STRUCTURAL ANALYSIS REPORT

For

ME5089 (LTE 6C/BWE)

Custom House Garage Pearl Street

25 Pearl Street
Portland, ME 04102

Façade Mounted Antennas; Equipment Located in Shelter

Prepared for:

EMPIRE telecom

at&t

Dated: December 8, 2017

Prepared by:

HUDSON Design Group LLC

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STATE OF MAINE
DANIEL P. HAMM
No. 10344
REGISTERED PROFESSIONAL ENGINEER

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SCOPE OF WORK:

Hudson Design Group LLC (HDG) has been authorized by AT&T to conduct a structural evaluation of the structure supporting the proposed AT&T equipment located in the areas depicted in the latest HDG construction drawings.

This report represents this office's findings, conclusions and recommendations pertaining to the support of AT&T's proposed equipment.

This office conducted an on-site visual survey of the above areas on November 9, 2017. Attendees included Manuel Tejada (HDG – Field Technician).

CONCLUSION SUMMARY:

Building plans were not available and could not be obtained for our use. A limited visual survey of the structure was completed in or near the areas of the proposed work.

Based on our evaluation, we have determined that the existing structure **IS CAPABLE** of supporting the proposed equipment loading.

APPURTENANCE/EQUIPMENT CONFIGURATION:

(3) P65-15-XLH-RR Antennas (51.0"x12.0"x6.0" – Wt. = 36 lbs. /each)

(6) HPA-65R-BUU-H6 Antennas (72.0"x14.8"x9.0" – Wt. = 51 lbs. /each)

(9) RRUS-11 RRH's (19.7"x17.0"x7.2" – Wt. = 60 lbs. /each)

(3) RRUS-32 RRH's (27.2"x12.1"x7.0" – Wt. = 60 lbs. /each)

(3) RRUW RRH's (23.6"x13.8"x4.4" – Wt. = 45 lbs. /each)

(3) Squid Surge Arrestors (24.0"x9.7"ø – Wt. = 33 lbs. / each)

(3) 800-10965 Antennas (78.7"x20.0"x6.9" – Wt. = 109 lbs. /each)

(6) RRUS-12 RRH's (20.4"x18.5"x7.5" – Wt. = 58 lbs. /each)

(3) RRUS-32 B66 RRH's (27.2"x12.1"x7.0" Wt. = 60 lbs. /each)

(3) B14 4478 RRH's (15.0"x13.2"x7.4" Wt. = 60 lbs. /each)

(3) Squid Surge Arrestors (24.0"x9.7"ø – Wt. = 33 lbs. / each)

**Proposed Loading Shown in Bold.*

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DESIGN CRITERIA:

1. International Building Code (IBC) 2009, and ASCE 7-05 (Minimum Design Loads for Buildings and Other Structures).

   Wind Analysis:

Reference Wind Speed:	115 MPH	(ASCE 7-05 Figure 6-1C)
Category:	B	(ASCE 7-05 Section 6.5.6.3)

Roof:

Ground Snow, Pg:	50 psf	(ASCE 7-05 Figure 7-1)
Occupancy Category:	II	(ASCE 7-05 Table 1.5-1)
Importance Factor, I:	1.0	(ASCE 7-05 Table 1.5-2)
Exposure Factor, Ce:	0.9	(Fully Exposed, Table 7-2)
Thermal Factor, Ct:	1.0	(ASCE 7-05 Table 7-3)

Calculated Flat Roof Snow Load:

Pf=0.7*Ce*Ct*I*Pg:	31.5 psf	(ASCE 7-05 Equation 7-1)

1. EIA/TIA -222- G Structural Standards for Steel Antenna Towers and Antenna Supporting Structures

City/Town:	Portland
County:	Cumberland
Wind Load:	100 mph
Nominal Ice Thickness:	1 inch

2. Approximate height above grade to the center of the Antennas:

   79'-6"+/- (Alpha Sector)
   89'-0"+/- (Beta Sector)
   67'-0"+/- (Gamma Sector)

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ANTENNA SUPPORT RECOMMENDATIONS:

The new antennas are proposed to be mounted on new pipe masts secured to the existing building wall with epoxy anchors.

