STRUCTURAL CALCULATIONS

PROJECT:

Oregon Convention Center
Chiller Plant Redesign

777 NE Martin Luther King Jr Blvd

Portland, OR 97232

MFIA, Inc Consulting Engineers
2007 SE Ash St
Portland, OR 97214

James G. Pierson, Inc.
Consulting Structural Engineers
610 S.W. ALDER SUITE 918 PORTLAND, OR. 97205
(503) 226-1286 FAX 226-3130

April 30, 2018

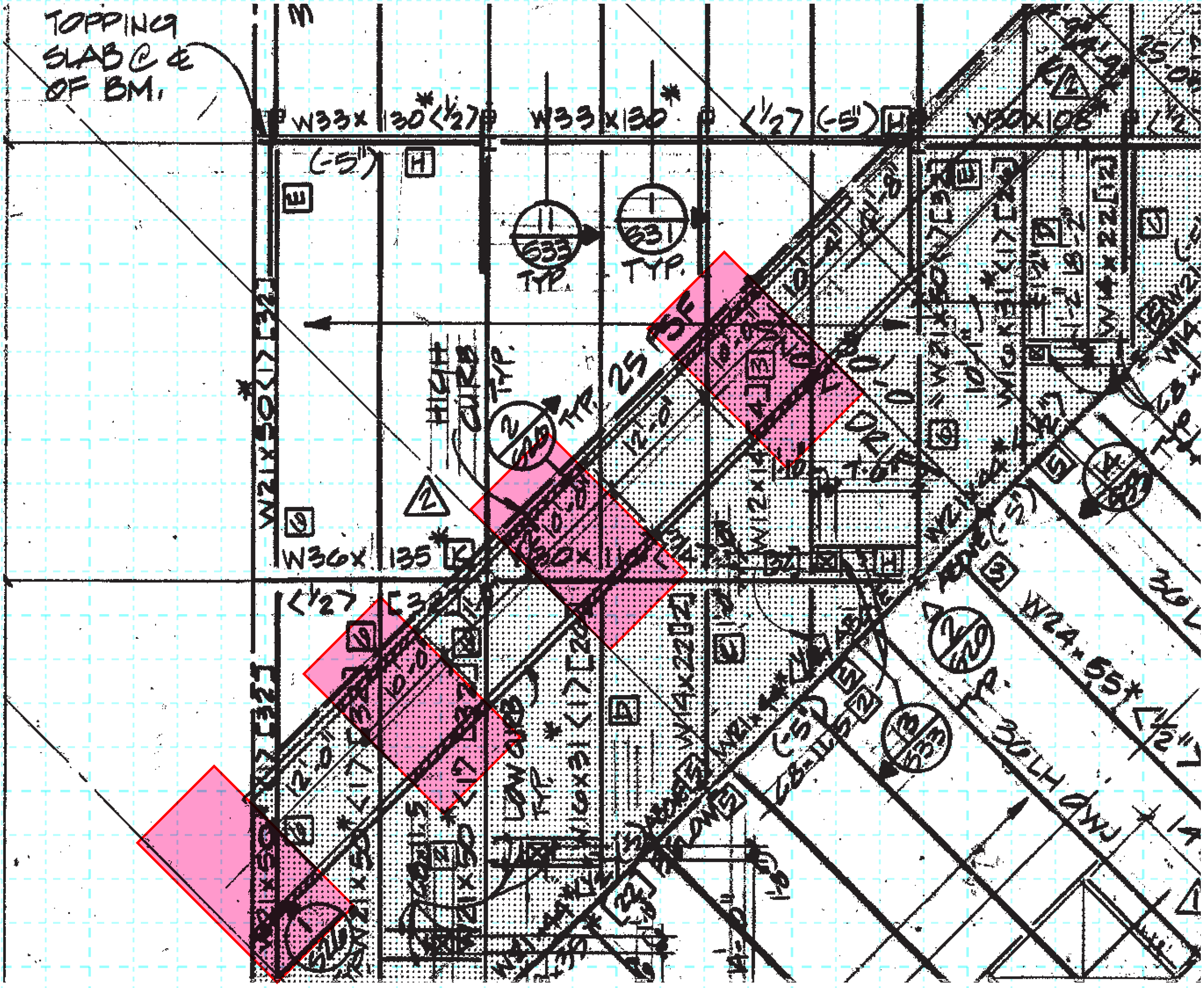
Structural Narrative

The four large cooling towers on the lower roof at the east side of the Oregon Convention Center are being replaced with a newer Chiller units that are both smaller and lighter in weight than the existing cooling towers and it will be located in the same area. The existing framing and cooling towers were part of the 1990 construction.

Summary:

The lateral support requirements of the HVAC units can be resisted by the existing beams and posts with a new frame added to these existing posts (frame sized for the smaller unit dimensions). The new cooling tower CT-1 weights 9,500 lbs compared to 14,000 lbs for the old one and the new CT-2, 3, 4 weighs 24,700 lbs compared to 26,000 lbs for the existing units.

The vertical load of the new Cooling Tower is resisted by the existing concrete curb walls on the roof. The curbs act as concrete beams spanning between steel beams that create the roof of the mechanical area. The existing steel beams at the top of the curb will remain with new steel curb located on top of it sized for the footprint of the new, smaller units. Lateral loads are transmitted the exact same as before, just lighter units.



