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November 15, 2018

VIA FEDERAL EXPRESS AND
ELECTRONIC MAIL

Melanie.bachman@ct.gov
Siting.council@ct.gov

Ms. Melanie A. Bachman, Esq., Executive Director
Connecticut Siting Council
Ten Franklin Square
New Britain, CT 06501

Re: Petition 1356 - T-Mobile Northeast, LLC for a Declaratory Ruling that a Certificate of Environmental Compatibility and Public Need is not Required for the Installation of a Rooftop Telecommunications Facility.

Dear Attorney Bachman:

This office represents T-Mobile Northeast, LLC ("T-Mobile"). On behalf of T-Mobile, I have enclosed an original and fifteen (15) copies of T-Mobile's responses to the First Set of Interrogatories by the Connecticut Siting Council in connection with the above-captioned matter.

Please do not hesitate to contact me with any questions.

Very truly yours,

Jesse A. Langer

Enclosures

STATE OF CONNECTICUT
CONNECTICUT SITING COUNCIL

PETITION OF T-MOBILE NORTHEAST, LLC FOR A DECLARATORY RULING THAT A CERTIFICATE OF ENVIRONMENTAL COMPATIBILITY AND PUBLIC NEED IS NOT REQUIRED FOR THE INSTALLATION OF A ROOFTOP TELECOMMUNICATIONS FACILITY	:	PETITION 1356 NOVEMBER 15, 2018

T-MOBILE NORTHEAST, LLC'S RESPONSES TO THE FIRST SET OF INTERROGATORIES BY THE CONNECTICUT SITING COUNCIL

T-Mobile Northeast, LLC ("T-Mobile") respectfully submits the following responses and non-privileged documentation to the First Set of Interrogatories by the Connecticut Siting Council.

Q1. Page 3 of the Petition identifies a "future microwave dish." Such dish is also identified on the Gamma Sector on Sheet C-2 as proposed. However, it is not identified in Section 1-1 of the Structural Analysis Report dated September 8, 2018. Is such dish proposed at this time? If yes, please submit a revised structural analysis to accommodate the dish.

A1. Yes. The microwave dish was added to the revised Structural Analysis Report, dated November 12, 2018 ("Report"). The Report is appended hereto as Attachment 1.

Q2. Section 1.3 of the Structural Analysis Report references TIA/EIA-222-F (EIA Rev. F). The State of Connecticut currently adopts EIA Rev. G. Please update the structural analysis report, as applicable, to accommodate EIA Rev. G.

A2. The reference to the TIA has been removed from the Report. The TIA standard does not apply to the design and analysis of building structures. The 2018 Connecticut Building code and ASCE-710 standards were used for the design and analysis of the proposed rooftop telecommunications facility ("Rooftop Facility").

Q3. If the microwave dish is proposed at this time, is it correct to say that the microwave dish would have a negligible effect on the total of approximately 17.4 percent of the maximum permissible exposure (MPE) noted in the September 14, 2018 RF Emissions Analysis?

A3. Yes, the microwave dish would have a minimal effect on the total MPE limit. The MPE limit would increase from 17.43 percent to 17.60 percent. A revised Radio Frequency Emissions Analysis Report is appended hereto as Attachment 2.

Q4. Would the Petitioner also install more remote radio leads (or three per sector) as referenced in the Structural Analysis Report? If yes, is it correct to say that such remote radio leads are included in Sheet C-2 under the "associated appurtenances" note?

A4. T-Mobile has proposed a total of nine remote radio heads, or three per sector, at the proposed Rooftop Facility. The reference to "associated appurtenances" listed on sheet -2 of Attachment A of the Petition, addresses the aforementioned installation as well as any possible tower mounted amplifiers or fiber management boxes.

Q5. Reference Photo- simulation No; 2 The building on the left appears to have a similar RF-transparent screening on its roof. Is there also a roof-top telecommunications facility installed on the building to the left?

A5. The adjacent building does not host a wireless telecommunications facility. The existing screening for the adjacent building serves as a mechanical screen wall intended to shield the existing rooftop mechanical units from public view. This Petition proposes a similar screen wall to match the aesthetic of the surrounding architecture.

Respectfully submitted by,

T-MOBILE NORTHEAST LLC

By: ______________________

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ATTACHMENT 1

(Revised Structural Analysis Report)

CENTEK engineering

Centered on Solutions℠

Structural Analysis Report

New Site Development (NSD)

Proposed T-Mobile
Telecommunications Facility

Site Ref: CTFF039A

181White Street
Danbury, CT

CENTEK Project No. 18067.00

Date: ~~September 8, 2018~~
REV 1: November 12, 2018

Prepared for:

T-Mobile USA
35 Griffin Road
Bloomfield, CT 06002

Table of Contents

Introduction

The purpose of this report is to summarize the results of the non-linear, P-Δ structural analysis for the telecommunications facility as proposed by T-Mobile on the existing roof of the host building located in Danbury, Connecticut.

The host structure is a ±61-ft tall, four-story building constructed circa 1966 and used as an educational institution. The host building geometry, structure member sizes and foundation system information were obtained from existing drawings as prepared by Philip N. and William Webb Sunderland, dated May 5th, 1966.

Antenna and appurtenance information were provided to this office by T-Mobile RF Data sheet dated April 24th, 2018. Additional information was obtained by CENTEK personnel during a site visit conducted on March 27th, 2018.

Antenna and Appurtenance Summary

The proposed loads considered in this analysis consist of the following:

- **T-MOBILE (PROPOSED):**
  Antennas: Three (3) Ericsson AIR3246 B66 panel antennas, three (3) RFS APX16DWV-16DWV-S-E-A20 panel antennas, three (3) RFS APXVAARR24_43-U-NA20 panel antennas, one (1) RFS SC2-W100AB microwave dish, three (3) Ericsson 4415 B25 remote radio units, three (3) Ericsson 2217 B66A remote radio units, and three (3) Ericsson 4449 B7/B12 remote radio mounted on antenna sector frames behind antenna concealment enclosure with a RAD center elevation of ±65'-6" above grade level.

  Coax Cables: Three (3) Ericsson 6x12 Hybrid Cable System (HCS) routed from the equipment platform on the lower roof and inside non-penetrating cable tray to each antenna sector on the upper roof.

Primary Assumptions Used in the Analysis

- The host building's theoretical capacity does not include any assessment of the condition of the structure.
- The host building structure transfers the horizontal and vertical loads due to the weight of antennas, ice load and wind.
- The host building structure was properly installed and maintained.
- The host building is in plumb condition.
- Superimposed loading, existing and proposed, experienced by the host structure as listed in this report.
- All bolts are appropriately tightened providing the necessary connection continuity.
- All welds are fabricated with ER-70S-6 electrodes.
- All members are assumed to be as specified in the original building design documents.
- All members exposed to the elements were "hot dipped" galvanized in accordance with ASTM A123 and ASTM A153 Standards.
- All existing member protective coatings are in good condition.
- All host building structure members were properly designed, detailed, fabricated, installed and have been properly maintained since erection.
- Any deviation from the analyzed antenna loading will require a new analysis for verification of structural adequacy.
- All coax cables to be installed as indicated in this report and construction drawings prepared by this office.

Analysis

The proposed antenna concealment enclosure was analyzed using a comprehensive finite element computer program entitled RISA 3D. The program analyzes the proposed concealment enclosure, considering the worst case loading condition. The enclosure is considered as loaded by concentric forces along the main structural supports, and the model assumes that the enclosure members are subjected to bending, axial, and shear forces. In addition to the enclosure the existing host building framing members were analyzed using a structural analysis software entitled TEDDS.

The proposed enclosure and existing framing members were analyzed using Allowable Stress Design (ASD).

The controlling wind speed is determined by evaluating the local available wind speed data as provided in Appendix N of the CSBC[1].

Loading

Ultimate Design Wind Speed:	Danbury; V_{ULT} = 120 mph	*[Appendix N of the 2016 CT Building Code Supplement]*
Load Cases (ASD):	Load Case 1; Dead Load	*[Section 1605.3.1 of 2012 IBC]*
	Load Case 2: Dead Load + Snow Load	*[Section 1605.3.1 of 2012 IBC]*
	Load Case 3: Dead Load + (0.6) Wind Load	*[Section 1605.3.1 of 2012 IBC]*
Snow Load (Flat roof):	30 psf (Minimum)	*[Section 1608.1.1 of 2016 CT Building Code Supplement]*
Snow Load (Drift Conditions):	60.534 psf (Max surcharge) Width of Drift =13.527-ft	*[Section 1608.1.1 of 2016 CT Building Code Supplement]*

[1] The 2012 International Building Code (IBC) as amended by the 2016 Connecticut State Building Code.

Design/Analysis Capacities

Host structure member stresses and proposed concealment enclosure stresses were calculated utilizing the structural analysis software RISA 3D.

- Existing Host Structure Members Stresses:

Section	Bending Ratio (percentage of capacity)	Shear Ratio (percentage of capacity)	Result
(E) W16x26 (Low Roof)	82.8%	20.5%	**PASS**
(E) W18x50 (High Roof)	74.6%	19.7%	**PASS**
(E) W18x45 (High Roof)	38.7%	16.9%	**PASS**

(1) Refer to section 3.0 for additional information.

