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

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

October 22, 2020

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

RE: **Notice of Exempt Modification**
Eversource Site # 2107
414 Chapel Hill Road, Montville, CT 06370
Latitude: 41-28-8.31 N / Longitude: 72-12-16.66 W

Dear Ms. Bachman:

The Connecticut Light and Power Company doing business as Eversource Energy ("Eversource") currently maintains multiple antennas and microwave dishes at various mounting heights on an existing 180-foot self-support tower located at 414 Chapel Hill Road in Montville. See Attachment A, Parcel Map and Property Card. The tower and property are owned by Eversource. Eversource plans to install one 12-foot 7-inch tall omni-directional antenna, to be mounted at approximately 177 feet above ground level ("AGL"), one 6-foot 7-inch diameter microwave dish, to be mounted at approximately 170 feet AGL, two 7/8-inch diameter coaxial cables, and one elliptical waveguide cable. There will be no changes to 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 September 2, 2020 and Attachment C, Structural Analysis, dated August 17, 2020. The tower was approved by the Council on July 26, 2007 under Petition No. 824.

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 Ronald K. McDaniel, Mayor for the Town of Montville and Marcia A. Vlaun, Town Planner for the Town of Montville via private carrier. Proof of delivery is attached. See Attachment D, Proof of Delivery of Notice.

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

1. There will be no change to the height of the existing tower.
2. The proposed modifications will not require 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 September 16, 2020 (Attachment E – Power Density Report).
5. The proposed modifications will not cause a change or alteration in the physical or environmental characteristics of the site.
6. The existing structure and its foundation can support the proposed loading.

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

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

By: ______________________________
Kathleen M. Shanley
Manager – Transmission Siting

cc: Honorable Ronald K. McDaniel, Mayor, Town of Montville
Marcia A. Vlaun, Town Planner, Town of Montville

Attachments

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

ATTACHMENT A – PARCEL MAP AND PROPERTY CARD

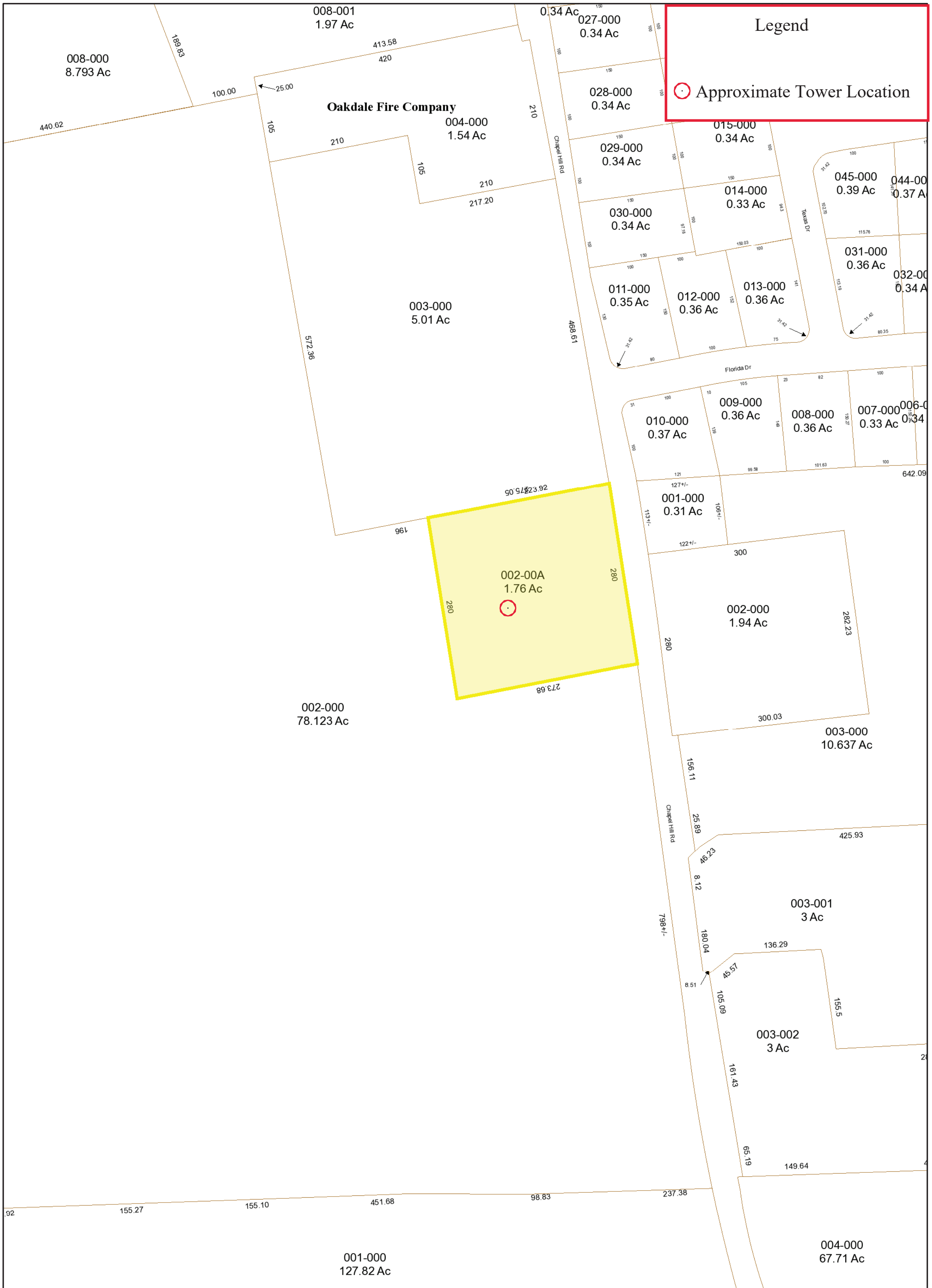
ES-022 Chapel Hill

Montville, CT

1 inch = 141 Feet

0 141 282 423

April 24, 2020



Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

Data shown on this map is provided for planning and informational purposes only. The municipality and CAI Technologies are not responsible for any use for other purposes or misuse or misrepresentation of this map.

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 2016.

Information on the Property Records for the Municipality of Montville was last updated on 4/24/2020.

Parcel Information

Location:	414 CHAPEL HILL RD	Property Use:	Vacant Land	Primary Use:	Cell Tower
Unique ID:	C0154400	Map Block Lot:	035/002/00A	Acres:	1.76
490 Acres:	0.00	Zone:	C-1	Volume / Page:	0131/1181
Developers Map / Lot:		Census:	695202		

Value Information

	Appraised Value	Assessed Value
Land	101,220	70,850
Buildings	0	0
Detached Outbuildings	8,800	6,160
Total	110,020	77,010

Owner's Information

Owner's Data
CONNECTICUT LIGHT & POWER COMPANY PO BOX 270 HARTFORD, CT 06141-0270

Detached Outbuildings

Type:	Year Built:	Length:	Width:	Area:
6 Ft Chain Fence	2007	400.00	0.00	400
Cell Shed	2007	128.00	0.00	128
Tower	2007	1.00	0.00	1

Owner History - Sales

Owner Name	Volume	Page	Sale Date	Deed Type	Valid Sale	Sale Price
CONNECTICUT LIGHT & POWER COMPANY	0131	1181	07/26/1977		No	$0

ATTACHMENT B – CONSTRUCTION DRAWINGS

EVERSOURCE ENERGY

CHAPEL HILL RADIO
414 CHAPEL HILL ROAD
MONTVILLE, CT 06370

PROJECT SUMMARY

THE GENERAL SCOPE OF WORK CONSISTS OF THE FOLLOWING:

1. INSTALL (1) NEW OMNI/WHIP ANTENNAS, (1) AT ELEVATION 189'-7 15/16"± AGL
2. INSTALL (1) NEW MW DISH ANTENNA AT ELEVATION 173'-0"± AGL
3. 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:	CHAPEL HILL RADIO
SITE ID NUMBER:	2107
SITE ADDRESS:	414 CHAPEL HILL ROAD MONTVILLE, CT 06370
MAP:	035
BLOCK:	002
LOT:	00A
ZONE:	C-1
LATITUDE:	41° 28' 8.31" N
LONGITUDE:	72° 12' 16.66" W
ELEVATION:	607'± AMSL
FEMA/FIRM DESIGNATION:	X
ACREAGE:	1.76± AC (BOOK: 0131, PAGE: 1181)

CONTACT INFORMATION

APPLICANTS:
EVERSOURCE ENERGY
107 SELDEN STREET
BERLIN, CT 06037

PROPERTY OWNER:
EVERSOURCE ENERGY
107 SELDEN STREET
BERLIN, CT 06307

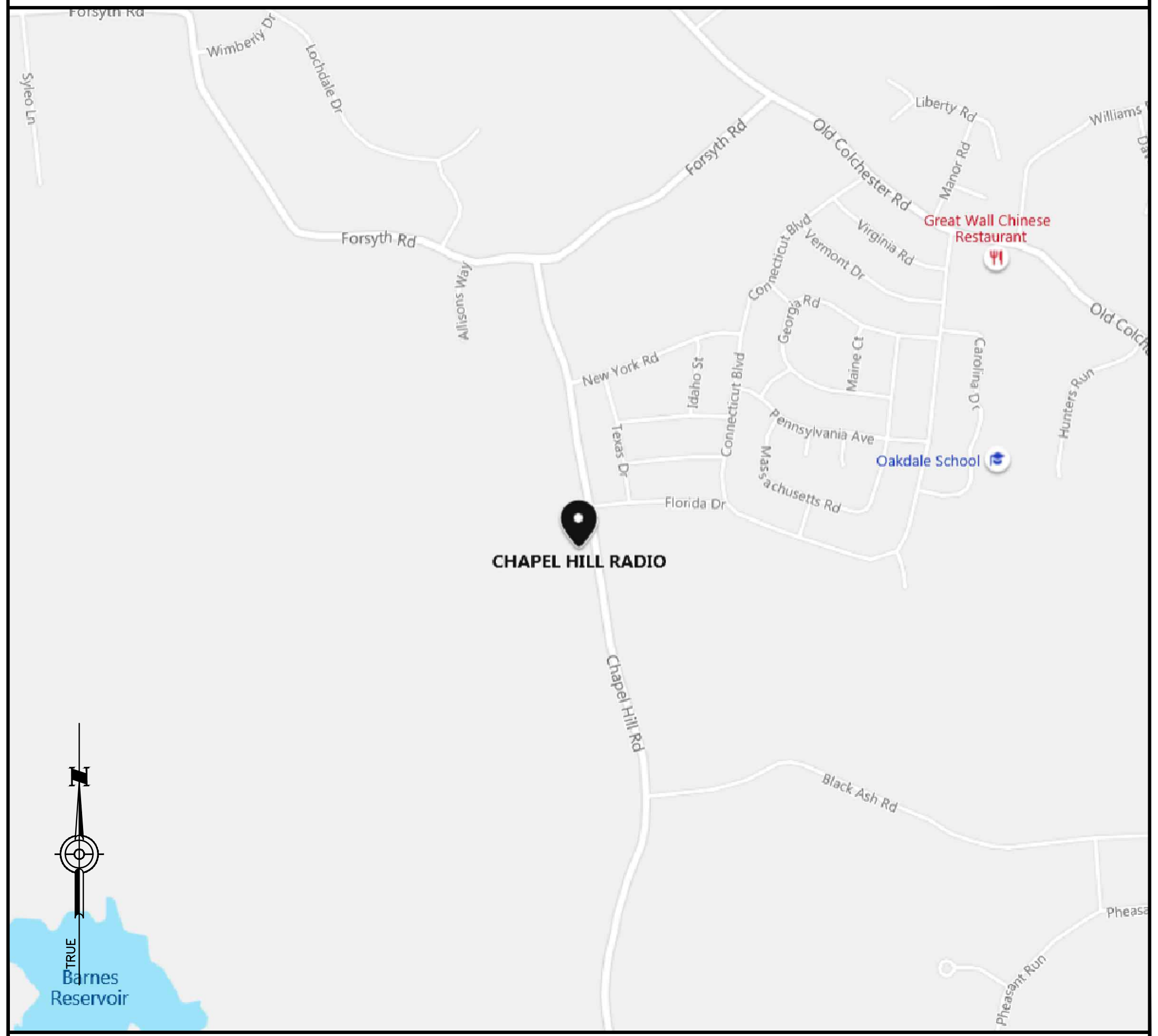
EVERSOURCE ENERGY PROJECT MANAGER:
NIKOLL PRECI
(860) 655-3079

POWER PROVIDER:
EVERSOURCE ENERGY
(800) 286-2000

TELCO PROVIDER:
FRONTIER
(800) 921-8102

CALL BEFORE YOU DIG:
(800) 922-4455

LOCATION MAP



NO SCALE

DESIGN TYPE

SITE UPGRADE
SELF-SUPPORT TOWER

DRAWING INDEX

SHEET NO:	SHEET TITLE
T-1	TITLE SHEET
C-1	COMPOUND PLAN
C-2	SITE PLAN
C-3	TOWER ELEVATION
C-4	MICROWAVE DISH MOUNT DETAILS
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:	405025
DRAWN BY:	TYW
CHECKED BY:	TH

REV	DATE	DESCRIPTION
0	09/01/20	ISSUED FOR FILING

09/02/2020

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.

CHAPEL HILL RADIO
414 CHAPEL HILL ROAD
MONTVILLE, CT 06370

SHEET TITLE
TITLE SHEET

SHEET NUMBER
T-1

COMPOUND PLAN

NO SCALE

EVERSOURCE ENERGY

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

BLACK & VEATCH

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

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

REV	DATE	DESCRIPTION
0	09/01/20	ISSUED FOR FILING

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

09/02/2020

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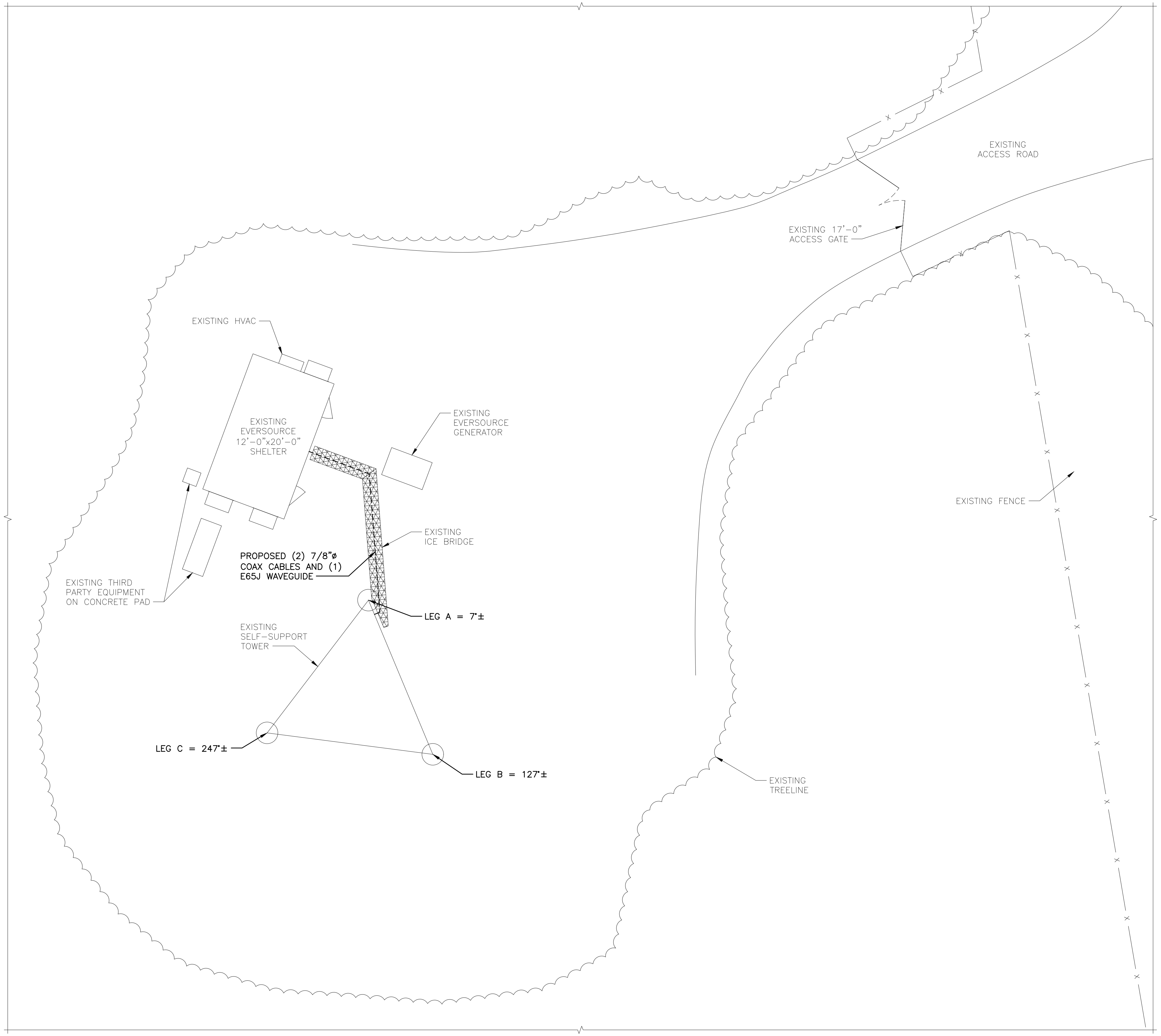
CHAPEL HILL RADIO
414 CHAPEL HILL ROAD
MONTVILLE, CT 06370

SHEET TITLE

COMPOUND PLAN

SHEET NUMBER

C-1



SITE PLAN
NO SCALE

N

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

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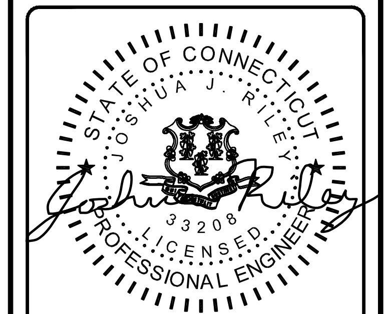

09/02/2020

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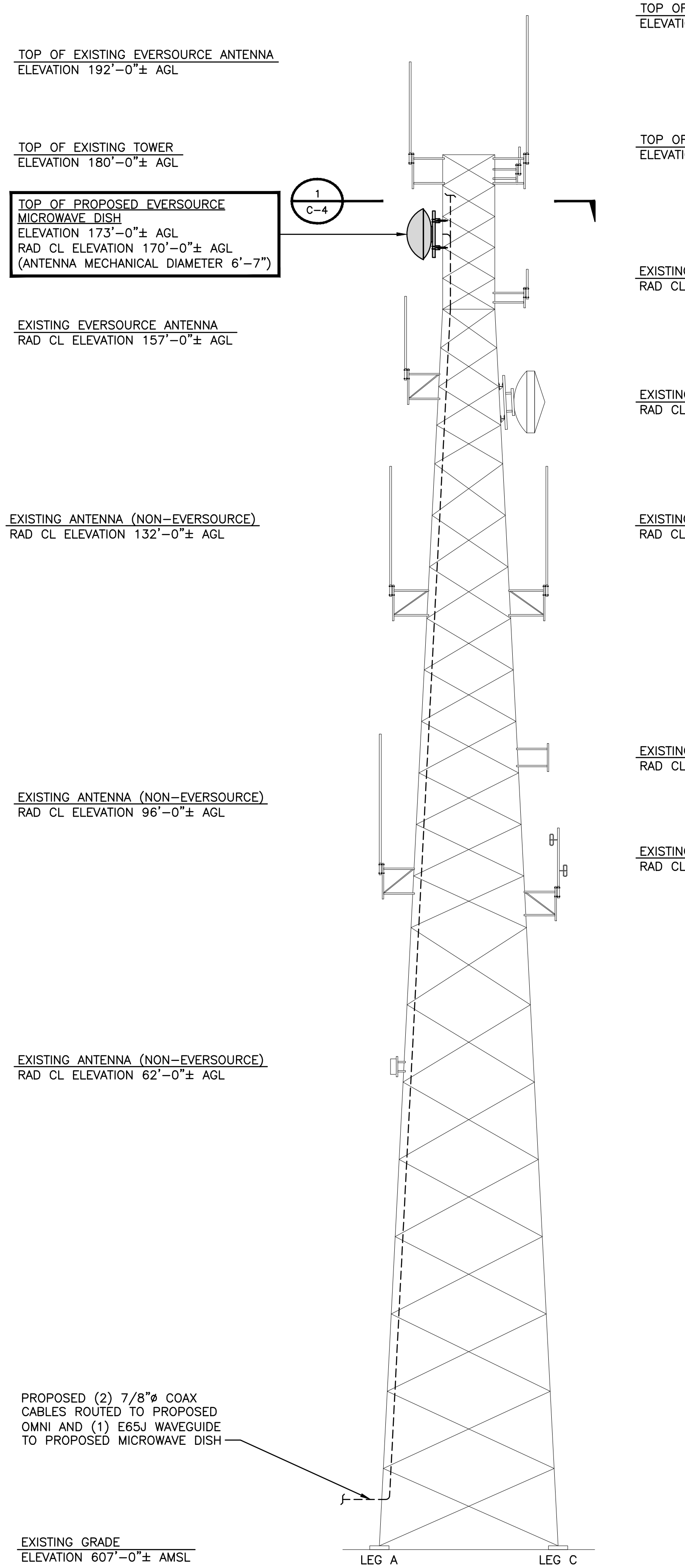
CHAPEL HILL RADIO
414 CHAPEL HILL ROAD
MONTVILLE, CT 06370

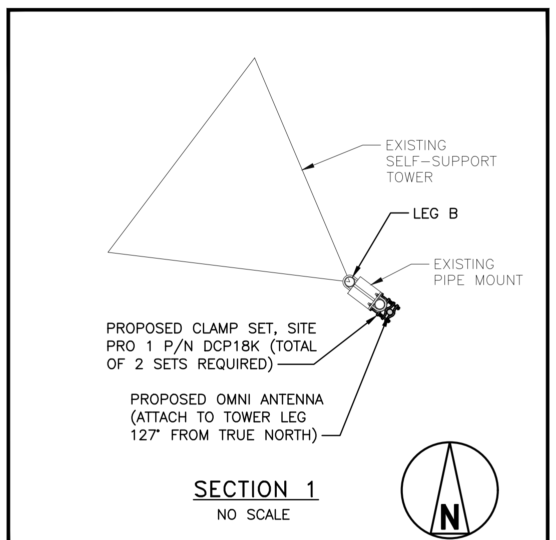
SHEET TITLE
SITE PLAN

SHEET NUMBER
C-2



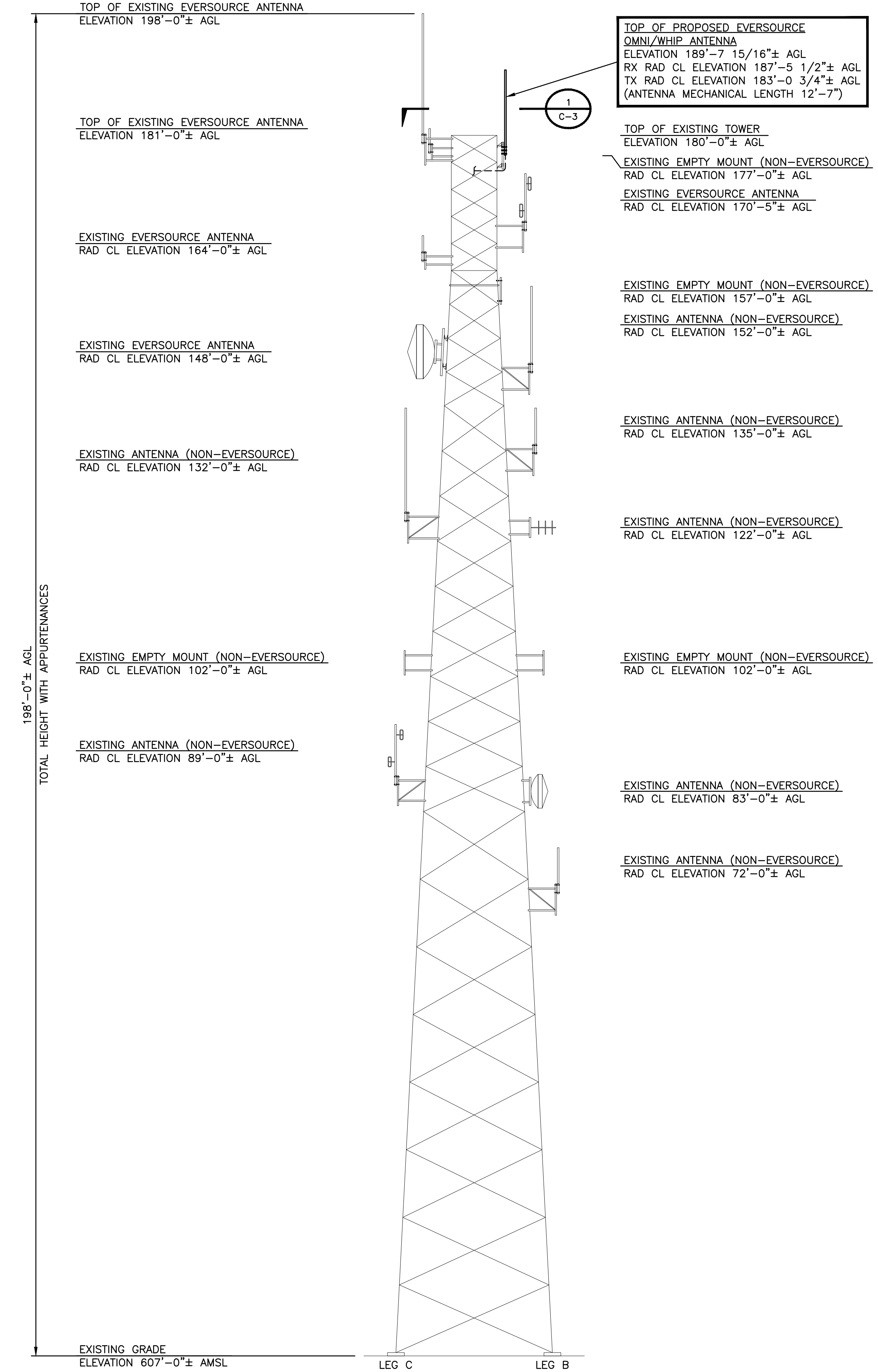
TOWER ELEVATION FACE AC

NO SCALE



SECTION 1

NO SCALE



TOWER ELEVATION FACE CB

NO SCALE

EVERSOURCE ENERGY

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

BLACK & VEATCH

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

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

REV	DATE	DESCRIPTION
0	09/01/20	ISSUED FOR FILING

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

09/02/2020

CHAPEL HILL RADIO
414 CHAPEL HILL ROAD
MONTVILLE, CT 06370

SHEET TITLE

TOWER ELEVATION & ANTENNA EQUIPMENT

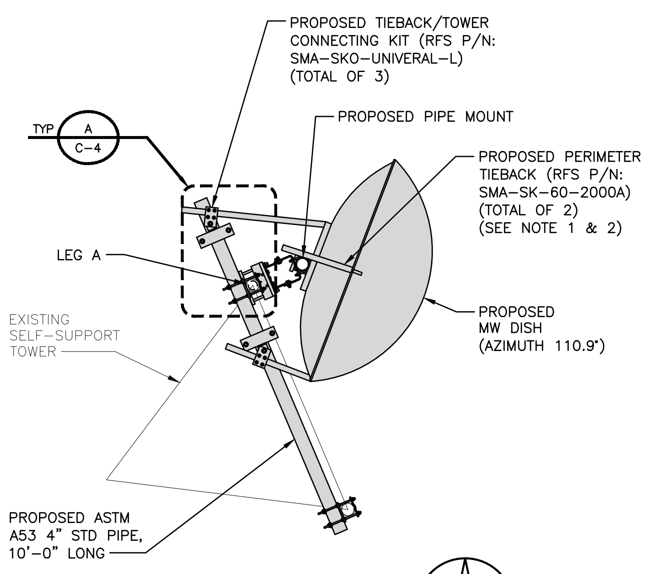
SHEET NUMBER

C-3

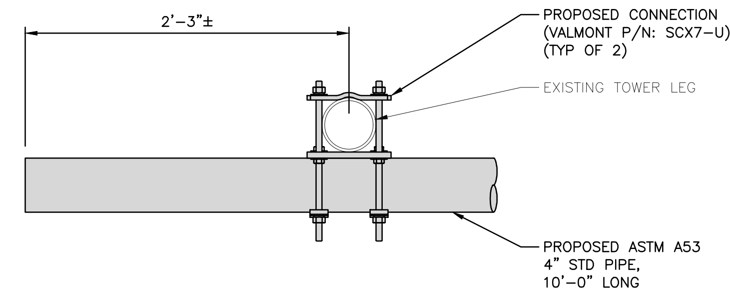
NOTES

1. ATTACH INNER TIEBACK AND RIGHT PERIMETER TIEBACK TO PROPOSED 4" STD PIPE. REFER TO ALLOWABLE TIEBACK ANGLE DIAGRAM.
2. ATTACH TOP PERIMETER TIEBACK TO PROPOSED PIPE MOUNT. REFER TO ALLOWABLE TIE BACK ANGLE DIAGRAM.
3. TRIM TIEBACK PIPE AND 4" STD PIPE AS REQUIRED TO MAINTAIN A 6" DISTANCE BETWEEN END OF CLAMPS AND END OF PIPE.

ALLOWABLE TIEBACK ANGLE
±15 DEGREES VERTICAL
±15 DEGREES HORIZONTAL



SECTION 1
NO SCALE



DETAIL A
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

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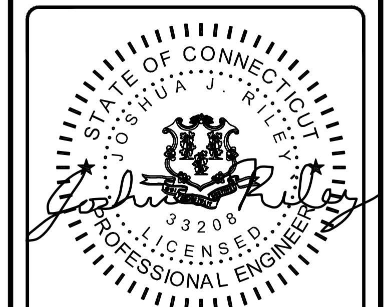

09/02/2020

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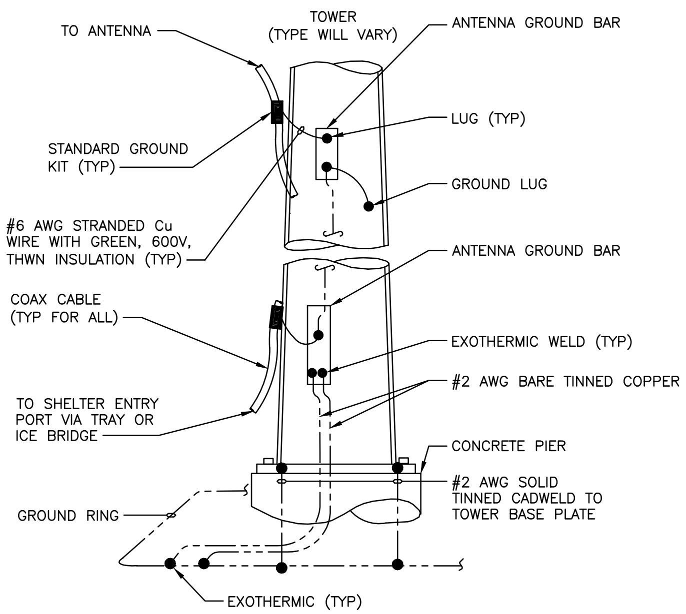
CHAPEL HILL RADIO
414 CHAPEL HILL ROAD
MONTVILLE, CT 06370

SHEET TITLE
MICROWAVE DISH MOUNT DETAILS

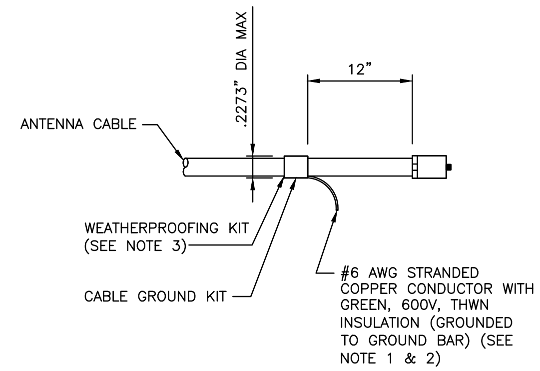
SHEET NUMBER
C-4



NOTE

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

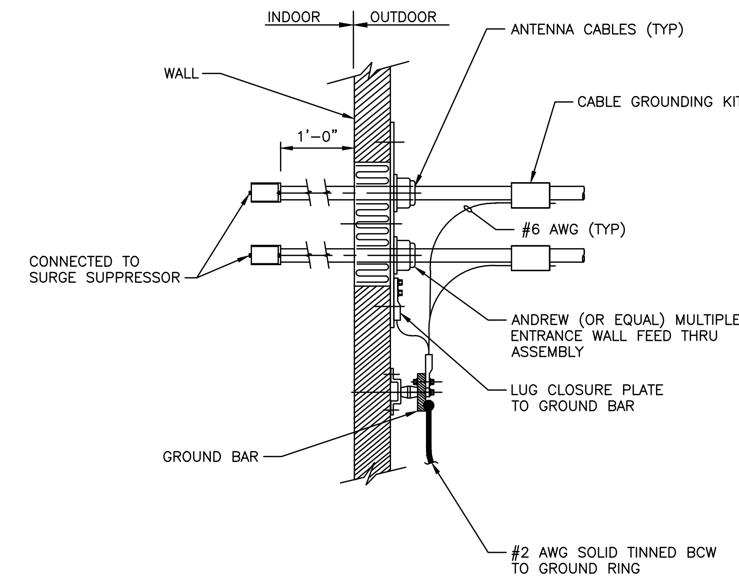
ANTENNA CABLE GROUNDING
NO SCALE



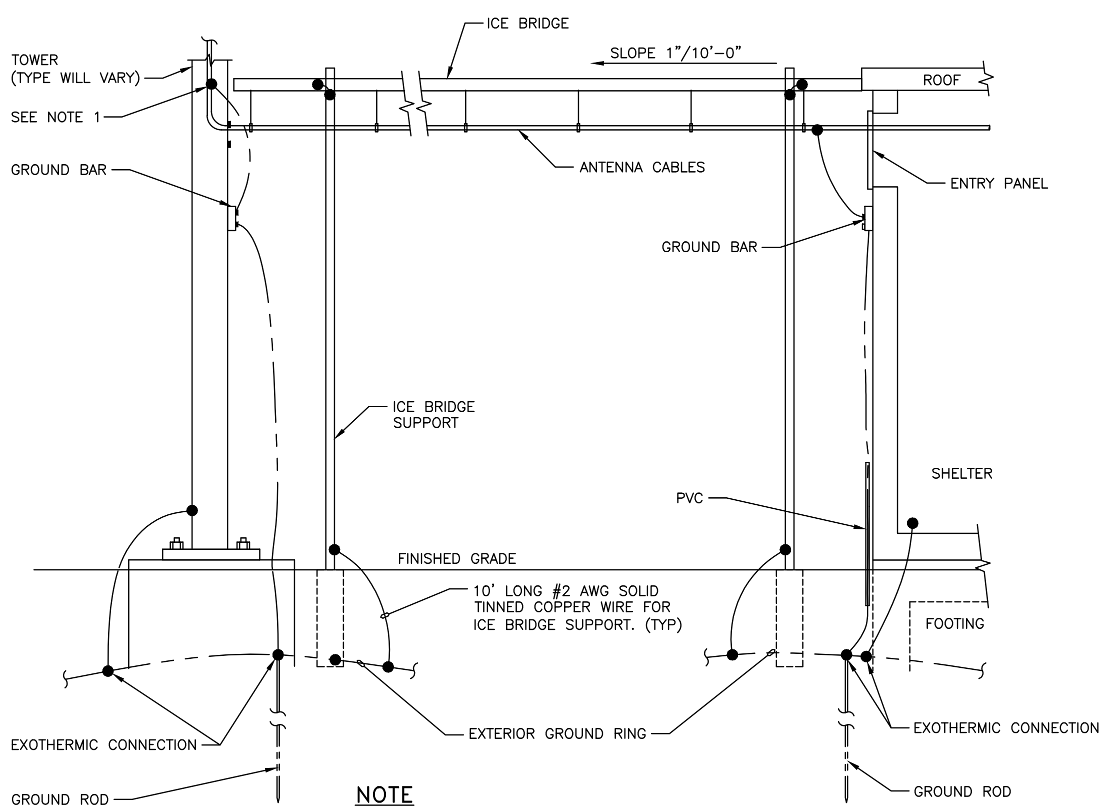
NOTES

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

CONNECTION OF CABLE GROUND
KIT TO ANTENNA CABLE
NO SCALE



CABLE INSTALLATION WITH WALL
FEED THRU ASSEMBLY
NO SCALE



NOTE

1. PROVIDE GROUND KIT 6" BEFORE TURN

ICE BRIDGE AND ANTENNA
CABLE DETAIL
NO SCALE

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

BLACK & VEATCH
6800 W 115TH ST, SUITE 2292
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PROJECT NO:	405025
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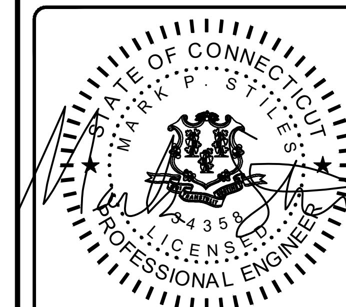
0	09/01/20	ISSUED FOR FILING



09/02/2020

CHAPEL HILL RADIO
414 CHAPEL HILL ROAD
MONTVILLE, CT 06370

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 AND ASTM 572, GR 50
ANGLE:	ASTM A570, GR 50 AND ASTM A36
BOLTS:	ASTM A325
GRATING:	TYPE GW-2 (1"x3/16" BARS)
MISC. MATERIAL:	ASTM A36

ALL STEEL SHAPES SHALL BE HOT-DIPPED GALVANIZED IN ACCORDANCE WITH ASTM A123 WITH A COATING WEIGHT OF 2 OZ/SF.