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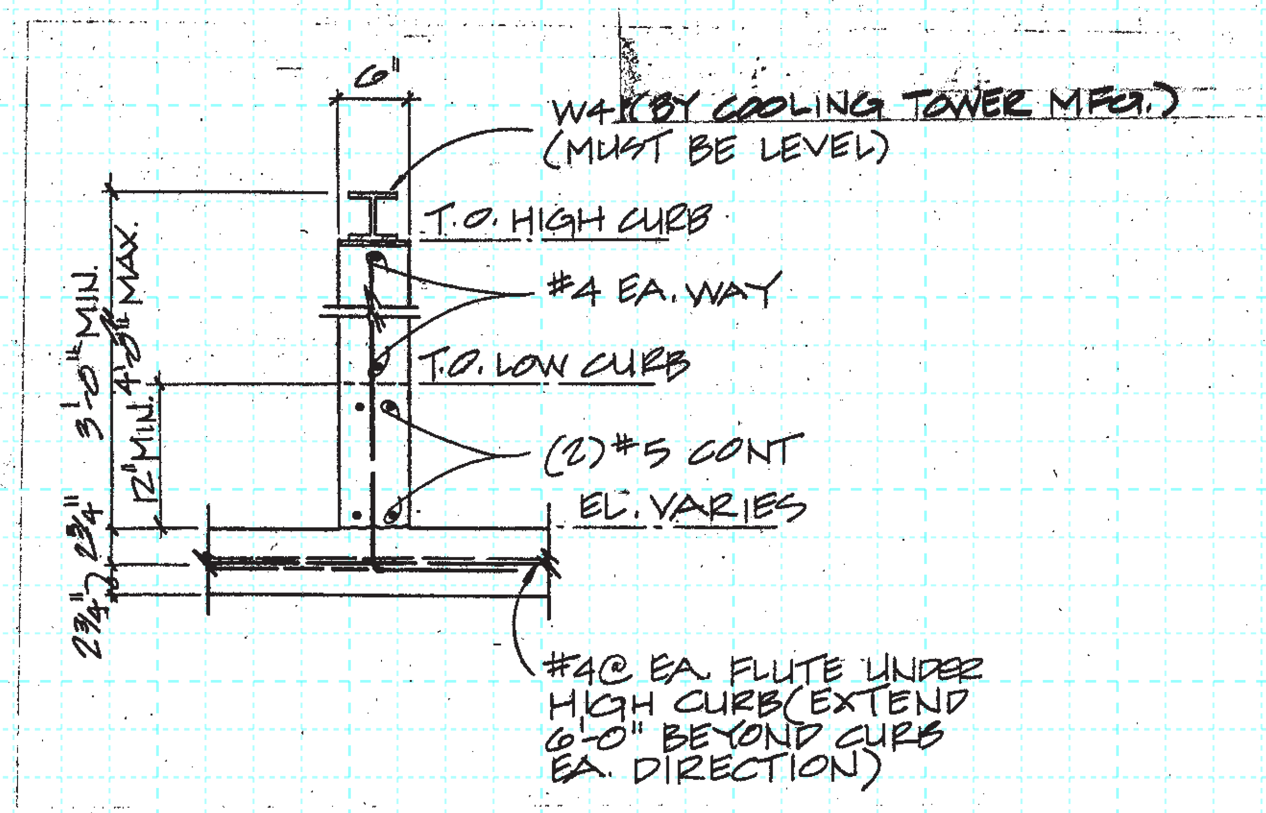
Project: OCC Chillers		Job no.
Location: Portland, OR		Date: 4/13/18
Client: MFIA		Sheet no.: Page 3 of 21



2 COOLING TOWER SUPPORT CURB SECTION

3/4" = 1'-0"

S18

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Project: OCC Chillers	Job no.
Location: Portland, OR	Date: 4/13/18
Client: MFIA	Sheet no. Page 4 of 21

Seismic Design Forces on Mechanical Units

Task: Determine the lateral forces (seismic) and required connections for HVAC equipment installed onto a floor or roof of a structure. The vertical adequacy of the structure for the weight of the equipment and other dead and live loads is beyond the scope of this section of the analysis and is by others unless specifically noted herein.

References: 2012 IBC (2014 OSSC) Section 1613.1

ASCE 7-10 Section 13.6 for mechanical components and systems

Criteria:

Seismic Design Category **D**,
Component Importance Factor
I_p = 1.00
Latitude = 45.528
Longitude =-122.662
Site class D
Risk Category III
W_p = 9500 lb
h = 204 in
w = 84 in
l = 168 in
W_{curb} = 1000 lb
h_{curb} = 48 in

Mapped acceleration parameters (Section 11.4.1)
at short period S_S = 0.976
at 1 sec period S_1 = 0.418

Site coefficient at short period (Table 11.4-1)
F_a = **1.110**
at 1 sec period (Table 11.4-2)
F_v = **1.582**

Spectral response acceleration parameters
at short period (Eq. 11.4-1)
$S_{MS} = F_a \times S_S$ = **1.083**
at 1 sec period (Eq. 11.4-2)
$S_{M1} = F_v \times S_1$ = **0.661**

4/10/2018 Design Maps Summary Report

USGS Design Maps Summary Report

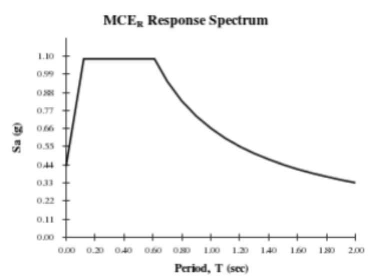
User–Specified Input

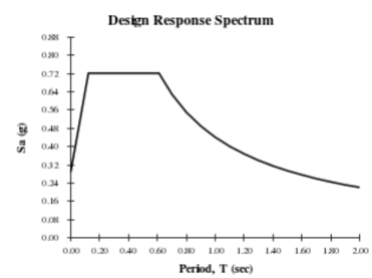
Report Title OCC Chiller
Tue April 10, 2018 21:20:40 UTC
Building Code Reference Document 2012/2015 International Building Code
(which utilizes USGS hazard data available in 2008)
Site Coordinates 45.5282°N, 122.6616°W
Site Soil Classification Site Class D – "Stiff Soil"
Risk Category I/II/III

USGS–Provided Output

S_S = 0.976 g S_{MS} = 1.083 g S_{DS} = 0.722 g
S_1 = 0.418 g S_{M1} = 0.662 g S_{D1} = 0.441 g

For information on how the SS and S1 values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please return to the application and select the "2009 NEHRP" building code reference document.





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Design spectral acceleration parameters (Sect 11.4.4)

Source: http://geohazards.usgs.gov/designmaps/us/application.php

at short period (Eq. 11.4-3) $S_{DS} = 2/3 \times S_{MS}$ = **0.722**
at 1 sec period (Eq. 11.4-4) $S_{D1} = 2/3 \times S_{M1}$ = **0.441**

Application of OSSC and ASCE 7-10 Requirements:

Section 13.3 — Attachments for floor or roof mounted equipment greater than 400 lbs in weight need to be designed for seismic forces

Section 13.3-1 - Design for Total Lateral Force

Total design lateral force $$F_p = \frac{a_p C_a I_p}{R_p}\left(1 + 3\frac{h_x}{h_r}\right)W_p$$ Eq. 13.3-1

Except that: $F_p > 0.7 C_a I_p W_p \quad and \quad F_p \leq 4 C_a I_p W_p$ (32-3)

Table 13.6-1 - Horizontal Force Factors, a_p and R_p

Electrical, mechanical and plumbing equipment and associated conduit and ductwork and piping. - $\mathbf{a_p}$ **= 1.0 and** $\mathbf{R_p}$ **= 2.5**

Unit on flat roof above mechanical room so $\mathbf{h_x}$ **= 16 ft** $\mathbf{h_r}$ **= 16 ft**

Load Combinations - Members and the connection design shall use the load combinations and factors specified in Section 2.3.2. The reliability/redundancy factor may be taken as 1.0 and Fp is substituted for Qe.

