EVERSOURCE ENERGY

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

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

July 22, 2020

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

RE: **Notice of Exempt Modification**
Eversource Site Ridgefield 22N
Off Prospect Street, Ridgefield, CT 06877
Latitude: 41-17-00.6 N / Longitude: 73-29.16.3 W

Dear Ms. Bachman:

The Connecticut Light and Power Company doing business as Eversource Energy ("Eversource") currently maintains multiple antennas and equipment at various mounting heights on an existing 84-foot steel monopole tower located off Prospect Street in Ridgefield. See Attachment A, Parcel Map and Property Card. The tower and property are owned by Eversource. Eversource plans to install one 14-foot 3-inch tall omni-directional antenna to be mounted at 82 feet above ground level ("AGL"), one 4-foot 3-inch tall omni-directional antenna to be inverse mounted at 82 feet AGL, and two 7/8-inch diameter coaxial cables. There will be no changes to the area of the fenced compound, the tower or the antennas and equipment currently mounted on the tower. The tower and existing and proposed equipment on the tower are depicted on Attachment B, Construction Drawings, dated March 26, 2020 and Attachment C, Structural Analysis, dated March 26, 2020. The Connecticut Siting Council approved the monopole at this location in Petition No. 1054 in January 2013.

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 Rudy Marconi, First Selectman for the Town of Ridgefield and Richard Baldelli, Director of Planning & Zoning for the Town of Ridgefield via the United States Postal Service or 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 April 2, 2020 (Attachment E – Power Density Report)[1].
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). Two copies of this notice and a check in the amount of $625 are enclosed.

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

By: ______________________________
Kathleen M. Shanley
Manager – Transmission Siting

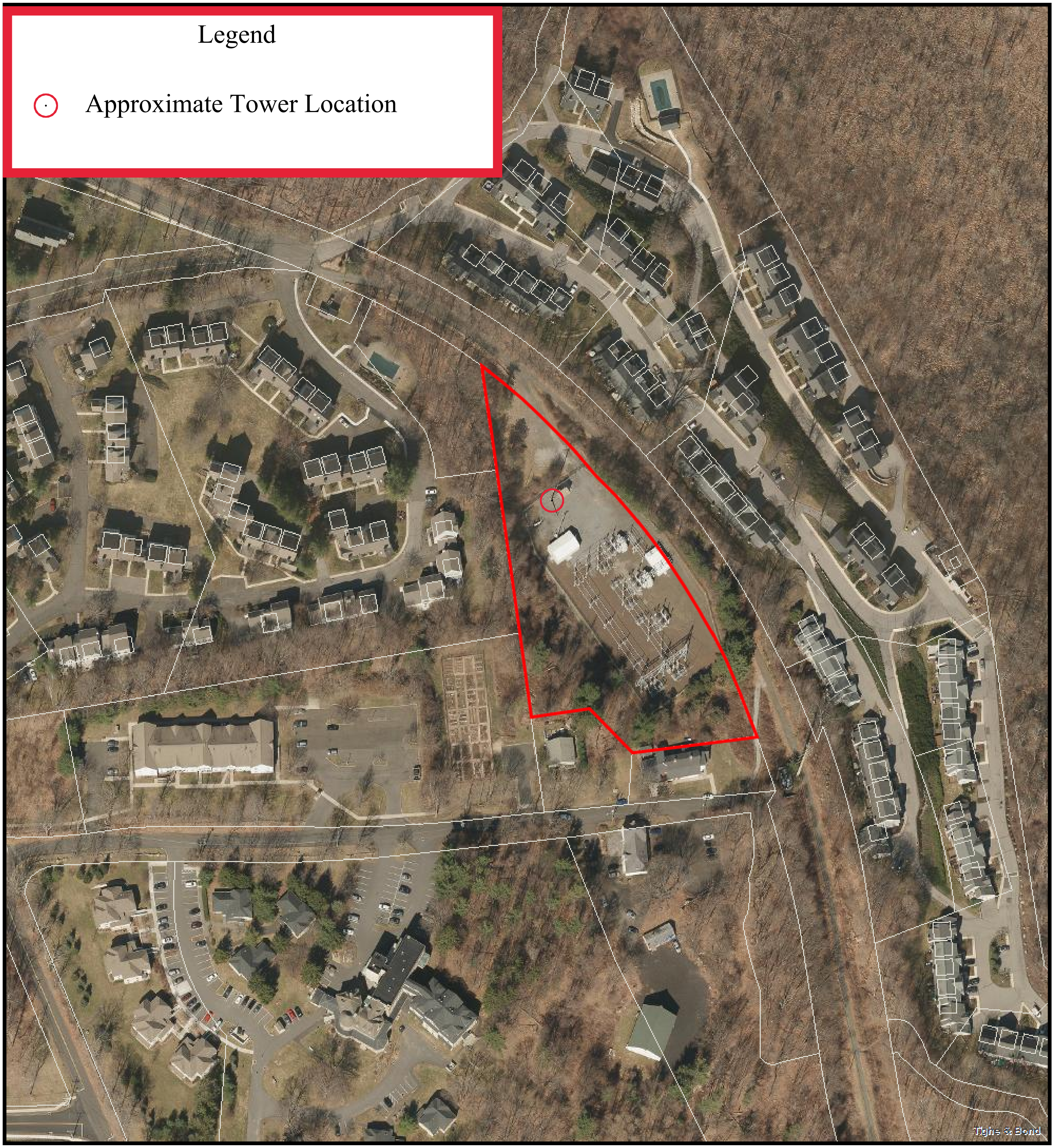
cc: Honorable Rudy Marconi, First Selectman, Town of Ridgefield
Richard Baldelli, Director of Planning & Zoning, Town of Ridgefield

Attachments

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

[1] It should be noted that the number of transmitting antennas accounted for in the Power Density Report accounts for two channels on the 88' centerline antenna. Also, the "Antenna Height" column on Table 1 in the Power Density Report only accounts for the centerline of the Transmit or "TX" antenna centerline.

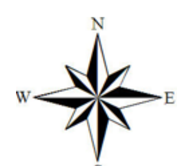
ATTACHMENT A – PARCEL MAP AND PROPERTY CARD



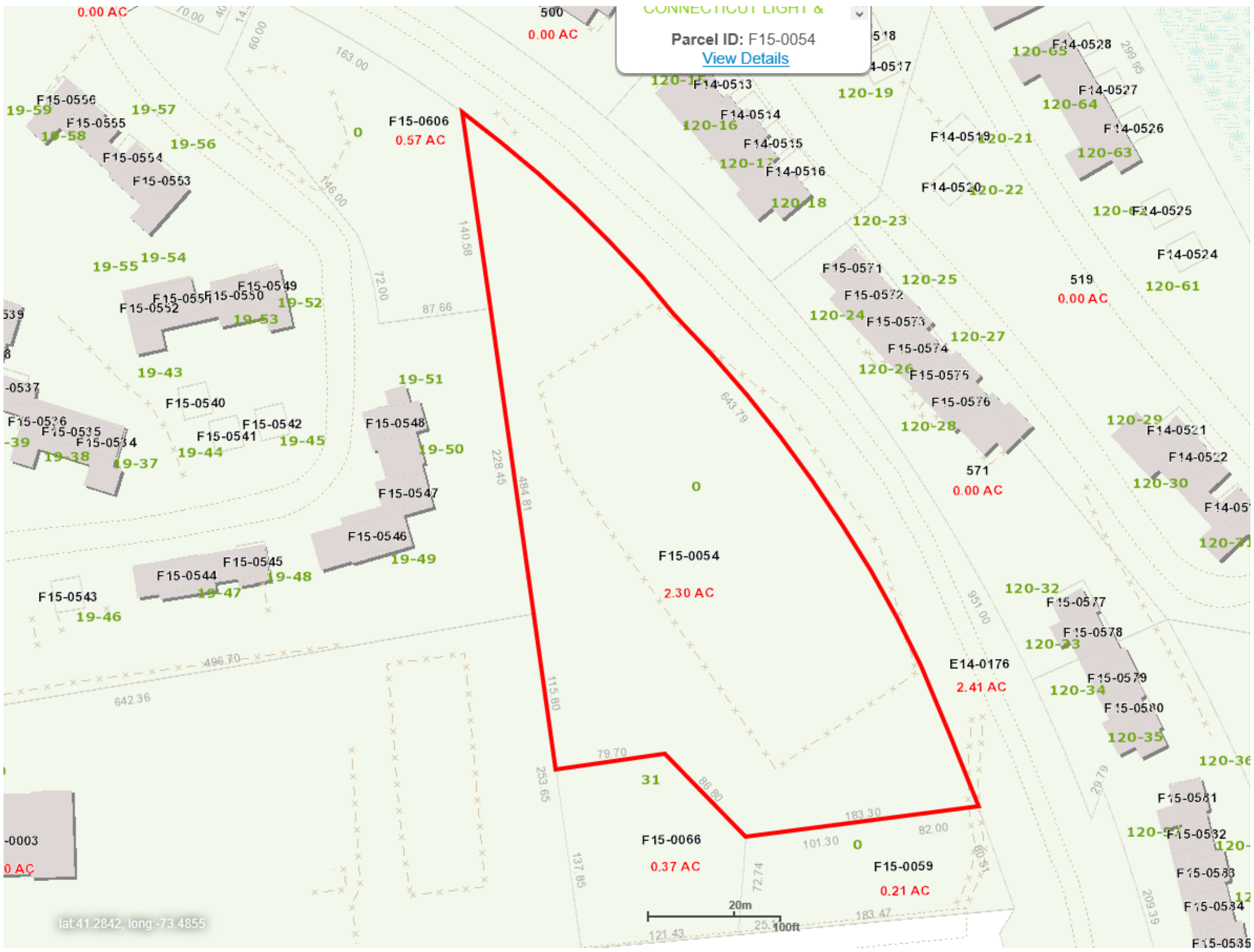
ES-286 Ridgefield22N Parcel

2/20/2020 8:34:14 AM

Scale: 1"=188'
Scale is approximate



The information depicted on this map is for planning purposes only.
It is not adequate for legal boundary definition, regulatory
interpretation, or parcel-level analyses.


Parcel ID: F15-0054
View Details
F15-0606
0.57 AC
F15-0054
2.30 AC
F15-0066
0.37 AC
F15-0059
0.21 AC
E14-0176
2.41 AC
571
0.00 AC
519
0.00 AC
500
0.00 AC
0.00 AC
F15-0556
F15-0555
F15-0554
F15-0553
F15-0552
F15-0549
F15-0550
F15-0540
F15-0541
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120-19
120-16
120-18
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120-25
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120-27
120-26
120-28
120-29
120-30
120-32
120-34
120-35
120-21
120-22
120-64
120-63
120-61
31
20m
100ft
lat 41.2842, long -73.4855

The Assessor’s office is responsible for the maintenance of records on the ownership of properties. Assessments are computed at 70% of the estimated market value of real property at the time of the last revaluation which was 2017.

Information on the Property Records for the Municipality of Ridgefield was last updated on 2/17/2020.

Parcel Information

Location:	SUNSET LA	Property Use:	Vacant Land	Primary Use:	Residential
Unique ID:	F150054	Map Block Lot:	F15-0054	Acres:	2.30
490 Acres:	0.00	Zone:	RAA	Volume / Page:	0178/0079
Developers Map / Lot:		Census:	2453		

Value Information

	Appraised Value	Assessed Value
Land	98,900	69,230
Buildings	0	0
Detached Outbuildings	0	0
Total	98,900	69,230

ATTACHMENT B – CONSTRUCTION DRAWINGS

EVERSOURCE ENERGY

RIDGEFIELD 22N
1 PROSPECT STREET
RIDGEFIELD, CT 06877

PROJECT SUMMARY

THE GENERAL SCOPE OF WORK CONSISTS OF THE FOLLOWING:

1. INSTALL (2) NEW OMNI/WHIP ANTENNAS, (1) AT ELEVATION 97'–0"± AGL AND (1) AT ELEVATION 82'–0"± AGL
2. INSTALL (1) NEW RACK WITH DMR EQUIPMENT IN EXISTING SHELTER

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:	RIDGEFIELD 22N
SITE ID NUMBER:	#F150054
SITE ADDRESS:	1 PROSPECT STREET RIDGEFIELD, CT 06877
MAP:	F15
LOT:	054
ZONE:	RAA
LATITUDE:	41° 17' 0.59" N
LONGITUDE:	73° 29' 16.27" W
ELEVATION:	666'± AMSL
FEMA/FIRM DESIGNATION:	X
ACREAGE:	2.3± AC (BOOK: 0178, PAGE: 0079)

CONTACT INFORMATION

APPLICANTS:
EVERSOURCE ENERGY
107 SELDEN STREET
BERLIN, CT 06037

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

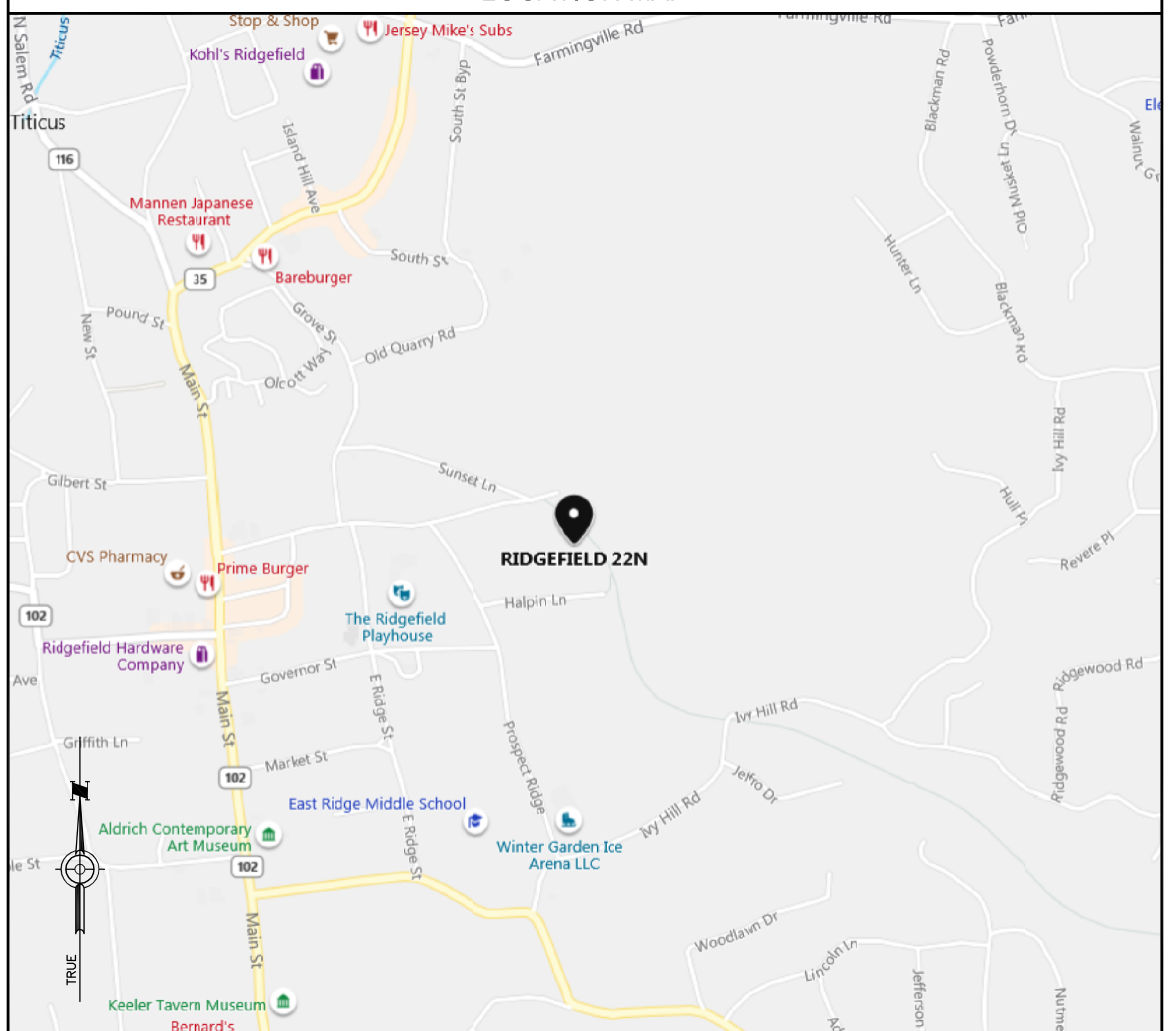
EVERSOURCE ENERGY PROJECT MANAGER:
NIKOLL PRECI
(860) 655–3079

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
MONOPOLE

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) 458–3595

PROJECT NO:	403093
DRAWN BY:	TCG
CHECKED BY:	JR

REV	DATE	DESCRIPTION
0	03/26/20	ISSUED FOR FILING

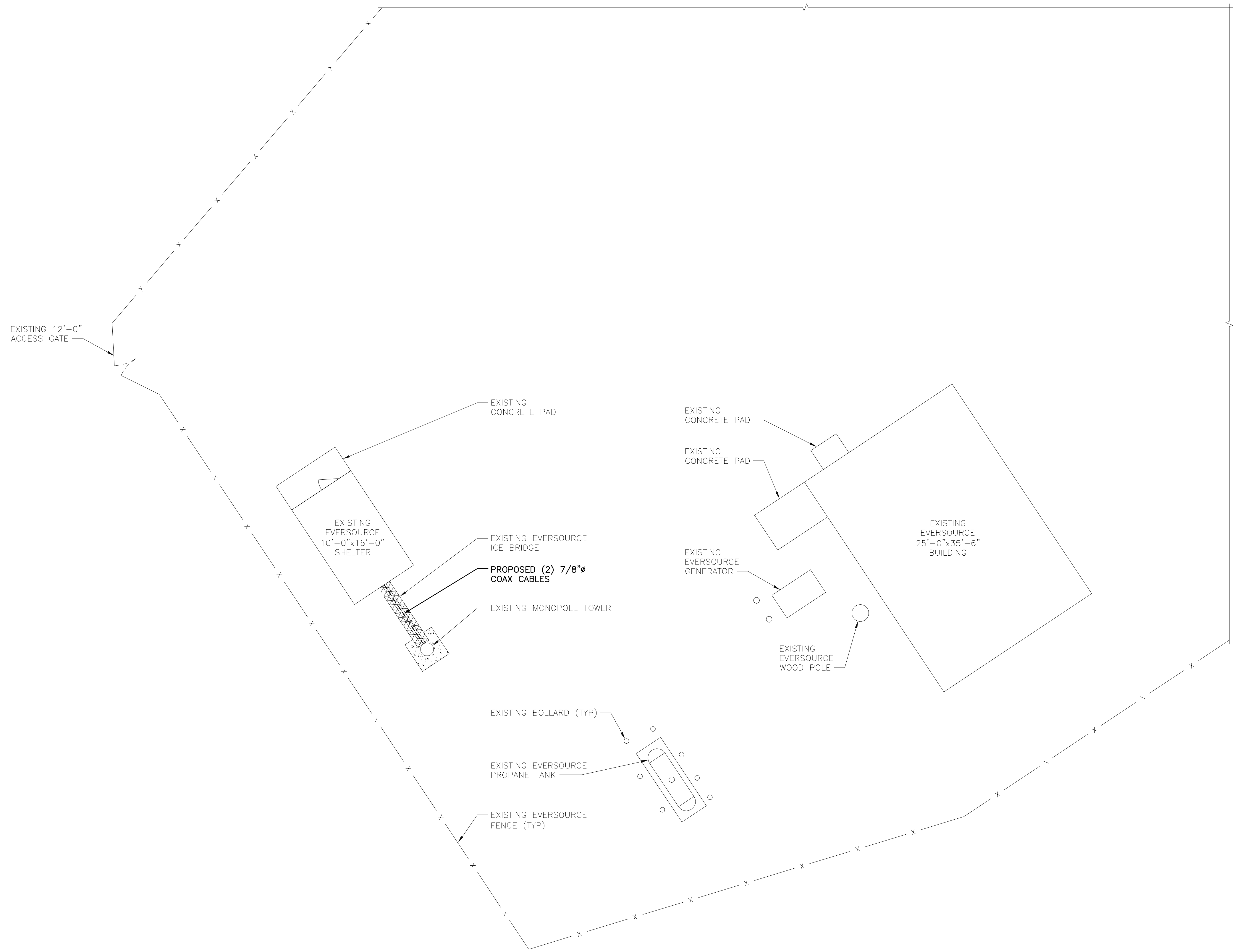
STATE OF CONNECTICUT
JOSHUA J. RILEY
33208
LICENSED PROFESSIONAL ENGINEER
03/26/2020

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.