- Proposed Concealment enclosure member stresses:

Tower Component	Stress Ratio (percentage of capacity)	Result
HSS5x5x3/8 (Stub Posts)	3.9%	**PASS**
HSS4x4x5/16 (Weldment)	7.5%	**PASS**
Pipe 3.5 STD (Horiz.)	15.8%	**PASS**
Pipe 2.0 STD (Vert.)	57.2%	**PASS**

Conclusion

This analysis shows that the subject structure **is adequate** to support the proposed superimposed loading due to the proposed telecommunications facility.

The analysis is based, in part, on the information provided to this office by T-Mobile and information provided by the host building management. 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:

Camilo A. Gaviria, PE
Structural Engineer

STATE OF CONNECTICUT
CAMILO A. GAVIRIA
27517
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 the governing state building code and all applicable referenced standards.
- All services performed, results obtained, and recommendations made are 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.

Roof Dead Load Summaries
(include: roofing, ballast, shingles, decking, sheathing, ceilings, joists/beam/girders, trusses, rafters, bridging, future reroofing, misc./mechanical/electrical, etc.)

Roof Type 1: ***Lower Roof Construction***

4.75 Thick total concrete on 1.3x22ga form deck	52.0	psf
Ceiling system	3.0	psf
Misc Mech/Electrical	5.0	psf
Roofing system	8.0	psf
		psf
		psf
		psf
Total =	**68.0**	**psf**

Roof Type 2: ***High Roof Construction***

5" Total Thickness concrete slab on 24 ga form deck	55.0	psf
Ceiling System	3.0	psf
Misc Mech/Elec	5.0	psf
Roofing System	8.0	psf
		psf
		psf
		psf
Total =	**71.0**	**psf**

Roof Type 2 :

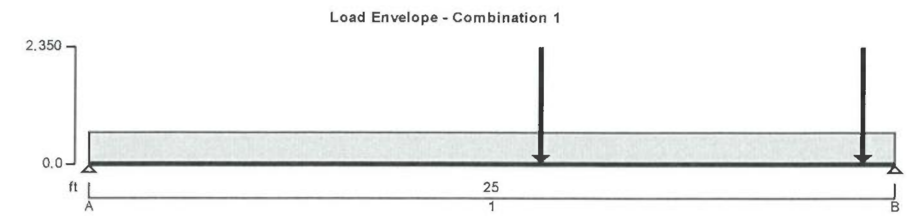
		psf
		psf
		psf
		psf
		psf
		psf
Total =	**0.0**	**psf**

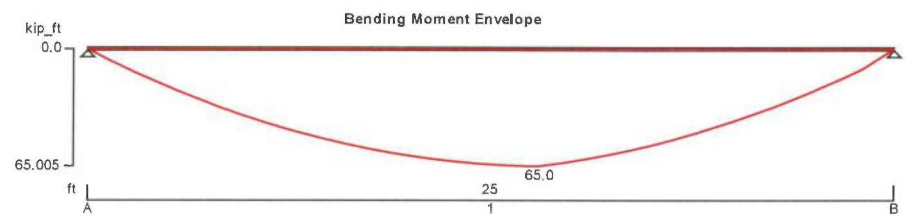
CENTEK engineering Centered on Solutions™ Centek Engineering, Inc. 63-2 North Branford Road Branford, CT 06405	Project TMO WCSU NSD				Job Ref. 18067.00	
	Section Existing W16x26 (RTP Loading)				Sheet no./rev. 1	
	Calc. by CAG	Date 9/9/2018	Chk'd by	Date	App'd by	Date

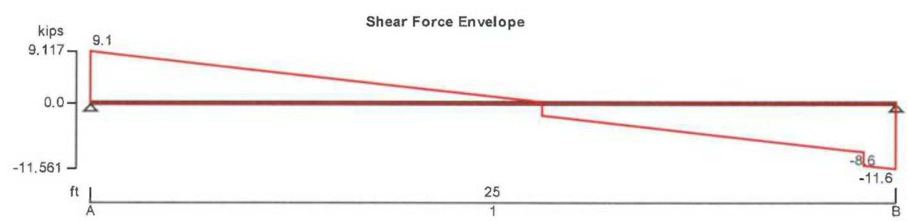
STEEL BEAM ANALYSIS & DESIGN (AISC360-10)

In accordance with AISC360 14th Edition published 2010 using the ASD method

Tedds calculation version 3.0.12







Support conditions

Support A	Vertically restrained
	Rotationally free
Support B	Vertically restrained
	Rotationally free

Applied loading

Beam loads	Self - Dead self weight of beam × 1
	Roof Dead - Dead full UDL 0.425 kips/ft
	Snow - Snow full UDL 0.188 kips/ft
	RTP DL - Dead point load 1.15 kips at 288.00 in
	RTP LL - Live point load 1.2 kips at 288.00 in
	RTP DL - Dead point load 1.15 kips at 168.00 in
	RTP LL - Live point load 1.2 kips at 168.00 in

Load combinations

Load combination 1	Support A	Dead × 1.00
		Live × 1.00
		Snow × 1.00
	Span 1	Dead × 1.00
		Live × 1.00
		Snow × 1.00
	Support B	Dead × 1.00
		Live × 1.00
		Snow × 1.00

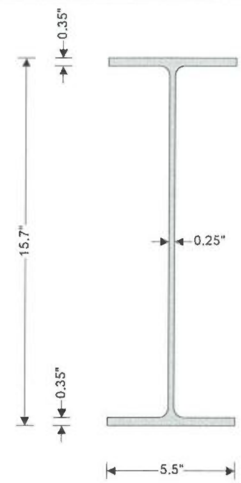
Analysis results

Maximum moment	M_{max} = **65** kips_ft	M_{min} = **0** kips_ft
Maximum moment span 1 segment 1	$M_{s1\_seg1\_max}$ = **44.5** kips_ft	$M_{s1\_seg1\_min}$ = **0** kips_ft
Maximum moment span 1 segment 2	$M_{s1\_seg2\_max}$ = **64** kips_ft	$M_{s1\_seg2\_min}$ = **0** kips_ft
Maximum moment span 1 segment 3	$M_{s1\_seg3\_max}$ = **65** kips_ft	$M_{s1\_seg3\_min}$ = **0** kips_ft
Maximum moment span 1 segment 4	$M_{s1\_seg4\_max}$ = **47.4** kips_ft	$M_{s1\_seg4\_min}$ = **0** kips_ft
Maximum shear	V_{max} = **9.1** kips	V_{min} = **-11.6** kips
Maximum shear span 1 segment 1	$V_{s1\_seg1\_max}$ = **9.1** kips	$V_{s1\_seg1\_min}$ = **0** kips
Maximum shear span 1 segment 2	$V_{s1\_seg2\_max}$ = **5.1** kips	$V_{s1\_seg2\_min}$ = **0** kips
Maximum shear span 1 segment 3	$V_{s1\_seg3\_max}$ = **1.1** kips	$V_{s1\_seg3\_min}$ = **-5.2** kips
Maximum shear span 1 segment 4	$V_{s1\_seg4\_max}$ = **0** kips	$V_{s1\_seg4\_min}$ = **-11.6** kips
Deflection segment 5	δ_{max} = **0** in	δ_{min} = **0** in
Maximum reaction at support A	R_{A_max} = **9.1** kips	R_{A_min} = **9.1** kips
Unfactored dead load reaction at support A	R_{A_Dead} = **6.2** kips	
Unfactored live load reaction at support A	R_{A_Live} = **0.6** kips	
Unfactored snow load reaction at support A	R_{A_Snow} = **2.4** kips	
Maximum reaction at support B	R_{B_max} = **11.6** kips	R_{B_min} = **11.6** kips
Unfactored dead load reaction at support B	R_{B_Dead} = **7.4** kips	
Unfactored live load reaction at support B	R_{B_Live} = **1.8** kips	
Unfactored snow load reaction at support B	R_{B_Snow} = **2.4** kips	

Section details

Section type	**W 16x26 (AISC 14th Edn 2010)**	ASTM steel designation **A36**

CENTEK engineering Centered on Solutions™ Centek Engineering, Inc. 63-2 North Branford Road Branford, CT 06405	Project TMO WCSU NSD			Job Ref. 18067.00	
	Section Existing W16x26 (RTP Loading)			Sheet no./rev. 3	
	Calc. by CAG	Date 9/9/2018	Chk'd by	Date	App'd by	Date



Flexure class **Compact**

Design of members for shear - Chapter G

Required shear strength V_r = **11.561** kips Allowable shear strength V_c = **56.520** kips

PASS - Allowable shear strength exceeds required shear strength

Design of members for flexure in the major axis - Chapter F

Required flexural strength M_r = **65.005** kips_ft Allowable flexural strength M_c = **78.549** kips_ft

PASS - Allowable flexural strength exceeds required flexural strength

Design of members for vertical deflection

Consider deflection due to loads

Limiting deflection δ_{lim} = **1.25** in Maximum deflection δ = **0** in

PASS - Maximum deflection does not exceed deflection limit

Design Wind Load on Other Structures: (Based on IBC 2012, CSBC 2016 and ASCE 7-10)

