November 22, 2016

VIA EMAIL AND OVERNIGHT DELIVERY

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

RE: T-Mobile Northeast LLC – CT11860A
Notice of Exempt Modification
48 Quail Trail, Trumbull, CT
Pole 838
LAT: 41-13-57.66N
LNG: 73-10-20.11W

Dear Ms. Bachman:

T-Mobile Northeast LLC ("T-Mobile") currently maintains three (3) antennas at the 105' level on the existing 95' transmission tower located at 48 Quail Trail, Trumbull, CT. The structure is owned by Eversource Energy, their use of the structure was approved by the Council on December 14, 2000 (Docket No. 496). T-Mobile submitted a Petition for a 10' extension on this structure, which was approved by the Council on December 4, 2008 (Petition 872).

Please accept this letter as notification pursuant to Regulations of Connecticut State Agencies 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. l6-50j-73, a copy of this letter is being sent to Timothy M. Herbst, First Selectman, Town of Trumbull, and the property owner, Eversource Energy.

The planned modifications to the facility fall squarely within those activities explicitly provided for in RC.S.A. 16-50j-72(b)(s).

1. The proposed modifications will not result in an increase in the height of the existing structure. T-Mobile proposes to swap (3) antennas, at a centerline height of 105' on the existing 95' structure.

2. The proposed modifications will not require the extension of the site boundary. There will be no effect on the site compound or T-Mobile's leased area.

3. The proposed modifications will not increase noise levels at the facility by six decibels or more, or to levels that exceed state and local

criteria. The incremental effect of the proposed changes will be negligible.

4. The operation of the replacement antennas will not increase radio frequency emissions at the facility to a level at or above the Federal Communications Commission safety standard. As indicated in the attached power density calculations, T-Mobile's operations at the site will result in a power density of 2.50%; the combined site operations will result in a total power density of 2.50%.

5. The proposed modifications will not cause a change or alteration in the physical or environmental characteristics of the site. T-Mobile will swap antennas on the existing mounts and the coax lines will be run within the existing cable tray.

6. The existing structure, and its foundation can support T-Mobile's proposed loading, as indicated in the attached structural analysis.

For the foregoing reasons, T-Mobile respectfully submits that the proposed modifications to the above-referenced telecommunications facility constitute an exempt modification under R.C.S.A. J 6-50j-72(b)(2) .

Please feel free to call me with any questions or concerns regarding this matter. Thank you for your consideration.

Respectfully submitted,

By: ______________________

Jamie Ford, Agent for T-Mobile
jford@verticaldevelopmentllc.com
774-248-5373

Attachments

cc: Timothy M. Herbst, First Selectman, Town of Trumbull
Eversource Energy

NOTES:

1. PROPOSED T-MOBILE INSTALLATION SHALL CONSIST OF THE REPLACEMENT OF THREE (3) DIRECTIONAL PANEL ANTENNAS MOUNTED AT A CENTERLINE ELEVATION OF ±105' AGL.

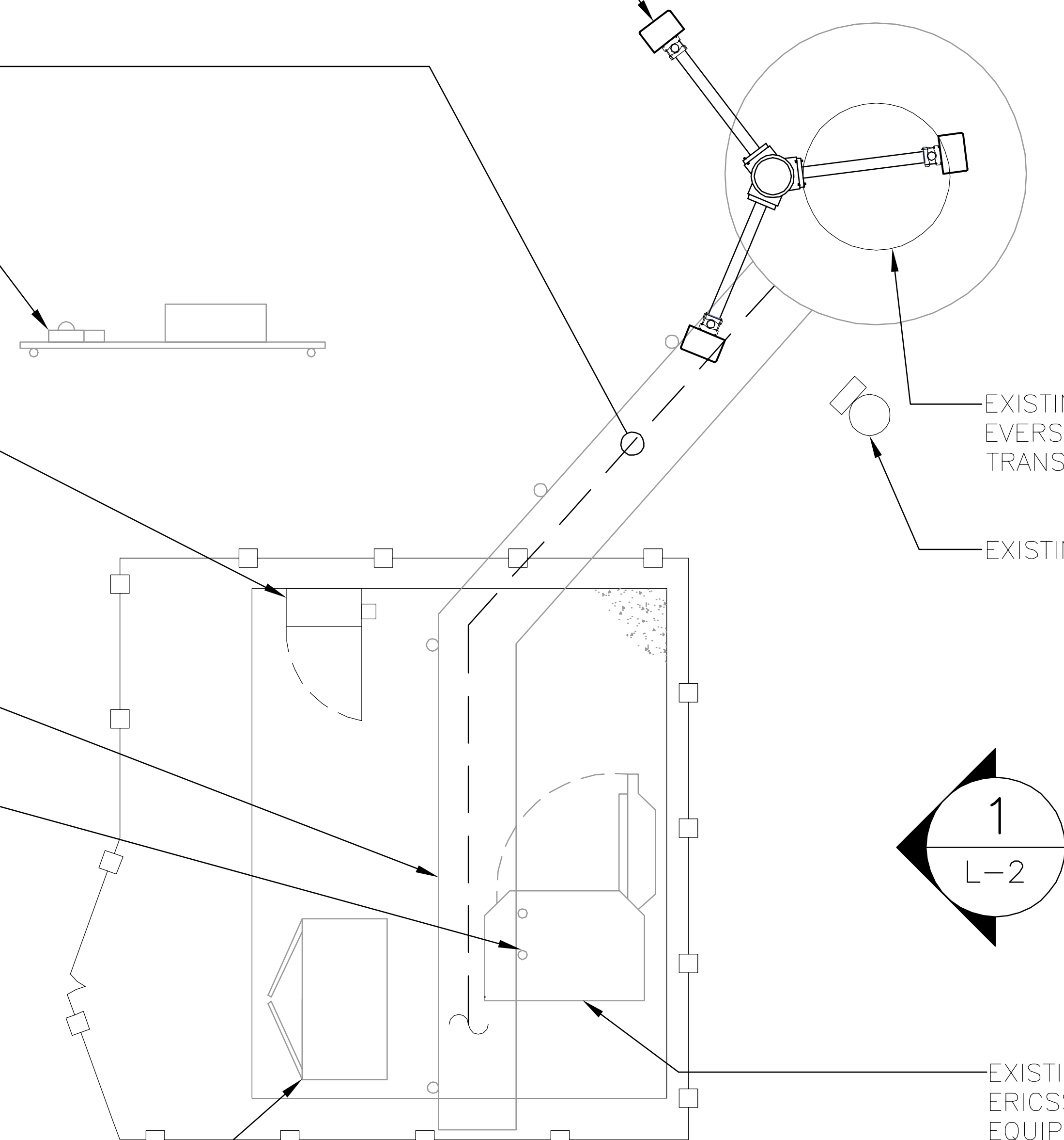
LEASE EXHIBIT

THIS LEASE PLAN IS DIAGRAMMATIC IN NATURE AND IS INTENDED TO PROVIDE GENERAL INFORMATION REGARDING THE LOCATION AND SIZE OF THE PROPOSED WIRELESS COMMUNICATION FACILITY. THE SITE LAYOUT WILL BE FINALIZED UPON COMPLETION OF SITE SURVEY AND FACILITY DESIGN.

TOWER COORDINATES:	LAT.: 41°-13'-57.74" LNG.: 73°-10'-19.87"
GROUND ELEVATION:	228± A.M.S.L.

COORDINATES AND GROUND ELEVATION REFERENCED FROM GOOGLE EARTH.

T-MOBILE RAN TEMPLATE: 704Bu OUTDOOR
T-MOBILE RF CONFIGURATION: 1HP_704Bu



1
L-1

SITE PLAN

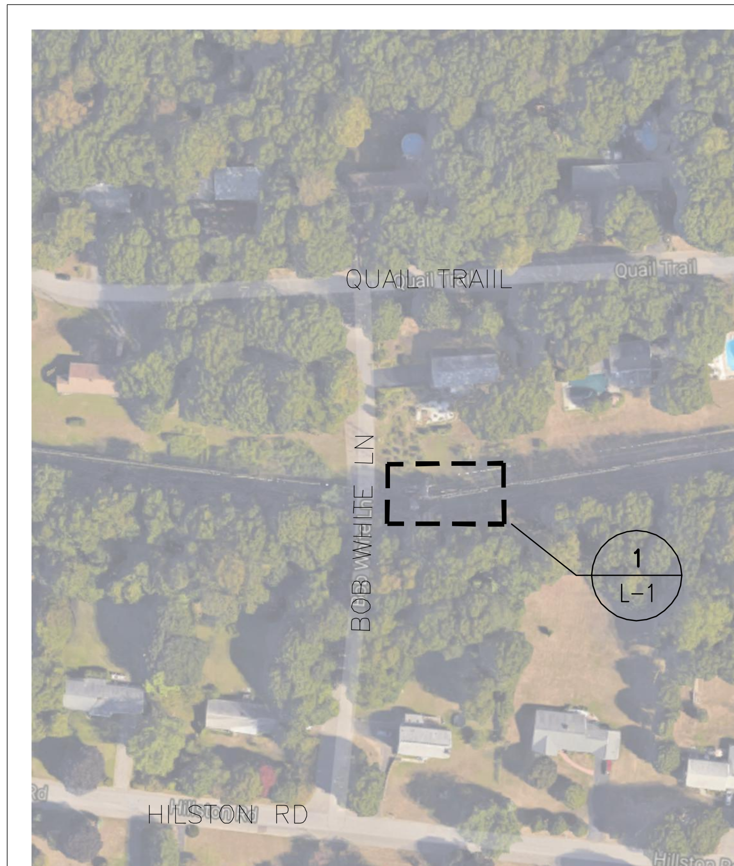
SCALE: 1" = 5'

APPROXIMATE NORTH

GRAPHIC SCALE

5 0 2.5 5 10 20

(IN FEET)
1 inch = 5 ft.



SITE KEY PLAN

SCALE: 1" = 150'

APPROXIMATE NORTH

REV.	DATE	DRAWN BY	CHK'D BY	DESCRIPTION
0	10/11/16	FPE	HMR	LEASE EXHIBIT
1	10/20/16	FPE	HMR	LEASE EXHIBIT – ISSUED FOR CLIENT REVIEW

PROFESSIONAL ENGINEER SEAL

CENTEK engineering
Centered on Solutions℠
(203) 488-0580
(203) 488-8587 Fax
63-2 North Branford Road, Branford, CT 06405
www.CentekEng.com

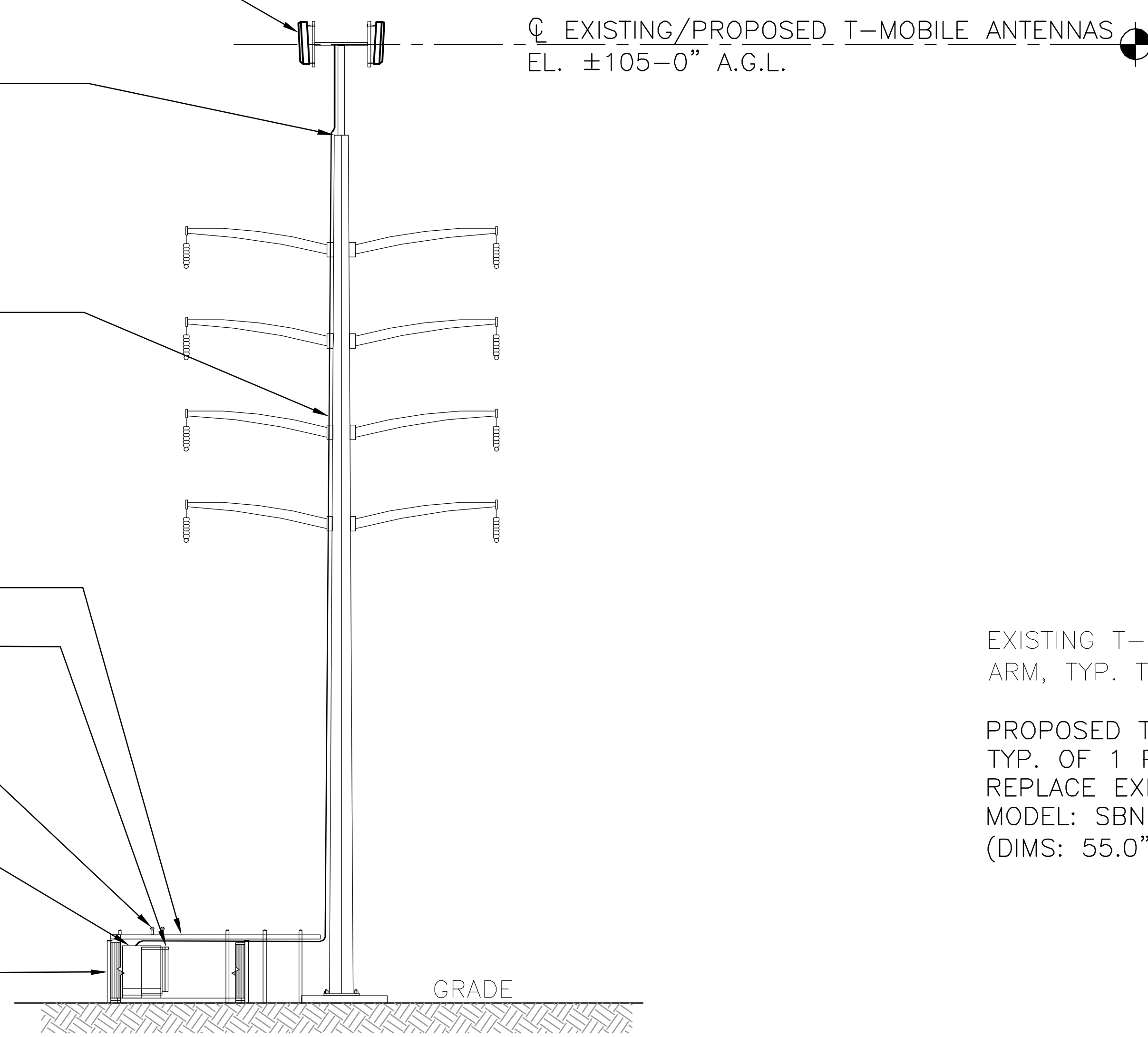
T-MOBILE NORTHEAST LLC
CT860/CL&P TRUMBULL
SITE ID: CT11860A
48 QUAIL TRAIL
TRUMBULL, CT 06611

DATE:	10/05/16
SCALE:	AS SHOWN
JOB NO.	16159.04

SHEET NO.
L-1

LEASE EXHIBIT

THIS LEASE PLAN IS DIAGRAMMATIC IN NATURE AND IS INTENDED TO PROVIDE GENERAL INFORMATION REGARDING THE LOCATION AND SIZE OF THE PROPOSED WIRELESS COMMUNICATION FACILITY. THE SITE LAYOUT WILL BE FINALIZED UPON COMPLETION OF SITE SURVEY AND FACILITY DESIGN.



PROPOSED T-MOBILE ANTENNAS, TYP. OF THREE (3) MOUNTED TO EXISTING ANTENNA MAST ATTACHED TO EVERSOURCE TRANSMISSION STRUCTURE.

EXISTING 95' TALL TOWER EVERSOURCE TRANSMISSION STRUCTURE.

TWELVE (12) EXISTING T-MOBILE 1-5/8"ø COAX CABLES AND SIX (6) PROPOSED 1-5/8" COAX CABLES ROUTED ALONG TRANSMISSION STRUCTURE EXTERIOR.

EXISTING T-MOBILE ICE BRIDGE, TYP.

EXISTING T-MOBILE ERICSSON RBS 6102 CABINET ON CONC. PAD TO REMAIN.

EXISTING GPS ANTENNA (TYP. OF 2).

EXISTING T-MOBILE ERICSSON RBS 3106 EQUIPMENT CABINET ON CONC. PAD TO REMAIN.

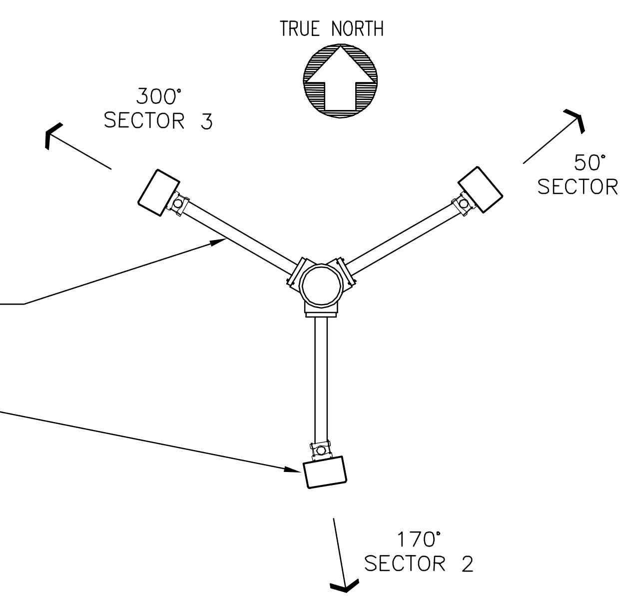
EXISTING 8' TALL WOOD STOCKADE FENCE, TYP.

1
L-2
EAST ELEVATION
SCALE: 1" = 10'

GRAPHIC SCALE

10 0 5 10 20 40

(IN FEET)
1 inch = 10 ft.



EXISTING T-MOBILE STAND OFF ARM, TYP. THREE (3) TOTAL.

PROPOSED T-MOBILE ANTENNA, TYP. OF 1 PER SECTOR, TO REPLACE EXISTING ANTENNA. MODEL: SBNHH-1D65A (DIMS: 55.0"Lx11.9"Wx7.1"D)

2
L-2
ANTEANNA LAYOUT PLAN
NOT TO SCALE

REV.	DATE	DRAWN BY	CHK'D BY	DESCRIPTION
1	10/20/16	FPE	HMR	LEASE EXHIBIT
0	10/11/16	FPE	HMR	LEASE EXHIBIT - ISSUED FOR CLIENT REVIEW

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T-MOBILE NORTHEAST LLC
CT860/CL&P TRUMBULL
SITE ID: CT11860A
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DATE: 10/05/16
SCALE: AS SHOWN
JOB NO. 16159.04

SHEET NO.
L-2

CENTEK engineering

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Structural Analysis of Antenna Mast and Pole

T-Mobile Site Ref: CT11860A

Eversource Structure No. 838
95' Electric Transmission Pole

48 Quail Trail
Trumbull, CT

CENTEK Project No. 16159.04

Date: October 24, 2016

STATE OF CONNECTICUT
TIMOTHY J. LYNN
No. 29336
LICENSED
PROFESSIONAL ENGINEER

Prepared for:
T-Mobile USA
35 Griffin Road
Bloomfield, CT 06002

Table of Contents

Introduction

The purpose of this report is to analyze the existing mast and 95' utility pole located at 48 Quail Trail in Trumbull, CT for the proposed antenna and equipment upgrade by T-Mobile.