RIDGEFIELD 22N
1 PROSPECT STREET
RIDGEFIELD, CT 06877

SHEET TITLE
TITLE SHEET

SHEET NUMBER
T-1



SITE PLAN
NO SCALE

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

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6800 W 115TH ST, SUITE 2292
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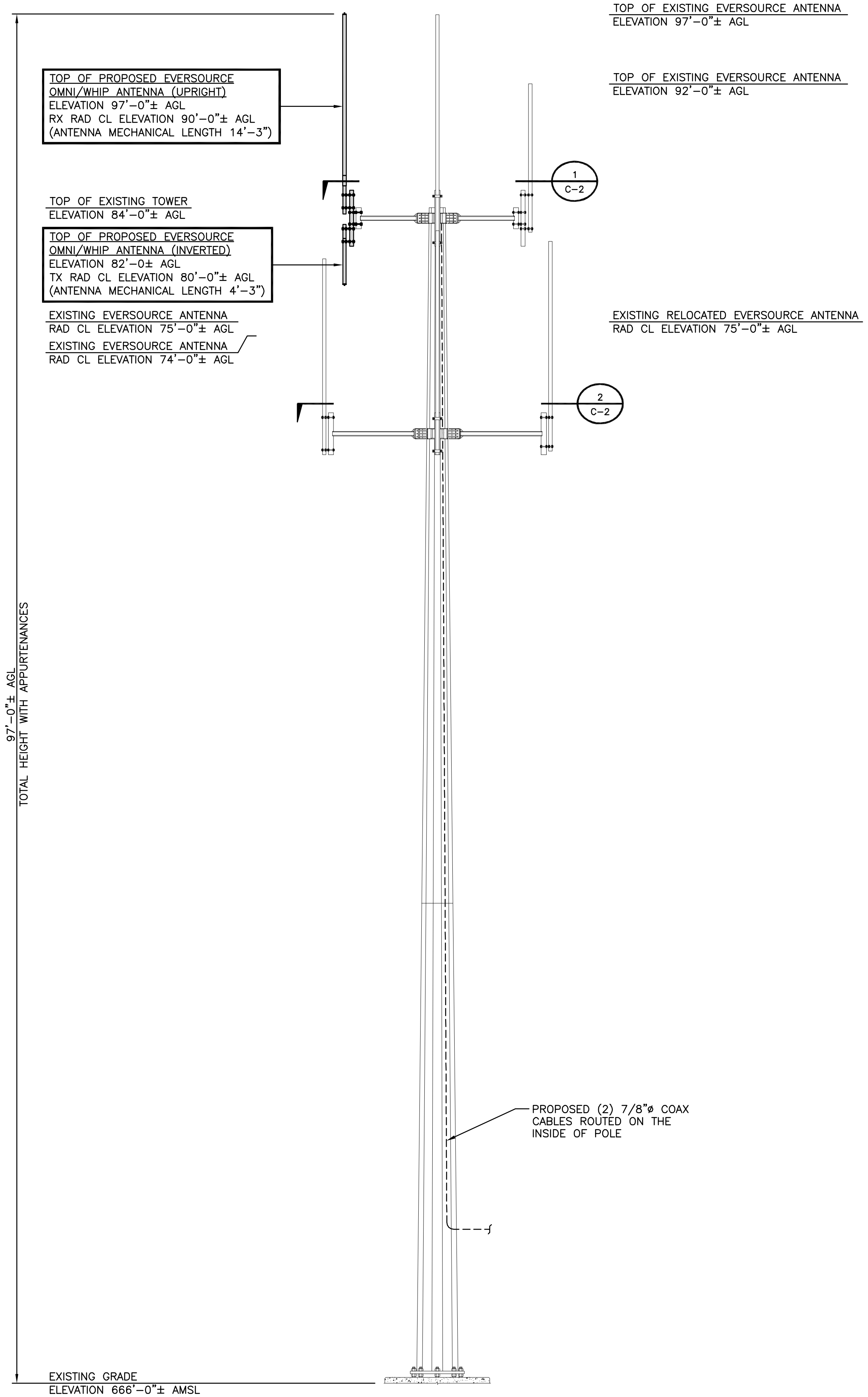
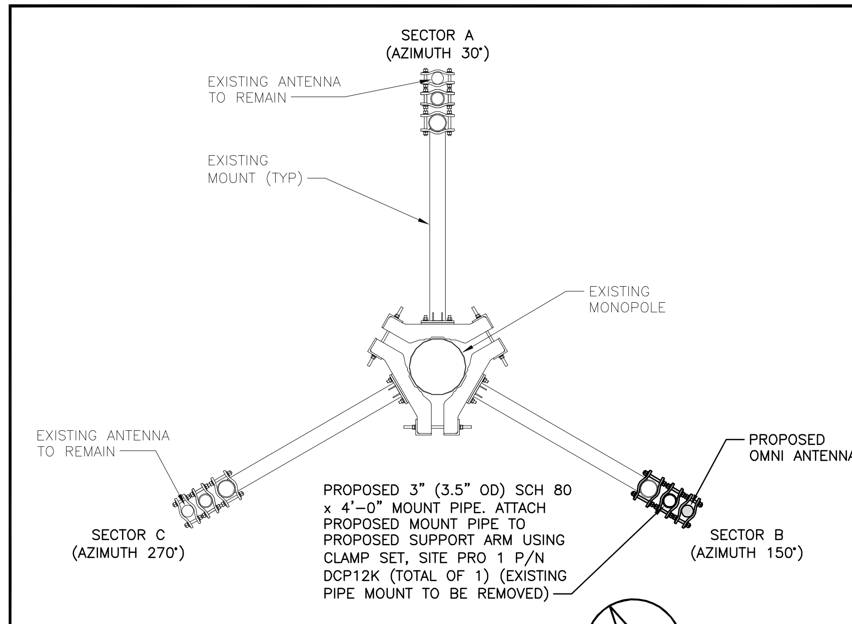
1 PROSPECT STREET
RIDGEFIELD, CT 06877

SHEET TITLE
SITE PLAN

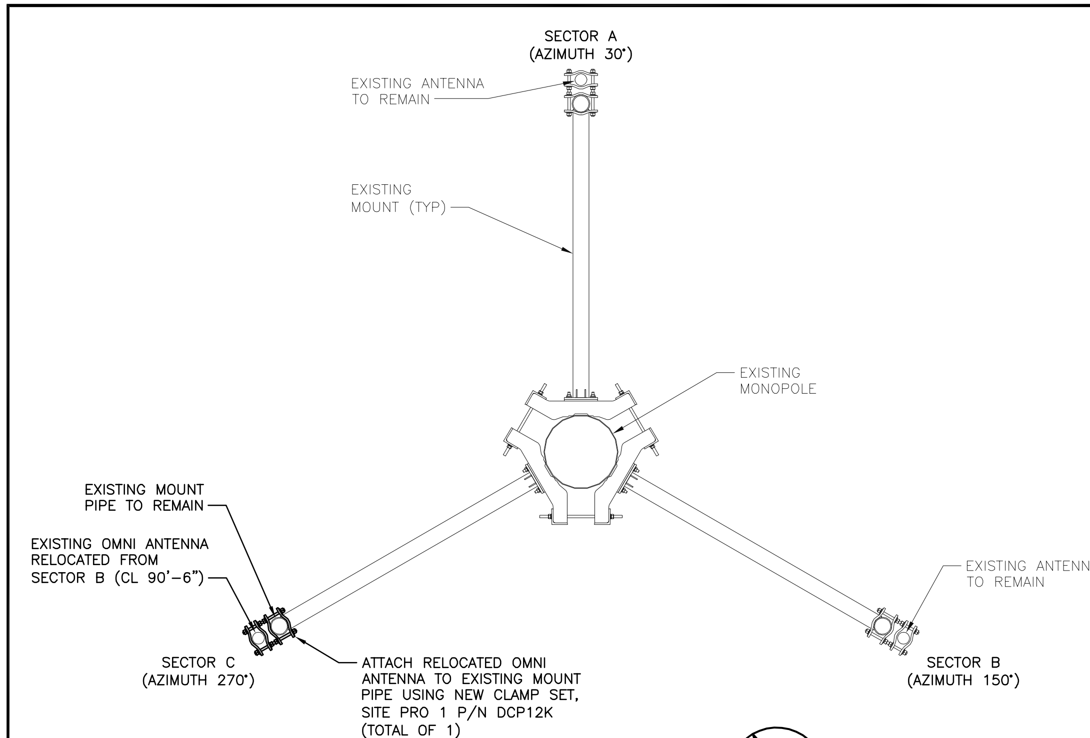
SHEET NUMBER
C-1



TOWER ELEVATION
NO SCALE



SECTION 1
NO SCALE



SECTION 2
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) 458–3595

PROJECT NO:	403093
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0	03/26/20	ISSUED FOR FILING

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03/26/2020

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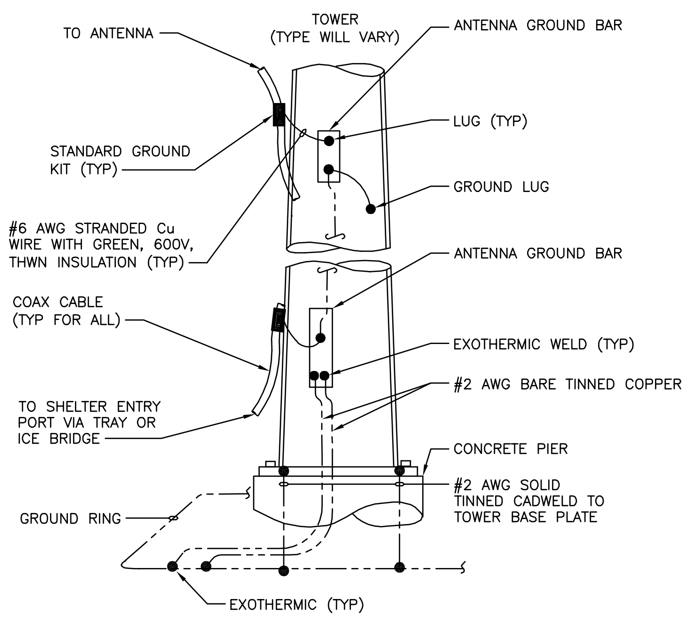
RIDGEFIELD 22N
1 PROSPECT STREET
RIDGEFIELD, CT 06877

SHEET TITLE
TOWER ELEVATION

SHEET NUMBER
C-2

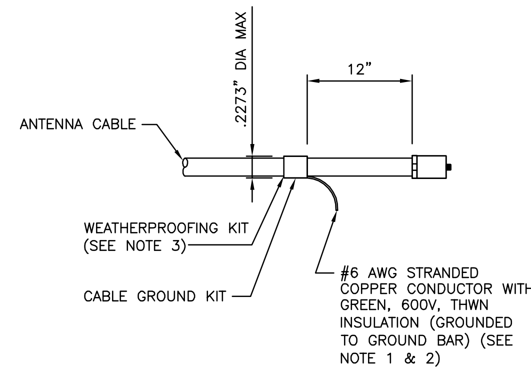


NOTE

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

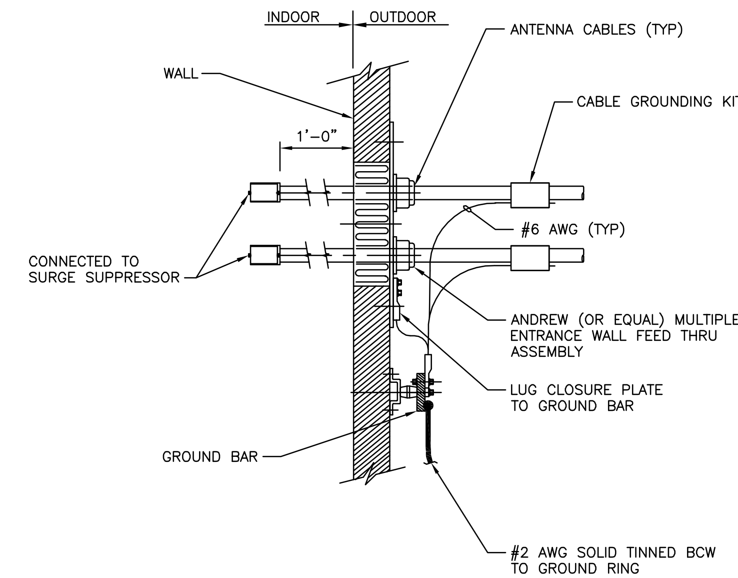


NOTES

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.

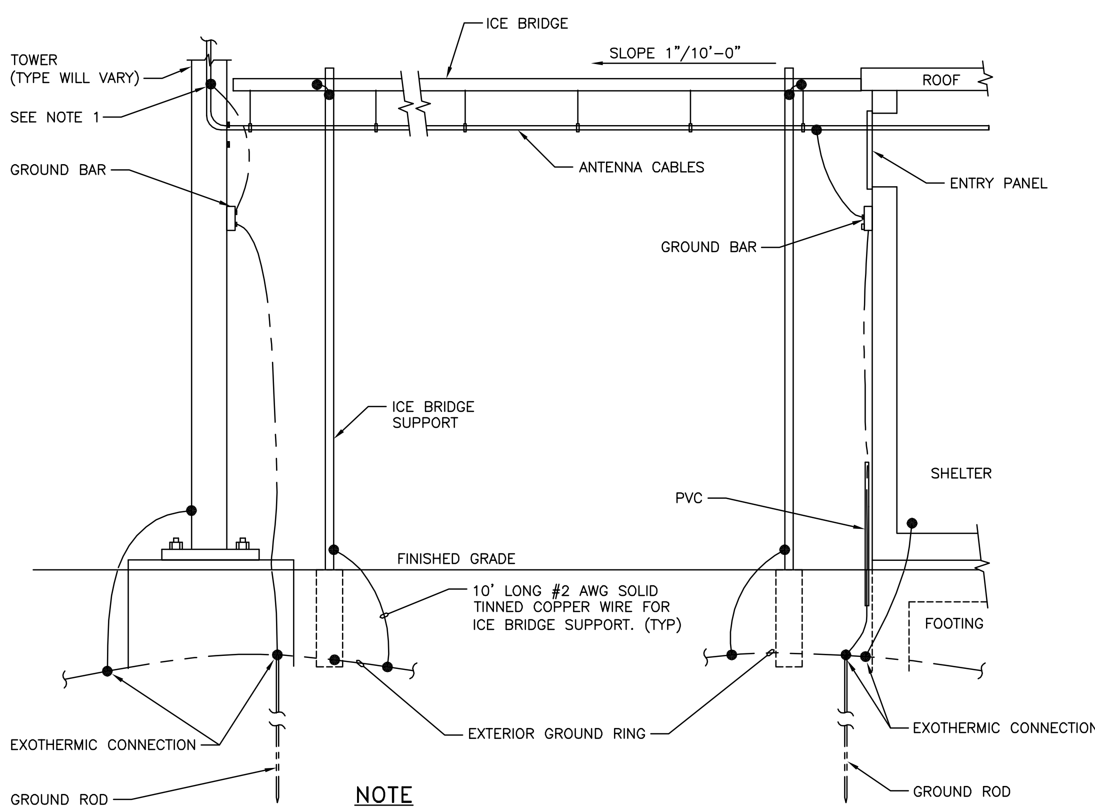
CONNECTION OF CABLE GROUND KIT TO ANTENNA CABLE

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

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BERLIN, CT 06037
PHONE: (800) 286-2000

BLACK & VEATCH

6800 W 115TH ST, SUITE 2292
OVERLAND PARK, KS 66211
PHONE: (913) 458-3595

PROJECT NO:	403093
DRAWN BY:	TCG
CHECKED BY:	JR

REV	DATE	DESCRIPTION
0	03/26/20	ISSUED FOR FILING

STATE OF CONNECTICUT
MARK P. STILES
34358
LICENSED PROFESSIONAL ENGINEER
03/26/2020

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RIDGEFIELD 22N
1 PROSPECT STREET
RIDGEFIELD, CT 06877

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.

STEEL

1. MATERIAL:

WIDE FLANGE:	ASTM A572, GR 50
TUBING:	ASTM A500, GR C
PIPE:	ASTM A53, GR B
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.

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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PROJECT NO:	403093
DRAWN BY:	TCG
CHECKED BY:	JR

REV	DATE	DESCRIPTION
0	03/26/20	ISSUED FOR FILING

03/26/2020

RIDGEFIELD 22N
1 PROSPECT STREET
RIDGEFIELD, CT 06877

SHEET TITLE
NOTES
& SPECIFICATIONS

SHEET NUMBER
N-1

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. 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).
4. 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.
5. 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.
6. 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.
7. THE MINIMUM BEND RADIUS SHALL BE 8 INCHES FOR #6 WIRE AND SMALLER AND 12 INCHES FOR WIRE LARGER THAN #6.
8. BOND THE FENCE TO THE GROUND RING AT EACH CORNER, AND AT EACH GATE POST WITH #2 SOLID TINNED WIRE. EXOTHERMIC WELD BOTH ENDS.
9. GROUND KITS SHALL BE SOLID COPPER STRAP WITH #6 WIRE 2—HOLE COMPRESSION CRIMPED LUGS AND SHALL BE SEALED ACCORDING TO MANUFACTURER INSTRUCTIONS.
10. FERROUS METAL CLIPS WHICH COMPLETELY SURROUND THE GROUNDING CONDUCTOR SHALL BE USED.
11. 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.

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.

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

03/26/2020

RIDGEFIELD 22N
1 PROSPECT STREET
RIDGEFIELD, CT 06877

SHEET TITLE

NOTES & SPECIFICATIONS

SHEET NUMBER

N-2

SYMBOLS

●	EXOTHERMIC CONNECTION
■	COMPRESSION CONNECTION
	5/8"øx10'-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		

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STATE OF CONNECTICUT
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LICENSED
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RIDGEFIELD 22N
1 PROSPECT STREET
RIDGEFIELD, CT 06877

SHEET TITLE
NOTES & SPECIFICATIONS

SHEET NUMBER
N-3

REFERENCE CUTSHEETS

216 - 225 MHz

ANT220F6

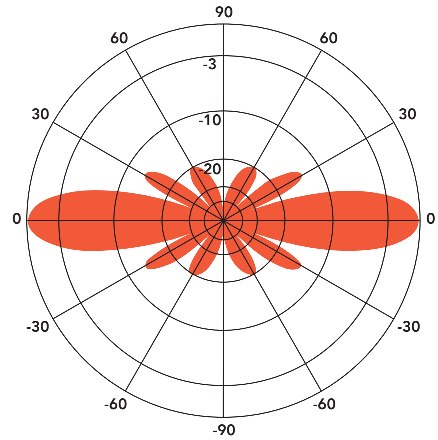
FIBERGLASS COLLINEAR ANTENNA 6 dBd

The Telewave ANT220F6 is an extremely rugged, medium-gain, fiberglass collinear antenna, designed for operation in all environmental conditions. The antenna is constructed with brass and copper elements, connected at DC ground potential for lightning impulse protection. The ANT220F6 is an excellent choice for wireless PTC systems in urban or rural areas.

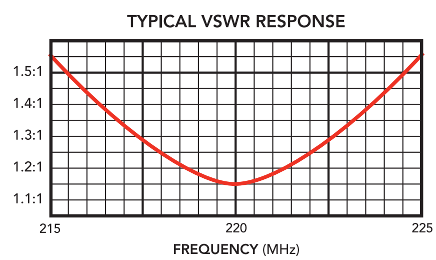
All junctions are fully soldered to prevent RF intermodulation, and each antenna is completely protected within a rugged, high-tech radome to ensure survivability in the worst environments. The "Cool Blue" radome provides maximum protection from corrosive gases, ultraviolet radiation, icing, salt spray, acid rain, and wind blown abrasives.

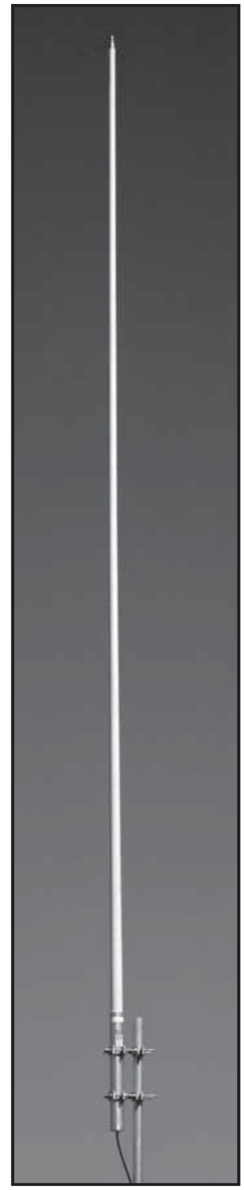
The ANT220F6 includes an ANTC482 dual clamp set for mounting to a 1.5" to 3.5" O.D. support pipe, and a 24" removable RG-213 N-Male jumper. Stand-off and top mounts are also available.

NOTE: THIS ANTENNA IS SHIPPED VIA TRUCK FREIGHT ONLY



ANT220F6 - 221 MHz
Vertical Plane
Gain = 6.11 dBd





SPECIFICATIONS			
Frequency (continuous)	216-225 MHz	**Dimensions (L x base diam.) in.**	171 x 2.75
Gain	6 dBd	**Tower weight (antenna + clamps)**	35 lb.
Power rating (typ.)	500 watts	**Shipping weight**	50 lb.
Impedance	50 ohms	**Wind rating / with 0.5" ice**	150 / 125 MPH
VSWR	1.5:1 or less	**Maximum exposed area**	3.1 ft.^{2}
Pattern	Omnidirectional	**Lateral thrust at 100 MPH**	122 lb.
Vertical beamwidth	20°	**Bending moment at top clamp**	494 ft. lb.
Termination	Recessed N Female 7-16 DIN-F opt.	**(100 MPH, 40 PSF flat plate equiv.)**	

TELEWAVE, INC.

195 - 260 MHz

ANT220F2-I w/DIN CONNECTOR to be used for the inverted antenna.

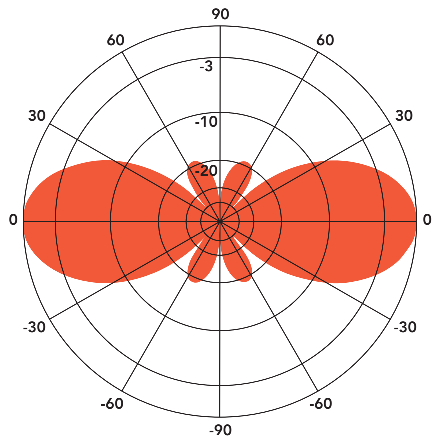
ANT220F2

FIBERGLASS COLLINEAR ANTENNA 2.5 dBd

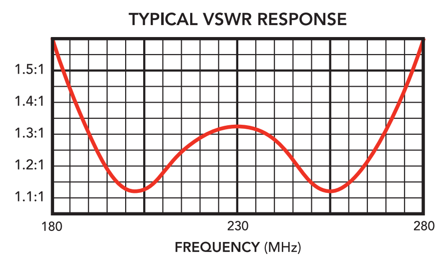
The Telewave ANT220F2 is an extremely rugged collinear antenna, with moderate gain and wide vertical beamwidth. This compact antenna produces 2.5 dBd gain, and is designed for operation in all environmental conditions. The antenna is constructed with brass and copper elements, with a path to ground potential for lightning impulse protection. The ANT220F2 is an excellent choice for wireless PTC systems in urban or rural areas.

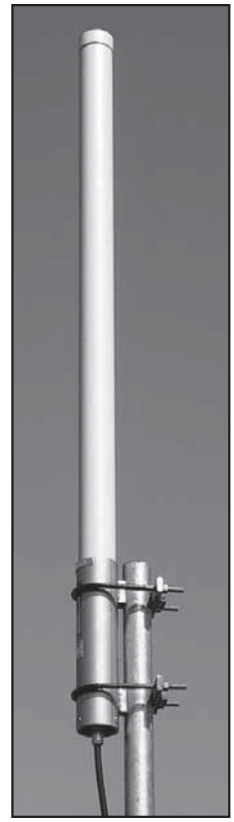
All junctions are fully soldered to prevent RF intermodulation, and each antenna is completely protected within a rugged, high-tech radome to ensure survivability in the worst environments. The "Cool Blue" radome provides maximum protection from corrosive gases, ultraviolet radiation, icing, salt spray, acid rain, and wind blown abrasives.

The ANT220F2 includes the ANTC485 dual clamp set for mounting to a 1.5" to 3" O.D. support pipe, and a 24" removable RG-213 N-Male jumper.



ANT220F2 - 230 MHz
Vertical Plane
Gain = 2.58 dBd

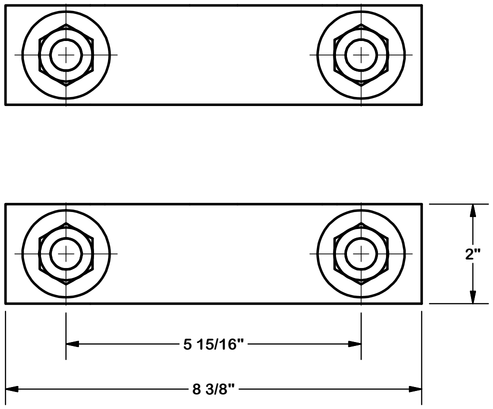


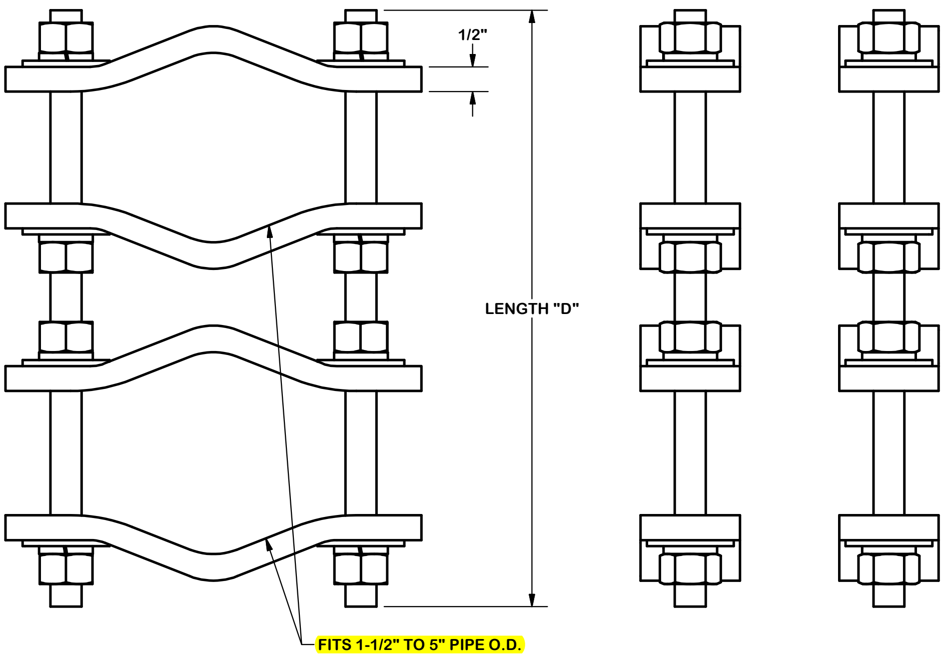


(1) ONE SITE PRO 1 P/N DCP12K CLAMP SET REQUIRED.