Wind Speed =	$V := 120$	mph	(User Input)	(CSBC Appendix-N)
Risk Category =	$BC := II$		(User Input)	(IBC Table 1604.5)
Exposure Category =	$Exp := B$		(User Input)	
Height Above Grade =	$Z := 70.33$	ft	(User Input)	
Structure Type =	Structuretype := Solid_Sign		(User Input)	
Structure Height =	$Height := 10$	ft	(User Input)	
Horizontal Dimension of Structure =	$Width := 8.0$	ft	(User Input)	

Terrain Exposure Constants:

Nominal Height of the Atmospheric Boundary Layer =

$$zg := \begin{cases} 1200 & \text{if } Exp = B \\ 900 & \text{if } Exp = C \\ 700 & \text{if } Exp = D \end{cases} = 1.2 \times 10^3$$ (Table 26.9-1)

3-Sec Gust Speed Power Law Exponent =

$$\alpha := \begin{cases} 7 & \text{if } Exp = B \\ 9.5 & \text{if } Exp = C \\ 11.5 & \text{if } Exp = D \end{cases} = 7$$ (Table 26.9-1)

Integral Length Scale Factor =

$$l := \begin{cases} 320 & \text{if } Exp = B \\ 500 & \text{if } Exp = C \\ 650 & \text{if } Exp = D \end{cases} = 320$$ (Table 26.9-1)

Integral Length Scale Power Law Exponent =

$$E := \begin{cases} \frac{1}{3} & \text{if } Exp = B \\ \frac{1}{5} & \text{if } Exp = C \\ \frac{1}{8} & \text{if } Exp = D \end{cases} = 0.333$$ (Table 26.9-1)

Turbulence Intensity Factor =

$$c := \begin{cases} 0.3 & \text{if } Exp = B \\ 0.2 & \text{if } Exp = C \\ 0.15 & \text{if } Exp = D \end{cases} = 0.3$$ (Table 26.9-1)

Exposure Constant =

$$Z_{min} := \begin{cases} 30 & \text{if } Exp = B \\ 15 & \text{if } Exp = C \\ 7 & \text{if } Exp = D \end{cases} = 30$$ (Table 26.9-1)

Exposure Coefficient =

$$K_z := \begin{cases} 2.01\left(\frac{Z}{zg}\right)^{\left(\frac{2}{\alpha}\right)} & \text{if } 15 \le Z \le zg \\ 2.01\left(\frac{15}{zg}\right)^{\left(\frac{2}{\alpha}\right)} & \text{if } Z < 15 \end{cases} = 0.89$$ (Table 29.3-1)

Topographic Factor =	$K_{zt} := 1$	(Eq. 26.8-2)
Wind Directionality Factor =	$K_d = 0.85$	(Table 26.6-1)
Velocity Pressure =	$q_z := 0.00256 \cdot K_z \cdot K_{zt} \cdot K_d \cdot V^2 = 28$	(Eq. 29.3-1)
Peak Factor for Background Response =	$g_Q := 3.4$	(Sec 26.9.4)
Peak Factor for Wind Response =	$g_v := 3.4$	(Sec 26.9.4)
Equivalent Height of Structure =	$z := \begin{cases} Z_{min} & \text{if } Z_{min} > 0.6 \cdot Height \\ 0.6 \cdot Height & \text{otherwise} \end{cases} = 30$	(Sec 26.9.4)
Intensity of Turbulence =	$I_z := c \cdot \left(\frac{33}{z}\right)^{\left(\frac{1}{6}\right)} = 0.305$	(Eq. 26.9-7)
Integral Length Scale of Turbulence =	$L_Z := l \cdot \left(\frac{z}{33}\right)^{E} = 309.993$	(Eq. 26.9-9)
Background Response Factor =	$Q := \sqrt{\frac{1}{1 + 0.63\left(\frac{Width + Height}{L_Z}\right)^{0.63}}} = 0.951$	(Eq. 26.9-8)
Gust Response Factor =	$G := 0.925 \cdot \left[\frac{(1 + 1.7 \cdot g_Q \cdot I_z \cdot Q)}{1 + 1.7 \cdot g_v \cdot I_z}\right] = 0.896$	(Eq. 26.9-6)
Force Coefficient =	$C_f = 1.2$	(Fig 29.5-1 - 29.5-3)
Wind Force =	$F := q_z \cdot G \cdot C_f = 30$ psf	

Development of Wind & Ice Load on Antennas

Antenna Data:

Antenna Model =	Ericsson AIR3246 B66		
Antenna Shape =	Flat		(User Input)
Antenna Height =	$L_{ant} := 58.1$	in	(User Input)
Antenna Width =	$W_{ant} := 15.7$	in	(User Input)
Antenna Thickness =	$T_{ant} := 9.4$	in	(User Input)
Antenna Weight =	$WT_{ant} := 180$	lbs	(User Input)
Number of Antennas =	$N_{ant} := 1$		(User Input)

Wind Load (Front)

Surface Area for One Antenna = $SA_{ant} := \frac{L_{ant} \cdot W_{ant}}{144} = 6.3$ sf

Antenna Projected Surface Area = $A_{ant} := SA_{ant} \cdot N_{ant} = 6.3$ sf

Total Antenna Wind Force = $F_{ant} := F \cdot A_{ant} = 191$ lbs

Wind Load (Side)

Surface Area for One Antenna = $SA_{ant} := \frac{L_{ant} \cdot T_{ant}}{144} = 3.8$ sf

Antenna Projected Surface Area = $A_{ant} := SA_{ant} \cdot N_{ant} = 3.8$ sf

Total Antenna Wind Force = $F_{ant} := F \cdot A_{ant} = 114$ lbs

Gravity Load (without ice)

Weight of All Antennas = $WT_{ant} \cdot N_{ant} = 180$ lbs

Development of Wind & Ice Load on Antennas

Antenna Data:

Antenna Model =	RFSAPXVAARR24-43		
Antenna Shape =	Flat		(User Input)
Antenna Height =	$L_{ant} := 95.9$	in	(User Input)
Antenna Width =	$W_{ant} := 24$	in	(User Input)
Antenna Thickness =	$T_{ant} := 8.7$	in	(User Input)
Antenna Weight =	$WT_{ant} := 153$	lbs	(User Input)
Number of Antennas =	$N_{ant} := 1$		(User Input)

Wind Load (Front)

Surface Area for One Antenna = $SA_{ant} := \frac{L_{ant} \cdot W_{ant}}{144} = 16$ sf

Antenna Projected Surface Area = $A_{ant} := SA_{ant} \cdot N_{ant} = 16$ sf

Total Antenna Wind Force = $F_{ant} := F \cdot A_{ant} = 481$ lbs

Wind Load (Side)

Surface Area for One Antenna = $SA_{ant} := \frac{L_{ant} \cdot T_{ant}}{144} = 5.8$ sf

Antenna Projected Surface Area = $A_{ant} := SA_{ant} \cdot N_{ant} = 5.8$ sf

Total Antenna Wind Force = $F_{ant} := F \cdot A_{ant} = 175$ lbs

Gravity Load (without ice)

Weight of All Antennas = $WT_{ant} \cdot N_{ant} = 153$ lbs

Development of Wind & Ice Load on Antennas

Antenna Data:

Antenna Model =	RFSAPX16DWV-16DWVS-A20		
Antenna Shape =	Flat		(User Input)
Antenna Height =	$L_{ant} := 55.9$	in	(User Input)
Antenna Width =	$W_{ant} := 13$	in	(User Input)
Antenna Thickness =	$T_{ant} := 3.15$	in	(User Input)
Antenna Weight =	$WT_{ant} := 40.7$	lbs	(User Input)
Number of Antennas =	$N_{ant} := 1$		(User Input)

Wind Load (Front)

Surface Area for One Antenna = $SA_{ant} := \frac{L_{ant} \cdot W_{ant}}{144} = 5$ sf

Antenna Projected Surface Area = $A_{ant} := SA_{ant} \cdot N_{ant} = 5$ sf

Total Antenna Wind Force = $F_{ant} := F \cdot A_{ant} = 152$ lbs

Wind Load (Side)

Surface Area for One Antenna = $SA_{ant} := \frac{L_{ant} \cdot T_{ant}}{144} = 1.2$ sf

Antenna Projected Surface Area = $A_{ant} := SA_{ant} \cdot N_{ant} = 1.2$ sf

Total Antenna Wind Force = $F_{ant} := F \cdot A_{ant} = 37$ lbs

Gravity Load (without ice)

Weight of All Antennas = $WT_{ant} \cdot N_{ant} = 41$ lbs

Development of Wind & Ice Load on RRHs

RRUS Data:

RRUS Model =	Ericsson 4449 B71/B12		
RRUS Shape =	Flat		(User Input)
RRUS Height =	$L_{RRH} := 14.9$	in	(User Input)
RRUS Width =	$W_{RRH} := 13.2$	in	(User Input)
RRUS Thickness =	$T_{RRH} := 10.4$	in	(User Input)
RRUS Weight =	$WT_{RRH} := 74$	lbs	(User Input)
Number of RRUS's =	$N_{RRH} := 1$		(User Input)

