} = M_{overturning}/P_{bearing\_1.2}$	$pre\_ec_{\_1.2\_p}$ =	0.00	ft	
*[Goal Seek] Load Eccentricity Iteration (0.9*D LC):*	$ec_{\_0.9\_p}$ = *goal seek*	$ec_{\_0.9\_p}$ =	0.00	ft	e <= L/4
*[Goal Seek] Load Eccentricity Iteration (1.2*D LC):*	$ec_{\_1.2\_p}$ = *goal seek*	$ec_{\_1.2\_p}$ =	0.00	ft	e <= L/4
*Non-Bearing Length (0.9*D LC):*	$NBL_{\_0.9}$ = 0	$NBL_{\_0.9}$ =	0.00	ft	
*Non-Bearing Length (1.2*D LC):*	$NBL_{\_1.2}$ = 0	$NBL_{\_1.2}$ =	0.00	ft	
*Total Factored Resisting Moment due to Pp and Soil Wedges / Shear (0.9*D LC):*	$\Phi M_{Resisting\_0.9} = \Phi M_{R\_Pp} + SUM(\Phi M_{R\_wedges\_0.9},\Phi M_{R\_shear\_0.9})$	$\Phi M_{Resisting\_0.9}$ =	29.70	kip*ft	
*Total Factored Resisting Moment due to Pp and Soil Wedges / Shear (1.2*D LC):*	$\Phi M_{Resisting\_1.2} = \Phi M_{R\_Pp} + SUM(\Phi M_{R\_wedges\_1.2},\Phi M_{R\_shear\_1.2})$	$\Phi M_{Resisting\_1.2}$ =	29.70	kip*ft	
*Adjusted Overturning Moment (0.9*D LC):*	$M_{overturning\_adj\_0.9} = M_{overturning} - \Phi M_{Resisting\_0.9}$	$M_{overturning\_0.9}$ =	0.00	kip*ft	
*Adjusted Overturning Moment (1.2*D LC):*	$M_{overturning\_adj\_1.2} = M_{overturning} - \Phi M_{Resisting\_1.2}$	$M_{overturning\_1.2}$ =	0.00	kip*ft	
*Total Resistance to Overturning (0.9*D LC):*	$\Phi M_{Resisting\_qu\_0.9} = P_{bearing\_0.9}*ec_{\_0.9\_p} + \Phi M_{Resisting\_0.9}$	$\Phi M_{Resisting\_qu\_0.9}$ =	29.70	kip*ft	
*Total Resistance to Overturning (1.2*D LC):*	$\Phi M_{Resisting\_qu\_1.2} = P_{bearing\_1.2}*ec_{\_1.2\_p} + \Phi M_{Resisting\_1.2}$	$\Phi M_{Resisting\_qu\_1.2}$ =	29.70	kip*ft	
[Goal Seek] Moment Comparison Iteration (0.9D LC):	$\Delta M_{\_0.9} = M_{overturning}-\Phi M_{Resisting\_qu\_0.9}$	$\Delta M_{\_0.9}$ =	-29.70	kip*ft	
[Goal Seek] Moment Comparison Iteration (1.2D LC):	$\Delta M_{\_1.2} = M_{overturning}-\Phi M_{Resisting\_qu\_1.2}$	$\Delta M_{\_1.2}$ =	-29.70	kip*ft	

Bearing Pressures

*Orthogonal Bearing Pressure (0.9*D LC):*	$q_{u\_orth\_0.9}$ = MAX(Pbearing_0.9/Area + Moverturning_0.9/Z, Pbearing_0.9/Area - Moverturning_0.9/Z)	$q_{u\_orth\_0.9}$ =	2.52	ksf
*Orthogonal Bearing Pressure (1.2*D LC):*	$q_{u\_orth\_1.2}$ = MAX(Pbearing_1.2/Area + Moverturning_1.2/Z, Pbearing_1.2/Area - Moverturning_1.2/Z)	$q_{u\_orth\_1.2}$ =	3.36	ksf
Ultimate Gross Bearing Pressure:	Q_{ult} = Qult + (γ/1000) * D	Q_{ult} =	31.38	ksf
Factored Ultimate Gross Bearing Pressure:	ΦQult = φs * Qult	Qa =	23.53	ksf

Check **ΦQult = 23.53 ksf >= q_u = 3.36 ksf** **RATING: 14.26% OK**

Soil Wedges (Cohesionless Soil)

Soil (above pad) Height:	soilht = D-T	soilht =	9.00	ft
Soil (above pad & under water table) Height:	soilht_gw = MIN(soilht-gw,D-T)	soilht_gw =	0.00	ft
Soil Wedge Projection at Grade:	$Wedge_{\_proj}$ = TAN(ϕ*PI()/180)*soilht	$Wedge_{\_proj}$ =	6.30	ft
Soil Wedge Projection at Water Table:	$Wedge_{\_proj\_gw}$ = TAN(ϕ*PI()/180)*(soilht_gw)	$Wedge_{\_proj\_gw}$ =	0.00	ft

Soil Wedges (Cohesionless Soil) (0.9*D LC)

Soil	Volume (ft³)	Soil Weight (kips)	Moment Arm (ft)	Unfactored Resisting Moment (kip*ft)
(2) End Prisms (above Water Table)	0.00	0.00	6.00	0.00
(2) End Prisms (below Water Table)	0.00	0.00	0.00	0.00
(2) Partial Sides (above Water Table)	0.00	0.00	6.00	0.00
(2) Partial Sides (below Water Table)	0.00	0.00	6.00	0.00
(1) Rear (above Water Table)	0.00	0.00	8.10	0.00
(1) Rear (below Water Table)	0.00	0.00	0.00	0.00
Total	0.00	0.00		0.00

Eccentricity relative to W/2:

Total Moment Arm (ft) =	0.00
Soil Wedge Wt (kip)=	0.00

*Unfactored Resisting Moment of Wedges (0.9*D LC):* $M_{R\_wedges\_0.9}$ = Total Moment Arm * Soil Wedge Wt $M_{R\_wedges\_0.9}$ = 0.00 kip*ft

*Factored Resisting Moment of Wedges (0.9*D LC):* $\Phi M_{R\_wedges\_0.9}$ = 0.75*MR_wedges_0.9 $\Phi M_{R\_wedges\_0.9}$ = 0.00 kip*ft

Soil Wedges (Cohesionless Soil) (1.2*D LC)

Soil	Volume (ft³)	Soil Weight (kips)	Moment Arm (ft)	Unfactored Resisting Moment (kip*ft)
(2) End Prisms (above Water Table)	0.00	0.00	6.00	0.00
(2) End Prisms (below Water Table)	0.00	0.00	0.00	0.00
(2) Partial Sides (above Water Table)	0.00	0.00	6.00	0.00
(2) Partial Sides (below Water Table)	0.00	0.00	6.00	0.00
(1) Rear (above Water Table)	0.00	0.00	8.10	0.00
(1) Rear (below Water Table)	0.00	0.00	0.00	0.00
Total	0.00	0.00		0.00

Eccentricity relative to W/2:

Total Moment Arm (ft) =	0.00
Soil Wedge Wt (kip)=	0.00

*Unfactored Resisting Moment of Wedges (1.2*D LC):* $M_{R\_wedges\_1.2}$ = Total Moment Arm * Soil Wedge Wt $M_{R\_wedges\_1.2}$ = 0.00 kip*ft

*Factored Resisting Moment of Wedges (1.2*D LC):* $\Phi M_{R\_wedges\_1.2}$ = 0.75*MR_wedges_1.2 $\Phi M_{R\_wedges\_1.2}$ = 0.00 kip*ft

Soil Shear Strength (Cohesive Soil)

Soil Shear Strength (Cohesive Soil) (0.9*D LC)

Plane	Area (ft²)	Resistance (kip)	Moment Arm (ft)	Unfactored Resisting Moment (kip*ft)
Rear	0.00	0.00	6.00	0.00
(2) Partial Sides	0.00	0.00	6.00	0.00
Total		0.00		0.00

Eccentricity relative to W/2:

Total Moment Arm (ft) =	0.00
Soil Shear Strength (kip)=	0.00

*Unfactored Resisting Moment of Soil Shear (0.9*D LC):* $M_{R\_shear\_0.9}$ = Total Moment Arm * Soil Shear Strength $M_{R\_shear\_0.9}$ = 0.00 kip*ft

*Factored Resisting Moment of Soil Shear (0.9*D LC):* $\Phi M_{R\_shear\_0.9}$ = 0.75 * (Total Moment Arm * Soil Shear Strength) $\Phi M_{R\_shear\_0.9}$ = 0.00 kip*ft

Soil Shear Strength (Cohesive Soil) (1.2*D LC)

Plane	Area (ft²)	Resistance (kip)	Moment Arm (ft)	Unfactored Resisting Moment (kip*ft)
Rear	0.00	0.00	6.00	0.00
(2) Partial Sides	0.00	0.00	6.00	0.00
Total		0.00		0.00