Design Lateral Force:

$\mathbf{F_p = 0.4 * a_p} * S_{DS} * I_p \ / R_p * (1 + 2 * h_x/h_r) * W_p$ — $\mathbf{F_p}$ = **3292.228 lbs** *Eq. 13.3-1*

Fp need not exceed $F_{p1} = 1.6 * S_{DS} * I_p * W_p$ = **10974.092** lbs *Eq. 13.3-2*

Fp shall not be less than $F_{p2} = 0.3 * S_{DS} * I_p * W_p$ = **2057.642** lbs *Eq. 13.3-3*

The design is controlled by $\mathbf{F_p}$ = **3292.228** lbs

$\mathbf{F_{pcurb} = 0.4 * a_p} * S_{DS} * I_p \ / R_p * (1 + 2 * h_x/h_r) * W_{curb}$ — $\mathbf{F_{pcurb}}$ = **346.550 lbs** *Eq. 13.3-1*

Overturning:

Overturning will be controlled by Equation 2.3.2-7 of the Basic Load Combinations for Strength Design which is:

0.9 D + E

In this equation, according to ASCE 7 the value of E shall include

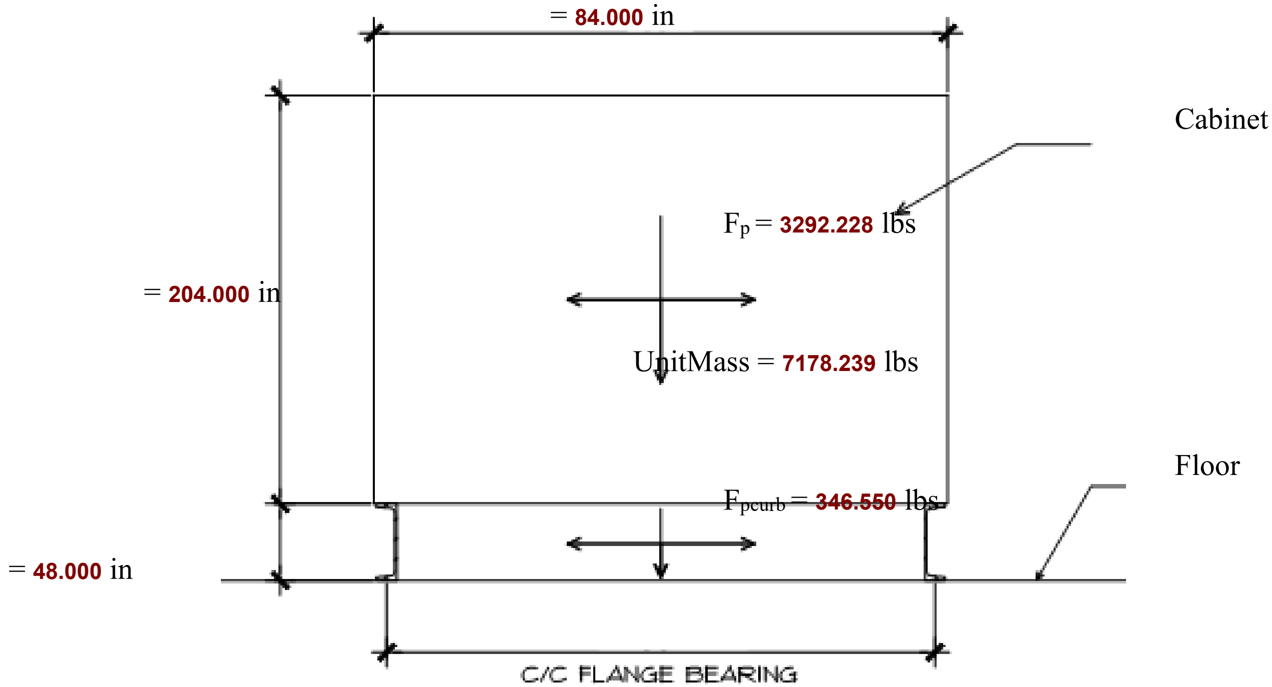
$E = pQe - 0.2\ Sds\ D = 1.0\ Qe - [\ 0.2 \times S_{DS} \times W_p] = \mathbf{Qe} - 0.144\ \mathbf{D}$

Therefore, when substituting Qe Equation 16-18 becomes 0.756 **D + E**

Assume Center of gravity of unit and curb is located at center of height. The following forces apply to allowable stress stability calculations using Equation 16-18 as modified for Qe

Unit Mass = 0.756 **D** = 7178.239 lbs

$\mathbf{F_p}$ = 3292.228 lbs



James G. Pierson, Inc.	Project: OCC CHILLERS - CT-1	Job no.
Consulting Structural Engineers	Location: 777 NE MLK JR BLVD, Portland, OR	Date: 5/2/2018
610 S.W. Alder, Suite 918 Portland, Oregon 97205 Tel: (503) 226-1286 Fax: (503) 226-3130	Client: MFIA Inc, Consulting Engineers	Sheet no.

Compute Stability about bottom of curb

$h = 204.000$ in

$h/2 = 102.000$ in

$h_{curb} = 48.000$ in

$w = 84.000$ in

$w/2 = 42.000$ in

Overturning_Moment = $F_p \times h/2 + h_{curb}) = 493834.138$ lbs_in

Curb Overturning_Moment$_c$ = $F_{pcurb} \times h_{curb} = 16634.413$ lbs_in

Total Overturning Moment = = 510468.551 lbs_in

Restoring_Moment = (UnitMass + UnitMassc) $\times$ w/2 = 333221.388 lbs_in

Safety Factor Against Overturning =Restoring_Moment / TM = 0.653

From this calculation, it is demonstrated that there is some overturning and will need the benefit of hold down anchors. Need to anchor unit for sliding forces also.