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

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:	405025
DRAWN BY:	TYW
CHECKED BY:	TH

REV	DATE	DESCRIPTION
0	09/01/20	ISSUED FOR FILING

STATE OF CONNECTICUT
JOSHUA J. RILEY
33208
LICENSED
PROFESSIONAL ENGINEER
09/02/2020

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.

CHAPEL HILL RADIO
414 CHAPEL HILL ROAD
MONTVILLE, CT 06370

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.

GROUNDING

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

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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PROJECT NO:	405025
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CHECKED BY:	TH

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STATE OF CONNECTICUT · MARK P. STILES · 34358 · LICENSED · PROFESSIONAL ENGINEER

09/02/2020

CHAPEL HILL RADIO
414 CHAPEL HILL ROAD
MONTVILLE, CT 06370

SHEET TITLE
NOTES & SPECIFICATIONS

SHEET NUMBER
N-2

SYMBOLS

●	EXOTHERMIC CONNECTION
■	COMPRESSION CONNECTION
⊣├●	5/8"ø x10–'0" COPPER CLAD STEEL GROUND ROD.
⊣├⊡	TEST GROUND ROD WITH INSPECTION SLEEVE
— – – —	GROUNDING CONDUCTOR
(A)	KEY NOTES
CHAINLINK FENCE	—— X —— X —— X —— X —— X ——
WOOD FENCE	—□—□—□—□—□—□—□—
LEASE AREA	— — — — — — — — — — — — — — —
ICE BRIDGE	
CABLE TRAY	
GAS LINE	—— G —— G —— G —— G —— G ——
UNDERGROUND ELECTRICAL/TELCO	—— E/T —— E/T —— E/T —— E/T ——
UNDERGROUND ELECTRICAL/CONTROL	—— E/C —— E/C —— E/C —— E/C ——
UNDERGROUND ELECTRICAL	—— E —— E —— E —— E —— E ——
UNDERGROUND TELCO	—— T —— T —— T —— T —— T ——
PROPERTY LINE (PL)	—— – – —— – – —— – – —— – – ——

ABBREVIATIONS

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

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SHEET TITLE

NOTES & SPECIFICATIONS

SHEET NUMBER

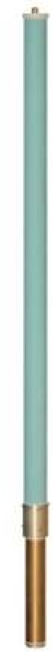
N-3

REFERENCE CUTSHEETS

dbSpectra

VHF Omni Antennas (160-222 MHz)

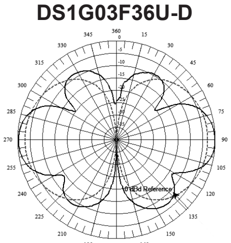
		160-174 MHz						217-222 MHz									
	Model Number	DS1G03F36U-N	DS1G03F36U-D	DS1G06F36U-N	DS1G06F36U-D	DS1G03F36D-N	DS1G03F36D-D	DS2C00F36U-N	DS2C00F36U-D	DS2C03F36U-N	DS2C03F36U-D	DS2C06F36U-N	DS2C06F36U-D	DS2C00F36D-N	DS2C00F36D-D	DS2C03F36D-N	DS2C03F36D-D
	Input Connector	N(F)	7/16 DIN	N(F)	7/16 DIN	N(F)	7/16 DIN	N(F)	7/16 DIN	N(F)	7/16 DIN	N(F)	7/16 DIN	N(F)	7/16 DIN	N(F)	7/16 DIN
	Type	Single		Single		Dual		Single		Single		Single		Dual		Dual	
ELECTRICAL	**Bandwidth**, MHz	14		14		14		5		5		5		5		5	
ELECTRICAL	**Power**, Watts	500		500		350		500		500		500		350		350	
ELECTRICAL	**Gain**, dBd	3		6		3		0		3		6		0		3	
ELECTRICAL	**Horizontal Beamwidth**, degrees	360		360		360		360		360		360		360		360	
ELECTRICAL	**Vertical Beamwidth**, degrees	30		16		30		60		30		16		60		30	
ELECTRICAL	**Beam Tilt**, degrees	0		0		0		0		0		0		0		0	
ELECTRICAL	**Isolation (minimum)**, dB	N/A		N/A		30		N/A		N/A		N/A		30		30	
MECHANICAL	**Number of Connectors**	1		1		2		1		1		1		2		2	
MECHANICAL	**Flat Plate Area**, ft²	2.10		3.63		3.69		1.28		1.64		2.58		2.09		3.08	
MECHANICAL	**Lateral Windload Thrust**, lbf	88		152		155		54		69		109		88		129	
MECHANICAL	**Wind Speed Rating without ice**, mph	190		150		150		250		225		175		190		160	
MECHANICAL	**Mounting Hardware** included	DSH3V3R		DSH3V3N		DSH3V3N		DSH2V3R		DSH2V3R		DSH3V3N		DSH3V3R		DSH3V3N	
DIMENSIONS	**Length**, ft(m)	12.7 (3.9)		21.9 (6.7)		22.3 (6.8)		7.7 (2.3)		9.9 (3)		15.6 (4.8)		12.6 (3.8)		18.6 (5.7)	
DIMENSIONS	**Radome O.D.**, in(cm)	3 (7.6)		3 (7.6)		3 (7.6)		3 (7.6)		3 (7.6)		3 (7.6)		3 (7.6)		3 (7.6)	
DIMENSIONS	**Mast O.D.**, in(cm)	2.5 (6.4)		2.5 (6.4)		2.5 (6.4)		2.5 (6.4)		2.5 (6.4)		2.5 (6.4)		2.5 (6.4)		2.5 (6.4)	
DIMENSIONS	**Net Weight** w/o bracket, lb(kg)	37 (16.8)		60 (27.2)		63 (28.6)		19 (8.6)		26 (11.8)		47 (21.3)		40 (18.1)		70 (31.8)	
DIMENSIONS	**Shipping Weight**, lb(kg)	67 (30.4)		90 (40.8)		93 (42.2)		39 (17.7)		56 (25.4)		77 (34.9)		70 (31.8)		100 (45.4)	



DS2C00F36D-D

VERTICAL PATTERNS

DS1G03F36U-N
DS1G03F36U-D



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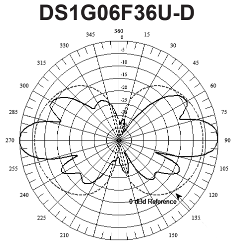

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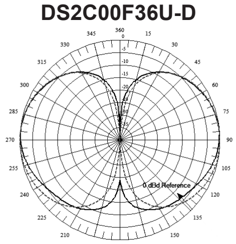

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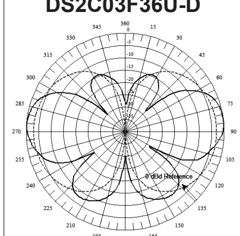

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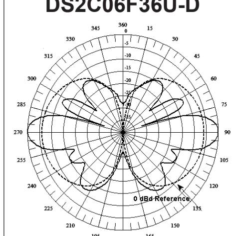

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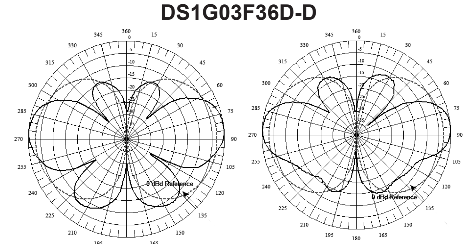

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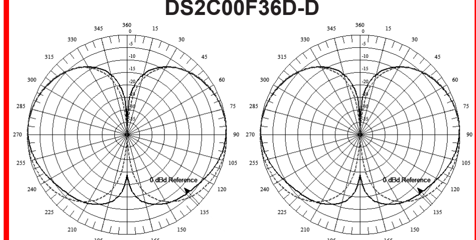

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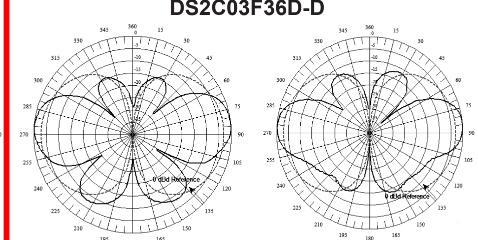

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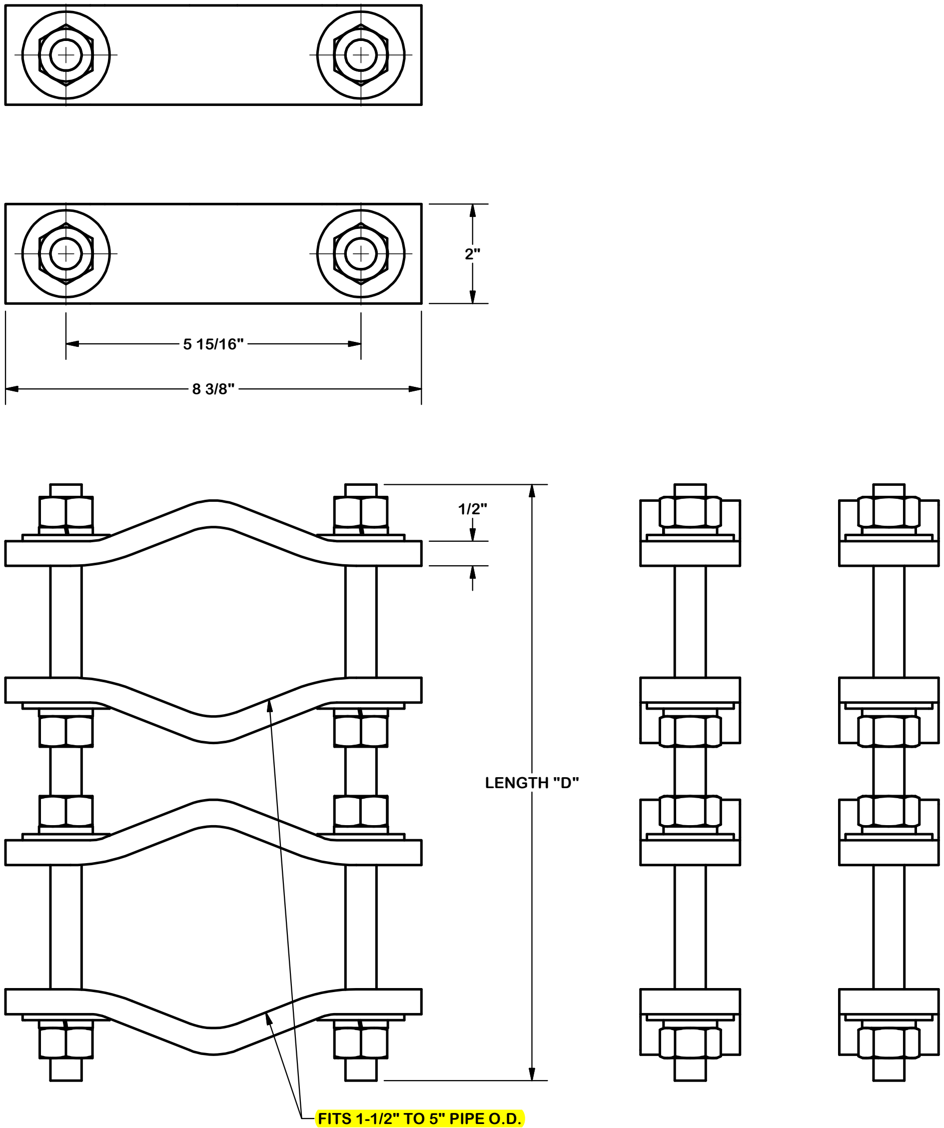
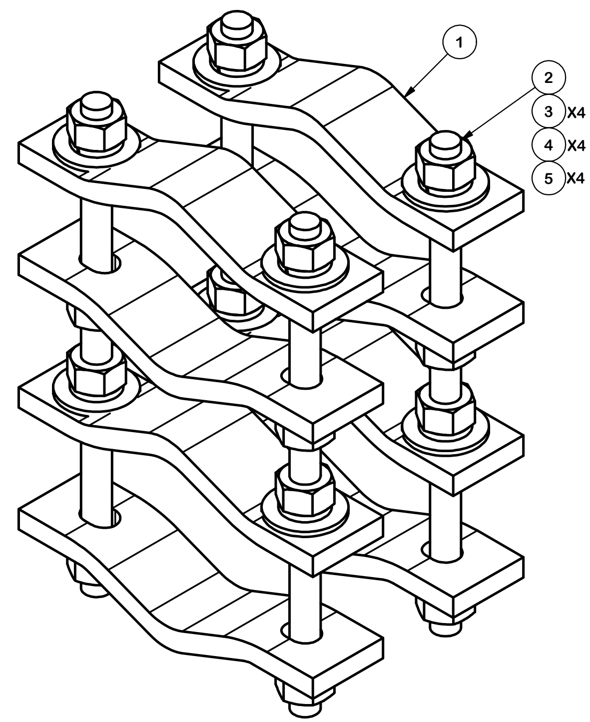


PARTS LIST						
ITEM	QTY	PART NO.	PART DESCRIPTION	LENGTH	UNIT WT.	NET WT.
1	8	DCP	CLAMP HALF, 1/2" THICK, 8-3/8"		2.40	19.20
2	B	C	5/8" THREADED ROD	D	E	F
3	16	G58NUT	5/8" HDG HEAVY 2H HEX NUT		0.13	2.08
4	16	G58LW	5/8" HDG LOCKWASHER		0.03	0.42
5	16	G58FW	5/8" HDG USS FLATWASHER		0.07	1.13

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

TIEBACK SPECIFICATIONS:
(1) SITE PRO 1 SPTB-NP
(1) SITE PRO 1 P2174 (2.375" O.D. X 14.5' LONG SCHEDULE 40 GALVANIZED PIPE)

2-3/8” Sliding Pipe Tie-Back Hardware, No Pipe

Qty: 1

Add to Cart

SKU: SPTB-NP
Size: See Description

My Cart

Checkout (https://www.sitepro1.com/store/cart.php?m=checkout)

Total: $0.00

No items in your cart
Your cart is currently empty. As you add items, they will appear in your cart.

Quick Navigation

Description

- **SPTB-NP**
- **Universal Sliding Pipe Tie-Back Assemblies**
- **2-3/8” Sliding Pipe Tie-Back Hardware, No Pipe**
- **Weight 48 lb**

- **VIEW ALL TOWER COMPONENTS (https://www.sitepro1.com/store/cart.php?m=product_list&c=58)**
- **VIEW ALL TOWER STEEL (https://www.sitepro1.com/store/cart.php?m=product_list&c=53)**
- **VIEW COMPLETE PRODUCT CATALOG (https://www.sitepro1.com/store/cart.php?m=product_list)**

Need Assistance?

Our support team is available from 8:30 AM - 8:00 PM ET to assist you.

888-438-7761 (tel:888-438-7761)

888-753-7446 (tel:888-753-7446)

SP1Support@Valmont.com (mailto:SP1Support@Valmont.com)

Go Back (https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=2ahUKEwjXj5e3y-_nAhUK26wKHaL1A80QFjAAegQIBBAB&url=https%3A%2F

SITE PRO 1

(https://www.facebook.com/ValmontSitePro1/)

(https://twitter.com/SitePro1)

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Resources

A&E Digital Database **(https://www.sitepro1.com/database.php)**
Catalogs **(https://www.sitepro1.com/request.php)**
Product Specs & Drawings **(https://www.sitepro1.com/product-specs/)**
Bill of Materials Manager **(https://www.sitepro1.com/store/cart.php?m=startBOM)**
SP1 Connection **(https://www.sitepro1.com/connection)**
Equipment Platforms **(https://sitepro1.com/reader/web/viewer.php?link=../../resources/pdf/Modular-**

Company

About Us **(https://www.sitepro1.com/company-htm/)**
Leadership Letter **(https://www.sitepro1.com/letter-htm/)**
Customer Service **(https://www.sitepro1.com/customer-service)**
Customer Testimonials **(https://www.sitepro1.com/testimonials-htm/)**
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Holiday Schedule **(https://www.sitepro1.com/holiday-schedule-htm/)**

RADIO FREQUENCY SYSTEMS
The Clear Choice®

TrunkLine Antenna, Standard (FCC 101, Cat A) , Single Polarized, 6 ft

RFS Microwave Antennas are designed for microwave systems in all common frequency ranges from 4 GHz to 24 GHz. This allows the use of antennas in areas where extreme wind conditions are normal. The antennas utilise a conventional feed system and are available in three performance classes offering complete flexibility when designing a network. Standard Performance antennas are economical solutions for systems where side lobe suppression is of less importance. These antennas are required for use in networks where there is a low interference potential. Antennas are available in 2 ft (0.6m) to 12 ft (3.7m) diameters. Antennas from 4ft up to 12 ft (3.7m) can be equipped with a moulded radome to reduce wind load and to protect the feed against the accumulation of ice and snow.

Antenna

FEATURES / BENEFITS

- Field-proven reliability and long life
- Withstanding winds up to 200 km/h (125 mph), an optional sway bar is available for added assurance in case mistakes are made during installation
- A single-piece configuration and compact packaging to reduce transportation costs
- Frequencies ranging from 4 GHz to 15 GHz with support for two wideband frequency ranges (5.725-6.875 and 7.125-8.5 GHz) to reduce antenna requirements and simplify logistics

Technical Features

GENERAL SPECIFICATIONS

Product Type		Point to point antennas
Profile		TrunkLine
Performance		Improved Performance
Polarization		Single
Antenna Input		CPR137G
Reflector		1-part
Radome		Optional
Antenna color		White RAL 9010
Swaybar		1: (2.0 m x Ø60 mm)

ELECTRICAL SPECIFICATIONS

Frequency	GHz	5.925 - 6.875
3dB beamwidth	degrees	1.7
Low Band Gain	dBi	38.4
Mid Band Gain	dBi	39.1
High Band Gain	dBi	39.7
F/B Ratio	dB	55.0
XPD	dB	30.0
Max VSWR / R L	VSWR / dB	1.08 (28.3)
Regulatory Compliance		FCC Category A

MECHANICAL SPECIFICATIONS

Diameter	ft (m)	6 (1.8)
Elevation Adjustment	degrees	± 5
Azimuth Adjustment	degrees	± 5
Polarization Adjustment	degrees	± 5
Mounting Pipe Diameter minimum	mm (in)	114 (4.5)
Mounting Pipe Diameter maximum	mm (in)	114 (4.5)
Approximate Weight	kg (lb)	65 (141)
Survival Windspeed	km/h (mph)	200 (125)
Operational Windspeed	km/h (mph)	190 (118)

STRUCTURE

Radome Material		Fiberglass

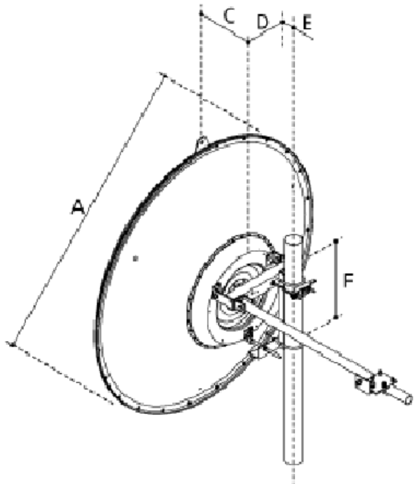
FURTHER ACCESSORIES

optional Swaybar		1: SMA-SK-60-2000A (2.0 m x Ø60mm)
Further Accessories		SMA-SKO-UNIVERSAL-L : Universal sway bar fixation kit

TrunkLine Antenna, Standard (FCC 101, Cat A) , Single Polarized, 6 ft

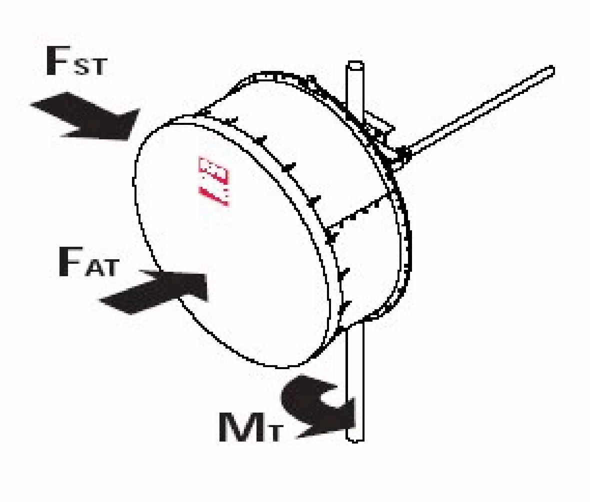
Mount Outline

Dimension A	mm (in)	2000 (79)
Dimension C	mm (in)	364 (14.3)
Dimension D for 114mm (4.5in) Pipe	mm (in)	175 (6.9)
Dimension E	mm (in)	283 (11.1)
Dimension F	mm (in)	590 (23.2)



Wind Load

FST Side force max. @ survival wind speed	N (lb)	2910 (651)
FAT Axial force max. @ survival wind speed	N (lb)	9900 (2217)
MT Torque maximum @ survival wind speed	Nm (lb ft)	3055 (2270)



External Document Links

Complete Antenna installation

RPE (IQ-Link format)

RPE (PDF format)

RPE (Pathloss format)

Notes

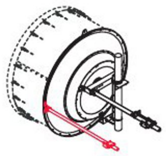
Only available in North America

(2) PERIMETER SWAY BARS REQUIRED (CONNECTIONS TO BE LOCATED ON THE TOP AND RIGHT PERIMETER QUADRANTS)

RADIO FREQUENCY SYSTEMS
The Clear Choice®

Perimeter Sway Bar for Parabolic Antennas 6ft

The perimeter sway bar reduces vibration of the reflector and increases stability of the antenna in worst case conditions.
If the perimeter sway bar is installed on a SU6/SUX6/UXA6 "high wind duty" antenna (survival windspeed = 155 mph or 252 km/h), then the operational wind speed of this antenna in increased up to 155 mph (252 km/h).



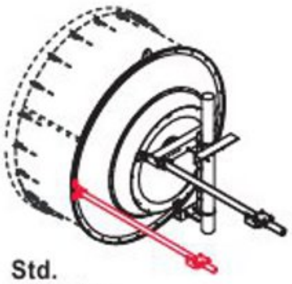
Technical Features

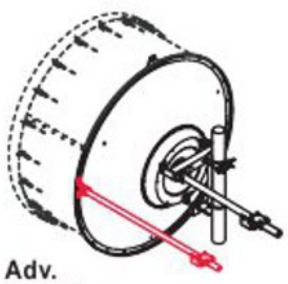
MECHANICAL PROPERTIES

Diameter	m (ft)	1.8 (6)
Weight	kg (lb)	16 (35.3)
Sway bar length	m (ft)	1.9 (6.23)
Sway bar diameter	mm (in)	60 (2.4)

STRUCTURE

Product Type		Reinforcement Hardware
Kit Type		Perimeter Sway Bar
Material		Hot-dip galvanised steel





External Document Links

Sway bar installation kit

Notes

The perimeter sway bar includes only the red marked parts and fixing hardware.

Only applicable for antennas PAD, PADX, DA, DAX, SU, SUX, UA, UDA, UXA antennas in 6ft.

Diameter of the sway bar: 60 mm (2.4 in)

Length of the sway bar: 1900 mm (74.8 in)

(3) SWAY BAR / TOWER CONNECTING KITS REQUIRED (1 PER SWAY BAR)

Addendum

Sway Bar / Tower Connecting Kit (SMA-SKO-UNIVERSAL-L) 6-8-10-12-15 ft antennas

RFS

NMT 758-00(e)

The sway bar / tower connecting kit allows the attachment of the sway bar extremity on tower with pipe or L-section structure profiles:

- Tower pipe compatibility: Ø 60 up to 114 mm (4.5" OD)
- Tower L-section compatibility: L 60x60 up to L 110x110 mm
- Sway bar compatibility: FS sway bar models (Ø 60 mm)
- Antenna compatibility: from 6Ft to 15Ft

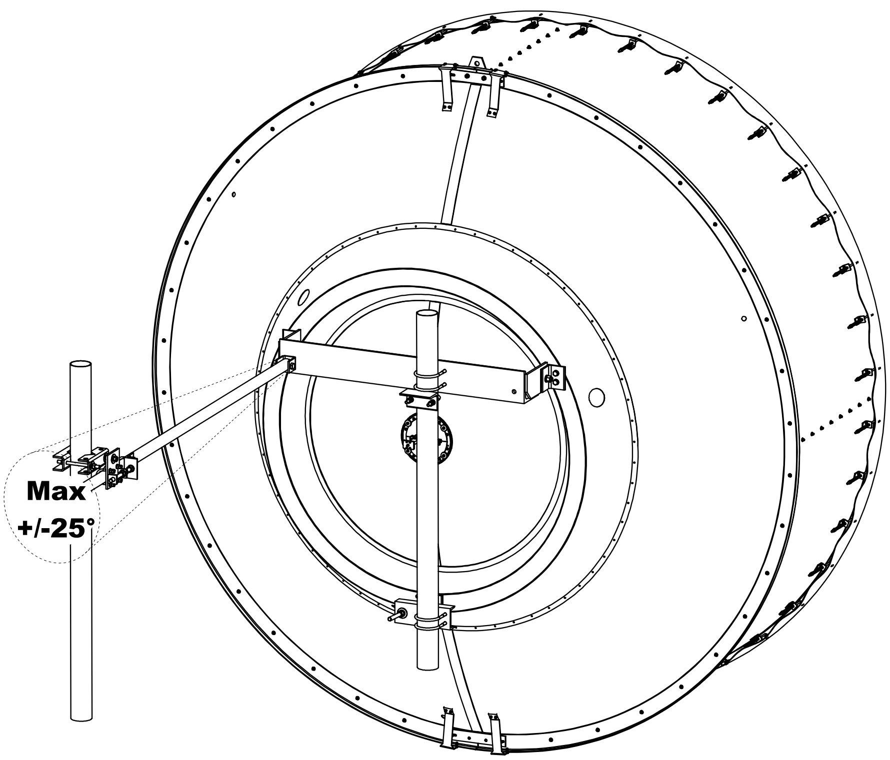
Notes:

For 6 ft antennas, fine azimuth and elevation adjustments have to be done before the sway bar attachment to the sway bar / tower connecting kit.

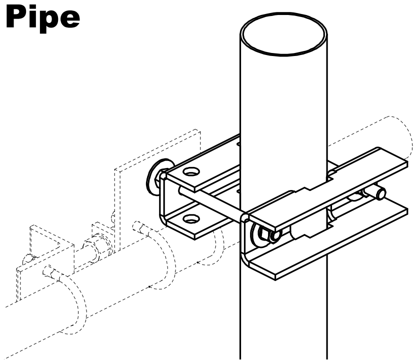
For 8, 10 and 12 ft antennas, as the fine azimuth adjustment system is integrated on the sway bar extremity, you must adjust fine elevation before sway bar attachment.

These installation instructions have been written for qualified, skilled personnel. The antenna shall be inspected once per year by qualified personnel to verify proper installation, maintenance, and condition of equipment. It is important to adhere precisely to all parts of the installation instructions. RFS disclaim any responsibility resulting from improper or unsafe installation. RFS reserves the right to alter details at any time, especially with respect to technical improvements.

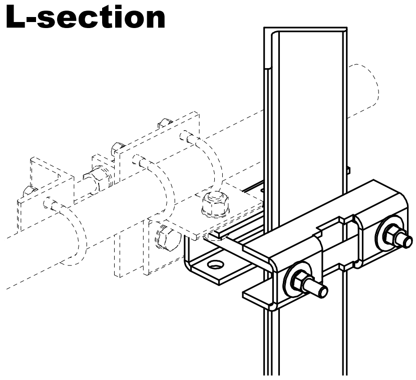
Sway bar kit installation overview (12ft antenna)



OPTION 1
Pipe



OPTION 2
L-section



Kit supplies

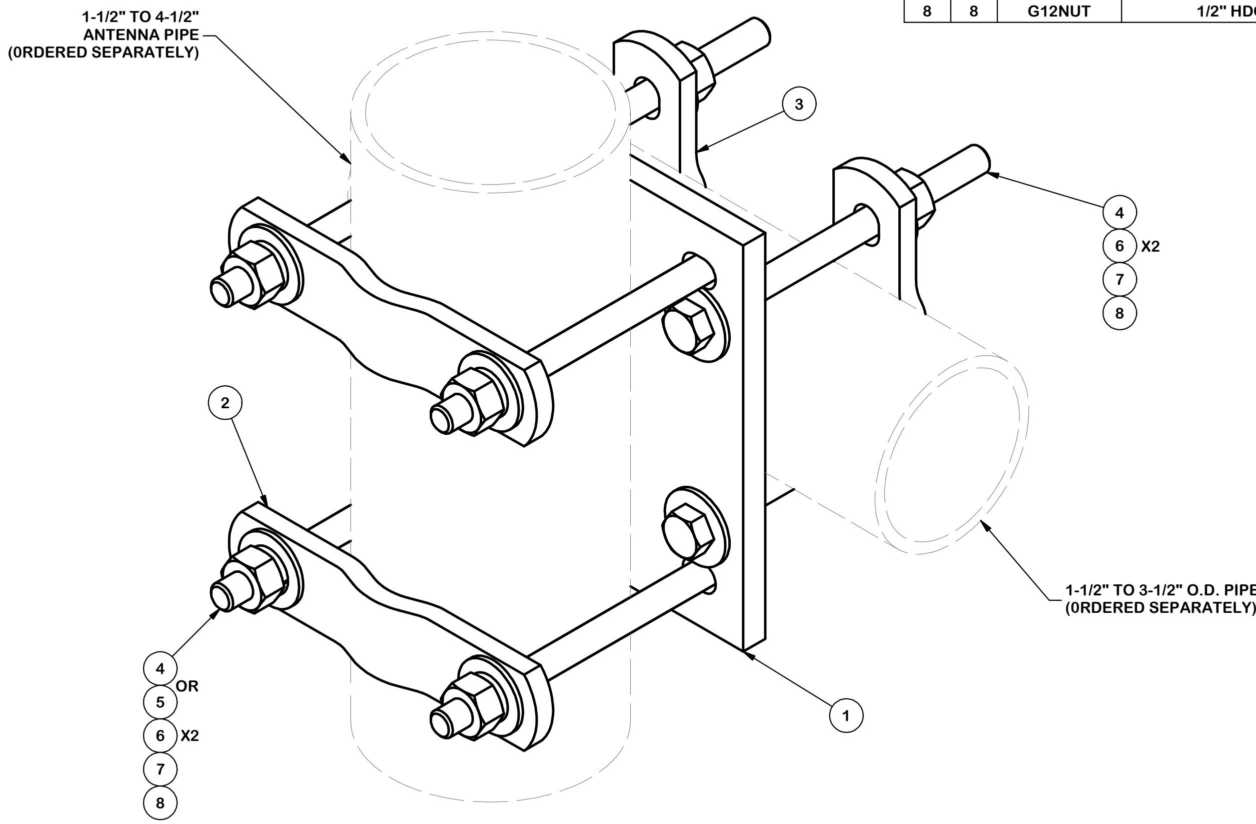
Description	Qty	Description	Qty
Clamp 1 Univ. Sway-bar Kit 6-15	1	Assembly grease	1
Clamp 2 Univ. Sway-bar Kit 6-15	1		
Equipped threaded rod 1 M16/250	1		
Equipped threaded rod 1 M16/250	1		
Strut Univ. Sway-bar Kit 6-15	1		

Tools and equipment required for installation

- Torque wrench 140 to 240 Nm with hex open/ring ends adapters M16(24), M20(30)
- Combination wrenches for hexagon bolts M16 (24), M20 (30)

( ) opening of spanner

PARTS LIST						
ITEM	QTY	PART NO.	PART DESCRIPTION	LENGTH	UNIT WT.	NET WT.
1	1	SCX7	CROSSOVER PLATE	8 in	7.55	7.55
2	2	X-115765	5" V-CLAMP		1.02	2.04
3	2	X-100064	CLAMP (S) (4" V-CLAMP) GALVANIZED		0.91	1.83
4	8	G12065	1/2" x 6-1/2" HDG HEX BOLT GR5 FULL THREAD	6 1/2 in	0.41	3.28
5	4	G12045	1/2" x 4.5" HDG HEX BOLT GR5 FULL THREAD	4 1/2 in	0.30	1.19
6	16	G12FW	1/2" HDG USS FLATWASHER		0.03	0.54
7	8	G12LW	1/2" HDG LOCKWASHER		0.01	0.11
8	8	G12NUT	1/2" HDG HEAVY 2H HEX NUT		0.07	0.57
					TOTAL WT. #	16.98



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")*

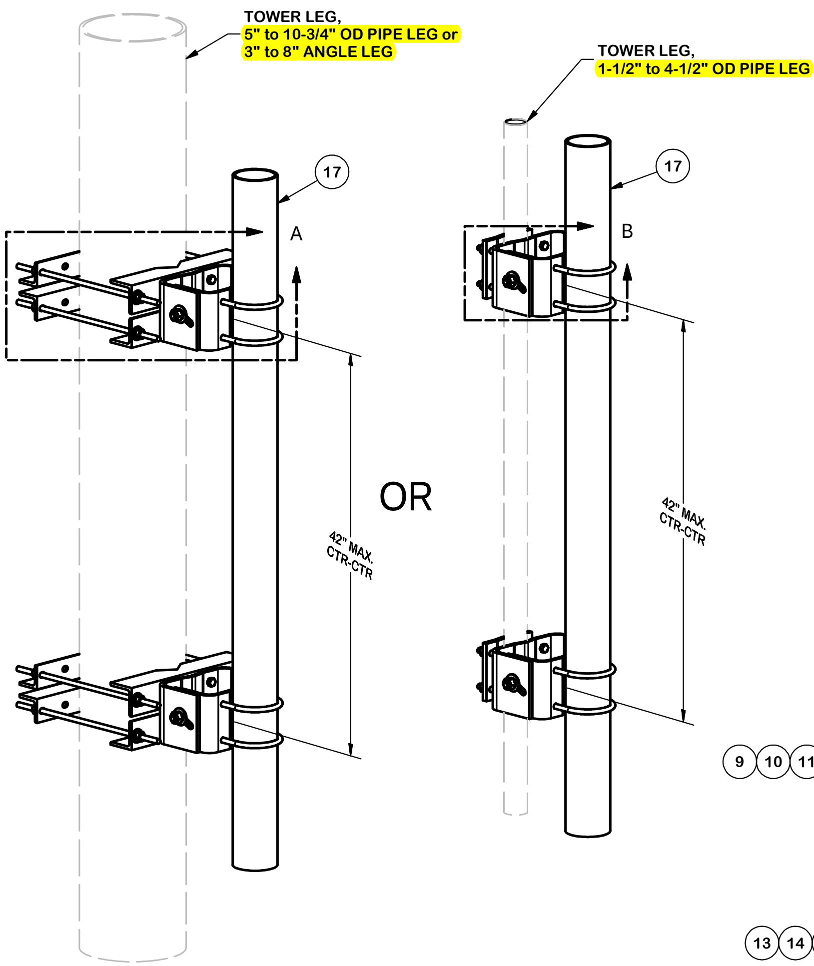
DESCRIPTION
CROSSOVER PLATE
(V-CLAMP STYLE)

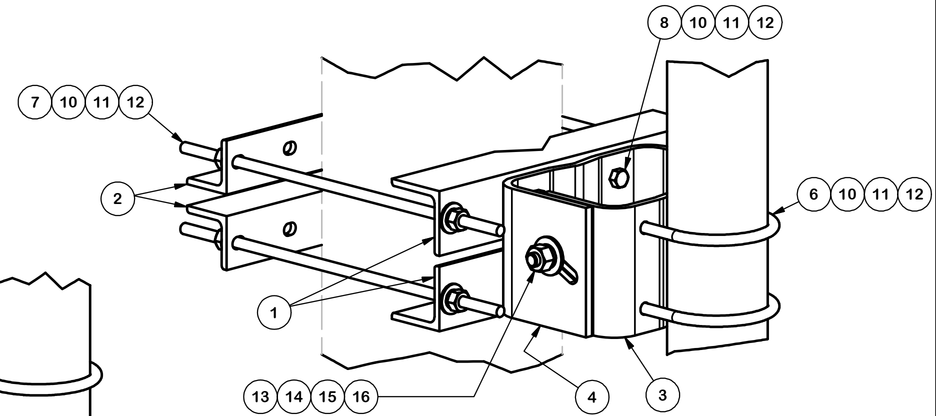
SITE PRO 1
A valmont COMPANY
Engineering Support Team:
1-888-753-7446
Locations:
New York, NY
Atlanta, GA
Los Angeles, CA
Plymouth, IN
Salem, OR
Dallas, TX

CPD NO.		DRAWN BY	ENG. APPROVAL	PART NO.
		CEK 10/7/2010		SCX7-U
CLASS	SUB	DRAWING USAGE	CHECKED BY	DWG. NO.
81	01	CUSTOMER	BMC 10/8/2010	SCX7-U

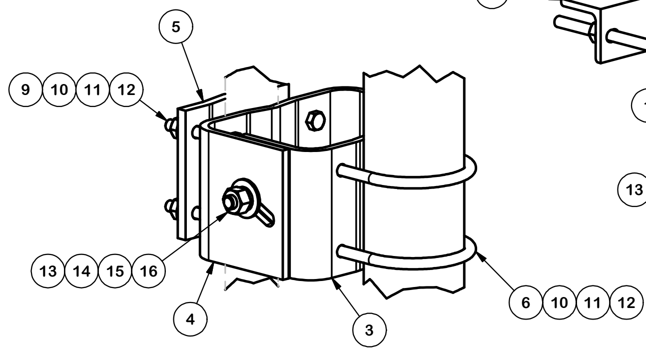
TOWER/MAST SIZE AT PROPOSED ANTENNA ATTACHMENT = 3.5" ± DIAMETER.