Eccentricity relative to W/2:

Total Moment Arm (ft) =	0.00
Soil Shear Strength (kip)=	0.00

*Unfactored Resisting Moment of Soil Shear (1.2*D LC):* $M_{R\_shear\_1.2}$ = Total Moment Arm * Soil Shear Strength $M_{R\_shear\_1.2}$ = 0.00 kip*ft

*Factored Resisting Moment of Soil Shear (1.2*D LC):* $\Phi M_{R\_shear\_1.2}$ = 0.75 * (Total Moment Arm * Soil Shear Strength) $\Phi M_{R\_shear\_1.2}$ = 0.00 kip*ft

DETERMINE MOMENT THAT WOULD CAUSE 100% OVERTURNING (ORTHOGONAL)

*Compressive Load for Bearing (0.9*D LC):*	$P_{\_100}$ = P_0.9D+0.9*(Ws+Wc)+0.75*Wwedges_100	$P_{\_100}$ =	152.98	kip
Preliminary Factored Overturning Moment:	pre_$M_{overturning_100}$ = (W/2-(P_100/ΦQult)/(2*W))*(P_100)	pre_$M_{overturning_100}$ =	376.05	kip*ft
*Preliminary Load Eccentricity (0.9*D LC):*	pre_$ec_{_100}$ = pre_$M_{overturning_100}$ / $P_{\_100}$	pre_$ec_{_100}$ =	2.46	ft
*[Goal Seek] Load Eccentricity Iteration (0.9*D LC):*	$ec_{\_100}$ = *goal seek*	$ec_{\_100}$ =	2.26	ft
*Non-Bearing Length (0.9*D LC):*	$NBL_{\_100}$ = 2*ec_100	$NBL_{\_100}$ =	4.53	ft
*Total Factored Resisting Moment due to Pp and Soil Wedges / Shear (0.9*D LC):*	$\Phi M_{Resisting\_100}$ = ΦM_{R_Pp} + SUM($\Phi M_{R\_wedges\_100}$,$\Phi M_{R\_shear\_100}$)	$\Phi M_{Resisting\_100}$ =	248.59	kip*ft
Moment Created by Shear:	M_{shear} = V_u * (D+E+bp_{dist}/12)	M_{shear} =	106.13	kip*ft
*Adjusted Overturning Moment (0.9*D LC):*	$M_{overturning\_100}$ = $M_{u\_max\_100}$ - ΦM_{R_Pp}	$M_{overturning\_100}$ =	594.94	kip*ft
*Total Resistance to Overturning (0.9*D LC):*	$\Phi M_{Resisting\_qu\_100}$ = $P_{\_100}$*$ec_{\_100}$ + $\Phi M_{Resisting\_100}$	$\Phi M_{Resisting\_qu\_100}$ =	594.94	kip*ft
[Goal Seek] Moment Comparison Iteration (0.9D LC):	$\Delta M_{\_100}$ = $M_{overturning}$ - $\Phi M_{Resisting\_qu\_100}$	$\Delta M_{\_100}$ =	0.00	ft
Maximum Applied Moment from Superstructure Analysis:	$M_{u\_max\_100}$ = pre_Moverturning_100 + ΦMResisting_100	$M_{u\_max\_100}$ =	624.64	kip*ft

L/4 < e <= l

Check **Mu_max_100 = 624.64 kip*ft >= Mu = 0.00 kip*ft** **RATING: 0.00% OK**

Soil Wedges (Cohesionless Soil) (0.9*D LC)

Soil	Volume (ft³)	Soil Weight (kips)	Moment Arm (ft)	Unfactored Resisting Moment (kip*ft)
(2) End Prisms (above Water Table)	238.28	29.79	8.36	249.10
(2) End Prisms (below Water Table)	0.00	0.00	0.00	0.00
(2) Partial Sides (above Water Table)	256.82	32.10	3.74	119.93
(2) Partial Sides (below Water Table)	0.00	0.00	3.74	0.00
(1) Rear (above Water Table)	170.15	21.27	8.10	172.29
(1) Rear (below Water Table)	0.00	0.00	0.00	0.00
Total	665.26	83.16		541.32

Wedge Eccentricity relative to W/2:

Total Moment Arm (ft) =	3.51
Soil Wedge Wt (kip)=	83.16

*Unfactored Resisting Moment of Wedges (0.9*D LC):*	$M_{R\_wedges\_100}$ =	Total Moment Arm * Soil Wedge Wt	$M_{R\_wedges\_100}$ = 291.85	kip*ft
*Factored Resisting Moment of Wedges (0.9*D LC):*	$\Phi M_{R\_wedges\_100}$ =	0.75*MR_wedges_100	$\Phi M_{R\_wedges\_100}$ = 218.89	kip*ft

Soil Shear Strength (Cohesive Soil) (0.9*D LC)

Plane	Area (ft²)	Resistance (kip)	Moment Arm (ft)	Unfactored Resisting Moment (kip*ft)
Rear	34.02	0.00	6.00	0.00
(2) Partial Sides	51.35	0.00	3.74	0.00
Total		0.00		0.00

Wedge Eccentricity relative to W/2:

Total Moment Arm (ft) =	0.00
Soil Shear Strength (kip)=	0.00

*Unfactored Resisting Moment of Soil Shear (0.9*D LC):*	$M_{R\_shear\_100}$ =	Total Moment Arm * Soil Shear Strength	$M_{R\_shear\_100}$ = 0.00	kip*ft
*Factored Resisting Moment of Soil Shear (0.9*D LC):*	$\Phi M_{R\_shear\_100}$ =	0.75 * (Total Moment Arm * Soil Shear Strength)	$\Phi M_{R\_shear\_100}$ = 0.00	kip*ft

PASSIVE PRESSURE RESISTANCE (DIAGONAL DIRECTION)

Force of Pp Applied on Pier:	$Force_{pier}$ =	MIN(Vu,Sum(Pp!M2:M7))	$Force_{pier}$ = 9.00	kip
Moment Arm of Pp on Pier:	M_{arm_pier} =	D-T-Pp!O2 + T	M_{arm_pier} = 4.40	ft
Force of Pp Applied on Pad:	$Force_{pad\_dia}$ =	MIN(Vu-$Force_{pier}$,SUM(Pp!M8:M13))*(T*W*SQRT(2))/(T*W))	$Force_{pad\_dia}$ = 0.00	kip
Moment Arm of Pp on Pad:	M_{arm_pad} =	D-Pp!O8	M_{arm_pad} = 0.97	ft
Unfactored Moment Resistance due to Passive Pressure:	$M_{R\_Pp\_dia}$ =	$Force_{pier}*M_{arm\_pier}+Force_{pad}*M_{arm\_pad}$	$M_{R\_Pp\_dia}$ = 39.60	kip*ft
Factored Moment Resistance due to Passive Pressure:	$\Phi M_{R\_Pp\_dia}$ =	$\Phi_s*M_{R\_Pp}$	$\Phi M_{R\_Pp\_dia}$ = 29.70	kip*ft

PLASTIC BEARING PRESSURE & OVERTURNING MOMENT (DIAGONAL DIRECTION)