SPECIFICATIONS			
Frequency (continuous)	195-260 MHz	**Dimensions (L x base diam.) in.**	51 x 2.75
Gain	2.5 dBd	**Tower weight (antenna + clamps)**	11 lb.
Power rating (typ.)	500 watts	**Shipping weight**	14 lb.
Impedance	50 ohms	**Wind rating / with 0.5" ice**	200 / 150 MPH
VSWR	1.5:1 or less	**Maximum exposed area**	1.1 ft.^{2}
Pattern	Omnidirectional	**Lateral thrust at 100 MPH**	44 lb.
Vertical beamwidth	38°	**Bending moment at top clamp**	47 ft. lb.
Termination	Recessed N Female 7-16 DIN-F opt.	**(100 MPH, 40 PSF flat plate equiv.)**	

A TOTAL OF (3) THREE CLAMP SETS REQUIRED.



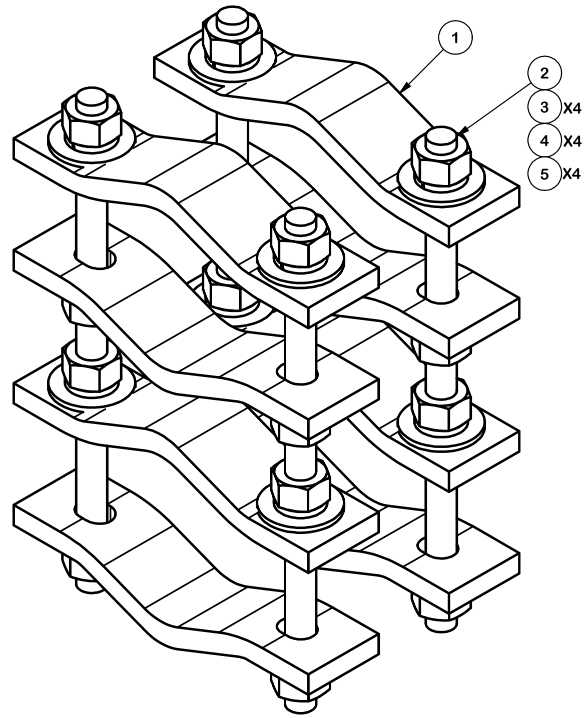


PARTS LIST

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

ATTACHMENT C – STRUCTURAL ANALYSIS REPORT

Date: **March 26, 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-286 Ridgefield22N
Engineering Firm Designation:	**Black & Veatch Corp. Project Number:**	403093
Site Data:	**Off Prospect Street, Ridgefield, Fairfield County, CT** **Latitude *41° 17′ 0.59″*, Longitude *-73° 29′ 16.27″*** **84 Foot - Monopole 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 – 57.8%**

This analysis utilizes an ultimate 3-second gust wind speed of 125 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: Anthony Reyes / Joshua J. Riley

Respectfully submitted by:

Joshua J. Riley, P.E.
Professional Engineer

03/26/2020

TABLE OF CONTENTS

1) INTRODUCTION

This tower is an 84 ft Monopole tower designed by Valmont in July of 2012.

2) ANALYSIS CRITERIA

TIA-222 Revision:	TIA-222-H
Risk Category:	III
Wind Speed:	125 mph ultimate
Exposure Category:	C
Topographic Factor:	1
Ice Thickness:	1.5 in
Wind Speed with Ice:	50 mph
Seismic Ss:	0.229
Seismic S_1:	0.068
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
83.0	90.0	1	telewave	ANT220F6	2	7/8	1
	82.0	1	generic	4'x3" Mount Pipe			
	80.0	1	telewave	ANT220F2			

Note:
1) Proposed equipment to be installed on existing relocated antenna's original antenna mount at 83.0ft MCL

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
83.0	90.0	1	kreco	CO-41A	2	7/8	1
	88.0	1	commscope	DB589-Y			
	83.0	1	tower mounts	Side Arm Mount [4' SO 701-3]			
67.0	74.0	1	celwave	1151-3	1	7/8	2
		1	kreco	CO-41A	2	7/8	1
	73.0	1	kreco	CO-41A			
	67.0	1	tower mounts	Side Arm Mount [6' SO 701-3]			

Note:
1) Existing equipment
2) Existing equipment to be relocated from 83.0ft MCL to empty antenna mount on 67.0ft MCL

3) ANALYSIS PROCEDURE

Table 3 - Documents Provided

Document	Remarks	Reference	Source
GEOTECHNICAL REPORTS	Dr. Clarence Welti, P.E., P.C., dated 06/14/2012	-	Eversource
TOWER FOUNDATION DRAWINGS/DESIGN/SPECS	Valmont, dated 7/27/2012	-	Eversource

Document	Remarks	Reference	Source
TOWER MANUFACTURER DRAWINGS	Valmont, dated 7/27/2012	-	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 A.

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) 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.

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.

4) ANALYSIS RESULTS

Table 5 - Tower Component Stresses vs. Capacity - LC1

Section No.	Elevation (ft)	Component Type	Size	Critical Element	P (K)	SF*P_allow (K)	% Capacity	Pass / Fail
L1	84 - 34.25	Pole	TP18.145x12.001x0.1875	1	-2.08	639.52	37.1	Pass
L2	34.25 - 0	Pole	TP22x17.3069x0.2188	2	-4.62	928.93	52.8	Pass
							Summary	
						Pole (L2)	52.8	Pass
						RATING =	52.8	Pass

Table 4 - Tower Component Stresses vs. Capacity - LC1

Notes	Component	Elevation (ft)	% Capacity	Pass / Fail
1	Anchor Rods	0	48.1	Pass
	Base Plate		22.8	Pass
1	Base Foundation	0	34.4	Pass
	Base Foundation Soil Interaction		47.0	Pass

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

Structure Rating (max from all components) =	57.8%

4.1) Recommendations

The tower and its foundation have 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**
L1	84 - 34.25	10.939	44	1.0208	0.0184	OK
L2	38 - 0	2.56	44	0.5996	0.0046	OK

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

1) Maximum Rotation = 4 Degrees

2) Maximum Deflection = 0.03 * Tower Height = 30 in.

Maximum Tower Deflections - Design Wind

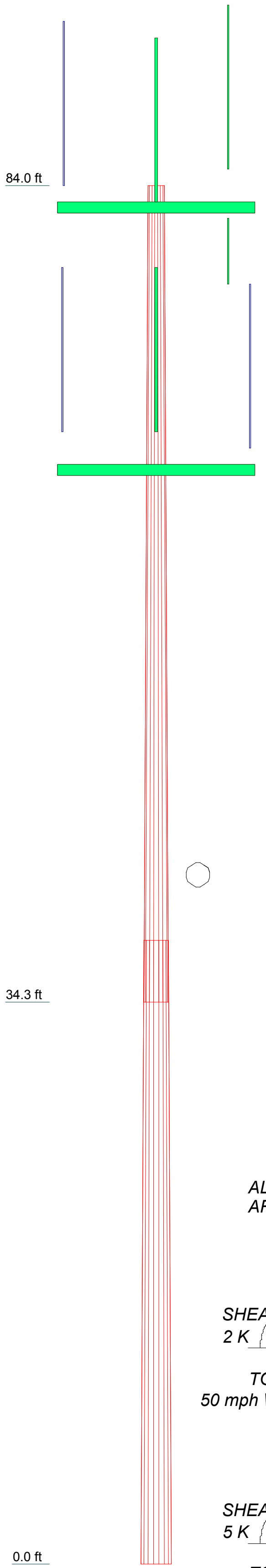
Section No.	*Elevation ft*	*Horz. Deflection in*	*Gov. Load Comb.*	*Tilt °*	*Twist °*	*Combined Max*	*Check**
L1	84 - 34.25	28.279	44	2.6212	0.048	2.622	OK**
L2	38 - 0	6.647	44	1.5557	0.0119	1.556	OK**

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

** Deflection approved by Eversource Energy

APPENDIX A

TNXTOWER OUTPUT



Section	Length (ft)	Number of Sides	Thickness (in)	Socket Length (ft)	Top Dia (in)	Bot Dia (in)	Grade	Weight (K)
1	49.75	18	0.1875	3.75	12.0010	18.1450	A572-65	1.5
2	38.00	18	0.2188		17.3069	22.0000	A572-65	1.7
								3.2

DESIGNED APPURTENANCE LOADING

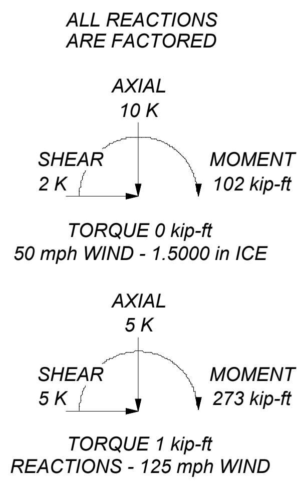
TYPE	ELEVATION	TYPE	ELEVATION
Side Arm Mount [4' SO 701-1]	83	ANT220F2	83
3' x 2" Pipe Mount	83	3' x 2" Pipe Mount	67
3' x 2" Pipe Mount	83	3' x 2" Pipe Mount	67
3' x 2" Pipe Mount	83	CO-41A	67
DB589-Y	83	CO-41A	67
CO-41A	83	1151-3	67
ANT220F6	83	Side Arm Mount [6' SO 701-1]	67
4'x3" Mount Pipe	83	3' x 2" Pipe Mount	67

MATERIAL STRENGTH

GRADE	Fy	Fu	GRADE	Fy	Fu
A572-65	65 ksi	80 ksi			

TOWER DESIGN NOTES

1. Tower is located in Fairfield County, Connecticut.
2. Tower designed for Exposure C to the TIA-222-H Standard.
3. Tower designed for a 125 mph basic wind in accordance with the TIA-222-H Standard.
4. Tower is also designed for a 50 mph basic wind with 1.50 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: 52.8%



BLACK & VEATCH Building a world of difference.	*Black & Veatch Corp.* 6800 W. 115th St., Suite 2292 Overland Park, KS 66211 Phone: FAX:	Job: ***ES-286 Ridgefield22N*** Project: ***403093 (Ridgefield22N)*** Client: Eversource — Drawn by: TH — App'd: Code: TIA-222-H — Date: 03/10/20 — Scale: NTS Path: C:\Users\hal92311\Desktop\Eversource\2019.11.11\Ridgefield22N\Structural\Rev. H\ES-286 Ridgefield22N Structural Analysis.eri — Dwg No. E-1

Tower Input Data

The tower is a monopole.
This tower is designed using the TIA-222-H standard.
The following design criteria apply:

1) Tower is located in Fairfield County, Connecticut.
2) Tower base elevation above sea level: 666.00 ft.
3) Basic wind speed of 125 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 1.5000 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) A non-linear (P-delta) analysis was used.
16) Pressures are calculated at each section.
17) Stress ratio used in pole design is 1.05.
18) 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

Tapered Pole Section Geometry

Section	Elevation ft	Section Length ft	Splice Length ft	Number of Sides	Top Diameter in	Bottom Diameter in	Wall Thickness in	Bend Radius in	Pole Grade
L1	84.00-34.25	49.75	3.75	18	12.0010	18.1450	0.1875	0.7500	A572-65 (65 ksi)
L2	34.25-0.00	38.00		18	17.3069	22.0000	0.2188	0.8750	A572-65 (65 ksi)

Tapered Pole Properties

Section	Tip Dia. in	Area in^2	I in^4	r in	C in	I/C in^3	J in^4	It/Q in^2	w in	w/t
L1	12.1572	7.0305	123.9600	4.1938	6.0965	20.3329	248.0830	3.5159	1.7822	9.505
	18.3960	10.6870	435.3948	6.3749	9.2177	47.2349	871.3626	5.3445	2.8635	15.272
L2	18.0104	11.8645	437.6998	6.0663	8.7919	49.7845	875.9756	5.9334	2.6610	12.165
	22.3056	15.1230	906.4437	7.7323	11.1760	81.1063	1814.0801	7.5629	3.4870	15.941

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
L1 84.00-34.25				1	1	1			
L2 34.25-0.00				1	1	1			

Feed Line/Linear Appurtenances - Entered As Round Or Flat

Description	Sector	Exclude From Torque Calculation	Component Type	Placement ft	Total Number	Number Per Row	Start/End Position	Width or Diameter in	Perimeter in	Weight plf
miscl										
Safety Line 3/8	C	No	Surface Ar (CaAa)	84.00 - 10.00	1	1	0.000 0.010	0.3750		0.22

Feed Line/Linear Appurtenances - Entered As Area

Description	Face or Leg	Allow Shield	Exclude From Torque Calculation	Component Type	Placement ft	Total Number		C_AA_A ft^2/ft	Weight plf
83									
LDF5-50A(7/8)	C	No	No	Inside Pole	83.00 - 0.00	2	No Ice	0.00	0.33
							1/2" Ice	0.00	0.33
							1" Ice	0.00	0.33
							2" Ice	0.00	0.33
66									
LDF5-50A(7/8)	C	No	No	Inside Pole	67.00 - 0.00	3	No Ice	0.00	0.33
							1/2" Ice	0.00	0.33
							1" Ice	0.00	0.33
							2" Ice	0.00	0.33
Proposed									
LDF5-50A(7/8)	A	No	No	Inside Pole	82.00 - 0.00	2	No Ice	0.00	0.33
							1/2" Ice	0.00	0.33
							1" Ice	0.00	0.33
							2" Ice	0.00	0.33

Feed Line/Linear Appurtenances Section Areas

Tower Section	Tower Elevation ft	Face	A_R ft²	A_F ft²	C_AA_A In Face ft²	C_AA_A Out Face ft²	Weight K
L1	84.00-34.25	A	0.000	0.000	0.000	0.000	0.03
		B	0.000	0.000	0.000	0.000	0.00
		C	0.000	0.000	1.866	0.000	0.08
L2	34.25-0.00	A	0.000	0.000	0.000	0.000	0.02
		B	0.000	0.000	0.000	0.000	0.00
		C	0.000	0.000	0.909	0.000	0.06

Feed Line/Linear Appurtenances Section Areas - With Ice

Tower Section	Tower Elevation ft	Face or Leg	Ice Thickness in	A_R ft²	A_F ft²	C_AA_A In Face ft²	C_AA_A Out Face ft²	Weight K
L1	84.00-34.25	A	1.825	0.000	0.000	0.000	0.000	0.03
		B		0.000	0.000	0.000	0.000	0.00
		C		0.000	0.000	20.025	0.000	0.32
L2	34.25-0.00	A	1.614	0.000	0.000	0.000	0.000	0.02
		B		0.000	0.000	0.000	0.000	0.00
		C		0.000	0.000	9.761	0.000	0.18

Feed Line Center of Pressure

Section	Elevation ft	CP_X in	CP_Z in	CP_X Ice in	CP_Z Ice in
L1	84.00-34.25	-0.0031	0.2996	-0.0142	1.3545
L2	34.25-0.00	-0.0022	0.2081	-0.0110	1.0499

Note: For pole sections, center of pressure calculations do not consider feed line shielding.

Shielding Factor Ka

Tower Section	Feed Line Record No.	Description	Feed Line Segment Elev.	K_a No Ice	K_a Ice
L1	2	Safety Line 3/8	34.25 - 84.00	1.0000	1.0000

Discrete Tower Loads

Description	Face or Leg	Offset Type	Offsets: Horz Lateral Vert ft ft ft	Azimuth Adjustment °	Placement ft		C_AA_A Front ft²	C_AA_A Side ft²	Weight K
83									
Side Arm Mount [4' SO 701-1]	C	None		0.0000	83.00	No Ice 1/2" Ice 1" Ice 2" Ice	1.13 1.52 1.91 2.68	2.23 3.12 4.01 5.80	0.09 0.11 0.12 0.16
3' x 2" Pipe Mount	A	From Face	6.00	0.0000	83.00	No Ice	0.58	0.58	0.01

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
			0.00			1/2"	0.77	0.77	0.02
			0.00			Ice	0.97	0.97	0.02
						1" Ice	1.39	1.39	0.05
						2" Ice			
3' x 2" Pipe Mount	B	From Face	6.00	0.0000	83.00	No Ice	0.58	0.58	0.01
			0.00			1/2"	0.77	0.77	0.02
			0.00			Ice	0.97	0.97	0.02
						1" Ice	1.39	1.39	0.05
						2" Ice			
3' x 2" Pipe Mount	C	From Face	6.00	0.0000	83.00	No Ice	0.58	0.58	0.01
			0.00			1/2"	0.77	0.77	0.02
			0.00			Ice	0.97	0.97	0.02
						1" Ice	1.39	1.39	0.05
						2" Ice			
DB589-Y	C	From Face	6.00	0.0000	83.00	No Ice	1.38	1.38	0.01
			0.00			1/2"	2.31	2.31	0.02
			5.00			Ice	3.27	3.27	0.04
						1" Ice	4.81	4.81	0.09
						2" Ice			
CO-41A	A	From Face	6.00	0.0000	83.00	No Ice	3.15	3.15	0.01
			0.00			1/2"	4.38	4.38	0.04
			6.00			Ice	5.63	5.63	0.07
						1" Ice	7.77	7.77	0.15
						2" Ice			
Relocated to 67									
1151-3	C	From Face	6.00	0.0000	67.00	No Ice	4.18	4.18	0.02
			0.00			1/2"	5.73	5.73	0.05
			7.00			Ice	7.30	7.30	0.09
						1" Ice	10.48	10.48	0.20
						2" Ice			
67									
Side Arm Mount [6' SO 701-1]	C	None		0.0000	67.00	No Ice	1.70	3.34	0.13
						1/2"	2.28	4.68	0.16
						Ice	2.86	6.02	0.19
						1" Ice	4.02	8.70	0.24
						2" Ice			
3' x 2" Pipe Mount	A	From Face	6.00	0.0000	67.00	No Ice	0.58	0.58	0.01
			0.00			1/2"	0.77	0.77	0.02
			0.00			Ice	0.97	0.97	0.02
						1" Ice	1.39	1.39	0.05
						2" Ice			
3' x 2" Pipe Mount	B	From Face	6.00	0.0000	67.00	No Ice	0.58	0.58	0.01
			0.00			1/2"	0.77	0.77	0.02
			0.00			Ice	0.97	0.97	0.02
						1" Ice	1.39	1.39	0.05
						2" Ice			
3' x 2" Pipe Mount	C	From Face	6.00	0.0000	67.00	No Ice	0.58	0.58	0.01
			0.00			1/2"	0.77	0.77	0.02
			0.00			Ice	0.97	0.97	0.02
						1" Ice	1.39	1.39	0.05
						2" Ice			
CO-41A	A	From Face	6.00	0.0000	67.00	No Ice	3.15	3.15	0.01
			0.00			1/2"	4.38	4.38	0.04
			7.00			Ice	5.63	5.63	0.07
						1" Ice	7.77	7.77	0.15
						2" Ice			
CO-41A	B	From Face	6.00	0.0000	67.00	No Ice	3.15	3.15	0.01
			0.00			1/2"	4.38	4.38	0.04
			6.00			Ice	5.63	5.63	0.07
						1" Ice	7.77	7.77	0.15
						2" Ice			
Proposed									
ANT220F6	B	From Leg	4.50	0.0000	83.00	No Ice	3.92	3.92	0.04
			0.00			1/2"	5.38	5.38	0.06
			7.00			Ice	6.85	6.85	0.10

Description	Face or Leg	Offset Type	Offsets: Horz Lateral Vert ft ft ft	Azimuth Adjustment °	Placement ft		C_AA_A Front ft²	C_AA_A Side ft²	Weight K
						1" Ice 2" Ice	9.84	9.84	0.21
4'x3" Mount Pipe	B	From Leg	4.00 0.00 -1.00	0.0000	83.00	No Ice 1/2" Ice 1" Ice 2" Ice	1.09 1.36 1.62 2.16	1.09 1.36 1.62 2.16	0.03 0.04 0.05 0.09
ANT220F2	B	From Leg	4.50 0.00 -3.00	0.0000	83.00	No Ice 1/2" Ice 1" Ice 2" Ice	1.03 1.29 1.56 2.13	1.03 1.29 1.56 2.13	0.01 0.02 0.03 0.06
***									
***									

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
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

Comb. No.	Description
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
L1	84 - 34.25	Pole	Max Tension	1	0.00	0.00	0.00
			Max. Compression	26	-5.52	-0.74	-1.54
			Max. Mx	8	-2.08	-106.92	-0.35
			Max. My	14	-2.08	-0.34	-106.95
			Max. Vy	8	3.53	-106.92	-0.35
			Max. Vx	14	3.53	-0.34	-106.95
			Max. Torque	19			1.06
L2	34.25 - 0	Pole	Max Tension	1	0.00	0.00	0.00
			Max. Compression	26	-9.79	-0.77	-1.70
			Max. Mx	8	-4.62	-272.39	-0.37
			Max. My	14	-4.62	-0.35	-272.42
			Max. Vy	8	5.14	-272.39	-0.37
			Max. Vx	14	5.14	-0.35	-272.42
			Max. Torque	19			1.05

Maximum Reactions

Location	Condition	Gov. Load Comb.	Vertical K	Horizontal, X K	Horizontal, Z K
Pole	Max. Vert	33	9.79	-0.00	-1.74
	Max. H_x	21	3.47	5.13	-0.00
	Max. H_z	2	4.62	-0.00	5.13
	Max. M_x	2	271.67	-0.00	5.13
	Max. M_z	8	272.39	-5.13	-0.00
	Max. Torsion	19	1.05	4.44	-2.57
	Min. Vert	7	3.47	-4.44	2.57
	Min. H_x	8	4.62	-5.13	-0.00
	Min. H_z	14	4.62	-0.00	-5.13
	Min. M_x	14	-272.42	-0.00	-5.13
	Min. M_z	20	-271.70	5.13	-0.00
	Min. Torsion	7	-1.05	-4.44	2.57

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	3.85	0.00	0.00	0.31	-0.29	0.00
1.2 Dead+1.0 Wind 0 deg - No Ice	4.62	0.00	-5.13	-271.67	-0.35	0.38
0.9 Dead+1.0 Wind 0 deg - No Ice	3.47	0.00	-5.13	-269.97	-0.26	0.38