The existing/proposed loads consist of the following:

- T-MOBILE (Existing to be removed):

  Antennas: Three (3) RFS APX16DWV-16DWVS-E-A20 panel antennas mounted on a mast with a RAD center elevation of 105-ft above tower base plate.

- T-MOBILE (Existing to remain):

  Coax Cables: Twelve (12) 1-5/8" ∅ coax cables running on the outside of the tower as indicated in section 4 of this report.

- **T-MOBILE (Proposed):**

  Antennas: Three (3) Andrew SBNHH-1D65A panel antennas mounted on three (3) existing standoff arms to the existing pipe mast with a RAD center elevation of 105-ft above tower base plate.
  Coax Cables: Six (6) 1-5/8" ∅ coax cables running on the outside of the tower as indicated in section 4 of this report.

Primary assumptions used in the analysis

- ASCE Manual No. 72, "Design of Steel Transmission Pole Structures Second Edition", defines steel stresses for evaluation of the utility pole.
- All utility pole members are adequately protected to prevent corrosion of steel members.
- All proposed antenna mounts are modeled as listed above.
- Pipe mast will be properly installed and maintained.
- No residual stresses exist due to incorrect pole erection.
- All bolts are appropriately tightened providing the necessary connection continuity.
- All welds conform to the requirements of AWS D1.1.
- Pipe mast and utility pole will be in plumb condition.
- Utility pole was properly installed and maintained and all members were properly designed, detailed, fabricated, and installed and have been properly maintained since erection.
- Any deviation from the analyzed loading will require a new analysis for verification of structural adequacy.

Analysis

Structural analysis of the existing antenna mast was independently completed using the current version of RISA-3D computer program licensed to CENTEK Engineering, Inc.

The existing mast consisting of a 12-in x 28.25-ft long SCH. 40 pipe (O.D. = 12.75") connected at two points to the existing tower was analyzed for its ability to resist loads prescribed by the TIA-222G standard. Section 5 of this report details these gravity and lateral wind loads. NESC prescribed loads were also applied to the mast in order to obtain reactions needed for analyzing the utility pole structure. These loads are developed in Section 7 of this report. Load cases and combinations used in RISA-3D for TIA-222-G loading and for NESC/NU loading are listed in report Sections 6 and 8, respectively.

An envelope solution was first made to determine maximum and minimum forces, stresses, and deflections to confirm the selected section as adequate. Additional analyses were then made to determine the NESC forces to be applied to the pole structure.

The RISA-3D program contains a library of all AISC shapes and corresponding section properties are computed and applied directly within the program. The program's Steel Code Check option was also utilized. The forces calculated in RISA-3D using NESC guidelines were then applied to the pole using PLS-Pole. Maximum usage for the pole was calculated considering the additional forces from the mast and associated appurtenances.

Design Basis

Our analysis was performed in accordance with TIA-222-G, ASCE Manual No. 72 – "Design of Steel Transmission Pole Structures Second Edition", NESC C2-2007 and Northeast Utilities Design Criteria.

- UTILITY POLE ANALYSIS

  The purpose of this analysis is to determine the adequacy of the existing utility pole to support the proposed antenna loads. The loading and design requirements were analyzed in accordance with the NU Design Criteria Table, NESC C2-2007 ~ Construction Grade B, and ASCE Manual No. 72.

  Load cases considered:

  Load Case 1: NESC Heavy
  Wind Pressure.................................. 4.0 psf
  Radial Ice Thickness............................ 0.5"
  Vertical Overload Capacity Factor............ 1.50
  Wind Overload Capacity Factor................ 2.50
  Wire Tension Overload Capacity Factor...... 1.65

  Load Case 2: NESC Extreme
  Wind Speed..................................... 110 mph (1)
  Radial Ice Thickness............................ 0"

  Note 1: NESC C2-2007, Section25, Rule 250C: Extreme Wind Loading, 1.25 x Gust Response Factor (wind speed: 3-second gust)

- MAST ASSEMBLY ANALYSIS

  Mast, appurtenances and connections to the utility tower were analyzed and designed in accordance with the NU Design Criteria Table, TIA-222-G and AISC standards.

  Load cases considered:

  Load Case 1:
  Wind Speed………………………………... 97 mph (2016 CSBC Appendix-N)
  Radial Ice Thickness………………………. 0”

  Load Case 2:
  Wind Pressure.……………………………. 50 mph wind pressure
  Radial Ice Thickness……………………….. 0.75”

Results

- MAST ASSEMBLY

  The existing mast was determined to be structurally **adequate**.

Member	Stress Ratio (% of capacity)	Result
12” Sch. 40 Pipe	17.3%	**PASS**
3/4” ∅ ASTM A325 Bolt	14.7%	**PASS**

- UTILITY POLE

  This analysis finds that the subject utility pole is adequate to support the proposed antenna mast and related appurtenances. The pole stresses meet the requirements set forth by the ASCE Manual No. 72, “Design of Steel Transmission Pole Structures Second Edition”, for the applied NESC Heavy and Hi-Wind load cases. The detailed analysis results are provided in Section 9 of this report. The analysis results are summarized as follows:

  A maximum usage of **68.59%** occurs in the utility pole base plate under the **NESC Heavy** loading condition.

  POLE SECTION:

  The utility pole was found to be within allowable limits.

Tower Section	Elevation	Stress Ratio (% of capacity)	Result
Tube Number 2	9.25-54.25’ (AGL)	68.59%	**PASS**

  BASE PLATE:

  The base plate was found to be within allowable limits from the PLS output based on 16 bend lines.

Tower Component	Design Limit	Stress Ratio (percentage of capacity)	Result
Base Plate	Bending	61.82%	**PASS**

- FOUNDATION AND ANCHORS

The existing foundation consists of a 10-ft square x 14-ft long reinforced concrete pier with (16) rock anchors. The base of the tower is connected to the foundation by means of (20) 2.25”∅, ASTM A615-75 anchor bolts embedded into the concrete foundation structure. Foundation information was obtained from NUSCO drawing # 01103-60000.

BASE REACTIONS:

From PLS-Pole analysis of pole based on NESC/NU prescribed loads.

Load Case	Shear	Axial	Moment
NESC Heavy Wind	47.97 kips	63.68 kips	3540.23 ft-kips
NESC Extreme Wind	49.98 kips	34.68 kips	3462.89 ft-kips

Note 1 – 10% increase applied to tower base reactions per OTRM 051

ANCHOR BOLTS:

The anchor bolts were found to be within allowable limits.

Tower Component	Design Limit	Stress Ratio (% of capacity)	Result
Anchor Bolts	Tension	58.71%	**PASS**

FOUNDATION:

The foundation was found to be within allowable limits.

Foundation	Design Limit	Allowable Limit	Proposed Loading (4)	Result
Reinf. Conc. Pier w/ Rock Anchors	OTM (1)	1.0 FS (2)	1.97 FS (2)	**PASS**
	Bearing Pressure	50 ksf (3)	39.6 ksf	**PASS**

Note 1: OTM denotes overturning moment.
Note 2: FS denotes Factor of Safety
Note 3: Bearing Capacity based on Weak Rock.
Note 4: 10% increase to PLS base reactions used in foundation analysis per OTRM 051.

Conclusion

This analysis shows that the subject utility pole **is adequate** to support the proposed T-Mobile equipment upgrade.

The analysis is based, in part on the information provided to this office by Eversource and T-Mobile. If the existing conditions are different than the information in this report, CENTEK engineering, Inc. must be contacted for resolution of any potential issues.

Please feel free to call with any questions or comments.

Respectfully Submitted by:

Timothy J. Lynn, PE
Structural Engineer

STATE OF CONNECTICUT TIMOTHY J. LYNN No. 29336 LICENSED PROFESSIONAL ENGINEER

STANDARD CONDITIONS FOR FURNISHING OF PROFESSIONAL ENGINEERING SERVICES ON EXISTING STRUCTURES

All engineering services are performed on the basis that the information used is current and correct. This information may consist of, but is not necessarily limited to:

- Information supplied by the client regarding the structure itself, its foundations, the soil conditions, the antenna and feed line loading on the structure and its components, or other relevant information.

- Information from the field and/or drawings in the possession of CENTEK engineering, Inc. or generated by field inspections or measurements of the structure.

- It is the responsibility of the client to ensure that the information provided to CENTEK engineering, Inc. and used in the performance of our engineering services is correct and complete. In the absence of information to the contrary, we assume that all structures were constructed in accordance with the drawings and specifications and are in an un-corroded condition and have not deteriorated. It is therefore assumed that its capacity has not significantly changed from the “as new” condition.

- All services will be performed to the codes specified by the client, and we do not imply to meet any other codes or requirements unless explicitly agreed in writing. If wind and ice loads or other relevant parameters are to be different from the minimum values recommended by the codes, the client shall specify the exact requirement. In the absence of information to the contrary, all work will be performed in accordance with the latest revision of ANSI/ASCE10 & ANSI/EIA-222.

- All services are performed, results obtained, and recommendations made in accordance with generally accepted engineering principles and practices. CENTEK engineering, Inc. is not responsible for the conclusions, opinions and recommendations made by others based on the information we supply.

GENERAL DESCRIPTION OF STRUCTURAL ANALYSIS PROGRAM ~ RISA-3D

RISA-3D Structural Analysis Program is an integrated structural analysis and design software package for buildings, bridges, tower structures, etc.

Modeling Features:

- Comprehensive CAD-like graphic drawing/editing capabilities that let you draw, modify and load elements as well as snap, move, rotate, copy, mirror, scale, split, merge, mesh, delete, apply, etc.
- Versatile drawing grids (orthogonal, radial, skewed)
- Universal snaps and object snaps allow drawing without grids
- Versatile general truss generator
- Powerful graphic select/unselect tools including box, line, polygon, invert, criteria, spreadsheet selection, with locking
- Saved selections to quickly recall desired selections
- Modification tools that modify single items or entire selections
- Real spreadsheets with cut, paste, fill, math, sort, find, etc.
- Dynamic synchronization between spreadsheets and views so you can edit or view any data in the plotted views or in the spreadsheets
- Simultaneous view of multiple spreadsheets
- Constant in-stream error checking and data validation
- Unlimited undo/redo capability
- Generation templates for grids, disks, cylinders, cones, arcs, trusses, tanks, hydrostatic loads, etc.
- Support for all units systems & conversions at any time
- Automatic interaction with RISASection libraries
- Import DXF, RISA-2D, STAAD and ProSteel 3D files
- Export DXF, SDNF and ProSteel 3D files

Analysis Features:

- Static analysis and P-Delta effects
- Multiple simultaneous dynamic and response spectra analysis using Gupta, CQC or SRSS mode combinations
- Automatic inclusion of mass offset (5% or user defined) for dynamic analysis
- Physical member modeling that does not require members to be broken up at intermediate joints
- State of the art 3 or 4 node plate/shell elements
- High-end automatic mesh generation — draw a polygon with any number of sides to create a mesh of well-formed quadrilateral (NOT triangular) elements.
- Accurate analysis of tapered wide flanges - web, top and bottom flanges may all taper independently
- Automatic rigid diaphragm modeling
- Area loads with one-way or two-way distributions
- Multiple simultaneous moving loads with standard AASHTO loads and custom moving loads for bridges, cranes, etc.
- Torsional warping calculations for stiffness, stress and design
- Automatic Top of Member offset modeling
- Member end releases & rigid end offsets
- Joint master-slave assignments
- Joints detachable from diaphragms
- Enforced joint displacements
- 1-Way members, for tension only bracing, slipping, etc.

- 1-Way springs, for modeling soils and other effects
- Euler members that take compression up to their buckling load, then turn off.
- Stress calculations on any arbitrary shape
- Inactive members, plates, and diaphragms allows you to quickly remove parts of structures from consideration
- Story drift calculations provide relative drift and ratio to height
- Automatic self-weight calculations for members and plates
- Automatic subgrade soil spring generator

Graphics Features:

- Unlimited simultaneous model view windows
- Extraordinary “true to scale” rendering, even when drawing
- High-speed redraw algorithm for instant refreshing
- Dynamic scrolling stops right where you want
- Plot & print virtually everything with color coding & labeling
- Rotate, zoom, pan, scroll and snap views
- Saved views to quickly restore frequent or desired views
- Full render or wire-frame animations of deflected model and dynamic mode shapes with frame and speed control
- Animation of moving loads with speed control
- High quality customizable graphics printing

Design Features:

- Designs concrete, hot rolled steel, cold formed steel and wood
- ACI 1999/2002, BS 8110-97, CSA A23.3-94, IS456:2000,EC 2-1992 with consistent bar sizes through adjacent spans
- Exact integration of concrete stress distributions using parabolic or rectangular stress blocks
- Concrete beam detailing (Rectangular, T and L)
- Concrete column interaction diagrams
- Steel Design Codes: AISC ASD 9th, LRFD 2nd & 3rd, HSS Specification, CAN/CSA-S16.1-1994 & 2004, BS 5950-1-2000, IS 800-1984, Euro 3-1993 including local shape databases
- AISI 1999 cold formed steel design
- NDS 1991/1997/2001 wood design, including Structural Composite Lumber, multi-ply, full sawn
- Automatic spectra generation for UBC 1997, IBC 2000/2003
- Generation of load combinations: ASCE, UBC, IBC, BOCA, SBC, ACI
- Unbraced lengths for physical members that recognize connecting elements and full lengths of members
- Automatic approximation of K factors
- Tapered wide flange design with either ASD or LRFD codes
- Optimization of member sizes for all materials and all design codes, controlled by standard or user-defined lists of available sizes and criteria such as maximum depths
- Automatic calculation of custom shape properties
- Steel Shapes: AISC, HSS, CAN, ARBED, British, Euro, Indian, Chilean
- Light Gage Shapes: AISI, SSMA, Dale / Incor, Dietrich, Marino\WARE
- Wood Shapes: Complete NDS species/grade database
- Full seamless integration with RISAFoot (Ver 2 or better) for advanced footing design and detailing
- Plate force summation tool

Results Features:

- Graphic presentation of color-coded results and plotted designs
- Color contours of plate stresses and forces with quadratic smoothing, the contours may also be animated
- Spreadsheet results with sorting and filtering of: reactions, member & joint deflections, beam & plate forces/stresses, optimized sizes, code designs, concrete reinforcing, material takeoffs, frequencies and mode shapes
- Standard and user-defined reports
- Graphic member detail reports with force/stress/deflection diagrams and detailed design calculations and expanded diagrams that display magnitudes at any dialed location
- Saved solutions quickly restore analysis and design results.

GENERAL DESCRIPTION OF STRUCTURAL ANALYSIS PROGRAM ~ PLS-TOWER

PLS-TOWER is a Microsoft Windows program for the analysis and design of steel latticed towers used in electric power lines or communication facilities. Both self-supporting and guyed towers can be modeled. The program performs design checks of structures under user specified loads. For electric power structures it can also calculate maximum allowable wind and weight spans and interaction diagrams between different ratios of allowable wind and weight spans.

Modeling Features:

- Powerful graphics module (stress usages shown in different colors)
- Graphical selection of joints and members allows graphical editing and checking
- Towers can be shown as lines, wire frames or can be rendered as 3-d polygon surfaces
- Can extract geometry and connectivity information from a DXF CAD drawing
- CAD design drawings, title blocks, drawing borders or photos can be tied to structure model
- XML based post processor interface
- Steel Detailing Neutral File (SDNF) export to link with detailing packages
- Can link directly to line design program PLS-CADD
- Automatic generation of structure files for PLS-CADD
- Databases of steel angles, rounds, bolts, guys, etc.
- Automatic generation of joints and members by symmetries and interpolations
- Automated mast generation (quickly builds model for towers that have regular repeating sections) via graphical copy/paste
- Steel angles and rounds modeled either as truss, beam or tension-only elements
- Guys are easily handled (can be modeled as exact cable elements)

Analysis Features:

- Automatic handling of tension-only members
- Automatic distribution of loads in 2-part suspension insulators (v-strings, horizontal vees, etc.)
- Automatic calculation of tower dead, ice, and wind loads as well as drag coefficients according to:
    - ASCE 74-1991
    - NESC 2002
    - NESC 2007
    - IEC 60826:2003
    - EN50341-1:2001 (CENELEC)
    - EN50341-3-9:2001 (UK NNA)
    - EN50341-3-17:2001 (Portugal NNA)
    - ESAA C(b)1-2003 (Australia)
    - TPNZ (New Zealand)
    - REE (Spain)
    - EIA/TIA 222-F
    - ANSI/TIA 222-G
    - CSA S37-01
- Automated microwave antenna loading as per EIA/TIA 222-F and ANSI/TIA 222-G
- Minimization of problems caused by unstable joints and mechanisms
- Automatic bandwidth minimization and ability to solve large problems
- Design checks according to (other standards can be added easily):
    - ASCE Standard 10-90

- AS 3995 (Australian Standard 3995)
- BS 8100 (British Standard 8100)
- EN50341-1 (CENELEC, both empirical and analytical methods are available)
- ECCS 1985
- NGT-ECCS
- PN-90/B-03200
- EIA/TIA 222-F
- ANSI/TIA 222-G
- CSA S37-01
- EDF/RTE Resal
- IS 802 (India Standard 802)

Results Features:

- Design summaries printed for each group of members
- Easy to interpret text, spreadsheet and graphics design summaries
- Automatic determination of allowable wind and weight spans
- Automatic determination of interaction diagrams between allowable wind and weight spans
- Capability to batch run multiple tower configurations and consolidate the results
- Automated optimum angle member size selection and bolt quantity determination

Tool for interactive angle member sizing and bolt quantity determination.