*Compressive Load for Bearing (0.9*D LC):*	$P_{bearing\_0.9\_dia}$ =	P_0.9D+0.9*(Ws+Wc)+0.75*Wwedges_0.9_bearing_dia	$P_{bearing\_0.9\_dia}$ = 90.61	kip	
*Compressive Load for Bearing (1.2*D LC):*	$P_{bearing\_1.2\_dia}$ =	P_1.2D+1.2*(Ws+Wc)+0.75*Wwedges_1.2_bearing_dia	$P_{bearing\_1.2\_dia}$ = 120.81	kip	
Factored Overturning Moment:	$M_{overturning}$ =	$M_u + V_u * (D+E+bp_{dist}/12)$	$M_{overturning}$ = 0.00	kip*ft	
Area of Pad:	Area =	W²	Area = 36.00	ft²	
Plastic Section Modulus of Pad:	$Z_{\_dia}$ =	W³ / (3*SQRT(2))	$Z_{\_dia}$ = 50.91	ft³	
*Preliminary Load Eccentricity (0.9*D LC):*	$pre\_ec_{\_0.9\_p\_dia}$ =	$M_{overturning}/P_{bearing\_0.9\_dia}$	$pre\_ec_{\_0.9\_p\_dia}$ = 0.00	ft	
*Preliminary Load Eccentricity (1.2*D LC):*	$pre\_ec_{\_1.2\_p\_dia}$ =	$M_{overturning}/P_{bearing\_1.2\_dia}$	$pre\_ec_{\_1.2\_p\_dia}$ = 0.00	ft	
*[Goal Seek] Load Eccentricity Iteration (0.9*D LC):*	$ec_{\_0.9\_p\_dia}$ =	*goal seek*	$ec_{\_0.9\_p\_dia}$ = 0.00	ft	e <= (L/4)*S
*[Goal Seek] Load Eccentricity Iteration (1.2*D LC):*	$ec_{\_1.2\_p\_dia}$ =	*goal seek*	$ec_{\_1.2\_p\_dia}$ = 0.00	ft	e <= (L/4)*S
*Non-Bearing Length (0.9*D LC):*	$NBL_{\_0.9\_dia}$ =	0	$NBL_{\_0.9\_dia}$ = 0.00	ft	
*Non-Bearing Length (1.2*D LC):*	$NBL_{\_1.2\_dia}$ =	0	$NBL_{\_1.2\_dia}$ = 0.00	ft	
*Total Factored Resisting Moment due to Pp and Soil Wedges / Shear (0.9*D LC):*	$\Phi M_{Resisting\_0.9}$ =	$\Phi M_{R\_Pp\_dia}$ + SUM($\Phi M_{R\_wedges\_0.9\_dia}$,$\Phi M_{R\_shear\_0.9\_dia}$)	$\Phi M_{Resisting\_0.9\_dia}$ = 29.70	kip*ft	
*Total Factored Resisting Moment due to Pp and Soil Wedges / Shear (1.2*D LC):*	$\Phi M_{Resisting\_1.2}$ =	$\Phi M_{R\_Pp\_dia}$ + SUM($\Phi M_{R\_wedges\_1.2\_dia}$,$\Phi M_{R\_shear\_1.2\_dia}$)	$\Phi M_{Resisting\_1.2\_dia}$ = 29.70	kip*ft	
*Adjusted Overturning Moment (0.9*D LC):*	$M_{overturning\_0.9\_dia}$ =	$M_{overturning} - \Phi M_{Resisting\_0.9\_dia}$	$M_{overturning\_0.9\_dia}$ = 0.00	kip*ft	
*Adjusted Overturning Moment (1.2*D LC):*	$M_{overturning\_1.2\_dia}$ =	$M_{overturning} - \Phi M_{Resisting\_1.2\_dia}$	$M_{overturning\_1.2\_dia}$ = 0.00	kip*ft	
*Total Resistance to Overturning (0.9*D LC):*	$\Phi M_{Resisting\_qu\_0.9\_dia}$ =	$P_{bearing\_0.9\_dia}*ec_{\_0.9\_p\_dia} + \Phi M_{Resisting\_0.9\_dia}$	$\Phi M_{Resisting\_qu\_0.9\_dia}$ = 29.70	kip*ft	
*Total Resistance to Overturning (1.2*D LC):*	$\Phi M_{Resisting\_qu\_1.2\_dia}$ =	$P_{bearing\_1.2\_dia}*ec_{\_1.2\_p\_dia} + \Phi M_{Resisting\_1.2\_dia}$	$\Phi M_{Resisting\_qu\_1.2\_dia}$ = 29.70	kip*ft	
[Goal Seek] Moment Comparison Iteration (0.9D LC):	$\Delta M_{\_0.9\_dia}$ =	$M_{overturning}-\Phi M_{Resisting\_qu\_0.9\_dia}$	$\Delta M_{\_0.9\_dia}$ = -29.70	kip*ft	
[Goal Seek] Moment Comparison Iteration (1.2D LC):	$\Delta M_{\_1.2\_dia}$ =	$M_{overturning}-\Phi M_{Resisting\_qu\_1.2\_dia}$	$\Delta M_{\_1.2\_dia}$ = -29.70	kip*ft	

Bearing Pressures

*Diagonal Bearing Pressure (0.9*D LC):*	$q_{u\_dia\_0.9}$ = Pbearing_0.9_dia/Area + Moverturning_0.9_dia / Z_dia	$q_{u\_dia\_0.9}$ = 2.52 ksf
*Diagonal Bearing Pressure (1.2*D LC):*	$q_{u\_dia\_1.2}$ = Pbearing_1.2_dia/Area + Moverturning_1.2_dia / Z_dia	$q_{u\_dia\_1.2}$ = 3.36 ksf
Ultimate Gross Bearing Pressure:	Q_{ult} = Qult + (γ/1000) * D	Q_{ult} = 31.38 ksf
Factored Ultimate Gross Bearing Pressure:	ΦQult = φs * Qult	Qa = 23.53 ksf

Check **ΦQult = 23.53 ksf >= q_u = 3.36 ksf** **RATING: 14.26% OK**

Soil Wedges (Cohesionless Soil)

Soil (above pad) Height:	soilht = D-T	soilht = 9.00 ft
Soil (above pad & under water table) Height:	soilht_gw = MIN(soilht-gw,D-T)	soilht_gw = 0.00 ft
Soil Wedge Projection at Grade:	$Wedge_{\_proj}$ = TAN(ϕ*PI()/180)*soilht	$Wedge_{\_proj}$ = 6.30 ft
Soil Wedge Projection at Water Table:	$Wedge_{\_proj\_gw}$ = TAN(ϕ*PI()/180)*(soilht_gw)	$Wedge_{\_proj\_gw}$ = 0.00 ft

Soil Wedges (Cohesionless Soil) (0.9*D LC)

Soil	Volume (ft³)	Soil Weight (kips)	Moment Arm (ft)	Unfactored Resisting Moment (kip*ft)
(2) End Prisms (above Water Table)	0.00	0.00	0.00	0.00
(2) End Prisms (below Water Table)	0.00	0.00	0.00	0.00
(1) End Prism (above Water Table)	0.00	0.00	0.00	0.00
(1) End Prisms (below Water Table)	0.00	0.00	0.00	0.00
(2) Partial Sides (above Water Table)	0.00	0.00	3.13	0.00
(2) Partial Sides (below Water Table)	0.00	0.00	0.00	0.00
(2) Rear (above Water Table)	0.00	0.00	7.48	0.00
(2) Rear (below Water Table)	0.00	0.00	0.00	0.00
Total	0.00	0.00		0.00

Eccentricity relative to W/2*SQRT(2):

Total Moment Arm (ft) =	0.00
Soil Wedge Wt (kip)=	0.00

*Unfactored Resisting Moment of Wedges (0.9*D LC):*	$M_{R\_wedges\_0.9}$ = Total Moment Arm * Soil Wedge Wt	$M_{R\_wedges\_0.9\_dia}$ = 0.00 kip*ft
*Factored Resisting Moment of Wedges (0.9*D LC):*	$ΦM_{R\_wedges\_0.9}$ = 0.75*MR_wedges_0.9_dia	$ΦM_{R\_wedges\_0.9\_dia}$ = 0.00 kip*ft

Soil Wedges (Cohesionless Soil) (1.2*D LC)

Soil	Volume (ft³)	Soil Weight (kips)	Moment Arm (ft)	Unfactored Resisting Moment (kip*ft)
(2) End Prisms (above Water Table)	0.00	0.00	0.00	0.00
(2) End Prisms (below Water Table)	0.00	0.00	0.00	0.00
(1) End Prism (above Water Table)	0.00	0.00	0.00	0.00
(1) End Prisms (below Water Table)	0.00	0.00	0.00	0.00
(2) Partial Sides (above Water Table)	0.00	0.00	3.13	0.00
(2) Partial Sides (below Water Table)	0.00	0.00	0.00	0.00
(2) Rear (above Water Table)	0.00	0.00	7.48	0.00
(2) Rear (below Water Table)	0.00	0.00	0.00	0.00
Total	0.00	0.00		0.00

Eccentricity relative to W/2*SQRT(2):

Total Moment Arm (ft) =	0.00
Soil Wedge Wt (kip)=	0.00

*Unfactored Resisting Moment of Wedges (1.2*D LC):*	$M_{R\_wedges\_1.2}$ = Total Moment Arm * Soil Wedge Wt	$M_{R\_wedges\_1.2\_dia}$ = 0.00 kip*ft
*Factored Resisting Moment of Wedges (1.2*D LC):*	$ΦM_{R\_wedges\_1.2}$ = 0.75*MR_wedges_1.2_dia	$ΦM_{R\_wedges\_1.2\_dia}$ = 0.00 kip*ft

Soil Shear Strength (Cohesive Soil)

Soil Shear Strength (Cohesive Soil) (0.9*D LC)

Plane	Area (ft²)	Resistance (kip)	Moment Arm (ft)	Unfactored Resisting Moment (kip*ft)
(2) Rear	0.00	0.00	6.36	0.00
(2) Partial Sides	0.00	0.00	4.24	0.00
Total		0.00		0.00

Eccentricity relative to W/2*SQRT(2):

Total Moment Arm (ft) =	0.00
Soil Shear Strength (kip)=	0.00

*Unfactored Resisting Moment of Soil Shear (0.9*D LC):*	$M_{R\_shear\_0.9}$ = Total Moment Arm * Soil Shear Strength	$M_{R\_shear\_0.9\_dia}$ = 0.00 kip*ft
*Factored Resisting Moment of Soil Shear (0.9*D LC):*	$ΦM_{R\_shear\_0.9}$ = 0.75 * (Total Moment Arm * Soil Shear Strength)	$ΦM_{R\_shear\_0.9\_dia}$ = 0.00 kip*ft