RRH's/SURGE ARRESTOR SUPPORT RECOMMENDATIONS:

The new RRH's and surge arrestors are proposed to be mounted on proposed unistrut components mounted to the existing exterior building wall with epoxy anchors.

Limitations and assumptions:

1. Reference the latest HDG construction drawings for all the equipment locations details.
2. Mount all equipment per manufacturer's specifications.
3. All structural members and their connections are assumed to be in good condition and are free from defects with no deterioration to its member capacities.
4. All antennas, coax cables and waveguide cables are assumed to be properly installed and supported as per the manufacturer requirements.
5. HDG is not responsible for any modifications completed prior to and hereafter which HDG was not directly involved.
6. If field conditions differ from what is assumed in this report, then the engineer of record is to be notified as soon as possible.

FIELD PHOTOS:

Photo 1: Sample photo illustrating the existing Alpha sector antennas.

Photo 2: Sample photo illustrating the existing Beta sector antennas.

FIELD PHOTOS (Cont.):

Photo 3: Sample photo illustrating the existing Gamma sector antennas.

Photo 4: Sample photo illustrating the existing RRH's and surge arrestor.

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Calculations

Date: 12/8/2017
Project Name: Custom House Garage Pearl Street
Project Number: ME5089
Designed By: BD **Checked By:** MSC

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2.6.5.2 Velocity Pressure Coeff:

$K_z = 2.01\ (z/z_g)^{2/\alpha}$

z=	89 (ft)
z_g=	1200 (ft)
α=	7.0

K_z= 0.956

Kzmin ≤ Kz ≤ 2.01

Table 2-4

Exposure	Z_g	α	K_{zmin}	K_e
B	1200 ft	7.0	0.70	0.9
C	900 ft	9.5	0.85	1.0
D	700 ft	11.5	1.03	1.1

2.6.6.4 Topographic Factor:

Table 2-5

Topo. Category	K_t	f
2	0.43	1.25
3	0.53	2.0
4	0.72	1.5

$K_{zt} = [1+(K_e K_t/K_h)]^2$

$K_h = e^{(f*z/H)}$

K_{zt}= #DIV/0!

K_h=	#DIV/0!
K_e=	0 (from Table 2-4)
K_t=	0 (from Table 2-5)
f=	0 (from Table 2-5)
z=	89
H=	0 (Ht. of the crest above surrounding terrain)
K_{zt}=	1.00

(If Category 1 then K_{zt} =1.0)

Category= **1**

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2.6.7 Gust Effect Factor

2.6.7.1 Self Supporting Lattice Structures

Gh = 1.0 Latticed Structures > 600 ft

Gh = 0.85 Latticed Structures 450 ft or less

Gh = 0.85 + 0.15 [h/150 - 3.0] h= ht. of structure

h=	106	Gh=	0.85

2.6.7.2 Guyed Masts Gh= 0.85

2.6.7.3 Pole Structures Gh= 1.1

2.6.9 Appurtenances Gh= 1.0

2.6.7.4 Structures Supported on Other Structures
(Cantilivered tubular or latticed spines, pole, structures on buildings (ht. : width ratio > 5)

Gh=	1.35	**Gh=**	**1.35**

2.6.9.2 Design Wind Force on Appurtenances

$$F = q_z * Gh * (EPA)_A$$

$$q_z = 0.00256 * K_z * K_{zt} * K_d * V_{max}^2 * I$$

q_z=	**23.25**	K_z=	0.956
$q_{z\,(ice)}$=	**3.72**	K_{zt}=	1.0
		K_d=	0.95
		V_{max}=	100
		$V_{max\,(ice)}$=	40
		I=	1.0