Criteria for Design of PCS Facilities On or Extending Above Metal Electric Transmission Towers & Analysis of Transmission Towers Supporting PCS Masts [(1)]

Introduction

This criteria is the result from an evaluation of the methods and loadings specified by the separate standards, which are used in designing telecommunications towers and electric transmission towers. That evaluation is detailed elsewhere, but in summary; the methods and loadings are significantly different. This criteria specifies the manner in which the appropriate standard is used to design PCS facilities including masts and brackets (hereafter referred to as "masts"), and to evaluate the electric transmission towers to support PCS masts. The intent is to achieve an equivalent level of safety and security under the extreme design conditions expected in Connecticut and Massachusetts.

ANSI Standard TIA-222 covering the design of telecommunications structures specifies a working strength/allowable stress design approach. This approach applies the loads from extreme weather loading conditions, and designs the structure so that it does not exceed some defined percentage of failure strength (allowable stress).

ANSI Standard C2-2007 (National Electrical Safety Code) covering the design of electric transmission metal structures is based upon an ultimate strength/yield stress design approach. This approach applies a multiplier (overload capacity factor) to the loads possible from extreme weather loading conditions, and designs the structure so that it does not exceed its ultimate strength (yield stress).

Each standard defines the details of how loads are to be calculated differently. Most of the NU effort in "unifying" both codes was to establish what level of strength each approach would provide, and then increasing the appropriate elements of each to achieve a similar level of security under extreme weather loadings.

Two extreme weather conditions are considered. The first is an extreme wind condition (hurricane) based upon a 50-year recurrence (2% annual probability). The second is a winter condition combining wind and ice loadings.

The following sections describe the design criteria for any PCS mast extending above the top of an electric transmission tower, and the analysis criteria for evaluating the loads on the transmission tower from such a mast from the lower portions of such a mast, and loads on the pre-existing electric lower portions of such a mast, and loads on the pre-existing electric transmission tower and the conductors it supports.

Note 1: Prepared from documentation provide from Northeast Utilities.

P C S   M a s t

The PCS facility (mast, external cable/trays, including the initial and any planned future support platforms, antennas, etc. extending the full height above the top level of the electric transmission structure) shall be designed in accordance with the provisions of TIA 222-G:

E L E C T R I C   T R A N S M I S S I O N   T O W E R

The electric transmission tower shall be analyzed using yield stress theory in accordance with the attached table titled "NU Design Criteria". This specifies uniform loadings (different from the TIA loadings) on the each of the following components of the installed facility:

- PCS mast for its total height above ground level, including the initial and planned future support platforms, antennas, etc. above the top of an electric transmission structure.
- Conductors are related devices and hardware.
- Electric transmission structure. The loads from the PCS facility and from the electric conductors shall be applied to the structure at conductor and PCS mast attachment points, where those load transfer to the tower.

The uniform loadings and factors specified for the above components in the table are based upon the National Electrical Safety Code 2007 Edition Extreme Wind (Rule 250C) and Combined Ice and Wind (Rule 250B-Heavy) Loadings. These provide equivalent loadings compared to TIA and its loads and factors with the exceptions noted above. (Note that the NESC does not require the projected wind surfaces of structures and equipment to be increased by the ice covering.)

In the event that the electric transmission tower is not sufficient to support the additional loadings of the PCS mast, reinforcement will be necessary to upgrade the strength of the overstressed members.

Attachment A

NU Design Criteria

Condition	Standard	Item	Basic Wind Speed V (MPH)	Pressure Q (PSF)	Height Factor Kz	Gust Factor Gh	Load or Stress Factor	Force Coef - Shape Factor
Ice Condition	TIA/EIA	Antenna Mount	TIA	TIA (.75Wi)	TIA	TIA	TIA, Section 3.1.1.1 disallowed for connection design	TIA
Ice Condition	NESC Heavy	Tower/Pole Analysis with antennas extending above top of Tower/Pole (Yield Stress)	------	4	1.00	1.00	2.50	1.6 Flat Surfaces 1.3 Round Surfaces
Ice Condition	NESC Heavy	Tower/Pole Analysis with Antennas below top of Tower/Pole (on two faces)	-----	4	1.00	1.00	2.50	1.6 Flat Surfaces 1.3 Round Surfaces
Ice Condition	NESC Heavy	Conductors:	Conductor loads provided by NU					
High Wind Condition	TIA/EIA	Antenna Mount	85	TIA	TIA	TIA	TIA, Section 3.1.1.1 disallowed for connection design	TIA
High Wind Condition	NESC Extreme Wind	Tower/Pole Analysis with antennas extending above top of Tower/Pole	Use NESC C2-2007, Section 25, Rule 250C: Extreme Wind Loading 1.25 x Gust Response Factor Height above ground level based on top of Mast/Antenna					1.6 Flat Surfaces 1.3 Round Surfaces
High Wind Condition	NESC Extreme Wind	Tower/Pole Analysis with Antennas below top of Tower/Pole	Use NESC C2-2007, Section 25, Rule 250C: Extreme Wind Loading Height above ground level based on top of Tower/Pole					1.6 Flat Surfaces 1.3 Round Surfaces
High Wind Condition	NESC Extreme Wind	Conductors:	Conductor loads provided by NU					
NESC Extreme Ice with Wind Conditon*		Tower/Pole Analysis with antennas extending above top of Tower/Pole	Use NESC C2-2007, Section 25, Rule 250D: Extreme Ice with Wind Loading 4PSF Wind Load 1.25 x Gust Response Factor Height above ground level based on top of Mast/Antenna					1.6 Flat Surfaces 1.3 Round Surfaces
NESC Extreme Ice with Wind Conditon*		Tower/Pole Analysis with Antennas below top of Tower/Pole	Use NESC C2-2007, Section 25, Rule 250D: Extreme Ice with Wind Loading 4PSF Wind Load Height above ground level based on top of Tower/Pole					1.6 Flat Surfaces 1.3 Round Surfaces
NESC Extreme Ice with Wind Conditon*		Conductors:	Conductor loads provided by NU					

* Only for Structures Installed after 2007

Shape Factor Criteria shall be per TIA Shape Factors.

2) STEP 2 - The electric transmission structure analysis and evaluation shall be performed in accordance with NESC requirements and shall include the mast and antenna loads determined from NESC applied loading conditions (not TIA/EIA Loads) on the structure and mount as specified below, and shall include the wireless communication mast and antenna loads per NESC criteria)

The structure shall be analyzed using yield stress theory in accordance with Attachment A, “NU Design Criteria.” This specifies uniform loadings (different from the TIA loadings) on each of the following components of the installed facility:

a) Wireless communication mast for its total height above ground level, including the initial and any planned future equipment (Support Platforms, Antennas, TMA’s etc.) above the top of an electric transmission structure.
b) Conductors and related devices and hardware (wire loads will be provided by NU).
c) Electric Transmission Structure
   i) The loads from the wireless communication equipment components based on NESC and NU Criteria in Attachment A, and from the electric conductors shall be applied to the structure at conductor and wireless communication mast attachment points, where those loads transfer to the tower.
   ii) Shape Factor Multiplier:

NESC Structure Shape	Cd
Polyround (for polygonal steel poles)	1.3
Flat	1.6
Open Lattice	3.2

   iii) When Coaxial Cables are mounted along side the pole structure, the shape multiplier shall be:

Mount Type	Cable Cd	Pole Cd
Coaxial Cables on outside periphery (One layer)	1.45	1.45
Coaxial Cables mounted on stand offs	1.6	1.3

d) The uniform loadings and factors specified for the above components in Attachment A, “NU Design Criteria” are based upon the National Electric Safety Code 2007 Edition Extreme Wind (Rule 250C) and Combined Ice and Wind (Rule 250B-Heavy) Loadings. These provide equivalent loadings compared to the TIA and its loads and factors with the exceptions noted above.

   Note: The NESC does not require ice load be included in the supporting structure. (Ice on conductors and shield wire only, and NU will provide these loads).
e) Mast reaction loads shall be evaluated for local effects on the transmission structure members at the attachment points.

INPUT DATA

TOWER ID: 838

Structure Height (ft) : 95

Wind Zone : Central CT (green)

Wind Speed : 90.5711047 mph

Tower Type : ○ Suspension ◉ Strain

Extreme Wind Model : PCS Addition

Shield Wire Properties:

	BACK	AHEAD
NAME =	*OPGW-120*	*OPGW-120*
DESCRIPTION =	6-Groove	6-Groove
STRANDING =	10/9 FOCAS	10/9 FOCAS
DIAMETER =	0.738 in	0.738 in
WEIGHT =	0.518 lb/ft	0.518 lb/ft

Conductor Properties:

	BACK	AHEAD
NAME =	*LAPWING*	*LAPWING*
	1590.000	1590.000
	45/7 ACSR	45/7 ACSR
DIAMETER =	1.504 in	1.504 in
WEIGHT =	1.790 lb/ft	1.790 lb/ft
Number of Conductors per phase	1	1

Insulator Weight = 0 lbs

Broken Wire Side = AHEAD SPAN

Horizontal Line Tensions:

	BACK		AHEAD	
	Shield	Conductor	Shield	Conductor
NESC HEAVY =	6,000	11,400	6,000	11,400
EXTREME WIND =	6,016	12,178	6,016	12,178
LONG. WIND =	na	na	na	na
250D COMBINED =	na	na	na	na
NESC W/O OLF =	na	na	na	na
60 DEG F NO WIND =	2,045	5,625	2,045	5,625

Line Geometry:

					SUM
LINE ANGLE (deg) =	BACK:	8	AHEAD:	8	**15**
WIND SPAN (ft) =	BACK:	262	AHEAD:	262	**524**
WEIGHT SPAN (ft) =	BACK:	396	AHEAD:	396	**792**

WIRE LOADING AT ATTACHMENTS

TOWER ID: 838

Wind Span =	524 ft
Weight Span =	792 ft
Total Angle =	15 degrees
Broken Wire Span =	AHEAD SPAN
Type of Insulator Attachment =	STRAIN

1. NESC RULE 250B Heavy Loading:

	INTACT CONDITION			BROKEN WIRE CONDITION		
	Horizontal	Longitudinal	Vertical	Horizontal	Longitudinal	Vertical
Shield Wire =	3,426 lb	0 lb	1,530 lb	1,713 lb	9,810 lb	765 lb
Conductor =	6,160 lb	0 lb	3,607 lb	3,080 lb	18,639 lb	1,803 lb

2. NESC RULE 250C Transverse Extreme Wind Loading:

	Horizontal	Longitudinal	Vertical
Shield Wire =	2,614 lb	0 lb	472 lb
Conductor =	5,302 lb	0 lb	1,630 lb

3. NESC RULE 250C Longitudinal Extreme Wind Loading:

	Horizontal	Longitudinal	Vertical
Shield Wire =	#VALUE!	#VALUE!	472 lb
Conductor =	#VALUE!	#VALUE!	1,630 lb

4. NESC RULE 250D Extreme Ice & Wind Loading:

	Horizontal	Longitudinal	Vertical
Shield Wire =	#VALUE!	#VALUE!	2,122 lb
Conductor =	#VALUE!	#VALUE!	3,884 lb

5. NESC RULE 250B w/o OLF's

	Horizontal	Longitudinal	Vertical
Shield Wire =	#VALUE!	#VALUE!	1,020 lb
Conductor =	#VALUE!	#VALUE!	2,405 lb

6. 60 Deg. F, No Wind

	Horizontal	Longitudinal	Vertical
Shield Wire =	551 lb	0 lb	410 lb
Conductor =	1,515 lb	0 lb	1,418 lb

7. Construction

	Horizontal	Longitudinal	Vertical
Shield Wire =	826 lb	0 lb	615 lb
Conductor =	2,273 lb	0 lb	2,127 lb

NOTE: All loads include required overload factors (OLF's).

Northeast Utilities System

Job :			Page of
		Spec. Number	Sheet of
Description:		Computed by	Date 9/29/09
		Checked by	Date

INPUT DATA

TOWER ID: 838

Structure Height (ft) : 95

Wind Zone : Central CT (green)

Wind Speed : 90.5711047 mph

Tower Type : ○ Suspension ◉ Strain

Extreme Wind Model : PCS Addition

Shield Wire Properties:

	BACK	AHEAD
NAME =	*3/8 AW*	*3/8 AW*
DESCRIPTION =	3/8	3/8
STRANDING =	7 #8 Al Weld	7 #8 Al Weld
DIAMETER =	0.385 in	0.385 in
WEIGHT =	0.262 lb/ft	0.262 lb/ft

Conductor Properties:

	BACK	AHEAD
NAME =	*LAPWING*	*LAPWING*
	1590.000	1590.000
	45/7 ACSR	45/7 ACSR
DIAMETER =	1.504 in	1.504 in
WEIGHT =	1.790 lb/ft	1.790 lb/ft
Number of Conductors per phase	1	1

Insulator Weight = 0 lbs

Broken Wire Side = AHEAD SPAN

Horizontal Line Tensions:

	BACK		AHEAD	
	Shield	Conductor	Shield	Conductor
NESC HEAVY =	4,200	11,400	4,200	11,400
EXTREME WIND =	3,440	12,178	3,440	12,178
LONG. WIND =	na	na	na	na
250D COMBINED =	na	na	na	na
NESC W/O OLF =	na	na	na	na
60 DEG F NO WIND =	1,234	5,625	1,234	5,625

Line Geometry:

					SUM
LINE ANGLE (deg) =	BACK:	8	AHEAD:	8	**15**
WIND SPAN (ft) =	BACK:	262	AHEAD:	262	**524**
WEIGHT SPAN (ft) =	BACK:	396	AHEAD:	396	**792**

Northeast Utilities System

Job :		Page	of
Description:	Spec. Number	Sheet	of
	Computed by	Date	9/29/09
	Checked by	Date	

WIRE LOADING AT ATTACHMENTS

TOWER ID: 838

Wind Span =	524	ft
Weight Span =	792	ft
Total Angle =	15	degrees

Broken Wire Span =	AHEAD SPAN
Type of Insulator Attachment =	STRAIN

1. NESC RULE 250B Heavy Loading:

	INTACT CONDITION			BROKEN WIRE CONDITION		
	Horizontal	Longitudinal	Vertical	Horizontal	Longitudinal	Vertical
Shield Wire =	2,471 lb	0 lb	965 lb	1,236 lb	6,867 lb	482 lb
Conductor =	6,160 lb	0 lb	3,607 lb	3,080 lb	18,639 lb	1,803 lb

2. NESC RULE 250C Transverse Extreme Wind Loading:

	Horizontal	Longitudinal	Vertical
Shield Wire =	1,457 lb	0 lb	238 lb
Conductor =	5,302 lb	0 lb	1,630 lb

3. NESC RULE 250C Longitudinal Extreme Wind Loading:

	Horizontal	Longitudinal	Vertical
Shield Wire =	#VALUE!	#VALUE!	238 lb
Conductor =	#VALUE!	#VALUE!	1,630 lb

4. NESC RULE 250D Extreme Ice & Wind Loading:

	Horizontal	Longitudinal	Vertical
Shield Wire =	#VALUE!	#VALUE!	1,571 lb
Conductor =	#VALUE!	#VALUE!	3,884 lb

5. NESC RULE 250B w/o OLF's

	Horizontal	Longitudinal	Vertical
Shield Wire =	#VALUE!	#VALUE!	643 lb
Conductor =	#VALUE!	#VALUE!	2,405 lb

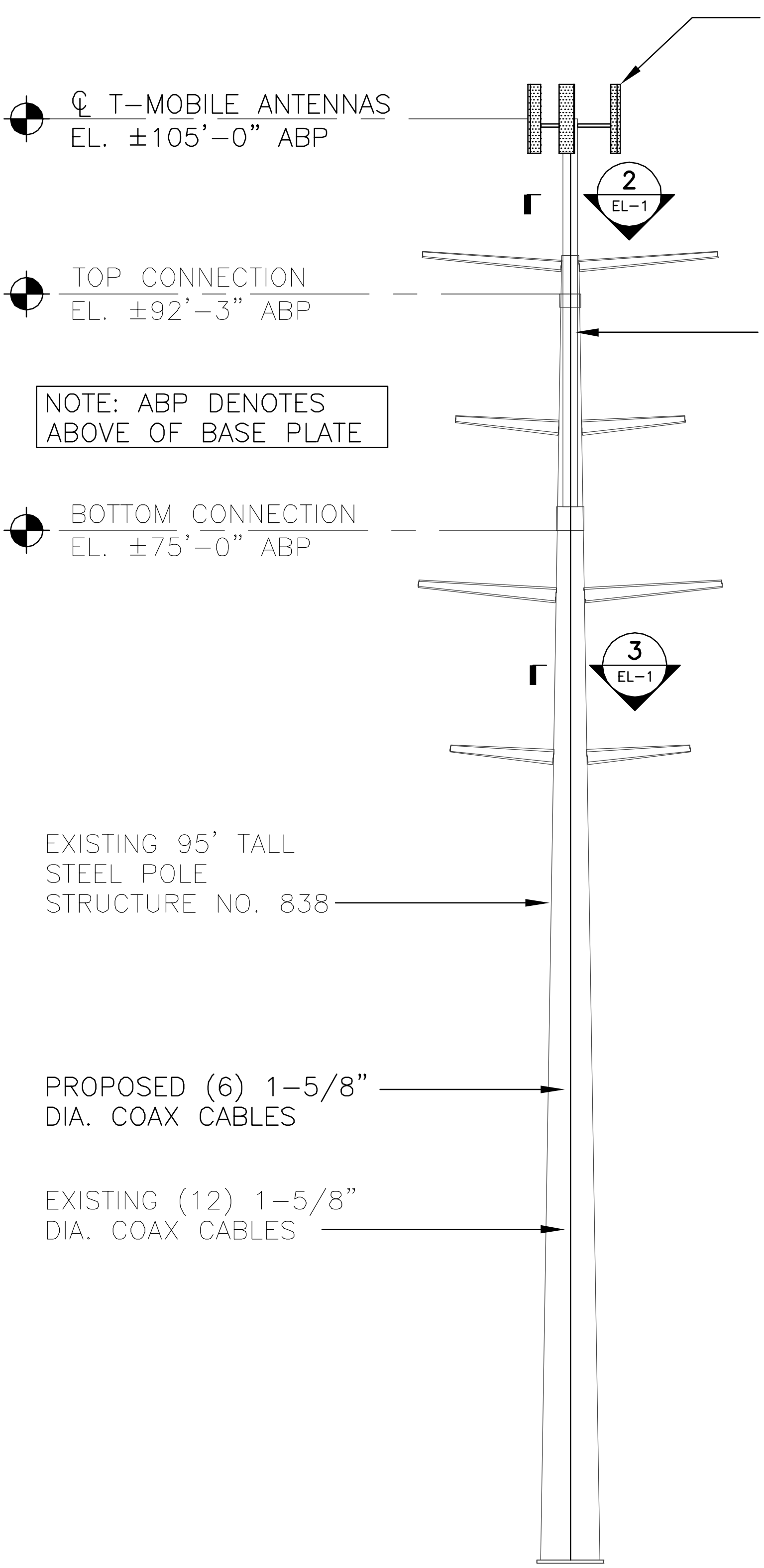
6. 60 Deg. F, No Wind

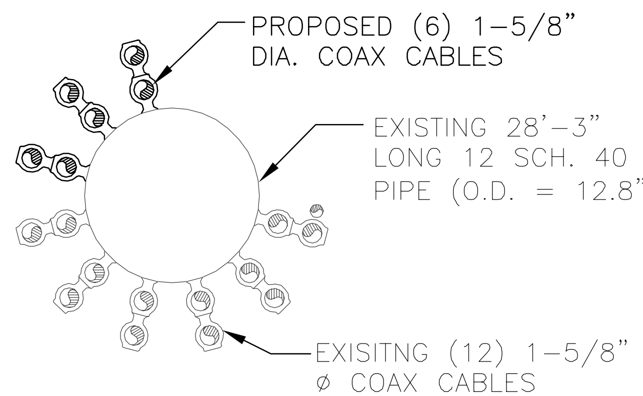
	Horizontal	Longitudinal	Vertical
Shield Wire =	332 lb	0 lb	207 lb
Conductor =	1,515 lb	0 lb	1,418 lb