Wind Load (Front)

Surface Area for One RRH = $SA_{RRH} := \frac{L_{RRH} \cdot W_{RRH}}{144} = 1.4$ sf

RRH Projected Surface Area = $A_{RRH} := SA_{RRH} \cdot N_{RRH} = 1.4$ sf

Total RRH Wind Force = $F_{RRH} := F \cdot A_{RRH} = 41$ lbs

Wind Load (Side)

Surface Area for One RRH = $SA_{RRH} := \frac{L_{RRH} \cdot T_{RRH}}{144} = 1.1$ sf

RRH Projected Surface Area = $A_{RRH} := SA_{RRH} \cdot N_{RRH} = 1.1$ sf

Total RRH Wind Force = $F_{RRH} := F \cdot A_{RRH} = 32$ lbs

Gravity Load (without ice)

Weight of All RRHs = $WT_{RRH} \cdot N_{RRH} = 74$ lbs

Development of Wind & Ice Load on RRHs

RRUS Data:

RRUS Model =	Ericsson 4415 B25		
RRUS Shape =	Flat		(User Input)
RRUS Height =	$L_{RRH} := 16.5$	in	(User Input)
RRUS Width =	$W_{RRH} := 13.4$	in	(User Input)
RRUS Thickness =	$T_{RRH} := 5.9$	in	(User Input)
RRUS Weight =	$WT_{RRH} := 46$	lbs	(User Input)
Number of RRUS's =	$N_{RRH} := 1$		(User Input)

Wind Load (Front)

Surface Area for One RRH = $SA_{RRH} := \frac{L_{RRH} \cdot W_{RRH}}{144} = 1.5$ sf

RRH Projected Surface Area = $A_{RRH} := SA_{RRH} \cdot N_{RRH} = 1.5$ sf

Total RRH Wind Force = $F_{RRH} := F \cdot A_{RRH} = 46$ lbs

Wind Load (Side)

Surface Area for One RRH = $SA_{RRH} := \frac{L_{RRH} \cdot T_{RRH}}{144} = 0.7$ sf

RRH Projected Surface Area = $A_{RRH} := SA_{RRH} \cdot N_{RRH} = 0.7$ sf

Total RRH Wind Force = $F_{RRH} := F \cdot A_{RRH} = 20$ lbs

Gravity Load (without ice)

Weight of All RRHs = $WT_{RRH} \cdot N_{RRH} = 46$ lbs

Development of Wind & Ice Load on RRHs

RRUS Data:

RRUS Model =	Ericsson 2217 B66A		
RRUS Shape =	Flat		(User Input)
RRUS Height =	$L_{RRH} := 13.8$	in	(User Input)
RRUS Width =	$W_{RRH} := 11.7$	in	(User Input)
RRUS Thickness =	$T_{RRH} := 5.4$	in	(User Input)
RRUS Weight =	$WT_{RRH} := 28.2$	lbs	(User Input)
Number of RRUS's =	$N_{RRH} := 1$		(User Input)

Wind Load (Front)

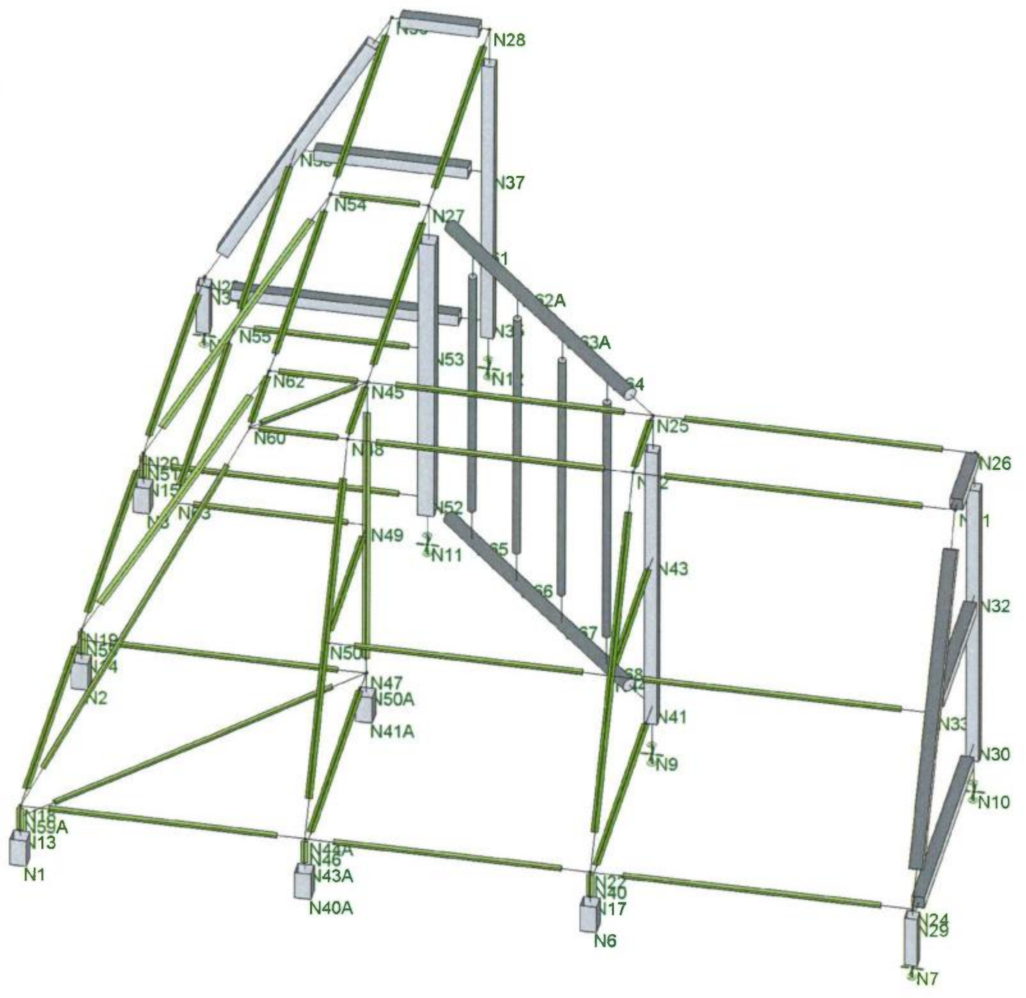
Surface Area for One RRH =	$SA_{RRH} := \frac{L_{RRH} \cdot W_{RRH}}{144} = 1.1$	sf
RRH Projected Surface Area =	$A_{RRH} := SA_{RRH} \cdot N_{RRH} = 1.1$	sf
Total RRH Wind Force =	$F_{RRH} := F \cdot A_{RRH} = 34$	lbs

Wind Load (Side)

Surface Area for One RRH =	$SA_{RRH} := \frac{L_{RRH} \cdot T_{RRH}}{144} = 0.5$	sf
RRH Projected Surface Area =	$A_{RRH} := SA_{RRH} \cdot N_{RRH} = 0.5$	sf
Total RRH Wind Force =	$F_{RRH} := F \cdot A_{RRH} = 16$	lbs

Gravity Load (without ice)

Weight of All RRHs =	$WT_{RRH} \cdot N_{RRH} = 28$	lbs



Envelope Only Solution

CENTEK		SK - 1
CAG	CTFF039A WCSU Danbury	Sept 9, 2018 at 10:40 AM
18067.00	Isometric View	18067.00 CTFF039A WCSU Danbu...

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design ...	A [in2]	Iyy [in4]	Izz [in4]	J [in4]
1	HSS Stub Posts	HSS5X5X6	Column	Tube	A500 Gr...	Typical	6.18	21.7	21.7	36.1
2	Weldment	HSS4X4X5	None	None	A500 Gr...	Typical	4.1	9.14	9.14	15.3
3	ANT SUPPORTS (HORI...	PIPE_3.5	Beam	Pipe	A53 Gr.B	Typical	2.5	4.52	4.52	9.04
4	ANT SUPPORTS (VERT)	PIPE_2.0	Column	Wide Flange	A53 Gr.B	Typical	1.02	.627	.627	1.25

Load Combinations

	Description	S...	P...	S...	B...	Fa...	BLC	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...
1	Deflection 1	Yes	Y		DL	1																		
2	IBC 16-8	Yes	Y		DL	1																		
3	IBC 16-10 (b)	Yes	Y		DL	1	SL	1	S...	1														
4	IBC 16-12 (a) (b)	Yes	Y		DL	1	WLZ	.6																
5	IBC 16-12 (a) (c)	Yes	Y		DL	1	WLX	.6																
6	IBC 16-12 (a) (d)	Yes	Y		DL	1	WLZ	-.6																
7		Yes	Y		DL	1	WLX	-.6																
8	IBC 16-13 (b) (a)	Yes	Y		DL	1	WLX	.45	LL	.75	L...	.75	SL	.75	S...	.75								
9	IBC 16-13 (b) (b)	Yes	Y		DL	1	WLZ	.45	LL	.75	L...	.75	SL	.75	S...	.75								
10	IBC 16-13 (b) (c)	Yes	Y		DL	1	WLX	-.45	LL	.75	L...	.75	SL	.75	S...	.75								
11	IBC 16-13 (b) (d)	Yes	Y		DL	1	WLZ	-.45	LL	.75	L...	.75	SL	.75	S...	.75								
12	IBC 16-15 (a)	Yes	Y		DL	.6	WLX	.6																
13	IBC 16-15 (b)	Yes	Y		DL	.6	WLZ	.6																
14	IBC 16-15 (c)	Yes	Y		DL	.6	WLX	-.6																
15	IBC 16-15 (d)	Yes	Y		DL	.6	WLZ	-.6																