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
1.2 Dead+1.0 Wind 30 deg - No Ice	4.62	2.57	-4.44	-235.22	-136.37	0.82
0.9 Dead+1.0 Wind 30 deg - No Ice	3.47	2.57	-4.44	-233.76	-135.38	0.83
1.2 Dead+1.0 Wind 60 deg - No Ice	4.62	4.44	-2.57	-135.65	-235.94	1.05
0.9 Dead+1.0 Wind 60 deg - No Ice	3.47	4.44	-2.57	-134.85	-234.30	1.05
1.2 Dead+1.0 Wind 90 deg - No Ice	4.62	5.13	0.00	0.37	-272.39	0.99
0.9 Dead+1.0 Wind 90 deg - No Ice	3.47	5.13	0.00	0.28	-270.51	1.00
1.2 Dead+1.0 Wind 120 deg - No Ice	4.62	4.44	2.57	136.40	-235.94	0.67
0.9 Dead+1.0 Wind 120 deg - No Ice	3.47	4.44	2.57	135.40	-234.30	0.67
1.2 Dead+1.0 Wind 150 deg - No Ice	4.62	2.57	4.44	235.97	-136.37	0.17
0.9 Dead+1.0 Wind 150 deg - No Ice	3.47	2.57	4.44	234.32	-135.38	0.17
1.2 Dead+1.0 Wind 180 deg - No Ice	4.62	0.00	5.13	272.42	-0.35	-0.38
0.9 Dead+1.0 Wind 180 deg - No Ice	3.47	0.00	5.13	270.53	-0.26	-0.38
1.2 Dead+1.0 Wind 210 deg - No Ice	4.62	-2.57	4.44	235.97	135.68	-0.82
0.9 Dead+1.0 Wind 210 deg - No Ice	3.47	-2.57	4.44	234.32	134.87	-0.83
1.2 Dead+1.0 Wind 240 deg - No Ice	4.62	-4.44	2.57	136.40	235.25	-1.05
0.9 Dead+1.0 Wind 240 deg - No Ice	3.47	-4.44	2.57	135.40	233.79	-1.05
1.2 Dead+1.0 Wind 270 deg - No Ice	4.62	-5.13	0.00	0.37	271.70	-0.99
0.9 Dead+1.0 Wind 270 deg - No Ice	3.47	-5.13	0.00	0.28	269.99	-1.00
1.2 Dead+1.0 Wind 300 deg - No Ice	4.62	-4.44	-2.57	-135.65	235.25	-0.67
0.9 Dead+1.0 Wind 300 deg - No Ice	3.47	-4.44	-2.57	-134.85	233.79	-0.67
1.2 Dead+1.0 Wind 330 deg - No Ice	4.62	-2.57	-4.44	-235.22	135.68	-0.17
0.9 Dead+1.0 Wind 330 deg - No Ice	3.47	-2.57	-4.44	-233.76	134.87	-0.17
1.2 Dead+1.0 Ice+1.0 Temp	9.79	0.00	0.00	1.70	-0.77	0.00
1.2 Dead+1.0 Wind 0 deg+1.0 Ice+1.0 Temp	9.79	0.00	-1.74	-98.26	-0.77	0.12
1.2 Dead+1.0 Wind 30 deg+1.0 Ice+1.0 Temp	9.79	0.87	-1.51	-84.86	-50.75	0.32
1.2 Dead+1.0 Wind 60 deg+1.0 Ice+1.0 Temp	9.79	1.51	-0.87	-48.28	-87.34	0.44
1.2 Dead+1.0 Wind 90 deg+1.0 Ice+1.0 Temp	9.79	1.74	0.00	1.71	-100.73	0.44
1.2 Dead+1.0 Wind 120 deg+1.0 Ice+1.0 Temp	9.79	1.51	0.87	51.69	-87.34	0.32
1.2 Dead+1.0 Wind 150 deg+1.0 Ice+1.0 Temp	9.79	0.87	1.51	88.28	-50.75	0.12
1.2 Dead+1.0 Wind 180 deg+1.0 Ice+1.0 Temp	9.79	0.00	1.74	101.67	-0.77	-0.12
1.2 Dead+1.0 Wind 210 deg+1.0 Ice+1.0 Temp	9.79	-0.87	1.51	88.28	49.21	-0.32
1.2 Dead+1.0 Wind 240 deg+1.0 Ice+1.0 Temp	9.79	-1.51	0.87	51.69	85.80	-0.44
1.2 Dead+1.0 Wind 270 deg+1.0 Ice+1.0 Temp	9.79	-1.74	0.00	1.71	99.20	-0.44
1.2 Dead+1.0 Wind 300 deg+1.0 Ice+1.0 Temp	9.79	-1.51	-0.87	-48.28	85.80	-0.32
1.2 Dead+1.0 Wind 330 deg+1.0 Ice+1.0 Temp	9.79	-0.87	-1.51	-84.86	49.21	-0.12

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 0 deg - Service	3.85	0.00	-1.06	-55.58	-0.29	0.08
Dead+Wind 30 deg - Service	3.85	0.53	-0.92	-48.10	-28.24	0.17
Dead+Wind 60 deg - Service	3.85	0.92	-0.53	-27.64	-48.70	0.22
Dead+Wind 90 deg - Service	3.85	1.06	0.00	0.31	-56.19	0.21
Dead+Wind 120 deg - Service	3.85	0.92	0.53	28.26	-48.70	0.14
Dead+Wind 150 deg - Service	3.85	0.53	0.92	48.72	-28.24	0.04
Dead+Wind 180 deg - Service	3.85	0.00	1.06	56.21	-0.29	-0.08
Dead+Wind 210 deg - Service	3.85	-0.53	0.92	48.72	27.66	-0.17
Dead+Wind 240 deg - Service	3.85	-0.92	0.53	28.26	48.12	-0.22
Dead+Wind 270 deg - Service	3.85	-1.06	0.00	0.31	55.61	-0.21
Dead+Wind 300 deg - Service	3.85	-0.92	-0.53	-27.64	48.12	-0.14
Dead+Wind 330 deg - Service	3.85	-0.53	-0.92	-48.10	27.66	-0.04

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	-3.85	0.00	0.00	3.85	0.00	0.000%
2	0.00	-4.62	-5.13	-0.00	4.62	5.13	0.000%
3	0.00	-3.47	-5.13	-0.00	3.47	5.13	0.000%
4	2.57	-4.62	-4.44	-2.57	4.62	4.44	0.000%
5	2.57	-3.47	-4.44	-2.57	3.47	4.44	0.000%
6	4.44	-4.62	-2.57	-4.44	4.62	2.57	0.000%
7	4.44	-3.47	-2.57	-4.44	3.47	2.57	0.000%
8	5.13	-4.62	0.00	-5.13	4.62	-0.00	0.000%
9	5.13	-3.47	0.00	-5.13	3.47	-0.00	0.000%
10	4.44	-4.62	2.57	-4.44	4.62	-2.57	0.000%
11	4.44	-3.47	2.57	-4.44	3.47	-2.57	0.000%
12	2.57	-4.62	4.44	-2.57	4.62	-4.44	0.000%
13	2.57	-3.47	4.44	-2.57	3.47	-4.44	0.000%
14	0.00	-4.62	5.13	-0.00	4.62	-5.13	0.000%
15	0.00	-3.47	5.13	-0.00	3.47	-5.13	0.000%
16	-2.57	-4.62	4.44	2.57	4.62	-4.44	0.000%
17	-2.57	-3.47	4.44	2.57	3.47	-4.44	0.000%
18	-4.44	-4.62	2.57	4.44	4.62	-2.57	0.000%
19	-4.44	-3.47	2.57	4.44	3.47	-2.57	0.000%
20	-5.13	-4.62	0.00	5.13	4.62	-0.00	0.000%
21	-5.13	-3.47	0.00	5.13	3.47	-0.00	0.000%
22	-4.44	-4.62	-2.57	4.44	4.62	2.57	0.000%
23	-4.44	-3.47	-2.57	4.44	3.47	2.57	0.000%
24	-2.57	-4.62	-4.44	2.57	4.62	4.44	0.000%
25	-2.57	-3.47	-4.44	2.57	3.47	4.44	0.000%
26	0.00	-9.79	0.00	-0.00	9.79	-0.00	0.000%
27	0.00	-9.79	-1.74	-0.00	9.79	1.74	0.000%
28	0.87	-9.79	-1.51	-0.87	9.79	1.51	0.000%
29	1.51	-9.79	-0.87	-1.51	9.79	0.87	0.000%
30	1.74	-9.79	0.00	-1.74	9.79	-0.00	0.000%
31	1.51	-9.79	0.87	-1.51	9.79	-0.87	0.000%
32	0.87	-9.79	1.51	-0.87	9.79	-1.51	0.000%
33	0.00	-9.79	1.74	-0.00	9.79	-1.74	0.000%
34	-0.87	-9.79	1.51	0.87	9.79	-1.51	0.000%
35	-1.51	-9.79	0.87	1.51	9.79	-0.87	0.000%
36	-1.74	-9.79	0.00	1.74	9.79	-0.00	0.000%
37	-1.51	-9.79	-0.87	1.51	9.79	0.87	0.000%
38	-0.87	-9.79	-1.51	0.87	9.79	1.51	0.000%
39	0.00	-3.85	-1.06	0.00	3.85	1.06	0.000%
40	0.53	-3.85	-0.92	-0.53	3.85	0.92	0.000%

Load Comb.	Sum of Applied Forces PX K	PY K	PZ K	Sum of Reactions PX K	PY K	PZ K	% Error
41	0.92	-3.85	-0.53	-0.92	3.85	0.53	0.000%
42	1.06	-3.85	0.00	-1.06	3.85	0.00	0.000%
43	0.92	-3.85	0.53	-0.92	3.85	-0.53	0.000%
44	0.53	-3.85	0.92	-0.53	3.85	-0.92	0.000%
45	0.00	-3.85	1.06	0.00	3.85	-1.06	0.000%
46	-0.53	-3.85	0.92	0.53	3.85	-0.92	0.000%
47	-0.92	-3.85	0.53	0.92	3.85	-0.53	0.000%
48	-1.06	-3.85	0.00	1.06	3.85	0.00	0.000%
49	-0.92	-3.85	-0.53	0.92	3.85	0.53	0.000%
50	-0.53	-3.85	-0.92	0.53	3.85	0.92	0.000%

Non-Linear Convergence Results

Load Combination	Converged?	Number of Cycles	Displacement Tolerance	Force Tolerance
1	Yes	4	0.00000001	0.00000001
2	Yes	4	0.00000001	0.00036066
3	Yes	4	0.00000001	0.00021032
4	Yes	5	0.00000001	0.00007528
5	Yes	5	0.00000001	0.00003093
6	Yes	5	0.00000001	0.00005202
7	Yes	5	0.00000001	0.00000001
8	Yes	4	0.00000001	0.00089402
9	Yes	4	0.00000001	0.00052611
10	Yes	5	0.00000001	0.00007258
11	Yes	5	0.00000001	0.00002956
12	Yes	5	0.00000001	0.00005886
13	Yes	5	0.00000001	0.00000001
14	Yes	4	0.00000001	0.00036146
15	Yes	4	0.00000001	0.00021045
16	Yes	5	0.00000001	0.00005258
17	Yes	5	0.00000001	0.00000001
18	Yes	5	0.00000001	0.00008001
19	Yes	5	0.00000001	0.00003304
20	Yes	4	0.00000001	0.00089270
21	Yes	4	0.00000001	0.00052612
22	Yes	5	0.00000001	0.00005311
23	Yes	5	0.00000001	0.00000001
24	Yes	5	0.00000001	0.00006268
25	Yes	5	0.00000001	0.00000001
26	Yes	4	0.00000001	0.00003779
27	Yes	5	0.00000001	0.00008567
28	Yes	5	0.00000001	0.00013913
29	Yes	5	0.00000001	0.00012489
30	Yes	5	0.00000001	0.00010876
31	Yes	5	0.00000001	0.00015051
32	Yes	5	0.00000001	0.00013200
33	Yes	5	0.00000001	0.00009101
34	Yes	5	0.00000001	0.00012660
35	Yes	5	0.00000001	0.00015272
36	Yes	5	0.00000001	0.00010553
37	Yes	5	0.00000001	0.00011843
38	Yes	5	0.00000001	0.00012387
39	Yes	4	0.00000001	0.00000001
40	Yes	4	0.00000001	0.00006612
41	Yes	4	0.00000001	0.00004990
42	Yes	4	0.00000001	0.00005699
43	Yes	4	0.00000001	0.00006005
44	Yes	4	0.00000001	0.00000001
45	Yes	4	0.00000001	0.00000001
46	Yes	4	0.00000001	0.00000001
47	Yes	4	0.00000001	0.00007779
48	Yes	4	0.00000001	0.00005580
49	Yes	4	0.00000001	0.00000001
50	Yes	4	0.00000001	0.00000001

Maximum Tower Deflections - Service Wind

Section No.	Elevation ft	Horz. Deflection in	Gov. Load Comb.	Tilt °	Twist °
L1	84 - 34.25	10.939	44	1.0208	0.0184
L2	38 - 0	2.560	44	0.5996	0.0046

Critical Deflections and Radius of Curvature - Service Wind

Elevation ft	Appurtenance	Gov. Load Comb.	Deflection in	Tilt °	Twist °	Radius of Curvature ft
83.00	Side Arm Mount [4' SO 701-1]	44	10.726	1.0135	0.0180	26942
67.00	1151-3	44	7.381	0.8917	0.0126	7924

Maximum Tower Deflections - Design Wind

Section No.	Elevation ft	Horz. Deflection in	Gov. Load Comb.	Tilt °	Twist °
L1	84 - 34.25	52.537	12	4.8662	0.0889
L2	38 - 0	12.369	12	2.8953	0.0220

Critical Deflections and Radius of Curvature - Design Wind

Elevation ft	Appurtenance	Gov. Load Comb.	Deflection in	Tilt °	Twist °	Radius of Curvature ft
83.00	Side Arm Mount [4' SO 701-1]	12	51.514	4.8325	0.0872	5704
67.00	1151-3	12	35.491	4.2718	0.0607	1676

Compression Checks

Pole Design Data

Section No.	Elevation ft	Size	L ft	L_u ft	Kl/r	A in^2	P_u K	ϕP_n K	Ratio $\frac{P_u}{\phi P_n}$
L1	84 - 34.25 (1)	TP18.145x12.001x0.1875	49.75	0.00	0.0	10.411 3	-2.08	609.06	0.003
L2	34.25 - 0 (2)	TP22x17.3069x0.2188	38.00	0.00	0.0	15.123 0	-4.62	884.70	0.005

Pole Bending Design Data

Section No.	Elevation ft	Size	M_{ux} kip-ft	ϕM_{nx} kip-ft	Ratio $\frac{M_{ux}}{\phi M_{nx}}$	M_{uy} kip-ft	ϕM_{ny} kip-ft	Ratio $\frac{M_{uy}}{\phi M_{ny}}$
L1	84 - 34.25 (1)	TP18.145x12.001x0.1875	107.06	277.48	0.386	0.00	277.48	0.000
L2	34.25 - 0 (2)	TP22x17.3069x0.2188	272.53	496.47	0.549	0.00	496.47	0.000

Pole Shear Design Data

Section No.	Elevation ft	Size	Actual V_u K	ϕV_n K	Ratio $\frac{V_u}{\phi V_n}$	Actual T_u kip-ft	ϕT_n kip-ft	Ratio $\frac{T_u}{\phi T_n}$
L1	84 - 34.25 (1)	TP18.145x12.001x0.1875	3.53	182.72	0.019	0.67	279.94	0.002
L2	34.25 - 0 (2)	TP22x17.3069x0.2188	5.14	265.41	0.019	0.67	506.26	0.001

Pole Interaction Design Data

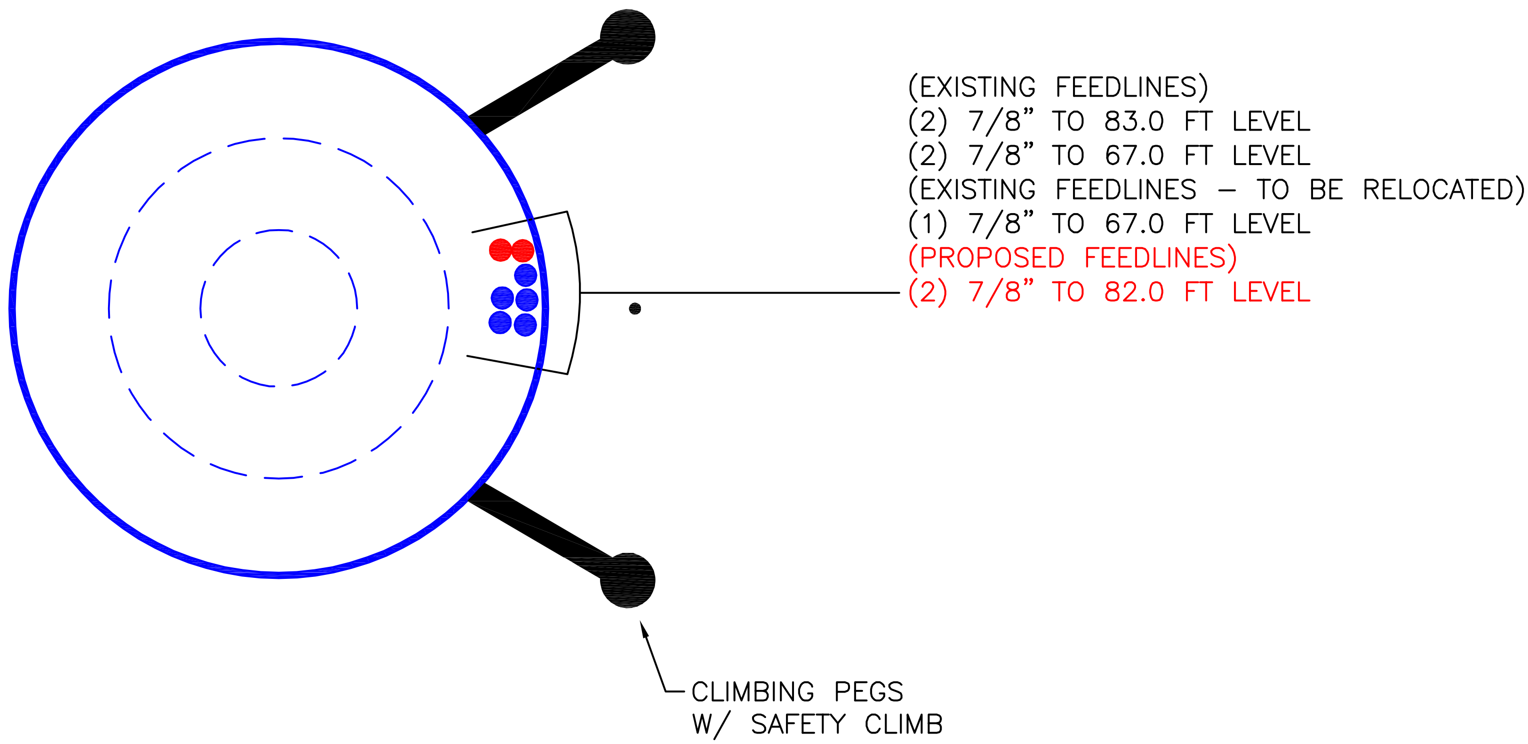
Section No.	Elevation ft	Ratio $\frac{P_u}{\phi P_n}$	Ratio $\frac{M_{ux}}{\phi M_{nx}}$	Ratio $\frac{M_{uy}}{\phi M_{ny}}$	Ratio $\frac{V_u}{\phi V_n}$	Ratio $\frac{T_u}{\phi T_n}$	Comb. Stress Ratio	Allow. Stress Ratio	Criteria
L1	84 - 34.25 (1)	0.003	0.386	0.000	0.019	0.002	0.390	1.050	4.8.2
L2	34.25 - 0 (2)	0.005	0.549	0.000	0.019	0.001	0.555	1.050	4.8.2

Section Capacity Table

Section No.	Elevation ft	Component Type	Size	Critical Element	P K	$øP_{allow}$ K	% Capacity	Pass Fail
L1	84 - 34.25	Pole	TP18.145x12.001x0.1875	1	-2.08	639.52	37.1	Pass
L2	34.25 - 0	Pole	TP22x17.3069x0.2188	2	-4.62	928.93	52.8	Pass
							Summary	
						Pole (L2)	52.8	Pass
						RATING =	**52.8**	**Pass**

APPENDIX B

BASE LEVEL DRAWING



RIDGEFIELD 22N

APPENDIX C

ADDITIONAL CALCULATIONS

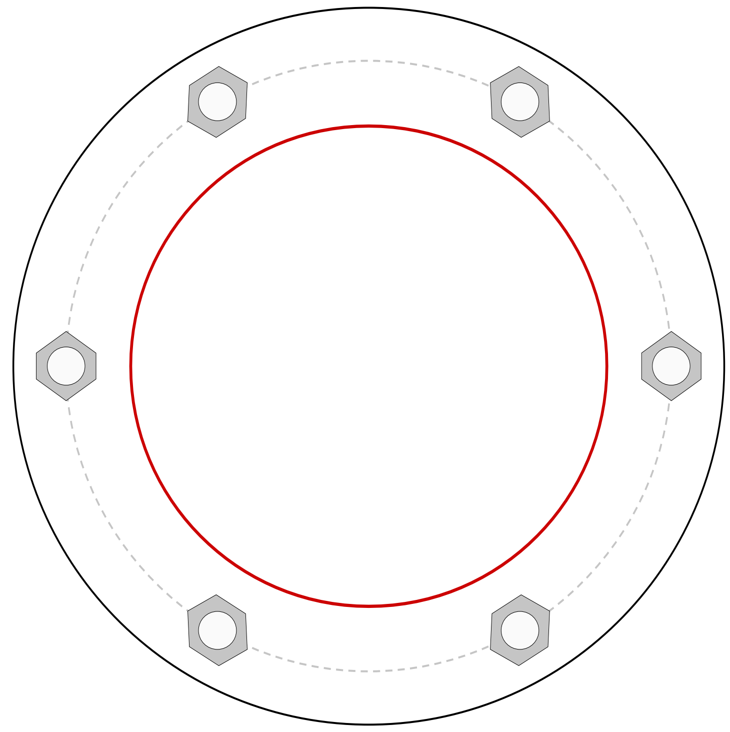
Monopole Base Plate Connection

Site Info	
	ES-074
	NewMilfordRS

Analysis Considerations	
TIA-222 Revision	H
Grout Considered:	No
I_{ar} (in)	2.125

Applied Loads	
Moment (kip-ft)	273.00
Axial Force (kips)	5.00
Shear Force (kips)	5.00

**TIA-222-H Section 15.5 Applied*



Connection Properties

Anchor Rod Data

(6) 1-3/4" ø bolts (A615-75 N; Fy=75 ksi, Fu=100 ksi) on 27.96" BC

Base Plate Data

32.84" OD x 2.25" Plate (A572-50; Fy=50 ksi, Fu=65 ksi)

Stiffener Data

N/A

Pole Data

22" x 0.21875" 18-sided pole (A572-65; Fy=65 ksi, Fu=80 ksi)

Analysis Results

Anchor Rod Summary *(units of kips, kip-in)*

Pu_c = 78.82	ϕPn_c = 162.36	**Stress Rating**
Vu = 0.83	ϕVn = 73.06	**48.1%**
Mu = 1.15	ϕMn = 60.29	Pass

Base Plate Summary

Max Stress (ksi):	10.76	(Flexural)
Allowable Stress (ksi):	45	
Stress Rating:	**22.8%**	Pass

Pier and Pad Foundation

ES-286
Ridgefield22N

TIA-222 Revision:	H	Top & Bot. Pad Rein. Different?:	✓
Tower Type:	Monopole	Block Foundation?:	☐

Superstructure Analysis Reactions		
Compression, P_{comp}:	5	kips
Base Shear, Vu_comp:	5	kips
Moment, M_u:	273	ft-kips
Tower Height, **H**:	84	ft
BP Dist. Above Fdn, bp_{dist}:	6	in

Foundation Analysis Checks	Capacity	Demand	Rating*	Check
Lateral (Sliding) (kips)	81.56	5.00	**5.8%**	**Pass**
Bearing Pressure (ksf)	6.00	1.71	**28.4%**	**Pass**
*Overturning (kip*ft)*	650.56	305.50	**47.0%**	**Pass**
*Pier Flexure (Comp.) (kip*ft)*	1147.94	293.00	**24.3%**	**Pass**
Pier Compression (kip)	7592.08	16.45	**0.2%**	**Pass**
*Pad Flexure (kip*ft)*	424.27	80.97	**18.2%**	**Pass**
Pad Shear - 1-way (kips)	235.14	25.18	**10.2%**	**Pass**
Pad Shear - 2-way (Comp) (ksi)	0.164	0.013	**7.4%**	**Pass**
*Flexural 2-way (Comp) (kip*ft)*	487.12	175.80	**34.4%**	**Pass**

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

Soil Rating*:	**47.0%**
Structural Rating*:	**34.4%**

Pier Properties		
Pier Shape:	Circular	
Pier Diameter, **dpier**:	4.5	ft
Ext. Above Grade, **E**:	0.5	ft
Pier Rebar Size, **Sc**:	9	
Pier Rebar Quantity, **mc**:	12	
Pier Tie/Spiral Size, **St**:	4	
Pier Tie/Spiral Quantity, **mt**:	7	
Pier Reinforcement Type:	Tie	
Pier Clear Cover, cc_{pier}:	6	in