PARTS LIST						
ITEM	QTY	PART NO.	PART DESCRIPTION	LENGTH	UNIT WT.	NET WT.
1	4	X-158320	ANGLE CLAMP	16 1/2 in	8.51	34.03
2	4	X-126501	BRACKET ANGLE LEG MOUNTING	16 1/2 in	7.13	28.51
3	2	X-154463	UNIVERSAL PIPE MOUNTING PLATE (INNER)		10.52	21.03
4	2	X-155561	UNIVERSAL PIPE MOUNTING PLATE (OUTER)		13.16	26.31
5	2	X-159999	BACKING PLATE		5.73	11.46
6	4	X-UB1458	1/2" X 4-5/8" X 7" X 3" GALV U-BOLT		0.97	3.89
7	8	G12R-20	1/2" x 20" GALV. THREADED ROD		1.12	8.92
8	8	G1203	1/2" x 3" HDG HEX BOLT GR5 FULL THREAD	3 in	0.22	1.74
9	8	G1204	1/2" x 4" HDG HEX BOLT GR5 FULL THREAD	4 in	0.27	2.16
9	8	G12065	1/2" x 6-1/2" HDG HEX BOLT GR5 FULL THREAD	6 1/2 in	0.41	3.28
10	32	G12FW	1/2" HDG USS FLATWASHER		0.03	1.09
11	32	G12LW	1/2" HDG LOCKWASHER		0.01	0.44
12	32	G12NUT	1/2" HDG HEAVY 2H HEX NUT		0.07	2.29
13	4	G5802	5/8" x 2" HDG HEX BOLT GR5		0.27	1.09
14	4	G58FW	5/8" HDG USS FLATWASHER		0.07	0.28
15	4	G58LW	5/8" HDG LOCKWASHER		0.03	0.10
16	4	G58NUT	5/8" HDG HEAVY 2H HEX NUT		0.13	0.52
17	1	P472	4-1/2" X 72" SCH. 40 GALVANIZED PIPE		64.89	64.89
					TOTAL WT. #	148.00





DETAIL A
USED FOR 5" to 10-3/4" OD PIPE LEGS & 3" to 8" ANGLE LEGS



DETAIL B
USED FOR 1-1/2" to 4-1/2" OD PIPE LEGS

TAPER NOTE:
THE MAXIMUM TAPER ADJUSTMENT IS 5.7° BASED UPON 30" SPACING OF ADJUSTABLE MOUNTING BRACKETS.

THE MAXIMUM TAPER ADJUSTMENT IS 3.8° BASED UPON 45" SPACING OF ADJUSTABLE MOUNTING BRACKET.

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
R5 PIPE MOUNT w/ LARGE LEG ADAPTER FOR 1-1/2" to 10-3/4" OD PIPE LEGS & 3" TO 8" ANGLE LEGS

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.
4718		RH18 3/30/2010		R5-LL
CLASS	SUB	DRAWING USAGE	CHECKED BY	DWG. NO.
81	01	CUSTOMER	BMC 4/21/2010	R5-LL

Pathloss

CT_ChapelHillRS_ES_180ft_GT	
Latitude	41 28 08.31 N
Longitude	072 12 16.66 W
Azimuth	110.90°
Elevation	607 ft ASL
Antenna CL	170.0 ft AGL

Frequency (MHz) = 6130.0
K = 1.33, 0.67
%F1 = 100.00, 30.00

CT_Stonington_SBA_190ft_MP	
Latitude	41 22 55.26 N
Longitude	071 54 12.91 W
Azimuth	291.10°
Elevation	141 ft ASL
Antenna CL	150.0 ft AGL

Microwave Path Data Sheet
COMSEARCH

19700 Janelia Farm Boulevard, Ashburn, VA, 20147
(703)636-5234 www.comsearch.com

PCN Date: 09/18/2019
Job Number 190918COMSDS04

New Path
RCN Number: 19091852

Administrative Information	**CHAPEL HILL CT**	**STONINGTON CT**
City/County	/New London	/New London
Status / License Basis	Engineering Proposal / PRIMARY OPERATION	Engineering Proposal / PRIMARY OPERATION
Call Sign	WNER798	
Licensee Code	S68716	S68716
Licensee Name	Eversource Energy Service Company	Eversource Energy Service Company
Radio Service / Station Class	MG -- Microwave Industrial/Business Pool	FXO -- Fixed

Site Information		
Latitude (NAD 83)	41 ° 28' 7.3" N	41 ° 22' 55.3" N
Longitude (NAD 83)	72 ° 12' 15.2" W	71 ° 54' 12.9" W
Ground Elevation (m/ft-AMSL)	182.90 / 600.1	34.63 / 113.6
Antenna Structure Registration #		
Path Azimuth (°)	110.858	291.057
Path Length (km / miles)	26.911 / 16.722	

Transmit Antenna	44008C	44008C
Manufacturer	RFS	RFS
Model	PAD6-59B	PAD6-59B
Gain(dBi) / Beamwidth(°) / Tilt(°)	38.7 / 1.80 / -0.42	38.7 / 1.80 / 0.24
Centerline (m / ft - AGL)	51.82 / 170.0	45.72 / 150.0

Receive Antenna	Same As Transmit	
Manufacturer		
Model		
Gain (dBi) / Beamwidth (°)		
Centerline (m / ft - AGL)		

Diversity Receive Antenna		
Manufacturer		
Model		
Gain (dBi) / Beamwidth (°)		
Centerline (m / ft - AGL)		

Radio Information	TEEV62			TEEV62		
Manufacturer	Aviat Networks, Inc.			Aviat Networks, Inc.		
Model	I600V4HL6-30M 256Q 179			I600V4HL6-30M 256Q 179		
Model Description	ECLIPSE IRU 600 RAC 60-6X MAX TP			ECLIPSE IRU 600 RAC 60-6X MAX TP		
Emission Designator / Modulation	30M0D7W	256 QAM		30M0D7W	256 QAM	
Loading	1 CH	DIG 179000.000		1 CH	DIG 179000.000	
Stability (%)	0.0005			0.0005		
	Nominal	Coordinated	Maximum	Nominal	Coordinated	Maximum
Power (dBm)		31.0			31.0	
Received Level (dBm)		-36.8			-36.8	
EIRP (dBm)		65.4			65.7	
Fixed Loss: Tx / Common (dB)	0.0 / 4.3			0.0 / 4.0		
Free Space Loss (dB)			136.9			

Transmit Frequencies (MHz)	6004.5000V(13T)	6256.5400V(23T)

ATTACHMENT C – STRUCTURAL ANALYSIS REPORT

Date: **August 17, 2020**

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

Subject:	**Structural Analysis Report**	
Eversource Designation:	**Eversource Number:**	ES-022
	Eversource Site Name:	ChapelHillRS
Engineering Firm Designation:	**Black & Veatch Corp. Project Number:**	403039
Site Data:	**414 Chapel Hill Road, Montville, New London County, CT** **Latitude *41° 28' 8.31"*, Longitude *-72° 12' 16.66'*** **180 Foot - Self Support Tower**	

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

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

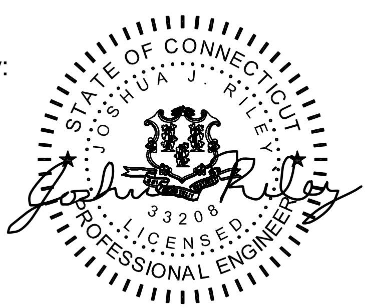
LC1: Proposed Equipment Configuration **Sufficient Capacity – 50.2%**

This analysis utilizes an ultimate 3-second gust wind speed of 145 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: Changzhi Zang / Robert Hudson II

Respectfully submitted by:

Joshua J. Riley, P.E.
Professional Engineer



08/17/2020

TABLE OF CONTENTS

1) INTRODUCTION

This tower is an 180 ft Self Support tower designed by Rohn in October of 2007.

2) ANALYSIS CRITERIA

TIA-222 Revision:	TIA-222-H
Risk Category:	III
Wind Speed:	145 mph
Exposure Category:	B
Topographic Factor:	1
Ice Thickness:	1.5 in
Wind Speed with Ice:	50 mph
Seismic Ss:	0.168
Seismic S_1:	0.060
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
177.0	183.0	1	dbspectra	DS2C00F36D-D	2	7/8	1
	177.0	1	site pro 1	DCP18K Clamp Set			
170.0	170.0	1	rfs	PAD6-59	1	E65J	-
		1	site pro 1	R5-LL [PM 602-1] w/ Tieback Assembly			

Notes:
1) Proposed antenna to be mounted on existing mount pipe at 177.0 ft

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
178.0	188.0	1	commander technologies	220-3AN	3	7/8	1
	185.0	1	commander technologies	1142-2CN			
	180.0	1	unknown	3' x 3" Dia Omni			
		1	unknown	12”x12”x6” Junction Box			
	178.0	1	tower mounts	Side Arm Mount [SO 305-1]			
		2	tower mounts	Side Arm Mount [SO 306-1]			
177.0	177.0	1	tower mounts	Pipe Mount [PM 601-1]	-	-	1
168.0	174.0	1	decibel	DB222			1
	168.0	1	tower mounts	Side Arm Mount [SO 308-1]			
163.0	166.0	1	miscl	6' x 3" Dia Omni	2	7/8	1
	163.0	1	tower mounts	Side Arm Mount [SO 305-1]			
152.0	159.0	1	commander technologies	1142-2CN	1	7/8	1
	152.0	1	tower mounts	Side Arm Mount [SO 308-1]			

Mounting Level (ft)	Center Line Elevation (ft)	Number of Antennas	Antenna Manufacturer	Antenna Model	Number of Feed Lines	Feed Line Size (in)	Note
148.0	148.0	1	tower mounts	Pipe Mount [PM 602-1]	1	EW90	1
		1	miscl	8' Dish			
144.0	150.0	1	decibel	DB222	1	7/8	1
	144.0	1	tower mounts	Side Arm Mount [SO 308-1]			
130.0	133.0	1	unknown	BNF800S-06	1	7/8	1
	130.0	1	tower mounts	Side Arm Mount [SO 308-1]			
122.0	132.0	1	decibel	DB222	3	7/8	1
	129.0	1	kreco	CO-36A			
	123.0	2	tower mounts	Side Arm Mount [SO 308-1]			
	122.0	1	tower mounts	Side Arm Mount [SO 305-1]			
		1	decibel	DB212-1			
103.0	103.0	2	tower mounts	Side Arm Mount [SO 305-1]	-	-	-
86.0	96.0	1	commander technologies	220-3AN	1	7/8	1
	86.0	1	tower mounts	Side Arm Mount [SO 308-1]			
83.0	84.5	1	unknown	Dipole	1 1	7/8 E65	1
	83.0	1	tower mounts	Side Arm Mount [SO 308-1]			
		1	tower mounts	Pipe Mount [PM 601-1]			
		1	miscl	2' Dish			
65.0	68.0	1	unknown	6' x 3" Dia Omni	2	1/2	1
	65.0	1	tower mounts	Side Arm Mount [SO 308-1]			
		1	unknown	8"x8" Antenna			
24.0	24.0	1	andrew	GPS-QBW-20N	1	1/2	1

Notes:
1) Existing Equipment; Considered In This Analysis

3) ANALYSIS PROCEDURE

Table 3 - Documents Provided

Document	Remarks	Reference	Source
GEOTECHNICAL REPORTS	Dr. Clarence Welti, P.E., P.C., dated 05/31/2007	-	Eversource
TOWER FOUNDATION DRAWINGS/DESIGN/SPECS	Rohn, dated 10/09/2007	-	Eversource
TOWER MANUFACTURER DRAWINGS	Rohn, dated 10/09/2007	-	Eversource
TOWER STRUCTURAL ANALYSIS REPORTS	Centek Engineering Inc. dated 10/29/2013	-	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) Existing tower loading is based on 2019 drone mapping photos and the 2013 Structural Analysis Report prepared by Centek Engineering Inc.
4) This analysis was performed under the assumption that all information provided to Black & Veatch is current and correct. This is to include site data, appurtenance loading, tower/foundation details, and geotechnical data.

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

Table 4 - Section Capacity (Summary)

Section No.	Elevation (ft)	Component Type	Size	Critical Element	P (K)	SF*P_allow (K)	% Capacity	Pass / Fail
T1	180 - 160	Leg	ROHN 3 STD	1	-10.62	92.98	11.4	Pass
T2	160 - 140	Leg	ROHN 4 EH	37	-30.00	184.49	16.3	Pass
T3	140 - 120	Leg	ROHN 5 EH	67	-52.61	251.35	20.9	Pass
T4	120 - 100	Leg	ROHN 6 EH	88	-76.81	360.24	21.3	Pass
T5	100 - 80	Leg	ROHN 8 EHS	109	-103.10	441.94	23.3	Pass
T6	80 - 60	Leg	ROHN 8 EH	130	-127.66	530.80	24.1	Pass
T7	60 - 40	Leg	ROHN 10 EH	145	-155.50	702.09	22.1	Pass
T8	40 - 20	Leg	ROHN 10 EH	160	-184.10	702.09	26.2	Pass
T9	20 - 0	Leg	ROHN 10 EH	175	-212.52	702.09	30.3	Pass
T1	180 - 160	Diagonal	L1 3/4x1 3/4x3/16	12	-2.31	11.54	20.0 30.7 (b)	Pass
T2	160 - 140	Diagonal	L2x2x1/4	48	-3.62	13.12	27.6 33.0 (b)	Pass
T3	140 - 120	Diagonal	L2 1/2x2 1/2x1/4	75	-4.28	16.39	26.1 32.0 (b)	Pass
T4	120 - 100	Diagonal	L3x3x1/4	96	-4.89	21.97	22.3 32.8 (b)	Pass
T5	100 - 80	Diagonal	L3x3x1/4	117	-6.00	17.78	33.8 40.3 (b)	Pass
T6	80 - 60	Diagonal	L3 1/2x3 1/2x1/4	138	-6.88	19.01	36.2 46.0 (b)	Pass
T7	60 - 40	Diagonal	L4x4x5/16	153	-7.95	29.97	26.5 42.5 (b)	Pass
T8	40 - 20	Diagonal	L4x4x5/16	168	-8.64	25.34	34.1 45.9 (b)	Pass
T9	20 - 0	Diagonal	L4x4x5/16	183	-9.77	21.65	45.1 50.2 (b)	Pass
T1	180 - 160	Top Girt	L2x2x1/8	4	-0.04	4.22	1.1	Pass
T2	160 - 140	Top Girt	L2x2x1/8	41	-0.08	4.23	1.9	Pass
							Summary	
						Leg (T9)	30.3	Pass
						Diagonal (T9)	50.2	Pass
						Top Girt (T2)	1.9	Pass
						Bolt Checks	50.2	Pass
						RATING =	50.2	Pass

Table 5 - Tower Component Stresses vs. Capacity - LC1

Notes	Component	Elevation (ft)	% Capacity	Pass / Fail
1	Anchor Rods	0	28.8	Pass
1	Base Foundation	0	20.1	Pass
	Base Foundation Soil Interaction		36.7	Pass

Structure Rating (max from all components) =	**50.2%**

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

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**
T1	180 - 160	1.142	47	0.0552	0.0165	OK
T2	160 - 140	0.91	47	0.0512	0.0125	OK
T3	140 - 120	0.699	47	0.0448	0.0086	OK
T4	120 - 100	0.517	47	0.037	0.0065	OK
T5	100 - 80	0.366	47	0.0299	0.0051	OK
T6	80 - 60	0.242	47	0.0229	0.004	OK

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

1) Maximum Rotation = 4 Degrees

2) Maximum Deflection = 0.03 * Tower Height = 65 in.

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

Elevation (ft)	*MW Dish*	*Tilt (°)*	*Twist (°)*	*Diameter, D (ft)*	*Frequency, α (GHz)*	*Decibel Points*	*Deformation Limit (θ)**	*Deformation Limit Exceeded?*
148	8' Dish	0.0476	0.01	8	10	10 dB	0.664	Not Exceeded
83	2' Dish	0.0239	0.0042	2	50	10 dB	0.531	Not Exceeded
170	PAD6-59	0.0534	0.0145	6	10	10 dB	0.885	Not Exceeded

*Limit per TIA-222-H Annex D

Maximum Tower Deflections - Design Wind

Section No.	*Elevation* ft	*Horz. Deflection* in	*Gov. Load Comb.*	*Tilt* °	*Twist* °	*Combined Max*	*Check**
T1	180 - 160	3.976	47	0.1901	0.0574	0.199	OK
T2	160 - 140	3.174	47	0.1777	0.0435	0.183	OK
T3	140 - 120	2.44	47	0.1556	0.0298	0.158	OK
T4	120 - 100	1.807	47	0.1291	0.0228	0.131	OK
T5	100 - 80	1.281	47	0.1044	0.0179	0.106	OK
T6	80 - 60	0.845	47	0.08	0.014	0.081	OK

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

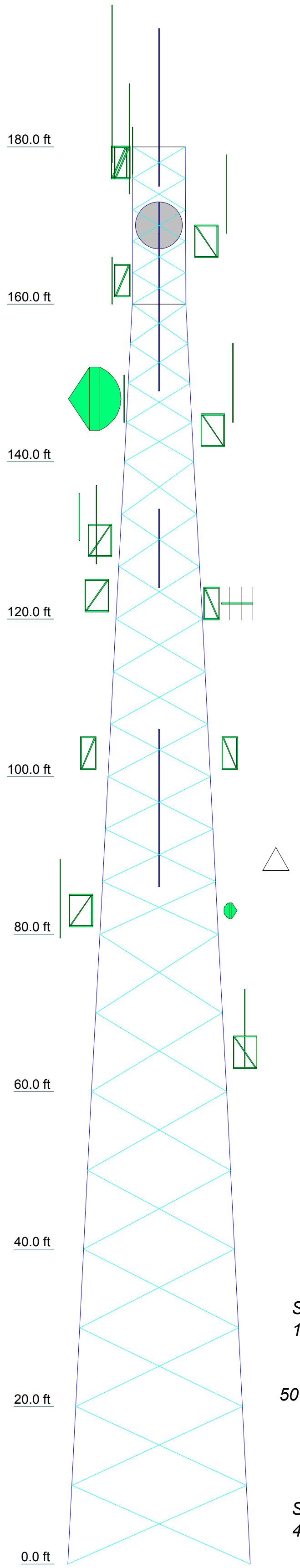
Critical Deflections of Tower at the MW Dish Elevations - Design Wind

Elevation ft	*Appurtenance*	*Gov. Load Comb.*	*Deflection* in	*Tilt* °	*Twist* °	*Radius of Curvature* ft
148	8' Dish	47	2.723	0.1655	0.0347	51576.000
83	2' Dish	47	0.904	0.0835	0.0146	45898.000
170	PAD6-59	47	3.57	0.1847	0.0506	124833.000

APPENDIX A

TNXTOWER OUTPUT

Section	Legs	Leg Grade	Diagonals	Diagonal Grade	Top Girts	Face Width (ft)	# Panels @ (ft)	Weight (K)
T1	ROHN 3 STD	A572-50	L1 3/4x1 3/4x3/16	A36	L2x2x1/8	6.6875	5 @ 4	1.0
T2	ROHN 4 EH		L2x2x1/4			6.761	4 @ 5	1.7
T3	ROHN 5 EH		L2 1/2x2 1/2x1/4		N.A.	8.8333	9 @ 6.66667	2.2
T4	ROHN 6 EH		L3x3x1/4	A570-50		10.9167		3.1
T5	ROHN 8 EHS					13.0521		3.6
T6	ROHN 8 EH		L3 1/2x3 1/2x1/4			14.9896	8 @ 10	4.1
T7	ROHN 10 EH		L4x4x5/16			17.1458		5.6
T8						19.1563		5.8
T9						21.1563		6.0
						23.1563		33.1



DESIGNED APPURTENANCE LOADING

TYPE	ELEVATION	TYPE	ELEVATION
12"x12"x6" Junction Box	178	Pipe Mount [PM 602-1]	148
3' x 3" Dia Omni	178	8' Dish	148
Side Arm Mount [SO 306-1]	178	DB222	144
Side Arm Mount [SO 306-1]	178	Side Arm Mount [SO 308-1]	144
Side Arm Mount [SO 305-1]	178	Side Arm Mount [SO 308-1]	130
1142-2CN	178	BNF800S-06	130
220-3AN	178	Side Arm Mount [SO 308-1]	123
6'x4" Mount Pipe	178	Side Arm Mount [SO 308-1]	123
6' Horizontal HSS4x4x1/4	178	Side Arm Mount [SO 305-1]	122
DS2C00F36D-D w/ DCP18K Clamp Sets	177	DB212-1	122
		CO-36A	122
Pipe Mount [PM 601-1]	177	DB222	122
R5-LL [PM 602-1]	170	Side Arm Mount [SO 305-1]	103
Tieback Assembly	170	Side Arm Mount [SO 305-1]	103
PAD6-59	170	Side Arm Mount [SO 308-1]	86
Side Arm Mount [SO 308-1]	168	220-3AN	86
DB222	168	Pipe Mount [PM 601-1]	83
Side Arm Mount [SO 305-1]	163	Side Arm Mount [SO 308-1]	83
6' x 3" Dia Omni	163	2' Dish	83
8' Horizontal HSS4x4x1/4	157	Dipole	83
8' Horizontal HSS4x4x1/4	156	6' x 3" Dia Omni	65
6'x4" Mount Pipe	155	8"x8" Antenna	65
Side Arm Mount [SO 308-1]	152	Side Arm Mount [SO 308-1]	65
1142-2CN	152	GPS-QBW-20N	24
8' Horizontal HSS4x4x1/4	151		

MATERIAL STRENGTH

GRADE	Fy	Fu	GRADE	Fy	Fu
A572-50	50 ksi	65 ksi	A570-50	50 ksi	65 ksi
A36	36 ksi	58 ksi			

TOWER DESIGN NOTES

1. Tower designed for Exposure B to the TIA-222-H Standard.
2. Tower designed for a 145 mph basic wind in accordance with the TIA-222-H Standard.
3. Tower is also designed for a 50 mph basic wind with 1.50 in ice. Ice is considered to increase in thickness with height.
4. Deflections are based upon a 60 mph wind.
5. Tower Risk Category III.
6. Topographic Category 1 with Crest Height of 0.00 ft
7. TOWER RATING: 50.2%

ALL REACTIONS ARE FACTORED

MAX. CORNER REACTIONS AT BASE:
DOWN: 220 K
SHEAR: 27 K

UPLIFT: -178 K
SHEAR: 23 K

AXIAL 120 K
SHEAR 11 K
MOMENT 1066 kip-ft
TORQUE 13 kip-ft
50 mph WIND - 1.5000 in ICE

AXIAL 49 K
SHEAR 44 K
MOMENT 4078 kip-ft
TORQUE 32 kip-ft
REACTIONS - 145 mph WIND

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Job: **ES-022 ChapelHill RS**		
Project: **403093 (ChapelHill RS)**		
Client:	Drawn by: TH	App'd:
Code: TIA-222-H	Date: 07/30/20	Scale: NTS
Path: C:\Users\hai92311\OneDrive - Black & Veatch\My Desktop\Structural\ChapelHillRS.eri		Dwg No. E-1

Tower Input Data

The main tower is a 3x free standing tower with an overall height of 180.00 ft above the ground line.
The base of the tower is set at an elevation of 0.00 ft above the ground line.
The face width of the tower is 6.69 ft at the top and 23.16 ft at the base.
This tower is designed using the TIA-222-H standard.
The following design criteria apply:

1) Tower base elevation above sea level: 606.00 ft.
2) Basic wind speed of 145 mph.
3) Risk Category III.
4) Exposure Category B.
5) Simplified Topographic Factor Procedure for wind speed-up calculations is used.
6) Topographic Category: 1.
7) Crest Height: 0.00 ft.
8) Nominal ice thickness of 1.5000 in.
9) Ice thickness is considered to increase with height.
10) Ice density of 56 pcf.
11) A wind speed of 50 mph is used in combination with ice.
12) Temperature drop of 50 °F.
13) Deflections calculated using a wind speed of 60 mph.
14) Pressures are calculated at each section.
15) Tower analysis based on target reliabilities in accordance with Annex S.
16) Load Modification Factors used: $K_{es}(F_w)$ = 1.0, $K_{es}(t_i)$ = 1.0.
17) Stress ratio used in tower member design is 1.05.
18) Local bending stresses due to climbing loads, feed line supports, and appurtenance mounts are not considered.

Options

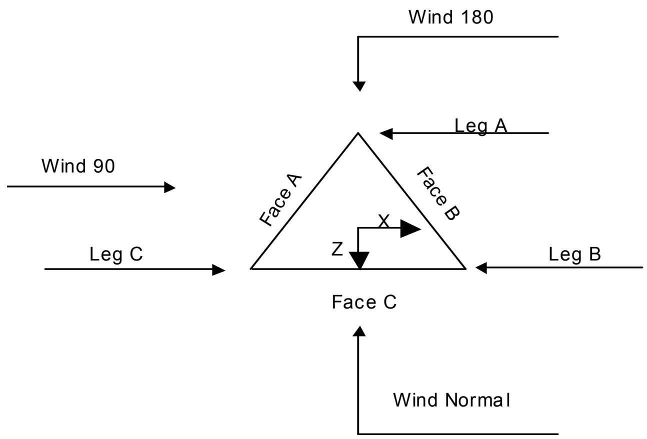
Consider Moments - Legs
Consider Moments - Horizontals
Consider Moments - Diagonals
Use Moment Magnification
Use Code Stress Ratios
√ Use Code Safety Factors - Guys
Escalate Ice
Always Use Max Kz
Use Special Wind Profile
√ Include Bolts In Member Capacity
Leg Bolts Are At Top Of Section
√ Secondary Horizontal 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



Triangular Tower

Tower Section Geometry

Tower Section	*Tower Elevation*	*Assembly Database*	*Description*	*Section Width*	*Number of Sections*	*Section Length*
	ft			*ft*		*ft*
T1	180.00-160.00			6.69	1	20.00
T2	160.00-140.00			6.76	1	20.00
T3	140.00-120.00			8.83	1	20.00
T4	120.00-100.00			10.92	1	20.00
T5	100.00-80.00			13.05	1	20.00
T6	80.00-60.00			14.99	1	20.00
T7	60.00-40.00			17.15	1	20.00
T8	40.00-20.00			19.16	1	20.00
T9	20.00-0.00			21.16	1	20.00

Tower Section Geometry *(cont'd)*

Tower Section	*Tower Elevation*	*Diagonal Spacing*	*Bracing Type*	*Has K Brace End Panels*	*Has Horizontals*	*Top Girt Offset*	*Bottom Girt Offset*
	ft	*ft*				*in*	*in*
T1	180.00-160.00	4.00	X Brace	No	No	0.0000	0.0000
T2	160.00-140.00	5.00	X Brace	No	No	0.0000	0.0000
T3	140.00-120.00	6.67	X Brace	No	No	0.0000	0.0000
T4	120.00-100.00	6.67	X Brace	No	No	0.0000	0.0000
T5	100.00-80.00	6.67	X Brace	No	No	0.0000	0.0000
T6	80.00-60.00	10.00	X Brace	No	No	0.0000	0.0000
T7	60.00-40.00	10.00	X Brace	No	No	0.0000	0.0000
T8	40.00-20.00	10.00	X Brace	No	No	0.0000	0.0000
T9	20.00-0.00	10.00	X Brace	No	No	0.0000	0.0000

Tower Section Geometry *(cont'd)*

Tower Elevation ft	Leg Type	Leg Size	Leg Grade	Diagonal Type	Diagonal Size	Diagonal Grade
T1 180.00-160.00	Pipe	ROHN 3 STD	A572-50 (50 ksi)	Single Angle	L1 3/4x1 3/4x3/16	A36 (36 ksi)
T2 160.00-140.00	Pipe	ROHN 4 EH	A572-50 (50 ksi)	Single Angle	L2x2x1/4	A36 (36 ksi)
T3 140.00-120.00	Pipe	ROHN 5 EH	A572-50 (50 ksi)	Single Angle	L2 1/2x2 1/2x1/4	A36 (36 ksi)
T4 120.00-100.00	Pipe	ROHN 6 EH	A572-50 (50 ksi)	Single Angle	L3x3x1/4	A570-50 (50 ksi)
T5 100.00-80.00	Pipe	ROHN 8 EHS	A572-50 (50 ksi)	Single Angle	L3x3x1/4	A570-50 (50 ksi)
T6 80.00-60.00	Pipe	ROHN 8 EH	A572-50 (50 ksi)	Single Angle	L3 1/2x3 1/2x1/4	A570-50 (50 ksi)
T7 60.00-40.00	Pipe	ROHN 10 EH	A572-50 (50 ksi)	Single Angle	L4x4x5/16	A570-50 (50 ksi)
T8 40.00-20.00	Pipe	ROHN 10 EH	A572-50 (50 ksi)	Single Angle	L4x4x5/16	A570-50 (50 ksi)
T9 20.00-0.00	Pipe	ROHN 10 EH	A572-50 (50 ksi)	Single Angle	L4x4x5/16	A570-50 (50 ksi)

Tower Section Geometry *(cont'd)*

Tower Elevation ft	Top Girt Type	Top Girt Size	Top Girt Grade	Bottom Girt Type	Bottom Girt Size	Bottom Girt Grade
T1 180.00-160.00	Single Angle	L2x2x1/8	A36 (36 ksi)	Solid Round		A36 (36 ksi)
T2 160.00-140.00	Single Angle	L2x2x1/8	A36 (36 ksi)	Solid Round		A36 (36 ksi)

Tower Section Geometry *(cont'd)*

Tower Elevation ft	Gusset Area (per face) ft^2	Gusset Thickness in	Gusset Grade	Adjust. Factor A_f	Adjust. Factor A_r	Weight Mult.	Double Angle Stitch Bolt Spacing Diagonals in	Double Angle Stitch Bolt Spacing Horizontals in	Double Angle Stitch Bolt Spacing Redundants in
T1 180.00-160.00	0.00	0.0000	A36 (36 ksi)	1.05	1	1.05	36.0000	36.0000	36.0000
T2 160.00-140.00	0.00	0.0000	A36 (36 ksi)	1.05	1	1.05	36.0000	36.0000	36.0000
T3 140.00-120.00	0.00	0.0000	A36 (36 ksi)	1.05	1	1.05	36.0000	36.0000	36.0000
T4 120.00-100.00	0.00	0.0000	A36 (36 ksi)	1.05	1	1.05	36.0000	36.0000	36.0000
T5 100.00-80.00	0.00	0.0000	A36 (36 ksi)	1.05	1	1.05	36.0000	36.0000	36.0000
T6 80.00-60.00	0.00	0.0000	A36 (36 ksi)	1.05	1	1.05	36.0000	36.0000	36.0000
T7 60.00-40.00	0.00	0.0000	A36 (36 ksi)	1.05	1	1.05	36.0000	36.0000	36.0000
T8 40.00-20.00	0.00	0.0000	A36 (36 ksi)	1.05	1	1.05	36.0000	36.0000	36.0000
T9 20.00-0.00	0.00	0.0000	A36 (36 ksi)	1.05	1	1.05	36.0000	36.0000	36.0000

Tower Section Geometry *(cont'd)*

Tower Elevation ft	Calc K Single Angles	Calc K Solid Rounds	K Factors[1] Legs	X Brace Diags X Y	K Brace Diags X Y	Single Diags X Y	Girts X Y	Horiz. X Y	Sec. Horiz. X Y	Inner Brace X Y
T1 180.00-160.00	Yes	Yes	1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
T2 160.00-140.00	Yes	Yes	1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
T3 140.00-120.00	Yes	Yes	1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
T4 120.00-100.00	Yes	Yes	1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
T5 100.00-80.00	Yes	Yes	1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
T6 80.00-60.00	Yes	Yes	1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
T7 60.00-40.00	Yes	Yes	1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
T8 40.00-20.00	Yes	Yes	1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
T9 20.00-0.00	Yes	Yes	1	1 1	1 1	1 1	1 1	1 1	1 1	1 1

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

Tower Section Geometry *(cont'd)*

Tower Elevation ft	Leg		Diagonal		Top Girt		Bottom Girt		Mid Girt		Long Horizontal		Short Horizontal	
	Net Width Deduct in	U	Net Width Deduct in	U	Net Width Deduct in	U	Net Width Deduct in	U	Net Width Deduct in	U	Net Width Deduct in	U	Net Width Deduct in	U
T1 180.00-160.00	0.0000	1	0.0000	0.75	0.0000	0.75	0.0000	0.75	0.0000	0.75	0.0000	1	0.0000	0.75
T2 160.00-140.00	0.0000	1	0.0000	0.75	0.0000	0.75	0.0000	0.75	0.0000	0.75	0.0000	1	0.0000	0.75
T3 140.00-120.00	0.0000	1	0.0000	0.75	0.0000	0.75	0.0000	0.75	0.0000	0.75	0.0000	1	0.0000	0.75
T4 120.00-100.00	0.0000	1	0.0000	0.75	0.0000	0.75	0.0000	0.75	0.0000	0.75	0.0000	0.75	0.0000	0.75
T5 100.00-80.00	0.0000	1	0.0000	0.75	0.0000	0.75	0.0000	0.75	0.0000	0.75	0.0000	0.75	0.0000	0.75
T6 80.00-60.00	0.0000	1	0.0000	0.75	0.0000	0.75	0.0000	0.75	0.0000	0.75	0.0000	0.75	0.0000	0.75
T7 60.00-40.00	0.0000	1	0.0000	0.75	0.0000	0.75	0.0000	0.75	0.0000	0.75	0.0000	0.75	0.0000	0.75
T8 40.00-20.00	0.0000	1	0.0000	0.75	0.0000	0.75	0.0000	0.75	0.0000	0.75	0.0000	0.75	0.0000	0.75
T9 20.00-0.00	0.0000	1	0.0000	0.75	0.0000	0.75	0.0000	0.75	0.0000	0.75	0.0000	0.75	0.0000	0.75