Envelope Joint Reactions

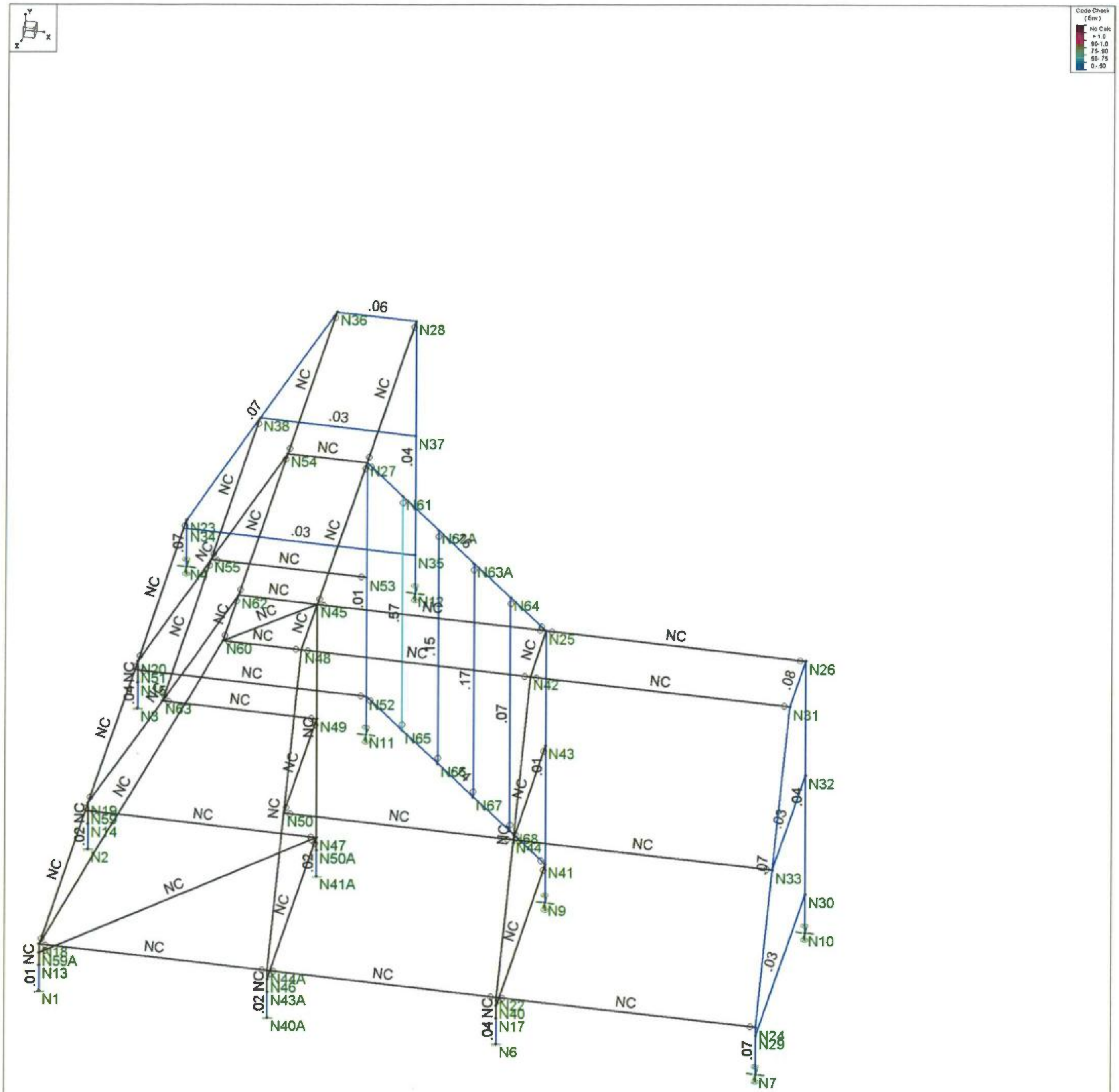
	Joint		X [k]	LC	Y [k]	LC	Z [k]	LC	MX [k-ft]	LC	MY [k-ft]	LC	MZ [k-...	LC
1	N1	max	.265	14	1.2	10	.285	4	.151	4	.006	5	.142	5
2		min	-.265	5	-1.587	5	-.285	15	-.15	15	-.006	7	-.14	14
3	N6	max	.265	14	2.584	3	1.541	4	.779	4	.006	12	.142	5
4		min	-.265	5	.026	13	-1.54	15	-.777	15	-.006	7	-.14	14
5	N2	max	.592	14	2.09	10	.285	4	.151	4	.006	5	.306	5
6		min	-.592	5	-1.32	5	-.285	15	-.15	15	-.006	7	-.304	14
7	N3	max	1.637	14	2.525	3	.285	4	.151	4	.006	12	.829	5
8		min	-1.638	5	-.008	12	-.285	15	-.15	15	-.006	7	-.826	14
9	N4	max	.547	7	1.201	10	.002	13	0	15	.001	12	0	15
10		min	-.533	12	-.415	12	-.002	6	0	1	-.001	7	0	1
11	N7	max	.002	6	1.252	11	.584	13	0	15	.001	6	0	15
12		min	-.002	13	-.46	13	-.601	6	0	1	-.001	13	0	1
13	N10	max	0	13	1.21	9	.213	4	0	15	0	6	0	15
14		min	0	6	-.377	15	-.205	11	0	1	0	13	0	1
15	N12	max	.187	10	1.094	8	0	7	0	15	0	12	0	15
16		min	-.199	5	-.337	14	0	12	0	1	0	7	0	1
17	N9	max	.091	7	.545	9	.029	13	0	15	0	12	0	15
18		min	-.091	12	.02	15	-.029	6	0	1	0	7	0	1
19	N40A	max	.265	14	1.996	8	.583	4	.3	4	.006	12	.142	5
20		min	-.265	5	-1.273	14	-.583	15	-.299	15	-.006	7	-.14	14
21	N41A	max	.592	14	2.886	8	.583	4	.3	4	.006	12	.306	5
22		min	-.592	5	-1.112	14	-.583	15	-.299	15	-.006	7	-.304	14

Envelope Joint Reactions (Continued)

	Joint		X [k]	LC	Y [k]	LC	Z [k]	LC	MX [k-ft]	LC	MY [k-ft]	LC	MZ [k-...	LC
23	N11	max	.071	7	.764	8	.174	13	0	15	0	12	0	15
24		min	-.07	12	.014	14	-.175	6	0	1	0	7	0	1
25	Totals:	max	4.508	14	15.57	3	4.558	13						
26		min	-4.508	5	1.547	15	-4.558	6						

Envelope AISC 14th(360-10): ASD Steel Code Checks

	Member	Shape	Code Check	Loc[ft]	LC	Shear Che...	Lo...	...	LC	Pnc/...	Pnt/o...	Mny...	Mnz...	...	Eqn
1	M1	HSS5X5X6	.014	0	4	.007	0	z	4	169....	170....	24.331	24.331	...	H1-...
2	M3	HSS5X5X6	.020	0	5	.013	0	y	14	169....	170....	24.331	24.331	...	H1-...
3	M4	HSS5X5X6	.039	0	7	.036	0	y	5	169....	170....	24.331	24.331	...	H1-...
4	M5	HSS5X5X6	.036	0	6	.034	0	z	4	169....	170....	24.331	24.331	...	H1-...
5	M6	HSS4X4X5	.045	6.107	9	.007	0	z	4	68.926	112....	12.831	12.831	...	H1-...
6	M7	HSS4X4X5	.074	1.489	6	.025	1....	z	6	111....	112....	12.831	12.831	...	H1-...
7	M8	HSS4X4X5	.033	8	4	.005	8	y	4	85.517	112....	12.831	12.831	...	H1-...
8	M9	HSS4X4X5	.074	0	9	.018	0	y	9	70.862	112....	12.831	12.831	...	H1-...
9	M10	HSS4X4X5	.075	2.583	9	.025	2....	y	9	109....	112....	12.831	12.831	...	H1-...
10	M11	HSS4X4X5	.029	0	9	.005	0	y	9	99.769	112....	12.831	12.831	...	H1-...
11	M12	HSS4X4X5	.039	6.107	8	.007	0	y	5	68.926	112....	12.831	12.831	...	H1-...
12	M13	HSS4X4X5	.067	1.489	7	.023	1....	y	7	111....	112....	12.831	12.831	...	H1-...
13	M14	HSS4X4X5	.065	0	8	.022	0	y	8	109....	112....	12.831	12.831	...	H1-...
14	M15	HSS4X4X5	.067	10.104	8	.018	10...	y	8	72.471	112....	12.831	12.831	...	H1-...
15	M16	HSS4X4X5	.031	7.5	5	.005	7.5	y	5	88.446	112....	12.831	12.831	...	H1-...
16	M17	HSS4X4X5	.027	0	8	.005	0	y	8	100....	112....	12.831	12.831	...	H1-...
17	M18	HSS4X4X5	.013	1.444	7	.003	0	y	7	68.926	112....	12.831	12.831	...	H1-...
18	M23A	HSS5X5X6	.019	0	6	.013	0	z	15	169....	170....	24.331	24.331	...	H1-...
19	M29A	HSS5X5X6	.020	0	5	.013	0	y	14	169....	170....	24.331	24.331	...	H1-...
20	M31	HSS5X5X6	.012	1.444	6	.004	0	z	6	124....	170....	24.331	24.331	...	H1-...
21	M66	PIPE_3.5	.158	4.455	5	.019	0		7	32.092	52.395	5.292	5.292	...	H1-...
22	M67	PIPE_3.5	.144	4.455	5	.018	0		5	32.092	52.395	5.292	5.292	...	H1-...
23	M68	PIPE_2.0	.572	4.008	5	.033	0		5	7.8	21.377	1.245	1.245	...	H1-...
24	M69	PIPE_2.0	.145	2.481	5	.013	0		5	7.8	21.377	1.245	1.245	...	H1-...
25	M70	PIPE_2.0	.170	2.576	6	.015	0		5	7.8	21.377	1.245	1.245	1	H1-...
26	M71	PIPE_2.0	.067	6.297	4	.012	0		5	7.8	21.377	1.245	1.245	1	H1-...