MASON INDUSTRIES, Inc.
Manufacturers of Vibration Control Products
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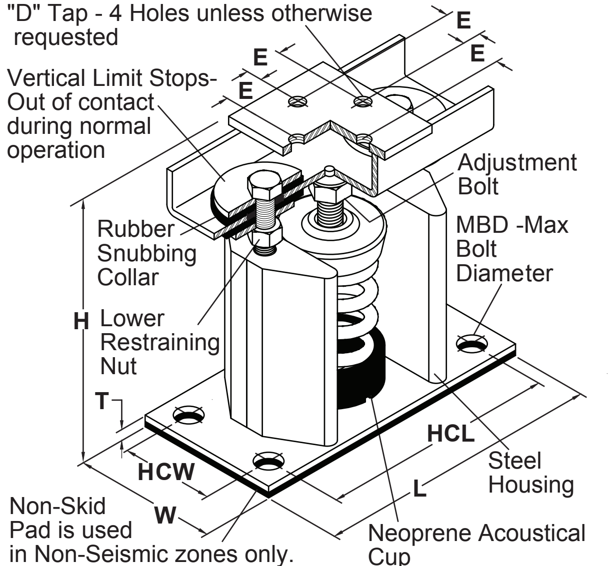
FAX 631/348-0279
Info@Mason-Ind.com
2101 W. Crescent Ave., Suite D
Anaheim, CA 92801
714/535-2727
FAX 714/535-5738
Info@MasonAnaheim.com
www.Mason-Ind.com

JOB NAME: Oregon Convention Center
CUSTOMER: MFIA Engineering
CUSTOMER P.O.:
MASON M.I.:
DWG. NO.:

SLRSO

2" DEFLECTION B, B2, C2, 2-C2 & 4-C2 SERIES SPRING MOUNTS



Non-Skid Pad is used in Non-Seismic zones only. Remove pad prior to installing in seismic zones. Reduce published height by 1/8" if pad is removed.

Baseplate must be uniformly supported

50% Travel to Solid					
SLRSO Size	Capacity (lbs)	Defl. (in)	SLRSO Size	Capacity (lbs)	Defl. (in)
B2-450	411	1.83	2-C2-2420	2020	1.67
B2-680	565	1.66	2-C2-3080	2570	1.67
C2-880	800	1.82	2-C2-3740	3120	1.67
C2-1210	1010	1.67	4-C2-4840	4040	1.67
C2-1540	1285	1.67	4-C2-6160	5145	1.67
C2-1870	1560	1.67	4-C2-7480	6245	1.67
2-C2-1760	1600	1.82			

SPRING DATA

Size	Spring OD (in)	Free Ht. (in)	Ratio Kx/Ky	Ratio OD/OH
B	2 3/8	4	0.55-0.65	0.95-1.00
B2	2 3/8	4 1/2	0.80-0.90	1.19-1.48
C2	2 7/8	5	0.63-0.85	0.96-1.15

#Published ratings allow minimum 25% additional travel to solid. For 50% minimum specified use the ratings shown above. All springs without "#" have additional travel to solid equal to 50% of the rated deflection.

TYPE SLRSO RATINGS

Size	Rated Capacity (lb)	Rated Defl. (in)	Spring Constant (lb/in)	Max. Horiz. Housing G Rating	Spring Color
SLRSO-B-20	20	2.40	8	70.0	Tan
SLRSO-B-26	26	2.18	12	53.9	Wht/Blue
SLRSO-B-35	35	2.20	16	40.0	Purple
SLRSO-B-50	50	2.20	24	28.0	Wht/Red
SLRSO-B-65	65	2.10	31	21.6	Brown
SLRSO-B-85	85	2.10	40	16.5	Wht/Blk
SLRSO-B-115	115	2.00	57	12.2	Silver
SLRSO-B-150	150	2.00	75	9.3	Orange
SLRSO-B2-210	210	2.12	99	6.8	Silver
SLRSO-B2-290	290	2.00	144	4.9	Blue
SLRSO-B2-450#	450	2.00	224	3.2	Tan
SLRSO-B2-680#	680	2.00	340	2.1	Gray
SLRSO-C2-125	125	2.50	50	35.2	Purple
SLRSO-C2-170	170	2.40	70	25.9	Brown
SLRSO-C2-210	210	2.30	90	21.0	Red
SLRSO-C2-260	260	2.20	120	16.9	White
SLRSO-C2-330	330	2.00	165	13.3	Black
SLRSO-C2-460	460	2.00	230	9.6	Blue
SLRSO-C2-610	610	2.00	305	7.2	Green
SLRSO-C2-880#	880	2.00	440	5.0	Gray
SLRSO-C2-1210#	1210	2.00	605	3.6	Silver
SLRSO-C2-1540#	1540	2.00	770	2.9	Gray*
SLRSO-C2-1870#	1870	2.00	935	2.4	Silver*
SLRSO-2-C2-340	340	2.40	140	17.7	Brown
SLRSO-2-C2-420	420	2.30	180	14.3	Red
SLRSO-2-C2-520	520	2.20	240	11.6	White
SLRSO-2-C2-660	660	2.00	330	9.1	Black
SLRSO-2-C2-920	920	2.00	460	6.5	Blue
SLRSO-2-C2-1220	1220	2.00	610	4.9	Green
SLRSO-2-C2-1760#	1760	2.00	880	3.4	Gray
SLRSO-2-C2-2420#	2420	2.00	1210	2.5	Silver
SLRSO-2-C2-3080#	3080	2.00	1540	1.9	Gray*
SLRSO-2-C2-3740#	3740	2.00	1870	1.6	Silver*
SLRSO-4-C2-4840#	4840	2.00	2420	2.2	Silver
SLRSO-4-C2-6160#	6160	2.00	3080	1.7	Gray*
SLRSO-4-C2-7480#	7480	2.00	3740	1.4	Silver*

* with RED inner spring

TYPE SLRSO DIMENSIONS (inches)

Size	L	W	H	T	MBD	HCW	HCL	D	E
SLRSO-B, B2	8 1/2	4 1/4	8 3/4	3/8	5/8	2 3/4	7	1/2	1 1/8
SLRSO-C2	9 1/2	5 1/4	8 3/4	3/8	5/8	3 1/2	7 1/2	5/8	1 3/8
SLRSO-2-C2	14	5 1/4	8 3/4	3/8	5/8	3 1/2	12 1/4	5/8	1 3/8
SLRSO-4-C2	13 3/4	8	8 3/4	3/8	3/4	6 1/4	11	7/8	1 3/8

Illustration shows SLRSO-B housing which contains one (1) B or B2 spring. Not shown is SLRSO-1 housing which contains one (1) C2 spring, SLRSO-2 housing which contains two (2) C2 springs and SLRSO-4 which contains four (4) C2 springs.