Table 2-2

Structure Type	Wind Direction Probability Factor, Kd
Latticed structures with triangular, square or rectangular cross sections	0.85
Tubular pole structures, latticed structures with other cross sections, appurtenances	0.95

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Determine Ca:

Table 2-8

Force Coefficients (Ca) for Appurtenances				
Member Type		Aspect Ratio ≤ 2.5	Aspect Ratio = 7	Aspect Ratio ≥ 25
		Ca	Ca	Ca
Flat		1.2	1.4	2.0
Round	C < 32 (Subcritical)	0.7	0.8	1.2
	32 ≤ C ≤ 64 (Transitional)	$3.76/(C^{0.485})$	$3.37/(C^{0.415})$	$38.4/(C^{1.0})$
	C > 64 (Supercritical)	0.5	0.6	0.6

Aspect Ratio is the overall length/width ratio in the plane normal to the wind direction.
(Aspect ratio is independent of the spacing between support points of a linear appurtenance, and the section length considered to have uniform wind load).

Note: Linear interpolation may be used for aspect ratios other than those shown.

Ice Thickness = **1.00 in**

Appurtenances	Height	Width	Depth	Flat Area	Aspect Ratio	Ca	Force (lbs)	Force (lbs) (1" Ice)
P65-15-XLH-RR Antenna	51.0	12.0	6.0	4.25	4.25	1.28	**170**	**33**
HPA-65R-BUU-H6 Antenna	72.0	14.8	9.0	7.40	4.86	1.31	**303**	**57**
800-10965 Antenna	78.7	20.0	6.9	10.93	3.94	1.26	**434**	**78**
RRUS-11 RRH	19.7	17.0	7.2	2.33	1.16	1.20	**88**	**17**
RRUS-32 RRH	27.2	12.1	7.0	2.29	2.25	1.20	**86**	**17**
RRUS-12 RRH	20.4	18.5	7.5	2.62	1.10	1.20	**99**	**19**
RRUS-32 B66 RRH	27.2	12.1	7.0	2.29	2.25	1.20	**86**	**17**
RRUW RRH	23.6	13.8	4.4	2.26	1.71	1.20	**85**	**17**
B14 4478 RRH	15.0	13.2	7.4	1.38	1.14	1.20	**52**	**11**
Squid Surge Arrestor	24.0	9.7	9.7	1.62	2.47	1.20	**61**	**13**

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ICE WEIGHT CALCULATIONS

Thickness of ice (in): 1.00
* Density of ice used = 56 PCF

800-10965 Antenna
Weight of ice based on total radial SF area:

Height (in):	78.7	
Width (in):	20.0	
Depth (in):	6.9	
Total weight of ice on object:		146 lbs
Weight of object:	109 lbs	
Combined weight of ice and object:		255 lbs

P65-15-XLH-RR Antenna
Weight of ice based on total radial SF area:

Height (in):	51.0	
Width (in):	12.0	
Depth (in):	6.0	
Total weight of ice on object:		64 lbs
Weight of object:	36 lbs	
Combined weight of ice and object:		100 lbs

HPA-65R-BUU-H6 Antenna
Weight of ice based on total radial SF area:

Height (in):	72.0	
Width (in):	14.8	
Depth (in):	9.0	
Total weight of ice on object:		120 lbs
Weight of object:	51 lbs	
Combined weight of ice and object:		171 lbs

RRUS-11 RRH
Weight of ice based on total radial SF area:

Height (in):	19.7	
Width (in):	17.0	
Depth (in):	7.2	
Total weight of ice on ob .		39 lbs
Weight of object:	60 lbs	
Combined weight of ice and object:		99 lbs

RRUS-12 RRH
Weight of ice based on total radial SF area:

Height (in):	20.4	
Width (in):	18.5	
Depth (in):	7.5	
Total weight of ice on objec .		43 lbs
Weight of object:	58 lbs	
Combined weight of ice and object:		101 lbs

RRUS-32 RRH
Weight of ice based on total radial SF area:

Height (in):	27.2	
Width (in):	12.1	
Depth (in):	7.0	
Total weight of ice on object:		39 lbs
Weight of object:	60 lbs	
Combined weight of ice and object:		99 lbs

RRUW RRH
Weight of ice based on total radial SF area:

Height (in):	23.6	
Width (in):	13.8	
Depth (in):	4.4	
Total weight of ice on object:		32 lbs
Weight of object:	45 lbs	
Combined weight of ice and object:		77 lbs

RRUS-32 B66 RRH
Weight of ice based on total radial SF area:

Height (in):	27.2	
Width (in):	12.1	
Depth (in):	7.0	
Total weight of ice on object:		39 lbs
Weight of object:	60 lbs	
Combined weight of ice and object:		99 lbs

B14 4478 RRH
Weight of ice based on total radial SF area:

Height (in):	15.0	
Width (in):	13.2	
Depth (in):	7.4	
Total weight of ice on objec .		26 lbs
Weight of object:	60 lbs	
Combined weight of ice and object:		86 lbs

2" pipe
Per foot weight of ice:

pipe weight per foot:	3.65	
pipe length (ft):	7	
diameter (in):	2.375	
Per foot weight of ice on object:		3 lbs/ft
Total weight of ice on object:		20 lbs
Total Wweight of pipe:		26 lbs
Combined weight of ice and object:		46 lbs

Squid Surge Arrestor
Weight of ice based on total radial SF area:

Height (in):	24.0	
Width (in):	9.7	
Depth (in):	9.7	
Total weight of ice on objec .		36 lbs
Weight of object:	33 lbs	
Combined weight of ice and object:		69 lbs

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ALPHA SECTOR

CHECK EPOXY ANCHOR CONNECTION CAPACITY → PROPOSED ANCHORS

Reference: Hilti Anchor Fastening Technical Guide 2014

Assumed Epoxy Type =	HIT-HY 200	
Assumed Anchor Diameter =	3/8	in.
Assumed Embedment Depth =	2 3/8	in.
f'c of Concrete =	2500	psi

Allowable Tensile Load =

F_{Tall} = 2855 lbs.

Allowable Shear Load =

F_{Vall} = 3075 lbs.

WIND FORCES

Reaction (Worst Case) F = 434 lbs.

GRAVITY LOADS

Ice and Equipment 301 lbs.

No. of Supports = 2
No. of Anchors / Support = 2

Tension Design Load / Anchor =

f_t = 108.50 lbs. < 2855 lbs. **Therefore, OK !**

Shear Design Load / Anchor=

f_v = 75.25 lbs. < 3075 lbs. **Therefore, OK !**

CHECK COMBINED TENSION AND SHEAR

f_t / F_T	+	f_v / F_V	≤	1.0			
0.038	+	0.024	=	0.062	<	1.0	**Therefore, OK !**

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BETA AND GAMMA SECTOR

CHECK CONNECTION CAPACITY (Worse Case)

Reference: Hilti HIT-HY 70 Hybrid Adhesive for Masonry

Epoxy Type =	HIT-HY70	
Anchor Diameter =	3/8	in.
Embedment Depth =	3-1/8	in. (Min.)

Allowable Tensile Load =

F_{Tall} = 905 lbs.

Allowable Shear Load =

F_{Vall} = 1045 lbs.

WIND FORCES

Reaction **F =** 434 lbs.

GRAVITY LOADS

Ice and Equipment 301 lbs.

No. of Supports =	2
No. of Anchors / Support =	2

Tension Design Load / Anchor =

f_t= 108.50 lbs. < 905 lbs. **Therefore, OK !**

Shear Design Load / Anchor=

f_v= 75.25 lbs. < 1045 lbs. **Therefore, OK !**

CHECK COMBINED TENSION AND SHEAR

f_t / F_T	+	f_v / F_V	≤	1.0			
0.120	+	0.072	=	0.192	<	1.0	**Therefore, OK !**