Tower Section Geometry *(cont'd)*

Tower Elevation ft	*Leg Connection Type*	*Leg*		*Diagonal*		*Top Girt*		*Bottom Girt*		*Mid Girt*		*Long Horizontal*		*Short Horizontal*	
		Bolt Size in	*No.*	*Bolt Size in*	*No.*	*Bolt Size in*	*No.*	*Bolt Size in*	*No.*	*Bolt Size in*	*No.*	*Bolt Size in*	*No.*	*Bolt Size in*	*No.*
T1 180.00-160.00	Flange	0.8750 A325N	4	0.6250 A325N	1	0.6250 A325N	1	0.6250 A325N	0	0.6250 A325N	0	0.6250 A325N	0	0.6250 A325N	0
T2 160.00-140.00	Flange	1.0000 A325N	4	0.6250 A325N	1	0.6250 A325N	1	0.6250 A325N	0	0.6250 A325N	0	0.6250 A325N	0	0.6250 A325N	0
T3 140.00-120.00	Flange	1.0000 A325N	6	0.7500 A325N	1	0.6250 A325N	0	0.6250 A325N	0	0.6250 A325N	0	0.6250 A325N	0	0.6250 A325N	0
T4 120.00-100.00	Flange	1.0000 A325N	8	0.7500 A325N	1	0.6250 A325N	0	0.6250 A325N	0	0.6250 A325N	0	0.6250 A325N	0	0.6250 A325N	0
T5 100.00-80.00	Flange	1.0000 A325N	8	0.7500 A325N	1	0.6250 A325N	0	0.6250 A325N	0	0.6250 A325N	0	0.6250 A325N	0	0.6250 A325N	0
T6 80.00-60.00	Flange	1.0000 A325N	12	0.7500 A325N	1	0.6250 A325N	0	0.6250 A325N	0	0.6250 A325N	0	0.6250 A325N	0	0.6250 A325N	0
T7 60.00-40.00	Flange	1.0000 A325N	12	0.7500 A325N	1	0.6250 A325N	0	0.6250 A325N	0	0.6250 A325N	0	0.6250 A325N	0	0.6250 A325N	0
T8 40.00-20.00	Flange	1.0000 A325N	12	0.7500 A325N	1	0.6250 A325N	0	0.6250 A325N	0	0.6250 A325N	0	0.6250 A325N	0	0.6250 A325N	0
T9 20.00-0.00	Flange	1.0000 A325N	0	0.7500 A325N	1	0.6250 A325N	0	0.6250 A325N	0	0.6250 A325N	0	0.6250 A325N	0	0.6250 A325N	0

Feed Line/Linear Appurtenances - Entered As Round Or Flat

Description	*Face or Leg*	*Allow Shield*	*Exclude From Torque Calculation*	*Component Type*	*Placement ft*	*Face Offset in*	*Lateral Offset (Frac FW)*	*#*	*# Per Row*	*Clear Spacing in*	*Width or Diameter in*	*Perimeter in*	*Weight plf*
Safety Line 3/8	A	No	No	Ar (CaAa)	180.00 - 0.00	-8.0000	-0.3	1	1	0.3750	0.3750		0.22
Climbing Ladder (Af)	A	No	No	Af (CaAa)	180.00 - 0.00	-8.0000	-0.3	1	1	0.5000	3.0000		8.40
Feedline Ladder (Af)	B	No	No	Af (CaAa)	180.00 - 0.00	0.0000	-0.4	1	1	3.0000	3.0000		8.40
***													
LDF5-50A(7/8)	B	No	No	Ar (CaAa)	178.00 - 0.00	0.0000	-0.47	3	3	0.5000	1.0300		0.33
LDF5-50A(7/8)	B	No	No	Ar (CaAa)	163.00 - 0.00	0.0000	-0.45	2	2	0.5000	1.0300		0.33
LDF5-50A(7/8)	B	No	No	Ar (CaAa)	152.00 - 0.00	0.0000	-0.43	1	1	0.5000	1.0300		0.33
LDF5-50A(7/8)	B	No	No	Ar (CaAa)	144.00 - 0.00	0.0000	-0.42	1	1	0.5000	1.0300		0.33
LDF5-50A(7/8)	B	No	No	Ar (CaAa)	130.00 - 0.00	0.0000	-0.41	1	1	0.5000	1.0300		0.33
LDF5-50A(7/8)	B	No	No	Ar (CaAa)	122.00 - 0.00	0.0000	-0.4	3	3	0.5000	1.0300		0.33
LDF5-50A(7/8)	B	No	No	Ar (CaAa)	86.00 - 0.00	0.0000	-0.38	1	1	0.5000	1.0300		0.33
LDF5-50A(7/8)	B	No	No	Ar (CaAa)	83.00 - 0.00	0.0000	-0.37	1	1	0.5000	1.0300		0.33
LDF4-50A(1/2)	B	No	No	Ar (CaAa)	65.00 - 0.00	0.0000	-0.36	2	2	0.5000	0.6250		0.15
LDF4-50A(1/2)	B	No	No	Ar (CaAa)	24.00 - 0.00	0.0000	-0.35	1	1	0.5000	0.6250		0.15
***													
EW90	B	No	No	Ar (CaAa)	148.00 - 0.00	0.0000	-0.34	1	1	0.5000	0.9869		0.32
***													
E65 (ELLIPTICAL AIR) ** Proposed for Discrete Loads	B	No	No	Ar (CaAa)	83.00 - 0.00	0.0000	-0.46	1	1	0.5000	1.2000		0.67
LDF5-	C	No	No	Ar (CaAa)	177.00 -	0.0000	-0.45	2	2	0.5000	1.0300		0.33

Description	Face or Leg	Allow Shield	Exclude From Torque Calculation	Component Type	Placement ft	Face Offset in	Lateral Offset (Frac FW)	#	# Per Row	Clear Spacing in	Width or Diameter in	Perimeter in	Weight plf
50A(7/8) ** Proposed for Dish					0.00								
WE65(ELLIPTICAL)	C	No	No	Ar (CaAa)	170.00 - 0.00	0.0000	-0.47	1	1	0.5000	2.0300		0.53
Feedline Ladder (Af)	C	No	No	Af (CaAa)	170.00 - 0.00	0.0000	-0.45	1	1	3.0000	3.0000		8.40

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
T1	180.00-160.00	A	0.000	0.000	10.750	0.000	0.17
		B	0.000	0.000	16.180	0.000	0.19
		C	0.000	0.000	10.532	0.000	0.10
T2	160.00-140.00	A	0.000	0.000	10.750	0.000	0.17
		B	0.000	0.000	22.738	0.000	0.21
		C	0.000	0.000	18.180	0.000	0.19
T3	140.00-120.00	A	0.000	0.000	10.750	0.000	0.17
		B	0.000	0.000	28.042	0.000	0.23
		C	0.000	0.000	18.180	0.000	0.19
T4	120.00-100.00	A	0.000	0.000	10.750	0.000	0.17
		B	0.000	0.000	34.634	0.000	0.25
		C	0.000	0.000	18.180	0.000	0.19
T5	100.00-80.00	A	0.000	0.000	10.750	0.000	0.17
		B	0.000	0.000	35.921	0.000	0.25
		C	0.000	0.000	18.180	0.000	0.19
T6	80.00-60.00	A	0.000	0.000	10.750	0.000	0.17
		B	0.000	0.000	41.779	0.000	0.28
		C	0.000	0.000	18.180	0.000	0.19
T7	60.00-40.00	A	0.000	0.000	10.750	0.000	0.17
		B	0.000	0.000	43.654	0.000	0.28
		C	0.000	0.000	18.180	0.000	0.19
T8	40.00-20.00	A	0.000	0.000	10.750	0.000	0.17
		B	0.000	0.000	43.904	0.000	0.28
		C	0.000	0.000	18.180	0.000	0.19
T9	20.00-0.00	A	0.000	0.000	10.750	0.000	0.17
		B	0.000	0.000	44.904	0.000	0.28
		C	0.000	0.000	18.180	0.000	0.19

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
T1	180.00-160.00	A	2.032	0.000	0.000	27.008	0.000	0.60
		B		0.000	0.000	42.897	0.000	0.76
		C		0.000	0.000	32.918	0.000	0.53
T2	160.00-140.00	A	2.007	0.000	0.000	26.806	0.000	0.60
		B		0.000	0.000	74.678	0.000	1.15
		C		0.000	0.000	50.831	0.000	0.90
T3	140.00-120.00	A	1.978	0.000	0.000	26.578	0.000	0.59
		B		0.000	0.000	99.286	0.000	1.51
		C		0.000	0.000	50.403	0.000	0.88
T4	120.00-100.00	A	1.946	0.000	0.000	26.316	0.000	0.58
		B		0.000	0.000	124.237	0.000	1.79
		C		0.000	0.000	49.911	0.000	0.87
T5	100.00-80.00	A	1.907	0.000	0.000	26.006	0.000	0.56
		B		0.000	0.000	128.525	0.000	1.83
		C		0.000	0.000	49.331	0.000	0.85

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
T6	80.00-60.00	A	1.860	0.000	0.000	25.628	0.000	0.55
		B		0.000	0.000	153.935	0.000	2.16
		C		0.000	0.000	48.621	0.000	0.83
T7	60.00-40.00	A	1.798	0.000	0.000	25.135	0.000	0.53
		B		0.000	0.000	163.355	0.000	2.17
		C		0.000	0.000	47.698	0.000	0.80
T8	40.00-20.00	A	1.709	0.000	0.000	24.419	0.000	0.50
		B		0.000	0.000	159.623	0.000	2.06
		C		0.000	0.000	46.355	0.000	0.75
T9	20.00-0.00	A	1.531	0.000	0.000	22.997	0.000	0.46
		B		0.000	0.000	154.770	0.000	1.86
		C		0.000	0.000	43.690	0.000	0.67

Feed Line Center of Pressure

Section	Elevation ft	CP_X in	CP_Z in	CP_X Ice in	CP_Z Ice in
T1	180.00-160.00	1.6541	-2.5166	2.0935	-2.2568
T2	160.00-140.00	3.6875	-3.6831	4.8106	-5.3512
T3	140.00-120.00	4.2113	-6.3411	5.6499	-10.4663
T4	120.00-100.00	4.2919	-8.9817	6.0506	-14.7719
T5	100.00-80.00	4.4069	-9.8479	6.4261	-16.9274
T6	80.00-60.00	5.1606	-13.8026	7.4878	-24.1611
T7	60.00-40.00	5.0196	-14.1193	7.7411	-26.3570
T8	40.00-20.00	5.2751	-15.0894	8.1655	-28.1835
T9	20.00-0.00	5.5432	-16.2704	8.5475	-30.1904

Shielding Factor Ka

Tower Section	Feed Line Record No.	Description	Feed Line Segment Elev.	K_a No Ice	K_a Ice
T1	1	Safety Line 3/8	160.00 - 180.00	0.6000	0.5560
T1	2	Climbing Ladder (Af)	160.00 - 180.00	0.6000	0.5560
T1	3	Feedline Ladder (Af)	160.00 - 180.00	0.6000	0.5560
T1	5	LDF5-50A(7/8)	160.00 - 178.00	0.6000	0.5560
T1	6	LDF5-50A(7/8)	160.00 - 163.00	0.6000	0.5560
T1	21	LDF5-50A(7/8)	160.00 - 177.00	0.6000	0.5560
T1	23	WE65(ELLIPTICAL)	160.00 - 170.00	0.6000	0.5560
T1	24	Feedline Ladder (Af)	160.00 - 170.00	0.6000	0.5560
T2	1	Safety Line 3/8	140.00 - 160.00	0.6000	0.6000
T2	2	Climbing Ladder (Af)	140.00 - 160.00	0.6000	0.6000
T2	3	Feedline Ladder (Af)	140.00 - 160.00	0.6000	0.6000
T2	5	LDF5-50A(7/8)	140.00 - 160.00	0.6000	0.6000
T2	6	LDF5-50A(7/8)	140.00 - 160.00	0.6000	0.6000

Tower Section	Feed Line Record No.	Description	Feed Line Segment Elev.	K_a No Ice	K_a Ice
T2	7	LDF5-50A(7/8)	140.00 - 152.00	0.6000	0.6000
T2	8	LDF5-50A(7/8)	140.00 - 144.00	0.6000	0.6000
T2	17	EW90	140.00 - 148.00	0.6000	0.6000
T2	21	LDF5-50A(7/8)	140.00 - 160.00	0.6000	0.6000
T2	23	WE65(ELLIPTICAL)	140.00 - 160.00	0.6000	0.6000
T2	24	Feedline Ladder (Af)	140.00 - 160.00	0.6000	0.6000
T3	1	Safety Line 3/8	120.00 - 140.00	0.6000	0.6000
T3	2	Climbing Ladder (Af)	120.00 - 140.00	0.6000	0.6000
T3	3	Feedline Ladder (Af)	120.00 - 140.00	0.6000	0.6000
T3	5	LDF5-50A(7/8)	120.00 - 140.00	0.6000	0.6000
T3	6	LDF5-50A(7/8)	120.00 - 140.00	0.6000	0.6000
T3	7	LDF5-50A(7/8)	120.00 - 140.00	0.6000	0.6000
T3	8	LDF5-50A(7/8)	120.00 - 140.00	0.6000	0.6000
T3	9	LDF5-50A(7/8)	120.00 - 130.00	0.6000	0.6000
T3	10	LDF5-50A(7/8)	120.00 - 122.00	0.6000	0.6000
T3	17	EW90	120.00 - 140.00	0.6000	0.6000
T3	21	LDF5-50A(7/8)	120.00 - 140.00	0.6000	0.6000
T3	23	WE65(ELLIPTICAL)	120.00 - 140.00	0.6000	0.6000
T3	24	Feedline Ladder (Af)	120.00 - 140.00	0.6000	0.6000
T4	1	Safety Line 3/8	100.00 - 120.00	0.6000	0.6000
T4	2	Climbing Ladder (Af)	100.00 - 120.00	0.6000	0.6000
T4	3	Feedline Ladder (Af)	100.00 - 120.00	0.6000	0.6000
T4	5	LDF5-50A(7/8)	100.00 - 120.00	0.6000	0.6000
T4	6	LDF5-50A(7/8)	100.00 - 120.00	0.6000	0.6000
T4	7	LDF5-50A(7/8)	100.00 - 120.00	0.6000	0.6000
T4	8	LDF5-50A(7/8)	100.00 - 120.00	0.6000	0.6000
T4	9	LDF5-50A(7/8)	100.00 - 120.00	0.6000	0.6000
T4	10	LDF5-50A(7/8)	100.00 - 120.00	0.6000	0.6000
T4	17	EW90	100.00 - 120.00	0.6000	0.6000
T4	21	LDF5-50A(7/8)	100.00 - 120.00	0.6000	0.6000
T4	23	WE65(ELLIPTICAL)	100.00 - 120.00	0.6000	0.6000
T4	24	Feedline Ladder (Af)	100.00 - 120.00	0.6000	0.6000
T5	1	Safety Line 3/8	80.00 - 100.00	0.6000	0.6000
T5	2	Climbing Ladder (Af)	80.00 - 100.00	0.6000	0.6000
T5	3	Feedline Ladder (Af)	80.00 -	0.6000	0.6000

Tower Section	Feed Line Record No.	Description	Feed Line Segment Elev.	K_a No Ice	K_a Ice
			100.00		
T5	5	LDF5-50A(7/8)	80.00 - 100.00	0.6000	0.6000
T5	6	LDF5-50A(7/8)	80.00 - 100.00	0.6000	0.6000
T5	7	LDF5-50A(7/8)	80.00 - 100.00	0.6000	0.6000
T5	8	LDF5-50A(7/8)	80.00 - 100.00	0.6000	0.6000
T5	9	LDF5-50A(7/8)	80.00 - 100.00	0.6000	0.6000
T5	10	LDF5-50A(7/8)	80.00 - 100.00	0.6000	0.6000
T5	12	LDF5-50A(7/8)	80.00 - 86.00	0.6000	0.6000
T5	13	LDF5-50A(7/8)	80.00 - 83.00	0.6000	0.6000
T5	17	EW90	80.00 - 100.00	0.6000	0.6000
T5	19	E65 (ELLIPTICAL AIR)	80.00 - 83.00	0.6000	0.6000
T5	21	LDF5-50A(7/8)	80.00 - 100.00	0.6000	0.6000
T5	23	WE65(ELLIPTICAL)	80.00 - 100.00	0.6000	0.6000
T5	24	Feedline Ladder (Af)	80.00 - 100.00	0.6000	0.6000
T6	1	Safety Line 3/8	60.00 - 80.00	0.6000	0.6000
T6	2	Climbing Ladder (Af)	60.00 - 80.00	0.6000	0.6000
T6	3	Feedline Ladder (Af)	60.00 - 80.00	0.6000	0.6000
T6	5	LDF5-50A(7/8)	60.00 - 80.00	0.6000	0.6000
T6	6	LDF5-50A(7/8)	60.00 - 80.00	0.6000	0.6000
T6	7	LDF5-50A(7/8)	60.00 - 80.00	0.6000	0.6000
T6	8	LDF5-50A(7/8)	60.00 - 80.00	0.6000	0.6000
T6	9	LDF5-50A(7/8)	60.00 - 80.00	0.6000	0.6000
T6	10	LDF5-50A(7/8)	60.00 - 80.00	0.6000	0.6000
T6	12	LDF5-50A(7/8)	60.00 - 80.00	0.6000	0.6000
T6	13	LDF5-50A(7/8)	60.00 - 80.00	0.6000	0.6000
T6	14	LDF4-50A(1/2)	60.00 - 65.00	0.6000	0.6000
T6	17	EW90	60.00 - 80.00	0.6000	0.6000
T6	19	E65 (ELLIPTICAL AIR)	60.00 - 80.00	0.6000	0.6000
T6	21	LDF5-50A(7/8)	60.00 - 80.00	0.6000	0.6000
T6	23	WE65(ELLIPTICAL)	60.00 - 80.00	0.6000	0.6000
T6	24	Feedline Ladder (Af)	60.00 - 80.00	0.6000	0.6000
T7	1	Safety Line 3/8	40.00 - 60.00	0.6000	0.6000
T7	2	Climbing Ladder (Af)	40.00 - 60.00	0.6000	0.6000
T7	3	Feedline Ladder (Af)	40.00 - 60.00	0.6000	0.6000
T7	5	LDF5-50A(7/8)	40.00 - 60.00	0.6000	0.6000

Tower Section	Feed Line Record No.	Description	Feed Line Segment Elev.	K_a No Ice	K_a Ice
T7	6	LDF5-50A(7/8)	40.00 - 60.00	0.6000	0.6000
T7	7	LDF5-50A(7/8)	40.00 - 60.00	0.6000	0.6000
T7	8	LDF5-50A(7/8)	40.00 - 60.00	0.6000	0.6000
T7	9	LDF5-50A(7/8)	40.00 - 60.00	0.6000	0.6000
T7	10	LDF5-50A(7/8)	40.00 - 60.00	0.6000	0.6000
T7	12	LDF5-50A(7/8)	40.00 - 60.00	0.6000	0.6000
T7	13	LDF5-50A(7/8)	40.00 - 60.00	0.6000	0.6000
T7	14	LDF4-50A(1/2)	40.00 - 60.00	0.6000	0.6000
T7	17	EW90	40.00 - 60.00	0.6000	0.6000
T7	19	E65 (ELLIPTICAL AIR)	40.00 - 60.00	0.6000	0.6000
T7	21	LDF5-50A(7/8)	40.00 - 60.00	0.6000	0.6000
T7	23	WE65(ELLIPTICAL)	40.00 - 60.00	0.6000	0.6000
T7	24	Feedline Ladder (Af)	40.00 - 60.00	0.6000	0.6000
T8	1	Safety Line 3/8	20.00 - 40.00	0.6000	0.6000
T8	2	Climbing Ladder (Af)	20.00 - 40.00	0.6000	0.6000
T8	3	Feedline Ladder (Af)	20.00 - 40.00	0.6000	0.6000
T8	5	LDF5-50A(7/8)	20.00 - 40.00	0.6000	0.6000
T8	6	LDF5-50A(7/8)	20.00 - 40.00	0.6000	0.6000
T8	7	LDF5-50A(7/8)	20.00 - 40.00	0.6000	0.6000
T8	8	LDF5-50A(7/8)	20.00 - 40.00	0.6000	0.6000
T8	9	LDF5-50A(7/8)	20.00 - 40.00	0.6000	0.6000
T8	10	LDF5-50A(7/8)	20.00 - 40.00	0.6000	0.6000
T8	12	LDF5-50A(7/8)	20.00 - 40.00	0.6000	0.6000
T8	13	LDF5-50A(7/8)	20.00 - 40.00	0.6000	0.6000
T8	14	LDF4-50A(1/2)	20.00 - 40.00	0.6000	0.6000
T8	15	LDF4-50A(1/2)	20.00 - 24.00	0.6000	0.6000
T8	17	EW90	20.00 - 40.00	0.6000	0.6000
T8	19	E65 (ELLIPTICAL AIR)	20.00 - 40.00	0.6000	0.6000
T8	21	LDF5-50A(7/8)	20.00 - 40.00	0.6000	0.6000
T8	23	WE65(ELLIPTICAL)	20.00 - 40.00	0.6000	0.6000
T8	24	Feedline Ladder (Af)	20.00 - 40.00	0.6000	0.6000
T9	1	Safety Line 3/8	0.00 - 20.00	0.6000	0.6000
T9	2	Climbing Ladder (Af)	0.00 - 20.00	0.6000	0.6000
T9	3	Feedline Ladder (Af)	0.00 - 20.00	0.6000	0.6000
T9	5	LDF5-50A(7/8)	0.00 - 20.00	0.6000	0.6000
T9	6	LDF5-50A(7/8)	0.00 - 20.00	0.6000	0.6000
T9	7	LDF5-50A(7/8)	0.00 - 20.00	0.6000	0.6000
T9	8	LDF5-50A(7/8)	0.00 - 20.00	0.6000	0.6000

Tower Section	Feed Line Record No.	Description	Feed Line Segment Elev.	K_a No Ice	K_a Ice
T9	9	LDF5-50A(7/8)	0.00 - 20.00	0.6000	0.6000
T9	10	LDF5-50A(7/8)	0.00 - 20.00	0.6000	0.6000
T9	12	LDF5-50A(7/8)	0.00 - 20.00	0.6000	0.6000
T9	13	LDF5-50A(7/8)	0.00 - 20.00	0.6000	0.6000
T9	14	LDF4-50A(1/2)	0.00 - 20.00	0.6000	0.6000
T9	15	LDF4-50A(1/2)	0.00 - 20.00	0.6000	0.6000
T9	17	EW90	0.00 - 20.00	0.6000	0.6000
T9	19	E65 (ELLIPTICAL AIR)	0.00 - 20.00	0.6000	0.6000
T9	21	LDF5-50A(7/8)	0.00 - 20.00	0.6000	0.6000
T9	23	WE65(ELLIPTICAL)	0.00 - 20.00	0.6000	0.6000
T9	24	Feedline Ladder (Af)	0.00 - 20.00	0.6000	0.6000

Discrete Tower Loads

Description	Face or Leg	Offset Type	Offsets: Horz Lateral Vert ft ft ft	Azimuth Adjustment °	Placement ft		C_AA_A Front ft²	C_AA_A Side ft²	Weight K
12"x12"x6" Junction Box	C	From Leg	0.00	0.0000	178.00	No Ice	1.20	0.60	0.05
			0.00			1/2" Ice	1.34	0.70	0.06
			0.00			1" Ice	1.48	0.81	0.07
						2" Ice	1.79	1.06	0.10
3' x 3" Dia Omni	C	From Leg	0.00	0.0000	178.00	No Ice	0.58	0.58	0.03
			0.00			1/2" Ice	0.77	0.77	0.04
			1.50			1" Ice	0.97	0.97	0.05
						2" Ice	1.39	1.39	0.07
Side Arm Mount [SO 306-1]	C	From Leg	2.00	0.0000	178.00	No Ice	0.98	2.18	0.04
			0.00			1/2" Ice	1.70	3.80	0.06
			0.00			1" Ice	2.42	5.42	0.08
						2" Ice	3.86	8.66	0.12
Side Arm Mount [SO 306-1]	A	From Leg	2.00	0.0000	178.00	No Ice	0.98	2.18	0.04
			0.00			1/2" Ice	1.70	3.80	0.06
			0.00			1" Ice	2.42	5.42	0.08
						2" Ice	3.86	8.66	0.12
Side Arm Mount [SO 305-1]	C	From Leg	1.50	0.0000	178.00	No Ice	0.94	1.41	0.03
			0.00			1/2" Ice	1.48	2.17	0.04
			0.00			1" Ice	2.02	2.93	0.06
						2" Ice	3.10	4.45	0.08
1142-2CN	A	From Leg	4.00	0.0000	178.00	No Ice	2.09	2.09	0.01
			0.00			1/2" Ice	3.37	3.37	0.03
			7.00			1" Ice	4.67	4.67	0.05
						2" Ice	7.32	7.32	0.13
220-3AN	C	From Leg	3.00	0.0000	178.00	No Ice	6.69	6.69	0.06
			0.00			1/2" Ice	10.27	10.27	0.11
			10.00			1" Ice	12.39	12.39	0.18
						2" Ice	16.70	16.70	0.36
6'x4" Mount Pipe	B	From Leg	0.50	0.0000	178.00	No Ice	1.67	1.67	0.06
			0.00			1/2" Ice	2.62	2.62	0.08
			0.00			1" Ice	3.00	3.00	0.11
						2" Ice	3.78	3.78	0.17
6' Horizontal HSS4x4x1/4	C	From Face	0.00	0.0000	178.00	No Ice	3.53	0.03	0.07

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
			0.00 0.00			1/2" Ice 1" Ice 2" Ice	4.48 5.42 7.31	0.04 0.05 0.08	0.09 0.12 0.16
***									
Side Arm Mount [SO 308-1]	B	From Leg	3.00 0.00 0.00	0.0000	168.00	No Ice 1/2" Ice 1" Ice 2" Ice	0.98 1.70 2.42 3.86	3.03 5.22 7.41 11.79	0.05 0.08 0.10 0.16
DB222	B	From Leg	6.00 0.00 6.00	0.0000	168.00	No Ice 1/2" Ice 1" Ice 2" Ice	1.60 2.88 4.16 6.72	1.60 2.88 4.16 6.72	0.02 0.02 0.03 0.04
***									
Side Arm Mount [SO 305-1]	C	From Leg	1.50 0.00 0.00	0.0000	163.00	No Ice 1/2" Ice 1" Ice 2" Ice	0.94 1.48 2.02 3.10	1.41 2.17 2.93 4.45	0.03 0.04 0.06 0.08
6' x 3" Dia Omni	C	From Leg	3.00 0.00 0.00	0.0000	163.00	No Ice 1/2" Ice 1" Ice 2" Ice	1.77 2.13 2.50 3.27	1.77 2.13 2.50 3.27	0.02 0.03 0.05 0.10
***									
8' Horizontal HSS4x4x1/4	B	From Face	0.00 0.00 0.00	0.0000	157.00	No Ice 1/2" Ice 1" Ice 2" Ice	5.27 6.66 8.04 10.81	0.03 0.04 0.05 0.08	0.10 0.13 0.15 0.21
8' Horizontal HSS4x4x1/4	C	From Face	0.00 0.00 0.00	0.0000	156.00	No Ice 1/2" Ice 1" Ice 2" Ice	5.27 6.66 8.04 10.81	0.03 0.04 0.05 0.08	0.10 0.13 0.15 0.21
6'x4" Mount Pipe	B	From Leg	0.50 0.00 0.00	0.0000	155.00	No Ice 1/2" Ice 1" Ice 2" Ice	1.69 2.62 3.00 3.78	1.69 2.62 3.00 3.78	0.06 0.08 0.11 0.17
8' Horizontal HSS4x4x1/4	C	From Face	0.00 0.00 0.00	0.0000	151.00	No Ice 1/2" Ice 1" Ice 2" Ice	5.27 6.66 8.04 10.81	0.03 0.04 0.05 0.08	0.10 0.13 0.15 0.21
***									
Side Arm Mount [SO 308-1]	A	From Leg	3.00 0.00 0.00	0.0000	152.00	No Ice 1/2" Ice 1" Ice 2" Ice	0.98 1.70 2.42 3.86	3.03 5.22 7.41 11.79	0.05 0.08 0.10 0.16
1142-2CN	A	From Leg	6.00 0.00 7.00	0.0000	152.00	No Ice 1/2" Ice 1" Ice 2" Ice	2.09 3.37 4.67 7.32	2.09 3.37 4.67 7.32	0.01 0.03 0.05 0.13
***									
Pipe Mount [PM 602-1]	C	From Leg	0.50 0.00 0.00	0.0000	148.00	No Ice 1/2" Ice 1" Ice 2" Ice	5.25 6.50 7.75 10.25	1.58 1.95 2.32 3.06	0.09 0.12 0.14 0.19
***									

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
***									
Side Arm Mount [SO 308-1]	B	From Leg	3.00 0.00 0.00	0.0000	144.00	No Ice 1/2" Ice 1" Ice 2" Ice	0.98 1.70 2.42 3.86	3.03 5.22 7.41 11.79	0.05 0.08 0.10 0.16
DB222	B	From Leg	6.00 0.00 6.00	0.0000	144.00	No Ice 1/2" Ice 1" Ice 2" Ice	1.60 2.88 4.16 6.72	1.60 2.88 4.16 6.72	0.02 0.02 0.03 0.04
***									
BNF800S-06	C	From Leg	6.00 0.00 3.00	0.0000	130.00	No Ice 1/2" Ice 1" Ice 2" Ice	0.19 0.31 0.43 0.67	0.19 0.31 0.43 0.67	0.10 0.10 0.10 0.10
Side Arm Mount [SO 308-1]	C	From Leg	3.00 0.00 0.00	0.0000	130.00	No Ice 1/2" Ice 1" Ice 2" Ice	0.98 1.70 2.42 3.86	3.03 5.22 7.41 11.79	0.05 0.08 0.10 0.16
***									
***									
Side Arm Mount [SO 308-1]	A	From Leg	3.00 0.00 0.00	0.0000	123.00	No Ice 1/2" Ice 1" Ice 2" Ice	0.98 1.70 2.42 3.86	3.03 5.22 7.41 11.79	0.05 0.08 0.10 0.16
CO-36A	A	From Leg	3.00 0.00 7.00	0.0000	122.00	No Ice 1/2" Ice 1" Ice 2" Ice	2.70 3.93 5.17 7.52	2.70 3.93 5.17 7.52	0.01 0.03 0.06 0.14
Side Arm Mount [SO 305-1]	B	From Leg	1.50 0.00 0.00	0.0000	122.00	No Ice 1/2" Ice 1" Ice 2" Ice	0.94 1.48 2.02 3.10	1.41 2.17 2.93 4.45	0.03 0.04 0.06 0.08
DB212-1	B	From Leg	3.00 0.00 0.00	0.0000	122.00	No Ice 1/2" Ice 1" Ice 2" Ice	4.50 8.10 11.70 18.90	4.50 8.10 11.70 18.90	0.03 0.04 0.05 0.07
Side Arm Mount [SO 308-1]	C	From Leg	3.00 0.00 0.00	0.0000	123.00	No Ice 1/2" Ice 1" Ice 2" Ice	0.98 1.70 2.42 3.86	3.03 5.22 7.41 11.79	0.05 0.08 0.10 0.16
DB222	C	From Leg	3.00 0.00 10.00	0.0000	122.00	No Ice 1/2" Ice 1" Ice 2" Ice	1.60 2.88 4.16 6.72	1.60 2.88 4.16 6.72	0.02 0.02 0.03 0.04
***									
Side Arm Mount [SO 305-1]	B	From Leg	3.00 0.00 0.00	0.0000	103.00	No Ice 1/2" Ice 1" Ice 2" Ice	0.53 0.78 1.06 1.73	1.52 2.07 2.66 3.91	0.03 0.04 0.06 0.13
Side Arm Mount [SO 305-1]	C	From Leg	3.00 0.00 0.00	0.0000	103.00	No Ice 1/2" Ice 1" Ice 2" Ice	0.53 0.78 1.06 1.73	1.52 2.07 2.66 3.91	0.03 0.04 0.06 0.13

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*
***									
Side Arm Mount [SO 308-1]	A	From Leg	3.00 0.00 0.00	0.0000	86.00	No Ice 1/2" Ice 1" Ice 2" Ice	0.98 1.70 2.42 3.86	3.03 5.22 7.41 11.79	0.05 0.08 0.10 0.16
220-3AN	A	From Leg	6.00 0.00 10.00	0.0000	86.00	No Ice 1/2" Ice 1" Ice 2" Ice	7.43 10.27 12.39 16.70	7.43 10.27 12.39 16.70	0.06 0.11 0.18 0.36
***									
Side Arm Mount [SO 308-1]	C	From Leg	3.00 0.00 0.00	0.0000	83.00	No Ice 1/2" Ice 1" Ice 2" Ice	0.98 1.70 2.42 3.86	3.03 5.22 7.41 11.79	0.05 0.08 0.10 0.16
Dipole	C	From Leg	6.00 0.00 1.50	0.0000	83.00	No Ice 1/2" Ice 1" Ice 2" Ice	1.60 2.88 4.16 6.72	1.60 2.88 4.16 6.72	0.02 0.02 0.03 0.04
***									
Pipe Mount [PM 601-1]	B	From Leg	0.50 0.00 0.00	0.0000	83.00	No Ice 1/2" Ice 1" Ice 2" Ice	3.00 3.74 4.48 5.96	0.90 1.12 1.34 1.78	0.07 0.08 0.09 0.12
***									
Side Arm Mount [SO 308-1]	B	From Leg	3.00 0.00 0.00	0.0000	65.00	No Ice 1/2" Ice 1" Ice 2" Ice	0.98 1.70 2.42 3.86	3.03 5.22 7.41 11.79	0.05 0.08 0.10 0.16
8"x8" Antenna	A	From Leg	0.00 0.00 0.00	0.0000	65.00	No Ice 1/2" Ice 1" Ice 2" Ice	0.67 0.77 0.88 1.13	0.33 0.41 0.50 0.70	0.01 0.02 0.02 0.04
6' x 3" Dia Omni	B	From Leg	3.00 0.00 3.00	0.0000	65.00	No Ice 1/2" Ice 1" Ice 2" Ice	1.77 2.13 2.50 3.27	1.77 2.13 2.50 3.27	0.02 0.03 0.05 0.10
***									
GPS-QBW-20N	C	From Leg	0.00 0.00 0.00	0.0000	24.00	No Ice 1/2" Ice 1" Ice 2" Ice	0.13 0.18 0.23 0.37	0.13 0.18 0.23 0.37	0.00 0.00 0.00 0.01
** Proposed									
R5-LL [PM 602-1]	A	From Leg	0.50 0.00 0.00	0.0000	170.00	No Ice 1/2" Ice 1" Ice 2" Ice	5.25 6.50 7.75 10.25	1.58 1.95 2.32 3.06	0.09 0.12 0.14 0.19
Tieback Assembly	A	From Face	0.00 0.00 0.00	0.0000	170.00	No Ice 1/2" Ice 1" Ice 2" Ice	2.38 3.41 4.45 5.91	0.01 0.05 0.10 0.24	0.04 0.05 0.08 0.15
DS2C00F36D-D w/ DCP18K Clamp Sets	C	From Leg	0.50 0.00 6.00	0.0000	177.00	No Ice 1/2" Ice 1" Ice	3.78 5.07 6.38 8.58	3.78 5.07 6.38 8.58	0.04 0.07 0.10 0.20

Description	*Face or Leg*	*Offset Type*	*Offsets: Horz Lateral Vert*	*Azimuth Adjustment*	*Placement*		*C_AA_A Front*	*C_AA_A Side*	*Weight*
			ft *ft* *ft*	*°*	*ft*		*ft^2*	*ft^2*	*K*
						2" Ice			
Pipe Mount [PM 601-1]	C	From Leg	0.50	0.0000	177.00	No Ice	1.32	1.32	0.07
			0.00			1/2"	1.58	1.58	0.08
			0.00			Ice	1.84	1.84	0.09
						1" Ice	2.40	2.40	0.13
						2" Ice			

Dishes

Description	*Face or Leg*	*Dish Type*	*Offset Type*	*Offsets: Horz Lateral Vert*	*Azimuth Adjustment*	*3 dB Beam Width*	*Elevation*	*Outside Diameter*		*Aperture Area*	*Weight*
				ft	*°*	*°*	*ft*	*ft*		*ft^2*	*K*
8' Dish	C	Paraboloid w/Radome	From Leg	1.00	30.0000		148.00	8.00	No Ice	50.27	0.10
				0.00					1/2" Ice	51.32	0.36
				0.00					1" Ice	52.37	0.63
									2" Ice	54.48	1.15
***											
2' Dish	B	Paraboloid w/Radome	From Leg	1.00	-50.0000		83.00	2.00	No Ice	3.14	0.07
				0.00					1/2" Ice	3.41	0.09
				0.00					1" Ice	3.68	0.11
									2" Ice	4.21	0.14
Proposed											
PAD6-59	A	Paraboloid w/Radome	From Leg	1.00	90.0000		170.00	6.00	No Ice	28.27	0.19
				0.00					1/2" Ice	29.07	0.33
				0.00					1" Ice	29.86	0.48
									2" Ice	31.44	0.78

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

Comb. No.	Description
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
41	Dead+Wind 60 deg - Service
42	Dead+Wind 90 deg - Service
43	Dead+Wind 120 deg - Service
44	Dead+Wind 150 deg - Service
45	Dead+Wind 180 deg - Service
46	Dead+Wind 210 deg - Service
47	Dead+Wind 240 deg - Service
48	Dead+Wind 270 deg - Service
49	Dead+Wind 300 deg - Service
50	Dead+Wind 330 deg - Service