7. Construction

	Horizontal	Longitudinal	Vertical
Shield Wire =	499 lb	0 lb	311 lb
Conductor =	2,273 lb	0 lb	2,127 lb

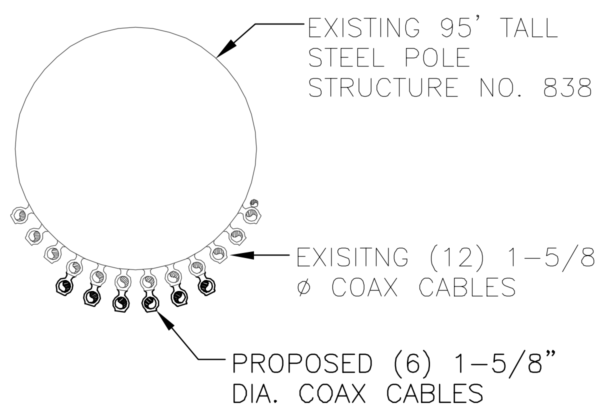
NOTE: All loads include required overload factors (OLF's).





2 EL-1 COAX PLAN

SCALE: NOT TO SCALE



3 EL-1 COAX PLAN

SCALE: NOT TO SCALE

1 EL-1 TOWER & MAST ELEVATION

SCALE: NOT TO SCALE

REVISIONS		
00	10/24/16	ISSUED FOR REVIEW

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48 QUAIL TRAIL
TRUMBULL, CT 06611

PROJECT NO:	16159.04
DRAWN BY:	TJL
CHECKED BY:	CFC
SCALE:	AS NOTED
DATE:	10/19/16

T-Mobile

TOWER AND MAST ELEVATION

EL-1

DWG. 1 OF 1

Development of Design Heights, Exposure Coefficients, and Velocity Pressures Per TIA-222-G

Wind Speeds

Basic Wind Speed $V := 97$ mph (User Input - 2016 CSBC Appendix N)

Basic Wind Speed with Ice $V_i := 50$ mph (User Input per Annex B of TIA-222-G)

Input

Structure Type = Structure_Type := Pole (User Input)

Structure Category = SC := III (User Input)

Exposure Category = Exp := C (User Input)

Structure Height = $h := 95$ ft (User Input)

Height to Center of Antennas = $z_{AT\&T} := 105$ ft (User Input)

Radial Ice Thickness = $Ir := 0.75$ in (User Input per Annex B of TIA-222-G)

Radial Ice Density = $Id := 56.00$ pcf (User Input)

$K_a := 0.8$ (User Input)

Output

Wind Direction Probability Factor =

$$K_d := \begin{cases} 0.95 & \text{if Structure\_Type = Pole} \\ 0.85 & \text{if Structure\_Type = Lattice} \end{cases} = 0.95$$

(Table 2-2 of TIA/EIA-222-G)

Importance Factor =

$$I := \begin{cases} 0.87 & \text{if } SC = 1 \\ 1.00 & \text{if } SC = 2 \\ 1.15 & \text{if } SC = 3 \end{cases} = 1.15$$

(Table 2-3 of TIA/EIA-222-G)

Velocity Pressure Coefficient =

$$Kz_{AT\&T} := 2.01\left(\left(\frac{z_{AT\&T}}{zg}\right)\right)^{\frac{2}{\alpha}} = 1.279$$

Velocity Pressure w/o Ice =

$$qz_{AT\&T} := 0.00256 \cdot K_d \cdot Kz_{AT\&T} \cdot V^2 \cdot I = 33.649$$

Velocity Pressure with Ice =

$$qz_{ice.AT\&T} := 0.00256 \cdot K_d \cdot Kz_{AT\&T} \cdot V_i^2 \cdot I = 8.941$$

Gust Response Factor = $G_H := 1.35$

Development of Wind & Ice Load on Mast

Mast Data: (Pipe 12" Sch. 40) (User Input)

Mast Shape = Round (User Input)

Mast Diameter = $D_{mast} := 12.75$ in (User Input)

Mast Length = $L_{mast} := 28.25$ ft (User Input)

Mast Thickness = $t_{mast} := 0.375$ in (User Input)

Mast Aspect Ratio = $Ar_{mast} := \frac{12L_{mast}}{D_{mast}} = 26.6$

Mast Force Coefficient = $Ca_{mast} = 1.2$

Wind Load (without ice)

Mast Projected Surface Area = $A_{mast} := \frac{D_{mast}}{12} = 1.063$ sf/ft

Total Mast Wind Force = $qz_{AT\&T} \cdot G_H \cdot Ca_{mast} \cdot A_{mast} = 58$ plf **BLC 5**

Wind Load (with ice)

Mast Projected Surface Area w/ Ice = $AICE_{mast} := \frac{(D_{mast} + 2 \cdot Ir)}{12} = 1.188$ sf/ft

Total Mast Wind Force w/ Ice = $qz_{ice.AT\&T} \cdot G_H \cdot Ca_{mast} \cdot AICE_{mast} = 17$ plf **BLC 4**

Gravity Loads (without ice)

Weight of the mast = Self Weight **(Computed internally by Risa-3D)** plf **BLC 1**

Gravity Loads (ice only)

Ice Area per Linear Foot = $Ai_{mast} := \frac{\pi}{4}\left[(D_{mast} + Ir \cdot 2)^2 - D_{mast}^2\right] = 31.8$ sq in

Weight of Ice on Mast = $W_{ICEmast} := Id \cdot \frac{Ai_{mast}}{144} = 12$ plf **BLC 3**

Development of Wind & Ice Load on Antennas

Proposed Antenna Data:

Antenna Model =	Andrew SBNHH-1D65A		
Antenna Shape =	Flat		(User Input)
Antenna Height =	$L_{ant} := 55.5$	in	(User Input)
Antenna Width =	$W_{ant} := 11.9$	in	(User Input)
Antenna Thickness =	$T_{ant} := 7.1$	in	(User Input)
Antenna Weight =	$WT_{ant} := 34$	lbs	(User Input)
Number of Antennas =	$N_{ant} := 3$		(User Input)
Antenna Aspect Ratio =	$Ar_{ant} := \frac{L_{ant}}{W_{ant}} = 4.7$		
Antenna Force Coefficient =	$Ca_{ant} = 1.3$		

Wind Load (without ice)

Surface Area for One Antenna =	$SA_{ant} := \frac{L_{ant} \cdot W_{ant}}{144} = 4.6$	sf	
Antenna Projected Surface Area =	$A_{ant} := SA_{ant} \cdot N_{ant} = 13.8$	sf	
Total Antenna Wind Force =	$F_{ant} := qz_{AT\&T} \cdot G_H \cdot Ca_{ant} \cdot K_a \cdot A_{ant} = 648$	lbs	**BLC 5**

Wind Load (with ice)

Surface Area for One Antenna w/ Ice =	$SA_{ICEant} := \frac{(L_{ant} + 2 \cdot Ir) \cdot (W_{ant} + 2 \cdot Ir)}{144} = 5.3$	sf	
Antenna Projected Surface Area w/ Ice =	$A_{ICEant} := SA_{ICEant} \cdot N_{ant} = 15.9$	sf	
Total Antenna Wind Force w/ Ice =	$Fi_{ant} := qz_{ice.AT\&T} \cdot G_H \cdot Ca_{ant} \cdot K_a \cdot A_{ICEant} = 199$	lbs	**BLC 4**

Gravity Load (without ice)

Weight of All Antennas =	$WT_{ant} \cdot N_{ant} = 102$	lbs	**BLC 2**

Gravity Loads (ice only)

Volume of Each Antenna =	$V_{ant} := L_{ant} \cdot W_{ant} \cdot T_{ant} = 4689$	cu in	
Volume of Ice on Each Antenna =	$V_{ice} := (L_{ant} + 2 \cdot Ir)(W_{ant} + 2 \cdot Ir) \cdot (T_{ant} + 2 \cdot Ir) - V_{ant} = 1879$	cu in	
Weight of Ice on Each Antenna =	$W_{ICEant} := \frac{V_{ice}}{1728} \cdot Id = 61$	lbs	
Weight of Ice on All Antennas =	$W_{ICEant} \cdot N_{ant} = 183$	lbs	**BLC 3**

Development of Wind & Ice Load on Antenna Mounts

Mount Data:

Mount Type: Valmont Standoff Arms

Mount Shape =	Flat		(User Input)
Mount Projected Surface Area =	$CaAa := 5$	sf	(User Input)
Mount Projected Surface Area w/ Ice =	$CaAa_{ice} := 9$	sf	(User Input)
Mount Weight =	$WT_{mnt} := 150$	lbs	(User Input)
Mount Weight w/ Ice =	$WT_{mnt.ice} := 400$	lbs	

Wind Load (without ice)

Total Mount Wind Force =	$F_{mnt} := qz_{AT\&T} \cdot G_H \cdot CaAa = 227$	lbs	**BLC 5**

Wind Load (with ice)

Total Mount Wind Force =	$Fi_{mnt} := qz_{ice.AT\&T} \cdot G_H \cdot CaAa_{ice} = 109$	lbs	**BLC 4**

Gravity Loads (without ice)

Weight of All Mounts =	$WT_{mnt} = 150$	lbs	**BLC 2**

Gravity Loads (ice only)

Weight of Ice on All Mounts =	$WT_{mnt.ice} - WT_{mnt} = 250$	lbs	**BLC 3**

Development of Wind & Ice Load on Coax Cables

Coax Cable Data:

Coax Type =	HELIAX 1-5/8"		
Shape =	Round		(User Input)
Coax Outside Diameter =	$D_{coax} := 1.98$	in	(User Input)
Coax Cable Length =	$L_{coax} := 30$	ft	(User Input)
Weight of Coax per foot =	$Wt_{coax} := 1.04$	plf	(User Input)
Total Number of Coax =	$N_{coax} := 18$		(User Input)
No. of Coax Projecting Outside Face of Mast =	$NP_{coax} := 4$		(User Input)

Coax aspect ratio, $Ar_{coax} := \frac{(L_{coax} \cdot 12)}{D_{coax}} = 181.8$

Coax Cable Force Factor Coefficient = $Ca_{coax} = 1.2$

Wind Load (without ice)

Coax projected surface area = $A_{coax} := \frac{(NP_{coax} D_{coax})}{12} = 0.7$ sf/ft

Total Coax Wind Force = $F_{coax} := Ca_{coax} \cdot qz_{AT\&T} \cdot G_H \cdot A_{coax} = 36$ plf **BLC 5**

Wind Load (with ice)

Coax projected surface area w/ Ice = $AICE_{coax} := \frac{(NP_{coax} \cdot D_{coax} + 2 \cdot Ir)}{12} = 0.8$ sf/ft

Total Coax Wind Force w/ Ice = $Fi_{coax} := Ca_{coax} \cdot qz_{ice.AT\&T} \cdot G_H \cdot AICE_{coax} = 11$ plf **BLC 4**

Gravity Loads (without ice)

Weight of all cables w/o ice $WT_{coax} := Wt_{coax} \cdot N_{coax} = 19$ plf **BLC 2**

Gravity Loads (ice only)

Ice Area per Linear Foot = $Ai_{coax} := \frac{\pi}{4}\left[(D_{coax} + 2 \cdot Ir)^2 - D_{coax}^{\ 2}\right] = 6.4$ sq in

Ice Weight All Coax per foot = $WTi_{coax} := N_{coax} \cdot Id \cdot \frac{Ai_{coax}}{144} = 45$ plf **BLC 3**

CENTEK engineering, INC.
Consulting Engineers
63-2 North Branford Road
Branford, CT 06405
Ph. 203-488-0580 / Fax. 203-488-8587

Subject: **Analysis of TIA-222G Wind and Ice Loads for Analysis of Mast Only**
Tabulated Load Cases
Location: **Trumbull, CT**

Date: 10/18/16 Prepared by: T.J.L. Checked by: C.F.C. Job No. 16159.04

Load Case	Description
1	Self Weight (Mast)
2	Weight of Appurtenances
3	Weight of Ice Only
4	TIA Wind with Ice
5	TIA Wind

Footnotes:

CENTEK engineering, INC.
Consulting Engineers
63-2 North Branford Road
Branford, CT 06405
Ph. 203-488-0580 / Fax. 203-488-8587

Subject: **Analysis of TIA-222G Wind and Ice Loads for Analysis of Mast Only**
Load Combinations Table

Location: **Trumbull, CT**

Date: 10/18/16 Prepared by: T.J.L. Checked by: C.F.C. Job No. 16159.04

Load Combination	Description	Envelope Soultion	Wind Factor	P-Delta	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	1.2D + 1.6W		1	Y	1	1.2	2	1.2	5	1.6				
2	0.9D + 1.6W		1	Y	1	0.9	2	0.9	5	1.6				
3	1.2D + 1.0Di + 1.0Wi		1	Y	1	1.2	2	1.2	3	1.0	4	1.0		

Footnotes:
BLC = Basic Load Case
D = Dead Load
Di = Dead Load of Ice
W = Wind Load
W = Wind Load w/ Ice

Mast Top Connection:

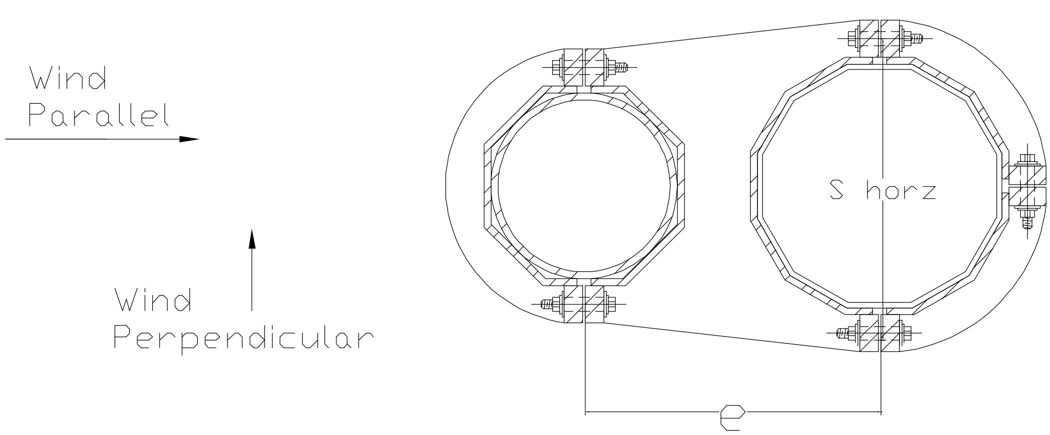
Maximum Design Reactions at Brace:

Vertical =	$Vert := 1.9 \cdot kips$	(User Input)
Horizontal =	$Horz := 6.2 \cdot kips$	(User Input)
Moment =	$Moment := 0$	(User Input)

Bolt Data:

Bolt Grade =	A325	(User Input)
Number of Bolts =	$n_b := 6$	(User Input)
Bolt Diameter =	$d_b := 0.75in$	(User Input)
Design Tensile Stress =	$F_{t.all} := 67.5 \cdot ksi$	(User Input)
Design Shear Stress =	$F_{v.all} := 40.5 \cdot ksi$	(User Input)
Bolt Eccentricity from C.L. Mast =	$e := 21.125 \cdot in$	(User Input)
Vetical Spacing Between Top and Bottom Bolts =	$S_{vert} := 9 \cdot in$	(User Input)
Horizontal Spacing Between Bolts =	$S_{horz} := 20.5 \cdot in$	(User Input)

Bolt Area = $a_b := \frac{1}{4} \cdot \pi \cdot d_b^2 = 0.442 \cdot in^2$



Check Bolt Stresses:

Wind Acting Parallel to Stiffiner Plate:

Shear Force per Bolt = $F_{v.conn} := \frac{Vert}{n_b} = 0.317 \cdot kips$

Shear Stress per Bolt = $F_{v.act} := \frac{F_{v.conn}}{a_b} = 0.717 \cdot ksi$

$Condition1 := if\left(F_{v.act} < F_{v.all}, \text{"OK"}, \text{"Overstressed"}\right)$