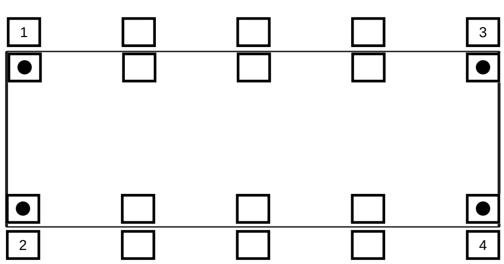
Housing load ratings expressed in G's are based on tests with bolted connections to steel top and bottom.

PLAN VIEW OF MOUNT LOCATIONS

TAG : 2-Fan Cooling Tower

UNIT : Tower Tech TTXL-i2

Click with mouse for each location >



1 : SLRSO-2-C2-3740	7 :
2 : SLRSO-2-C2-3740	8 :
3 : SLRSO-2-C2-3740	9 :
4 : SLRSO-2-C2-3740	10 :
5 :	11 :
6 :	12 :
Sets Required : (1)	

Seismic Design Forces on Mechanical Units

Task: Determine the lateral forces (seismic) and required connections for HVAC equipment installed onto a floor or roof of a structure. The vertical adequacy of the structure for the weight of the equipment and other dead and live loads is beyond the scope of this section of the analysis and is by others unless specifically noted herein.

References: 2012 IBC (2014 OSSC) Section 1613.1

ASCE 7-10 Section 13.6 for mechanical components and systems

Criteria:

Seismic Design Category **D**,
Component Importance Factor
I_p = 1.00
Latitude = 45.528
Longitude =-122.662
Site class D
Risk Category III
W_p = 24700 lb **h = 204 in**
w = 144 in
l = 306 in
W_{curb} = 1000 lb
h_{curb} = 48 in

4/10/2018 Design Maps Summary Report

USGS Design Maps Summary Report

User–Specified Input

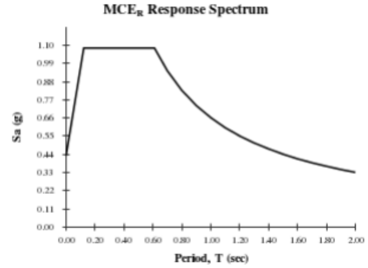
Report Title	OCC Chiller Tue April 10, 2018 21:20:40 UTC
Building Code Reference Document	2012/2015 International Building Code (which utilizes USGS hazard data available in 2008)
Site Coordinates	45.5282°N, 122.6616°W
Site Soil Classification	Site Class D – "Stiff Soil"
Risk Category	I/II/III

USGS–Provided Output

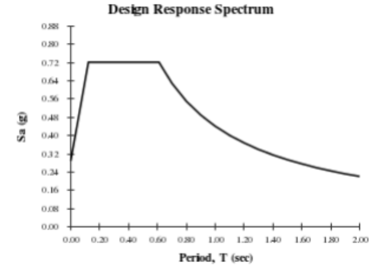
S_S =	0.976 g	S_{MS} =	1.083 g	S_{DS} =	0.722 g
S_1 =	0.418 g	S_{M1} =	0.662 g	S_{D1} =	0.441 g

For information on how the SS and S1 values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please return to the application and select the "2009 NEHRP" building code reference document.

MCE_R Response Spectrum



Design Response Spectrum



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Source: http://geohazards.usgs.gov/designmaps/us/application.php

Mapped acceleration parameters (Section 11.4.1)

at short period S_S = 0.976

at 1 sec period S_1 = 0.418

Site coefficient at short period (Table 11.4-1)

F_a = **1.110**

at 1 sec period (Table 11.4-2)

F_v = **1.582**

Spectral response acceleration parameters

at short period (Eq. 11.4-1)

$S_{MS} = F_a \times S_S$ = **1.083**

at 1 sec period (Eq. 11.4-2)

$S_{M1} = F_v \times S_1$ = **0.661**

Design spectral acceleration parameters (Sect 11.4.4)

at short period (Eq. 11.4-3) $S_{DS} = 2/3 \times S_{MS}$ = **0.722**

at 1 sec period (Eq. 11.4-4) $S_{D1} = 2/3 \times S_{M1}$ = **0.441**

Application of OSSC and ASCE 7-10 Requirements:

Section 13.3 Attachments for floor or roof mounted equipment greater than 400 lbs in weight need to be designed for seismic forces

Section 13.3-1 - Design for Total Lateral Force

Total design lateral force $$F_p = \frac{a_p C_a I_p}{R_p}\left(1 + 3\frac{h_x}{h_r}\right)W_p$$ Eq. 13.3-1

Except that: $F_p > 0.7 C_a I_p W_p \quad and \quad F_p \le 4 C_a I_p W_p$ (32-3)

Table 13.6-1 - Horizontal Force Factors, a_p and R_p

Electrical, mechanical and plumbing equipment and associated conduit and ductwork and piping. - $\mathbf{a_p}$ **= 1.0 and** $\mathbf{R_p}$ **= 2.5**

Unit on flat roof above mechanical room so $\mathbf{h_x}$ **= 16 ft** $\mathbf{h_r}$ **= 16 ft**

Load Combinations - Members and the connection design shall use the load combinations and factors specified in Section 2.3.2. The reliability/redundancy factor may be taken as 1.0 and Fp is substituted for Qe.

Design Lateral Force:

$\mathbf{F_p = 0.4 * a_p}$ $* S_{DS} * I_p / R_p * (1 + 2 * h_x/h_r) * W_p$ $\mathbf{F_p}$ **= 8559.792 lbs** *Eq. 13.3-1*

Fp need not exceed $Fp_1 = 1.6 * S_{DS} * I_p * W_p =$ **28532.639** lbs *Eq. 13.3-2*

Fp shall not be less than $Fp_2 = 0.3 * S_{DS} * I_p * W_p =$ **5349.870** lbs *Eq. 13.3-3*

The design is controlled by $\mathbf{F_p}$ = **8559.792** lbs

$\mathbf{F_{pcurb} = 0.4 * a_p}$ $* S_{DS} * I_p / R_p * (1 + 2 * h_x/h_r) * W_{curb}$ $\mathbf{F_{pcurb}}$ **= 346.550 lbs** *Eq. 13.3-1*

Overturning:

Overturning will be controlled by Equation 2.3.2-7 of the Basic Load Combinations for Strength Design which is:

0.9 D + E

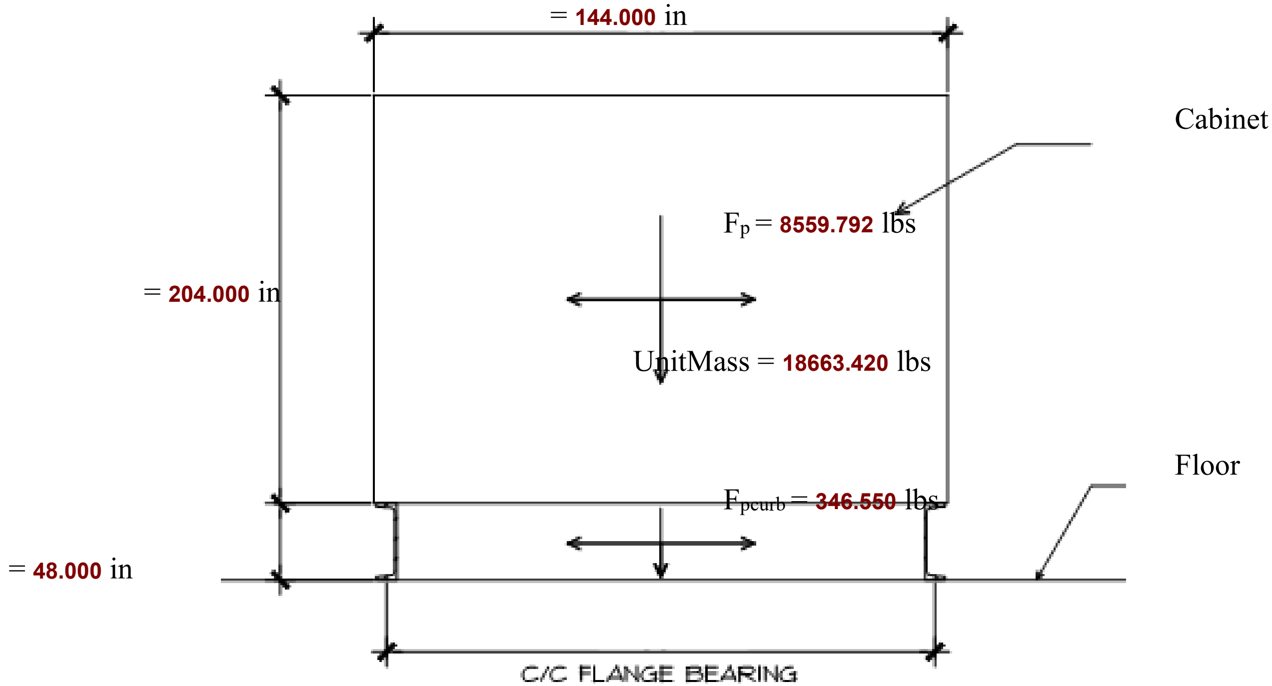
In this equation, according to ASCE 7 the value of E shall include

$E = pQe - 0.2\ Sds\ D = 1.0\ Qe - [\ 0.2 \times S_{DS} \times W_p] = \mathbf{Qe - 0.144\ D}$

Therefore, when substituting Qe Equation 16-18 becomes **0.756 D + E**

Assume Center of gravity of unit and curb is located at center of height. The following forces apply to allowable stress stability calculations using Equation 16-18 as modified for Qe

Unit Mass = 0.756 **D** = 18663.420 lbs
F_p = 8559.792 lbs



Compute Stability about bottom of curb

h = **204.000** in

$h/2$ = **102.000** in

h_{curb} = **48.000** in

w = **144.000** in

$w/2$ = **72.000** in

Overturning_Moment = $F_p \times h/2 + h_{curb})$ = **1283968.758** lbs_in

Curb Overturning_Moment$_c$ = $F_{pcurb} \times h_{curb}$ = **16634.413** lbs_in

Total Overturning Moment = = **1300603.171** lbs_in

Restoring_Moment = (UnitMass + UnitMassc) $\times$ w/2 = **1398169.740** lbs_in

Safety Factor Against Overturning =Restoring_Moment / TM = **1.075**

From this calculation, it is demonstrated that there is some overturning and will need the benefit of hold down anchors. Need to anchor unit for sliding forces also.

Wind Loads on Rooftop Structures and Equipment for buildings with h<=60ft,ASCE7-10 Sec 29.5.1

Lateral force ,$F_h = q_h * GC_r * A_f$ - 29.5-2

$q_h = 0.00256 * K_z * K_d * K_{zt} * V^2$ psf- 29.3-1

The following table shows the calculation for lateral force and net uplift on roof top equipment along long and short directions :

<u>Long Direction :</u>

OTM = $F_{h\text{-long}}$ x Total Height/2 ; R.M = Total Weight x Width/2

T/C(lbs) = (O.T.M - 0.6 R.M)/Width

<u>Short Direction:</u>

OTM = $F_{h\text{-short}}$*Total Height/2 ; RM = Total weight * Length/2

T/C(lbs) = (OTM-0.6RM)/length

ASCE7-10,Sec 29.5.1 Windloads for Roof top Structures,h<=60ft **All units in lb,ft**

Unit Tag	**MAU-1**
Component Data	
Component Weight ,Wp	24600
Curb Weight, W_c	1000
Total Weight, W	25600
Component Height ,H	17
Component Length, l	25
Component Width , W	12
Height of Curb	1
Total Height	18

Building Dimesnions	
Building Length ,L	150
Building Width. B	150
Building Height , h	30

Wind Parameters	
Basic Wind Speed,mph (Sec 26.5)	120
Wind directionality Factor K_d (Sec 26.6)	0.85
Exposure Category (Sec 26.7)	B
Topographic factor K_{zt} (Sec 26.8)	1
velocity pressure coefficient K_z (Sec 29.3.1)	0.701
velocity pressure q_z or q_h in psf (sec 29.3.2)	21.953

As per section 29.5.1	**long**	**short**
Vertically projected Area A_f	450.00	216.00
Guss coefficient GC_r	1.9	1.9
q_z or q_h in psf(ASD)	13.22	13.22
Lateral Force F_h , lbs(q_h*GC_r*A_f)	11306.91	5427.32
Total OTM ,ft-lb(F_h * Htotal/2)	101762.21	48845.86
Total RM,ft-lb (Total Weight*(width or length)/2)	153600	320000
T/C,lbs ((OTM - 0.6RM)/(width or length)	**800.18**	**-5726.17**