Pad Properties		
Depth, **D**:	5.5	ft
Pad Width, **W**:	12	ft
Pad Thickness, **T**:	2	ft
Pad Rebar Size (Top), Sp_{top}:	4	
Pad Top Rebar Quantity (Top), mp_{top}:	9	
Pad Rebar Size (Bottom), **Sp**:	6	
Pad Rebar Quantity (Bottom), **mp**:	11	
Pad Clear Cover, cc_{pad}:	3	in

Material Properties		
Rebar Grade, **Fy**:	60	ksi
Concrete Compressive Strength, **F'c**:	3	ksi
Dry Concrete Density, δ**c**:	150	pcf

Soil Properties			
Total Soil Unit Weight, γ:	125	pcf	
Ultimate Gross Bearing, Qult:	8.000	ksf	<--Toggle between Gross and Net
Cohesion, **Cu**:		ksf	
Friction Angle, φ:	34	degrees	
SPT Blow Count, N_{blows}:			
Base Friction, μ:	0.6		
Neglected Depth, **N**:	3.50	ft	
Foundation Bearing on Rock?	No		
Groundwater Depth, **gw**:	N/A	ft	

Version 3.3.1

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

PHYSICAL PARAMETERS

Pier Height Above Water Table:	h_{pier_above} = (MIN(gw,D-T) + E)	h_{pier_above} =	4	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} = (π/4) * (dpier^2) * hpier_above * δc / 1000 + (π/4) * (dpier^2) * hpier_below * (δc-62.4) / 1000	W_{pier} =	9.54	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} =	43.20	kips
Concrete weight:	W_c = V * δc	W_c =	52.7	kips
Soil weight:	W_s = (D - T) * (W² - (dpier² / 4 * π)) * γ	W_s =	56.0	kips
EIA/TIA-222 Load Factor:	LF = 1	LF =	1.00	
Soil Depth from Top of Pad to Mid. Layer (Cohesionless Soil):	$H_{cohesionless}$ = T / 2	$H_{cohesionless}$ =	1.00	ft
Soil Depth from Grade to Mid. Layer (Silty Soil):	H_{silty} = (D-T)+T/2	H_{silty} =	4.50	ft

LATERAL RESISTANCE

Total Nominal Pp Resistance:	P_{p_total} = Pp_pier *Ap_pier + Pp_pad * Ap_pad	P_{p_total} =	47.75	kips
Factored Total Weight for Compression:	$P_{factored\_comp}$ = φD * (Wc + Ws + Pcomp / 1.2)	$P_{factored\_comp}$ =	101.66	kips
Nominal Base Friction Resistance (Comp):	R_{s_comp} = P * μ	R_{s_comp} =	60.99	kips
Lateral Resistance (Comp):	Va_comp = Φs * (Pp_total + Rs_comp)	Va_comp =	81.56	kips

Check **Va_comp = 81.56 kips >= Vu_comp = 5.00 kips** **RATING: 6.13% OK**

PIER REINFORCEMENT

Pier / Column Compression

Pier Cross-Sectional Area:	A_1 = dpier^2 * π/4	A_1 =	2290.22	in²
Support Area (2H:1V Slope):	A_2 = (MIN(W, dpier + 4 * T))²*(π/4)	A_2 =	16286.02	in²
Compressive Resistance (H/D < 3):	$ΦP_{n1}$ = 0.65*0.85 * F'c * A1 * MIN(√(A2/A1),2)	$ΦP_{n1}$ =	7592.08	kips
Rebar:	$s_{\_pier}$ = 9; $m_{\_pier}$ = 12	d_{b_pier} = 1.128 in; A_{b_pier} = 1 in²		
Provided area of steel:	A_{s_pier} = Ab_pier * m_pier	A_{s_pier} =	12.00	in²
Compressive Resistance (H/D >= 3):	$ΦP_{n2}$ = 0.65 * 0.8 * (0.85 * (F\c) * (A_1 - As_pier) + ((Fy) * As_pier))	$ΦP_{n2}$ =	3395.32	kips
	H/D = (D - T + E) / dpier	H/D =	0.89	
Utilized Compressive Resistance:	$ΦP_n$ = Pn1	$ΦP_n$ =	7592.08	kips
Applied Compressive Force:	P_u = Pcomp + 1.2 * Wpier	P_u =	16.45	kips

Check **$ΦP_n$ = 7592.08 kips >= P_u = 16.45 kips** **RATING: 0.22% OK**

Pier Flexure

Cross-sectional area:	A_g = dpier² * π / 4	A_g =	2290.22	in²
Min. area of steel (pier):	A_{smin_pier} = Ag * 0.005	A_{smin_pier} =	11.45	in²
Cage Diameter:	d_o = dpier - 2 * cc - 2 * tie - d_b	d_o =	39.87	in

Check **A_{s_pier} = 12.00 in² >= A_{smin_pier} = 11.45 in²** **OK**

Applied Moment to DSMC (Compression):	M_{u_comp} = (D - T + E) * Vu + Mu	M_{u_comp} =	293.00	ft-kips
Pier Moment Capacity (Compression):	$ΦM_{n\_comp}$ = *from DSMC*	$ΦM_{n\_comp}$ =	1147.94	ft-kips

Check **M_{u_comp} = 293.00 ft-kips >= $ΦM_{n\_comp}$ = 1147.94 ft-kips** **RATING: 25.52% OK**

PAD REINFORCEMENT

Elastic Bearing Pressure for Soil Checks

Overturning Moment:	$Mo = M + Vu\_comp * (D + E + bpdist/12)$	Mo =	305.50	ft-kips
Compressive Load for Bearing:	$P_{bearing}$ = Wc + Ws + Pcomp / 1.2	$P_{bearing}$ =	112.95	kips
*Load Eccentricity (0.9*D LC):*	ec_0.9 = Mo / 0.9*Pbearing	ec_0.9 =	3.01	ft	L/6 < e <= L
*Load Eccentricity (1.2*D LC):*	ec_1.2 = Mo / 1.2*Pbearing	ec_1.2 =	2.25	ft	L/6 < e <= L
Elastic Section Modulus:	$S = W^3 / 6$	S =	288.00	ft³
*Positive Pressure 0.9*D LC):*	Ppos_0.9 = 0.9*Pbearing / Area + Mo / S	$P_{pos\_st\_0.9}$ =	1.77	ksf
*Positive Pressure (1.2*D LC):*	Ppos_1.2 = 1.2*Pbearing / Area + Mo / S	$P_{pos\_st\_1.2}$ =	2.00	ksf
*Negative Pressure (0.9*D LC):*	Pneg_0.9 = 0.9*Pbearing / Area - Mo / S **Note: The stress resultant is NOT within the kern. Bearing area has been adjusted below.**	$P_{neg\_st\_0.9}$ =	-0.35	ksf
*Negative Pressure (1.2*D LC):*	Pneg_1.2 = 1.2*Pbearing / Area - Mo / S **Note: The stress resultant is NOT within the kern. Bearing area has been adjusted below.**	$P_{neg\_st\_1.2}$ =	-0.12	ksf
*Adjusted Pressure (0.9*D LC):*	Padj_0.9 = 2*0.9*Pbearing/(3*W*(W/2-ec_0.9))	$P_{adj\_0.9}$ =	1.89	ksf
*Adjusted Pressure (1.2*D LC):*	Padj_1.2 = 2*1.2*Pbearing/(3*W*(W/2-ec_0.9))	$P_{adj\_1.2}$ =	2.01	ksf
*Maximum Pressure (0.9*D LC):*	$q_{u1\_0.9}$ = IF(Pneg ≥ 0, Ppos , Padj)	$q_{u\_st\_0.9}$ =	1.89	ksf
*Maximum Pressure (1.2*D LC):*	$q_{u1\_1.2}$ = IF(Pneg ≥ 0, Ppos , Padj)	$q_{u\_st\_1.2}$ =	2.01	ksf

One-Way Shear

Rebar: $s_{\_pad}$ = 6, $m_{\_pad}$ = 11 — *Equally spaced; bottom layer in one direction* — d_{b_pad} = 0.75 in; A_{b_pad} = 0.44 in^2

Effective depth:	d_c = T - cc - 1.5 * db	d_c =	19.9	in
Distance from Edge of Pad to Column Face:	d' = W / 2 - dpier / 2	d' =	3.8	ft
Distance from Edge of Pad to dc from Column Face:	d'' = d' - d_c / 12	d'' =	2.09	ft
Distance to qs (0.9D LC):	L' _0.9 = (W / 2 - ec_0.9) * 3	L' _0.9 =	8.98	ft
Distance to qs (1.2D LC):	L' _1.2 = (W / 2 - ec_1.2) * 3	L' _1.2 =	11.24	ft
*Slope of qs (0.9*D LC):*	sqs_0.9 = IF(L' > W, (Ppos - Pneg) / W, qu / L')	sqs_0.9 =	0.21	kcf
*Slope of qs (1.2*D LC):*	sqs_1.2 = IF(L' > W, (Ppos - Pneg) / W, qu / L')	sqs_1.2 =	0.18	kcf
Nominal Shear Strength:	V_{n1} = 2 * W * √(F'c*1000) * dc	V_{n1} =	313.52	kips
Shear Reduction Factor:	$φ_{shear}$ = 0.75	$φ_{shear}$ =	0.75	
Design Shear Strength:	$φV_{n1}$ = φshear * V_{n1}	$φV_{n1}$ =	235.14	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:	3.5	0.125	9.89	13.19
Soil Below Water Table:	0	0.063	0.00	0.00
Pad Above Water Table:	2	0.150	6.78	9.05
Pad Below Water Table:	0	0.088	0.00	0.00
Total:			16.68	22.24

*Applied Shear (0.9*D LC):*	$V_{u1\_0.9}$ = sqs_0.9 * MIN(L'_0.9,d'') * (W / 2 - dpier / 2 - dc) * W	$V_{u1\_0.9}$ =	25.18	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	$V_{u1\_1.2}$ =	23.56	kips

Check **$φV_{n1}$ = 235.14 kips >= V_{u1} = 25.18 kips** **RATING: 10.71% OK**

Two-Way Shear (Compression)

Pier Shape:	Pier Shape: Circular	Pier Shape:	Circular	
Pier Diameter:	d_{pier1} = d_{pier} * 12 in / ft	d_{pier1} =	54.00	in
Equivalent Square Pier Diameter:	d_{pier_sq} = √π / 2 * dpier	d_{pier_sq} =	47.86	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} =	20.25	in
Area of Concrete in Shear:	A_c = ((dpier1 + dc_2)*PI()) * dc_2	A_c =	4723.58	in^2
Eq. Square Area of Concrete in Shear:	A_{c_sq} = (4*(dpier_sq+dc_2))*dc_2	A_{c_sq} =	5516.61	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 =	3516.00	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} =	5628915.12	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} =	4359017.90	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)	$q_{u\_AB\_1.2}$ =	0.00	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)	$q_{u\_CD\_1.2}$ =	0.00	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)	$q_{u\_AB\_1.2\_sq}$ =	0.00	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)	$q_{u\_CD\_1.2\_sq}$ =	0.00	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)	$V_{u\_1.2}$ =	16.45	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)))	$v_{u\_1.2\_controlling}$ =	0.013	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))	$v_{u\_1.2\_controlling\_sq}$ =	0.014	ksi
Shear Stress Capacity:	Φv_n =	φs * 4 * (√F'c*1000) / 1000	Φv_n =	0.164	ksi

Check	**Φv_n =**	**0.164**	**ksi**	**>=**	**v_{u_demand} =**	**0.013**	**ksi**	**RATING:** **7.76%**	**OK**

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

Effective Pad Width:	$b_{\_pad}$ =	MIN(dpier+3*T,W)	$b_{\_pad}$ =	10.5	ft
Bar Spacing:	B_{s_pad} =	Bs_pad (see design checks below)	B_{s_pad} =	13.73	in
Fraction of Bars in Effective Width:	$m_{\_effective}$ =	IF(b_pad=W,mp,12*b_pad/Bs_pad)	$m_{\_effective}$ =	9.18	
Area of Steel in Effective Width:	$A_{s\_effective}$ =	VLOOKUP(Sp,Ref!$A$2:$C$12,3,0)*m_effective	$A_{s\_effective}$ =	4.04	in²
Depth of Equivalent Rectangular Stress Block:	$a_{\_effective}$ =	$A_{s\_effective}$ * Fy / (0.85 * F'c * $b_{\_slab}$*12)	$a_{\_effective}$ =	0.75	in
	β_{pad} =	β_{pad} (see design checks below)	β_{pad} =	0.85	
Distance from Top to Nuetral Axis:	$c_{\_effective}$ =	$a_{\_effective}$ / β_{pad}	$c_{\_effective}$ =	0.89	
Effective depth:	dc =	dc (see One-Way Shear check above)	dc =	19.875	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	$\varepsilon_{s\_effective}$ =	0.06419	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:	$\varphi flex_{\_effective}$ =	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)	$M_{n\_effective}$ =	393.79	ft-kips
Design Flexural Strength:	$\varphi M_{n\_effective}$ =	φflex_effective * Mn_effective	$\varphi M_{n\_effective}$ =	354.41	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)	$B_{s\_pad\_top}$ =	17.19	in
Fraction of Bars in Effective Width:	$m_{\_effective\_top}$ =	IF(b_pad=W,mptop,12*b_pad/Bs_pad_top)	$m_{\_effective\_top}$ =	7.33	
Area of Steel in Effective Width:	$A_{s\_effective\_top}$ =	VLOOKUP(sptop,Ref!$A$2:$C$12,3,0)*m_effective_top	$A_{s\_effective\_top}$ =	1.47	in²
Depth of Equivalent Rectangular Stress Block:	$a_{\_effective\_top}$ =	$A_{s\_effective\_top}$ * Fy / (0.85 * F'c * $b_{\_slab}$*12)	$a_{\_effective\_top}$ =	0.27	in
Distance from Top to Nuetral Axis:	$c_{\_effective\_top}$ =	$a_{\_effective\_top}$ / β_{pad}	$c_{\_effective\_top}$ =	0.32	
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	$\varepsilon_{s\_effective\_top}$ =	0.18560	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)	$M_{n\_effective\_top}$ =	147.45	ft-kips
Design Flexural Strength:	$\varphi M_{n\_effective\_top}$ =	φflex_effective * Mn_effective	$\varphi M_{n\_effective\_top}$ =	132.70	ft-kips
Applied Moment:	$Yf*M_{u\_comp}$ =	$Yf*M_{u\_comp}$	$Yf*M_{u\_comp}$ =	175.8	ft-kips

Check	**$\varphi M_{n\_effective}$ =**	**487.12**	**ksi**	**>=**	**$Yf*M_{u\_comp}$ =**	**175.80**	**ksi**	**RATING:** **36.09%**	**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} = 4.84 in^2
Depth of Equivalent Rectangular Stress Block:	a = A_{s_pad} * Fy / (0.85 * F'c * W)	a = 0.79 in
Distance from Top to Nuetral Axis:	c = a / β_{pad}	c = 0.93 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 = 0.06108 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 = 471.41 ft-kips
Design Flexural Strength:	φM_n = φflex * Mn	φM_n = 424.27 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 = 1.10 ksf
*Bearing Press. at Crit. Section (1.2*D LC):*	qmid_1.2 = qu_st_1.2 - sqs_1.2 * d'	qmid_1.2 = 1.34 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:	3.5	0.125	17.72	23.63	1.875	33.22	44.296875
Soil Below Water Table:	0	0.063	0.00	0.00	1.875	0.00	0
Pad Above Water Table:	2	0.150	12.15	16.20	1.875	22.78	30.375
Pad Below Water Table:	0	0.088	0.00	0.00	1.875	0.00	0
Total:			29.87	39.83		56.00	74.67

*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 = 80.97 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 = 76.07 ft-kips

Check **φM_n = 424.27 ft-kips >= M_{u_pad} = 80.97 ft-kips** **RATING: 19.09% OK**

PIER DESIGN CHECKS

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 = 1
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	$c_{\_c}$ = 5.2 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 = 0.95
Development (tensile):	$L_{dt}'_{\_c}$ = (3 / 40) * (Fy*1000 / √(F'c*1000)) * αβ_c * γ_c * λ_c * R_c * db_c / c_c'	$L_{dt}'_{\_c}$ = 45.99 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} = 45.99 in
Development (comp.):	$L_{dc}'_{\_c}$ = 0.02 * db_c * Fy*1000 / √(F'c*1000)	$L_{dc}'_{\_c}$ = 24.71 in

	$L_{dc}''_{\_c}$ =	0.0003 * db_c * Fy*1000	$L_{dc}''_{\_c}$ =	20.30	in
Development length:	L_{dc_c} =	MAX(8, Ldc'_c, Ldc''_c)	L_{dc_c} =	24.71	in
Length available in pier:	L_{vc} =	D - T + E - cc	L_{vc} =	42.0	in

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}' =	17.3	in
Minimum length:	L_{dh_min} =	the larger of: 8 * d_b or 6 in	L_{dh_min} =	9.0	in
Development length:	L_{dh} =	MAX(Ldh_min, Ldh')	L_{dh} =	17.3	in

Check **L_{vp} = 21.00 in >= L_{dh} = 17.30 in** **OK**

Hook tail length:	L_{h_tail} =	12 * db beyond the bend radius	L_{h_tail} =	19.2	in
Length available in pad:	L_{h_pad} =	(W - dpier) / 2 + ccpier - ccpad	L_{h_pad} =	48	in

Check **L_{h_pad} = 48.00 in >= L_{dh_tail} = 19.18 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:	$s_{\_t}$ =	4	d_{b_t} =	0.5	in
	$m_{\_t}$ =	7	A_{b_t} =	0.2	in^2
Allowable tie spacing per vertical rebar:	$B_{s\_t\_max1}$ =	8 / z * db_c	$B_{s\_t\_max1}$ =	18.048	in
per tie size:	$B_{s\_t\_max2}$ =	24 / z * db_t	$B_{s\_t\_max2}$ =	24	in

per pier diameter:	$B_{s\_t\_max3}$ =	di / (4 * z²)	$B_{s\_t\_max3}$ =	54	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)	$B_{s\_t\_max}$ =	18	in
Minimum required ties:	$m_{\_t\_min}$ =	(D - T + E) / Bs_t_max + 2	$m_{\_t\_min}$ =	5.00	

Check **$m_{\_t}$ = 7.00 >= $m_{\_t\_min}$ = 5.00** **OK**

PAD DESIGN CHECKS

Bar Separation

Bar separation:	B_{s_pad} =	(W - 2 * cc - db) / (m - 1)	B_{s_pad} =	13.73	in

Check **18" >= B_{s_p} = 13.73 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 =	3.38	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} =	90.0	ft-kips
Steel estimate:	A_{st_p}' =	Mn / (φt * Fy * dc)	A_{st_p}' =	1.006	in^2
	a_p =	Ast' * Fy / (β * F'c * W)	a_p =	0.16	in
Required steel:	$A_{st\_p\_st}$ =	M_{nr} / (Fy * (dc - ap / 2))	$A_{st\_p\_st}$ =	0.909	in^2
Excess reinforcement:	R_p =	Ast_p / As_p	R_p =	1.29	
Development (tensile):	L_d =	(3 / 40) * (Fy*1000 / √(F'c*1000)) * αβ * γ * λ * R * db / c'	L_d =	32.95	in
Minimum length:	L_{d_min} =	12 inches	L_{d_min} =	12.0	in
Development length:	L_{dp} =	MAX(Ld_min, Ldp')	L_{dp} =	32.95	in
Length available in pad:	L_{pad} =	W / 2 - dpier / 2 - ccpad	L_{pad} =	42.00	in

Check **L_{pad} = 42.00 in >= L_{dp} = 32.95 in** **OK**

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-286
Ridgefield22N

Maximum Shaft Superimposed Forces		
TIA Revision:	H	
Max. Factored Shaft Mu:	293	ft-kips **(* Note)**
Max. Factored Shaft Pu:	5	kips
Max Axial Force Type:	Comp.	

(*) 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:	293	ft-kips
1.00	Pu:	5	kips

Pier Properties		
Concrete:		
Pier Diameter =	4.5	ft
Concrete Area =	2290.2	in^2
Reinforcement:		
Clear Cover to **Tie**=	6.00	in
Horiz. **Tie** Bar Size=	4	
Vert. Cage Diameter =	3.32	ft
Vert. Cage Diameter =	39.87	in
Vertical Bar Size =	9	
Bar Diameter =	1.13	in
Bar Area =	1	in^2
Number of Bars =	12	
As Total=	12	in^2
A s/ Aconc, Rho:	0.0052	0.52%

Material Properties		
Concrete Comp. strength, f'c =	3000	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:

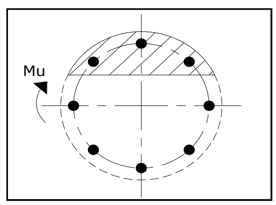
(3)*(Sqrt(f'c)/Fy:	0.0027
200 / Fy:	0.0033

Minimum Rho Check:

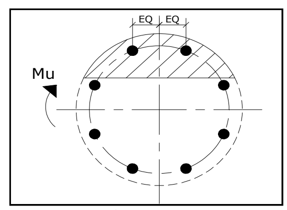
Assumed Min. Rho:	0.50%	
Provided Rho:	0.52%	OK

Results:

Governing Orientation Case: **1**



Case 1



Case 2

Dist. From Edge to Neutral Axis:	**9.29**	in
Extreme Steel Strain, εt:	**0.0119**	

εt > 0.0050, Tension Controlled

Reduction Factor,φ: **0.900**

Ref. Shaft Max Axial Capacities, ϕ Max(Pn or Tn):		
Max Pu = (φ=0.65) Pn. Pn per ACI 318 (10-2)	3395.32	kips
at Mu=(ϕ=0.65)Mn=	1278.88	ft-kips
Max Tu, (φ=0.9) Tn =	648	kips
at Mu=ϕ=(0.90)Mn=	0.00	ft-kips

Output Note: Negative Pu=Tension

For Axial Compression, φ Pn = Pu:	4.50	kips
Drilled Shaft Moment Capacity, φMn:	**1147.94**	ft-kips
Drilled Shaft Superimposed Mu:	**293.00**	ft-kips

(Mu/φMn, Drilled Shaft Flexure CSR:	**25.5%**

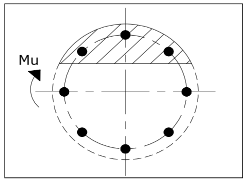
Maximum Allowable Moment of a Circular Pier

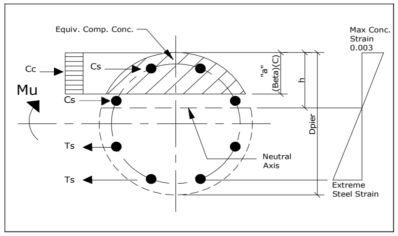
Pu: 5 kips (from Results Tab)
Axial Force type: Comp. (from Results Tab)

For Internal Calculations:
Axial Load (Negative for Compression) = -5.00 kips

	Case 1	Case 2	
Reduction factor, ϕ2002 =	0.9	0.9	<-- 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 spirals: φ=0.57+67(ϵt).
Reduction factor, ϕ2005 =	0.9	0.9	<-- 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 equation for spirals: φ=0.70+((ϵt)-0.002)(200/3).
Reduction factor, ϕ2014 =	0.9	0.9	<-- 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 equation for spirals: φ=0.75+0.15((ϵt-ϵty)/(0.005-ϵty).
ł ACI code:	0.9	0.9	

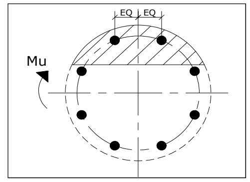
Case 1: Single Bar Near the Extreme Fiber