$Condition1 = \text{"OK"}$

Allowable Tensile Stress Adjusted for Shear = $F_{t.adj} := \sqrt{F_{t.all}^2 - 4.39 \cdot F_{v.act}^2} = 67.48 \cdot ksi$

Moment From Mast Eccentricity = $M_{par} := Vert \cdot e = 40.1 \cdot kips \cdot in$

Total Tension Force = $F_{tension} := Horz = 6.2 \cdot kips$

Tension Force Each Bolt = $F_{tension.bolt} := \frac{F_{tension}}{n_b} + \frac{M_{par}}{S_{vert} \cdot 2} = 3.263 \cdot kips$

Tension Stress Each Bolt = $F_{t.act} := \frac{F_{tension.bolt}}{a_b} = 7.4 \cdot ksi$

$Condition2 := if\left(F_{t.act} < F_{t.adj}, \text{"OK"}, \text{"Overstressed"}\right)$

$Condition2 = \text{"OK"}$

Wind Acting Perpendicular to Stiffiner Plate:

Shear Force per Bolt = $F_{v.conn} := \frac{\sqrt{Vert^2 + Horz^2}}{n_b} = 1.081 \cdot kips$

Shear Stress per Bolt = $F_{v.act} := \frac{F_{v.conn}}{a_b} = 2.446 \cdot ksi$

$Condition3 := if\left(F_{v.act} < F_{v.all}, \text{"OK"}, \text{"Overstressed"}\right)$

$Condition3 = \text{"OK"}$

Allowable Tensile Stress Adjusted for Shear = $F_{t.adj} := \sqrt{F_{t.all}^2 - 4.39 \cdot F_{v.act}^2} = 67.31 \cdot ksi$

Moment from Mast Eccentricity = $M_{perp} := Horz \cdot e = 131 \cdot kips \cdot in$

Tension Force per Bolt = $F_{tension.conn} := \frac{M_{perp}}{S_{horz} \cdot 3} + \frac{M_{par}}{S_{vert} \cdot 2} = 4.36 \cdot kips$

Tension Stress Each Bolt = $F_{tension.act} := \frac{F_{tension.conn}}{a_b} = 9.868 \cdot ksi$

$Condition4 := if\left(F_{tension.act} < F_{t.adj}, \text{"OK"}, \text{"Overstressed"}\right)$

$Condition4 = \text{"OK"}$

Mast Connection to Bottom Bracket:

Design Reactions at Brace:

Axial =	$Axial := 0.7 \cdot kips$	(User Input)
Shear =	$Shear := 0.5 \cdot kips$	(User Input)
Moment =	$Moment := 6.5 \cdot kips \cdot ft$	(User Input)

Anchor Bolt Data:

Bolt Grade =	A325	(User Input)
Design Shear Stress =	$F_v := 40.5 \cdot ksi$	(User Input)
Design Tension Stress =	$F_T := 67.5 \cdot ksi$	(User Input)
Total Number of Bolts =	$n_b := 4$	(User Input)
Number of Bolts Tension Side Parallel =	$n_{b.par} := 2$	(User Input)
Number of Bolts Tension Side Diagonal =	$n_{b.diag} := 1$	(User Input)
Bolt Diameter =	$d_b := 1in$	(User Input)
Bolt Spacing X Direction =	$S_x := 11 \cdot in$	(User Input)
Bolt Spacing Z Direction =	$S_z := 11 \cdot in$	(User Input)

Base Plate Data:

Base Plate Steel =	A36	(User Input)
Allowable Yield Stress =	$F_y := 36 \cdot ksi$	(User Input)
Base Plate Width =	$Pl_w := 14.5 \cdot in$	(User Input)
Base Plate Thickness =	$Pl_t := 1 \cdot in$	(User Input)
Bolt Edge Distance =	$B_E := 1.75 \cdot in$	(User Input)
Pole Diameter =	$D_p := 12.75 \cdot in$	(User Input)

Base Plate Data:

Weld Grade	E70XX	(User Input)
Weld Yield Stress =	$F_{yw} := 70 \cdot ksi$	(User Input)
Weld Size =	$sw := 0.3125 \cdot in$	(User Input)

Anchor Bolt Check:

Bolt Area = $a_b := \frac{1}{4}\cdot\pi\cdot d_b^{\,2} = 0.785\cdot in^2$

Bolt Spacing Diag. Direction = $S_{diag} := \sqrt{S_x^{\,2} + S_z^{\,2}} = 15.56\cdot in$

Tension Load per Bolt Parallel = $T_{par} := \frac{Moment}{S_x\cdot n_{b.par}} - \frac{Axial}{n_b} = 3.37\cdot kips$

Tension Load per Bolt Diagonal = $T_{diag} := \frac{Moment}{S_{diag}\cdot n_{b.diag}} - \frac{Axial}{n_b} = 4.84\cdot kips$

Actual Shear Stress = $f_v := \frac{Shear}{a_b\cdot n_b} = 0.16\cdot ksi$

Condition1 := if($f_v < F_v$, "OK", "Overstressed")

Condition1 = "OK"

Allowable Tensile Stress Adjusted for Shear = $F_{t.adj} := \sqrt{F_T^{\,2} - 4.39\cdot f_v^{\,2}} = 67.499\cdot ksi$

Tension per bolt = $T := if(T_{par} > T_{diag}, T_{par}, T_{diag}) = 4.839\cdot kips$

Actual Tensile Stress = $f_t := \frac{T}{a_b} = 6.16\cdot ksi$

Condition2 := if($f_t < F_{t.adj}$, "OK", "Overstressed")

Condition2 = "OK"

Base Plate Check:

Allowable Bending Stress = $F_b := 0.9\cdot F_y = 32.4\cdot ksi$

Plate Bending Width = $Z := \left(Pl_w\cdot\sqrt{2} - D_p\right) = 7.76\cdot in$

Moment Arm = $K := \frac{\left(S_{diag} - D_p\right)}{2} = 1.4\cdot in$

Moment in Base Plate = $M := K\cdot T = 6.79\cdot kips\cdot in$

Section Modulus = $S_Z := \frac{1}{6}\cdot Z\cdot Pl_t^{\,2} = 1.29\cdot in^3$

Bending Stress = $f_b := \frac{M}{S_Z} = 5.25\cdot ksi$

Condition3 := if($f_b < F_b$, "OK", "Overstressed")

Condition3 = "OK"

Base Plate to Mast Weld Check:

Allowable Weld Stress = $F_w := 0.45 \cdot F_{yw} = 31.5 \cdot ksi$

$c := \frac{D_p}{2} + sw \cdot 0.707 = 6.6 \cdot in$

Weld Moment of Inertia = $I_w := \frac{\pi}{64} \cdot \left[\left(D_p + 2sw \cdot 0.707 \right)^4 - D_p{}^4 \right] = 189.4 \cdot in^4$

Section Modulus of Weld = $S_w := \frac{I_w}{c} = 28.71 \cdot in^3$

Weld Stress = $f_w := \frac{Moment}{S_w} = 2.72 \cdot ksi$

Condition4 := if($f_w < F_w$,"OK" ,"Overstressed")

Condition4 = "OK"

Mast Bottom Connection:

Maximum Design Reactions at Brace:

Vertical = $Vert := 0.7\cdot kips$ (User Input)

Horizontal = $Horz := 0.5\cdot kips$ (User Input)

Moment = $Moment := 6.5\cdot ft\cdot kips$ (User Input)

Bolt Data:

Bolt Grade = A325 (User Input)

Number of Bolts = $n_b := 16$ (User Input)

Bolt Diameter = $d_b := 0.75in$ (User Input)

Design Tensile Stress = $F_{t.all} := 67.5\cdot ksi$ (User Input)

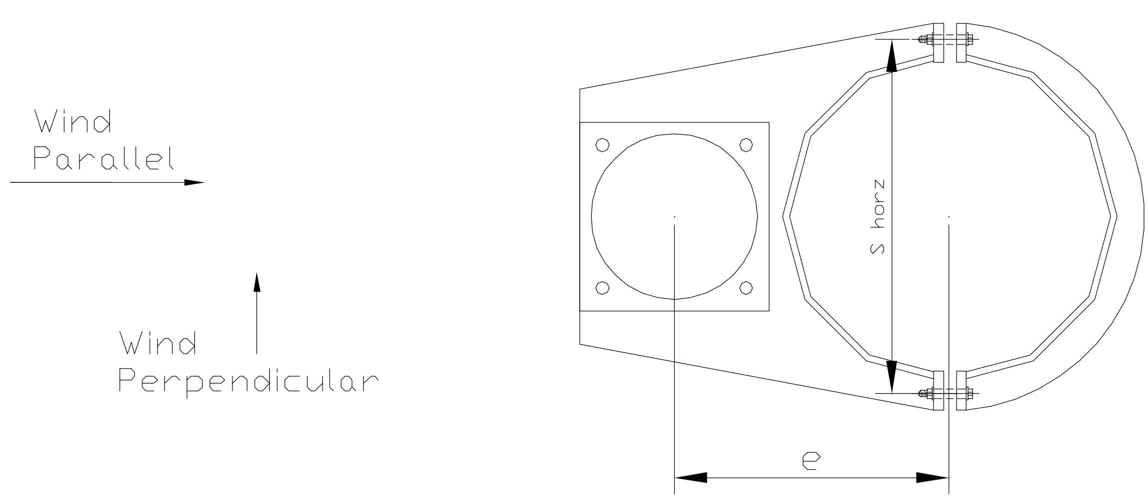
Design Shear Stress = $F_{v.all} := 40.5\cdot ksi$ (User Input)

Bolt Eccentricity from C.L. Mast = $e := 21.125\cdot in$ (User Input)

Vetical Spacing Between Top and Bottom Bolts = $S_{vert} := 21\cdot in$ (User Input)

Horizontal Spacing Between Bolts = $S_{horz} := 27.25\cdot in$ (User Input)

Bolt Area = $a_b := \frac{1}{4}\cdot\pi\cdot d_b^{\,2} = 0.442\cdot in^2$



Check Bolt Stresses:

Wind Acting Parallel to Stiffiner Plate:

Shear Force per Bolt = $F_{v.conn} := \frac{Vert}{n_b} = 0.044 \cdot kips$

Shear Stress per Bolt = $F_{v.act} := \frac{F_{v.conn}}{a_b} = 0.099 \cdot ksi$

$Condition1 := if(F_{v.act} < F_{v.all}, "OK", "Overstressed")$

$Condition1 = "OK"$

Allowable Tensile Stress Adjusted for Shear = $F_{t.adj} := \sqrt{F_{t.all}^2 - 4.39 \cdot F_{v.act}^2} = 67.5 \cdot ksi$ (AISC 9th Ed. Table J3.3)

Moment From Mast Eccentricity = $M_{par} := Vert \cdot e + Moment = 92.8 \cdot kips \cdot in$

Total Tension Force = $F_{tension} := Horz = 0.5 \cdot kips$

Tension Force Each Bolt = $F_{tension.bolt} := \frac{F_{tension}}{n_b} + \frac{M_{par}}{S_{vert} \cdot 2} = 2.24 \cdot kips$

Tension Stress Each Bolt = $F_{t.act} := \frac{F_{tension.bolt}}{a_b} = 5.1 \cdot ksi$

$Condition2 := if(F_{t.act} < F_{t.adj}, "OK", "Overstressed")$

$Condition2 = "OK"$

Wind Acting Perpendicular to Stiffiner Plate:

Shear Force per Bolt = $F_{v.conn} := \frac{\sqrt{\left(Vert + \frac{Moment \cdot 2}{S_{horz} \cdot n_b}\right)^2 + Horz^2}}{n_b} = 0.073 \cdot kips$

Shear Stress per Bolt = $F_{v.act} := \frac{F_{v.conn}}{a_b} = 0.166 \cdot ksi$

$Condition3 := if(F_{v.act} < F_{v.all}, "OK", "Overstressed")$

$Condition3 = "OK"$

Allowable Tensile Stress Adjusted for Shear = $F_{t.adj} := \sqrt{F_{t.all}^2 - 4.39 \cdot F_{v.act}^2} = 67.5 \cdot ksi$ (AISC 9th Ed. Table J3.3)

Moment from Mast Eccentricity = $M_{perp} := Horz \cdot e = 11 \cdot kips \cdot in$

Tension Force per Bolt = $F_{tension.conn} := \frac{M_{perp} \cdot 2}{S_{horz} \cdot n_b} + \frac{M_{par}}{S_{vert} \cdot 2} = 2.258 \cdot kips$

Tension Stress Each Bolt = $F_{tension.act} := \frac{F_{tension.conn}}{a_b} = 5.11 \cdot ksi$

$Condition4 := if(F_{tension.act} < F_{t.adj}, "OK", "Overstressed")$

$Condition4 = "OK"$

CENTEK engineering Centered on Solutions™ www.centekeng.com 63-2 North Branford Road P: (203) 488-0580 Branford, CT 06405 F: (203) 488-8587	Subject: Location: Rev. 0: 10/18/16	Load Analysis of T-Mobile Equipment on Structure #838 Trumbull, CT Prepared by: T.J.L Checked by: C.F.C. Job No. 16159.04

Basic Components

Heavy Wind Pressure =	$p := 4.00$	psf	(User Input NESC 2007 Figure 250-1 & Table 250-1)
Basic Windspeed =	$V := 110$	mph	(User Input NESC 2007 Figure 250-2(e))
Radial Ice Thickness =	$Ir := 0.50$	in	(User Input)
Radial Ice Density =	$Id := 56.0$	pcf	(User Input)

Factors for Extreme Wind Calculation

Elevation of Top of PCS Mast Above Grade = $TME := 105$ ft (User Input)

Multiplier Gust Response Factor = $m := 1.25$ (User Input - Only for NESC Extreme wind case)

NESC Factor = $kv := 1.43$ (User Input from NESC 2007 Table 250-3 equation)

Importance Factor = $I := 1.0$ (User Input from NESC 2007 Section 250.C.2)

Velocity Pressure Coefficient = $Kz := 2.01 \cdot \left(\frac{TME}{900}\right)^{\frac{2}{9.5}} = 1.279$ (NESC 2007 Table 250-2)

Exposure Factor = $Es := 0.346 \left[\frac{33}{(0.67 \cdot TME)}\right]^{\frac{1}{7}} = 0.311$ (NESC 2007 Table 250-3)

Response Term = $Bs := \frac{1}{\left(1 + 0.375 \cdot \frac{TME}{220}\right)} = 0.848$ (NESC 2007 Table 250-3)

Gust Response Factor = $Grf := \frac{\left[1 + \left(2.7 \cdot Es \cdot Bs^{\frac{1}{2}}\right)\right]}{kv^2} = 0.867$ (NESC 2007 Table 250-3)

Wind Pressure = $qz := 0.00256 \cdot Kz \cdot V^2 \cdot Grf \cdot I = 34.3$ psf (NESC 2007 Section 250.C.2)

Shape Factors

NUS Design Criteria Issued April 12, 2007

Shape Factor for Round Members =	$Cd_R := 1.3$	(User Input)
Shape Factor for Flat Members =	$Cd_F := 1.6$	(User Input)
Shape Factor for Coax Cables Attached to Outside of Pole =	$Cd_{coax} := 1.45$	(User Input)

Overload Factors

NU Design Criteria Table

Overload Factors for Wind Loads:

NESC Heavy Loading =	**2.5**	(User Input)	Apply in Risa-3D Analysis
NESC Extreme Loading =	**1.0**	(User Input)	Apply in Risa-3D Analysis

Overload Factors for Vertical Loads:

NESC Heavy Loading =	**1.5**	(User Input)	Apply in Risa-3D Analysis
NESC Extreme Loading =	**1.0**	(User Input)	Apply in Risa-3D Analysis

Development of Wind & Ice Load on PCS Mast

Mast Data: (Pipe 12" Sch. 40)

Mast Shape =	Round		(User Input)
Mast Diameter =	$D_{mast} := 12.75$	in	(User Input)
Mast Length =	$L_{mast} := 28.25$	ft	(User Input)
Mast Thickness =	$t_{mast} := 0.375$	in	(User Input)

Wind Load (NESC Extreme)

Mast Projected Surface Area = $A_{mast} := \frac{D_{mast}}{12} = 1.063$ sf/ft

Total Mast Wind Force (Below NU Structure) = $qz \cdot Cd_R \cdot A_{mast} \cdot m = 59$ plf **BLC 5**

Wind Load (NESE Heavy)

Mast Projected Surface Area w/ Ice = $AICE_{mast} := \frac{(D_{mast} + 2 \cdot Ir)}{12} = 1.146$ sf/ft

Total Mast Wind Force w/ Ice = $p \cdot Cd_R \cdot AICE_{mast} = 6$ plf **BLC 4**

Gravity Loads (without ice)

Weight of the mast = Self Weight **(Computed internally by Risa-3D)** plf **BLC 1**

Gravity Loads (ice only)

Ice Area per Linear Foot = $Ai_{mast} := \frac{\pi}{4}\left[(D_{mast} + Ir \cdot 2)^2 - D_{mast}^{\ 2}\right] = 20.8$ sq in

Weight of Ice on Mast = $W_{ICEmast} := Id \cdot \frac{Ai_{mast}}{144} = 8$ plf **BLC 3**

Development of Wind & Ice Load on Antennas

Proposed Antenna Data:

Antenna Model =	SBNHH-1D65A		
Antenna Shape =	Flat		(User Input)
Antenna Height =	$L_{ant} := 55.5$	in	(User Input)
Antenna Width =	$W_{ant} := 11.9$	in	(User Input)
Antenna Thickness =	$T_{ant} := 7.1$	in	(User Input)
Antenna Weight =	$WT_{ant} := 34$	lbs	(User Input)
Number of Antennas =	$N_{ant} := 3$		(User Input)

Wind Load (NESC Extreme)

Assumes Maximum Possible Wind Pressure Applied to all Antennas Simultaneously

Surface Area for One Antenna = $SA_{ant} := \frac{L_{ant} \cdot W_{ant}}{144} = 4.6$ sf