Maximum Member Forces

Section No.	Elevation ft	Component Type	Condition	Gov. Load Comb.	Axial K	Major Axis Moment kip-ft	Minor Axis Moment kip-ft
T1	180 - 160	Leg	Max Tension	23	8.73	0.02	0.03
			Max. Compression	18	-10.62	0.18	-0.05
			Max. Mx	22	3.07	0.31	-0.10
			Max. My	21	-0.29	0.00	0.65
			Max. Vy	3	-0.27	0.15	0.10
			Max. Vx	20	-0.49	0.00	-0.29
		Diagonal	Max Tension	17	2.20	0.00	0.00
			Max. Compression	18	-2.31	0.00	0.00
			Max. Mx	38	0.25	0.03	-0.00
			Max. My	18	-2.15	0.00	-0.00
			Max. Vy	38	-0.03	0.03	-0.00
			Max. Vx	18	0.00	0.00	0.00
		Top Girt	Max Tension	19	0.01	0.00	0.00
			Max. Compression	27	-0.04	0.00	0.00
			Max. Mx	26	-0.04	-0.08	0.00
			Max. My	26	-0.04	0.00	0.00
			Max. Vy	26	0.05	0.00	0.00
			Max. Vx	26	-0.00	0.00	0.00
T2	160 - 140	Leg	Max Tension	23	24.61	-0.23	0.17
			Max. Compression	18	-30.00	0.16	-0.01
			Max. Mx	6	18.35	0.53	-0.00
			Max. My	10	8.14	-0.17	0.91
			Max. Vy	6	-0.48	-0.40	-0.00
			Max. Vx	12	-0.67	-0.03	-0.43
		Diagonal	Max Tension	16	3.61	0.00	0.00
			Max. Compression	16	-3.62	0.00	0.00
			Max. Mx	37	0.53	0.04	0.01
			Max. My	35	-0.80	0.04	-0.01
			Max. Vy	37	0.04	0.04	0.01
			Max. Vx	35	0.00	0.00	0.00
		Top Girt	Max Tension	11	0.07	0.00	0.00
			Max. Compression	6	-0.08	0.00	0.00
			Max. Mx	26	-0.01	-0.08	0.00
			Max. My	26	-0.01	0.00	0.00

Section No.	Elevation ft	Component Type	Condition	Gov. Load Comb.	Axial K	Major Axis Moment kip-ft	Minor Axis Moment kip-ft
			Max. Vy	26	0.05	0.00	0.00
			Max. Vx	26	-0.00	0.00	0.00
T3	140 - 120	Leg	Max Tension	7	43.63	-0.26	0.01
			Max. Compression	18	-52.61	0.47	-0.03
			Max. Mx	19	-51.72	0.47	-0.03
			Max. My	20	-2.82	-0.00	-0.43
			Max. Vy	22	0.21	-0.45	-0.03
			Max. Vx	20	0.22	-0.00	-0.43
		Diagonal	Max Tension	16	4.24	0.00	0.00
			Max. Compression	16	-4.28	0.00	0.00
			Max. Mx	37	0.66	0.08	-0.01
			Max. My	35	0.56	0.08	-0.01
			Max. Vy	37	0.06	0.08	-0.01
			Max. Vx	35	0.00	0.00	0.00
T4	120 - 100	Leg	Max Tension	7	64.48	-0.37	0.01
			Max. Compression	18	-76.81	0.39	0.00
			Max. Mx	19	-59.42	0.47	-0.03
			Max. My	16	-5.11	-0.01	0.48
			Max. Vy	11	0.11	0.47	0.03
			Max. Vx	17	-0.13	-0.01	0.48
		Diagonal	Max Tension	16	4.87	0.00	0.00
			Max. Compression	16	-4.89	0.00	0.00
			Max. Mx	29	0.79	0.13	0.02
			Max. My	35	-1.38	0.12	-0.02
			Max. Vy	29	0.09	0.13	0.02
			Max. Vx	35	0.00	0.00	0.00
T5	100 - 80	Leg	Max Tension	7	86.25	-0.55	-0.04
			Max. Compression	18	-103.10	1.38	-0.11
			Max. Mx	18	-103.10	1.38	-0.11
			Max. My	21	-4.37	0.01	-1.07
			Max. Vy	11	-0.29	1.38	0.07
			Max. Vx	9	0.37	-0.01	0.58
		Diagonal	Max Tension	16	5.98	0.00	0.00
			Max. Compression	16	-6.00	0.00	0.00
			Max. Mx	29	0.91	0.16	0.02
			Max. My	36	-0.63	0.14	-0.02
			Max. Vy	29	0.10	0.16	0.02
			Max. Vx	36	0.00	0.00	0.00
T6	80 - 60	Leg	Max Tension	7	106.55	-0.56	-0.00
			Max. Compression	18	-127.66	1.56	-0.07
			Max. Mx	18	-127.66	1.56	-0.07
			Max. My	21	-5.81	-0.01	-1.33
			Max. Vy	19	-0.27	1.55	-0.07
			Max. Vx	2	0.23	-0.74	-1.20
		Diagonal	Max Tension	16	6.83	0.00	0.00
			Max. Compression	16	-6.88	0.00	0.00
			Max. Mx	29	1.03	0.24	0.03
			Max. My	36	1.21	0.24	-0.03
			Max. Vy	29	0.12	0.24	0.03
			Max. Vx	36	0.01	0.00	0.00
T7	60 - 40	Leg	Max Tension	7	128.56	-1.28	0.04
			Max. Compression	18	-155.50	1.35	-0.03
			Max. Mx	29	9.00	-1.69	0.04
			Max. My	8	-11.62	-0.00	1.38
			Max. Vy	33	0.25	-1.68	0.01
			Max. Vx	20	0.21	-0.01	-1.37
		Diagonal	Max Tension	16	7.88	0.00	0.00
			Max. Compression	16	-7.95	0.00	0.00
			Max. Mx	29	1.29	0.34	0.04
			Max. My	36	-1.25	0.33	-0.05
			Max. Vy	29	0.16	0.34	0.04
			Max. Vx	36	0.01	0.00	0.00
T8	40 - 20	Leg	Max Tension	7	150.81	-1.33	0.03
			Max. Compression	18	-184.10	1.62	-0.02
			Max. Mx	29	9.30	-6.05	0.02
			Max. My	8	-12.94	-0.08	1.45
			Max. Vy	33	0.93	-6.02	0.01
			Max. Vx	8	0.23	-0.08	1.45
		Diagonal	Max Tension	16	8.52	0.00	0.00

Section No.	Elevation ft	Component Type	Condition	Gov. Load Comb.	Axial K	Major Axis Moment kip-ft	Minor Axis Moment kip-ft
			Max. Compression	16	-8.64	0.00	0.00
			Max. Mx	29	0.52	0.38	0.05
			Max. My	36	-0.24	0.36	-0.05
			Max. Vy	29	0.17	0.37	0.05
			Max. Vx	36	0.01	0.00	0.00
T9	20 - 0	Leg	Max Tension	7	172.67	-1.47	0.05
			Max. Compression	18	-212.52	0.00	0.00
			Max. Mx	27	-92.59	7.88	0.02
			Max. My	8	-16.17	-0.18	2.58
			Max. Vy	33	-1.38	-6.02	0.01
			Max. Vx	8	0.43	-0.18	2.58
		Diagonal	Max Tension	16	9.31	0.00	0.00
			Max. Compression	18	-9.77	0.00	0.00
			Max. Mx	29	-1.58	0.46	0.05
			Max. My	30	5.19	0.33	0.06
			Max. Vy	29	0.17	0.46	0.05
			Max. Vx	30	-0.01	0.00	0.00

Maximum Reactions

Location	Condition	Gov. Load Comb.	Vertical K	Horizontal, X K	Horizontal, Z K
Leg C	Max. Vert	18	219.62	22.97	-14.02
	Max. H_x	18	219.62	22.97	-14.02
	Max. H_z	7	-178.06	-19.24	11.72
	Min. Vert	7	-178.06	-19.24	11.72
	Min. H_x	7	-178.06	-19.24	11.72
	Min. H_z	18	219.62	22.97	-14.02
Leg B	Max. Vert	10	217.40	-22.71	-13.84
	Max. H_x	23	-172.62	18.68	11.51
	Max. H_z	23	-172.62	18.68	11.51
	Min. Vert	23	-172.62	18.68	11.51
	Min. H_x	10	217.40	-22.71	-13.84
	Min. H_z	10	217.40	-22.71	-13.84
Leg A	Max. Vert	2	212.82	0.21	26.18
	Max. H_x	20	16.01	4.21	1.36
	Max. H_z	2	212.82	0.21	26.18
	Min. Vert	15	-168.95	-0.14	-21.66
	Min. H_x	9	13.12	-4.17	1.10
	Min. H_z	15	-168.95	-0.14	-21.66

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	40.90	0.00	0.00	-4.74	-3.36	0.00
1.2 Dead+1.0 Wind 0 deg - No Ice	49.08	0.18	-42.56	-3939.70	-29.86	8.33
0.9 Dead+1.0 Wind 0 deg - No Ice	36.81	0.18	-42.56	-3938.27	-28.85	8.33
1.2 Dead+1.0 Wind 30 deg - No Ice	49.08	20.46	-35.41	-3319.17	-1915.43	-6.53
0.9 Dead+1.0 Wind 30 deg - No Ice	36.81	20.46	-35.41	-3317.75	-1914.42	-6.53
1.2 Dead+1.0 Wind 60 deg - No Ice	49.08	34.87	-20.34	-1937.98	-3290.26	-21.03
0.9 Dead+1.0 Wind 60 deg - No Ice	36.81	34.87	-20.34	-1936.56	-3289.25	-21.03
1.2 Dead+1.0 Wind 90 deg -	49.08	41.02	-0.07	-18.41	-3862.13	-30.46

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
No Ice						
0.9 Dead+1.0 Wind 90 deg - No Ice	36.81	41.02	-0.07	-16.99	-3861.12	-30.46
1.2 Dead+1.0 Wind 120 deg - No Ice	49.08	37.36	21.69	2024.56	-3486.45	-24.97
0.9 Dead+1.0 Wind 120 deg - No Ice	36.81	37.36	21.69	2025.98	-3485.44	-24.97
1.2 Dead+1.0 Wind 150 deg - No Ice	49.08	19.61	34.11	3190.58	-1831.60	-14.78
0.9 Dead+1.0 Wind 150 deg - No Ice	36.81	19.61	34.11	3192.00	-1830.59	-14.78
1.2 Dead+1.0 Wind 180 deg - No Ice	49.08	0.03	38.97	3632.74	-3.61	-5.39
0.9 Dead+1.0 Wind 180 deg - No Ice	36.81	0.03	38.97	3634.16	-2.60	-5.39
1.2 Dead+1.0 Wind 210 deg - No Ice	49.08	-20.25	35.31	3294.57	1882.93	11.57
0.9 Dead+1.0 Wind 210 deg - No Ice	36.81	-20.25	35.31	3295.99	1883.94	11.57
1.2 Dead+1.0 Wind 240 deg - No Ice	49.08	-37.81	22.03	2061.80	3516.45	26.27
0.9 Dead+1.0 Wind 240 deg - No Ice	36.81	-37.81	22.03	2063.22	3517.46	26.27
1.2 Dead+1.0 Wind 270 deg - No Ice	49.08	-40.90	0.07	7.12	3838.55	32.35
0.9 Dead+1.0 Wind 270 deg - No Ice	36.81	-40.90	0.07	8.54	3839.56	32.35
1.2 Dead+1.0 Wind 300 deg - No Ice	49.08	-34.05	-19.78	-1874.37	3199.07	25.29
0.9 Dead+1.0 Wind 300 deg - No Ice	36.81	-34.05	-19.78	-1872.95	3200.08	25.29
1.2 Dead+1.0 Wind 330 deg - No Ice	49.08	-19.42	-33.97	-3185.91	1799.87	15.34
0.9 Dead+1.0 Wind 330 deg - No Ice	36.81	-19.42	-33.97	-3184.49	1800.88	15.34
1.2 Dead+1.0 Ice+1.0 Temp	120.07	0.00	-0.00	-79.78	-25.10	0.00
1.2 Dead+1.0 Wind 0 deg+1.0 Ice+1.0 Temp	120.07	0.02	-10.26	-1065.99	-28.53	3.81
1.2 Dead+1.0 Wind 30 deg+1.0 Ice+1.0 Temp	120.07	5.07	-8.84	-933.62	-513.48	-2.95
1.2 Dead+1.0 Wind 60 deg+1.0 Ice+1.0 Temp	120.07	8.80	-5.13	-579.06	-874.14	-9.80
1.2 Dead+1.0 Wind 90 deg+1.0 Ice+1.0 Temp	120.07	10.14	-0.01	-81.63	-1003.68	-12.85
1.2 Dead+1.0 Wind 120 deg+1.0 Ice+1.0 Temp	120.07	8.86	5.16	418.86	-876.91	-11.47
1.2 Dead+1.0 Wind 150 deg+1.0 Ice+1.0 Temp	120.07	4.92	8.59	751.88	-498.31	-8.20
1.2 Dead+1.0 Wind 180 deg+1.0 Ice+1.0 Temp	120.07	0.00	9.90	877.65	-24.69	-3.43
1.2 Dead+1.0 Wind 210 deg+1.0 Ice+1.0 Temp	120.07	-5.05	8.82	772.54	460.37	3.59
1.2 Dead+1.0 Wind 240 deg+1.0 Ice+1.0 Temp	120.07	-9.09	5.30	432.41	846.34	10.48
1.2 Dead+1.0 Wind 270 deg+1.0 Ice+1.0 Temp	120.07	-10.13	0.01	-77.91	951.67	13.10
1.2 Dead+1.0 Wind 300 deg+1.0 Ice+1.0 Temp	120.07	-8.52	-4.96	-562.36	799.00	11.51
1.2 Dead+1.0 Wind 330 deg+1.0 Ice+1.0 Temp	120.07	-4.90	-8.57	-909.47	445.31	8.27
Dead+Wind 0 deg - Service	40.90	0.03	-7.29	-678.34	-7.79	1.43
Dead+Wind 30 deg - Service	40.90	3.50	-6.06	-572.09	-330.64	-1.12
Dead+Wind 60 deg - Service	40.90	5.97	-3.48	-335.60	-566.05	-3.60
Dead+Wind 90 deg - Service	40.90	7.02	-0.01	-6.92	-663.97	-5.21
Dead+Wind 120 deg - Service	40.90	6.40	3.71	342.89	-599.64	-4.28
Dead+Wind 150 deg - Service	40.90	3.36	5.84	542.54	-316.29	-2.53
Dead+Wind 180 deg -	40.90	0.01	6.67	618.25	-3.29	-0.92

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
Service						
Dead+Wind 210 deg - Service	40.90	-3.47	6.05	560.35	319.73	1.98
Dead+Wind 240 deg - Service	40.90	-6.47	3.77	349.26	599.43	4.50
Dead+Wind 270 deg - Service	40.90	-7.00	0.01	-2.55	654.58	5.54
Dead+Wind 300 deg - Service	40.90	-5.83	-3.39	-324.70	545.09	4.33
Dead+Wind 330 deg - Service	40.90	-3.32	-5.82	-549.27	305.51	2.63

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	-40.90	0.00	0.00	40.90	0.00	0.000%
2	0.18	-49.08	-42.56	-0.18	49.08	42.56	0.000%
3	0.18	-36.81	-42.56	-0.18	36.81	42.56	0.000%
4	20.46	-49.08	-35.41	-20.46	49.08	35.41	0.000%
5	20.46	-36.81	-35.41	-20.46	36.81	35.41	0.000%
6	34.87	-49.08	-20.34	-34.87	49.08	20.34	0.000%
7	34.87	-36.81	-20.34	-34.87	36.81	20.34	0.000%
8	41.02	-49.08	-0.07	-41.02	49.08	0.07	0.000%
9	41.02	-36.81	-0.07	-41.02	36.81	0.07	0.000%
10	37.36	-49.08	21.69	-37.36	49.08	-21.69	0.000%
11	37.36	-36.81	21.69	-37.36	36.81	-21.69	0.000%
12	19.61	-49.08	34.11	-19.61	49.08	-34.11	0.000%
13	19.61	-36.81	34.11	-19.61	36.81	-34.11	0.000%
14	0.03	-49.08	38.97	-0.03	49.08	-38.97	0.000%
15	0.03	-36.81	38.97	-0.03	36.81	-38.97	0.000%
16	-20.25	-49.08	35.31	20.25	49.08	-35.31	0.000%
17	-20.25	-36.81	35.31	20.25	36.81	-35.31	0.000%
18	-37.81	-49.08	22.03	37.81	49.08	-22.03	0.000%
19	-37.81	-36.81	22.03	37.81	36.81	-22.03	0.000%
20	-40.90	-49.08	0.07	40.90	49.08	-0.07	0.000%
21	-40.90	-36.81	0.07	40.90	36.81	-0.07	0.000%
22	-34.05	-49.08	-19.78	34.05	49.08	19.78	0.000%
23	-34.05	-36.81	-19.78	34.05	36.81	19.78	0.000%
24	-19.42	-49.08	-33.97	19.42	49.08	33.97	0.000%
25	-19.42	-36.81	-33.97	19.42	36.81	33.97	0.000%
26	0.00	-120.07	0.00	-0.00	120.07	0.00	0.000%
27	0.02	-120.07	-10.26	-0.02	120.07	10.26	0.000%
28	5.07	-120.07	-8.84	-5.07	120.07	8.84	0.000%
29	8.80	-120.07	-5.13	-8.80	120.07	5.13	0.000%
30	10.14	-120.07	-0.01	-10.14	120.07	0.01	0.000%
31	8.86	-120.07	5.16	-8.86	120.07	-5.16	0.000%
32	4.92	-120.07	8.59	-4.92	120.07	-8.59	0.000%
33	0.00	-120.07	9.90	-0.00	120.07	-9.90	0.000%
34	-5.05	-120.07	8.82	5.05	120.07	-8.82	0.000%
35	-9.09	-120.07	5.30	9.09	120.07	-5.30	0.000%
36	-10.13	-120.07	0.01	10.13	120.07	-0.01	0.000%
37	-8.52	-120.07	-4.96	8.52	120.07	4.96	0.000%
38	-4.90	-120.07	-8.57	4.90	120.07	8.57	0.000%
39	0.03	-40.90	-7.29	-0.03	40.90	7.29	0.000%
40	3.50	-40.90	-6.06	-3.50	40.90	6.06	0.000%
41	5.97	-40.90	-3.48	-5.97	40.90	3.48	0.000%
42	7.02	-40.90	-0.01	-7.02	40.90	0.01	0.000%
43	6.40	-40.90	3.71	-6.40	40.90	-3.71	0.000%
44	3.36	-40.90	5.84	-3.36	40.90	-5.84	0.000%
45	0.01	-40.90	6.67	-0.01	40.90	-6.67	0.000%
46	-3.47	-40.90	6.05	3.47	40.90	-6.05	0.000%
47	-6.47	-40.90	3.77	6.47	40.90	-3.77	0.000%
48	-7.00	-40.90	0.01	7.00	40.90	-0.01	0.000%
49	-5.83	-40.90	-3.39	5.83	40.90	3.39	0.000%

	Sum of Applied Forces			Sum of Reactions			
Load Comb.	PX K	PY K	PZ K	PX K	PY K	PZ K	% Error
50	-3.32	-40.90	-5.82	3.32	40.90	5.82	0.000%

Maximum Tower Deflections - Service Wind

Section No.	Elevation ft	Horz. Deflection in	Gov. Load Comb.	Tilt °	Twist °
T1	180 - 160	1.142	47	0.0552	0.0165
T2	160 - 140	0.910	47	0.0512	0.0125
T3	140 - 120	0.699	47	0.0448	0.0086
T4	120 - 100	0.517	47	0.0370	0.0065
T5	100 - 80	0.366	47	0.0299	0.0051
T6	80 - 60	0.242	47	0.0229	0.0040
T7	60 - 40	0.146	47	0.0168	0.0028
T8	40 - 20	0.076	47	0.0115	0.0019
T9	20 - 0	0.026	47	0.0059	0.0010

Critical Deflections and Radius of Curvature - Service Wind

Elevation ft	Appurtenance	Gov. Load Comb.	Deflection in	Tilt °	Twist °	Radius of Curvature ft
178.00	12"x12"x6" Junction Box	47	1.119	0.0549	0.0161	788794
177.00	DS2C00F36D-D w/ DCP18K Clamp Sets	47	1.107	0.0547	0.0159	788794
170.00	PAD6-59	47	1.025	0.0534	0.0145	394392
168.00	Side Arm Mount [SO 308-1]	47	1.002	0.0530	0.0141	328660
163.00	Side Arm Mount [SO 305-1]	47	0.944	0.0520	0.0131	232619
157.00	8' Horizontal HSS4x4x1/4	47	0.877	0.0504	0.0118	193425
156.00	8' Horizontal HSS4x4x1/4	47	0.866	0.0501	0.0116	191686
155.00	6'x4" Mount Pipe	47	0.855	0.0499	0.0114	190291
152.00	Side Arm Mount [SO 308-1]	47	0.823	0.0489	0.0108	184523
151.00	8' Horizontal HSS4x4x1/4	47	0.812	0.0486	0.0106	182104
148.00	8' Dish	47	0.780	0.0476	0.0100	175212
144.00	Side Arm Mount [SO 308-1]	47	0.739	0.0462	0.0092	166803
130.00	BNF800S-06	47	0.604	0.0409	0.0074	152064
123.00	Side Arm Mount [SO 308-1]	47	0.542	0.0382	0.0068	147621
122.00	CO-36A	47	0.534	0.0378	0.0067	147346
103.00	Side Arm Mount [SO 305-1]	47	0.387	0.0310	0.0053	194418
86.00	Side Arm Mount [SO 308-1]	47	0.276	0.0249	0.0044	166504
83.00	2' Dish	47	0.258	0.0239	0.0042	159973
65.00	Side Arm Mount [SO 308-1]	47	0.167	0.0182	0.0031	175330
24.00	GPS-QBW-20N	47	0.034	0.0071	0.0012	176357

Maximum Tower Deflections - Design Wind

Section No.	Elevation ft	Horz. Deflection in	Gov. Load Comb.	Tilt °	Twist °
T1	180 - 160	6.663	18	0.3181	0.0962
T2	160 - 140	5.320	19	0.2977	0.0729
T3	140 - 120	4.091	19	0.2608	0.0500
T4	120 - 100	3.031	19	0.2163	0.0382
T5	100 - 80	2.148	19	0.1751	0.0300
T6	80 - 60	1.416	19	0.1341	0.0234
T7	60 - 40	0.855	19	0.0986	0.0164

Section No.	Elevation ft	Horz. Deflection in	Gov. Load Comb.	Tilt °	Twist °
T8	40 - 20	0.443	19	0.0678	0.0113
T9	20 - 0	0.155	19	0.0347	0.0058

Critical Deflections and Radius of Curvature - Design Wind

Elevation ft	Appurtenance	Gov. Load Comb.	Deflection in	Tilt °	Twist °	Radius of Curvature ft
178.00	12"x12"x6" Junction Box	18	6.527	0.3165	0.0939	150343
177.00	DS2C00F36D-D w/ DCP18K Clamp Sets	18	6.458	0.3156	0.0928	150343
170.00	PAD6-59	18	5.984	0.3094	0.0848	75172
168.00	Side Arm Mount [SO 308-1]	18	5.849	0.3074	0.0824	62643
163.00	Side Arm Mount [SO 305-1]	19	5.517	0.3017	0.0765	44322
157.00	8' Horizontal HSS4x4x1/4	19	5.127	0.2933	0.0691	36079
156.00	8' Horizontal HSS4x4x1/4	19	5.063	0.2917	0.0679	35373
155.00	6'x4" Mount Pipe	19	4.999	0.2900	0.0667	34733
152.00	Side Arm Mount [SO 308-1]	19	4.811	0.2848	0.0630	32961
151.00	8' Horizontal HSS4x4x1/4	19	4.749	0.2830	0.0618	32410
148.00	8' Dish	19	4.565	0.2773	0.0582	30863
144.00	Side Arm Mount [SO 308-1]	19	4.325	0.2693	0.0538	29017
130.00	BNF800S-06	19	3.538	0.2385	0.0429	26386
123.00	Side Arm Mount [SO 308-1]	19	3.178	0.2229	0.0395	25759
122.00	CO-36A	19	3.129	0.2207	0.0390	25727
103.00	Side Arm Mount [SO 305-1]	19	2.271	0.1812	0.0311	33576
86.00	Side Arm Mount [SO 308-1]	19	1.619	0.1461	0.0255	28524
83.00	2' Dish	19	1.516	0.1401	0.0245	27382
65.00	Side Arm Mount [SO 308-1]	19	0.980	0.1068	0.0180	29917
24.00	GPS-QBW-20N	19	0.201	0.0416	0.0069	29967

Bolt Design Data

Section No.	Elevation ft	Component Type	Bolt Grade	Bolt Size in	Number Of Bolts	Maximum Load per Bolt K	Allowable Load per Bolt K	Ratio Load / Allowable	Allowable Ratio	Criteria
T1	180	Leg	A325N	0.8750	4	2.18	41.56	0.053	1.05	Bolt Tension
		Diagonal	A325N	0.6250	1	2.20	6.83	0.322	1.05	Member Block Shear
		Top Girt	A325N	0.6250	1	0.04	8.70	0.005	1.05	Member Bearing
T2	160	Leg	A325N	1.0000	4	6.15	54.52	0.113	1.05	Bolt Tension
		Diagonal	A325N	0.6250	1	3.61	10.44	0.346	1.05	Member Bearing
		Top Girt	A325N	0.6250	1	0.07	5.22	0.014	1.05	Member Bearing
T3	140	Leg	A325N	1.0000	6	7.27	54.52	0.133	1.05	Bolt Tension
		Diagonal	A325N	0.7500	1	4.24	12.62	0.336	1.05	Member Bearing
T4	120	Leg	A325N	1.0000	8	8.06	54.52	0.148	1.05	Bolt Tension
		Diagonal	A325N	0.7500	1	4.87	14.14	0.344	1.05	Member Bearing
T5	100	Leg	A325N	1.0000	8	10.78	54.52	0.198	1.05	Bolt Tension
		Diagonal	A325N	0.7500	1	5.98	14.14	0.423	1.05	Member Bearing
T6	80	Leg	A325N	1.0000	12	8.88	54.52	0.163	1.05	Bolt Tension
		Diagonal	A325N	0.7500	1	6.83	14.14	0.483	1.05	Member Bearing
T7	60	Leg	A325N	1.0000	12	10.71	54.52	0.197	1.05	Bolt Tension
		Diagonal	A325N	0.7500	1	7.88	17.67	0.446	1.05	Member Bearing

Section No.	Elevation ft	Component Type	Bolt Grade	Bolt Size in	Number Of Bolts	Maximum Load per Bolt K	Allowable Load per Bolt K	Ratio Load / Allowable	Allowable Ratio	Criteria
T8	40	Leg	A325N	1.0000	12	12.57	54.52	0.231	1.05	Bolt Tension
		Diagonal	A325N	0.7500	1	8.52	17.67	0.482	1.05	Member Bearing
T9	20	Diagonal	A325N	0.7500	1	9.31	17.67	0.527	1.05	Member Bearing

Compression Checks

Leg Design Data (Compression)

Section No.	Elevation ft	Size	L ft	L_u ft	Kl/r	A in^2	P_u K	ϕP_n K	Ratio $\frac{P_u}{\phi P_n}$
T1	180 - 160	ROHN 3 STD	20.00	4.00	41.3 K=1.00	2.2285	-10.62	88.55	0.120 [1]
T2	160 - 140	ROHN 4 EH	20.04	5.01	40.7 K=1.00	4.4074	-30.00	175.71	0.171 [1]
T3	140 - 120	ROHN 5 EH	20.04	6.68	43.6 K=1.00	6.1120	-52.61	239.38	0.220 [1]
T4	120 - 100	ROHN 6 EH	20.04	6.68	36.5 K=1.00	8.4049	-76.81	343.08	0.224 [1]
T5	100 - 80	ROHN 8 EHS	20.03	6.68	27.0 K=1.00	9.8666	-103.10	420.89	0.245 [1]
T6	80 - 60	ROHN 8 EH	20.04	10.02	41.8 K=1.00	12.762 7	-127.66	505.52	0.253 [1]
T7	60 - 40	ROHN 10 EH	20.03	10.02	33.1 K=1.00	16.100 7	-155.50	668.66	0.233 [1]
T8	40 - 20	ROHN 10 EH	20.03	10.02	33.1 K=1.00	16.100 7	-184.10	668.66	0.275 [1]
T9	20 - 0	ROHN 10 EH	20.03	10.02	33.1 K=1.00	16.100 7	-212.52	668.66	0.318 [1]

[1] P_u / ϕP_n controls

Diagonal Design Data (Compression)

Section No.	Elevation ft	Size	L ft	L_u ft	Kl/r	A in^2	P_u K	ϕP_n K	Ratio $\frac{P_u}{\phi P_n}$
T1	180 - 160	L1 3/4x1 3/4x3/16	7.85	3.64	127.2 K=1.00	0.6211	-2.31	10.99	0.210 [1]
T2	160 - 140	L2x2x1/4	9.93	4.78	146.6 K=1.00	0.9380	-3.62	12.49	0.289 [1]
T3	140 - 120	L2 1/2x2 1/2x1/4	12.50	6.04	147.7 K=1.00	1.1900	-4.28	15.61	0.275 [1]
T4	120 - 100	L3x3x1/4	14.34	6.92	140.4 K=1.00	1.4400	-4.89	20.92	0.234 [1]
T5	100 - 80	L3x3x1/4	16.11	7.70	156.0 K=1.00	1.4400	-6.00	16.93	0.354 [1]
T6	80 - 60	L3 1/2x3 1/2x1/4	19.39	9.45	163.5 K=1.00	1.6900	-6.88	18.10	0.380 [1]
T7	60 - 40	L4x4x5/16	21.17	10.23	155.1 K=1.00	2.4000	-7.95	28.55	0.278 [1]
T8	40 - 20	L4x4x5/16	22.95	11.12	168.7 K=1.00	2.4000	-8.64	24.14	0.358 [1]
T9	20 - 0	L4x4x5/16	24.77	12.03	182.5	2.4000	-9.77	20.62	0.474 [1]

Section No.	Elevation ft	Size	L ft	L_u ft	Kl/r	A in^2	P_u K	ϕP_n K	Ratio $\frac{P_u}{\phi P_n}$
					K=1.00				

[1] P_u / ϕP_n controls

Top Girt Design Data (Compression)

Section No.	Elevation ft	Size	L ft	L_u ft	Kl/r	A in^2	P_u K	ϕP_n K	Ratio $\frac{P_u}{\phi P_n}$
T1	180 - 160	L2x2x1/8	6.69	6.16	185.8 K=1.00	0.4844	-0.04	4.01	0.011 [1]
T2	160 - 140	L2x2x1/8	6.76	6.15	185.5 K=1.00	0.4844	-0.08	4.03	0.020 [1]

[1] P_u / ϕP_n controls

Tension Checks

Leg Design Data (Tension)

Section No.	Elevation ft	Size	L ft	L_u ft	Kl/r	A in^2	P_u K	ϕP_n K	Ratio $\frac{P_u}{\phi P_n}$
T1	180 - 160	ROHN 3 STD	20.00	4.00	41.3	2.2285	8.73	100.28	0.087 [1]
T2	160 - 140	ROHN 4 EH	20.04	5.01	40.7	4.4074	24.61	198.34	0.124 [1]
T3	140 - 120	ROHN 5 EH	20.04	6.68	43.6	6.1120	43.63	275.04	0.159 [1]
T4	120 - 100	ROHN 6 EH	20.04	6.68	36.5	8.4049	64.48	378.22	0.170 [1]
T5	100 - 80	ROHN 8 EHS	20.03	6.68	27.0	9.8666	86.25	444.00	0.194 [1]
T6	80 - 60	ROHN 8 EH	20.04	10.02	41.8	12.762 7	106.55	574.32	0.186 [1]
T7	60 - 40	ROHN 10 EH	20.03	10.02	33.1	16.100 7	128.56	724.53	0.177 [1]
T8	40 - 20	ROHN 10 EH	20.03	10.02	33.1	16.100 7	150.81	724.53	0.208 [1]
T9	20 - 0	ROHN 10 EH	20.03	10.02	33.1	16.100 7	172.67	724.53	0.238 [1]

[1] P_u / ϕP_n controls

Diagonal Design Data (Tension)

Section No.	Elevation ft	Size	L ft	L_u ft	Kl/r	A in^2	P_u K	ϕP_n K	Ratio $\frac{P_u}{\phi P_n}$
T1	180 - 160	L1 3/4x1 3/4x3/16	7.85	3.64	84.0	0.3604	2.20	15.68	0.140 [1]
T2	160 - 140	L2x2x1/4	9.93	4.78	96.5	0.5629	3.61	24.49	0.148 [1]
T3	140 - 120	L2 1/2x2 1/2x1/4	12.50	6.04	96.4	0.7284	4.24	31.69	0.134 [1]
T4	120 - 100	L3x3x1/4	14.34	6.92	91.1	0.9159	4.87	44.65	0.109 [1]
T5	100 - 80	L3x3x1/4	16.11	7.70	101.1	0.9159	5.98	44.65	0.134 [1]
T6	80 - 60	L3 1/2x3 1/2x1/4	19.39	9.45	105.6	1.1034	6.83	53.79	0.127 [1]
T7	60 - 40	L4x4x5/16	21.17	10.23	100.3	1.5949	7.88	77.75	0.101 [1]
T8	40 - 20	L4x4x5/16	22.95	11.12	108.9	1.5949	8.52	77.75	0.110 [1]
T9	20 - 0	L4x4x5/16	24.77	12.03	117.7	1.5949	9.31	77.75	0.120 [1]

Section No.	Elevation ft	Size	L ft	L_u ft	Kl/r	A in^2	P_u K	ϕP_n K	Ratio $\frac{P_u}{\phi P_n}$

[1] P_u / ϕP_n controls

Top Girt Design Data (Tension)

Section No.	Elevation ft	Size	L ft	L_u ft	Kl/r	A in^2	P_u K	ϕP_n K	Ratio $\frac{P_u}{\phi P_n}$
T1	180 - 160	L2x2x1/8	6.69	6.16	122.6	0.2930	0.01	12.74	0.000 [1]
T2	160 - 140	L2x2x1/8	6.76	6.15	122.4	0.2930	0.07	12.74	0.006 [1]