Member Code Checks Displayed (Enveloped)
Envelope Only Solution

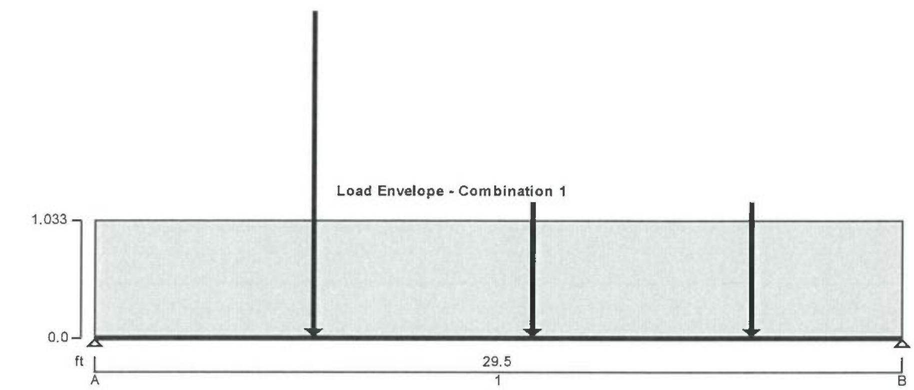
CENTEK	CTFF039A WCSU Danbury	SK - 2
CAG		Sept 9, 2018 at 10:40 AM
18067.00	Unity Check	18067.00 CTFF039A WCSU Danbu...

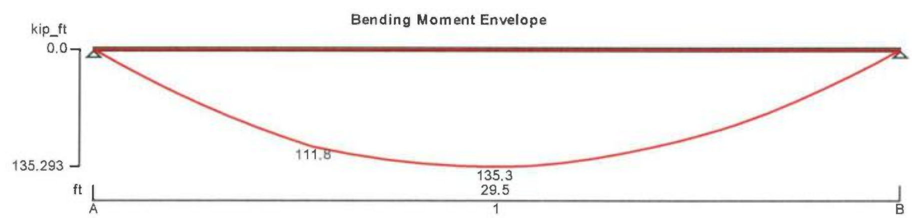
CENTEK engineering Centered on Solutions Centek Engineering, Inc. 63-2 North Branford Road Branford, CT 06405	Project CTFF039A WCSU Danbury			Job Ref. 18067.00	
	Section (E) W18x50			Sheet no./rev. 1	
	Calc. by CAG	Date 9/9/2018	Chk'd by	Date	App'd by	Date

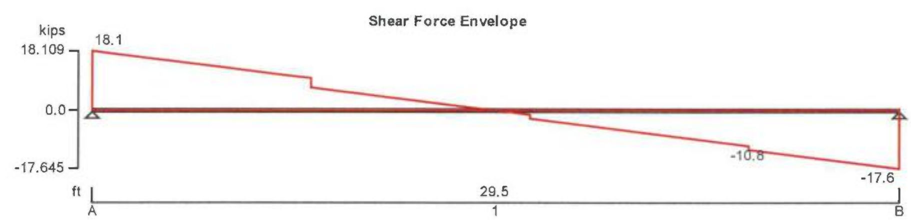
STEEL BEAM ANALYSIS & DESIGN (AISC360-05)

In accordance with AISC360 13th Edition published 2005 using the ASD method

Tedds calculation version 3.0.12







Support conditions

Support A	Vertically restrained
	Rotationally free
Support B	Vertically restrained
	Rotationally free

Applied loading

Beam loads	self - Dead self weight of beam × 1
	roof dead - Dead full UDL 0.533 kips/ft
	Snow (drift) - Snow full UDL 0.45 kips/ft

Enclosure - Dead point load 2.88 kips at 96.00 in
Enclosure - Dead point load 1.2 kips at 192.00 in
Enclosure - Dead point load 1.2 kips at 288.00 in

Load combinations

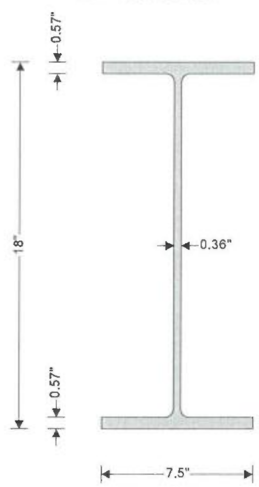
Load combination 1	Support A	Dead × 1.00
		Snow × 1.00
	Span 1	Dead × 1.00
		Snow × 1.00
	Support B	Dead × 1.00
		Snow × 1.00

Analysis results

Maximum moment	M_{max} = **135.3** kips_ft	M_{min} = **0** kips_ft
Maximum shear	V_{max} = **18.1** kips	V_{min} = **-17.6** kips
Deflection	δ_{max} = **0.9** in	δ_{min} = **0** in
Maximum reaction at support A	R_{A_max} = **18.1** kips	R_{A_min} = **18.1** kips
Unfactored dead load reaction at support A	R_{A_Dead} = **11.5** kips	
Unfactored snow load reaction at support A	R_{A_Snow} = **6.6** kips	
Maximum reaction at support B	R_{B_max} = **17.6** kips	R_{B_min} = **17.6** kips
Unfactored dead load reaction at support B	R_{B_Dead} = **11** kips	
Unfactored snow load reaction at support B	R_{B_Snow} = **6.6** kips	

Section details

Section type	**W 18x50 (AISC 14th Edn 2010)**
ASTM steel designation	**A36**
Steel yield stress	F_y = **36** ksi
Steel tensile stress	F_u = **58** ksi
Modulus of elasticity	E = **29000** ksi



Safety factors

Safety factor for tensile yielding	Ω_{ty} = **1.67**
Safety factor for tensile rupture	Ω_{tr} = **2.00**

Safety factor for compression	Ω_c = **1.67**
Safety factor for flexure	Ω_b = **1.67**
Safety factor for shear	Ω_v = **1.50**

Lateral bracing

Span 1 has continuous lateral bracing

Classification of sections for local buckling - Section B4.1

Classification of flanges in flexure - Table B4.1 (case 1)

Width to thickness ratio	$b_f / (2 \times t_f)$ = **6.58**	
Limiting ratio for compact section	$\lambda_{pff} = 0.38 \times \sqrt{[E / F_y]}$ = **10.79**	
Limiting ratio for non-compact section	$\lambda_{rff} = 1.0 \times \sqrt{[E / F_y]}$ = **28.38**	Compact

Classification of web in flexure - Table B4.1 (case 9)

Width to thickness ratio	$(d - 2 \times k) / t_w$ = **45.23**	
Limiting ratio for compact section	$\lambda_{pwf} = 3.76 \times \sqrt{[E / F_y]}$ = **106.72**	
Limiting ratio for non-compact section	$\lambda_{rwf} = 5.70 \times \sqrt{[E / F_y]}$ = **161.78**	Compact

Section is compact in flexure

Design of members for shear - Chapter G

Required shear strength	$V_r = \max(\text{abs}(V_{max}), \text{abs}(V_{min}))$ = **18.109** kips
Web area	$A_w = d \times t_w$ = **6.39** in^2
Web plate buckling coefficient	k_v = **5**
Web shear coefficient - eq G2-2	C_v = **1.000**
Nominal shear strength - eq G2-1	$V_n = 0.6 \times F_y \times A_w \times C_v$ = **138.024** kips
Allowable shear strength	$V_c = V_n / \Omega_v$ = **92.016** kips