Overturning. Need to bolt to frame

MASON INDUSTRIES, Inc.
Manufacturers of Vibration Control Products

350 Rabro Drive
Hauppauge, NY 11788
631/348-0282
FAX 631/348-0279
Info@Mason-Ind.com

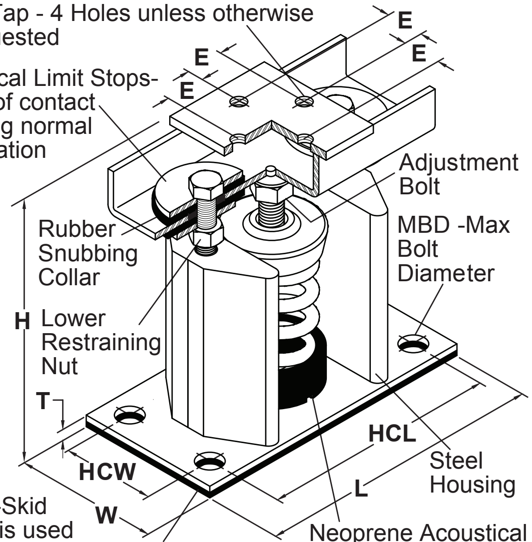
2101 W. Crescent Ave., Suite D
Anaheim, CA 92801
714/535-2727
FAX 714/535-5738
Info@MasonAnaheim.com

www.Mason-Ind.com

JOB NAME Oregon Convention Center
CUSTOMER MFIA Engineering
CUSTOMER P.O.
MASON M.I.
DWG. NO.

SLRSO

2" DEFLECTION B, B2, C2, 2-C2 & 4-C2 SERIES SPRING MOUNTS



Non-Skid Pad is used in Non-Seismic zones only. Remove pad prior to installing in seismic zones. Reduce published height by 1/8" if pad is removed.

Baseplate must be uniformly supported

50% Travel to Solid					
SLRSO Size	Capacity (lbs)	Defl. (in)	SLRSO Size	Capacity (lbs)	Defl. (in)
B2-450	411	1.83	2-C2-2420	2020	1.67
B2-680	565	1.66	2-C2-3080	2570	1.67
C2-880	800	1.82	2-C2-3740	3120	1.67
C2-1210	1010	1.67	4-C2-4840	4040	1.67
C2-1540	1285	1.67	4-C2-6160	5145	1.67
C2-1870	1560	1.67	4-C2-7480	6245	1.67
2-C2-1760	1600	1.82			

SPRING DATA

Size	Spring OD (in)	Free Ht. (in)	Ratio Kx/Ky	Ratio OD/OH
B	2 3/8	4	0.55-0.65	0.95-1.00
B2	2 3/8	4 1/2	0.80-0.90	1.19-1.48
C2	2 7/8	5	0.63-0.85	0.96-1.15

#Published ratings allow minimum 25% additional travel to solid. For 50% minimum specified use the ratings shown above. All springs without "#" have additional travel to solid equal to 50% of the rated deflection.

TYPE SLRSO RATINGS

Size	Rated Capacity (lb)	Rated Defl. (in)	Spring Constant (lb/in)	Max. Horiz. Housing G Rating	Spring Color
SLRSO-B-20	20	2.40	8	70.0	Tan
SLRSO-B-26	26	2.18	12	53.9	Wht/Blue
SLRSO-B-35	35	2.20	16	40.0	Purple
SLRSO-B-50	50	2.20	24	28.0	Wht/Red
SLRSO-B-65	65	2.10	31	21.6	Brown
SLRSO-B-85	85	2.10	40	16.5	Wht/Blk
SLRSO-B-115	115	2.00	57	12.2	Silver
SLRSO-B-150	150	2.00	75	9.3	Orange
SLRSO-B2-210	210	2.12	99	6.8	Silver
SLRSO-B2-290	290	2.00	144	4.9	Blue
SLRSO-B2-450#	450	2.00	224	3.2	Tan
SLRSO-B2-680#	680	2.00	340	2.1	Gray
SLRSO-C2-125	125	2.50	50	35.2	Purple
SLRSO-C2-170	170	2.40	70	25.9	Brown
SLRSO-C2-210	210	2.30	90	21.0	Red
SLRSO-C2-260	260	2.20	120	16.9	White
SLRSO-C2-330	330	2.00	165	13.3	Black
SLRSO-C2-460	460	2.00	230	9.6	Blue
SLRSO-C2-610	610	2.00	305	7.2	Green
SLRSO-C2-880#	880	2.00	440	5.0	Gray
SLRSO-C2-1210#	1210	2.00	605	3.6	Silver
SLRSO-C2-1540#	1540	2.00	770	2.9	Gray*
SLRSO-C2-1870#	1870	2.00	935	2.4	Silver*
SLRSO-2-C2-340	340	2.40	140	17.7	Brown
SLRSO-2-C2-420	420	2.30	180	14.3	Red
SLRSO-2-C2-520	520	2.20	240	11.6	White
SLRSO-2-C2-660	660	2.00	330	9.1	Black
SLRSO-2-C2-920	920	2.00	460	6.5	Blue
SLRSO-2-C2-1220	1220	2.00	610	4.9	Green
SLRSO-2-C2-1760#	1760	2.00	880	3.4	Gray
SLRSO-2-C2-2420#	2420	2.00	1210	2.5	Silver
SLRSO-2-C2-3080#	3080	2.00	1540	1.9	Gray*
SLRSO-2-C2-3740#	3740	2.00	1870	1.6	Silver*
SLRSO-4-C2-4840#	4840	2.00	2420	2.2	Silver
SLRSO-4-C2-6160#	6160	2.00	3080	1.7	Gray*
SLRSO-4-C2-7480#	7480	2.00	3740	1.4	Silver*

* with RED inner spring

TYPE SLRSO DIMENSIONS (inches)

Size	L	W	H	T	MBD	HCW	HCL	D	E
SLRSO-B, B2	8 1/2	4 1/4	8 3/4	3/8	5/8	2 3/4	7	1/2	1 1/8
SLRSO-C2	9 1/2	5 1/4	8 3/4	3/8	5/8	3 1/2	7 1/2	5/8	1 3/8
SLRSO-2-C2	14	5 1/4	8 3/4	3/8	5/8	3 1/2	12 1/4	5/8	1 3/8
SLRSO-4-C2	13 3/4	8	8 3/4	3/8	3/4	6 1/4	11	7/8	1 3/8

Illustration shows SLRSO-B housing which contains one (1) B or B2 spring. Not shown is SLRSO-1 housing which contains one (1) C2 spring, SLRSO-2 housing which contains two (2) C2 springs and SLRSO-4 which contains four (4) C2 springs.