Antenna Projected Surface Area = $A_{ant} := SA_{ant} \cdot N_{ant} = 13.8$ sf

Total Antenna Wind Force = $F_{ant} := qz \cdot Cd_F \cdot A_{ant} \cdot m = 945$ lbs **BLC 5**

Wind Load (NESC Heavy)

Assumes Maximum Possible Wind Pressure Applied to all Antennas Simultaneously

Surface Area for One Antenna w/ Ice = $SA_{ICEant} := \frac{(L_{ant} + 1) \cdot (W_{ant} + 1)}{144} = 5.1$ sf

Antenna Projected Surface Area w/ Ice = $A_{ICEant} := SA_{ICEant} \cdot N_{ant} = 15.2$ sf

Total Antenna Wind Force w/ Ice = $Fi_{ant} := p \cdot Cd_F \cdot A_{ICEant} = 97$ lbs **BLC 4**

Gravity Load (without ice)

Weight of All Antennas = $WT_{ant} \cdot N_{ant} = 102$ lbs **BLC 2**

Gravity Load (ice only)

Volume of Each Antenna = $V_{ant} := L_{ant} \cdot W_{ant} \cdot T_{ant} = 4689$ cu in

Volume of Ice on Each Antenna = $V_{ice} := (L_{ant} + 1)(W_{ant} + 1) \cdot (T_{ant} + 1) - V_{ant} = 1214$ cu in

Weight of Ice on Each Antenna = $W_{ICEant} := \frac{V_{ice}}{1728} \cdot Id = 39$ lbs

Weight of Ice on All Antennas = $W_{ICEant} \cdot N_{ant} = 118$ lbs **BLC 3**

Development of Wind & Ice Load on Antenna Mounts

Mount Data:

Mount Type:	Valmont Standoff Arms		
Mount Shape =	Flat		(User Input)
Mount Projected Surface Area =	$CdAa := 5$	sf	(User Input)
Mount Projected Surface Area w/ Ice =	$CdAa_{ice} := 9$	sf	(User Input)
Mount Weight =	$WT_{mnt} := 150$	lbs	(User Input)
Mount Weight w/ Ice =	$WT_{mnt.ice} := 400$	lbs	

Wind Load (NESC Extreme)

Total Mount Wind Force = $F_{mnt} := qz \cdot CdAa \cdot m = 215$ lbs **BLC 5,7**

Wind Load (NESC Heavy)

Total Mount Wind Force w/ Ice = $Fi_{mnt} := p \cdot CdAa_{ice} = 36$ lbs **BLC 4,6**

Gravity Loads (without ice) (per TIA/EIA-222-F-1996)

Weight of All Mounts = $WT_{mnt} = 150$ lbs **BLC 2**

Gravity Load (ice only) (per TIA/EIA-222-F-1996)

Weight of Ice on All Mounts = $WT_{mnt.ice} - WT_{mnt} = 250$ lbs **BLC 3**

Development of Wind & Ice Load on Coax Cables

Coax Cable Data:

Coax Type =	HELIAX 1-5/8"		
Shape =	Round		(User Input)
Coax Outside Diameter =	$D_{coax} := 1.98$	in	(User Input)
Coax Cable Length =	$L_{coax} := 30$	ft	(User Input)
Weight of Coax per foot =	$Wt_{coax} := 1.04$	plf	(User Input)
Total Number of Coax =	$N_{coax} := 18$		(User Input)
No. of Coax Projecting Outside Face of PCS Mast =	$NP_{coax} := 4$		(User Input)

Wind Load (NESC Extreme)

Coax projected surface area = $A_{coax} := \frac{(NP_{coax} D_{coax})}{12} = 0.7$ sf/ft

Total Coax Wind Force (Above NU Structure) = $F_{coax} := qz \cdot Cd_{coax} \cdot A_{coax} \cdot m = 41$ plf **BLC 5**

Wind Load (NESC Heavy)

Coax projected surface area w/ Ice = $AICE_{coax} := \frac{(NP_{coax} \cdot D_{coax} + 2 \cdot Ir)}{12} = 0.7$ sf/ft

Total Coax Wind Force w/ Ice = $Fi_{coax} := p \cdot Cd_{coax} \cdot AICE_{coax} = 4$ plf **BLC 4**

Gravity Loads (without ice)

Weight of all cables w/o ice $WT_{coax} := Wt_{coax} \cdot N_{coax} = 19$ plf **BLC 2**

Gravity Load (ice only)

Ice Area per Linear Foot = $Ai_{coax} := \frac{\pi}{4}\left[(D_{coax} + 2 \cdot Ir)^2 - D_{coax}^{\,2}\right] = 3.9$ sq in

Ice Weight All Coax per foot = $WTi_{coax} := N_{coax} \cdot Id \cdot \frac{Ai_{coax}}{144} = 27$ plf **BLC 3**

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Ph. 203-488-0580 / Fax. 203-488-8587

Subject: **Analysis of NESC Heavy Wind and NESC Extreme Wind for Obtaining Reactions Applied to Utility Pole**
Tabulated Load Cases
Location: **Trumbull, CT**

Date:10/18/16 Prepared by: T.J.L. Checked by: C.F.C. Job No. 16159.04

Load Case	Description
1	Self Weight (Mast)
2	Weight of Appurtenances
3	Weight of Ice Only
4	NESC Heavy Wind
5	NESC Extreme Wind

Footnotes:

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Subject: **Analysis of NESC Heavy Wind and NESC Extreme Wind for Obtaining Reactions Applied to Utility Pole Load Combinations Table**

Location: **Trumbull, CT**

Date: 10/18/16 Prepared by: T.J.L. Checked by: C.F.C. Job No. 16159.04

Load Combination	Description	Envelope Soultion	Wind Factor	P-Delta	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	NESC Heavy Wind		1		1	1.5	2	1.5	3	1.5	4	2.5		
2	NESC Extreme Wind		1		1	1	2	1	5	1				

Footnotes:
(1) BLC = Basic Load Case

Coax Cable on Pole

Distance Between Coax Cable Attach Points =

Coaxial Cable Span = $Coax_{Span} := \begin{pmatrix} 10 \\ 10 \\ 10 \\ 10 \\ 10 \\ 10 \\ 10 \end{pmatrix} \cdot ft$ *(User Input)*

Diameter of Coax Cable = $D_{coax} := 1.98 \cdot in$ *(User Input)*

Weight of Coax Cable = $W_{coax} := 1.04 \cdot plf$ *(User Input)*

Number of Coax Cables = $N_{coax} := 18$ *(User Input)*

Number of Projected Coax Cables = $NP_{coax} := 3$ *(User Input)*

Extreme Wind Pressure = $qz := 34.3 \cdot psf$ *(User Input)*

Heavy Wind Pressure = $p := 4 \cdot psf$ *(User Input)*

Radial Ice Thickness = $Ir := 0.5 \cdot in$ *(User Input)*

Radial Ice Density = $Id := 56 \cdot pcf$ *(User Input)*

Shape Factor = $Cd_{coax} := 1.6$ *(User Input)*

Overload Factor for NESC Heavy Wind Load = $OF_{HW} := 2.5$ *(User Input)*

Overload Factor for NESC Extreme Wind Load = $OF_{EW} := 1.0$ *(User Input)*

Overload Factor for NESC Heavy Vertical Load = $OF_{HV} := 1.5$ *(User Input)*

Overload Factor for NESC Extreme Vertical Load = $OF_{EV} := 1.0$ *(User Input)*

Wind Area with Ice = $A_{ice} := \left(NP_{coax} \cdot D_{coax} + 2 \cdot Ir\right) = 6.94 \cdot in$

Wind Area without Ice = $A := \left(NP_{coax} \cdot D_{coax}\right) = 5.94 \cdot in$

Ice Area per Liner Ft = $Ai_{coax} := \frac{\pi}{4} \cdot \left[\left(D_{coax} + 2 \cdot Ir\right)^2 - D_{coax}^{\ 2}\right] = 0.027 \, ft^2$

Weight of Ice on All Coax Cables = $W_{ice} := Ai_{coax} \cdot Id \cdot N_{coax} = 27.269 \cdot plf$

Heavy Vertical Load =

$$Heavy_{Vert} := \overrightarrow{\left[\left(N_{coax} \cdot W_{coax} + W_{ice}\right) \cdot Coax_{Span} \cdot OF_{HV}\right]}$$

Heavy Transverse Load =

$$Heavy_{Trans} := \overrightarrow{\left(p \cdot A_{ice} \cdot Cd_{coax} \cdot Coax_{Span} \cdot OF_{HW}\right)}$$

$$Heavy_{Vert} = \begin{pmatrix} 690 \\ 690 \\ 690 \\ 690 \\ 690 \\ 690 \\ 690 \end{pmatrix} lb \qquad Heavy_{Trans} = \begin{pmatrix} 93 \\ 93 \\ 93 \\ 93 \\ 93 \\ 93 \\ 93 \end{pmatrix} lb$$

Extreme Vertical Load =

$$Extreme_{Vert} := \overrightarrow{\left[\left(N_{coax} \cdot W_{coax}\right) \cdot Coax_{Span} \cdot OF_{EV}\right]}$$

Extreme Transverse Load =

$$Extreme_{Trans} := \overrightarrow{\left[\left(qz \cdot A \cdot Cd_{coax}\right) \cdot Coax_{Span} \cdot OF_{EW}\right]}$$

$$Extreme_{Vert} = \begin{pmatrix} 187 \\ 187 \\ 187 \\ 187 \\ 187 \\ 187 \\ 187 \end{pmatrix} lb \qquad Extreme_{Trans} = \begin{pmatrix} 272 \\ 272 \\ 272 \\ 272 \\ 272 \\ 272 \\ 272 \end{pmatrix} lb$$

Centek Engineering Inc, Project: "cl&p structure # 838"
PLS-POLE Version 12.50, 5:03:21 PM Tuesday, October 18, 2016
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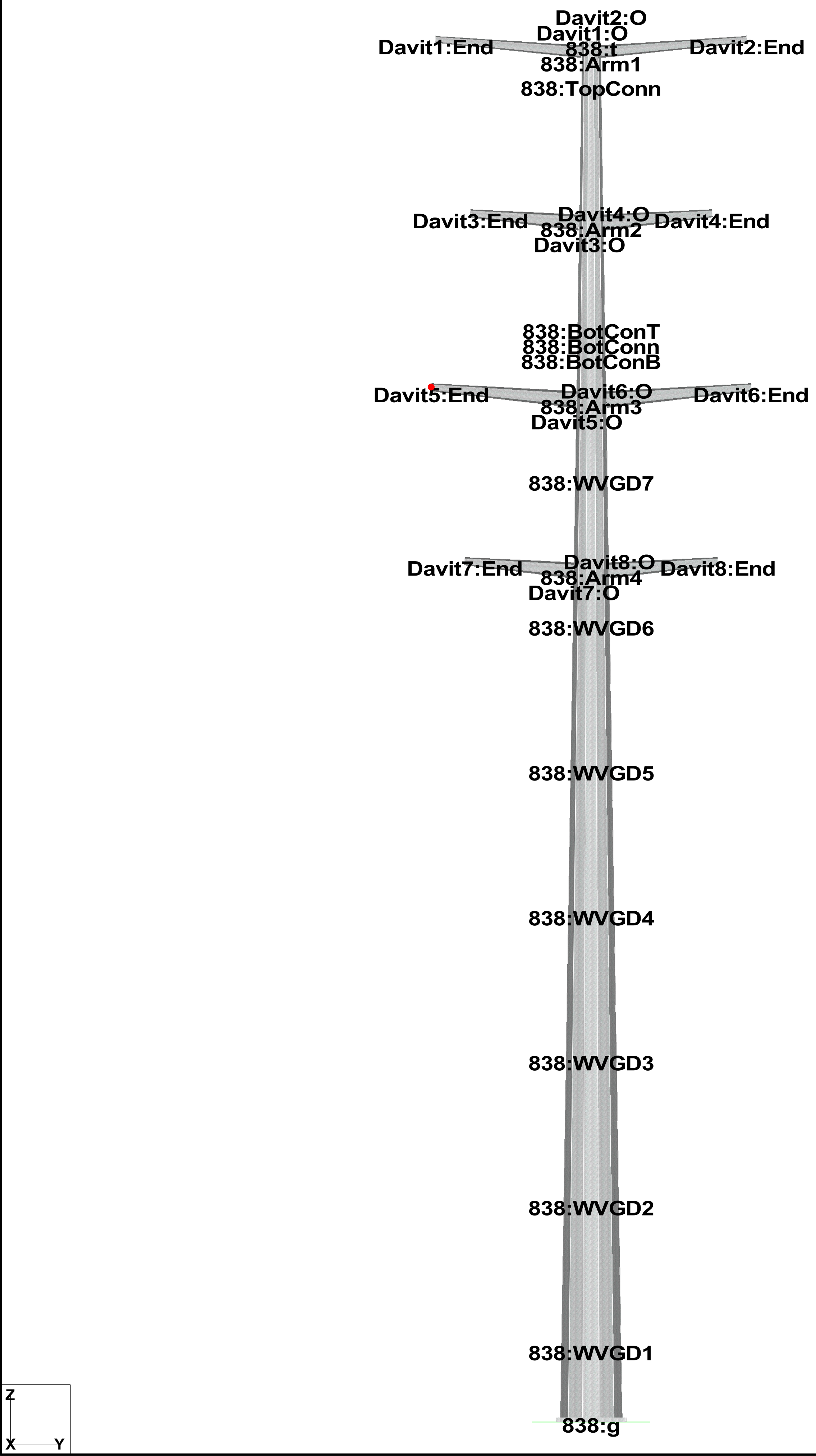

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Anchor Bolt Analysis:

Input Data:

Bolt Force:

Maximum Tensile Force =	$T_{Max} := 143 \cdot kips$	(User Input from PLS-Pole)

Anchor Bolt Data:

Use ASTM A615 Grade 75

Number of Anchor Bolts =	$N := 20$	(User Input)
Bolt "Column" Distance =	$l := 3.0 \cdot in$	(User Input)
Bolt Ultimate Strength =	$F_u := 100 \cdot ksi$	(User Input)
Bolt Yeild Strength=	$F_y := 75 \cdot ksi$	(User Input)
Bolt Modulus =	$E := 29000 \cdot ksi$	(User Input)
Diameter of Anchor Bolts =	$D := 2.25 \cdot in$	(User Input)
Threads per Inch =	$n := 4.5$	(User Input)

Anchor Bolt Analysis:

Calculated Anchor Bolt Properties:

Net Area of Bolt = $A_n := \frac{\pi}{4} \cdot \left(D - \frac{0.9743 \cdot in}{n}\right)^2 = 3.248 \cdot in^2$

Bolt Tension Check:

Allowable Tensile Force (Net Area) = $T_{ALL.Net} := 1.0 \cdot (A_n \cdot F_y) = 243.576 \cdot kips$

Bolt Tension % of Capacity = $\frac{T_{Max}}{T_{ALL.Net}} = 58.71 \cdot \%$

Condition1 = $Condition1 := if\left(\frac{T_{Max}}{T_{ALL.Net}} \le 1.00, \text{"OK"}, \text{"Overstressed"}\right)$

Condition1 = "OK"

Foundation:

Input Data:

Tower Data

Overturning Moment =	$OM := 4039 \cdot 1.1 \cdot ft \cdot kips = 4443 \cdot ft \cdot kips$	(User Input from PLS-Pole)	
Shear Force =	$Shear := 52 \cdot kip \cdot 1.1 = 57.2 \cdot kips$	(User Input from PLS-Pole)	
Axial Force =	$Axial := 58 \cdot kip \cdot 1.1 = 63.8 \cdot kips$	(User Input from PLS-Pole)	
Tower Height =	$H_t := 95 \cdot ft$	(User Input)	

Footing Data:

Depth to Bottom of Footing =	$D_f := 13.5 \cdot ft$	(User Input)	
Length of Pier =	$L_p := 14 \cdot ft$	(User Input)	
Extension of Pier Above Grade =	$L_{pag} := 0.5 \cdot ft$	(User Input)	
Width of Pier =	$W_p := 10 \cdot ft$	(User Input)	
Depth of Soil =	$D_{soil} := 13.5 \cdot ft$	(User Input)	
Depth of Rock =	$D_{rock} := 18 \cdot ft$	(User Input)	

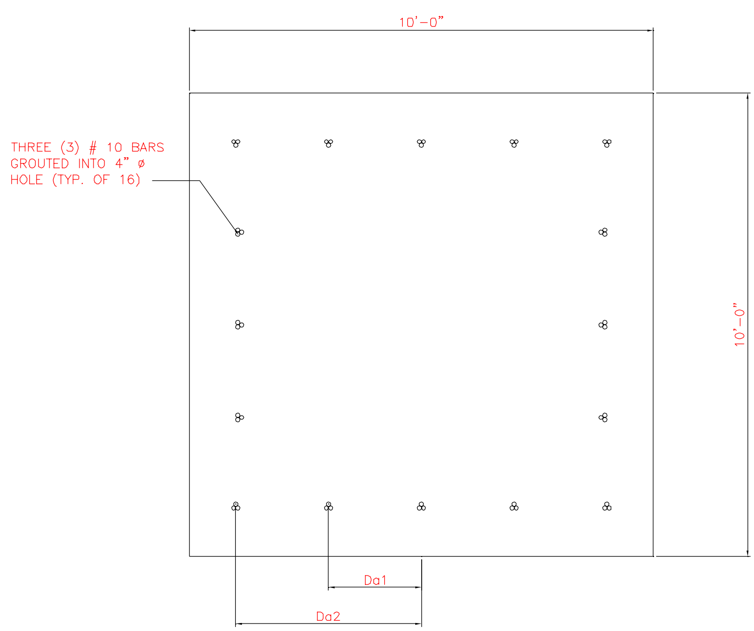
Material Properties:

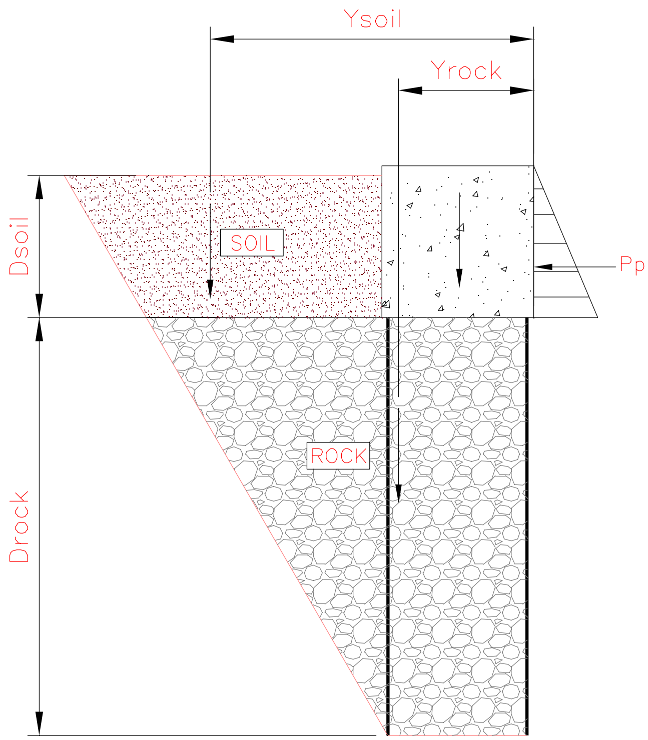
Concrete Compressive Strength =	$f_c := 3500 \cdot psi$	(User Input)	
Steel Reinforcment Yield Strength =	$f_y := 60000 \cdot psi$	(User Input)	
Anchor Bolt Yield Strength =	$f_{ya} := 75000 \cdot psi$	(User Input)	
Internal Friction Angle of Soil =	$\Phi_s := 30 \cdot deg$	(User Input)	
Allowable Soil Bearing Capacity =	$q_s := 4000 \cdot psf$	(User Input)	
Allowable Rock Bearing Capacity =	$q_{rock} := 50000 \cdot psf$	(User Input)	
Unit Weight of Soil =	$\gamma_{soil} := 120 \cdot pcf$	(User Input)	
Unit Weight of Concrete =	$\gamma_{conc} := 150 \cdot pcf$	(User Input)	
Unit Weight of Rock =	$\gamma_{rock} := 160 \cdot pcf$	(User Input)	
Foundation Bouyancy =	$Bouyancy := 0$	(User Input)	(Yes=1 / No=0)
Depth to Neglect =	$n := 1.0 \cdot ft$	(User Input)	
Cohesion of Clay Type Soil =	$c := 0 \cdot ksf$	(User Input)	(Use 0 for Sandy Soil)
Seismic Zone Factor =	$Z := 2$	(User Input)	(UBC-1997 Fig 23-2)
Coefficient of Friction Between Concrete =	$\mu := 0.45$	(User Input)	

Rock Anchor Properties:

ASTM A615 Grade 60

Bolt Ultimate Strength =	$F_u := 90 \cdot ksi$	(User Input)	
Bolt Yield Strength =	$F_y := 60 \cdot ksi$	(User Input)	
Anchor Diameter =	$d_{ra} := 3.81 \cdot in$	(User Input)	(3 # 10 Bars)
Hole Diameter =	$d_{Hole} := 4 \cdot in$	(User Input)	
Grout Strength =	$\tau := 120 \cdot psi$	(User Input)	(Assumed Conservative Value)
Distance to Rock Anchor Group 1 =	$D_{a1} := 24 \cdot in$	(User Input)	
Distance to Rock Anchor Group 2 =	$D_{a2} := 48 \cdot in$	(User Input)	
Number of Rock Anchors in Group 1 =	$N_{a1} := 4$	(User Input)	
Number of Rock Anchors in Group 2 =	$N_{a2} := 10$	(User Input)	
Total Number of Rock Anchors =	$N_{atot} := 16$	(User Input)	





Area 1 =	$A1_s := \frac{1}{2} \cdot \tan(\Phi_s) \cdot D_{soil}^2 = 52.611\,ft^2$	sf
Area 2 =	$A2_s := \tan(\Phi_s) \cdot D_{rock} \cdot D_{soil} = 140.296\,ft^2$	sf
Distance to Centroid 1 =	$Y1 := \tan(\Phi_s) \cdot D_{rock} + \frac{1}{3} \cdot \tan(\Phi_s) \cdot D_{soil} = 12.99\,ft$	ft
Distance to Centroid 2 =	$Y2 := \frac{1}{2} \cdot \tan(\Phi_s) \cdot D_{rock} = 5.196\,ft$	ft
Distance from Toe to Centroid of Soil =	$Y_{soil} := \frac{(A1_s \cdot Y1 + A2_s \cdot Y2)}{(A1_s + A2_s)} + W_p = 17.32\,ft$	ft
Area 1 =	$A1_r := \frac{1}{2} \cdot \tan(\Phi_s) \cdot D_{rock}^2 = 93.531\,ft^2$	sf
Area 2 =	$A2_r := W_p \cdot D_{rock} = 180\,ft^2$	sf
Distance to Centroid 1 =	$Y1 := W_p + \frac{1}{3} \cdot \tan(\Phi_s) \cdot D_{rock} = 13.464\,ft$	ft
Distance to Centroid 2 =	$Y2 := \frac{W_p}{2} = 5\,ft$	ft
Distance from Toe to Centroid of Rock =	$Y_{rock} := \frac{(A1_r \cdot Y1 + A2_r \cdot Y2)}{(A1_r + A2_r)} = 7.89\,ft$	ft

Stability of Footing:

Adjusted Concrete Unit Weight = $\gamma_c := \text{if}(\text{Bouyancy} = 1, \gamma_{conc} - 62.4\text{pcf}, \gamma_{conc}) = 150 \cdot \text{pcf}$

Adjusted Soil Unit Weight = $\gamma_s := \text{if}(\text{Bouyancy} = 1, \gamma_{soil} - 62.4\text{pcf}, \gamma_{soil}) = 120 \cdot \text{pcf}$

Coefficient of Lateral Soil Pressure = $K_p := \dfrac{1 + \sin(\Phi_s)}{1 - \sin(\Phi_s)} = 3$

Passive Pressure = $P_{top} := 0 = 0 \cdot \text{ksf}$

$P_{bot} := K_p \cdot \gamma_s \cdot D_{soil} + c \cdot 2 \cdot \sqrt{K_p} = 4.86 \cdot \text{ksf}$

$P_{ave} := \dfrac{P_{top} + P_{bot}}{2} = 2.43 \cdot \text{ksf}$

$A_p := W_p \cdot (L_p - L_{pag}) = 135\text{ft}^2$

Ultimate Shear = $S_u := P_{ave} \cdot A_p = 328.05 \cdot \text{kip}$

Weight of Concrete Pad = $WT_c := (W_p{}^2 \cdot L_p) \cdot \gamma_c = 210 \cdot \text{kip}$

Total Weight of Soil = $WT_{Stot} := (A1_s + A2_s) \cdot W_p \cdot \gamma_s = 231.5 \cdot \text{kips}$

Total Weight of Rock = $WT_{Rtot} := (A1_r + A2_r) \cdot W_p \cdot \gamma_{rock} = 437.6 \, \text{kips}$

Resisting Moment = $M_r := (WT_c + \text{Axial}) \cdot \dfrac{W_p}{2} + S_u \cdot \dfrac{(L_p - L_{pag})}{3} + WT_{Stot} \cdot Y_{soil} + WT_{Rtot} \cdot Y_{rock} = 10310 \cdot \text{kip} \cdot \text{ft}$

Overturning Moment = $M_{ot} := OM + \text{Shear} \cdot L_p = 5244 \cdot \text{kip} \cdot \text{ft}$

Factor of Safety Actual = $FS := \dfrac{M_r}{M_{ot}} = 1.97$

Factor of Safety Required = $FS_{req} := 1.0$

OverTurning_Moment_Check := if($FS \geq FS_{req}$, "Okay" , "No Good")

OverTurning_Moment_Check = "Okay"

Rock Anchor Check:

Polar Moment of Inertia = $I_p := \left(D_{a1}^2 \cdot N_{a1} + D_{a2}^2 \cdot N_{a2}\right) = 25344 \cdot in^2$

$T_2 := \frac{M_{ot} \cdot D_{a2}}{I_p} = 119.2 \cdot kips$

$T_1 := \frac{M_{ot} \cdot D_{a1}}{I_p} = 59.6 \cdot kips$

Maximum Tension Force = $T_{Max} := max\left(T_2, T_1\right) = 119.2 \cdot kips$

Gross Area of Bolt = $A_g := \frac{\pi}{4} \cdot d_{ra}^2 = 11.401 \cdot in^2$

Allowable Tension = $T_{all} := 0.75 \cdot A_g \cdot F_u = 769.6 \cdot kips$

$\frac{T_{Max}}{T_{all}} = 15.5 \cdot \%$

Condition1 := if$\left(T_{Max} < T_{all}, \text{"OK"}, \text{"NG"}\right)$

Condition1 = "OK"

Check Bond Strength:

Bond Strength = Bond_Strength := $d_{Hole} \cdot \pi \cdot D_{rock} \cdot \tau = 326 \cdot kips$

$\frac{T_{Max}}{Bond\_Strength} = 36.6 \cdot \%$

Condition2 := if$\left(T_{Max} < Bond_Strength, \text{"OK"}, \text{"NG"}\right)$

Condition2 = "OK"

Bearing Pressure Caused by Footing:

Area of the Mat = $A_{mat} := \frac{\left(W_p \cdot \frac{W_p}{2}\right)}{2} = 25 ft^2$

Maximum Pressure in Mat = $P_{max} := \frac{WT_c + Axial + T_1 \cdot \frac{N_{a1}}{2} + T_2 \cdot \frac{N_{a2}}{2}}{A_{mat}} = 39.554 \cdot ksf$

Max_Pressure_Check := if$\left(P_{max} < q_{rock}, \text{"Okay"}, \text{"No Good"}\right)$

Max_Pressure_Check = "Okay"

RAN Template:	A&L Template:
704Bu Outdoor	1HP_704Bu

CT11860A_1.1_L700

Section 1 - Site Information

Site ID: CT11860A
Status: Draft
Version: 1.1
Project Type: L700
Approved: Not Approved
Approved By: Not Approved
Last Modified: 9/23/2016 7:01:54 AM
Last Modified By: GSM1900\AMurill9

Site Name: CT860/CL&P Trumbull
Site Class: Monopole
Site Type: Structure Non Building
Solution Type:
Plan Year:
Market: CONNECTICUT
Vendor: Ericsson
Landlord: CL&P

Latitude: 41.23250000
Longitude: -73.17220000
Address: 48 Quail Trail
City, State: Trumbull, CT
Region: NORTHEAST

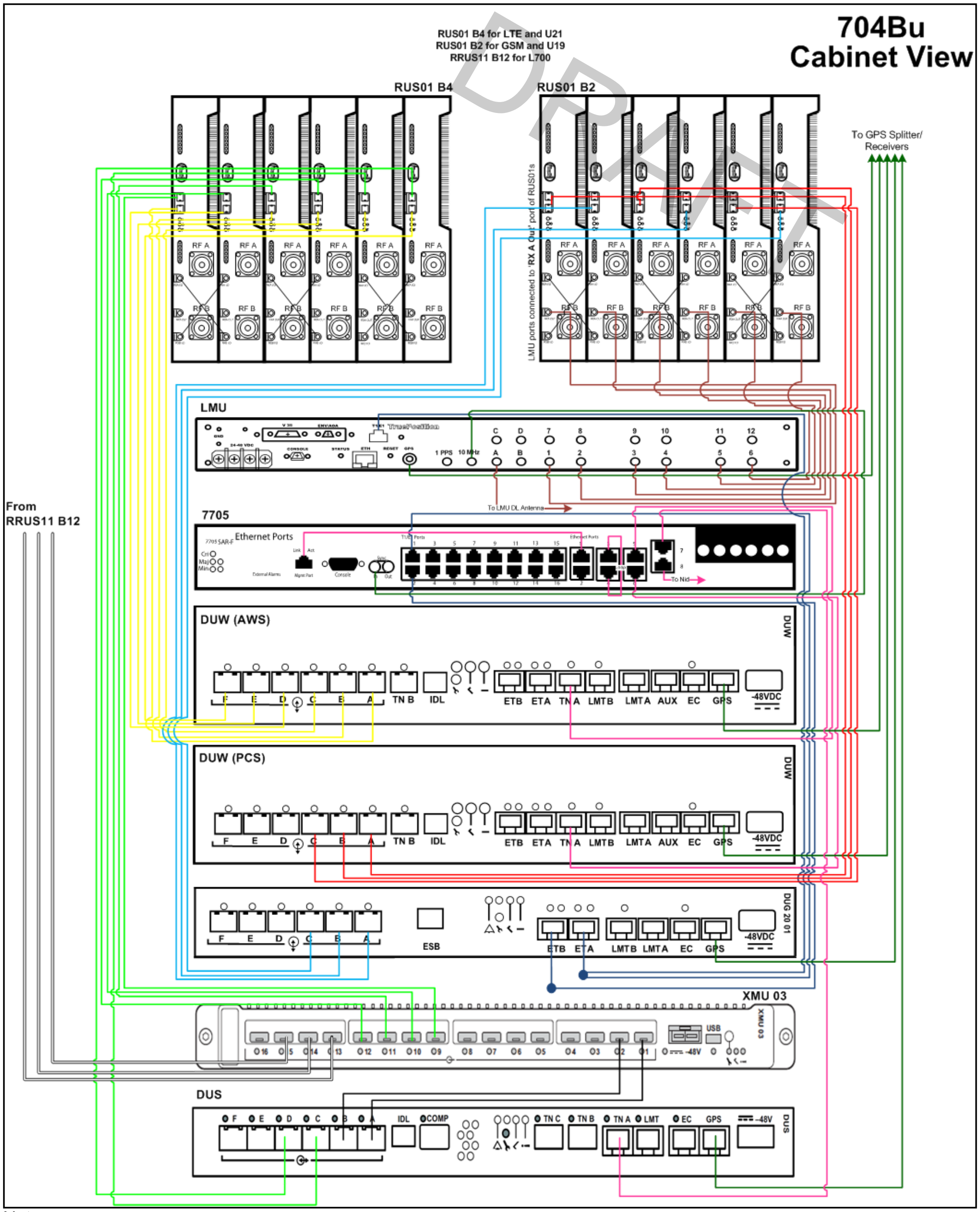
RAN Template: 704Bu Outdoor	AL Template: 1HP_704Bu			
Sector Count: 3	Antenna Count: 3	Coax Line Count: 18	TMA Count: 0	RRU Count: 3

Section 2 - Existing Template Images

----- This section is intentionally blank. -----

Section 3 - Proposed Template Images

704Bu.png



Notes:

Section 4 - Siteplan Images

----- This section is intentionally blank. -----

RAN Template:	**A&L Template:**
704Bu Outdoor	1HP_704Bu

CT11860A_1.1_L700

Section 5 - RAN Equipment

Existing RAN Equipment

Template: 4B

Enclosure	**1**	**2**
Enclosure Type	RBS 3106	RBS 6102
Baseband		DUL20, DUG20, DUW30 **(x2)**
Radio		RUS01 B4 **(x6)**, RUS01 B2 **(x6)**

Proposed RAN Equipment

Template: 704Bu Outdoor

Enclosure	**1**	**2**
Enclosure Type	RBS 6102	Ground Mount
Baseband	DUG20 (G1900), DUW30 (U1900), DUW30 (U2100), DUS41 (L2100, L700)	
Multiplexer	XMU (L2100, L700)	
Radio	RUS01 B2 **(x3)** (G1900), RUS01 B2 **(x3)** (U1900), RUS01 B4 **(x6)** (U2100, L2100)	RRUS11 B12 **(x3)** (L700)

RAN Scope of Work:

RAN Template:	A&L Template:
704Bu Outdoor	1HP_704Bu

CT11860A_1.1_L700

Section 6 - A&L Equipment

Existing Template: 4B
Proposed Template: 1HP_704Bu

Sector 1 (Existing) view from behind		
Coverage Type	A - Outdoor Macro	
Antenna	1	
Antenna Model	APX16DWV-16DWV-S-E-A20 (Quad)	
Azimuth	50	
M. Tilt	0	
Height	105	
Ports	P1	P2
Active Tech.	U1900 G1900	U2100 L2100
Dark Tech.		
Restricted Tech.		
Decomm. Tech.		
E. Tilt	2	2
Cables	1-5/8" Coax - 150 ft. 1-5/8" Coax - 150 ft. 1-5/8" Coax - 150 ft. 1-5/8" Coax - 150 ft.	1-5/8" Coax - 150 ft. 1-5/8" Coax - 150 ft. 1-5/8" Coax - 150 ft. 1-5/8" Coax - 150 ft.
TMAs		
Diplexers / Combiners		
Radio		
Sector Equipment		

Unconnected Equipment:

Scope of Work:

RAN Template:	A&L Template:
704Bu Outdoor	1HP_704Bu

CT11860A_1.1_L700

Sector 1 (Proposed) view from behind			
Coverage Type	A - Outdoor Macro		
Antenna	1		
Antenna Model	SBNHH-1D65A (Hex)		
Azimuth	50		
M. Tilt	0		
Height	105		
Ports	P1	P2	P3
Active Tech.	U1900 G1900	U2100 L2100	L700
Dark Tech.			
Restricted Tech.			
Decomm. Tech.			
E. Tilt	2	2	2
Cables	1-5/8" Coax - 150 ft. 1-5/8" Coax - 150 ft.	1-5/8" Coax - 150 ft. 1-5/8" Coax - 150 ft.	1-5/8" Coax - 150 ft. 1-5/8" Coax - 150 ft.
TMAs			
Diplexers / Combiners			
Radio			
Sector Equipment			

Unconnected Equipment:

Scope of Work:

Install Bias-T's up top for RET's

RAN Template:	A&L Template:
704Bu Outdoor	1HP_704Bu

CT11860A_1.1_L700

Sector 2 (Existing) view from behind		
Coverage Type	A - Outdoor Macro	
Antenna	1	
Antenna Model	APX16DWV-16DWV-S-E-A20 (Quad)	
Azimuth	170	
M. Tilt	0	
Height	105	
Ports	P1	P2
Active Tech.	U1900 G1900	U2100 L2100
Dark Tech.		
Restricted Tech.		
Decomm. Tech.		
E. Tilt	7	8
Cables	1-5/8" Coax - 150 ft. 1-5/8" Coax - 150 ft. 1-5/8" Coax - 150 ft. 1-5/8" Coax - 150 ft.	1-5/8" Coax - 150 ft. 1-5/8" Coax - 150 ft. 1-5/8" Coax - 150 ft. 1-5/8" Coax - 150 ft.
TMAs		
Diplexers / Combiners		
Radio		
Sector Equipment		