Soil Shear Strength (Cohesive Soil) (1.2*D LC)

Plane	Area (ft²)	Resistance (kip)	Moment Arm (ft)	Unfactored Resisting Moment (kip*ft)
(2) Rear	0.00	0.00	6.36	0.00
(2) Partial Sides	0.00	0.00	4.24	0.00
Total		0.00		0.00

Eccentricity relative to W/2*SQRT(2):

Total Moment Arm (ft) =	0.00
Soil Shear Strength (kip)=	0.00

*Unfactored Resisting Moment of Soil Shear (1.2*D LC):*	$M_{R\_shear\_1.2}$ = Total Moment Arm * Soil Shear Strength	$M_{R\_shear\_1.2\_dia}$ = 0.00 kip*ft
*Factored Resisting Moment of Soil Shear (1.2*D LC):*	$ΦM_{R\_shear\_1.2}$ = 0.75 * (Total Moment Arm * Soil Shear Strength)	$ΦM_{R\_shear\_1.2\_dia}$ = 0.00 kip*ft

DETERMINE MOMENT THAT WOULD CAUSE 100% OVERTURNING (DIAGONAL)

*Compressive Load for Bearing (0.9*D LC):*	$P_{\_100\_dia}$ = P_0.9D+0.9*(Ws+Wc)+0.75*Wwedges_100_dia	$P_{\_100\_dia}$ =	90.61	kip
Preliminary Factored Overturning Moment:	pre_$M_{overturning_100_dia}$ = (P_100_dia/(SQRT(2)))*(W-SQRT(P_100_dia/ΦQult))	pre_$M_{overturning_100_dia}$ =	258.69	kip*ft
*Preliminary Load Eccentricity (0.9*D LC):*	pre_$ec_{_100_dia}$ = pre_$M_{overturning_100_dia}$ / $P_{bearing\_0.9}$	pre_$ec_{_100_dia}$ =	2.86	ft
*[Goal Seek] Load Eccentricity Iteration (0.9*D LC):*	$ec_{\_100\_dia}$ = *goal seek*	$ec_{\_100\_dia}$ =	2.53	ft (L/4)*SQRT
*Non-Bearing Length (0.9*D LC):*	$NBL_{\_100\_dia}$ = 0	$NBL_{\_100\_dia}$ =	0.00	ft
*Total Factored Resisting Moment due to Pp and Soil Wedges / Shear (0.9*D LC):*	$\Phi M_{Resisting\_100\_dia}$ = $\Phi M_{R\_Pp\_dia}$ + SUM($\Phi M_{R\_wedges\_100\_dia}$,$\Phi M_{R\_shear\_100\_dia}$)	$\Phi M_{Resisting\_100\_dia}$ =	29.70	kip*ft
Moment Created by Shear:	M_{shear} = V_u * (D+E+bp_{dist}/12)	M_{shear} =	106.13	kip*ft
*Adjusted Overturning Moment (0.9*D LC):*	$M_{overturning\_100\_dia}$ = $M_{u\_max\_100\_dia}$ - $\Phi M_{R\_Pp\_dia}$	$M_{overturning\_100\_dia}$ =	258.69	kip*ft
*Total Resistance to Overturning (0.9*D LC):*	$\Phi M_{Resisting\_qu\_100\_dia}$ = $P_{bearing\_0.9}$*$ec_{\_100\_dia}$ + $\Phi M_{Resisting\_100\_dia}$	$\Phi M_{Resisting\_qu\_100\_dia}$ =	258.69	kip*ft
[Goal Seek] Moment Comparison Iteration (0.9D LC):	$\Delta M_{\_100\_dia}$ = $M_{overturning}$ - $\Phi M_{Resisting\_qu\_100\_dia}$	$\Delta M_{\_100\_dia}$ =	0.00	ft
Maximum Applied Moment from Superstructure Analysis:	$M_{u\_max\_100\_dia}$ = pre_Moverturning_100_dia + ΦMResisting_100_dia	$M_{u\_max\_100\_dia}$ =	288.40	kip*ft

Check **Mu_max_100_dia = 288.40 kip*ft >= Mu = 0.00 kip*ft** **RATING: 0.00% OK**

Soil Wedges (Cohesionless Soil) (0.9*D LC)

Soil	Volume (ft³)	Soil Weight (kips)	Moment Arm (ft)	Unfactored Resisting Moment (kip*ft)
(2) End Prisms (above Water Table)	0.00	0.00	0.00	0.00
(2) End Prisms (below Water Table)	0.00	0.00	0.00	0.00
(1) End Prism (above Water Table)	0.00	0.00	0.00	0.00
(1) End Prisms (below Water Table)	0.00	0.00	0.00	0.00
(2) Partial Sides (above Water Table)	0.00	0.00	3.13	0.00
(2) Partial Sides (below Water Table)	0.00	0.00	0.00	0.00
(2) Rear (above Water Table)	0.00	0.00	7.48	0.00
(2) Rear (below Water Table)	0.00	0.00	0.00	0.00
Total	0.00	0.00		0.00

Eccentricity relative to W/2*SQRT(2):

Total Moment Arm (ft) =	0.00
Soil Wedge Wt (kip)=	0.00

*Unfactored Resisting Moment of Wedges (0.9*D LC):*	$M_{R\_wedges\_100\_dia}$ = Total Moment Arm * Soil Wedge Wt	$M_{R\_wedges\_100\_dia}$ =	0.00	kip*ft
*Factored Resisting Moment of Wedges (0.9*D LC):*	$\Phi M_{R\_wedges\_100\_dia}$ = 0.75*MR_wedges_100_dia	$\Phi M_{R\_wedges\_100\_dia}$ =	0.00	kip*ft

Soil Shear Strength (Cohesive Soil) (0.9*D LC)

Plane	Area (ft²)	Resistance (kip)	Moment Arm (ft)	Unfactored Resisting Moment (kip*ft)
(2) Rear	0.00	0.00	6.36	0.00
(2) Partial Sides	0.00	0.00	4.24	0.00
Total		0.00		0.00

Eccentricity relative to W/2*SQRT(2):

Total Moment Arm (ft) =	0.00
Soil Shear Strength (kip)=	0.00

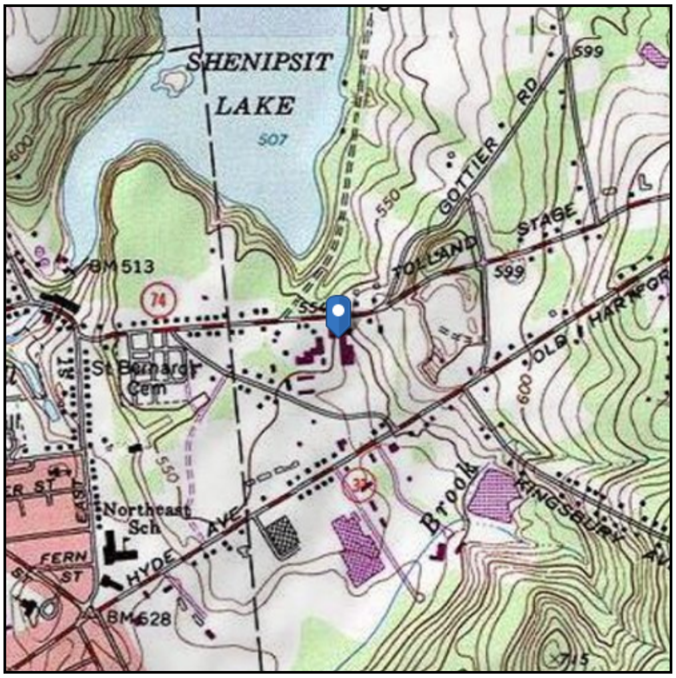
*Unfactored Resisting Moment of Soil Shear (0.9*D LC):*	$M_{R\_shear\_100\_dia}$ = Total Moment Arm * Soil Shear Strength	$M_{R\_shear\_100\_dia}$ =	0.00	kip*ft
*Factored Resisting Moment of Soil Shear (0.9*D LC):*	$\Phi M_{R\_shear\_100\_dia}$ = 0.75 * (Total Moment Arm * Soil Shear Strength)	$\Phi M_{R\_shear\_100\_dia}$ =	0.00	kip*ft