General Sketch (Variables) for both cases

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



Case 1

Neutral Axis

Distance from extreme edge to neutral axis, h = 9.34 in
Equivalent compression zone factor = 0.85
Distance from extreme edge to equivalent compression zone factor, a = 7.94 in
Distance from centroid to neutral axis = 17.66 in

Compression Zone

Area of steel in compression zone, Asc = 1.00 in^2
Angle from centroid of pier to intersection of equivalent compression zone and edge of pier = 45.10 deg <-- 1/2 of total angle
Area of concrete in compression, Acc = 209.28 in^2
Force in concrete = 0.85 * f'c * Acc, Fc = 533.67 kips <-- ϕ Not Involved = Concrete Pn
Total reinforcement forces, Fs = -528.67 kips <-- ϕ Not Involved = Total Steel Pn
Case 1, φ= 0.900
Axial (comp=negative), Pu = -5.00 kips <-- Pu
Balance Force in concrete, Fs+Fu = -533.67 kips
Shaft Comp. Capacity, ϕPn= **4.50** 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 = 4662.73 in^3
Distance between centroid of concrete in compression and centroid of pier = 22.28 in
Moment of concrete in compression = 11889.95 in-kips 990.8294 ft-kips
Total reinforcement moment = 3513.44 in-kips 292.7869 ft-kips
Nominal Moment strength of Drilled Shaft Mn = 15403.40 in-kips
Moment Capacity of Drilled Shaft, ϕMn = 13863.06 in-kips 1155.255 ft-kips

Case 1, φMn = 1155.25 ft-kips

Case 2

Neutral Axis

Distance from extreme edge to neutral axis, h = 9.29 in
Equivalent compression zone factor = 0.85
Distance from extreme edge to equivalent compression zone factor, a = 7.89 in
Distance from centroid to neutral axis = 17.71 in

Compression Zone

Area of steel in compression zone, Asc = 2.00 in^2
Angle from centroid of pier to intersection of equivalent compression zone and edge of pier = 44.95 deg <-- 1/2 of total angle
Area of concrete in compression, Acc = 207.45 in^2
Force in concrete = 0.85 * f'c * Acc, Fc = 529.01 kips <-- ϕ Not Involved = Concrete Pn
Total reinforcement forces, Fs = -524.01 kips <-- ϕ Not Involved = Total Steel Pn
Case 2, φ= 0.900
Axial (comp=negative), Pu = -5.00 kips <-- Pu
Balance Force in concrete, Fs+Fu = -529.01 kips
Shaft Comp. Capacity, ϕPn= **4.50** kips <--φ Pn=Pu

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

Maximum Moment

First moment of the concrete area in compression about the centoid = 4627.84 in^3
Distance between centroid of concrete in compression and centroid of pier = 22.31 in
Moment of concrete in compression = 11800.98 in-kips 983.4154 ft-kips
Total reinforcement moment = 3504.84 in-kips 292.0699 ft-kips
Nominal Moment strength of Drilled Shaft Mn = 15305.82 in-kips
Moment Capacity of Drilled Shaft, ϕMn = 13775.24 in-kips 1147.937 ft-kips

Case 2, φMn = 1147.94 ft-kips

Case 3

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 = 48.80 in
Equivalent compression zone factor = 0.85
Distance from extreme edge to equivalent compression zone factor, a = 41.48 in
Distance from centroid to neutral axis = -21.80 in

Compression Zone

Area of steel in compression zone, Asc = 9.00 in^2
Angle from centroid of pier to intersection of equivalent compression zone and edge of pier = 122.43 deg <-- 1/2 of total angle
Area of concrete in compression, Acc = 1887.78 in^2
Force in concrete = 0.85 * f'c * Acc, Fc = 4813.83 kips <-- ϕ Not Involved = Concrete Pn
Total reinforcement forces, Fs = 409.74 kips <-- ϕ Not Involved = Total Steel Pn
φ= 0.65
Magnified, Max Axial Comp, Pn, per ACI 318 (10-2)/(ϕ=0.65)= -5223.57 kips <-- (Pn per ACI 10-2)/ϕ
Balance Force in concrete, Fs+Fu = -4813.83 kips
Shaft Comp. Capacity, (ϕ=0.65)Pn= **3395.32** 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 = 7889.38 in^3
Distance between centroid of concrete in compression and centroid of pier = 4.18 in
Moment of concrete in compression = 20117.91 in-kips 1676.493 ft-kips
Total reinforcement moment = 3492.12 in-kips 291.0097 ft-kips
Nominal Moment strength of Drilled Shaft Mn = 23610.03 in-kips
Moment Capacity of Drilled Shaft, (ϕ=0.65)Mn = 15346.52 in-kips 1278.877 ft-kips

Case 3, at Pmax, (φ=0.65)Mn = 1278.88 ft-kips

Final Results

Final Results		
Governing Orientation Case=	**2**	
phi, φ=	0.900	
Shaft ϕ*Mn=	**1147.94**	ft-kips
Distance from Edge of Shaft to N.A.=	9.29	in
Shaft Beta=	0.85	
Maximum Tensile Strain=	-0.01195	<------------ ϵt > 0.0050, Tension Controlled — TC
Shaft Tension Cap., φTn= (φ=0.9)*(Total As)(Fy)=	648.00	kips
Shaft Max Comp, (φ=0.65)(0.80)[0.85*f'c*(Ag-Ast)+Ast*Fy]=	3395.32	kips

Individual Bars (Case 1)

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	19.94	2.28	0.88	0.00073	1.00	21.21	18.66	372.02
2	30.00	17.27	-0.39	-1.79	-0.00013	0.00	-3.66	-3.66	-63.27
3	60.00	9.97	-7.69	-9.09	-0.00247	0.00	-60.00	-60.00	-598.08
4	90.00	0.00	-17.66	-19.06	-0.00567	0.00	-60.00	-60.00	0.00
5	120.00	-9.97	-27.63	-29.03	-0.00887	0.00	-60.00	-60.00	598.08
6	150.00	-17.27	-34.92	-36.32	-0.01122	0.00	-60.00	-60.00	1035.90
7	180.00	-19.94	-37.59	-39.00	-0.01207	0.00	-60.00	-60.00	1196.16
8	210.00	-17.27	-34.92	-36.32	-0.01122	0.00	-60.00	-60.00	1035.90
9	240.00	-9.97	-27.63	-29.03	-0.00887	0.00	-60.00	-60.00	598.08
10	270.00	0.00	-17.66	-19.06	-0.00567	0.00	-60.00	-60.00	0.00
11	300.00	9.97	-7.69	-9.09	-0.00247	0.00	-60.00	-60.00	-598.08
12	330.00	17.27	-0.39	-1.79	-0.00013	0.00	-3.66	-3.66	-63.27
				Min-->	-0.01207	1.00		-528.67	3513.44
									292.7869

(Case 2)

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	19.26	1.54	0.15	0.00050	1.00	14.45	11.90	229.09
2	45.00	14.10	-3.62	-5.01	-0.00117	0.00	-33.90	-33.90	-477.88
3	75.00	5.16	-12.56	-13.95	-0.00406	0.00	-60.00	-60.00	-309.59
4	105.00	-5.16	-22.87	-24.27	-0.00739	0.00	-60.00	-60.00	309.59
5	135.00	-14.10	-31.81	-33.20	-0.01028	0.00	-60.00	-60.00	845.81
6	165.00	-19.26	-36.97	-38.36	-0.01195	0.00	-60.00	-60.00	1155.40
7	195.00	-19.26	-36.97	-38.36	-0.01195	0.00	-60.00	-60.00	1155.40
8	225.00	-14.10	-31.81	-33.20	-0.01028	0.00	-60.00	-60.00	845.81
9	255.00	-5.16	-22.87	-24.27	-0.00739	0.00	-60.00	-60.00	309.59
10	285.00	5.16	-12.56	-13.95	-0.00406	0.00	-60.00	-60.00	-309.59
11	315.00	14.10	-3.62	-5.01	-0.00117	0.00	-33.90	-33.90	-477.88
12	345.00	19.26	1.54	0.15	0.00050	1.00	14.45	11.90	229.09
				Min-->	-0.01195	2.00		-524.01	3504.84
									292.0699

Individual Bars (Case 3)

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	19.94	41.74	34.42	0.00257	1.00	60.00	57.45	1145.32
2	30.00	17.27	39.07	31.75	0.00240	1.00	60.00	57.45	991.88
3	60.00	9.97	31.77	24.45	0.00195	1.00	56.64	54.09	539.13
4	90.00	0.00	21.80	14.48	0.00134	1.00	38.87	36.32	0.00
5	120.00	-9.97	11.83	4.51	0.00073	1.00	21.10	18.55	-184.86
6	150.00	-17.27	4.54	-2.78	0.00028	0.00	8.09	8.09	-139.61
7	180.00	-19.94	1.86	-5.46	0.00011	0.00	3.32	3.32	-66.28
8	210.00	-17.27	4.54	-2.78	0.00028	0.00	8.09	8.09	-139.61
9	240.00	-9.97	11.83	4.51	0.00073	1.00	21.10	18.55	-184.86
10	270.00	0.00	21.80	14.48	0.00134	1.00	38.87	36.32	0.00
11	300.00	9.97	31.77	24.45	0.00195	1.00	56.64	54.09	539.13
12	330.00	17.27	39.07	31.75	0.00240	1.00	60.00	57.45	991.88
				Min-->	0.00011	9.00		409.74	3492.12
									291.0097

TIA-222- H

FACTORED LOADS

Axial Load 0.9D:	$P_{\_0.9D}$ = 0.9 * Pcomp / 1.2	$P_{\_0.9D}$ =	3.75	kip
Axial Load 1.2D:	$P_{\_1.2D}$ = 1.2 * Pcomp / 1.2	$P_{\_1.2D}$ =	5.00	kip
Shear Load:	V_u = Vu_comp	V_u =	5.00	kip
Moment:	M_u = Mu	M_u =	273.00	kip*ft

Solve

*Highlighted cells have been modified

PASSIVE PRESSURE RESISTANCE (ORTHOGONAL DIRECTION)

Force of Pp Applied on Pier:	$Force_{pier}$ = MIN(Vu,Sum(Pp!M2:M7))	$Force_{pier}$ =	0.00	kip
Moment Arm of Pp on Pier:	M_{arm_pier} = D-T-Pp!O2 + T	M_{arm_pier} =	5.50	ft
Force of Pp Applied on Pad:	$Force_{pad}$ = MIN(Vu-$Force_{pier}$,SUM(Pp!M8:M13))	$Force_{pad}$ =	5.00	kip
Moment Arm of Pp on Pad:	M_{arm_pad} = D-Pp!O8	M_{arm_pad} =	0.93	ft
Unfactored Moment Resistance due to Passive Pressure:	$M_{R\_Pp} = Force_{pier}*M_{arm\_pier}+Force_{pad}*M_{arm\_pad}$	M_{R_Pp} =	4.63	kip*ft
Factored Moment Resistance due to Passive Pressure:	$\Phi M_{R\_Pp} = \Phi_s*M_{R\_Pp}$	ΦM_{R_Pp} =	3.47	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	$P_{bearing\_0.9}$ =	101.66	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	$P_{bearing\_1.2}$ =	135.54	kip	
Factored Overturning Moment:	$M_{overturning} = M_u + V_u$ * (MAX(T,D)+E+bp_{dist}/12)	$M_{overturning}$ =	305.50	kip*ft	
Area of Pad:	Area = W²	Area =	144.00	ft²	
Plastic Section Modulus of Pad:	Z = W³ / 4	Z =	432.00	ft³	
*Preliminary Load Eccentricity (0.9*D LC):*	$pre\_ec_{\_0.9\_p} = M_{overturning}/P_{bearing\_0.9}$	$pre\_ec_{\_0.9\_p}$ =	3.01	ft	
*Preliminary Load Eccentricity (1.2*D LC):*	$pre\_ec_{\_1.2\_p} = M_{overturning}/P_{bearing\_1.2}$	$pre\_ec_{\_1.2\_p}$ =	2.25	ft	
*[Goal Seek] Load Eccentricity Iteration (0.9*D LC):*	$ec_{\_0.9\_p}$ = *goal seek*	$ec_{\_0.9\_p}$ =	2.97	ft	e <= L/4
*[Goal Seek] Load Eccentricity Iteration (1.2*D LC):*	$ec_{\_1.2\_p}$ = *goal seek*	$ec_{\_1.2\_p}$ =	2.23	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($\Phi M_{R\_wedges\_0.9}$,$\Phi M_{R\_shear\_0.9}$)	$\Phi M_{Resisting\_0.9}$ =	3.47	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($\Phi M_{R\_wedges\_1.2}$,$\Phi M_{R\_shear\_1.2}$)	$\Phi M_{Resisting\_1.2}$ =	3.47	kip*ft	
*Adjusted Overturning Moment (0.9*D LC):*	$M_{overturning\_adj\_0.9} = M_{overturning} - \Phi M_{Resisting\_0.9}$	$M_{overturning\_0.9}$ =	302.03	kip*ft	
*Adjusted Overturning Moment (1.2*D LC):*	$M_{overturning\_adj\_1.2} = M_{overturning} - \Phi M_{Resisting\_1.2}$	$M_{overturning\_1.2}$ =	302.03	kip*ft	
*Total Resistance to Overturning (0.9*D LC):*	$\Phi M_{Resisting\_qu\_0.9} = P_{bearing\_0.9}*ec_{\_0.9\_p} + \Phi M_{Resisting\_0.9}$	$\Phi M_{Resisting\_qu\_0.9}$ =	305.50	kip*ft	
*Total Resistance to Overturning (1.2*D LC):*	$\Phi M_{Resisting\_qu\_1.2} = P_{bearing\_1.2}*ec_{\_1.2\_p} + \Phi M_{Resisting\_1.2}$	$\Phi M_{Resisting\_qu\_1.2}$ =	305.50	kip*ft	
[Goal Seek] Moment Comparison Iteration (0.9D LC):	$\Delta M_{\_0.9} = M_{overturning}-\Phi M_{Resisting\_qu\_0.9}$	$\Delta M_{\_0.9}$ =	0.00	kip*ft	
[Goal Seek] Moment Comparison Iteration (1.2D LC):	$\Delta M_{\_1.2} = M_{overturning}-\Phi M_{Resisting\_qu\_1.2}$	$\Delta M_{\_1.2}$ =	0.00	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)	$q_{u\_orth\_0.9}$ =	1.41	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)	$q_{u\_orth\_1.2}$ =	1.64	ksf
Ultimate Gross Bearing Pressure:	Q_{ult} = Qult	Q_{ult} =	8.00	ksf
Factored Ultimate Gross Bearing Pressure:	ΦQult = φs * Qult	Qa =	6.00	ksf

Check **ΦQult = 6.00 ksf >= q_u = 1.64 ksf** **RATING: 27.34% OK**

Soil Wedges (Cohesionless Soil)

1 1 Load Resistance Utilization R

Soil (above pad) Height:	soilht = D-T	soilht =	3.50	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	$Wedge_{\_proj}$ =	2.36	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	12.00	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	12.00	0.00
(2) Partial Sides (below Water Table)	0.00	0.00	12.00	0.00
(1) Rear (above Water Table)	0.00	0.00	12.79	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	12.00	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	12.00	0.00
(2) Partial Sides (below Water Table)	0.00	0.00	12.00	0.00
(1) Rear (above Water Table)	0.00	0.00	12.79	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	12.00	0.00
(2) Partial Sides	0.00	0.00	12.00	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	12.00	0.00
(2) Partial Sides	0.00	0.00	12.00	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	$P_{\_100}$ =	115.53	kip
Preliminary Factored Overturning Moment:	pre_$M_{overturning_100}$ = (W/2-(P_100/ΦQult)/(2*W))*(P_100)	pre_$M_{overturning_100}$ =	600.49	kip*ft
*Preliminary Load Eccentricity (0.9*D LC):*	pre_$ec_{_100}$ = pre_$M_{overturning_100}$ / $P_{\_100}$	pre_$ec_{_100}$ =	5.20	ft
*[Goal Seek] Load Eccentricity Iteration (0.9*D LC):*	$ec_{\_100}$ = *goal seek*	$ec_{\_100}$ =	5.17	ft (L/4 < e <= L/2)
*Non-Bearing Length (0.9*D LC):*	$NBL_{\_100}$ = 2*ec_100	$NBL_{\_100}$ =	10.34	ft
*Total Factored Resisting Moment due to Pp and Soil Wedges / Shear (0.9*D LC):*	$\Phi M_{Resisting\_100}$ = ΦM_{R_Pp} + SUM($\Phi M_{R\_wedges\_100}$,$\Phi M_{R\_shear\_100}$)	$\Phi M_{Resisting\_100}$ =	50.07	kip*ft
Moment Created by Shear:	M_{shear} = V_u * (D+E+bp_{dist}/12)	M_{shear} =	32.50	kip*ft
*Adjusted Overturning Moment (0.9*D LC):*	$M_{overturning\_100}$ = $M_{u\_max\_100}$ - ΦM_{R_Pp}	$M_{overturning\_100}$ =	647.09	kip*ft
*Total Resistance to Overturning (0.9*D LC):*	$\Phi M_{Resisting\_qu\_100}$ = $P_{\_100}$*$ec_{\_100}$ + $\Phi M_{Resisting\_100}$	$\Phi M_{Resisting\_qu\_100}$ =	647.09	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_Movertuming_100 + ΦMResisting_100	$M_{u\_max\_100}$ =	650.56	kip*ft

Check **Mu_max_100 = 650.56 kip*ft >= Mu = 305.50 kip*ft RATING: 46.96% 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)	13.00	1.63	12.89	20.95
(2) End Prisms (below Water Table)	0.00	0.00	0.00	0.00
(2) Partial Sides (above Water Table)	85.40	10.67	6.83	72.93
(2) Partial Sides (below Water Table)	0.00	0.00	6.83	0.00
(1) Rear (above Water Table)	49.58	6.20	12.79	79.24
(1) Rear (below Water Table)	0.00	0.00	0.00	0.00
Total	147.98	18.50		173.12

Wedge Eccentricity relative to W/2:

Total Moment Arm (ft) =	3.36
Soil Wedge Wt (kip)=	18.50

*Unfactored Resisting Moment of Wedges (0.9*D LC):* $M_{R\_wedges\_100}$ = Total Moment Arm * Soil Wedge Wt — $M_{R\_wedges\_100}$ = 62.14 kip*ft

*Factored Resisting Moment of Wedges (0.9*D LC):* $\Phi M_{R\_wedges\_100}$ = 0.75*MR_wedges_100 — $\Phi M_{R\_wedges\_100}$ = 46.60 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	0.00	0.00	12.00	0.00
(2) Partial Sides	0.00	0.00	6.83	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))	$Force_{pier}$ =	0.00	kip
Moment Arm of Pp on Pier:	M_{arm_pier} = D-T-Pp!O2 + T	M_{arm_pier} =	5.50	ft
Force of Pp Applied on Pad:	$Force_{pad\_dia}$ = MIN(Vu-$Force_{pier}$,SUM(Pp!M8:M13))*(T*W*SQRT(2))/(T*W))	$Force_{pad\_dia}$ =	5.00	kip
Moment Arm of Pp on Pad:	M_{arm_pad} = D-Pp!O8	M_{arm_pad} =	0.93	ft
Unfactored Moment Resistance due to Passive Pressure:	$M_{R\_Pp\_dia}$ = $Force_{pier}$*M_{arm_pier}+$Force_{pad}$*M_{arm_pad}	$M_{R\_Pp\_dia}$ =	4.63	kip*ft
Factored Moment Resistance due to Passive Pressure:	$\Phi M_{R\_Pp\_dia}$ = Φ_s*M_{R_Pp}	$\Phi M_{R\_Pp\_dia}$ =	3.47	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	$P_{bearing\_0.9\_dia}$ =	115.22	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	$P_{bearing\_1.2\_dia}$ =	138.17	kip	
Factored Overturning Moment:	$M_{overturning} = M_u + V_u * (D+E+bp_{dist}/12)$	$M_{overturning}$ =	305.50	kip*ft	
Area of Pad:	Area = W²	Area =	144.00	ft²	
Plastic Section Modulus of Pad:	$Z_{\_dia}$ = W³ / (3*SQRT(2))	$Z_{\_dia}$ =	407.29	ft³	
*Preliminary Load Eccentricity (0.9*D LC):*	$pre\_ec_{\_0.9\_p\_dia} = M_{overturning}/P_{bearing\_0.9\_dia}$	$pre\_ec_{\_0.9\_p\_dia}$ =	2.65	ft	
*Preliminary Load Eccentricity (1.2*D LC):*	$pre\_ec_{\_1.2\_p\_dia} = M_{overturning}/P_{bearing\_1.2\_dia}$	$pre\_ec_{\_1.2\_p\_dia}$ =	2.21	ft	
*[Goal Seek] Load Eccentricity Iteration (0.9*D LC):*	$ec_{\_0.9\_p\_dia}$ = *goal seek*	$ec_{\_0.9\_p\_dia}$ =	2.23	ft	(L/4)*SQRT(2)/2 < e <= (L/2)*SQRT(2)
*[Goal Seek] Load Eccentricity Iteration (1.2*D LC):*	$ec_{\_1.2\_p\_dia}$ = *goal seek*	$ec_{\_1.2\_p\_dia}$ =	2.12	ft	(L/4)*SQRT(2)/2 < e <= (L/2)*SQRT(2)
*Non-Bearing Length (0.9*D LC):*	$NBL_{\_0.9\_dia}$ = SQRT(2)*ec_0.9_p_dia	$NBL_{\_0.9\_dia}$ =	3.15	ft	
*Non-Bearing Length (1.2*D LC):*	$NBL_{\_1.2\_dia}$ = SQRT(2)*ec_1.2_p_dia	$NBL_{\_1.2\_dia}$ =	3.00	ft	
*Total Factored Resisting Moment due to Pp and Soil Wedges / Shear (0.9*D LC):*	$\Phi M_{Resisting\_0.9} = \Phi M_{R\_Pp\_dia} + SUM(\Phi M_{R\_wedges\_0.9\_dia}, \Phi M_{R\_shear\_0.9\_dia})$	$\Phi M_{Resisting\_0.9\_dia}$ =	48.73	kip*ft	
*Total Factored Resisting Moment due to Pp and Soil Wedges / Shear (1.2*D LC):*	$\Phi M_{Resisting\_1.2} = \Phi M_{R\_Pp\_dia} + SUM(\Phi M_{R\_wedges\_1.2\_dia}, \Phi M_{R\_shear\_1.2\_dia})$	$\Phi M_{Resisting\_1.2\_dia}$ =	12.39	kip*ft	
*Adjusted Overturning Moment (0.9*D LC):*	$M_{overturning\_0.9\_dia} = M_{overturning} - \Phi M_{Resisting\_0.9\_dia}$	$M_{overturning\_0.9\_dia}$ =	256.77	kip*ft	
*Adjusted Overturning Moment (1.2*D LC):*	$M_{overturning\_1.2\_dia} = M_{overturning} - \Phi M_{Resisting\_1.2\_dia}$	$M_{overturning\_1.2\_dia}$ =	293.11	kip*ft	
*Total Resistance to Overturning (0.9*D LC):*	$\Phi M_{Resisting\_qu\_0.9\_dia} = P_{bearing\_0.9\_dia} * ec_{\_0.9\_p\_dia} + \Phi M_{Resisting\_0.9\_dia}$	$\Phi M_{Resisting\_qu\_0.9\_dia}$ =	305.50	kip*ft	
*Total Resistance to Overturning (1.2*D LC):*	$\Phi M_{Resisting\_qu\_1.2\_dia} = P_{bearing\_1.2\_dia} * ec_{\_1.2\_p\_dia} + \Phi M_{Resisting\_1.2\_dia}$	$\Phi M_{Resisting\_qu\_1.2\_dia}$ =	305.50	kip*ft	
[Goal Seek] Moment Comparison Iteration (0.9D LC):	$\Delta M_{\_0.9\_dia} = M_{overturning} - \Phi M_{Resisting\_qu\_0.9\_dia}$	$\Delta M_{\_0.9\_dia}$ =	0.00	kip*ft	
[Goal Seek] Moment Comparison Iteration (1.2D LC):	$\Delta M_{\_1.2\_dia} = M_{overturning} - \Phi M_{Resisting\_qu\_1.2\_dia}$	$\Delta M_{\_1.2\_dia}$ =	0.00	kip*ft	