[1] P_u / ϕP_n controls

Section Capacity Table

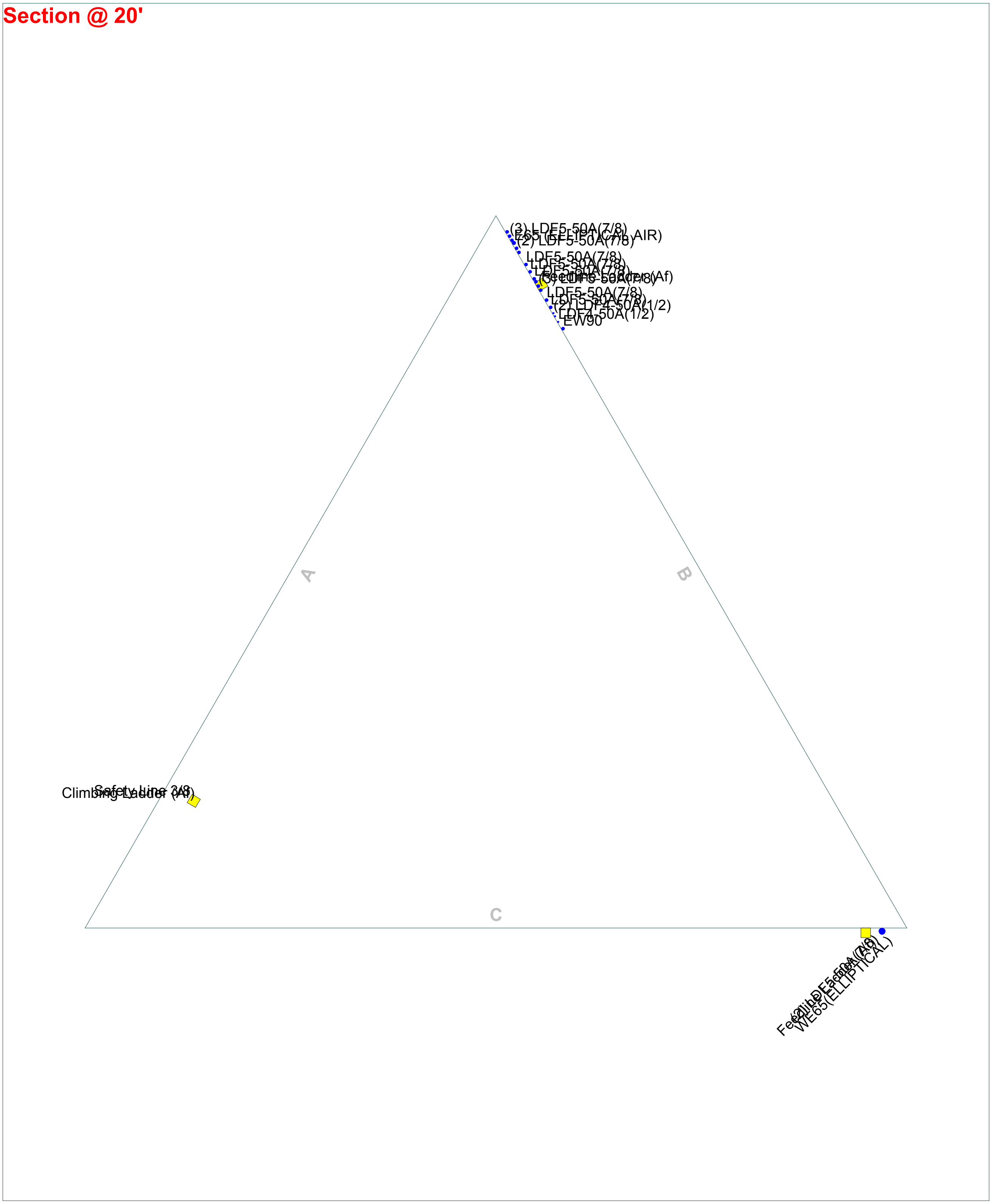
Section No.	Elevation ft	Component Type	Size	Critical Element	P K	$øP_{allow}$ K	% Capacity	Pass Fail
T1	180 - 160	Leg	ROHN 3 STD	1	-10.62	92.98	11.4	Pass
T2	160 - 140	Leg	ROHN 4 EH	37	-30.00	184.49	16.3	Pass
T3	140 - 120	Leg	ROHN 5 EH	67	-52.61	251.35	20.9	Pass
T4	120 - 100	Leg	ROHN 6 EH	88	-76.81	360.24	21.3	Pass
T5	100 - 80	Leg	ROHN 8 EHS	109	-103.10	441.94	23.3	Pass
T6	80 - 60	Leg	ROHN 8 EH	130	-127.66	530.80	24.1	Pass
T7	60 - 40	Leg	ROHN 10 EH	145	-155.50	702.09	22.1	Pass
T8	40 - 20	Leg	ROHN 10 EH	160	-184.10	702.09	26.2	Pass
T9	20 - 0	Leg	ROHN 10 EH	175	-212.52	702.09	30.3	Pass
T1	180 - 160	Diagonal	L1 3/4x1 3/4x3/16	12	-2.31	11.54	20.0 30.7 (b)	Pass
T2	160 - 140	Diagonal	L2x2x1/4	48	-3.62	13.12	27.6 33.0 (b)	Pass
T3	140 - 120	Diagonal	L2 1/2x2 1/2x1/4	75	-4.28	16.39	26.1 32.0 (b)	Pass
T4	120 - 100	Diagonal	L3x3x1/4	96	-4.89	21.97	22.3 32.8 (b)	Pass
T5	100 - 80	Diagonal	L3x3x1/4	117	-6.00	17.78	33.8 40.3 (b)	Pass
T6	80 - 60	Diagonal	L3 1/2x3 1/2x1/4	138	-6.88	19.01	36.2 46.0 (b)	Pass
T7	60 - 40	Diagonal	L4x4x5/16	153	-7.95	29.97	26.5 42.5 (b)	Pass
T8	40 - 20	Diagonal	L4x4x5/16	168	-8.64	25.34	34.1 45.9 (b)	Pass
T9	20 - 0	Diagonal	L4x4x5/16	183	-9.77	21.65	45.1 50.2 (b)	Pass
T1	180 - 160	Top Girt	L2x2x1/8	4	-0.04	4.22	1.1	Pass
T2	160 - 140	Top Girt	L2x2x1/8	41	-0.08	4.23	1.9	Pass
							Summary	
						Leg (T9)	30.3	Pass
						Diagonal (T9)	50.2	Pass
						Top Girt (T2)	1.9	Pass
						Bolt Checks	50.2	Pass
						RATING =	**50.2**	**Pass**

APPENDIX B

BASE LEVEL DRAWING

Feed Line Plan
20'

Round Flat App In Face App Out Face



Black & Veatch Corp. 6800 W. 115th St., Suite 2292 Overland Park, KS 66211 Phone: FAX:	Job: ES-022 ChapelHill RS		
	Project: 403093 (ChapelHill RS)		
	Client:	Drawn by: TH	App'd:
	Code: TIA-222-H	Date: 07/29/20	Scale: NTS
	Path: C:\Users\hai92311\OneDrive - Black & Veatch\My Desktop\Structural\ChapelHillRS.eri		Dwg No. E-7

APPENDIX C

ADDITIONAL CALCULATION

References

ANCHOR ROD ANALYSIS

Project Information

Site Name:ES-022 ChapelHillRS

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

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

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

Max Leg Reactions

Compression	*Uplift*
$Axial\_C := 220 \cdot kip$	$Axial\_U := 178 \cdot kip$
$Shear\_C := 27 \cdot kip$	$Shear\_U := 23 \cdot kip$

Anchor Rod Data

Diameter of Anchor Rod: $D := 1.0 \cdot in$

Number of Anchor Rods: $N := 12$

Length from top of concrete to bottom of anchor rod leveling nut: $lar := 1.0 \cdot in$

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

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

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

Consider Base Plate Grout? Yes / No (selected: No)

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

Threads per Inch: $n = 8$ (Thread selection invalid if n = 0)

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

Rod Yield Strength: $Fy = 105 \cdot ksi$

Anchor Rod Plastic Section Modulus: (based on tension root diameter)
$$Z := \frac{1}{6} \cdot \left(D - \frac{0.9743in}{n}\right)^3 = 0.113 \cdot in^3$$

Radius of Gyration:
$$r := \left(\frac{1}{4}\right) \cdot \left(D - \frac{0.9743in}{n}\right) = 0.22 \cdot in$$

Net Area of Anchor Rod:
$$An := \frac{\pi}{4} \cdot \left(D - \frac{0.9743in}{n}\right)^2 = 0.606 \cdot in^2$$
TIA-222-G/H Section 4.9.6.1

Nominal Unthreaded Area of Anchor Rod:
$$Ab := \frac{\pi}{4} \cdot (D)^2 = 0.785 \cdot in^2$$

Anchor Rod Design Capacities

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

$Rnt := Fu \cdot An = 75.718 \cdot kip$

$\phi t = 0.75$

$\phi Rnt := \phi t \cdot Rnt = 56.788 \cdot kip$

Design Compression Strength:

$Rnc := Fy \cdot An = 63.603 \cdot kip$

$\phi c = 1$

$\phi Rnc := \phi c \cdot Rnc = 63.603 \cdot kip$

Design Buckling Strength: TIA-222-H Section 4.5.4.2

$K_0 := 1.2$

$Fcr = 104.519 \cdot ksi$

$Fe = 9.581 \times 10^3 \cdot ksi$

$Rnb := Fcr \cdot An = 63.312 \cdot kip$

$\phi c = 1$

$\phi Rnb := \phi c \cdot Rnb = 63.312 \cdot kip$

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

$$Rnv := \begin{cases} 0.55 \cdot Fu \cdot Ab & \text{if } Thread\_Type = \text{"No"} \wedge TIA = \text{"Rev-G"} \\ 0.45 \cdot Fu \cdot Ab & \text{if } Thread\_Type = \text{"Yes"} \wedge TIA = \text{"Rev-G"} \\ 0.625 \cdot Fu \cdot Ab & \text{if } Thread\_Type = \text{"No"} \wedge TIA = \text{"Rev-H"} \\ 0.5 \cdot Fu \cdot Ab & \text{if } Thread\_Type = \text{"Yes"} \wedge TIA = \text{"Rev-H"} \end{cases}$$

$Rnv = 49.087 \cdot kip$

$Rnvc := 0.6 \cdot Fy \cdot 0.5 \cdot An = 19.081 \cdot kip$ TIA-222-H Section 4.9.9

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

$\phi Rnv := \phi v \cdot Rnv = 36.816 \cdot kip$ $\phi Rnvc := \phi c \cdot Rnvc = 19.081 \cdot kip$

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

$Rmn := Fy \cdot Z = 11.853 \cdot kip \cdot in$

$\phi f = 0.9$

$\phi Rmn := \phi f \cdot Rmn = 10.668 \cdot kip \cdot in$

Anchor Rod Loading Demands

Tension Demand:

$$Put := \frac{Axial\_U}{N} = 14.833 \cdot kip$$

Compression Demand:

$$Puc := \frac{Axial\_C}{N} = 18.333 \cdot kip$$

Shear Demand:

$$Vut := \frac{Shear\_U}{N} = 1.917 \cdot kip$$

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

Moment Demand:

$$Mut := 0.65 \cdot lar \cdot Vut = 1.246 \cdot kip \cdot in$$

$$Muc := 0.65 \cdot lar \cdot Vuc = 1.463 \cdot kip \cdot in$$

Anchor Rod Interaction Check

TIA-222-G Section 4.9.9

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

$$SR\_g = 0.402$$

Anchor Rod Interaction Check

TIA-222-H Section 4.9.9

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

$SR\_Pt = 0.071$

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

$SR\_Pc = 0.302$

$$SR := \begin{cases} SR\_g & \text{if } TIA = \text{"Rev-G"} \\ \max(SR\_Pt, SR\_Pc) & \text{if } TIA = \text{"Rev-H"} \wedge S15 = \text{"No"} \\ \frac{\max(SR\_Pt, SR\_Pc)}{1.05} & \text{if } TIA = \text{"Rev-H"} \wedge S15 = \text{"Yes"} \end{cases} = 0.288$$

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

Anchor Rod Results

Axial Tension Demand:	$Put = 14.833 \cdot kip$
Axial Tension Capacity:	$\phi Rnt = 56.788 \cdot kip$
Axial Compression Demand:	$Puc = 18.333 \cdot kip$
Axial Compression Capacity:	$\phi Rnc = 63.603 \cdot kip$
Shear Tension Demand:	$Vut = 1.917 \cdot kip$
Tension Shear Capacity:	$\phi Rnv = 36.816 \cdot kip$
Shear Compression Demand:	$Vuc = 2.25 \cdot kip$
Compresison Shear Capacity:	$\phi R_{nvc} = 19.081 \cdot kip$
Moment Tension Demand:	M_{ut} = "Moment Not Considered" $\cdot kip \cdot in$
Moment Compression Demand:	M_{uc} = "Moment Not Considered" $\cdot kip \cdot in$
Moment Capacity:	ϕR_{mn} = "Moment Not Considered" $\cdot kip \cdot in$

Governing Stress Ratio

$SR = 28.776 \cdot \%$

$Check_{SR}$ = "Passing"

SST Unit Base Foundation

ES-022
ChapelHillRS

TIA-222 Revision: H

Top & Bot. Pad Rein. Different?:	☐
Tower Centroid Offset?:	☑
Block Foundation?:	☐

Superstructure Analysis Reactions		
Global Moment, **M**:	4078	ft-kips
Global Axial, **P**:	49	kips
Global Shear, **V**:	44	kips
Leg Compression, $\mathbf{P_{comp}}$:	220	kips
Leg Comp. Shear, $\mathbf{V_{u\_comp}}$:	27	kips
Leg Uplift, $\mathbf{P_{uplift}}$:	178	kips
Leg Uplift. Shear, $\mathbf{V_{u\_uplift}}$:	23	kips
Tower Height, **H**:	180	ft
Base Face Width, **BW**:	23.1563	ft
BP Dist. Above Fdn, $\mathbf{bp_{dist}}$:	2	in

Foundation Analysis Checks	Capacity	Demand	Rating*	Check
Lateral (Sliding) (kips)	396.38	44.00	**10.6%**	**Pass**
Bearing Pressure (ksf)	9.00	1.48	**15.6%**	**Pass**
*Overturning (kip*ft)*	12336.72	4531.70	**36.7%**	**Pass**
*Pier Flexure (Comp.) (kip*ft)*	1375.70	94.50	**6.5%**	**Pass**
*Pier Flexure (Tension) (kip*ft)*	873.09	80.50	**8.8%**	**Pass**
Pier Compression (kip)	7998.24	227.92	**2.7%**	**Pass**
*Pad Flexure (kip*ft)*	4037.60	252.15	**5.9%**	**Pass**
Pad Shear - 1-way (kips)	957.98	60.24	**6.0%**	**Pass**
Pad Shear - Comp 2-way (ksi)	0.190	0.040	**20.1%**	**Pass**
*Flexural 2-way (Comp) (kip*ft)*	2399.15	56.70	**2.3%**	**Pass**
Pad Shear - Tension 2-way (ksi)	0.190	0.036	**17.9%**	**Pass**
*Flexural 2-way (Tension) (kip*ft)*	2399.15	48.30	**1.9%**	**Pass**

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

Soil Rating*:	**36.7%**
Structural Rating*:	**20.1%**

Pier Properties		
Pier Shape:	Circular	
Pier Diameter, **dpier**:	4.0	ft
Ext. Above Grade, **E**:	0.50	ft
Pier Rebar Size, **Sc**:	8	
Pier Rebar Quantity, **mc**:	16	
Pier Tie/Spiral Size, **St**:	3	
Pier Tie/Spiral Quantity, **mt**:	6	
Pier Reinforcement Type:	Tie	
Pier Clear Cover, $\mathbf{cc_{pier}}$:	3	in

Pad Properties		
Depth, **D**:	5.50	ft
Pad Width, **W**:	33.00	ft
Pad Thickness, **T**:	2.50	ft
Pad Rebar Size (Bottom), **Sp**:	8	
Pad Rebar Quantity (Bottom), **mp**:	46	
Pad Clear Cover, $\mathbf{cc_{pad}}$:	3	in

Material Properties		
Rebar Grade, **Fy**:	60	ksi
Concrete Compressive Strength, **F'c**:	4	ksi
Dry Concrete Density, δ**c**:	150	pcf

Soil Properties			
Total Soil Unit Weight, γ:	125	pcf	
Ultimate Gross Bearing, Qult:	12.000	ksf	<-- Toggle between Gross and Net
Cohesion, **Cu**:	0.000	ksf	
Friction Angle, φ:	34	degrees	
SPT Blow Count, $\mathbf{N_{blows}}$:			
Base Friction, μ:	0.45		
Neglected Depth, **N**:		ft	
Foundation Bearing on Rock?	No		
Groundwater Depth, **gw**:	n/a	ft	

Version 3.2.1

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

PHYSICAL PARAMETERS

Pier Height Above Water Table:	h_{pier_above} = (MIN(gw,D-T) + E)	h_{pier_above} =	3.5	ft
Pier Height Below Water Table:	h_{pier_below} = ((D-T) - MIN(gw,D-T))	h_{pier_below} =	0	ft
Buoyant Weight of Pier:	W_{pier} = (π/4) * (dpier^2) * hpier_above * δc / 1000 + (π/4) * (dpier^2) * hpier_below * (δc-62.4) / 1000	W_{pier} =	6.60	kips
Pad Height Above Water Table:	h_{pad_above} = IF(gw<=D-T,0,IF(gw>D,T,T-(D-gw)))	h_{pad_above} =	2.5	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} =	408.38	kips
Concrete weight:	W_c = V * δc	W_c =	428.2	kips
Soil weight:	W_s = (D - T) * (W² - 3*(dpier² / 4 * π)) * γ	W_s =	394.2	kips
EIA/TIA-222 Load Factor:	LF = 1	LF =	1.00	

LATERAL RESISTANCE

Total Nominal Pp Resistance:	P_{p_total} = Pp_pier *Ap_piers + Pp_pad * Ap_pad	P_{p_total} =	178.90	kips
Factored Total Weight for Compression:	$P_{factored\_comp}$ = φD * (Wc + Ws + P / 1.2)	$P_{factored\_comp}$ =	776.91	kips
Nominal Base Friction Resistance (Comp):	R_{s_comp} = P * μ	R_{s_comp} =	349.61	kips
Lateral Resistance (Comp):	ΦVn = Φs * (Pp_total + Rs_comp)	ΦVn =	396.38	kips

Check **ΦVn = 396.38 kips >= Vu = 44.00 kips** **RATING: 11.10% OK**

PIER REINFORCEMENT

Pier / Column Compression

Pier Cross-Sectional Area:	A_1 = dpier^2 * π/4	A_1 =	1809.56	in²
Support Area (2H:1V Slope):	A_2 = (MIN((2*(W/2-(2/3)*BW*cos(30°)+Offset)),(W-BW),dpier+4*T))²*(π/4)	A_2 =	10958.95	in²
Compressive Resistance (H/D < 3):	$ΦP_{n1}$ = 0.65*0.85 * F'c * A1 * MIN(√(A2/A1),2)	$ΦP_{n1}$ =	7998.24	kips
Rebar:	$s_{\_pier}$ = 8; $m_{\_pier}$ = 16; d_{b_pier} = 1 in; A_{b_pier} = 0.79 in^2			
Provided area of steel:	A_{s_pier} = Ab_pier * m_pier	A_{s_pier} =	12.64	in^2
Compressive Resistance (H/D >= 3):	$ΦP_{n2}$ = 0.65 * 0.8 * (0.85 * (F\c) * (A_1 - As_pier) + ((Fy) * As_pier))	$ΦP_{n2}$ =	3571.32	kips
	H/D = (D - T + E) / dpier	H/D =	0.88	
Utilized Compressive Resistance:	$ΦP_n$ = Pn1	$ΦP_n$ =	7998.24	kips
Applied Compressive Force:	P_u = Pcomp + 1.2 * Wpier	P_u =	227.92	kips

Check **$ΦP_n$ = 7998.24 kips >= P_u = 227.92 kips** **RATING: 2.85% OK**

Pier Flexure

Cross-sectional area:	A_g = dpier² * π / 4	A_g =	1809.56	in^2
Min. area of steel (pier):	A_{smin_pier} = Ag * 0.005	A_{smin_pier} =	9.05	in^2
Cage Diameter:	d_o = dpier - 2 * cc - 2 * tie - d_b	d_o =	40.25	in

Check **A_{s_pier} = 12.64 in^2 >= A_{smin_pier} = 9.05 in^2** **OK**

Applied Moment to DSMC (Compression):	M_{u_comp} = IF(T>D,E,(D - T + E)) * Vu_comp	M_{u_comp} =	94.50	ft-kips
Pier Moment Capacity (Compression):	$ΦM_{n\_comp}$ = *from DSMC*	$ΦM_{n\_comp}$ =	1375.70	ft-kips

Check **M_{u_comp} = 94.50 ft-kips >= $ΦM_{n\_comp}$ = 1375.70 ft-kips** **RATING: 6.87% OK**

Applied Moment to DSMC (Tension):	$M_{u\_tension}$ = IF(T>D,E,(D - T + E)) * Vu_uplift	$M_{u\_tension}$ =	80.50	ft-kips
Pier Moment Capacity (Tension):	$ΦM_{n\_tension}$ = *from DSMC*	$ΦM_{n\_tension}$ =	873.09	ft-kips

Check **M_{u_comp} = 80.50 ft-kips >= $ΦM_{n\_comp}$ = 873.09 ft-kips** **RATING: 9.22% OK**

PAD REINFORCEMENT

Elastic Bearing Pressure for Soil Checks

Tower Cetroid offset from Fdn Centroid:	Offset = (1/2-1/3)*BW*sin(60°)	Offset =	3.34	ft	
Distance from Leg to Edge of Pad:	L_{edge} = (1/2)*W - Offset - (1/3)*BW*sin(60°)	L_{edge} =	6.47	ft	
*Overturning Moment (0.9*D LC):*	$M_{o\_0.9}$ = M + V * (D + E + bpdist/12) + (0.9/1.2)*(P+3*Wpier*1.2)*Offset	$M_{o\_0.9}$ =	4531.70	ft-kips	
*Overturning Moment (1.2*D LC):*	$M_{o\_1.2}$ = M + V * (D + E + bpdist/12) + (1.2/1.2)*(P+3*Wpier*1.2)*Offset	$M_{o\_1.2}$ =	4592.49	ft-kips	
Compressive Load for Bearing:	$P_{bearing}$ = Wc + Ws + P / 1.2	$P_{bearing}$ =	863.24	kips	
*Load Eccentricity (0.9*D LC):*	$e_{c\_0.9}$ = Mo / 0.9*Pbearing	$e_{c\_0.9}$ =	5.83	ft	L/6 < e <= L/

*Load Eccentricity (1.2*D LC):*	$e_{c\_1.2}$ = Mo / 1.2*Pbearing	$e_{c\_1.2}$ =	4.43	ft	e <= L/6
Elastic Section Modulus:	S = W³ / 6	S =	5989.50	ft³	
*Positive Pressure (0.9*D LC):*	$P_{pos\_st\_0.9}$ = 0.9*Pbearing / Area + Mo / S	$P_{pos\_st\_0.9}$ =	1.47	ksf	
*Positive Pressure (1.2*D LC):*	$P_{pos\_st\_1.2}$ = 1.2*Pbearing / Area + Mo / S	$P_{pos\_st\_1.2}$ =	1.72	ksf	
*Negative Pressure (0.9*D LC):*	$P_{neg\_st\_0.9}$ = 0.9*Pbearing / Area - Mo / S **Note: The stress resultant is NOT within the kern. Bearing area has been adjusted below.**	$P_{neg\_st\_0.9}$ =	-0.04	ksf	
*Negative Pressure (1.2*D LC):*	$P_{neg\_st\_1.2}$ = 1.2*Pbearing / Area - Mo / S **Note: The resultant stress is within the kern. No adjustment is required.**	$P_{neg\_st\_1.2}$ =	0.18	ksf	
*Adjusted Pressure (0.9*D LC):*	$P_{adj\_0.9}$ = (2 * 0.9*Pbearing) / (3 * W * (W / 2 - ec_0.9))	$P_{adj\_0.9}$ =	1.47	ksf	
*Adjusted Pressure (1.2*D LC):*	$P_{adj\_1.2}$ = (2 * 1.2*Pbearing) / (3 * W * (W / 2 - ec_1.2))	$P_{adj\_1.2}$ =	1.73	ksf	
*Maximum Pressure (0.9*D LC):*	$q_{u\_st\_0.9}$ = IF(Pneg ≥ 0, Ppos , Padj)	$q_{u\_st\_0.9}$ =	1.47	ksf	
*Maximum Pressure (1.2*D LC):*	$q_{u\_st\_1.2}$ = IF(Pneg ≥ 0, Ppos , Padj)	$q_{u\_st\_1.2}$ =	1.72	ksf	

One-Way Shear

Rebar:	$s_{\_pad}$ = 8 $m_{\_pad}$ = 46	*Equally spaced, top and bottom, both directions.*	d_{b_pad} = 1 in A_{b_pad} = 0.79 in²		
Effective depth:	d_c = T - cc - 1.5 * db	d_c =	25.5	in	
Distance from Edge of Pad to Column Face:	d' = Ledge - dpier/2	d' =	4.5	ft	
Distance from Edge of Pad to dc from Column Face:	d'' = d' - d_c / 12	d'' =	2.35	ft	
Distance to qs (0.9D LC):	$L'_{\_0.9}$ = (W / 2 - ec_0.9) * 3	$L'_{\_0.9}$ =	32.00	ft	
Distance to qs (1.2D LC):	$L'_{\_1.2}$ = (W / 2 - ec_1.2) * 3	$L'_{\_1.2}$ =	36.20	ft	
*Slope of qs (0.9*D LC):*	$sq_{s\_0.9}$ = IF(L' > W, (Ppos - Pneg) / W, qu / L')	$sq_{s\_0.9}$ =	0.05	kcf	
*Slope of qs (1.2*D LC):*	$sq_{s\_1.2}$ = IF(L' > W, (Ppos - Pneg) / W, qu / L')	$sq_{s\_1.2}$ =	0.05	kcf	
Nominal Shear Strength:	V_{n1} = 2 * W * √(F'c*1000) * dc	V_{n1} =	1277.31	kips	
Shear Reduction Factor:	$φ_{shear}$ = 0.75	$φ_{shear}$ =	0.75		
Design Shear Strength:	$φV_{n1}$ = φshear * V_{n1}	$φV_{n1}$ =	957.98	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	0.125	26.15	34.87
Soil Below Water Table:	0	0.063	0.00	0.00
Pad Above Water Table:	2.5	0.150	26.15	34.87
Pad Below Water Table:	0	0.088	0.00	0.00
Total:			52.30	69.74

*Applied Shear (0.9*D LC):*	$V_{u1\_0.9}$ = 'Pad Shear and Moment Diagrams'!$AY$21	$V_{u1\_0.9}$ =	58.31	kips
*Applied Shear (1.2*D LC):*	$V_{u1\_1.2}$ = 'Pad Shear and Moment Diagrams'!$CG$21	$V_{u1\_1.2}$ =	60.24	kips

Check **$φV_{n1}$ = 957.98 kips >= V_{u1} = 60.24 kips** **RATING: 6.29% OK**

Two-Way Shear (Compression)

Avg. Effective Depth for Punching Shear:	d_{c_2} = T - cc - AVERAGE(0.5 * db , 1.5 * db)	d_{c_2} =	26.00	in
Radius of Two-Way Shear Plane:	r_{2way} = 0.5*(dpier + dc_2/12)	r_{2way} =	3.08	ft
Length to Edge of Pad from Pier Centroid:	L_{edge2} = W/2 - 2/3*SIN(60°)*BW + Offset	L_{edge2} =	6.47	ft
Length of Shear Perimeter to Deduct:	s = r_{2way} * (2 * ACOS(((r_{2way}-MAX(r_{2way}-L_{edge},0))/r_{2way}))	s =	0.00	ft
Pier Shape:	Pier Shape: Circular	Pier Shape:	Circular	
Pier Diameter:	d_{pier1} = d_{pier} * 12 in / ft	d_{pier1} =	48.00	in
Equivalent Square Pier Diameter:	d_{pier_sq} = √π / 2 * dpier	d_{pier_sq} =	42.54	in
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 =	1134.00	kip*in
Circular Critical Perimeter:	P_{crit_cir} = (dpier+dc_2/12)*PI() - $L$171)*12	P_{crit_cir} =	232.48	in
Equivalent Square Critical Perimeter 1:	$P_{crit\_sq\_1}$ = 4*(dpier_sq+dc_2)	$P_{crit\_sq\_1}$ =	274.16	in
Equivalent Square Critical Perimeter 2:	$P_{crit\_sq\_2}$ = 2*(dpier_sq + dc_2) + (W*12-BW*12)	$P_{crit\_sq\_2}$ =	255.20	in
Equivalent Square Critical Perimeter 3:	$P_{crit\_sq\_3}$ = 2 * (dpier_sq + dc_2 + (W - BW * COS(RADIANS(30)) - Ledge2)*12)	$P_{crit\_sq\_3}$ =	292.43	in
Equivalent Square Critical Perimeter 4:	$P_{crit\_sq\_4}$ = 2 * (dpier_sq + dc_2 + Ledge2 * 12)	$P_{crit\_sq\_4}$ =	292.43	in
Equivalent Square Critical Perimeter 5:	$P_{crit\_sq\_5}$ = dpier_sq + dc_2 + 0.5*(W-BW)*12 + (W - BW * COS(RADIANS(30)) - Ledge2	$P_{crit\_sq\_5}$ =	205.28	in
Area of Concrete in Shear:	A_c = ((dpier1 + dc_2)*PI()) * dc_2	A_c =	6044.42	in²
Eq. Square Area of Concrete in Shear (1):	$A_{c\_sq\_1}$ = $P_{crit\_sq\_1}$ * d_{c_2}	$A_{c\_sq\_1}$ =	7128.04	in²

Eq. Square Area of Concrete in Shear (2):	$A_{c\_sq\_2} = P_{crit\_sq\_2} * d_{c\_2}$	$A_{c\_sq\_2}$ =	6635.26	in^2
Eq. Square Area of Concrete in Shear (3):	$A_{c\_sq\_3} = P_{crit\_sq\_3} * d_{c\_2}$	$A_{c\_sq\_3}$ =	7603.19	in^2
Eq. Square Area of Concrete in Shear (4):	$A_{c\_sq\_4} = P_{crit\_sq\_4} * d_{c\_2}$	$A_{c\_sq\_4}$ =	7603.19	in^2
Eq. Square Area of Concrete in Shear (5):	$A_{c\_sq\_5} = P_{crit\_sq\_5} * d_{c\_2}$	$A_{c\_sq\_5}$ =	5337.21	in^2
Polar Moment of Inertia at assumed Critical Section:	J_c_cir = dc_2*(dpier1+dc_2)^3/6 + ((dpier1+dc_2)*(dc_2^3))/6 + (dc_2*(dpier1+dc_2))*(dpier1+dc_2)^2/(IF($L$169=0,2,4))	J_{c_cir} =	7240653.33	in^4
Eq. Square Polar Moment of Inertia at assumed Critical Section 1:	J_c_sq_1 = (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	$J_{c\_sq\_1}$ =	5781533.12	in^4
Eq. Square Polar Moment of Inertia at assumed Critical Section:	J_c_sq_2 = (dc_2*(dpier_sq+dc_2)^3)/12 + ((dpier_sq+dc_2)*(dc_2^3))/12 + (dc_2*(dpier_sq+dc_2)*(dpier_sq+dc_2)^2)/2	$J_{c\_sq\_2}$ =	4983551.51	in^4
Eq. Square Polar Moment of Inertia at assumed Critical Section:	J_c_sq_3 = (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)/4	$J_{c\_sq\_3}$ =	3688748.17	in^4
Eq. Square Polar Moment of Inertia at assumed Critical Section:	J_c_sq_4 = (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)/4	$J_{c\_sq\_4}$ =	3688748.17	in^4
Eq. Square Polar Moment of Inertia at assumed Critical Section:	J_c_sq_5 = (dc_2*(dpier_sq+dc_2)^3)/12 + ((dpier_sq+dc_2)*(dc_2^3))/12 + (dc_2*(dpier_sq+dc_2)*(dpier_sq+dc_2)^2)/4	$J_{c\_sq\_5}$ =	2890766.56	in^4
*Applied Shear Force (1.2*D LC):*	V_u_1.2 = 1.2*W_pier + 1.2 * IF(OR($B$1="G",$B$1="H"), P_comp / 1.2, P_comp)	$V_{u\_1.2}$ =	227.92	kip
*Controlling Shear Stress (1.2*D LC):*	$v_{u\_1.2\_controlling} = V_{u\_1.2} / A_c + (\Upsilon_v * M_v * (d_{pier1} + dc\_2)/2) / J_{c\_1}$	$v_{u\_1.2\_controlling}$ =	0.040	ksi
*Eq. Sq. Controlling Shear Stress (1.2*D LC):*	$v_{u\_1.2\_controlling\_sq} = V_{u\_1.2} / A_c + (\Upsilon_v * M_v * (d_{pier\_sq} + dc\_2)/2) / J_c$	$v_{u\_1.2\_controlling\_sq}$ =	0.048	ksi
Shear Stress Capacity:	$\Phi v_n = \varphi s * 4 * (\sqrt{F'c*1000}) / 1000$	Φv_n =	0.190	ksi

Check Φv_n = **0.190 ksi** >= v_{u_demand} = **0.040 ksi** **RATING: 21.09% OK**

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

Distance To Outside Edge:	$dist_{outside}$ = MIN((W-BW)/2,BW/2)*2	$dist_{outside}$ =	9.8437	ft
Effective Pad Width:	$b_{\_pad}$ = MIN(dpier+3*T,W,dist_outside)	$b_{\_pad}$ =	9.84	ft
Bar Spacing:	B_{s_pad} = Bs_pad (see design checks below)	B_{s_pad} =	8.64	in
Fraction of Bars in Effective Width:	$m_{\_effective}$ = IF(b_pad=W,mp,12*b_pad/Bs_pad)	$m_{\_effective}$ =	13.66	
Area of Steel in Effective Width:	$A_{s\_effective}$ = VLOOKUP(Sp,Ref!$A$2:$C$12,3,0)*m_slab	$A_{s\_effective}$ =	10.80	in²
Depth of Equivalent Rectangular Stress Block:	$a_{\_effective} = A_{s\_effective} * Fy / (0.85 * F'c * b_{\_slab}*12)$	$a_{\_effective}$ =	1.61	in
	$\beta_{pad} = \beta_{pad}$ (see design checks below)	β_{pad} =	0.85	
Distance from Top to Nuetral Axis:	$c_{\_effective} = a_{\_effective} / \beta_{pad}$	$c_{\_effective}$ =	1.90	
Effective depth:	dc = dc (see One-Way Shear check above)	dc =	25.5	in
Modulus of Elasticity of Steel:	E_s = 29000 ksi	E_s =	29000	ksi
Strain in Steel:	$\varepsilon_{s\_effective} = 0.003 * (dc-c) / c$	$\varepsilon_{s\_effective}$ =	0.03732	in/in
Compression-Controlled Strain Limit::	$\varepsilon_c = F_y / E_s$	ε_c =	0.00207	in/in
Tension-Controlled Strain Limit::	$\varepsilon_t = 0.005$	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:	$M_{n\_effective} = A_{s\_effective} * (F_y) * (dc - a_{\_effective} / 2) * (1/12)$	$M_{n\_effective}$ =	1332.86	ft-kips
Design Flexural Strength:	$\varphi M_{n\_effective}$ = φflex_effective * Mn_effective	$\varphi M_{n\_effective}$ =	1199.57	ft-kips

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

Bar Spacing:	$B_{s\_pad\_top}$ = IF(Input!$S$6=TRUE,(W*12 - 2 * ccpad - VLOOKUP(sptop,Ref!$A$2:$C$12,2	$B_{s\_pad\_top}$ =	9.84	in
Fraction of Bars in Effective Width:	$m_{\_effective\_top}$ = IF(b_pad=W,mp,12*b_pad/Bs_pad_top)	$m_{\_effective\_top}$ =	13.66	
Area of Steel in Effective Width:	$A_{s\_effective\_top}$ = VLOOKUP(Sptop,Ref!$A$2:$C$12,3,0)*m_slab	$A_{s\_effective\_top}$ =	10.80	in²
Depth of Equivalent Rectangular Stress Block:	$a_{\_effective\_top} = A_{s\_effective\_top} * Fy / (0.85 * F'c * b_{\_slab}*12)$	$a_{\_effective\_top}$ =	1.61	in
Distance from Top to Nuetral Axis:	$c_{\_effective\_top} = a_{\_effective\_top} / \beta_{pad}$	$c_{\_effective\_top}$ =	1.90	
Effective depth:	dc_top = T *12 - ccpad - 1.5 * VLOOKUP(sptop,Ref!$A$2:$C$12,2,0)	d_{c_top} =	25.5	in
Strain in Steel:	$\varepsilon_{s\_effective\_top}$ = 0.003 * (dc_top-c_effective_top) / c_effective_top	$\varepsilon_{s\_effective\_top}$ =	0.03732	in/in
Flexure Strength Reduction Factor:	$\varphi flex_{effective\_top}$ = IF(εs>=εt,0.9,IF(εs<=εc,0.65,0.65+(0.9-0.65)*((εs-εc)/(εt-εc))))	$\varphi flex_{effective\_top}$ =	0.9	
Nominal Flexural Strength:	$M_{n\_effective\_top} = A_{s\_effective\_top} * (F_y) * (dc\_top - a_{\_effective\_top} / 2) * (1/12)$	$M_{n\_effective\_top}$ =	1332.86	ft-kips
Design Flexural Strength:	$\varphi M_{n\_effective\_top}$ = φflex_effective * Mn_effective	$\varphi M_{n\_effective\_top}$ =	1199.57	ft-kips

Applied Moment:	$Yf*M_{u\_comp}$ =	$Yf*M_{u\_comp}$	$Yf*M_{u\_comp}$ =	56.7	ft-kips
Check	**$\varphi M_{n\_effective}$ = 2399.15 ksi**	**>= $Yf*M_{u\_comp}$ = 56.70 ksi**	**RATING:**	**2.36%**	**OK**

Two-Way Shear (Uplift)