PASS - Allowable shear strength exceeds required shear strength

Design of members for flexure in the major axis - Chapter F

Required flexural strength $M_r = \max(\text{abs}(M_{s1\_max}), \text{abs}(M_{s1\_min}))$ = **135.293** kips_ft

Yielding - Section F2.1

Nominal flexural strength for yielding - eq F2-1	$M_{nyld} = M_p = F_y \times Z_x$ = **303** kips_ft
Nominal flexural strength	$M_n = M_{nyld}$ = **303.000** kips_ft
Allowable flexural strength	$M_c = M_n / \Omega_b$ = **181.437** kips_ft

PASS - Allowable flexural strength exceeds required flexural strength

Design of members for vertical deflection

Consider deflection due to dead and snow loads

Limiting deflection	$\delta_{lim} = L_{s1} / 240$ = **1.475** in
Maximum deflection span 1	$\delta = \max(\text{abs}(\delta_{max}), \text{abs}(\delta_{min}))$ = **0.916** in

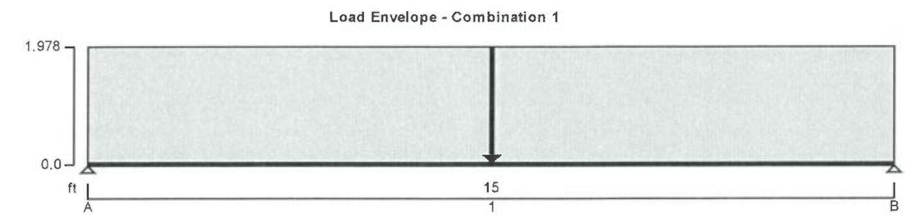
PASS - Maximum deflection does not exceed deflection limit

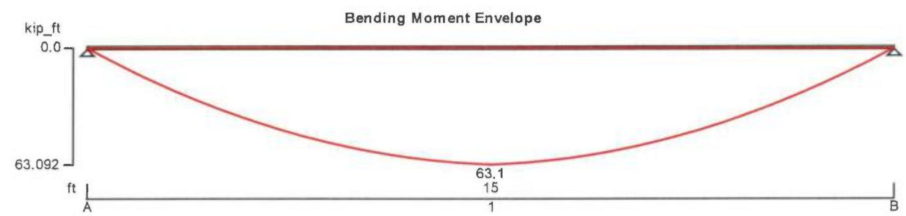
CENTEK engineering Centered on Solutions Centek Engineering, Inc. 63-2 North Branford Road Branford, CT 06405	Project CTFF039A WCSU Danbury				Job Ref. 18067.00	
	Section (E) W18x45				Sheet no./rev. 1	
	Calc. by CAG	Date 9/9/2018	Chk'd by	Date	App'd by	Date

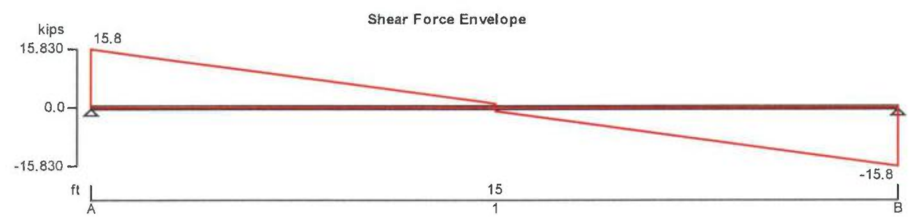
STEEL BEAM ANALYSIS & DESIGN (AISC360-10)

In accordance with AISC360 14th Edition published 2010 using the ASD method

Tedds calculation version 3.0.12







Support conditions

Support A	Vertically restrained
	Rotationally free
Support B	Vertically restrained
	Rotationally free

Applied loading

Beam loads	self - Dead self weight of beam × 1
	roof dead - Dead full UDL 1.047 kips/ft
	snow drift - snow full UDL 0.885 kips/ft
	Enclosure - Dead point load 1.99 kips at 90.00 in

Load combinations

Load combination 1	Support A	Dead × 1.00
		snow × 1.00
	Span 1	Dead × 1.00

CENTEK engineering Centered on Solutions Centek Engineering, Inc. 63-2 North Branford Road Branford, CT 06405	Project CTFF039A WCSU Danbury			Job Ref. 18067.00	
	Section (E) W18x45			Sheet no./rev. 2	
	Calc. by CAG	Date 9/9/2018	Chk'd by	Date	App'd by	Date

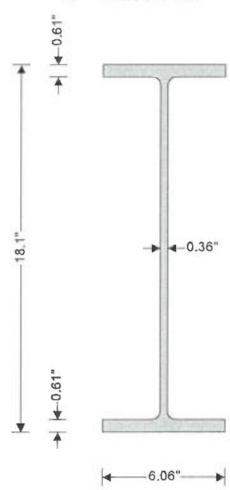
		snow × 1.00
	Support B	Dead × 1.00
		snow × 1.00

Analysis results

Maximum moment	M_{max} = **63.1** kips_ft	M_{min} = **0** kips_ft
Maximum shear	V_{max} = **15.8** kips	V_{min} = **-15.8** kips
Deflection	δ_{max} = **0.1** in	δ_{min} = **0** in
Maximum reaction at support A	R_{A_max} = **15.8** kips	R_{A_min} = **15.8** kips
Unfactored dead load reaction at support A	R_{A_Dead} = **9.2** kips	
Unfactored snow load reaction at support A	R_{A_snow} = **6.6** kips	
Maximum reaction at support B	R_{B_max} = **15.8** kips	R_{B_min} = **15.8** kips
Unfactored dead load reaction at support B	R_{B_Dead} = **9.2** kips	
Unfactored snow load reaction at support B	R_{B_snow} = **6.6** kips	

Section details

Section type	**W 18x46 (AISC 14th Edn 2010)**
ASTM steel designation	**A36**
Steel yield stress	F_y = **36** ksi
Steel tensile stress	F_u = **58** ksi
Modulus of elasticity	E = **29000** ksi



Safety factors

Safety factor for tensile yielding	Ω_{ty} = **1.67**
Safety factor for tensile rupture	Ω_{tr} = **2.00**
Safety factor for compression	Ω_c = **1.67**
Safety factor for flexure	Ω_b = **1.67**
Safety factor for shear	Ω_v = **1.50**

Lateral bracing

Span 1 has continuous lateral bracing

Classification of sections for local buckling - Section B4.1

Classification of flanges in flexure - Table B4.1b (case 10)

Width to thickness ratio $b_f / (2 \times t_f) = \mathbf{5.01}$

Limiting ratio for compact section $\lambda_{pff} = 0.38 \times \sqrt{[E / F_y]} = \mathbf{10.79}$

Limiting ratio for non-compact section $\lambda_{rff} = 1.0 \times \sqrt{[E / F_y]} = \mathbf{28.38}$ Compact

Classification of web in flexure - Table B4.1b (case 15)

Width to thickness ratio $(d - 2 \times k) / t_w = \mathbf{44.67}$

Limiting ratio for compact section $\lambda_{pwf} = 3.76 \times \sqrt{[E / F_y]} = \mathbf{106.72}$

Limiting ratio for non-compact section $\lambda_{rwf} = 5.70 \times \sqrt{[E / F_y]} = \mathbf{161.78}$ Compact

Section is compact in flexure

Design of members for shear - Chapter G

Required shear strength $V_r = max(abs(V_{max}), abs(V_{min})) = \mathbf{15.830}$ kips

Web area $A_w = d \times t_w = \mathbf{6.516}$ in^2

Web plate buckling coefficient $k_v = \mathbf{5}$

Web shear coefficient - eq G2-2 $C_v = \mathbf{1.000}$

Nominal shear strength - eq G2-1 $V_n = 0.6 \times F_y \times A_w \times C_v = \mathbf{140.746}$ kips

Allowable shear strength $V_c = V_n / \Omega_v = \mathbf{93.830}$ kips

PASS - Allowable shear strength exceeds required shear strength

Design of members for flexure in the major axis - Chapter F

Required flexural strength $M_r = max(abs(M_{s1\_max}), abs(M_{s1\_min})) = \mathbf{63.092}$ kips_ft

Yielding - Section F2.1

Nominal flexural strength for yielding - eq F2-1 $M_{nyld} = M_p = F_y \times Z_x = \mathbf{272.1}$ kips_ft

Nominal flexural strength $M_n = M_{nyld} = \mathbf{272.100}$ kips_ft

Allowable flexural strength $M_c = M_n / \Omega_b = \mathbf{162.934}$ kips_ft

PASS - Allowable flexural strength exceeds required flexural strength

Design of members for vertical deflection

Consider deflection due to dead and snow loads

Limiting deflection $\delta_{lim} = L_{s1} / 240 = \mathbf{0.75}$ in

Maximum deflection span 1 $\delta = max(abs(\delta_{max}), abs(\delta_{min})) = \mathbf{0.121}$ in

PASS - Maximum deflection does not exceed deflection limit

ATTACHMENT 2

(Revised Radio Frequency Emissions Analysis Report)

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

T-Mobile Existing Facility

Site ID: CTFF039A

WCSU Cell Split
181 White Street
Danbury, CT 06810

November 15, 2018

EBI Project Number: 6218006175

Site Compliance Summary	
Compliance Status:	**COMPLIANT**
Site total MPE% of FCC general population allowable limit:	**17.60 %**

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November 15, 2018

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

Emissions Analysis for Site: **CTFF039A – WCSU Cell Split**

EBI Consulting was directed to analyze the proposed T-Mobile facility located at **181 White Street, Danbury, 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 population 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 population 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 limits for the 600 MHz and 700 MHz frequency bands are approximately 400 $\mu W/cm^2$ and 467 $\mu W/cm^2$ respectively. The general population exposure limit for the 1900 MHz (PCS), 2100 MHz (AWS) and 11 GHz frequency 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 **181 White Street, Danbury, 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 for directional panel antennas and 20 dB for highly focused parabolic microwave dishes, 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) 1 GSM channels (PCS Band - 1900 MHz) was considered for each sector of the proposed installation. These Channels have a transmit power of 15 Watts per Channel.