Bearing Pressures

*Diagonal Bearing Pressure (0.9*D LC):*	$q_{u\_dia\_0.9}$ = Pbearing_0.9_dia/((W-(SQRT(2))*ec_0.9_p_dia))^2	$q_{u\_dia\_0.9}$ =	1.47	ksf
*Diagonal Bearing Pressure (1.2*D LC):*	$q_{u\_dia\_1.2}$ = Pbearing_1.2_dia/((W-(SQRT(2))*ec_1.2_p_dia))^2	$q_{u\_dia\_1.2}$ =	1.71	ksf
Ultimate Gross Bearing Pressure:	Q_{ult} = Qult	Q_{ult} =	8.00	ksf
Factored Ultimate Gross Bearing Pressure:	ΦQult = φs * Qult	Qa =	6.00	ksf

Check **ΦQult = 6.00 ksf >= q_u = 1.71 ksf** **RATING: 28.43%** **OK**

Soil Wedges (Cohesionless Soil)

1 0.19571964 Load Resistance Utilization I

Soil (above pad) Height:	soilht = D-T	soilht =	3.50	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	$Wedge_{\_proj}$ =	2.36	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)	13.00	1.63	8.49	13.79
(2) End Prisms (below Water Table)	0.00	0.00	0.00	0.00
(1) End Prism (above Water Table)	6.50	0.81	17.81	14.47
(1) End Prisms (below Water Table)	0.00	0.00	0.00	0.00
(2) Partial Sides (above Water Table)	26.04	3.26	6.95	22.63
(2) Partial Sides (below Water Table)	0.00	0.00	0.00	0.00
(2) Rear (above Water Table)	99.15	12.39	13.15	162.92
(2) Rear (below Water Table)	0.00	0.00	0.00	0.00
Total	144.70	18.09		213.82

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

Total Moment Arm (ft) =	3.34
Soil Wedge Wt (kip)=	18.09

*Unfactored Resisting Moment of Wedges (0.9*D LC):*	$M_{R\_wedges\_0.9}$ = Total Moment Arm * Soil Wedge Wt	$M_{R\_wedges\_0.9\_dia}$ =	60.35	kip*ft
*Factored Resisting Moment of Wedges (0.9*D LC):*	$\Phi M_{R\_wedges\_0.9}$ = 0.75*MR_wedges_0.9_dia	$\Phi M_{R\_wedges\_0.9\_dia}$ =	45.26	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)	13.00	1.63	8.49	13.79
(2) End Prisms (below Water Table)	0.00	0.00	0.00	0.00
(1) End Prism (above Water Table)	6.50	0.81	17.81	14.47
(1) End Prisms (below Water Table)	0.00	0.00	0.00	0.00
(2) Partial Sides (above Water Table)	24.79	3.10	7.01	21.71
(2) Partial Sides (below Water Table)	0.00	0.00	0.00	0.00
(2) Rear (above Water Table)	99.15	12.39	13.15	162.92
(2) Rear (below Water Table)	0.00	0.00	0.00	0.00
Total	143.45	17.93		212.90

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

Total Moment Arm (ft) =	3.39
Soil Wedge Wt (kip)=	3.51

*Unfactored Resisting Moment of Wedges (1.2*D LC):*	$M_{R\_wedges\_1.2}$ = Total Moment Arm * Soil Wedge Wt	$M_{R\_wedges\_1.2\_dia}$ =	11.89	kip*ft
*Factored Resisting Moment of Wedges (1.2*D LC):*	$\Phi M_{R\_wedges\_1.2}$ = 0.75*MR_wedges_1.2_dia	$\Phi M_{R\_wedges\_1.2\_dia}$ =	8.92	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	12.73	0.00
(2) Partial Sides	0.00	0.00	7.37	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):* $\Phi M_{R\_shear\_0.9}$ = 0.75 * (Total Moment Arm * Soil Shear Strength) $\Phi M_{R\_shear\_0.9\_dia}$ = 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	12.73	0.00
(2) Partial Sides	0.00	0.00	7.42	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):* $\Phi M_{R\_shear\_1.2}$ = 0.75 * (Total Moment Arm * Soil Shear Strength) $\Phi M_{R\_shear\_1.2\_dia}$ = 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 $P_{\_100\_dia}$ = 118.60 kip

Preliminary Factored Overturning Moment: pre_$M_{overturning_100_dia}$ = (P_100_dia/(SQRT(2)))*(W-SQRT(P_100_dia/ΦQult)) pre_$M_{overturning_100_dia}$ = 633.50 kip*ft

*Preliminary Load Eccentricity (0.9*D LC):* pre_$ec_{_100_dia}$ = pre_$M_{overturning_100_dia}$ / $P_{bearing\_0.9}$ pre_$ec_{_100_dia}$ = 5.34 ft

*[Goal Seek] Load Eccentricity Iteration (0.9*D LC):* $ec_{\_100\_dia}$ = *goal seek* $ec_{\_100\_dia}$ = 5.31 ft (L/4)*SQRT(2)/2 < e <= (L/2)*SQRT(2)

*Non-Bearing Length (0.9*D LC):* $NBL_{\_100\_dia}$ = SQRT(2)*ec_100_dia $NBL_{\_100\_dia}$ = 7.51 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($\Phi M_{R\_wedges\_100\_dia}$,$\Phi M_{R\_shear\_100\_dia}$) $\Phi M_{Resisting\_100\_dia}$ = 34.58 kip*ft

Moment Created by Shear: M_{shear} = V_u * (D+E+bp_{dist}/12) M_{shear} = 32.50 kip*ft

*Adjusted Overturning Moment (0.9*D LC):* $M_{overturning\_100\_dia}$ = $M_{u\_max\_100\_dia}$ - $\Phi M_{R\_Pp\_dia}$ $M_{overturning\_100\_dia}$ = 664.61 kip*ft

*Total Resistance to Overturning (0.9*D LC):* $\Phi M_{Resisting\_qu\_100\_dia}$ = $P_{bearing\_0.9}$*$ec_{\_100\_dia}$ + $\Phi M_{Resisting\_100\_dia}$ $\Phi M_{Resisting\_qu\_100\_dia}$ = 664.61 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 $M_{u\_max\_100\_dia}$ = 668.09 kip*ft

Check **Mu_max_100_dia = 668.09 kip*ft >= Mu = 305.50 kip*ft** **RATING: 45.73% 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)	13.00	1.63	8.49	13.79
(2) End Prisms (below Water Table)	0.00	0.00	0.00	0.00
(1) End Prism (above Water Table)	6.50	0.81	17.81	14.47
(1) End Prisms (below Water Table)	0.00	0.00	0.00	0.00
(2) Partial Sides (above Water Table)	62.07	7.76	5.41	41.99
(2) Partial Sides (below Water Table)	0.00	0.00	0.00	0.00
(2) Rear (above Water Table)	99.15	12.39	13.15	162.92
(2) Rear (below Water Table)	0.00	0.00	0.00	0.00
Total	180.73	22.59		233.18

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

Total Moment Arm (ft) =	1.84
Soil Wedge Wt (kip)=	22.59

*Unfactored Resisting Moment of Wedges (0.9*D LC):* $M_{R\_wedges\_100\_dia}$ = Total Moment Arm * Soil Wedge Wt $M_{R\_wedges\_100\_dia}$ = 41.48 kip*ft

*Factored Resisting Moment of Wedges (0.9*D LC):* $\Phi M_{R\_wedges\_100\_dia}$ = 0.75*MR_wedges_100_dia $\Phi M_{R\_wedges\_100\_dia}$ = 31.11 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	12.73	0.00
(2) Partial Sides	0.00	0.00	5.83	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

TIA-222- H

FACTORED LOADS

Axial Load 0.9D:	$P_{\_0.9D}$ = 0.9 * Pcomp / 1.2	$P_{\_0.9D}$ =	3.75	kip
Axial Load 1.2D:	$P_{\_1.2D}$ = 1.2 * Pcomp / 1.2	$P_{\_1.2D}$ =	5.00	kip
Shear Load:	V_u = Vu_comp	V_u =	5.00	kip
Moment:	M_u = Mu	M_u =	273.00	kip*ft

Solve

*Highlighted cells have been modified

PASSIVE PRESSURE RESISTANCE

Force of Pp Applied on Pier:	$Force_{pier}$ = MIN(Vu,Sum(Pp!M2:M7))	$Force_{pier}$ =	0.00	kip
Moment Arm of Pp on Pier:	M_{arm_pier} = D-T-Pp!O2 + T	M_{arm_pier} =	5.50	ft
Force of Pp Applied on Pad:	$Force_{pad}$ = MIN(Vu-Forcepier,SUM(Pp!M8:M13))	$Force_{pad}$ =	5.00	kip
Moment Arm of Pp on Pad:	M_{arm_pad} = D-Pp!O8	M_{arm_pad} =	0.93	ft
Unfactored Moment Resistance due to Passive Pressure:	$M_{R\_Pp} = Force_{pier} * M_{arm\_pier} + Force_{pad} * M_{arm\_pad}$	M_{R_Pp} =	4.63	kip*ft
Factored Moment Resistance due to Passive Pressure:	$\Phi M_{R\_Pp} = \Phi_s * M_{R\_Pp}$	ΦM_{R_Pp} =	3.47	kip*ft

PLASTIC BEARING PRESSURE & OVERTURNING MOMENT

*Compressive Load for Bearing (0.9*D LC):*	$P_{bearing\_0.9\_e}$ = P_0.9D+0.9*(Ws+Wc)+0.75*Wwedges_0.9_bearing_e	$P_{bearing\_0.9\_e}$ =	101.66	kip	
*Compressive Load for Bearing (1.2*D LC):*	$P_{bearing\_1.2\_e}$ = P_1.2D+1.2*(Ws+Wc)+0.75*Wwedges_1.2_bearing_e	$P_{bearing\_1.2\_e}$ =	135.54	kip	
Factored Overturning Moment:	$M_{overturning} = M_u + V_u * (D+E+bp_{dist}/12)$	$M_{overturning}$ =	305.50	kip*ft	
Area of Pad:	Area = W^2	Area =	144.00	ft^2	
Elastic Section Modulus of Pad:	S = W^3 / 6	S =	288.00	ft^3	
*Preliminary Load Eccentricity (0.9*D LC):*	$pre\_ec_{\_0.9\_e} = M_{overturning}/P_{bearing\_0.9}$	$pre\_ec_{\_0.9\_e}$ =	3.01	ft	
*Preliminary Load Eccentricity (1.2*D LC):*	$pre\_ec_{\_1.2\_e} = M_{overturning}/P_{bearing\_1.2}$	$pre\_ec_{\_1.2\_e}$ =	2.25	ft	
*[Goal Seek] Load Eccentricity Iteration (0.9*D LC):*	$ec_{\_0.9\_e}$ = *goal seek*	$ec_{\_0.9\_e}$ =	0.00	ft	e <= L/6
*[Goal Seek] Load Eccentricity Iteration (1.2*D LC):*	$ec_{\_1.2\_e}$ = *goal seek*	$ec_{\_1.2\_e}$ =	0.00	ft	e <= L/6
*Non-Bearing Length (0.9*D LC):*	$NBL_{\_0.9\_e}$ = 0	$NBL_{\_0.9\_e}$ =	0.00	ft	
*Non-Bearing Length (1.2*D LC):*	$NBL_{\_1.2\_e}$ = 0	$NBL_{\_1.2\_e}$ =	0.00	ft	
*Total Factored Resisting Moment due to Pp and Soil Wedges / Shear (0.9*D LC):*	$\Phi M_{Resisting\_0.9\_e} = \Phi M_{R\_Pp}$ + SUM($\Phi M_{R\_wedges\_0.9}, \Phi M_{R\_shear\_0.9}$)	$\Phi M_{Resisting\_0.9\_e}$ =	3.47	kip*ft	
*Total Factored Resisting Moment due to Pp and Soil Wedges / Shear (1.2*D LC):*	$\Phi M_{Resisting\_1.2\_e} = \Phi M_{R\_Pp}$ + SUM($\Phi M_{R\_wedges\_1.2}, \Phi M_{R\_shear\_1.2}$)	$\Phi M_{Resisting\_1.2\_e}$ =	3.47	kip*ft	
*Adjusted Overturning Moment (0.9*D LC):*	$M_{overturning\_0.9\_e} = M_{overturning} - \Phi M_{Resisting\_0.9}$	$M_{overturning\_0.9\_e}$ =	302.03	kip*ft	
*Adjusted Overturning Moment (1.2*D LC):*	$M_{overturning\_1.2\_e} = M_{overturning} - \Phi M_{Resisting\_1.2}$	$M_{overturning\_1.2\_e}$ =	302.03	kip*ft	
*Total Resistance to Overturning (0.9*D LC):*	$\Phi M_{Resisting\_qu\_0.9\_e} = P_{bearing\_0.9} * ec_{\_0.9\_p} + \Phi M_{Resisting\_0.9}$	$\Phi M_{Resisting\_qu\_0.9\_e}$ =	3.47	kip*ft	
*Total Resistance to Overturning (1.2*D LC):*	$\Phi M_{Resisting\_qu\_1.2\_e} = P_{bearing\_1.2} * ec_{\_1.2\_p} + \Phi M_{Resisting\_1.2}$	$\Phi M_{Resisting\_qu\_1.2\_e}$ =	3.47	kip*ft	
[Goal Seek] Moment Comparison Iteration (0.9D LC):	$\Delta M_{\_0.9\_e} = M_{overturning} - \Phi M_{Resisting\_qu\_0.9}$	$\Delta M_{\_0.9\_e}$ =	302.03	kip*ft	
[Goal Seek] Moment Comparison Iteration (1.2D LC):	$\Delta M_{\_1.2\_e} = M_{overturning} - \Phi M_{Resisting\_qu\_1.2}$	$\Delta M_{\_1.2\_e}$ =	302.03	kip*ft	

Bearing Pressures

*Orthogonal Bearing Pressure (0.9*D LC):*	$q_{u\_orth\_0.9\_e}$ = Pbearing_0.9_e/Area + Moverturning_0.9/S	$q_{u\_orth\_0.9\_e}$ =	1.75	ksf
*Orthogonal Bearing Pressure (1.2*D LC):*	$q_{u\_orth\_1.2\_e}$ = Pbearing_1.2_e/Area + Moverturning_1.2/S	$q_{u\_orth\_1.2\_e}$ =	1.99	ksf
Ultimate Gross Bearing Pressure:	Q_{ult} = Qult	Q_{ult} =	8.00	ksf
Factored Ultimate Gross Bearing Pressure:	Qa = φs * Qult	Qa =	6.00	ksf

Check **Qa = 6.00 ksf >= q_u = 1.99 ksf** **RATING: 33.17% OK**

Soil Wedges (Cohesionless Soil)

1 1 Load Resistance Utilization F

Soil (above pad) Height:	soilht = D-T	soilht =	3.50	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	$Wedge_{\_proj}$ =	2.36	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 (ft^3)	Soil Weight (kips)	Moment Arm (ft)	Unfactored Resisting Moment (kip*ft)
(2) End Prisms (above Water Table)	0.00	0.00	12.00	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	12.00	0.00
(2) Partial Sides (below Water Table)	0.00	0.00	12.00	0.00
(1) Rear (above Water Table)	0.00	0.00	12.79	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):*	$M_{R\_wedges\_0.9\_e}$ = Total Moment Arm * Soil Wedge Wt	$M_{R\_wedges\_0.9\_e}$ =	0.00	kip*ft
*Factored Resisting Moment of Wedges (0.9*D LC):*	$\Phi M_{R\_wedges\_0.9\_e}$ = 0.75*MR_wedges_0.9_e	$\Phi M_{R\_wedges\_0.9\_e}$ =	0.00	kip*ft

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

Soil	Volume (ft^3)	Soil Weight (kips)	Moment Arm (ft)	Unfactored Resisting Moment (kip*ft)

(2) End Prisms (above Water Table)	0.00	0.00	12.00	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	12.00	0.00
(2) Partial Sides (below Water Table)	0.00	0.00	12.00	0.00
(1) Rear (above Water Table)	0.00	0.00	12.79	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):* $M_{R\_wedges\_1.2\_e}$ = Total Moment Arm * Soil Wedge Wt — $M_{R\_wedges\_1.2\_e}$ = 0.00 kip*ft

*Factored Resisting Moment of Wedges (1.2*D LC):* $\Phi M_{R\_wedges\_1.2\_e}$ = 0.75*MR_wedges_1.2_e — $\Phi M_{R\_wedges\_1.2\_e}$ = 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	12.00	0.00
(2) Partial Sides	0.00	0.00	12.00	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):* $M_{R\_shear\_0.9\_e}$ = Total Moment Arm * Soil Shear Strength — $M_{R\_shear\_0.9\_e}$ = 0.00 kip*ft

*Factored Resisting Moment of Soil Shear (0.9*D LC):* $\Phi M_{R\_shear\_0.9\_e}$ = 0.75 * (Total Moment Arm * Soil Shear Strength) — $\Phi M_{R\_shear\_0.9\_e}$ = 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	12.00	0.00
(2) Partial Sides	0.00	0.00	12.00	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):* $M_{R\_shear\_1.2\_e}$ = Total Moment Arm * Soil Shear Strength — $M_{R\_shear\_1.2\_e}$ = 0.00 kip*ft

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

DETERMINE MOMENT THAT WOULD CAUSE 100% OVERTURNING (ORTHOGONAL)

*Compressive Load for Bearing (0.9*D LC):*	$P_{\_100\_e}$ = P_0.9D+0.9*(Ws+Wc)+0.75*Wwedges_100_e	$P_{\_100\_e}$ =	112.94	kip
Preliminary Factored Overturning Moment:	pre_$M_{overturning_100_e}$ = P_100_e * (W/2 - ((2/3) * P_100_e) / (W * ΦQult))	pre_$M_{overturning_100_e}$ =	559.52	kip*ft
*Preliminary Load Eccentricity (0.9*D LC):*	pre_ec$_{_100_e}$ = pre_$M_{overturning_100}$ / $P_{\_100}$	pre_ec$_{_100_e}$ =	4.95	ft
*[Goal Seek] Load Eccentricity Iteration (0.9*D LC):*	ec$_{_100_e}$ = *goal seek*	ec$_{_100_e}$ =	4.33	ft (L/6 < e <= L/2)
*Non-Bearing Length (0.9*D LC):*	NBL$_{_100_e}$ = W-(W/2-ec_100_e)*3	NBL$_{_100_e}$ =	6.99	ft
*Total Factored Resisting Moment due to Pp and Soil Wedges / Shear (0.9*D LC):*	$\Phi M_{Resisting\_100\_e}$ = ΦM_{R_Pp} + SUM($\Phi M_{R\_wedges\_100}$,$\Phi M_{R\_shear\_100}$)	$\Phi M_{Resisting\_100\_e}$ =	56.98	kip*ft
Moment Created by Shear:	M_{shear_e} = V_u * (D+E+bp_{dist}/12)	M_{shear_e} =	32.50	kip*ft
*Adjusted Overturning Moment (0.9*D LC):*	$M_{overturning\_100\_e}$ = $M_{u\_max\_100}$ - ΦM_{R_Pp}	$M_{overturning\_100\_e}$ =	613.02	kip*ft
*Total Resistance to Overturning (0.9*D LC):*	$\Phi M_{Resisting\_qu\_100\_e}$ = $P_{\_100}$*ec$_{_100}$ + $\Phi M_{Resisting\_100}$	$\Phi M_{Resisting\_qu\_100\_e}$ =	545.93	kip*ft
[Goal Seek] Moment Comparison Iteration (0.9D LC):	$\Delta M_{\_100\_e}$ = $M_{overturning}$ - $\Phi M_{Resisting\_qu\_100}$	$\Delta M_{\_100\_e}$ =	67.10	ft
Maximum Applied Moment from Superstructure Analysis:	$M_{u\_max\_100\_e}$ = pre_Moverturning_100 + ΦMResisting_100	$M_{u\_max\_100\_e}$ =	616.50	kip*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)	13.00	1.63	12.89	20.95
(2) End Prisms (below Water Table)	0.00	0.00	0.00	0.00
(2) Partial Sides (above Water Table)	57.74	7.22	8.51	61.39
(2) Partial Sides (below Water Table)	0.00	0.00	8.51	0.00
(1) Rear (above Water Table)	49.58	6.20	12.79	79.24
(1) Rear (below Water Table)	0.00	0.00	0.00	0.00
Total	120.32	15.04		161.58

Eccentricity relative to W/2:

Total Moment Arm (ft) =	4.74
Soil Wedge Wt (kip)=	15.04

*Unfactored Resisting Moment of Wedges (0.9*D LC):* $M_{R\_wedges\_100\_e}$ = Total Moment Arm * Soil Wedge Wt — $M_{R\_wedges\_100\_e}$ = 71.34 kip*ft

*Factored Resisting Moment of Wedges (0.9*D LC):* $\Phi M_{R\_wedges\_100\_e}$ = 0.75*MR_wedges_100_e — $\Phi M_{R\_wedges\_100\_e}$ = 53.50 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	0.00	0.00	12.00	0.00
(2) Partial Sides	0.00	0.00	8.51	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):* $M_{R\_shear\_100\_e}$ = Total Moment Arm * Soil Shear Strength — $M_{R\_shear\_100\_e}$ = 0.00 kip*ft

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

PASSIVE PRESSURE RESISTANCE (DIAGONAL DIRECTION)

Force of Pp Applied on Pier:	$Force_{pier}$ = MIN(Vu,Sum(Pp!M2:M7))	$Force_{pier}$ =	0.00	kip
Moment Arm of Pp on Pier:	M_{arm_pier} = D-T-Pp!O2 + T	M_{arm_pier} =	5.50	ft
Force of Pp Applied on Pad:	$Force_{pad\_dia}$ = MIN(Vu-$Force_{pier}$,SUM(Pp!M8:M13))*(T*W*SQRT(2))/(T*W))	$Force_{pad\_dia}$ =	5.00	kip
Moment Arm of Pp on Pad:	M_{arm_pad} = D-Pp!O8	M_{arm_pad} =	0.93	ft
Unfactored Moment Resistance due to Passive Pressure:	M_{R_Pp} = $Force_{pier}$*M_{arm_pier}+$Force_{pad}$*M_{arm_pad}	M_{R_Pp} =	4.63	kip*ft
Factored Moment Resistance due to Passive Pressure:	$\Phi M_{R\_Pp\_dia}$ = Φ_s*M_{R_Pp}	$\Phi M_{R\_Pp\_dia}$ =	3.47	kip*ft

PLASTIC BEARING PRESSURE & OVERTURNING MOMENT (DIAGONAL DIRECTION)

*Compressive Load for Bearing (0.9*D LC):*	$P_{bearing\_0.9\_dia\_e}$ = P_0.9D+0.9*(Ws+Wc)+0.75*Wwedges_0.9_bearing_dia_e	$P_{bearing\_0.9\_dia\_e}$ =	101.66	kip
*Compressive Load for Bearing (1.2*D LC):*	$P_{bearing\_1.2\_dia\_e}$ = P_1.2D+1.2*(Ws+Wc)+0.75*Wwedges_1.2_bearing_dia_e	$P_{bearing\_1.2\_dia\_e}$ =	135.54	kip