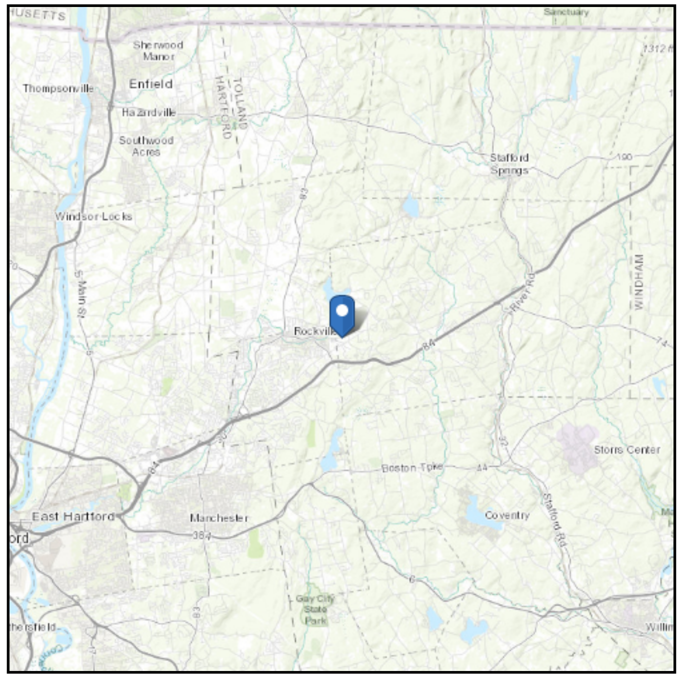
ASCE 7 Hazards Report

Address:
No Address at This Location

Standard: ASCE/SEI 7-10
Risk Category: III
Soil Class: D - Stiff Soil

Elevation: 546.92 ft (NAVD 88)
Latitude: 41.86699
Longitude: -72.42307





Wind

Results:

Wind Speed:	135 ~~134~~ Vmph
10-year MRI	77 Vmph
25-year MRI	87 Vmph
50-year MRI	94 Vmph
100-year MRI	101 Vmph

Data Source: ASCE/SEI 7-10, Fig. 26.5-1B and Figs. CC-1–CC-4, incorporating errata of March 12, 2014

Date Accessed: Thu Apr 02 2020

Value provided is 3-second gust wind speeds at 33 ft above ground for Exposure C Category, based on linear interpolation between contours. Wind speeds are interpolated in accordance with the 7-10 Standard. Wind speeds correspond to approximately a 3% probability of exceedance in 50 years (annual exceedance probability = 0.000588, MRI = 1,700 years).

Site is in a hurricane-prone region as defined in ASCE/SEI 7-10 Section 26.2. Glazed openings need not be protected against wind-borne debris.

Mountainous terrain, gorges, ocean promontories, and special wind regions should be examined for unusual wind conditions.

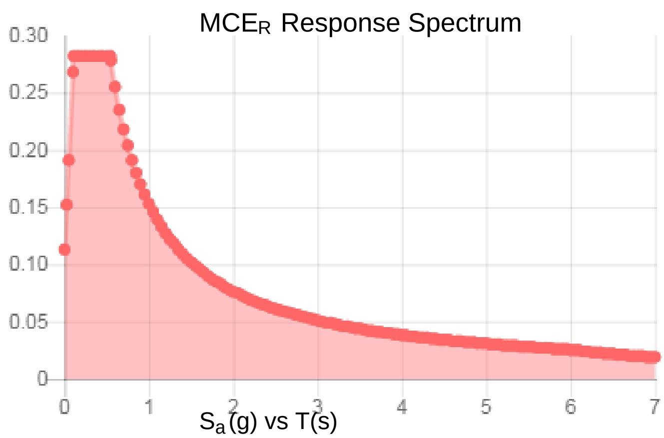
Seismic

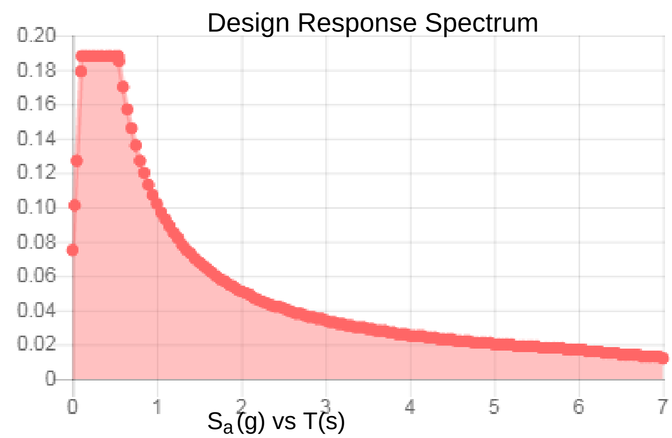
Site Soil Class: D - Stiff Soil

Results:

S_S :	0.176	S_{DS} :	0.188
S_1 :	0.064	S_{D1} :	0.102
F_a :	1.6	T_L :	6
F_v :	2.4	PGA :	0.087
S_{MS} :	0.282	PGA_M :	0.14
S_{M1} :	0.153	F_{PGA} :	1.6
		I_e :	1.25

Seismic Design Category B





Data Accessed: Thu Apr 02 2020

Date Source: USGS Seismic Design Maps based on ASCE/SEI 7-10, incorporating Supplement 1 and errata of March 31, 2013, and ASCE/SEI 7-10 Table 1.5-2. Additional data for site-specific ground motion procedures in accordance with ASCE/SEI 7-10 Ch. 21 are available from USGS.

AMERICAN SOCIETY OF CIVIL ENGINEERS

Ice

Results:

Ice Thickness:	1.00 in.
Concurrent Temperature:	5 F
Gust Speed:	50 mph
Data Source:	Standard ASCE/SEI 7-10, Figs. 10-2 through 10-8
Date Accessed:	Thu Apr 02 2020

Ice thicknesses on structures in exposed locations at elevations higher than the surrounding terrain and in valleys and gorges may exceed the mapped values.

Values provided are equivalent radial ice thicknesses due to freezing rain with concurrent 3-second gust speeds, for a 50-year mean recurrence interval, and temperatures concurrent with ice thicknesses due to freezing rain. Thicknesses for ice accretions caused by other sources shall be obtained from local meteorological studies. Ice thicknesses in exposed locations at elevations higher than the surrounding terrain and in valleys and gorges may exceed the mapped values.

ATTACHMENT D – PROOF OF DELIVERY OF NOTICE

Ref: ES-043 TOLLAND Date: 21Oct20 SHIPPING: 0.00
Dep: BL GRAPHICS Wgt: 0.95 LBS SPECIAL: 0.00
HANDLING: 0.00
DV: 0.00 TOTAL: 0.00

Svcs: PRIORITY OVERNIGHT
TRCK: 9151 3346 5879

ORIGIN ID:RSPA (800) 301-3077

BL COMPANIES
355 RESEARCH PARKWAY

MERIDEN, CT 06450
UNITED STATES US

SHIP DATE: 21OCT20
ACTWGT: 0.95 LB MAN
CAD: 0765627/CAFE3407

BILL THIRD PARTY

TO

CONNECTICUT SITING COUNCIL
10 FRANKLIN SQUARE

NEW BRITAIN CT 06051
REF: ES-043 TOLLAND
DEPT: BL GRAPHICS

56DC2/A27E/05A2

FedEx
Express

E

J201019110601uv

THU - 22 OCT 10:30A
PRIORITY OVERNIGHT

TRK# 0201 **9151 3346 5879**

00 BDLA

06051
CT-US **BDL**

Part # 156148-434 RIT EXP 09/21

Ref: ES-043 TOLLAND
Dep: BL GRAPHICS

Date: 21Oct20
Wgt: 0.95 LBS

DV: 0.00

SHIPPING:	0.00
SPECIAL:	0.00
HANDLING:	0.00
TOTAL:	0.00

Svcs: PRIORITY OVERNIGHT
TRCK: 9151 3346 5868

ORIGIN ID:RSPA (800) 301-3077

BL COMPANIES
355 RESEARCH PARKWAY

MERIDEN, CT 06450
UNITED STATES US

SHIP DATE: 21OCT20
ACTWGT: 0.95 LB MAN
CAD: 0765627/CAFE3407

BILL THIRD PARTY

56DC2/A27E/05A2

TO **HEIDI SAMOKAR, AICP**
TOWN OF TOLLAND
21 TOLLAND GREEN

TOLLAND CT 06084

REF: ES-043 TOLLAND

DEPT: BL GRAPHICS

FedEx
Express

E

J201019110601uv

THU - 22 OCT 10:30A
PRIORITY OVERNIGHT

TRK# 0201 **9151 3346 5868**

00 QCWA

06084
CT-US **BDL**

Part # 156148-434 RIT EXP 09/21

Ref: ES-043 TOLLAND
Dep: BL GRAPHICS

Date: 21Oct20
Wgt: 0.95 LBS
DV: 0.00

SHIPPING:	0.00
SPECIAL:	0.00
HANDLING:	0.00
TOTAL:	0.00

Svcs: PRIORITY OVERNIGHT
TRCK: 9151 3346 5857

ORIGIN ID:RSPA (800) 301-3077

BL COMPANIES
355 RESEARCH PARKWAY

MERIDEN, CT 06450
UNITED STATES US

SHIP DATE: 21OCT20
ACTWGT: 0.95 LB MAN
CAD: 0765627/CAFE3407

BILL THIRD PARTY

TO **MICHAEL ROSEN, TOWN MANAGER**
TOWN OF TOLLAND
21 TOLLAND GREEN

TOLLAND CT 06084

REF: ES-043 TOLLAND
DEPT: BL GRAPHICS

56DC2/A27E/05A2

FedEx Express

E

J201019110601uv

THU - 22 OCT 10:30A
PRIORITY OVERNIGHT

TRK# 0201 **9151 3346 5857**

00 QCWA

06084
CT-US **BDL**

Part # 156148-434 RIT EXP 09/21

Ref: ES-043 TOLLAND Date: 21Oct20 SHIPPING: 0.00
Dep: BL GRAPHICS Wgt: 0.95 LBS SPECIAL: 0.00
HANDLING: 0.00
DV: 0.00 TOTAL: 0.00