Moment applied at base of Pier:	M_{v_tens} =	$M_{u\_tension}$ * 12 in / ft	M_{v_tens} =	966.00	kip*in
Diameter of Longitudinal Rebar Cage:	$d_{\_cage}$ =	dpier*12-2*(ccpier+VLOOKUP(St,Ref!$A$2:$C$12,2,0))-VLOOKUP(Sc,Ref!$A$2:$C$12,2,0)	$d_{\_cage}$ =	40.25	in
Eq. Sq. Diameter of Longitudinal Rebar Cage:	$d_{\_cage\_sq}$ =	SQRT(PI())/2*d_cage	$d_{\_cage\_sq}$ =	35.67	in
Steel Embedment Length:	L_{embed} =	dc_2 (see One-Way Shear check above)	L_{embed} =	26.00	in
Radius of Two-Way Shear Plane:	r_{2way_tens} =	0.5*(d_cage/12 + Lembed/12)	r_{2way_tens} =	2.76	ft
	$r_{2way\_tens\_sq}$ =	0.5*(SQRT(PI())/2*d_cage/12 + Lembed/12)	$r_{2way\_tens\_sq}$ =	2.57	ft
Length of Shear Perimeter to Deduct:	s_{tens} =	r_tens*RADIANS(2*ACOS(((r_tens-MAX(r_tens-Ledge,0))/r_tens))*180/PI())	s_{tens} =	0.00	ft
Eq. Sq. Length of Shear Perimeter to Deduct:	s_{tens_sq} =	0	s_{tens_sq} =	0.00	ft
Circular Critical Perimeter:	P_{crit_tens} =	((d_cage/12+Lembed/12)*PI() - stens)*12	P_{crit_tens} =	208.13	in
Equivalent Square Critical Perimeter 1:	$P_{crit\_tens\_sq\_1}$ =	4*(d_cage_sq+Lembed)	$P_{crit\_tens\_sq\_1}$ =	246.68	in
Equivalent Square Critical Perimeter 2:	$P_{crit\_tens\_sq\_2}$ =	2*(d_cage_sq + Lembed) + (W*12-BW*12)	$P_{crit\_tens\_sq\_2}$ =	241.47	in
Equivalent Square Critical Perimeter 3:	$P_{crit\_tens\_sq\_3}$ =	2 * (d_cage_sq + Lembed) + (W - BW * COS(RADIANS(30)) - Ledge2)*12)	$P_{crit\_tens\_sq\_3}$ =	278.69	in
Equivalent Square Critical Perimeter 4:	$P_{crit\_tens\_sq\_4}$ =	2 * (d_cage_sq + Lembed + Ledge2 * 12)	$P_{crit\_tens\_sq\_4}$ =	278.69	in
Equivalent Square Critical Perimeter 5:	$P_{crit\_tens\_sq\_5}$ =	d_cage_sq + Lembed + 0.5*(W-BW)*12 + (W - BW * COS(RADIANS(30)) - Le	$P_{crit\_tens\_sq\_5}$ =	198.41	in
Area of Concrete in Shear:	A_{c_tens} =	Pcrit_tens*Lembed	A_{c_tens} =	5411.39	in^2
Equivalent Square Area of Concrete in Shear:	$A_{c\_tens\_sq1}$ =	Pcrit_tens_sq1*Lembed	$A_{c\_tens\_sq1}$ =	6413.75	in^2
	$A_{c\_tens\_sq2}$ =	'Pcrit_tens_sq2*Lembed	$A_{c\_tens\_sq2}$ =	6278.11	in^2
	$A_{c\_tens\_sq3}$ =	Pcrit_tens_sq3*Lembed	$A_{c\_tens\_sq3}$ =	7246.04	in^2
	$A_{c\_tens\_sq4}$ =	Pcrit_tens_sq4*Lembed	$A_{c\_tens\_sq4}$ =	7246.04	in^2
	$A_{c\_tens\_sq5}$ =	Pcrit_tens_sq5*Lembed	$A_{c\_tens\_sq5}$ =	5158.64	in^2
Polar Moment of Inertia at assumed Critical Section:	J_{c_tens} =	Lembed*(d_cage+Lembed)^3/6 + ((d_cage+Lembed)*(Lembed^3))/6 + (Lembed*(d_cage+Lembed))*(d_cage+Lembed)^2/(IF(Ledge2=0,2,4))	J_{c_tens} =	3344135.07	in^4
Eq. Square Polar Moment of Inertia at assumed Critical Section 1:	$J_{c\_tens\_sq\_1}$ =	(Lembed*(d_cage_sq+Lembed)^3)/6 + ((d_cage_sq+Lembed)*(Lembed^3))/6 + (Lembed*(d_cage_sq+Lembed)*(d_cage_sq+Lembed)^2)/2	$J_{c\_tens\_sq\_1}$ =	4246185.28	in^4
Eq. Square Polar Moment of Inertia at assumed Critical Section:	$J_{c\_tens\_sq\_2}$ =	(Lembed*(d_cage_sq+Lembed)^3)/12 + ((d_cage_sq+Lembed)*(Lembed^3))/12 + (Lembed*(d_cage_sq+Lembed)*(d_cage_sq+Lembed)^2)/2	$J_{c\_tens\_sq\_2}$ =	3647666.93	in^4
Eq. Square Polar Moment of Inertia at assumed Critical Section:	$J_{c\_tens\_sq\_3}$ =	(Lembed*(d_cage_sq+Lembed)^3)/6 + ((d_cage_sq+Lembed)*(Lembed^3))/6 + (Lembed*(d_cage_sq+Lembed)*(d_cage_sq+Lembed)^2)/4	$J_{c\_tens\_sq\_3}$ =	2721610.99	in^4
Eq. Square Polar Moment of Inertia at assumed Critical Section:	$J_{c\_tens\_sq\_4}$ =	(Lembed*(d_cage_sq+Lembed)^3)/6 + ((d_cage_sq+Lembed)*(Lembed^3))/6 + (Lembed*(d_cage_sq+Lembed)*(d_cage_sq+Lembed)^2)/4	$J_{c\_tens\_sq\_4}$ =	2721610.99	in^4
Eq. Square Polar Moment of Inertia at assumed Critical Section:	$J_{c\_tens\_sq\_5}$ =	(Lembed*(d_cage_sq+Lembed)^3)/12 + ((d_cage_sq+Lembed)*(Lembed^3))/12 + (Lembed*(d_cage_sq+Lembed)*(d_cage_sq+Lembed)^2)/4	$J_{c\_tens\_sq\_5}$ =	2123092.64	in^4
*Applied Shear Force (0.9*D LC):*	$V_{u\_0.9\_tens}$ =	MAX(-0.9*Wpier + 0.9 * IF(OR($B$1="G",$B$1="H"), Puplift / 0.9, Puplift),0)	$V_{u\_0.9\_tens}$ =	172.06	kip
*Controlling Shear Stress (0.9*D LC):*	$v_{u\_0.9\_controlling\_tens}$ =	$V_{u\_0.9} / A_{c\_tens} + (Y_v * M_v * (d_{cage} + Lembed)/2) / J_{c\_tens}$	$v_{u\_0.9\_controlling\_tens}$ =	0.036	ksi
*Equivalent Square Shear Stress (0.9*D LC):*	$v_{u\_0.9\_tens\_sq}$ =	Vu_0.9_tens/Ac_tens_sq5 + (Yv * Mv_tens * (d_cage_sq + Lembed)/2) / Jc_t	$v_{u\_0.9\_tens\_sq}$ =	0.039	ksi
Shear Stress Capacity:	Φv_n =	φs * 4 * (√F'c*1000) / 1000	Φv_n =	0.190	ksi
Check	**Φv_n = 0.190 ksi**	**>= v_{u_demand} = 0.036 ksi**	**RATING:**	**18.78%**	**OK**

Two-Way Shear (Uplift, Flexural Component)

Applied Moment:	$Yf*M_{u\_tension}$ =	$Yf*M_{u\_tension}$	$Yf*M_{u\_tension}$ =	48.3	
Check	**$\varphi M_{n\_effective}$ = 2399.15 ksi**	**>= ʼf*$M_{u\_tension}$ = 48.30 ksi**	**RATING:**	**2.01%**	**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} =	36.34	in^2
Depth of Equivalent Rectangular Stress Block:	a = A_{s_pad} * Fy / (0.85 * F'c * W)	a =	1.62	in
Distance from Top to Nuetral Axis:	c = a / β_{pad}	c =	1.91	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 =	0.03715	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 =	4486.22	ft-kips
Design Flexural Strength:	φM_n = φflex * Mn	φM_n =	4037.60	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 =	1.27	ksf
*Bearing Press. at Crit. Section (1.2*D LC):*	qmid_1.2 = qu_st_1.2 - sqs_1.2 * d'	qmid_1.2 =	1.51	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	0.125	49.82	66.42	2.236513986	111.42	148.56
Soil Below Water Table:	0	0.063	0.00	0.00	2.236513986	0.00	0.00
Pad Above Water Table:	2.5	0.150	49.82	66.42	2.236513986	111.42	148.56
Pad Below Water Table:	0	0.088	0.00	0.00	2.236513986	0.00	0.00
Total:			99.64	132.85		222.84	297.12

*Factored Bending Moment (0.9*D LC):*	Mu_pad_0.9 = 'Pad Shear and Moment Diagrams'!$AZ$21	Mu_pad_0.9 =	243.80	ft-kips
*Factored Bending Moment (1.2*D LC):*	Mu_pad_1.2 = 'Pad Shear and Moment Diagrams'!$CH$21	Mu_pad_1.2 =	252.15	ft-kips

Check **φM_n = 4037.60 ft-kips >= M_{u_pad} = 252.15 ft-kips** **RATING: 6.24% OK**

PIER DESIGN CHECKS

Minimum Steel

Min. area of steel (pier):	A_{st_c} = Ag * 0.005	A_{st_c} =	9.05	in^2

Check **A_{s_pier} = 12.64 in² >= A_{st_c} = 9.05 in²**

Bar Spacing

Bar separation:	B_{s_pier} = (do * π) / m_pier - db_pier	B_{s_pier} =	6.90	in

Check **18.00 in >= B_{s_pier} = 6.90 in**

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	$c_{\_c}$ =	3.5	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 =	0.72	
Development (tensile):	$L_{dt}'_{\_c}$ = (3 / 40) * (Fy*1000 / √(F'c*1000)) * αβ_c * γ_c * λ_c * R_c * db_c / c_c'	$L_{dt}'_{\_c}$ =	26.48	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} =	26.48	in
Development (comp.):	$L_{dc}'_{\_c}$ = 0.02 * db_c * Fy*1000 / √(F'c*1000)	$L_{dc}'_{\_c}$ =	18.97	in
	$L_{dc}''_{\_c}$ = 0.0003 * db_c * Fy*1000	$L_{dc}''_{\_c}$ =	18.00	in
Development length:	L_{dc_c} = MAX(8, Ldc'_c, Ldc''_c)	L_{dc_c} =	18.97	in
Length available in pier:	L_{vc} = D - T + E - cc	L_{vc} =	39.0	in

Check **L_{vc} = 39.00 in >= L_{dt_c} = 26.48 in** **OK**

Check **L_{vc} = 39.00 in >= L_{dc_c} = 18.97 in** **OK**

Length available in pad:	L_{vp} = T - ccpad	L_{vp} =	27.0	in

Check	**L_{vp} =**	**27.00**	**in**	**>=**	**L_{dt_c} =**	**26.48**	**in**	**OK**
Check	**L_{vp} =**	**27.00**	**in**	**>=**	**L_{dc_c} =**	**18.97**	**in**	**OK**

Vertical Rebar Hook Ending

Bar size & clear cover:	α_h = =if bar <= 11, and cc >= 2.5", use 0.7, else use 1.0	α_h =	0.7	
Epoxy coating:	β_h = for non- epoxy coated, use 1.0	β_h =	1.0	
Light weight concrete:	λ_h = 1.0	λ_h =	1.0	
Development (hook):	L_{dh}' = 0.02 * αh * βh * λh * Fy*1000 / √(F'c*1000) * db_c	L_{dh}' =	13.3	in
Minimum length:	L_{dh_min} = the larger of: 8 * d_b or 6 in	L_{dh_min} =	8.0	in
Development length:	L_{dh} = MAX(Ldh_min, Ldh')	L_{dh} =	13.3	in

Check	**L_{vp} =**	**27.00**	**in**	**>=**	**L_{dh} =**	**13.28**	**in**	**OK**

Hook tail length:	L_{h_tail} = 12 * db beyond the bend radius	L_{h_tail} =	16.0	in
Length available in pad:	L_{h_pad} = 12*MIN((W/2-(2/3)*BW*cos(30°)+Offset-dpier/2),(W-BW-dpier)/2) + ccpier - ccpad	L_{h_pad} =	35.1	in

Check	**L_{h_pad} =**	**35.06**	**in**	**>=**	**L_{dh_tail} =**	**16.00**	**in**	**OK**

Pier Ties

Minimum size: [ACI 7.10.5.1]	$s_{\_t\_min}$ =IF(s_c <= 10, 3, 4)	$s_{\_t\_min}$ =	3	
z factor:	z_seismic = 0.5 if the SDC is A, B, or C, else 1.0	z_seismic =	0.5	

Tie parameters:	$s_{\_t}$ = 3	d_{b_t} =	0.375	in
	$m_{\_t}$ = 6	A_{b_t} =	0.11	in^2

Allowable tie spacing per vertical rebar:	$B_{s\_t\_max1}$ = 8 / z * db_c	$B_{s\_t\_max1}$ =	16	in
per tie size:	$B_{s\_t\_max2}$ = 24 / z * db_t	$B_{s\_t\_max2}$ =	18	in

per pier diameter:	$B_{s\_t\_max3}$ =	di / (4 * z²)	$B_{s\_t\_max3}$ =	48	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)	$B_{s\_t\_max}$ =	16	in
Minimum required ties:	$m_{\_t\_min}$ =	(D - T + E) / Bs_t_max + 2	$m_{\_t\_min}$ =	5.00	

Check **$m_{\_t}$ = 6.00 >= $m_{\_t\_min}$ = 5.00** **OK**

PAD DESIGN CHECKS

Minimum Steel Required for Shrinkage

Shrinkage:	ρ_{sh} =	IF(Fy >= 60, 0.0018, 0.002)	ρ_{sh} =	0.0018	
Min. Required Shrinkage Steel:	$A_{st\_p\_sh}$ =	ρsh * W * T	$A_{st\_p\_sh}$ =	21.384	in^2

Check **A_{s_p} = 36.34 in^2 >= A_{st_p} = 21.38 in^2** **OK**

Bar Separation

Bar separation:	B_{s_pad} =	(W - 2 * cc - db) / (m - 1)	B_{s_pad} =	8.64	in

Check **18" >= B_{s_p} = 8.64 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 =	1	
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 =	3.50	in
Transverse bars:	k_{tr_p} =	0 in (per 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} =	280.2	ft-kips
Steel estimate:	A_{st_p}' =	Mn / (φt * Fy * dc)	A_{st_p}' =	2.442	in^2
	a_p =	Ast' * Fy / (β * F'c * W)	a_p =	0.11	in
Required steel:	$A_{st\_p\_st}$ =	M_{nr} / (Fy * (dc - ap / 2))	$A_{st\_p\_st}$ =	2.202	in^2
Excess reinforcement:	R_p =	Ast_p / As_p	R_p =	0.59	
Development (tensile):	L_d =	(3 / 40) * (Fy*1000 / √(F'c*1000)) * αβ * γ * λ * R * db / c'	L_d =	21.77	in
Minimum length:	L_{d_min} =	12 inches	L_{d_min} =	12.0	in
Development length:	L_{dp} =	MAX(Ld_min, Ldp')	L_{dp} =	21.77	in
Length available in pad:	L_{pad} =	12*MIN((W/2-(2/3)*BW*cos(30°)+Offset-dpier/2),(W-BW-dpier)/2)- ccpad	L_{pad} =	50.68	in

Check **L_{pad} = 50.68 in >= L_{dp} = 21.77 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-022
ChapelHillRS

Maximum Shaft Superimposed Forces		
TIA Revision:	H	
Max. Factored Shaft Mu:	80.5	ft-kips **(* Note)**
Max. Factored Shaft Pu:	178	kips
Max Axial Force Type:	Tension	

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

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

Load Factor	Shaft Factored Loads		
1.00	Mu:	80.5	ft-kips
1.00	Pu:	178	kips

Pier Properties

Concrete:		
Pier Diameter =	4.0	ft
Concrete Area =	1809.6	in^2
Reinforcement:		
Clear Cover to **Tie**=	3.00	in
Horiz. **Tie** Bar Size=	3	
Vert. Cage Diameter =	3.35	ft
Vert. Cage Diameter =	40.25	in
Vertical Bar Size =	8	
Bar Diameter =	1.00	in
Bar Area =	0.79	in^2
Number of Bars =	16	
As Total=	12.64	in^2
A s/ Aconc, Rho:	0.0070	0.70%

Material Properties

Concrete Comp. strength, f'c =	4000	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:

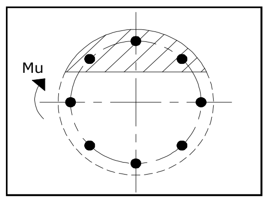
(3)*(Sqrt(f'c)/Fy:	0.0032
200 / Fy:	0.0033

Minimum Rho Check:

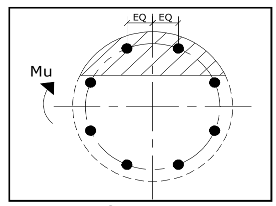
Assumed Min. Rho:	0.50%	
Provided Rho:	0.70%	OK

Results:

Governing Orientation Case: **2**



Case 1



Case 2

Dist. From Edge to Neutral Axis:	**6.28**	in
Extreme Steel Strain, εt:	**0.0179**	
	εt > 0.0050, Tension Controlled	
Reduction Factor,φ:	**0.900**	

Output Note: Negative Pu=Tension

For Axial Compression, φ Pn = Pu:	-160.20	kips
Drilled Shaft Moment Capacity, φMn:	**873.09**	ft-kips
Drilled Shaft Superimposed Mu:	**80.50**	ft-kips
(Mu/φMn, Drilled Shaft Flexure CSR:	**9.2%**	

Ref. Shaft Max Axial Capacities, ϕ Max(Pn or Tn):		
Max Pu = (φ=0.65) Pn. Pn per ACI 318 (10-2)	3571.32	kips
at Mu=(ϕ=0.65)Mn=	1225.35	ft-kips
Max Tu, (φ=0.9) Tn =	682.56	kips
at Mu=ϕ=(0.90)Mn=	0.00	ft-kips

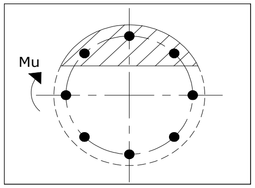
Maximum Allowable Moment of a Circular Pier

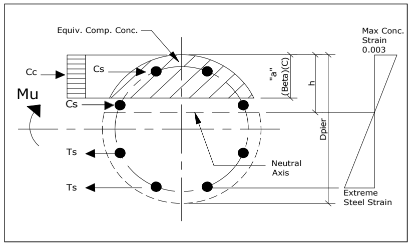
Pu: 178 kips (from Results Tab)
Axial Force type: Tension (from Results Tab)

For Internal Calculations:
Axial Load (Negative for Compression) = 178.00 kips

	Case 1	Case 2	
Reduction factor, ϕ2002 =	0.90	0.90	<-- 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 =	0.90	0.90	<-- 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 =	0.90	0.90	<-- 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:	0.90	0.90	

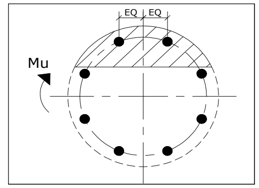
Case 1: Single Bar Near the Extreme Fiber





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 = 6.30 in
Equivalent compression zone factor = 0.85
Distance from extreme edge to equivalent compression zone factor, a = 5.35 in
Distance from centroid to neutral axis = 17.70 in

Compression Zone
Area of steel in compression zone, Asc = 0.79 in^2
Angle from centroid of pier to intersection of equivalent compression zone and edge of pier = 39.02 deg <-- 1/2 of total angle
Area of concrete in compression, Acc = 110.55 in^2
Force in concrete = 0.85 * f'c * Acc, Fc = 375.87 kips <-- ϕ Not Involved = Concrete Pn
Total reinforcement forces, Fs = -553.87 kips <-- ϕ Not Involved = Total Steel Pn
Case 1, φ= 0.900
Axial (comp=negative), Pu = 178.00 kips <-- Pu
Balance Force in concrete, Fs+Fu = -375.87 kips
Shaft Comp. Capacity, ϕPn= **-160.20** 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 = 2300.45 in^3
Distance between centroid of concrete in compression and centroid of pier = 20.81 in
Moment of concrete in compression = 7821.52 in-kips 651.7933 ft-kips
Total reinforcement moment = 3828.61 in-kips 319.0505 ft-kips
Nominal Moment strength of Drilled Shaft Mn = 11650.13 in-kips
Moment Capacity of Drilled Shaft, ϕMn = 10485.11 in-kips 873.7594 ft-kips

Case 1, φMn = 873.76 ft-kips

Case 2

Neutral Axis
Distance from extreme edge to neutral axis, h = 6.28 in
Equivalent compression zone factor = 0.85
Distance from extreme edge to equivalent compression zone factor, a = 5.33 in
Distance from centroid to neutral axis = 17.72 in

Compression Zone
Area of steel in compression zone, Asc = 1.58 in^2
Angle from centroid of pier to intersection of equivalent compression zone and edge of pier = 38.95 deg <-- 1/2 of total angle
Area of concrete in compression, Acc = 109.93 in^2
Force in concrete = 0.85 * f'c * Acc, Fc = 373.77 kips <-- ϕ Not Involved = Concrete Pn
Total reinforcement forces, Fs = -551.77 kips <-- ϕ Not Involved = Total Steel Pn
Case 2, φ= 0.900
Axial (comp=negative), Pu = 178.00 kips <-- Pu
Balance Force in concrete, Fs+Fu = -373.77 kips
Shaft Comp. Capacity, ϕPn= **-160.20** 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 = 2288.93 in^3
Distance between centroid of concrete in compression and centroid of pier = 20.82 in
Moment of concrete in compression = 7782.36 in-kips 648.5301 ft-kips
Total reinforcement moment = 3858.87 in-kips 321.5728 ft-kips
Nominal Moment strength of Drilled Shaft Mn = 11641.24 in-kips
Moment Capacity of Drilled Shaft, ϕMn = 10477.11 in-kips 873.0926 ft-kips

Case 2, φMn = 873.09 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 = 43.48 in
Equivalent compression zone factor = 0.85
Distance from extreme edge to equivalent compression zone factor, a = 36.96 in
Distance from centroid to neutral axis = -19.48 in

Compression Zone
Area of steel in compression zone, Asc = 8.69 in^2
Angle from centroid of pier to intersection of equivalent compression zone and edge of pier = 122.69 deg <-- 1/2 of total angle
Area of concrete in compression, Acc = 1495.20 in^2
Force in concrete = 0.85 * f'c * Acc, Fc = 5083.69 kips <-- ϕ Not Involved = Concrete Pn
Total reinforcement forces, Fs = 410.64 kips <-- ϕ Not Involved = Total Steel Pn
φ= 0.65
Magnified, Max Axial Comp, Pn, per ACI 318 (10-2)/(ϕ=0.65)= -5494.34 kips <-- (Pn per ACI 10-2)/ϕ
Balance Force in concrete, Fs+Fu = -5083.69 kips
Shaft Comp. Capacity, (ϕ=0.65)Pn= **3571.32** 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 = 5494.11 in^3
Distance between centroid of concrete in compression and centroid of pier = 3.67 in
Moment of concrete in compression = 18679.96 in-kips 1556.663 ft-kips
Total reinforcement moment = 3941.89 in-kips 328.491 ft-kips
Nominal Moment strength of Drilled Shaft Mn = 22621.85 in-kips
Moment Capacity of Drilled Shaft, (ϕ=0.65)Mn = 14704.20 in-kips 1225.35 ft-kips

Case 3, at Pmax, (φ=0.65)Mn = 1225.35 ft-kips

Final Results

Final Results		
Governing Orientation Case=	**2**	
phi, φ=	0.900	
Shaft ϕ*Mn=	**873.09**	ft-kips
Distance from Edge of Shaft to N.A.=	6.28	in
Shaft Beta=	0.85	
Maximum Tensile Strain=	-0.01791	<------------ εt > 0.0050, Tension Controlled
Shaft Tension Cap., φTn= (φ=0.9)*(Total As)(Fy)=	682.56	kips
Shaft Max Comp, (φ=0.65)(0.80)[0.85*f'c*(Ag-Ast)+Ast*Fy]=	3571.32	kips

TC

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	20.13	2.42	1.48	0.00115	0.79	33.48	23.77	478.31
2	22.50	18.59	0.89	-0.05	0.00043	0.00	12.33	9.74	181.08
3	45.00	14.23	-3.47	-4.41	-0.00165	0.00	-47.92	-37.86	-538.73
4	67.50	7.70	-10.00	-10.94	-0.00476	0.00	-60.00	-47.40	-365.05
5	90.00	0.00	-17.70	-18.65	-0.00843	0.00	-60.00	-47.40	0.00
6	112.50	-7.70	-25.40	-26.35	-0.01210	0.00	-60.00	-47.40	365.05
7	135.00	-14.23	-31.93	-32.88	-0.01521	0.00	-60.00	-47.40	674.53
8	157.50	-18.59	-36.29	-37.24	-0.01728	0.00	-60.00	-47.40	881.31
9	180.00	-20.13	-37.83	-38.77	-0.01801	0.00	-60.00	-47.40	953.93
10	202.50	-18.59	-36.29	-37.24	-0.01728	0.00	-60.00	-47.40	881.31
11	225.00	-14.23	-31.93	-32.88	-0.01521	0.00	-60.00	-47.40	674.53
12	247.50	-7.70	-25.40	-26.35	-0.01210	0.00	-60.00	-47.40	365.05
13	270.00	0.00	-17.70	-18.65	-0.00843	0.00	-60.00	-47.40	0.00
14	292.50	7.70	-10.00	-10.94	-0.00476	0.00	-60.00	-47.40	-365.05
15	315.00	14.23	-3.47	-4.41	-0.00165	0.00	-47.92	-37.86	-538.73
16	337.50	18.59	0.89	-0.05	0.00043	0.00	12.33	9.74	181.08
				Min-->	-0.01801	0.79		-553.87	3828.61
									319.0505

(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	11.25	19.74	2.01	1.07	0.00096	0.79	27.92	19.37	382.32
2	33.75	16.73	-0.99	-1.93	-0.00047	0.00	-13.74	-10.86	-181.64
3	56.25	11.18	-6.54	-7.48	-0.00313	0.00	-60.00	-47.40	-529.97
4	78.75	3.93	-13.80	-14.74	-0.00660	0.00	-60.00	-47.40	-186.10
5	101.25	-3.93	-21.65	-22.59	-0.01035	0.00	-60.00	-47.40	186.10
6	123.75	-11.18	-28.91	-29.85	-0.01382	0.00	-60.00	-47.40	529.97
7	146.25	-16.73	-34.46	-35.40	-0.01647	0.00	-60.00	-47.40	793.16
8	168.75	-19.74	-37.46	-38.40	-0.01791	0.00	-60.00	-47.40	935.60
9	191.25	-19.74	-37.46	-38.40	-0.01791	0.00	-60.00	-47.40	935.60
10	213.75	-16.73	-34.46	-35.40	-0.01647	0.00	-60.00	-47.40	793.16
11	236.25	-11.18	-28.91	-29.85	-0.01382	0.00	-60.00	-47.40	529.97
12	258.75	-3.93	-21.65	-22.59	-0.01035	0.00	-60.00	-47.40	186.10
13	281.25	3.93	-13.80	-14.74	-0.00660	0.00	-60.00	-47.40	-186.10
14	303.75	11.18	-6.54	-7.48	-0.00313	0.00	-60.00	-47.40	-529.97
15	326.25	16.73	-0.99	-1.93	-0.00047	0.00	-13.74	-10.86	-181.64
16	348.75	19.74	2.01	1.07	0.00096	0.79	27.92	19.37	382.32
				Min-->	-0.01791	1.58		-551.77	3858.87
									321.5728

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	20.13	39.61	33.09	0.00273	0.79	60.00	44.71	899.87
2	22.50	18.59	38.08	31.55	0.00263	0.79	60.00	44.71	831.37
3	45.00	14.23	33.71	27.19	0.00233	0.79	60.00	44.71	636.30
4	67.50	7.70	27.19	20.66	0.00188	0.79	54.39	40.28	310.24
5	90.00	0.00	19.48	12.96	0.00134	0.79	38.98	28.11	0.00
6	112.50	-7.70	11.78	5.26	0.00081	0.79	23.57	15.94	-122.74
7	135.00	-14.23	5.25	-1.27	0.00036	0.00	10.51	8.30	-118.17
8	157.50	-18.59	0.89	-5.63	0.00006	0.00	1.78	1.41	-26.19
9	180.00	-20.13	-0.64	-7.16	-0.00004	0.00	-1.28	-1.01	20.38
10	202.50	-18.59	0.89	-5.63	0.00006	0.00	1.78	1.41	-26.19
11	225.00	-14.23	5.25	-1.27	0.00036	0.00	10.51	8.30	-118.17
12	247.50	-7.70	11.78	5.26	0.00081	0.79	23.57	15.94	-122.74
13	270.00	0.00	19.48	12.96	0.00134	0.79	38.98	28.11	0.00
14	292.50	7.70	27.19	20.66	0.00188	0.79	54.39	40.28	310.24
15	315.00	14.23	33.71	27.19	0.00233	0.79	60.00	44.71	636.30
16	337.50	18.59	38.08	31.55	0.00263	0.79	60.00	44.71	831.37
				Min-->	-0.00004	8.69		410.64	3941.89
									328.491

TIA-222- H

FACTORED LOADS

Axial Load 0.9D:	$P_{\_0.9D}$ = 0.9 * P / 1.2	$P_{\_0.9D}$ =	36.75	kip
Axial Load 1.2D:	$P_{\_1.2D}$ = 1.2 * P / 1.2	$P_{\_1.2D}$ =	49.00	kip
Shear Load:	V_u = V	V_u =	44.00	kip
Moment:	M_u = Mu	M_u =	4078.00	kip*ft

PASSIVE PRESSURE RESISTANCE

Force of Pp Applied on Pier:	$Force_{pier}$ = MIN(Vu,Sum(Pp!M2:M7))	$Force_{pier}$ =	23.88	kip
Moment Arm of Pp on Pier:	M_{arm_pier} = D-T-Pp!O2 + T	M_{arm_pier} =	3.50	ft
Force of Pp Applied on Pad:	$Force_{pad}$ = MIN(Vu-Forcepier,SUM(Pp!M8:M13))	$Force_{pad}$ =	20.12	kip
Moment Arm of Pp on Pad:	M_{arm_pad} = D-Pp!O8	M_{arm_pad} =	1.13	ft
Unfactored Moment Resistance due to Passive Pressure:	$M_{R\_Pp} = Force_{pier}*M_{arm\_pier}+Force_{pad}*M_{arm\_pad}$	M_{R_Pp} =	106.25	kip*ft
Factored Moment Resistance due to Passive Pressure:	ΦM_{R_Pp} = Φs*MR_Pp	ΦM_{R_Pp} =	79.69	kip*ft

PLASTIC BEARING PRESSURE & OVERTURNING MOMENT

*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	$P_{bearing\_0.9}$ =	776.91	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	$P_{bearing\_1.2}$ =	1035.89	kip	
*Factored Overturning Moment (0.9*D LC):*	$M_{overturning\_0.9}$ = M + V * (MAX(T,D) + E + bpdist/12) + (0.9)*(P/1.2+3*Wpier)*Offset	$M_{overturning\_0.9}$ =	4531.70	kip*ft	
*Factored Overturning Moment (1.2*D LC):*	$M_{overturning\_1.2}$ = M + V * (MAX(T,D) + E + bpdist/12) + (1.2)*(P/1.2+3*Wpier)*Offset	$M_{overturning\_1.2}$ =	4592.49	kip*ft	
Area of Pad:	Area = W²	Area =	1089.00	ft^2	
Plastic Section Modulus of Pad:	Z = W³ / 4	Z =	8984.25	ft³	
*Preliminary Load Eccentricity (0.9*D LC):*	$pre\_ec_{\_0.9\_p} = M_{overturning}/P_{bearing\_0.9}$	$pre\_ec_{\_0.9\_p}$ =	5.83	ft	
*Preliminary Load Eccentricity (1.2*D LC):*	$pre\_ec_{\_1.2\_p} = M_{overturning}/P_{bearing\_1.2}$	$pre\_ec_{\_1.2\_p}$ =	4.43	ft	
*[Goal Seek] Load Eccentricity Iteration (0.9*D LC):*	$ec_{\_0.9\_p}$ = *goal seek*	$ec_{\_0.9\_p}$ =	5.73	ft	e <= L/4
*[Goal Seek] Load Eccentricity Iteration (1.2*D LC):*	$ec_{\_1.2\_p}$ = *goal seek*	$ec_{\_1.2\_p}$ =	4.36	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($\Phi M_{R\_wedges\_0.9}$,$\Phi M_{R\_shear\_0.9}$)	$\Phi M_{Resisting\_0.9}$ =	79.69	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($\Phi M_{R\_wedges\_1.2}$,$\Phi M_{R\_shear\_1.2}$)	$\Phi M_{Resisting\_1.2}$ =	79.69	kip*ft	
*Adjusted Overturning Moment (0.9*D LC):*	$M_{overturning\_adj\_0.9} = M_{overturning} - \Phi M_{Resisting\_0.9}$	$M_{overturning\_0.9}$ =	4452.01	kip*ft	
*Adjusted Overturning Moment (1.2*D LC):*	$M_{overturning\_adj\_1.2} = M_{overturning} - \Phi M_{Resisting\_1.2}$	$M_{overturning\_1.2}$ =	4512.80	kip*ft	
*Total Resistance to Overturning (0.9*D LC):*	$\Phi M_{Resisting\_qu\_0.9} = P_{bearing\_0.9}*ec_{\_0.9\_p} + \Phi M_{Resisting\_0.9}$	$\Phi M_{Resisting\_qu\_0.9}$ =	4531.70	kip*ft	
*Total Resistance to Overturning (1.2*D LC):*	$\Phi M_{Resisting\_qu\_1.2} = P_{bearing\_1.2}*ec_{\_1.2\_p} + \Phi M_{Resisting\_1.2}$	$\Phi M_{Resisting\_qu\_1.2}$ =	4592.49	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	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	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)	$q_{u\_orth\_0.9}$ =	1.21	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)	$q_{u\_orth\_1.2}$ =	1.45	ksf
Ultimate Gross Bearing Pressure:	Q_{ult} = Qult	Q_{ult} =	12.00	ksf
Factored Ultimate Gross Bearing Pressure:	ΦQult = φs * Qult	Qa =	9.00	ksf

Check **ΦQult =** **9.00** **ksf** **>=** **q_u =** **1.45** **ksf** **RATING:** **16.15%** **OK**

Soil Wedges (Cohesionless Soil)

Soil (above pad) Height:	soilht = D-T	soilht =	3.00	ft
Soil (above pad & under water table) Height:	soilht_gw = MIN(soilht-gw,D-T)	soilht_gw =	0.00	ft
Soil Wedge Projection Grade:	$Wedge_{\_proj}$ = TAN(ϕ*PI()/180)*soilht	$Wedge_{\_proj}$ =	2.02	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	33.00	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	33.00	0.00
(2) Partial Sides (below Water Table)	0.00	0.00	33.00	0.00
(1) Rear (above Water Table)	0.00	0.00	33.67	0.00
(1) Rear (below Water Table)	0.00	0.00	0.00	0.00
Total	0.00	0.00		0.00

Wedge 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	33.00	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	33.00	0.00
(2) Partial Sides (below Water Table)	0.00	0.00	33.00	0.00
(1) Rear (above Water Table)	0.00	0.00	33.67	0.00
(1) Rear (below Water Table)	0.00	0.00	0.00	0.00
Total	0.00	0.00		0.00

Wedge 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)

Effective Soil Unit Weight: $\gamma_{eff\_shear} = \gamma$ — γ_{eff_shear} = 0.1250 kcf

Depth to Mid-Layer of Soil: $H_{\_shear}$ = ((D - T) - N) / 2 + N — $H_{\_shear}$ = 1.50 ft