Factored Overturning Moment:	$M_{overturning} = M_u + V_u * (D+E+bp_{dist}/12)$	$M_{overturning}$ = 305.50	kip*ft
Area of Pad:	Area = W²	Area = 144.00	ft^2
*Preliminary Load Eccentricity (0.9*D LC):*	$pre\_ec_{0.9\_e\_dia} = M_{overturning}/P_{bearing\_0.9\_dia\_e}$	$pre\_ec_{0.9\_e\_dia}$ = 3.01	ft
*Preliminary Load Eccentricity (1.2*D LC):*	$pre\_ec_{1.2\_e\_dia} = M_{overturning}/P_{bearing\_1.2\_dia\_e}$	$pre\_ec_{1.2\_e\_dia}$ = 2.25	ft
*[Goal Seek] Load Eccentricity Iteration (0.9*D LC):*	$ec_{0.9\_e\_dia}$ = *goal seek*	$ec_{0.9\_e\_dia}$ = 0.00	ft e <= (L/6)*SQRT(2)/2
*[Goal Seek] Load Eccentricity Iteration (1.2*D LC):*	$ec_{1.2\_e\_dia}$ = *goal seek*	$ec_{1.2\_e\_dia}$ = 0.00	ft e <= (L/6)*SQRT(2)/2
	S_{dia} = (W³)/(6*SQRT(2))	S_{dia} = 203.65	ft³

*Non-Bearing Length (0.9*D LC):*	$NBL_{0.9\_dia\_e}$ = 0	$NBL_{0.9\_dia\_e}$ = 0.00	ft
*Non-Bearing Length (1.2*D LC):*	$NBL_{1.2\_dia\_e}$ = 0	$NBL_{1.2\_dia\_e}$ = 0.00	ft
*Non-Bearing Length (0.9*D LC):*	$NBL_{0.9\_dia\_e\_2}$ = 0	$NBL_{0.9\_dia\_e\_2}$ = 0.00	ft
*Non-Bearing Length (1.2*D LC):*	$NBL_{1.2\_dia\_e\_2}$ = 0	$NBL_{1.2\_dia\_e\_2}$ = 0.00	ft
*Total Factored Resisting Moment due to Pp and Soil Wedges / Shear (0.9*D LC):*	$\Phi M_{Resisting\_0.9\_dia\_e} = \Phi M_{R\_Pp\_dia}$ + SUM($\Phi M_{R\_wedges\_0.9\_dia\_e}$,$\Phi M_{R\_shear\_0.9\_dia\_e}$)	$\Phi M_{Resisting\_0.9\_dia\_e}$ = 3.47	kip*ft
*Total Factored Resisting Moment due to Pp and Soil Wedges / Shear (1.2*D LC):*	$\Phi M_{Resisting\_1.2\_dia\_e} = \Phi M_{R\_Pp\_dia}$ + SUM($\Phi M_{R\_wedges\_1.2\_dia\_e}$,$\Phi M_{R\_shear\_1.2\_dia\_e}$)	$\Phi M_{Resisting\_1.2\_dia\_e}$ = 3.47	kip*ft
*Adjusted Overturning Moment (0.9*D LC):*	$M_{overturning\_0.9\_dia\_e} = M_{overturning} - \Phi M_{Resisting\_0.9\_dia\_e}$	$M_{overturning\_0.9\_dia\_e}$ = 302.03	kip*ft
*Adjusted Overturning Moment (1.2*D LC):*	$M_{overturning\_1.2\_dia\_e} = M_{overturning} - \Phi M_{Resisting\_1.2\_dia\_e}$	$M_{overturning\_1.2\_dia\_e}$ = 302.03	kip*ft
*Total Resistance to Overturning (0.9*D LC):*	$\Phi M_{Resisting\_qu\_0.9\_dia\_e} = P_{bearing\_0.9\_dia\_e} * ec_{0.9\_e\_dia} + \Phi M_{Resisting\_0.9\_dia\_e}$	$\Phi M_{Resisting\_qu\_0.9\_dia\_e}$ = 3.47	kip*ft
*Total Resistance to Overturning (1.2*D LC):*	$\Phi M_{Resisting\_qu\_1.2\_dia\_e} = P_{bearing\_1.2\_dia\_e} * ec_{1.2\_e\_dia} + \Phi M_{Resisting\_1.2\_dia\_e}$	$\Phi M_{Resisting\_qu\_1.2\_dia\_e}$ = 3.47	kip*ft
[Goal Seek] Moment Comparison Iteration (0.9D LC):	$\Delta M_{0.9\_dia\_e} = M_{overturning} - \Phi M_{Resisting\_qu\_0.9\_dia\_e}$	$\Delta M_{0.9\_dia\_e}$ = 302.03	kip*ft
[Goal Seek] Moment Comparison Iteration (1.2D LC):	$\Delta M_{1.2\_dia\_e} = M_{overturning} - \Phi M_{Resisting\_qu\_1.2\_dia\_e}$	$\Delta M_{1.2\_dia\_e}$ = 302.03	kip*ft

Bearing Pressures

*Diagonal Bearing Pressure (0.9*D LC):*	$q_{u\_dia\_0.9\_e}$ = Pbearing_0.9_dia_e/Area + Moverturning_0.9_dia_e/S_dia	$q_{u\_dia\_0.9\_e}$ = 2.19	ksf
*Diagonal Bearing Pressure (1.2*D LC):*	$q_{u\_dia\_1.2\_e}$ = Pbearing_1.2_dia_e/Area + Moverturning_1.2_dia_e/S_dia	$q_{u\_dia\_1.2\_e}$ = 2.42	ksf
Ultimate Gross Bearing Pressure:	Q_{ult} = Qult	Q_{ult} = 8.00	ksf
Factored Ultimate Gross Bearing Pressure:	ΦQult = φs * Qult	Qa = 6.00	ksf

Check **ΦQult = 6.00 ksf >= q_u = 2.42 ksf RATING: 40.41% OK**

Soil Wedges (Cohesionless Soil) 1 1 Load Resistance Utilization F

Soil (above pad) Height:	soilht = D-T	soilht = 3.50	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	$Wedge_{proj}$ = 2.36	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) Rear Sides (above Water Table)	0.00	0.00	0.00	0.00
(2) Rear Sides (below Water Table)	0.00	0.00	0.00	0.00
(2) Partial Sides (above Water Table)	0.00	0.00	0.00	0.00
(2) Partial Sides (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	$M_{R\_wedges\_0.9\_dia\_e}$ = 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_dia_e	$\Phi M_{R\_wedges\_0.9\_dia\_e}$ = 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	0.00	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	0.00	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 — $M_{R\_wedges\_1.2\_dia\_e}$ = 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_dia_e — $\Phi M_{R\_wedges\_1.2\_dia\_e}$ = 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	16.97	0.00
(2) Partial Sides	0.00	0.00	8.49	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 — $M_{R\_shear\_0.9\_dia\_e}$ = 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) — $\Phi M_{R\_shear\_0.9\_dia\_e}$ = 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	16.97	0.00
(2) Partial Sides	0.00	0.00	8.49	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 — $M_{R\_shear\_1.2\_dia\_e}$ = 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) — $\Phi M_{R\_shear\_1.2\_dia\_e}$ = 0.00 kip*ft

DETERMINE MOMENT THAT WOULD CAUSE 100% OVERTURNING (DIAGONAL)

*Compressive Load for Bearing (0.9*D LC):* $P_{\_100\_dia\_e}$ = P_0.9D+0.9*(Ws+Wc)+0.75*Wwedges_100_dia_e — $P_{\_100\_dia\_e}$ = 106.83 kip

Preliminary Factored Overturning Moment: $pre\_M_{overturning\_100\_dia\_e}$ = P_100_dia_e*(W*SQRT(2) - SQRT(6*P_100_dia_e/(2*ΦQult)))/2 — $pre\_M_{overturning\_100\_dia\_e}$ = 516.09 kip*ft

*Preliminary Load Eccentricity (0.9*D LC):* $pre\_ec_{\_100\_dia\_e}$ = $pre\_M_{overturning\_100\_dia\_e}/P_{\_100\_dia\_e}$ — $pre\_ec_{\_100\_dia\_e}$ = 4.83 ft

*[Goal Seek] Load Eccentricity Iteration (0.9*D LC):* $ec_{\_100\_dia\_e}$ = *goal seek* — $ec_{\_100\_dia\_e}$ = 3.41 ft

*Slope of Bearing Pressure in Diagonal Direction (0.9*D LC):* $slope_{\_100\_dia\_e}$ = D_3*($q_{max\_dia\_0.9\_e}$/(W/2*SQRT(2)+D_3)) — $slope_{\_100\_dia\_e}$ = 2.02 ft/ft

*Diagonal Bearing Pressure Solution (if bearing area is > Area/2) (0.9*D LC):*

	Wedge 1	Wedge 2	Total
	4.32	6.00	
Volume (ft³):	61.64	241.18	302.83
Distance to Centroid from Center of Foundation (ft):	-1.29	3.39	2.44

*Non-Bearing Length (0.9*D LC):* $NBL_{\_100\_dia\_e}$ = MAX((W/2*SQRT(2)-D_3)*SQRT(2),0) — $NBL_{\_100\_dia\_e}$ = 5.89 ft

*Non-Bearing Length (0.9*D LC):* $NBL_{\_100\_dia\_e\_2}$ = 0 — $NBL_{\_100\_dia\_e\_2}$ = 0.00 ft

*Total Factored Resisting Moment due to Pp and Soil Wedges / Shear (0.9*D LC):* $\Phi M_{Resisting\_100\_dia\_e}$ = $\Phi M_{R\_Pp\_dia}$ + SUM($\Phi M_{R\_wedges\_100\_dia}$,$\Phi M_{R\_shear\_100\_dia}$) — $\Phi M_{Resisting\_100\_dia\_e}$ = 40.26 kip*ft

Moment Created by Shear: M_{shear_e} = V_u * (D+E+bp_{dist}/12) — M_{shear_e} = 32.50 kip*ft

*Adjusted Overturning Moment (0.9*D LC):* $M_{overturning\_100\_dia\_e}$ = $M_{u\_max\_100\_dia}$ - $\Phi M_{R\_Pp\_dia}$ — $M_{overturning\_100\_dia\_e}$ = 552.88 kip*ft

*Total Resistance to Overturning (0.9*D LC):* $\Phi M_{Resisting\_qu\_100\_dia\_e}$ = $P_{\_100\_dia\_e}$*$ec_{\_100\_dia\_e}$ + $\Phi M_{Resisting\_100\_dia\_e}$ — $\Phi M_{Resisting\_qu\_100\_dia\_e}$ = 404.87 kip*ft

[Goal Seek] Moment Comparison Iteration (0.9D LC): $\Delta M_{\_100\_dia\_e}$ = $M_{overturning}$ - $\Phi M_{Resisting\_qu\_100\_dia}$ — $\Delta M_{\_100\_dia\_e}$ = 148.01 kip*ft

Maximum Applied Moment from Superstructure Analysis: $M_{u\_max\_100\_dia\_e}$ = pre_Moverturning_100_dia + ΦMResisting_100_dia — $M_{u\_max\_100\_dia\_e}$ = 556.35 kip*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)	6.50	0.81	17.81	14.47
(1) End Prisms (below Water Table)	0.00	0.00	0.00	0.00
(2) Rear Sides (above Water Table)	48.65	6.08	15.31	93.09
(2) Rear Sides (below Water Table)	0.00	0.00	0.00	0.00
(2) Partial Sides (above Water Table)	0.00	0.00	0.00	0.00
(2) Partial Sides (below Water Table)	0.00	0.00	0.00	0.00
Total	55.16	6.89		107.56

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

Total Moment Arm (ft) =	7.12
Soil Wedge Wt (kip)=	6.89

*Unfactored Resisting Moment of Wedges (0.9*D LC):* $M_{R\_wedges\_100\_dia\_e}$ = Total Moment Arm * Soil Wedge Wt — $M_{R\_wedges\_100\_dia\_e}$ = 49.06 kip*ft

*Factored Resisting Moment of Wedges (0.9*D LC):* $\Phi M_{R\_wedges\_100\_dia\_e}$ = 0.75*MR_wedges_100_dia_e — $\Phi M_{R\_wedges\_100\_dia\_e}$ = 36.79 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	14.89	0.00
(2) Partial Sides	0.00	0.00	8.49	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):* $M_{R\_shear\_100\_dia\_e}$ = Total Moment Arm * Soil Shear Strength — $M_{R\_shear\_100\_dia\_e}$ = 0.00 kip*ft

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

ATTACHMENT D – PROOF OF DELIVERY OF NOTICE

Ref: CT587100 ES RIDG Date: 23Jul20 Wgt: 0.80 LBS
Dep: BL GRAPHICS
DV: 0.00

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

Svcs: PRIORITY OVERNIGHT
TRCK: 1714 2090 7100

ORIGIN ID:RSPA (800) 301-3077
BL GRAPHICS
BL GRAPHICS
355 RESEARCH PARKWAY

MERIDEN, CT 06450
UNITED STATES US

SHIP DATE: 23JUL20
ACTWGT: 0.80 LB MAN
CAD: 0765627/CAFE3311

BILL THIRD PARTY

TO

CONNECTICUT SITING COUNCIL
10 FRANKLIN SQUARE

NEW BRITAIN CT 06051

REF: CT587100 ES RIDGEFIELD

DEPT: BL GRAPHICS

565C3/C6A6/05A2

FedEx Express

E

J191219082081uv

FRI – 24 JUL 10:30A
PRIORITY OVERNIGHT

TRK# 0201 **1714 2090 7100**

00 BDLA

06051
CT-US **BDL**

Ref: CT587100 ES RIDG Date: 23Jul20
Dep: BL GRAPHICS Wgt: 0.80 LBS
DV: 0.00

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

Svcs: PRIORITY OVERNIGHT
TRCK: 1714 2090 7085

ORIGIN ID:RSPA (800) 301-3077
BL GRAPHICS
BL GRAPHICS
355 RESEARCH PARKWAY

MERIDEN, CT 06450
UNITED STATES US

SHIP DATE: 23JUL20
ACTWGT: 0.80 LB
CAD: 0765627/CAFE3311

BILL THIRD PARTY

TO **HONORABLE RUDY MARCONI, FIRST SELEC**
TOWN OF RIDGEFIELD
400 MAIN STREET

RIDGEFIELD CT 06877
REF: CT587100 ES RIDGEFIELD
DEPT: BL GRAPHICS

565C3/C6A6/05A2

FedEx
Express

E

J191219082001uv

FRI – 24 JUL 10:30A
PRIORITY OVERNIGHT

TRK# 0201 **1714 2090 7085**

EG WODA

06877
CT-US **SWF**

Ref: CT587100 ES RIDG Date: 23Jul20
Dep: BL GRAPHICS Wgt: 0.80 LBS
DV: 0.00

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

Svcs: PRIORITY OVERNIGHT
TRCK: 1714 2090 7096

ORIGIN ID:RSPA (800) 301-3077
BL GRAPHICS
BL GRAPHICS
355 RESEARCH PARKWAY

MERIDEN, CT 06450
UNITED STATES US

SHIP DATE: 23JUL20
ACTWGT: 0.80 LB MAN
CAD: 0765627/CAFE3311

BILL THIRD PARTY

TO RICHARD BALDELLI, DIRECTOR OF PLANN
TOWN OF RIDGEFIELD
400 MAIN STREET

RIDGEFIELD CT 06877
REF: CT587100 ES RIDGEFIELD
DEPT: BL GRAPHICS

565C3/C6A6/05A2

FedEx
Express

E

J191219082001uv

TRK# 0201 1714 2090 7096

FRI – 24 JUL 10:30A
PRIORITY OVERNIGHT

EG WODA

06877
CT-US SWF

Part # 156148-434 RIT2 EXP 06/20

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-286

Off Prospect Street

Ridgefield, CT 06877

April 2, 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 to be located off Prospect Street in Ridgefield, CT.

Eversource is proposing to install two omnidirectional antennas as part of its 220 MHz communications system – one transmit antenna and one receive antenna.

This report considers the planned antenna configuration as provided by Eversource along with power density information of the existing antennas to calculate the overall % MPE (Maximum Permissible Exposure) of the proposed facility at ground level.

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.

3. 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.

4. Calculated % MPE Results

Table 1 below outlines the power density information for the site. The proposed Eversource omnidirectional antenna has a vertical beamwidth of 38°; therefore, the majority of the RF power is focused out towards the horizon. Please refer to Attachment C for the vertical pattern of the proposed Eversource antenna. Likewise, the other transmit antennas exhibit similar directionality of varying vertical beamwidths. As a result, there will be less RF power directed below the antennas relative to the horizon, and consequently lower power density levels around the base of the facility. The calculated results in Table 1 include a nominal 10 dB off-beam pattern loss to account for the lower relative gain below the antennas. Any inactive or receive-only antennas are not listed in the table, as they are irrelevant in terms of the % MPE calculations.

Carrier	Antenna Height (Feet)	Operating Frequency (MHz)	Number of Trans.	ERP Per Transmitter (Watts)	Power Density (mw/cm^2)	Limit	%MPE
CL&P	*85*	*37.74*	*1*	*100*	*0.0006*	*0.2000*	*0.29%*
CL&P	*70*	*44*	*1*	*100*	*0.0009*	*0.2000*	*0.44%*
CL&P	*70*	*48*	*1*	*100*	*0.0009*	*0.2000*	*0.44%*
CL&P	*85*	*450*	*1*	*251*	*0.0014*	*0.3000*	*0.48%*
CL&P	*85*	*937*	*2*	*240*	*0.0028*	*0.6247*	*0.44%*
Eversource	90	44.34	1	100	0.0005	0.2000	0.25%
Eversource	88	936.6375	1	240	0.0013	0.6244	0.21%
Eversource	88	938.45	1	240	0.0013	0.6256	0.21%
Eversource	74	37.74	1	100	0.0008	0.2000	0.39%
Eversource	74	451.675	1	251	0.0020	0.3011	0.65%
Eversource	73	48.34	1	100	0.0008	0.2000	0.40%
Eversource	80	217	4	124	0.0033	0.2000	1.63%
						Total	**3.73%**

Table 1: Proposed Facility % MPE [1] [2]

The CT Siting Council power density database reflects entries for existing Eversource (f.k.a. CL&P) antennas. These entries are shown as grey in the table above and should be replaced by the unshaded entries, which are based upon updated operating parameters provided by Eversource as part of this project. The blue entry reflects the parameters of the proposed Eversource antenna. Therefore, the total % MPE calculated is based upon only the unshaded and blue entries.

[1] Please note that % MPE values listed are rounded to two decimal points and the total % MPE listed is a summation of each unrounded contribution. Therefore, summing each rounded value may not identically match the total value reflected in the table.

[2] The antenna heights listed for Eversource are in reference to the Black & Veatch Structural Analysis Report dated 03/26/2020.

5. Conclusion

The above analysis concludes that RF exposure at ground level 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. Using the conservative calculation methods discussed herein, the highest expected percent of Maximum Permissible Exposure at ground level with the proposed installation is **3.73% of the FCC General Population/Uncontrolled limit**.

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

6. 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.

Sokol Andoni

April 2, 2020

Report Prepared By: Sokol Andoni
RF Engineer
C Squared Systems, LLC

Date

Keith Vellante

April 2, 2020

Reviewed/Approved By: Keith Vellante
Director – RF Services
C Squared Systems, LLC

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[3]

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (E) (A/m)	Power Density (S) (mW/cm^2)	Averaging Time $\lvert E\rvert^2$, $\lvert H\rvert^2$ 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[4]

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (E) (A/m)	Power Density (S) (mW/cm^2)	Averaging Time $\lvert E\rvert^2$, $\lvert H\rvert^2$ 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 2: FCC Limits for Maximum Permissible Exposure (MPE)

[3] 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

[4] 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

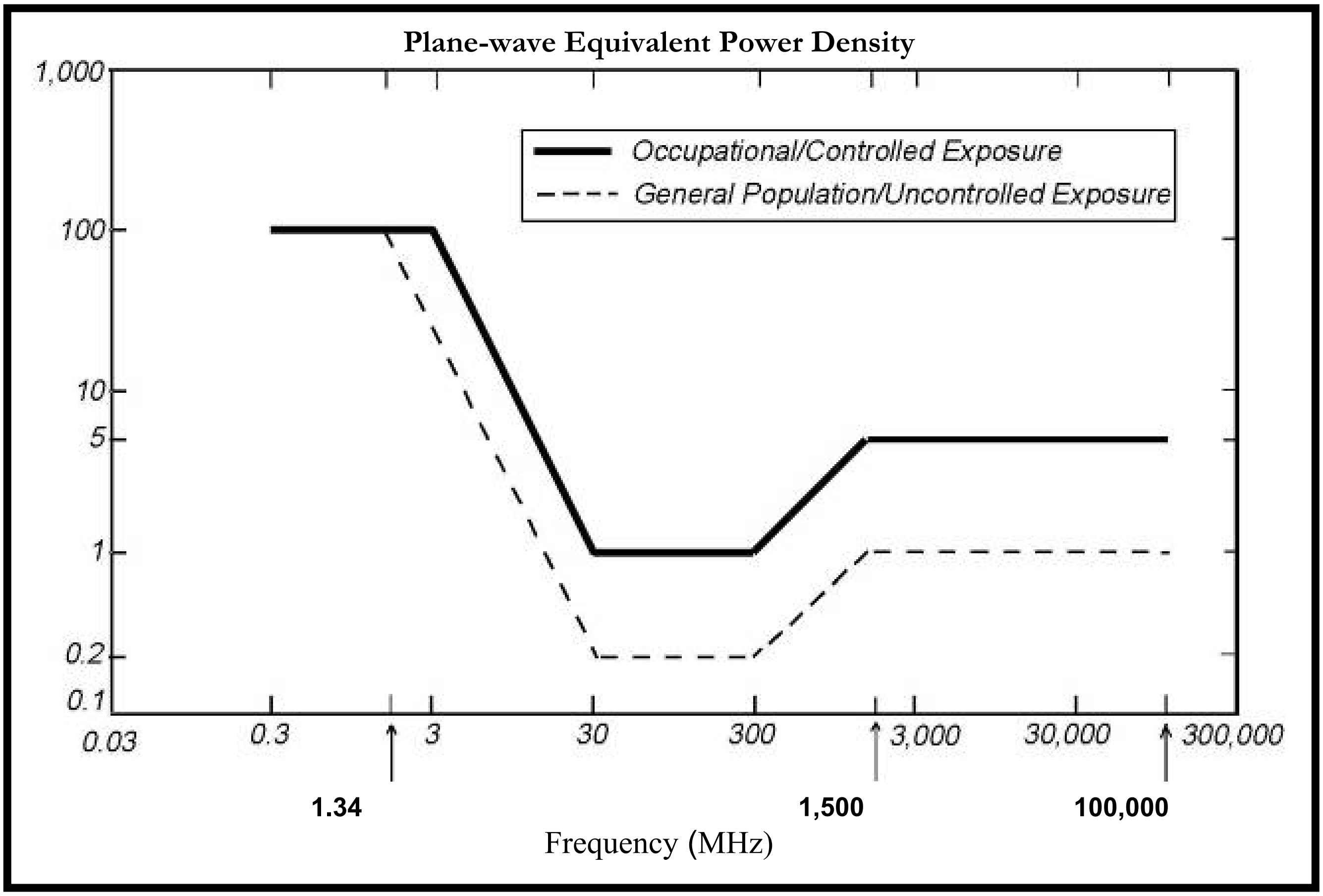


Figure 1: Graph of FCC Limits for Maximum Permissible Exposure (MPE)

Attachment C: Eversource Antenna Data Sheets and Electrical Patterns

217 MHz	
Manufacturer:	Telewave
Model #:	ANT220F2
Frequency Band:	195-260 MHz
Gain:	2.5 dBd
Vertical Beamwidth:	38°
Horizontal Beamwidth:	360°
Polarization:	Vertical
Length:	51”