Svcs: PRIORITY OVERNIGHT
TRCK: 9151 3346 5846

ORIGIN ID:RSPA (800) 301-3077
BL COMPANIES
355 RESEARCH PARKWAY
MERIDEN, CT 06450
UNITED STATES US

SHIP DATE: 21OCT20
ACTWGT: 0.95 LB
CAD: 0765627/CAFE3407

BILL THIRD PARTY

56DC2/A27E/05A2

TO **TAMMY NUCIO, TOWN COUNCIL CHAIR**
TOWN OF TOLLAND
21 TOLLAND GREEN

TOLLAND CT 06084

REF: ES-043 TOLLAND

DEPT: BL GRAPHICS

FedEx Express

E

J201019110601uv

THU – 22 OCT 10:30A
PRIORITY OVERNIGHT

TRK# 0201 **9151 3346 5846**

00 QCWA

06084
CT-US **BDL**

Part # 156148-434 RIT EXP 09/21

ATTACHMENT E - POWER DENSITY REPORT

C Squared Systems, LLC
65 Dartmouth Drive
Auburn, NH 03032
603-644-2800
support@csquaredsystems.com

Calculated Radio Frequency Emissions Report

ES-043

48 Tolland Stage Road

Tolland, CT 06084

August 31, 2020

Table of Contents

List of Tables

List of Figures

1. Introduction

The purpose of this report is to investigate compliance with applicable FCC regulations for the proposed Eversource installation on the lattice tower at 48 Tolland Stage Road in Tolland, CT. Eversource is proposing to install one omnidirectional antenna as part of its 220 MHz communications system, and one transmit-only dipole for its low band communications system.

This report considers the proposed antenna configuration as detailed by Eversource along with % MPE (Maximum Permissible Exposure) measurements around the existing tower to determine FCC compliance of the facility.

Figure 1: View of ES-043 Tolland

Site Address	48 Tolland Stage Road
Latitude	41° 52' 1.2" N
Longitude	72° 25' 23.1" W
Site Elevation AMSL	557’
Survey Engineer	Marc Salas
Survey Date/Time	6/16/2020; 2:00 PM – 3:00 PM

Table 1: Survey Information

2. FCC Guidelines for Evaluating RF Radiation Exposure Limits

In 1985, the FCC established rules to regulate radio frequency (RF) exposure from FCC licensed antenna facilities. In 1996, the FCC updated these rules, which were further amended in August 1997 by OET Bulletin 65 Edition 97-01. These new rules include Maximum Permissible Exposure (MPE) limits for transmitters operating between 300 kHz and 100 GHz. The FCC MPE limits are based upon those recommended by the National Council on Radiation Protection and Measurements (NCRP), developed by the Institute of Electrical and Electronics Engineers, Inc., (IEEE) and adopted by the American National Standards Institute (ANSI).

The FCC general population/uncontrolled limits set the maximum exposure to which most people may be subjected. General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or cannot exercise control over their exposure.

Public exposure to radio frequencies is regulated and enforced in units of milliwatts per square centimeter (mW/cm^2). The general population exposure limits for the various frequency ranges are defined in the attached "FCC Limits for Maximum Permissible Exposure (MPE)" in Attachment B of this report.

Higher exposure limits are permitted under the occupational/controlled exposure category, but only for persons who are exposed as a consequence of their employment and who have been made fully aware of the potential for exposure, and they must be able to exercise control over their exposure. General population/uncontrolled limits are five times more stringent than the levels that are acceptable for occupational, or radio frequency trained individuals. Attachment B contains excerpts from OET Bulletin 65 and defines the Maximum Exposure Limit.

Finally, it should be noted that the MPE limits adopted by the FCC for both general population/uncontrolled exposure and for occupational/controlled exposure incorporate a substantial margin of safety and have been established to be well below levels generally accepted as having the potential to cause adverse health effects.

4. Power Density Calculation Methods

The power density calculation results were generated using the following formula as outlined in FCC bulletin OET 65, and Connecticut Siting Council recommendations:

$$\text{Power Density} = \left(\frac{1.6^2 \times 1.64 \times \text{ERP}}{4\pi \times R^2}\right) \text{X Off Beam Loss}$$

Where:

EIRP = Effective Isotropic Radiated Power = 1.64 x ERP

R = Radial Distance = $\sqrt{(H^2 + V^2)}$

H = Horizontal Distance from antenna

V = Vertical Distance from radiation center of antenna

Ground reflection factor of 1.6

Off Beam Loss is determined by the selected antenna pattern

These calculations assume that the antennas are operating at 100 percent capacity and full power, and that all antenna channels are transmitting simultaneously. Obstructions (trees, buildings, etc.) that would normally attenuate the signal are not taken into account. The calculations assume even terrain in the area of study and do not consider actual terrain elevations which could attenuate the signal. As a result, the calculated power density and corresponding % MPE levels reported below are much higher than the actual levels will be from the final installation.

5. Proposed Antenna Configuration

Table 2 below lists the technical details of the proposed Eversource installation. These parameters are applied to the above calculation methods in order to calculate the % MPE values of the proposed equipment.

Operator	Antenna Model	TX Freq. (MHz)	Ant Gain (dBd)	Power ERP (Watts)	Number of Channels	Vertical Beamwidth	Length (ft)	Antenna Centerline Height (ft)
Eversource	dBSpectra DS2C00F36D	217	0	124	4	60°	12.6	95
Eversource	Comprod 531-70	37.74	2.95	197	1	360°	15.7	70

Table 2: Eversource Antenna Configuration (Proposed) [1] [2]

[1] Transmit power assumes 0 dB of cable loss.

[2] Transmit antenna height listed for the proposed 217 MHz antenna is conservatively based on the Black & Veatch Structural Analysis Report dated July 31, 2020 and the overall mechanical length of the antenna. The proposed antenna consists of two internally stacked antennas – upper is for receive, lower is for transmit. In cases where the digital antenna pattern is unavailable, a similar antenna pattern was substituted in the calculations.

6. Measurement Procedure

Frequencies from 300 KHz to 50 GHz were measured using the Narda Probe EA 5091, E-Field, shaped, FCC probe in conjunction with the NBM550 survey meter. The EA 5091 probe is "shaped" such that in a mixed signal environment (i.e.: more than one frequency band is used in a particular location), it accurately measures the percent of MPE.

From FCC OET Bulletin No. 65 - Edition 97-01 – "A useful characteristic of broadband probes used in multiple-frequency RF environments is a frequency-dependent response that corresponds to the variation in MPE limits with frequency. Broadband probes having such a "shaped" response permit direct assessment of compliance at sites where RF fields result from antennas transmitting over a wide range of frequencies. Such probes can express the composite RF field as a percentage of the applicable MPEs".

Probe Description - As suggested in FCC OET Bulletin No. 65 - Edition 97-01, the response of the measurement instrument should be essentially isotropic, (i.e., independent of orientation or rotation angle of the probe). For this reason, the Narda EA 5091 probe was used for these measurements.

Sampling Description - At each measurement location, a spatially averaged measurement is collected over the height of an average human body. The NBM550 survey meter performs a time average measurement while the user slowly moves the probe over a distance range of 20 cm to 200 cm (about 6 feet) above ground level. The results recorded at each measurement location include average values over the spatial distance.

Instrumentation Information - A summary of specifications for the equipment used is provided in the table below.