2) 1 UMTS channel (AWS Band – 2100 MHz) was considered for each sector of the proposed installation. These Channels have a transmit power of 40 Watts per Channel.

3) 2 LTE channels (PCS Band - 1900 MHz) were considered for each sector of the proposed installation. These Channels have a transmit power of 40 Watts per Channel.

4) 4 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) 2 LTE channels (600 MHz Band) were considered for each sector of the proposed installation. These Channels have a transmit power of 40 Watts per Channel.

6) 2 LTE channels (700 MHz Band) were considered for each sector of the proposed installation. These Channels have a transmit power of 20 Watts per Channel.

7) 1 microwave channel (11 GHz) was considered for Sector C of the proposed facility. This channel has a transmit power of 1 Watt.

8) 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.

9) 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 for directional panel antennas and 20 dB for highly focused parabolic microwave dishes, 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.

10) The antennas used in this modeling are the **Ericsson AIR 3246 B66** & **RFS APX16DWV-16DWVS-E-A20, RFS APXVAARR24_43-U-NA20** for 600 MHz, 700 MHz, 1900 MHz and 2100 MHz channels as well as the **RFS SC2-W100AB** for the 11 GHz microwave link. There is also one **Ericsson AIR 5121 n257** (5G) antenna to be installed per sector for future use. This is based on feedback from the carrier with regard to anticipated antenna selection. All Antenna gain values and associated transmit power levels are shown in the Site Inventory and Power Data table below. The maximum gain of the antenna per the antenna manufactures supplied specifications, minus 10 dB for directional panel antennas and 20 dB for highly focused parabolic microwave dishes, 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.

11) The antenna mounting height centerlines of the proposed panel antennas and microwave dish are **65.5 feet** above ground level (AGL).

12) 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.

13) All calculations were done with respect to uncontrolled / general population threshold limits.

T-Mobile Site Inventory and Power Data

Sector:	A	Sector:	B	Sector:	C
Antenna #:	**1**	Antenna #:	**1**	Antenna #:	**1**
Make / Model:	Ericsson AIR 3246 B66	Make / Model:	Ericsson AIR 3246 B66	Make / Model:	Ericsson AIR 3246 B66
Gain:	15.9 dBd	Gain:	15.9 dBd	Gain:	15.9 dBd
Height (AGL):	65.5 feet	Height (AGL):	65.5 feet	Height (AGL):	65.5 feet
Frequency Bands	2100 MHz (AWS)	Frequency Bands	2100 MHz (AWS)	Frequency Bands	2100 MHz (AWS)
Channel Count	4	Channel Count	4	Channel Count	4
Total TX Power(W):	160	Total TX Power(W):	160	Total TX Power(W):	160
ERP (W):	6,224.72	ERP (W):	6,224.72	ERP (W):	6,224.72
Antenna A1 MPE%	**6.32**	Antenna B1 MPE%	**6.32**	Antenna C1 MPE%	**6.32**
Antenna #:	**2**	Antenna #:	**2**	Antenna #:	**2**
Make / Model:	RFS APX16DWV-16DWVS-E-A20	Make / Model:	RFS APX16DWV-16DWVS-E-A20	Make / Model:	RFS APX16DWV-16DWVS-E-A20
Gain:	16.3 dBd	Gain:	16.3 dBd	Gain:	16.3 dBd
Height (AGL):	65.5 feet	Height (AGL):	65.5 feet	Height (AGL):	65.5 feet
Frequency Bands	1900 MHz (PCS)	Frequency Bands	1900 MHz (PCS)	Frequency Bands	1900 MHz (PCS)
Channel Count	2	Channel Count	2	Channel Count	2
Total TX Power(W):	80	Total TX Power(W):	80	Total TX Power(W):	80
ERP (W):	3,412.64	ERP (W):	3,412.64	ERP (W):	3,412.64
Antenna A2 MPE%	**3.47**	Antenna B2 MPE%	**3.47**	Antenna C2 MPE%	**3.47**
Antenna #:	**3**	Antenna #:	**3**	Antenna #:	**3**
Make / Model:	RFS APXVAARR24_43-U-NA20	Make / Model:	RFS APXVAARR24_43-U-NA20	Make / Model:	RFS APXVAARR24_43-U-NA20
Gain:	16.35 / 12.95 / 13.35 dBd	Gain:	16.35 / 12.95 / 13.35 dBd	Gain:	16.35 / 12.95 / 13.35 dBd
Height (AGL):	65.5 feet	Height (AGL):	65.5 feet	Height (AGL):	65.5 feet
Frequency Bands	2100 MHz / 600 MHz / 700 MHz	Frequency Bands	2100 MHz / 600 MHz / 700 MHz	Frequency Bands	2100 MHz / 600 MHz / 700 MHz
Channel Count	5	Channel Count	5	Channel Count	5
Total TX Power(W):	160	Total TX Power(W):	160	Total TX Power(W):	160
ERP (W):	4,169.10	ERP (W):	4,169.10	ERP (W):	4,169.10
Antenna A3 MPE%	**7.64**	Antenna B3 MPE%	**7.64**	Antenna C3 MPE%	**7.64**
Antenna #:	**4**	Antenna #:	**4**	Antenna #:	**4**
Make / Model:	Ericsson AIR 5121 n257 **(FUTURE USE)**	Make / Model:	Ericsson AIR 5121 n257 **(FUTURE USE)**	Make / Model:	Ericsson AIR 5121 n257 **(FUTURE USE)**
Gain:	15.05	Gain:	15.05	Gain:	15.05
Height (AGL):	65.5	Height (AGL):	65.5	Height (AGL):	65.5
Frequency Bands	NA	Frequency Bands	NA	Frequency Bands	NA
Channel Count	NA	Channel Count	NA	Channel Count	NA
Total TX Power(W):	0.00	Total TX Power(W):	0.00	Total TX Power(W):	0.00
ERP (W):	0.00	ERP (W):	0.00	ERP (W):	0.00
Antenna A3 MPE%	**0.00**	Antenna B3 MPE%	**0.00**	Antenna C3 MPE%	**0.00**

Site Summary Tables

Site Composite MPE%	
Carrier	MPE%
T-Mobile (Sector C)	**17.60 %**
No Additional Carriers on this Facility	**NA**
Site Total MPE %:	**17.60 %**

T-Mobile Sector A Total:	17.43 %
T-Mobile Sector B Total:	17.43 %
T-Mobile Sector C Total:	17.60 %
Site Total:	17.60 %

Microwave Backhaul Data								
Make / Model:	Gain	Height (AGL):	Frequency Bands	Channel Count	Total TX Power(W)	ERP (W)	MPE %	Sector
Commscope SC2-100AB	32.35 dBd	65.5	11 GHz	1	1	1717.91	**0.17**	C

T-Mobile Maximum MPE Power Values (Per Sector)

T-Mobile _Frequency Band / Technology (Sector C)	# 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	4	1,556.18	65.5	63.21	AWS - 2100 MHz	1000.00	6.32%
T-Mobile PCS - 1900 MHz LTE	2	1,706.32	65.5	34.65	PCS - 1900 MHz	1000.00	3.47%
T-Mobile AWS - 2100 MHz UMTS	1	1,726.08	65.5	17.53	AWS - 2100 MHz	1000.00	1.75%
T-Mobile 600 MHz LTE	2	788.97	65.5	16.02	600 MHz	400.00	4.01%
T-Mobile 700 MHz LTE	2	432.54	65.5	8.78	700 MHz	467.00	1.88%
T-Mobile 11 GHz Microwave	1	1,717.91	65.5	1.74	11 GHz	1000.00	0.17%
						Total:	**17.60%**

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Summary

All calculations performed for this analysis yielded results that were **within** the allowable limits for general population 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 population exposure to RF Emissions are shown here:

T-Mobile Sector	Power Density Value (%)
Sector A:	17.43 %
Sector B:	17.43 %
Sector C:	17.60 %
T-Mobile Maximum MPE % (Sector C):	17.60 %
Site Total:	**17.60 %**
Site Compliance Status:	**COMPLIANT**

The anticipated composite MPE value for this site assuming all carriers present is **17.60%** of the allowable FCC established general population 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.

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