Unconnected Equipment:

Scope of Work:

RAN Template:	A&L Template:
704Bu Outdoor	1HP_704Bu

CT11860A_1.1_L700

Sector 2 (Proposed) view from behind			
Coverage Type	A - Outdoor Macro		
Antenna	1		
Antenna Model	SBNHH-1D65A (Hex)		
Azimuth	170		
M. Tilt	0		
Height	105		
Ports	P1	P2	P3
Active Tech.	U1900 G1900	U2100 L2100	L700
Dark Tech.			
Restricted Tech.			
Decomm. Tech.			
E. Tilt	2	2	2
Cables	1-5/8" Coax - 150 ft. 1-5/8" Coax - 150 ft.	1-5/8" Coax - 150 ft. 1-5/8" Coax - 150 ft.	1-5/8" Coax - 150 ft. 1-5/8" Coax - 150 ft.
TMAs			
Diplexers / Combiners			
Radio			
Sector Equipment			

Unconnected Equipment:

Scope of Work:

Install Bias-T's up top for RET's

RAN Template:	A&L Template:
704Bu Outdoor	1HP_704Bu

CT11860A_1.1_L700

Sector 3 (Existing) view from behind		
Coverage Type	A - Outdoor Macro	
Antenna	1	
Antenna Model	APX16DWV-16DWV-S-E-A20 (Quad)	
Azimuth	300	
M. Tilt	0	
Height	105	
Ports	P1	P2
Active Tech.	U1900 G1900	U2100 L2100
Dark Tech.		
Restricted Tech.		
Decomm. Tech.		
E. Tilt	2	2
Cables	1-5/8" Coax - 150 ft. 1-5/8" Coax - 150 ft. 1-5/8" Coax - 150 ft. 1-5/8" Coax - 150 ft.	1-5/8" Coax - 150 ft. 1-5/8" Coax - 150 ft. 1-5/8" Coax - 150 ft. 1-5/8" Coax - 150 ft.
TMAs		
Diplexers / Combiners		
Radio		
Sector Equipment		

Unconnected Equipment:

Scope of Work:

RAN Template:	A&L Template:
704Bu Outdoor	1HP_704Bu

CT11860A_1.1_L700

Sector 3 (Proposed) view from behind			
Coverage Type	A - Outdoor Macro		
Antenna	1		
Antenna Model	SBNHH-1D65A (Hex)		
Azimuth	300		
M. Tilt	0		
Height	105		
Ports	P1	P2	P3
Active Tech.	U1900 G1900	U2100 L2100	L700
Dark Tech.			
Restricted Tech.			
Decomm. Tech.			
E. Tilt	2	2	2
Cables	1-5/8" Coax - 150 ft. 1-5/8" Coax - 150 ft.	1-5/8" Coax - 150 ft. 1-5/8" Coax - 150 ft.	1-5/8" Coax - 150 ft. 1-5/8" Coax - 150 ft.
TMAs			
Diplexers / Combiners			
Radio			
Sector Equipment			

Unconnected Equipment:

Scope of Work:

Install Bias-T's up top for RET's

Product Specifications

COMMSCOPE®

POWERED BY ANDREW®

SBNHH-1D65A

Andrew® Tri-band Antenna, 698–896 and 2x 1695–2360 MHz, 65° horizontal beamwidth, internal RET. Both high bands share the same electrical tilt.

- Interleaved dipole technology providing for attractive, low wind load mechanical package

Electrical Specifications

Frequency Band, MHz	**698–806**	**806–896**	**1695–1880**	**1850–1990**	**1920–2180**	**2300–2360**
Gain, dBi	13.6	13.7	16.5	16.9	17.1	17.6
Beamwidth, Horizontal, degrees	66	61	70	65	62	61
Beamwidth, Vertical, degrees	17.6	15.9	7.1	6.6	6.2	5.5
Beam Tilt, degrees	0–18	0–18	0–10	0–10	0–10	0–10
USLS, dB	16	13	13	13	12	12
Front-to-Back Ratio at 180°, dB	25	27	28	28	27	29
CPR at Boresight, dB	20	16	20	23	17	20
CPR at Sector, dB	10	5	11	6	1	4
Isolation, dB	25	25	25	25	25	25
Isolation, Intersystem, dB	30	30	30	30	30	30
VSWR | Return Loss, dB	1.5 | 14.0	1.5 | 14.0	1.5 | 14.0	1.5 | 14.0	1.5 | 14.0	1.5 | 14.0
PIM, 3rd Order, 2 x 20 W, dBc	-153	-153	-153	-153	-153	-153
Input Power per Port, maximum, watts	350	350	350	350	350	300
Polarization	±45°	±45°	±45°	±45°	±45°	±45°
Impedance	50 ohm	50 ohm	50 ohm	50 ohm	50 ohm	50 ohm

Electrical Specifications, BASTA*

Frequency Band, MHz	**698–806**	**806–896**	**1695–1880**	**1850–1990**	**1920–2180**	**2300–2360**
Gain by all Beam Tilts, average, dBi	13.1	13.1	16.1	16.5	16.7	17.2
Gain by all Beam Tilts Tolerance, dB	±0.5	±0.5	±0.5	±0.3	±0.5	±0.4
	0 ° | 13.4	0 ° | 13.4	0 ° | 16.0	0 ° | 16.3	0 ° | 16.5	0 ° | 17.0
Gain by Beam Tilt, average, dBi	9 ° | 13.1	9 ° | 13.1	5 ° | 16.2	5 ° | 16.5	5 ° | 16.8	5 ° | 17.3
	18 ° | 12.7	18 ° | 12.7	10 ° | 16.1	10 ° | 16.5	10 ° | 16.6	10 ° | 16.9
Beamwidth, Horizontal Tolerance, degrees	±3.1	±5.4	±2.8	±4	±6.6	±4.6
Beamwidth, Vertical Tolerance, degrees	±1.8	±1.4	±0.3	±0.4	±0.5	±0.3
USLS, dB	15	14	15	15	15	14
Front-to-Back Total Power at 180° ± 30°, dB	22	21	26	26	24	25
CPR at Boresight, dB	22	16	22	25	21	22
CPR at Sector, dB	10	6	12	8	5	4

* CommScope® supports NGMN recommendations on Base Station Antenna Standards (BASTA). To learn more about the benefits of BASTA, download the whitepaper Time to Raise the Bar on BSAs.

General Specifications

Antenna Brand	Andrew®
Antenna Type	DualPol® multiband with internal RET
Band	Multiband
Brand	DualPol® | Teletilt®
Operating Frequency Band	1695 – 2360 MHz | 698 – 896 MHz

Mechanical Specifications

Color	Light gray
Lightning Protection	dc Ground
Radiator Material	Aluminum | Low loss circuit board
Radome Material	Fiberglass, UV resistant
RF Connector Interface	7-16 DIN Female
RF Connector Location	Bottom
RF Connector Quantity, total	6
Wind Loading, maximum	445.0 N @ 150 km/h 100.0 lbf @ 150 km/h
Wind Speed, maximum	241.4 km/h | 150.0 mph

Dimensions

Depth	180.0 mm | 7.1 in
Length	1409.0 mm | 55.5 in
Width	301.0 mm | 11.9 in
Net Weight	15.2 kg | 33.5 lb

Remote Electrical Tilt (RET) Information

Input Voltage	10–30 Vdc
Power Consumption, idle state, maximum	2.0 W
Power Consumption, normal conditions, maximum	13.0 W
Protocol	3GPP/AISG 2.0 (Multi-RET)
RET Interface	8-pin DIN Female | 8-pin DIN Male
RET Interface, quantity	1 female | 1 male
RET System	Teletilt®

Regulatory Compliance/Certifications

Agency	Classification
RoHS 2011/65/EU	Compliant by Exemption
China RoHS SJ/T 11364-2006	Above Maximum Concentration Value (MCV)
ISO 9001:2008	Designed, manufactured and/or distributed under this quality management system

Included Products

BSAMNT-1 — Wide Profile Antenna Downtilt Mounting Kit for 2.4 - 4.5 in (60 - 115 mm) OD round members. Kit contains one scissor top bracket set and one bottom bracket set.

EBI Consulting
environmental | engineering | due diligence

RADIO FREQUENCY EMISSIONS ANALYSIS REPORT EVALUATION OF HUMAN EXPOSURE POTENTIAL TO NON-IONIZING EMISSIONS

T-Mobile Existing Facility

Site ID: CT11860A

CT860/CL&P Trumbull
48 Quail Trail
Trumbull, CT 06611

November 22, 2016

EBI Project Number: 6216005487

Site Compliance Summary	
Compliance Status:	**COMPLIANT**
Site total MPE% of FCC general public allowable limit:	**2.50 %**

November 22, 2016

T-Mobile USA
Attn: Jason Overbey, RF Manager
35 Griffin Road South
Bloomfield, CT 06002

Emissions Analysis for Site: **CT11860A – CT860/CL&P Trumbull**

EBI Consulting was directed to analyze the proposed T-Mobile facility located at **48 Quail Trail, Trumbull, CT**, for the purpose of determining whether the emissions from the Proposed T-Mobile Antenna Installation located on this property are within specified federal limits.

All information used in this report was analyzed as a percentage of current Maximum Permissible Exposure (% MPE) as listed in the FCC OET Bulletin 65 Edition 97-01and ANSI/IEEE Std C95.1. The FCC regulates Maximum Permissible Exposure in units of microwatts per square centimeter (μW/cm2). The number of $\mu W/cm^2$ calculated at each sample point is called the power density. The exposure limit for power density varies depending upon the frequencies being utilized. Wireless Carriers and Paging Services use different frequency bands each with different exposure limits, therefore it is necessary to report results and limits in terms of percent MPE rather than power density.

All results were compared to the FCC (Federal Communications Commission) radio frequency exposure rules, 47 CFR 1.1307(b)(1) – (b)(3), to determine compliance with the Maximum Permissible Exposure (MPE) limits for General Population/Uncontrolled environments as defined below.

General population/uncontrolled exposure limits apply to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Therefore, members of the general public would always be considered under this category when exposure is not employment related, for example, in the case of a telecommunications tower that exposes persons in a nearby residential area.

Public exposure to radio frequencies is regulated and enforced in units of microwatts per square centimeter ($\mu W/cm^2$). The general population exposure limit for the 700 MHz Band is approximately 467 $\mu W/cm^2$, and the general population exposure limit for the 1900 MHz (PCS) and 2100 MHz (AWS) bands is 1000 $\mu W/cm^2$. Because each carrier will be using different frequency bands, and each frequency band has different exposure limits, it is necessary to report percent of MPE rather than power density.

Occupational/controlled exposure limits apply to situations in which persons are exposed as a consequence of their employment and in which those persons who are exposed have been made fully aware of the potential for exposure and can exercise control over their exposure. Occupational/controlled exposure limits also apply where exposure is of a transient nature as a result of incidental passage through a location where exposure levels may be above general population/uncontrolled limits (see below), as long as the exposed person has been made fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means.

Additional details can be found in FCC OET 65.

CALCULATIONS

Calculations were done for the proposed T-Mobile Wireless antenna facility located at **48 Quail Trail, Trumbull, CT**, using the equipment information listed below. All calculations were performed per the specifications under FCC OET 65. Since T-Mobile is proposing highly focused directional panel antennas, which project most of the emitted energy out toward the horizon, all calculations were performed assuming a lobe representing the maximum gain of the antenna per the antenna manufactures supplied specifications, minus 10 dB, was focused at the base of the tower. For this report the sample point is the top of a 6-foot person standing at the base of the tower.

For all calculations, all equipment was calculated using the following assumptions:

1) 2 GSM channels (PCS Band - 1900 MHz) were considered for each sector of the proposed installation. These Channels have a transmit power of 30 Watts per Channel.

2) 2 UMTS channels (PCS Band - 1900 MHz) were considered for each sector of the proposed installation. These Channels have a transmit power of 30 Watts per Channel.

3) 2 UMTS channels (AWS Band – 2100 MHz) were considered for each sector of the proposed installation. These Channels have a transmit power of 30 Watts per Channel.

4) 2 LTE channels (AWS Band – 2100 MHz) were considered for each sector of the proposed installation. These Channels have a transmit power of 60 Watts per Channel

5) 1 LTE channel (700 MHz Band) was considered for each sector of the proposed installation. This channel has a transmit power of 30 Watts.

6) Since all radios are ground mounted there are additional cabling losses accounted for. For each ground mounted RF path the following losses were calculated. 0.84 dB of additional cable loss for all ground mounted 700 MHz Channels, 1.55 dB of additional cable loss for all ground mounted 1900 MHz channels and 1.59 dB of additional cable loss for all ground mounted 2100 MHz channels. This is based on manufacturers Specifications for 105 feet of 1-5/8" coax cable on each path.

7) All radios at the proposed installation were considered to be running at full power and were uncombined in their RF transmissions paths per carrier prescribed configuration. Per FCC OET Bulletin No. 65 - Edition 97-01 recommendations to achieve the maximum anticipated value at each sample point, all power levels emitting from the proposed antenna installation are increased by a factor of 2.56 to account for possible in-phase reflections from the surrounding environment. This is rarely the case, and if so, is never continuous.

8) For the following calculations the sample point was the top of a 6-foot person standing at the base of the tower. The maximum gain of the antenna per the antenna manufactures supplied specifications minus 10 dB was used in this direction. This value is a very conservative estimate as gain reductions for these particular antennas are typically much higher in this direction.

9) The antennas used in this modeling are the **Commscope SBNHH-1D65A** for 700 MHz, 1900 MHz (PCS) and 2100 MHz (AWS) channels. This is based on feedback from the carrier with regards to anticipated antenna selection. The **Commscope SBNHH-1D65A** has a maximum gain of **14.7 dBd** at its main lobe at 1900 MHz and 2100 MHz and a maximum gain of **10.9 dBd** at its main lobe at 700 MHz. The maximum gain of the antenna per the antenna manufactures supplied specifications, minus 10 dB, was used for all calculations. This value is a very conservative estimate as gain reductions for these particular antennas are typically much higher in this direction.

10) The antenna mounting height centerline of the proposed antennas is **105 feet** above ground level (AGL).

11) Emissions values for additional carriers were taken from the Connecticut Siting Council active database. Values in this database are provided by the individual carriers themselves.

12) All calculations were done with respect to uncontrolled / general public threshold limits.

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T-Mobile Site Inventory and Power Data

Sector:	A	Sector:	B	Sector:	C
Antenna #:	**1**	Antenna #:	**1**	Antenna #:	**1**
Make / Model:	Commscope SBNHH-1D65A	Make / Model:	Commscope SBNHH-1D65A	Make / Model:	Commscope SBNHH-1D65A
Gain:	14.7 dBd	Gain:	14.7 dBd	Gain:	14.7 dBd
Height (AGL):	105	Height (AGL):	105	Height (AGL):	105
Frequency Bands	700 MHz / 1900 MHz (PCS) / 2100 MHz (AWS)	Frequency Bands	700 MHz / 1900 MHz (PCS) / 2100 MHz (AWS)	Frequency Bands	700 MHz / 1900 MHz (PCS) / 2100 MHz (AWS)
Channel Count	9	Channel Count	9	Channel Count	9
Total TX Power(W):	330	Total TX Power(W):	330	Total TX Power(W):	330
ERP (W):	6,466.23	ERP (W):	6,466.23	ERP (W):	6,466.23
Antenna A1 MPE%	2.50	Antenna B1 MPE%	2.50	Antenna C1 MPE%	2.50

Site Composite MPE%	
Carrier	**MPE%**
T-Mobile (Per Sector Max)	**2.50 %**
No Additional Carriers Per CSC Active Database	NA
Site Total MPE %:	**2.50 %**

T-Mobile Sector A Total:	2.50 %
T-Mobile Sector B Total:	2.50 %
T-Mobile Sector C Total:	2.50 %
Site Total:	2.50 %

T-Mobile _per sector	# Channels	Watts ERP (Per Channel)	Height (feet)	Total Power Density ($\mu W/cm^2$)	Frequency (MHz)	Allowable MPE ($\mu W/cm^2$)	Calculated % MPE
T-Mobile AWS - 2100 MHz LTE	2	1,227.87	105	9.01	AWS - 2100 MHz	1000	0.90%
T-Mobile AWS - 2100 MHz UMTS	2	613.93	105	4.50	AWS - 2100 MHz	1000	0.45%
T-Mobile PCS - 1950 MHz UMTS	2	619.61	105	4.55	PCS - 1950 MHz	1000	0.45%
T-Mobile PCS - 1950 MHz GSM	2	619.61	105	4.55	PCS - 1950 MHz	1000	0.45%
T-Mobile 700 MHz LTE	1	304.17	105	1.12	700 MHz	467	0.24%
						Total:	**2.50%**

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Summary

All calculations performed for this analysis yielded results that were **within** the allowable limits for general public exposure to RF Emissions.

The anticipated maximum composite contributions from the T-Mobile facility as well as the site composite emissions value with regards to compliance with FCC's allowable limits for general public exposure to RF Emissions are shown here:

T-Mobile Sector	Power Density Value (%)
Sector A:	2.50 %
Sector B:	2.50 %
Sector C:	2.50 %
T-Mobile Per Sector Maximum:	2.50 %
Site Total:	2.50 %
Site Compliance Status:	**COMPLIANT**

The anticipated composite MPE value for this site assuming all carriers present is **2.50%** of the allowable FCC established general public limit sampled at the ground level. This is based upon values listed in the Connecticut Siting Council database for existing carrier emissions.

FCC guidelines state that if a site is found to be out of compliance (over allowable thresholds), that carriers over a 5% contribution to the composite value will require measures to bring the site into compliance. For this facility, the composite values calculated were well within the allowable 100% threshold standard per the federal government.