<table>
<tr><td>Manufacturer</td><td colspan="4">Narda Microwave</td></tr>
<tr><td>Probe</td><td colspan="4">EA 5091, Serial# 0116</td></tr>
<tr><td>Calibration Date</td><td colspan="4">May 2020</td></tr>
<tr><td>Calibration Interval</td><td colspan="4">24 Months</td></tr>
<tr><td>Meter</td><td colspan="4">NBM550, Serial# E-1069</td></tr>
<tr><td>Calibration Date</td><td colspan="4">May 2020</td></tr>
<tr><td>Calibration Interval</td><td colspan="4">24 Months</td></tr>
<tr><td rowspan="2">Probe Specifications</td><td>Frequency Range</td><td>Field Measured</td><td>Standard</td><td>Measurement Range</td></tr>
<tr><td>300 KHz-50 GHz</td><td>Electric Field</td><td>U.S. FCC 1997 Occupational/Controlled</td><td>0.2 – 600 % of Standard</td></tr>
</table>

Table 3: Instrumentation Information

Instrument Measurement Uncertainty - The total measurement uncertainty of the NARDA measurement probe and meter is no greater than ±3 dB (0.5% to 6%), ±1 dB (6% to 100%), ±2 dB (100% to 600%). The factors which contribute to this include the probe's frequency response deviation, calibration uncertainty, ellipse ratio, and isotropic response[3]. Every effort is taken to reduce the overall uncertainty during measurement collection including pointing the probe directly at the likely highest source of emissions.

[3] For further details, please refer to Narda Safety Test Solutions NBM550 Probe Specifications, pg. 64
http://www.narda-sts.us/pdf_files/DataSheets/NBM-Probes_DataSheet.pdf

7. Surveyed and Calculated % MPE Results

Measured and calculated results and a description of each survey location are detailed in the table below. Measurements were recorded on June 16, 2020 between 2:00 PM and 3:00 PM. The calculated % MPE contribution from the proposed equipment modifications was then added to the measured % MPE values in the "Composite % MPE" column. These calculated values incorporate the antenna pattern of the antenna model specified by Eversource to determine the "Off Beam Loss" factor shown in the power density formula from Section 4. All % MPE values are in reference to the FCC Uncontrolled/General Population exposure limit.

Table 4 below lists 22 measurements recorded in the vicinity of the tower. The highest spatially averaged measurement was 9.23% (Average Uncontrolled/General Population MPE) and was recorded at Location 20 in the parking area to the southeast of the tower compound. The highest composite (measured + calculated) % MPE value is calculated to be 11.19% (Average Uncontrolled/General Population) at Location 15 (northwest of tower, driveway to security gate).

Meas. Location	Location Description	Latitude	Longitude	Dist. From Site (feet)	Ave % Controlled/ Occupational	Measured % MPE (Uncontrolled/ General)	Calculated % MPE (Eversource Proposed)	Composite % MPE (Uncontrolled/ General)
1	Base of the tower	41.8670	-72.4231	14	0.3743	1.87%	1.00%	2.87%
2	East side of tower	41.8670	-72.4233	51	0.377	1.89%	6.33%	8.22%
3	Inside security gate	41.8669	-72.4234	103	0.3677	1.84%	6.15%	7.99%
4	SW of tower	41.8669	-72.4231	30	0.5183	2.59%	2.92%	5.51%
5	South of tower	41.8668	-72.4231	60	0.5555	2.78%	6.40%	9.18%
6	South of tower (parking lot)	41.8667	-72.4231	122	0.427	2.14%	4.80%	6.94%
7	SW of tower (parking lot)	41.8667	-72.4234	151	0.3696	1.85%	3.85%	5.70%
8	SW of tower	41.8668	-72.4234	116	0.4198	2.10%	5.38%	7.48%
9	SW of tower	41.8669	-72.4233	70	0.3509	1.75%	7.26%	9.01%
10	SW of tower (parking lot)	41.8664	-72.4234	236	0.6203	3.10%	1.81%	4.91%
11	SW of tower (parking lot)	41.8660	-72.4234	375	0.5552	2.78%	0.72%	3.50%
12	SW corner of gated area	41.8658	-72.4234	463	0.5045	2.52%	0.47%	2.99%
13	South end of gated area	41.8658	-72.4228	458	0.6751	3.38%	0.48%	3.86%
14	Southeast of gated area	41.8661	-72.4229	334	0.8564	4.28%	0.91%	5.19%
15	**Northwest of tower (driveway)**	**41.8672**	**-72.4235**	**128**	**1.261**	**6.31%**	**4.88%**	**11.19%**
16	Northeast of tower (front parking area)	41.8674	-72.4229	138	1.12	5.59%	4.44%	10.03%
17	Northeast of tower (eastern parking area)	41.8673	-72.4224	213	1.32	6.62%	2.24%	8.86%
18	Southeast of tower (eastern parking area)	41.8668	-72.4223	226	1.71	8.55%	1.95%	10.50%
19	Southeast of tower (south east parking area)	41.8665	-72.4220	341	1.78	8.92%	0.87%	9.79%
20	**Southeast of tower (south east parking area)**	**41.8663**	**-72.4217**	**459**	**1.85**	**9.23%**	**0.48%**	**9.70%**
21	Southeast of tower (East parking area driveway)	41.8660	-72.4218	498	1.80	9.02%	0.40%	9.42%
22	Northwest of tower (Fire Protection LLC parking lot)	41.8673	-72.4240	278	1.74	8.70%	1.32%	10.02%

Table 4: Measured and Calculated % MPE Results [4]

[4] Due to measurement uncertainty at low levels (See Table 3), any readings outside the measurement range of the probe (< 1.00 % FCC General Population/Uncontrolled MPE) are noted as such.

Figures 2 and 3 below are aerial views[5] of the tower location and the surrounding area, along with the measurement locations listed in Table 4.

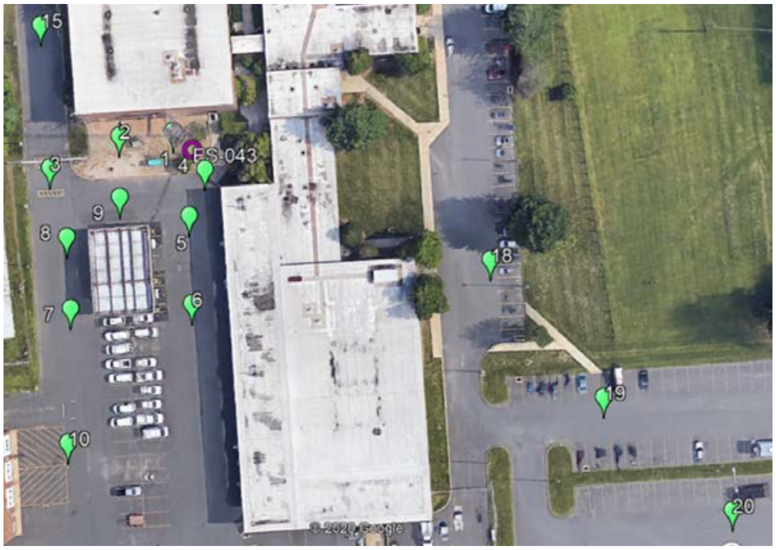


Figure 2: Measurement Points – Zoom In

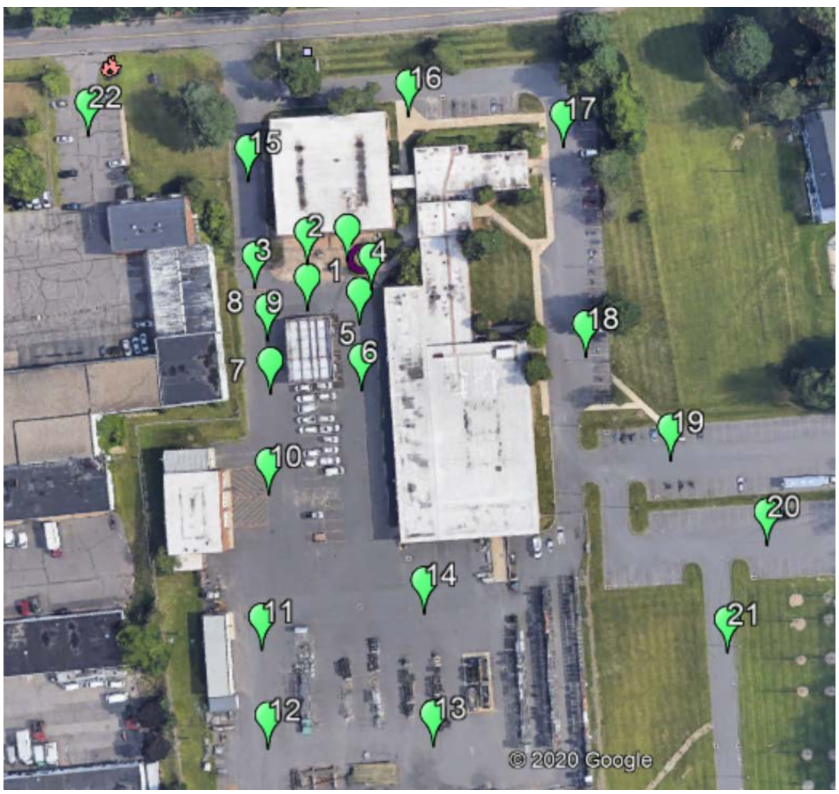


Figure 3: All Measurement Points

[5] Map showing location of telecommunications facility and the surrounding area. *Google Earth*, https://earth.google.com/web/.