Cohesion at Mid-Layer of Soil: S_u = 0 — S_u = 0.00 ksf

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	33.00	0.00
(2) Partial Sides	0.00	0.00	33.00	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):* $M_{R\_shear\_0.9}$ = 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	33.00	0.00
(2) Partial Sides	0.00	0.00	33.00	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 (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	$P_{\_100}$ =	804.03	kip
Preliminary Factored Overturning Moment:	pre_$M_{overturning_100}$ = (W/2-($P_{\_100}$/ΦQult)/(2*W))*$P_{\_100}$	pre_$M_{overturning_100}$ =	12055.29	kip*ft
*Preliminary Load Eccentricity (0.9*D LC):*	pre_$ec_{_100}$ = pre_$M_{overturning_100}$ / $P_{\_100}$	pre_$ec_{_100}$ =	14.99	ft
*[Goal Seek] Load Eccentricity Iteration (0.9*D LC):*	$ec_{\_100}$ = *goal seek*	$ec_{\_100}$ =	14.89	ft (L/4 < e <= L/2)
*Non-Bearing Length (0.9*D LC):*	$NBL_{\_100}$ = 2*ec_100	$NBL_{\_100}$ =	29.79	ft
*Total Factored Resisting Moment due to Pp and Soil Wedges / Shear (0.9*D LC):*	$\Phi M_{Resisting\_100} = \Phi M_{R\_Pp} + SUM(\Phi M_{R\_wedges\_100}, \Phi M_{R\_shear\_100})$	$\Phi M_{Resisting\_100}$ =	281.43	kip*ft
Moment Created by Shear:	$M_{shear} = V_u * (D+E+bp_{dist}/12)$	M_{shear} =	271.33	kip*ft
*Adjusted Overturning Moment (0.9*D LC):*	$M_{overturning\_100} = M_{u\_max\_100} - \Phi M_{R\_Pp}$	$M_{overturning\_100}$ =	12257.03	kip*ft
*Total Resistance to Overturning (0.9*D LC):*	$\Phi M_{Resisting\_qu\_100} = P_{\_100} * ec_{\_100} + \Phi M_{Resisting\_100}$	$\Phi M_{Resisting\_qu\_100}$ =	12257.03	kip*ft
[Goal Seek] Moment Comparison Iteration (0.9D LC):	$\Delta M_{\_100} = M_{overturning} - \Phi M_{Resisting\_qu\_100}$	$\Delta M_{\_100}$ =	0.00	ft
Maximum Applied Moment from Superstructure Analysis:	$M_{u\_max\_100}$ = pre_Moverturning_100 + ΦMResisting_100	$M_{u\_max\_100}$ =	12336.72	kip*ft

Check **Mu_max_100 = 12336.72 kip*ft >= Mu = 4531.70 kip*ft** **RATING: 36.73% 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)	8.19	1.02	33.76	34.56

(2) End Prisms (below Water Table)	0.00	0.00	0.00	0.00
(2) Partial Sides (above Water Table)	180.84	22.60	18.11	409.27
(2) Partial Sides (below Water Table)	0.00	0.00	18.11	0.00
(1) Rear (above Water Table)	100.16	12.52	33.67	421.62
(1) Rear (below Water Table)	0.00	0.00	0.00	0.00
Total	289.19	36.15		865.45

Wedge Eccentricity relative to W/2:

Total Moment Arm (ft) =	7.44
Soil Wedge Wt (kip)=	36.15

*Unfactored Resisting Moment of Wedges (0.9*D LC):*	$M_{R\_wedges\_100}$ = Total Moment Arm * Soil Wedge Wt	$M_{R\_wedges\_100}$ = 268.99	kip*ft
*Factored Resisting Moment of Wedges (0.9*D LC):*	$\Phi M_{R\_wedges\_100}$ = 0.75*MR_wedges_100	$\Phi M_{R\_wedges\_100}$ = 201.74	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	99.00	0.00	33.00	0.00
(2) Partial Sides	178.73	0.00	18.11	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)))	$Force_{pier}$ =	23.88	kip
Moment Arm of Pp on Pier:	M_{arm_pier} = D-T-Pp!O2 + T	M_{arm_pier} =	3.50	ft
Force of Pp Applied on Pad:	$Force_{pad\_dia}$ = MIN(V_u-$Force_{pier}$,SUM(Pp!M8:M13))	$Force_{pad\_dia}$ =	20.12	kip
Moment Arm of Pp on Pad:	M_{arm_pad} = D-Pp!O8	M_{arm_pad} =	1.13	ft
Unfactored Moment Resistance due to Passive Pressure:	$M_{R\_Pp\_dia}$ = $Force_{pier}$*M_{arm_pier}+$Force_{pad}$*M_{arm_pad}	$M_{R\_Pp\_dia}$ =	106.25	kip*ft
Factored Moment Resistance due to Passive Pressure:	$\Phi M_{R\_Pp\_dia}$ = Φ_s*$M_{R\_Pp\_dia}$	$\Phi M_{R\_Pp\_dia}$ =	79.69	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	$P_{bearing\_0.9\_dia}$ =	776.91	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	$P_{bearing\_1.2\_dia}$ =	1035.89	kip	
Factored Overturning Moment:	$M_{overturning}$ = M_u + V_u * (D+E+bp_{dist}/12)	$M_{overturning}$ =	4349.33	kip*ft	
Area of Pad:	Area = W²	Area =	1089.00	ft²	
Plastic Section Modulus of Pad:	$Z_{\_dia}$ = W³ / (3*SQRT(2))	$Z_{\_dia}$ =	8470.43	ft³	
*Preliminary Load Eccentricity (0.9*D LC):*	$pre\_ec_{\_0.9\_p\_dia}$ = $M_{overturning}$/$P_{bearing\_0.9\_dia}$	$pre\_ec_{\_0.9\_p\_dia}$ =	5.83	ft	
*Preliminary Load Eccentricity (1.2*D LC):*	$pre\_ec_{\_1.2\_p\_dia}$ = $M_{overturning}$/$P_{bearing\_1.2\_dia}$	$pre\_ec_{\_1.2\_p\_dia}$ =	4.37	ft	
*[Goal Seek] Load Eccentricity Iteration (0.9*D LC):*	$ec_{\_0.9\_p\_dia}$ = *goal seek*	$ec_{\_0.9\_p\_dia}$ =	5.73	ft	e <= (L/4)*SQRT(2)/2
*[Goal Seek] Load Eccentricity Iteration (1.2*D LC):*	$ec_{\_1.2\_p\_dia}$ = *goal seek*	$ec_{\_1.2\_p\_dia}$ =	4.30	ft	e <= (L/4)*SQRT(2)/2
*Non-Bearing Length (0.9*D LC):*	$NBL_{\_0.9\_dia}$ = 0	$NBL_{\_0.9\_dia}$ =	0.00	ft	
*Non-Bearing Length (1.2*D LC):*	$NBL_{\_1.2\_dia}$ = 0	$NBL_{\_1.2\_dia}$ =	0.00	ft	
*Total Factored Resisting Moment due to Pp and Soil Wedges / Shear (0.9*D LC):*	$\Phi M_{Resisting\_0.9}$ = $\Phi M_{R\_Pp\_dia}$ + SUM($\Phi M_{R\_wedges\_0.9\_dia}$,$\Phi M_{R\_shear\_0.9\_dia}$)	$\Phi M_{Resisting\_0.9\_dia}$ =	79.69	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($\Phi M_{R\_wedges\_1.2\_dia}$,$\Phi M_{R\_shear\_1.2\_dia}$)	$\Phi M_{Resisting\_1.2\_dia}$ =	79.69	kip*ft	
*Adjusted Overturning Moment (0.9*D LC):*	$M_{overturning\_0.9\_dia}$ = $M_{overturning}$ - $\Phi M_{Resisting\_0.9\_dia}$	$M_{overturning\_0.9\_dia}$ =	4452.01	kip*ft	
*Adjusted Overturning Moment (1.2*D LC):*	$M_{overturning\_1.2\_dia}$ = $M_{overturning}$ - $\Phi M_{Resisting\_1.2\_dia}$	$M_{overturning\_1.2\_dia}$ =	4452.01	kip*ft	
*Total Resistance to Overturning (0.9*D LC):*	$\Phi M_{Resisting\_qu\_0.9\_dia}$ = $P_{bearing\_0.9\_dia}$*$ec_{\_0.9\_p\_dia}$ + $\Phi M_{Resisting\_0.9\_dia}$	$\Phi M_{Resisting\_qu\_0.9\_dia}$ =	4531.70	kip*ft	
*Total Resistance to Overturning (1.2*D LC):*	$\Phi M_{Resisting\_qu\_1.2\_dia}$ = $P_{bearing\_1.2\_dia}$*$ec_{\_1.2\_p\_dia}$ + $\Phi M_{Resisting\_1.2\_dia}$	$\Phi M_{Resisting\_qu\_1.2\_dia}$ =	4531.70	kip*ft	
[Goal Seek] Moment Comparison Iteration (0.9D LC):	$\Delta M_{\_0.9\_dia}$ = $M_{overturning}$-$\Phi M_{Resisting\_qu\_0.9\_dia}$	$\Delta M_{\_0.9\_dia}$ =	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/Area + Moverturning_0.9_dia / Z_dia	$q_{u\_dia\_0.9}$ =	1.24	ksf
*Diagonal Bearing Pressure (1.2*D LC):*	$q_{u\_dia\_1.2}$ = Pbearing_1.2_dia/Area + Moverturning_1.2_dia / Z_dia	$q_{u\_dia\_1.2}$ =	1.48	ksf
Ultimate Gross Bearing Pressure:	Q_{ult} = Qult	Q_{ult} =	12.00	ksf
Factored Ultimate Gross Bearing Pressure:	ΦQult = φs * Qult	Qa =	9.00	ksf

Check **ΦQult =** **9.00** **ksf** **>=** **q_u =** **1.48** **ksf** **RATING:** **16.41%** **OK**

Soil Wedges (Cohesionless Soil)

1

Soil (above pad) Height:	soilht = D-T	soilht =	3.00	ft
Soil (above pad & under water table) Height:	soilht_gw = MIN(soilht-gw,D-T)	soilht_gw =	0.00	ft
Soil Wedge Projection at Grade:	$Wedge_{\_proj}$ = TAN(ϕ*PI()/180)*soilht	$Wedge_{\_proj}$ =	2.02	ft

Soil Wedge Projection at Water Table:	$Wedge_{\_proj\_gw}$ =	TAN(ϕ*PI()/180)*(soilht_gw)	$Wedge_{\_proj\_gw}$ =	0.00 ft

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

Soil	Volume (ft³)	Soil Weight (kips)	Moment Arm (ft)	Unfactored Resisting Moment (kip*ft)
(2) End Prisms (above Water Table)	0.00	0.00	0.00	0.00
(2) End Prisms (below Water Table)	0.00	0.00	0.00	0.00
(1) End Prism (above Water Table)	0.00	0.00	0.00	0.00
(1) End Prisms (below Water Table)	0.00	0.00	0.00	0.00
(2) Partial Sides (above Water Table)	0.00	0.00	22.98	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	35.36	0.00
(2) Rear (below Water Table)	0.00	0.00	0.00	0.00
Total	0.00	0.00		0.00

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

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

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

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

Soil	Volume (ft³)	Soil Weight (kips)	Moment Arm (ft)	Unfactored Resisting Moment (kip*ft)
(2) End Prisms (above Water Table)	0.00	0.00	0.00	0.00
(2) End Prisms (below Water Table)	0.00	0.00	0.00	0.00
(1) End Prism (above Water Table)	0.00	0.00	0.00	0.00
(1) End Prisms (below Water Table)	0.00	0.00	0.00	0.00
(2) Partial Sides (above Water Table)	0.00	0.00	22.98	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	35.36	0.00
(2) Rear (below Water Table)	0.00	0.00	0.00	0.00
Total	0.00	0.00		0.00

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

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

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

Soil Shear Strength (Cohesive Soil)

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

Plane	Area (ft²)	Resistance (kip)	Moment Arm (ft)	Unfactored Resisting Moment (kip*ft)
(2) Rear	0.00	0.00	35.00	0.00
(2) Partial Sides	0.00	0.00	23.33	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	35.00	0.00
(2) Partial Sides	0.00	0.00	23.33	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	$P_{\_100\_dia}$ =	810.15 kip	
Preliminary Factored Overturning Moment:	$pre\_M_{overturning\_100\_dia}$ =	(P_100_dia/(SQRT(2)))*(W-SQRT(P_100_dia/ΦQult))	$pre\_M_{overturning\_100\_dia}$ =	13469.30 kip*ft	
*Preliminary Load Eccentricity (0.9*D LC):*	$pre\_ec_{\_100\_dia}$ =	$pre\_M_{overturning\_100\_dia} / P_{bearing\_0.9}$	$pre\_ec_{\_100\_dia}$ =	16.63 ft	
*[Goal Seek] Load Eccentricity Iteration (0.9*D LC):*	$ec_{\_100\_dia}$ =	*goal seek*	$ec_{\_100\_dia}$ =	16.53 ft	(L/4)*SQRT(2)/2 < e <
*Non-Bearing Length (0.9*D LC):*	$NBL_{\_100\_dia}$ =	SQRT(2)*ec_100_dia	$NBL_{\_100\_dia}$ =	23.37 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($\Phi M_{R\_wedges\_100\_dia}$,$\Phi M_{R\_shear\_100\_dia}$)	$\Phi M_{Resisting\_100\_dia}$ =	200.08 kip*ft	
Moment Created by Shear:	M_{shear} =	V_u * (D+E+bp_{dist}/12)	M_{shear} =	271.33 kip*ft	
*Adjusted Overturning Moment (0.9*D LC):*	$M_{overturning\_100\_dia}$ =	$M_{u\_max\_100\_dia} - \Phi M_{R\_Pp\_dia}$	$M_{overturning\_100\_dia}$ =	13589.68 kip*ft	
*Total Resistance to Overturning (0.9*D LC):*	$\Phi M_{Resisting\_qu\_100\_dia}$ =	$P_{bearing\_0.9}*ec_{\_100\_dia} + \Phi M_{Resisting\_100\_dia}$	$\Phi M_{Resisting\_qu\_100\_dia}$ =	13589.68 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	$M_{u\_max\_100\_dia}$ =	13669.38 kip*ft	

Check **Mu_max_100_dia =** **13669.38** **kip*ft** **>=** **Mu =** **4531.70** **kip*ft** **RATING:** **33.15%** **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)	8.19	1.02	23.33	23.89
(2) End Prisms (below Water Table)	0.00	0.00	0.00	0.00
(1) End Prism (above Water Table)	4.09	0.51	47.38	24.25
(1) End Prisms (below Water Table)	0.00	0.00	0.00	0.00
(2) Partial Sides (above Water Table)	141.89	17.74	14.71	260.95
(2) Partial Sides (below Water Table)	0.00	0.00	0.00	0.00
(2) Rear (above Water Table)	200.33	25.04	35.36	885.44
(2) Rear (below Water Table)	0.00	0.00	0.00	0.00
Total	354.50	44.31		1194.53

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

Total Moment Arm (ft) =	3.62
Soil Wedge Wt (kip)=	44.31

*Unfactored Resisting Moment of Wedges (0.9*D LC):* $M_{R\_wedges\_100\_dia}$ = Total Moment Arm * Soil Wedge Wt $M_{R\_wedges\_100\_dia}$ = 160.52 kip*ft

*Factored Resisting Moment of Wedges (0.9*D LC):* $\Phi M_{R\_wedges\_100\_dia}$ = 0.75*MR_wedges_100_dia $\Phi M_{R\_wedges\_100\_dia}$ = 120.39 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	198.00	0.00	35.00	0.00
(2) Partial Sides	140.24	0.00	15.07	0.00
Total		0.00		0.00

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

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

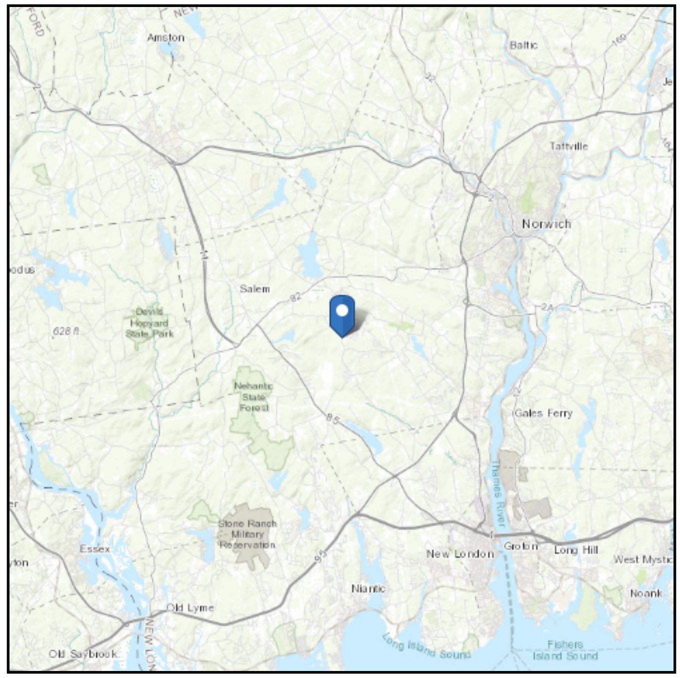
*Unfactored Resisting Moment of Soil Shear (0.9*D LC):* $M_{R\_shear\_100\_dia}$ = Total Moment Arm * Soil Shear Strength $M_{R\_shear\_100\_dia}$ = 0.00 kip*ft

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

ASCE
AMERICAN SOCIETY OF CIVIL ENGINEERS

ASCE 7 Hazards Report

Address:	**Standard:**	ASCE/SEI 7-10	**Elevation:**	605.68 ft (NAVD 88)
No Address at This Location	**Risk Category:**	III	**Latitude:**	41.46903
	Soil Class:	D - Stiff Soil	**Longitude:**	-72.204486



Wind

Results:	**79 Vmph**
Wind Speed:	142 Vmph ← 145 mph per the 2018 CSBC
10-year MRI	79 Vmph
25-year MRI	89 Vmph
50-year MRI	98 Vmph
100-year MRI	107 Vmph
Data Source:	ASCE/SEI 7-10, Fig. 26.5-1B and Figs. CC-1–CC-4, incorporating errata of March 12, 2014
Date Accessed:	Thu Oct 25 2018

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

Site is in a hurricane-prone region as defined in ASCE/SEI 7-10 Section 26.2. Glazed openings in health-care facilities shall be protected against wind-borne debris as specified in Section 26.10.3.

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

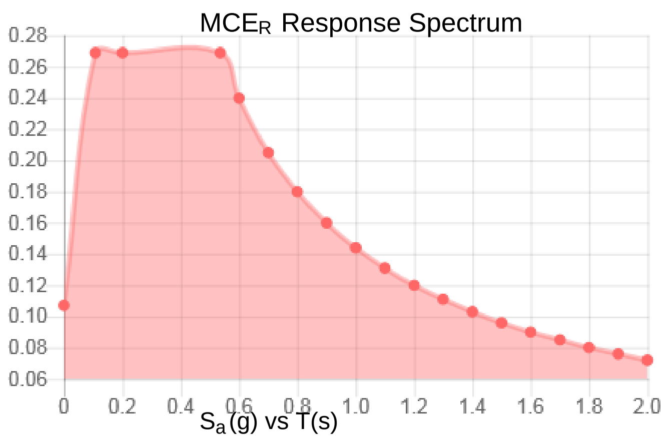
Seismic

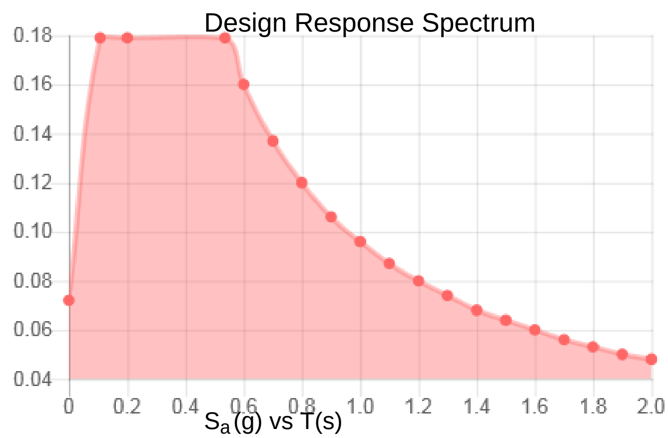
Site Soil Class: D - Stiff Soil

Results:

S_S :	0.168	S_{DS} :	0.179
S_1 :	0.060	S_{D1} :	0.096
F_a :	1.600	T_L :	6.000
F_v :	2.400	PGA :	0.084
S_{MS} :	0.269	PGA_M :	0.135
S_{M1} :	0.144	F_{PGA} :	1.600
		I_e :	1.25

Seismic Design Category B





Data Accessed: Thu Oct 25 2018

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

Ice

Results:

Ice Thickness:	0.75 in.
Concurrent Temperature:	15 F
Gust Speed:	50 mph
Data Source:	Standard ASCE/SEI 7-10, Figs. 10-2 through 10-8
Date Accessed:	Thu Oct 25 2018

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

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

ATTACHMENT D – PROOF OF DELIVERY OF NOTICE

Ref: ES-022 CHAPEL HI Date: 21Oct20 | SHIPPING: 0.00
Dep: BL GRAPHICS Wgt: 1.10 LBS | SPECIAL: 0.00
HANDLING: 0.00
DV: 0.00 TOTAL: 0.00

Svcs: PRIORITY OVERNIGHT
TRCK: 9151 3346 5927

ORIGIN ID:RSPA (800) 301-3077

BL COMPANIES
355 RESEARCH PARKWAY

MERIDEN, CT 06450
UNITED STATES US

SHIP DATE: 21OCT20
ACTWGT: 1.10 LB
CAD: 0765627/CAFE3407

BILL THIRD PARTY

TO HONORABLE RONALD K. MCDANIEL
TOWN OF MONTVILLE
310 NORWICH-NEW LONDON TPKE.

UNCASVILLE CT 06382
REF: ES-022 CHAPEL HILL

DEPT: BL GRAPHICS

56DC2/A27E/05A2

FedEx
Express

E

J201819110601uv

THU - 22 OCT 10:30A
PRIORITY OVERNIGHT

TRK# 0201 9151 3346 5927

00 SKKA

06382
CT-US BDL

Part # 156148-434 RIT EXP 09/21

Ref: ES-022 CHAPEL HI Date: 21Oct20
Dep: BL GRAPHICS Wgt: 1.10 LBS

DV: 0.00

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

Svcs: PRIORITY OVERNIGHT
TRCK: 9151 3346 5938

ORIGIN ID:RSPA (800) 301-3077

BL COMPANIES
355 RESEARCH PARKWAY

MERIDEN, CT 06450
UNITED STATES US

SHIP DATE: 21OCT20
ACTWGT: 1.10 LB MAN
CAD: 0765627/CAFE3407

BILL THIRD PARTY

56DC2/A27E/05A2

TO **MARCIA A. VLAUN, TOWN PLANNER**
TOWN OF MONTVILLE
15 ROPE FERRY ROAD

WATERFORD CT 06385

REF: ES-022 CHAPEL HILL

DEPT: BL GRAPHICS

FedEx Express

E

J201019110601uv

THU - 22 OCT 10:30A
PRIORITY OVERNIGHT

TRK# 0201 **9151 3346 5938**

00 SKKA

06385
CT-US **BDL**

Part # 156148-434 RIT EXP 09/21

Ref: ES-022 CHAPEL HI Date: 21Oct20
Dep: BL GRAPHICS Wgt: 1.10 LBS
DV: 0.00

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

Svcs: PRIORITY OVERNIGHT
TRCK: 9151 3346 5949

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

SHIP DATE: 21OCT20
ACTWGT: 1.10 LB MAN
CAD: 0765627/CAFE3407

BILL THIRD PARTY

TO

CONNECTICUT SITING COUNCIL
10 FRANKLIN SQUARE

NEW BRITAIN CT 06051
REF: ES-022 CHAPEL HILL
DEPT: BL GRAPHICS

56DC2/A27E/05A2

FedEx
Express

E

J201019110601uv

THU - 22 OCT 10:30A
PRIORITY OVERNIGHT

TRK# 0201 **9151 3346 5949**

00 BDLA

06051
CT-US **BDL**

Part # 156148-434 RIT EXP 09/21

ATTACHMENT E - POWER DENSITY REPORT

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

Calculated Radio Frequency Emissions Report

ES-022

414 Chapel Hill Road

Montville, CT 06370

September 16, 2020

Table of Contents

List of Tables

List of Figures

1. Introduction

The purpose of this report is to investigate compliance with applicable FCC regulations for the proposed Eversource installation on the tower at 414 Chapel Hill Road in Montville, CT. Eversource is proposing to install one omnidirectional antenna and a microwave dish as part of its 220 MHz communications system.

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

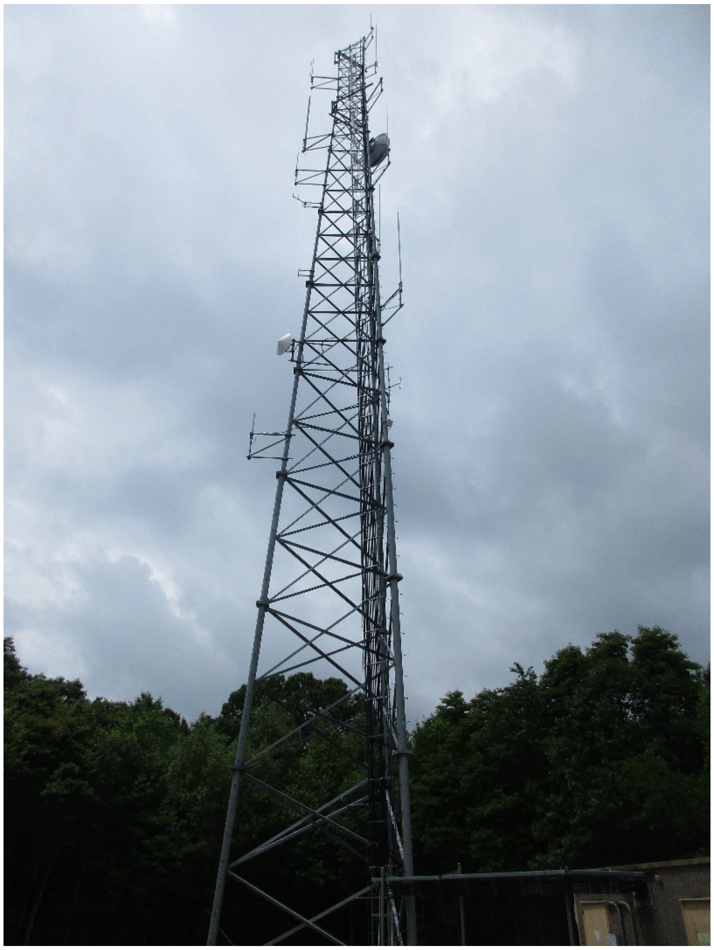


Figure 1: View of ES-022 Chapel Hill

Site Address	414 Chapel Hill Road
Latitude	41° 28' 8.31" N
Longitude	72° 12' 16.66" W
Site Elevation AMSL	607'
Survey Engineer	Marc Salas
Survey Date/Time	6/24/2020; 11:30 AM – 12:30 PM

Table 1: Survey Information

2. FCC Guidelines for Evaluating RF Radiation Exposure Limits

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

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

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

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

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

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. Proposed Antenna Configuration

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

Operator	Antenna Model	TX Freq. (MHz)	Ant Gain (dBd)	Power ERP (Watts)	Number of Channels	Vertical Beamwidth	Length (ft)	Antenna Centerline Height (ft)
Eversource	dBSpectra DS2C00F36D	217	0	124	4	60°	13.6	180
Eversource	RFS PAD6-59	6004.5	36.3	2129	1	1.7°	6.0	170

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

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

[2] Transmit antenna height listed for the proposed 217 MHz antenna is based on the Black & Veatch Structural Analysis Report dated August 17, 2020 and the overall mechanical length of the antenna. The proposed antenna consists of two internally stacked antennas – upper is for receive, lower is for transmit. Due to the unavailability of these specific digital patterns for these specific antennas, patterns for a like antennas were substituted in the calculations.

5. Measurement Procedure

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

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

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

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

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

Manufacturer	Narda Microwave			
Probe	EA 5091, Serial# 01116			
Calibration Date	May 2020			
Calibration Interval	24 Months			
Meter	NBM550, Serial# E-1069			
Calibration Date	May 2020			
Calibration Interval	24 Months			
Probe Specifications	**Frequency Range**	**Field Measured**	**Standard**	**Measurement Range**
	300 KHz-50 GHz	Electric Field	U.S. FCC 1997 Occupational/Controlled	0.2 – 600 % of Standard

Table 3: Instrumentation Information

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

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

6. Surveyed and Calculated % MPE Results

Measured and calculated results and a description of each survey location are detailed in the table below. Measurements were recorded on June 24, 2020 between 11:30 AM and 12:30 PM. The calculated % MPE contribution from the proposed equipment modifications was then added to the measured % MPE values in the “Composite % MPE” column. These calculated values incorporate the antenna pattern of the antenna model specified by Eversource to determine the “Off Beam Loss” factor shown in the power density formula from Section 4. All % MPE values are in reference to the FCC Uncontrolled/General Population exposure limit.

Table 4 below lists 13 measurements recorded in the vicinity of the tower. The highest spatially averaged measurement was 3.11% (Average Uncontrolled / General Population MPE) and was recorded near the compound access gate (Location 1). The highest composite (measured + calculated) % MPE value is calculated to be 4.43% (Average Uncontrolled / General Population) and is also calculated to occur by the compound access gate (Location 1).

Meas. Location	Location Description	Latitude	Longitude	Dist. From Site (feet)	Measured % MPE (Uncontrolled / General)	Calculated % MPE (Eversource Proposed)	Composite % MPE (Uncontrolled / General)
1	**Compound access gate**	**41.46913**	**-72.20434**	**96**	**3.11%**	**1.32%**	**4.43%**
2	Enear Equipment Shelter	41.46905	-72.20460	30	< 1.00%	0.27%	< 1.27%
3	South section of compound parking area	41.46888	-72.20447	56	< 1.00%	0.68%	< 1.68%
4	Near SW tower leg	41.46893	-72.20469	24	< 1.00%	0.20%	< 1.20%
5	Adjacent tower access road	41.46859	-72.20396	230	< 1.00%	1.07%	< 2.07%
6	Middle of nearby cemetery	41.46930	-72.20399	213	< 1.00%	1.17%	< 2.17%
7	North strip entrance	41.46988	-72.20446	335	< 1.00%	0.62%	< 1.62%
8	In front of fire department	41.47093	-72.20474	715	2.58%	0.14%	2.72%
9	Intersection of Florida Drive and Texas Drive	41.47007	-72.20302	594	1.74%	0.20%	1.94%
10	Intersection of New Hampshire Lane and Texas Drive	41.47191	-72.20339	1124	1.76%	0.05%	1.81%
11	Intersection of New Hampshire Lane and Connecticut Blvd.	41.47189	-72.20004	1647	2.32%	0.02%	2.35%
12	Intersection of Florida Drive and Connecticut Blvd.	41.47009	-72.20015	1291	2.33%	0.04%	2.37%
13	Intersection of Chapel Hill Road and New York Road	41.47280	-72.20491	1399	2.42%	0.03%	2.46%

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

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

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

Figure 2: Measurement Points – Zoom In

Figure 3: All Measurement Points

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

7. Conclusion

A number of accessible areas around the tower at 414 Chapel Hill Road in Montville, CT were surveyed and found to be well within the mandated General Population/Uncontrolled limits for Maximum Permissible Exposure, as delineated in the Federal Communications Commission's Radio Frequency exposure rules published in 47 CFR 1.1307(b)(1)-(b)(3).

The highest spatially averaged % MPE measurement of all surveyed points based on the 1997 FCC standard for exposure to the general population is 3.11% MPE. This measurement was recorded at Location 1 by the tower compound access gate.

The highest composite (measured + calculated) power density is **4.43% of the FCC General Population MPE limit** with the proposed Eversource equipment is also calculated to occur at Location 1 at the tower compound access gate.

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

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

8. 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.

Marc Salas (signature)

September 14, 2020

Report Prepared By: Marc Salas
RF Engineer
C Squared Systems, LLC

Date

Keith Vellante (signature)

September 16, 2020

Reviewed/Approved By: Keith Vellante
Director of 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[6]

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

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

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

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

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

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

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

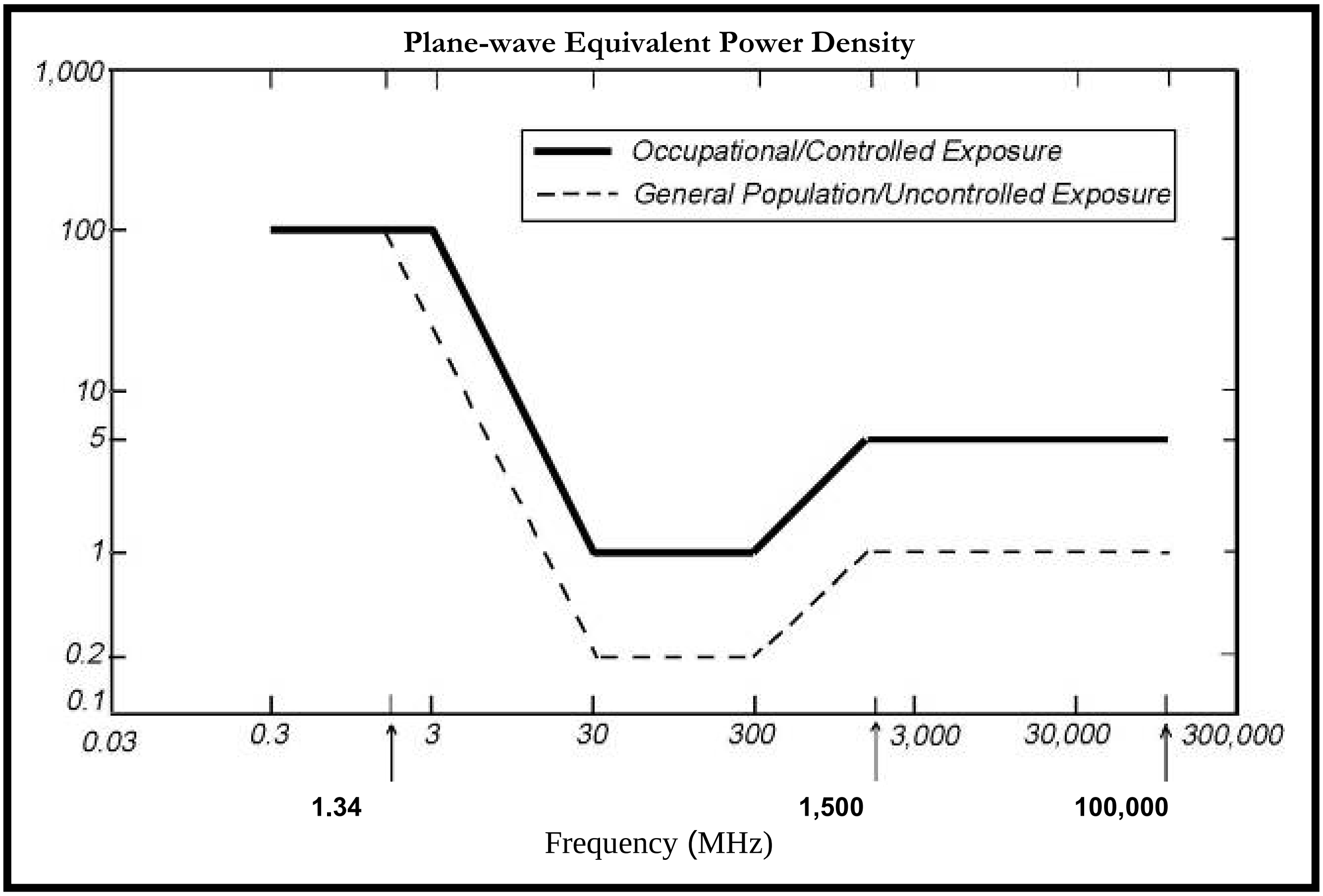
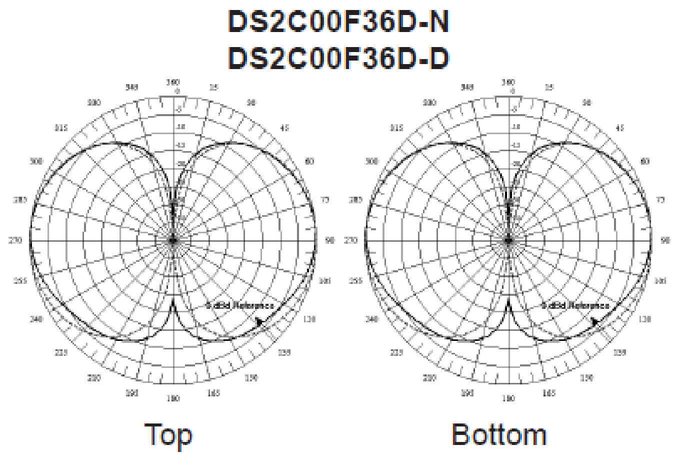


Figure 4: Graph of FCC Limits for Maximum Permissible Exposure (MPE)

Attachment C: Eversource Antenna Data Sheet and Electrical Patterns

217 MHz

Manufacturer:	dbSpectra
Model #:	DS2C00F36D
Frequency Band:	217 - 222 MHz
Gain:	0 dBd
Vertical Beamwidth:	60°
Horizontal Beamwidth:	360°
Polarization:	Vertical-Polarization
Length:	12.6’



217 MHz

Manufacturer:	RFS
Model #:	PAD6-W59BC
Frequency Band:	5925 - 6875 MHz
Gain:	36.3 dBd
Vertical Beamwidth:	1.7°
Horizontal Beamwidth:	1.7°
Polarization:	Single
Length:	6’