8. Conclusion

A number of publicly accessible areas around the tower at 48 Tolland Stage Road in Tolland, CT were surveyed and found to be well within the mandated General Population/Uncontrolled limits for Maximum Permissible Exposure, as delineated in the Federal Communications Commission's Radio Frequency exposure rules published in 47 CFR 1.1307(b)(1)-(b)(3).

The highest spatially averaged % MPE measurement of all surveyed points based on the 1997 FCC standard for exposure to the general population is 9.23% MPE. This measurement was recorded at Location 20 in the parking area to the southeast of the tower.

The highest composite (measured + calculated) power density is **11.19% of the FCC General Population MPE limit** with the proposed Eversource equipment is calculated to occur at Location 15, along the entranceway towards the security gate.

The above analysis concludes that RF exposure at ground level around the tower, both currently and with the proposed antenna installation, will be below the maximum power density limits as outlined by the FCC in the OET Bulletin 65 Ed. 97-01.

As noted previously, the calculated % MPE levels are more conservative (higher) than the actual levels will be from the finished installation.

9. Statement of Certification

I certify to the best of my knowledge that the statements in this report are true and accurate. The calculations follow guidelines set forth in FCC OET Bulletin 65 Edition 97-01, IEEE Std. C95.1, and IEEE Std. C95.3.

Report Prepared By:	Cory Goulet Associate RF Engineer C Squared Systems, LLC	August 26, 2020 Date
Reviewed/Approved By:	Keith Vellante Director of RF Services C Squared Systems, LLC	August 31, 2020 Date

Attachment A: References

OET Bulletin 65 - Edition 97-01 - August 1997 Federal Communications Commission Office of Engineering & Technology

IEEE C95.1-2005, IEEE Standard Safety Levels With Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz IEEE-SA Standards Board

IEEE C95.3-2002 (R2008), IEEE Recommended Practice for Measurements and Computations of Radio Frequency Electromagnetic Fields With Respect to Human Exposure to Such Fields, 100 kHz-300 GHz IEEE-SA Standards Board

Attachment B: FCC Limits for Maximum Permissible Exposure (MPE)

(A) Limits for Occupational/Controlled Exposure[6]

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (E) (A/m)	Power Density (S) (mW/cm^2)	Averaging Time $\|E\|^2$, $\|H\|^2$ or S (minutes)
0.3-3.0	614	1.63	(100)*	6
3.0-30	1842/f	4.89/f	$(900/f^2)$*	6
30-300	61.4	0.163	1.0	6
300-1500	-	-	f/300	6
1500-100,000	-	-	5	6

(B) Limits for General Population/Uncontrolled Exposure[7]

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (E) (A/m)	Power Density (S) (mW/cm^2)	Averaging Time $\|E\|^2$, $\|H\|^2$ or S (minutes)
0.3-1.34	614	1.63	(100)*	30
1.34-30	824/f	2.19/f	$(180/f^2)$*	30
30-300	27.5	0.073	0.2	30
300-1500	-	-	f/1500	30
1500-100,000	-	-	1.0	30

f = frequency in MHz * Plane-wave equivalent power density

Table 5: FCC Limits for Maximum Permissible Exposure (MPE)

[6] Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure

[7] General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or cannot exercise control over their exposure

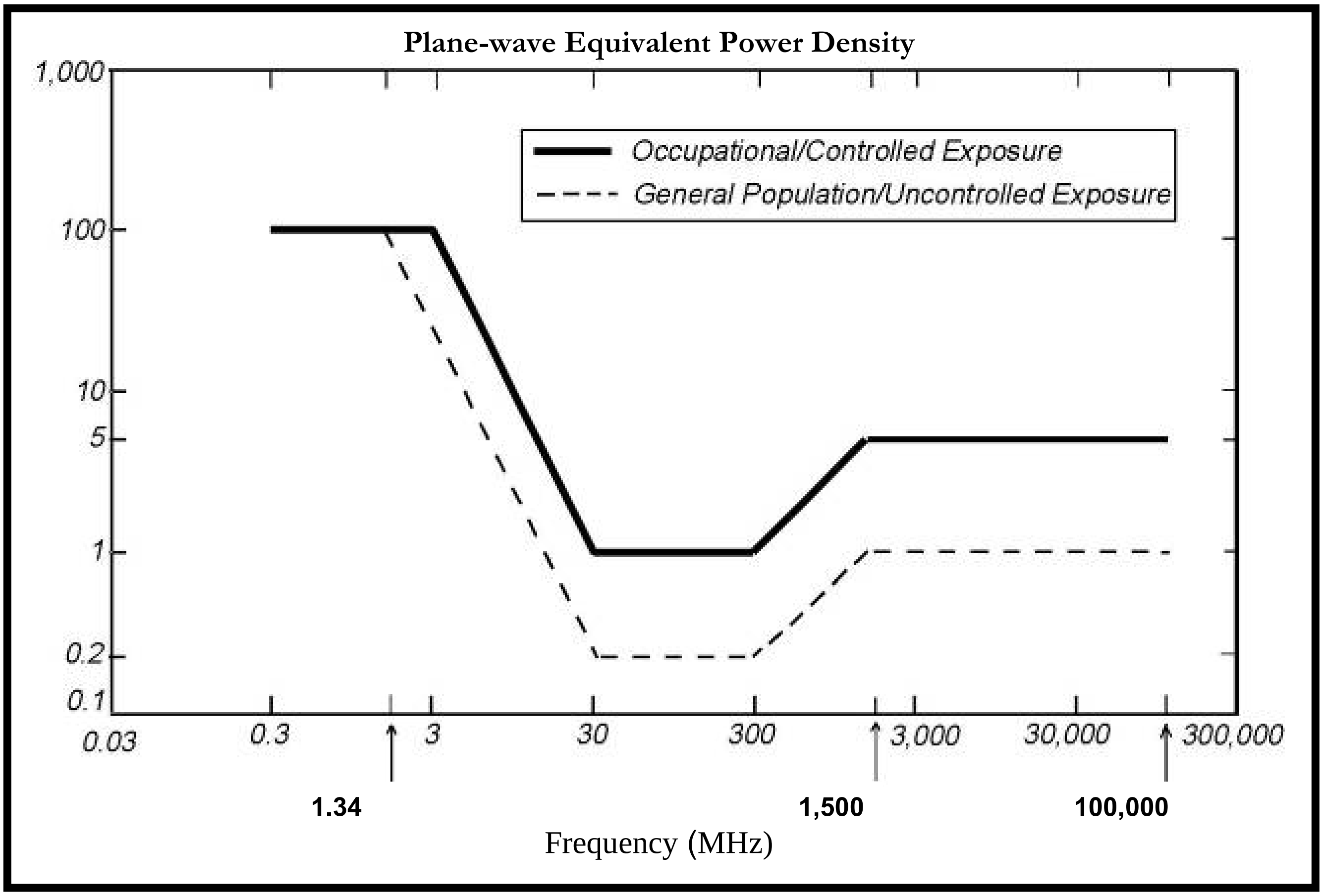
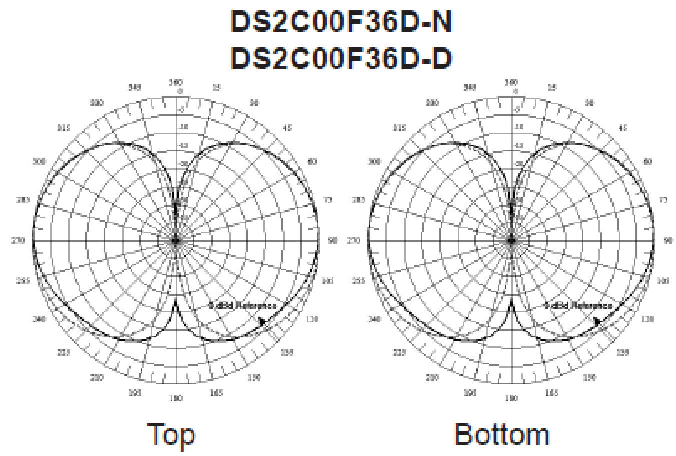


Figure 4: Graph of FCC Limits for Maximum Permissible Exposure (MPE)

Attachment C: Eversource Antenna Data Sheet and Electrical Patterns

217 MHz

Manufacturer:	dbSpectra
Model #:	DS2C00F36D
Frequency Band:	160 - 222 MHz
Gain:	0 dBd
Vertical Beamwidth:	60°
Horizontal Beamwidth:	360°
Polarization:	Vertical-Polarization
Length:	12.6’



37.74 MHz

Manufacturer:	Comprod
Model #:	531-70
Frequency Band:	30 - 76 MHz
Gain:	2.95 dBd
Vertical Beamwidth:	~60°
Horizontal Beamwidth:	~180°
Polarization:	Vertical-Polarization
Length:	~15.5’