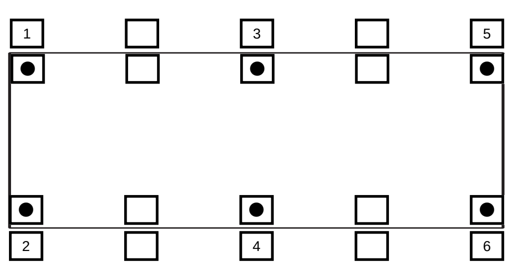
Housing load ratings expressed in G's are based on tests with bolted connections to steel top and bottom.

PLAN VIEW OF MOUNT LOCATIONS

TAG : 8-Fan Cooling Tower

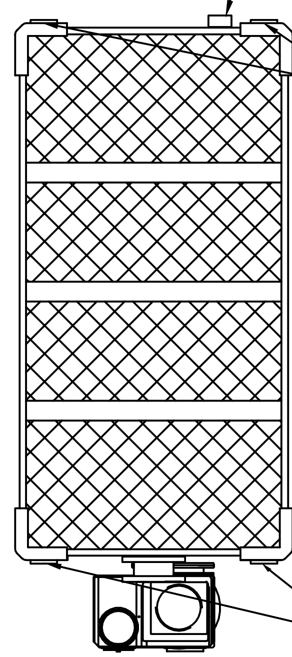
UNIT : Tower Tech TTXL-08

Click with mouse for each location >



1 : SLRSO-4-C2-4840	7 :
2 : SLRSO-4-C2-4840	8 :
3 : SLRSO-4-C2-7480	9 :
4 : SLRSO-4-C2-7480	10 :
5 : SLRSO-4-C2-4840	11 :
6 : SLRSO-4-C2-4840	12 :
Sets Required : (1)	

FORM S-175 10/2008 | DWN: MDC | CHKD: | DATE: 5/1/2018 | DWG. No.



GENERAL NOTES

BASIN DATA (PER MODULE):

MIN/MAX GPM RANGE	-	200/600
ACTUAL GPM	-	
HOT WATER TEMP F°	-	
COLD WATER TEMP F°	-	
WET BULB TEMP F°	-	

MOTOR DATA (PER MODULE):

BRAND	-	BALDOR (OR EQUIV.)
EFFICIENCY	-	HIGH
HP	-	3.0 / 5.0 / 7.5
kW	-	2.2 / 3.7 / 5.6
VOLTAGE	-	200 / 230 / 460 / 575
HZ	-	60
PHASE	-	3
NUMBER	-	2
POWER FACTOR	-	.61 / .63 / .68

WEIGHTS (PER MODULE):

DRY SHIPPING WEIGHT	-	4,360lbs,	-	1,978 kg
OPERATING WEIGHT	-	9,470 lbs,	-	4,305 kg

NOTES:

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2. EXTERNAL PIPING TO BE "STAND ALONE" (INDEPENDENTLY SUPPORTED. FINAL CONNECTIONS TO THE COOLING TOWER MODULE MUST BE FIELD FITTED AFTER TOWER INSTALLATION TO PREVENT PIPE STRESS ON TOWER.
3. NO LOAD TO BE APPLIED TO TOWER TECH TOWER OR SUMP.
4. FOR APPROPRIATE WATER LEVEL REFER TO STARTUP SECTION IN TOWER TECH'S DESIGN, INSTALLATION & OPERATION MANUAL.
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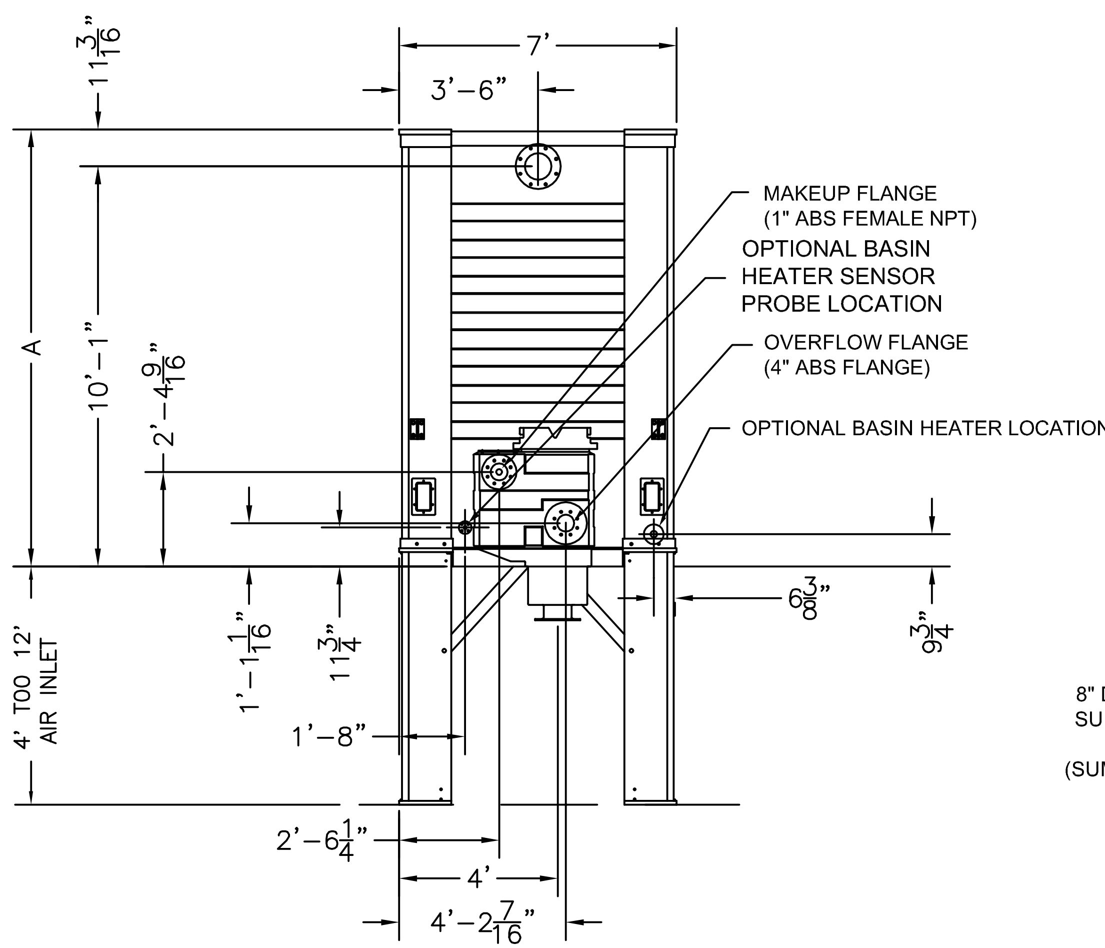

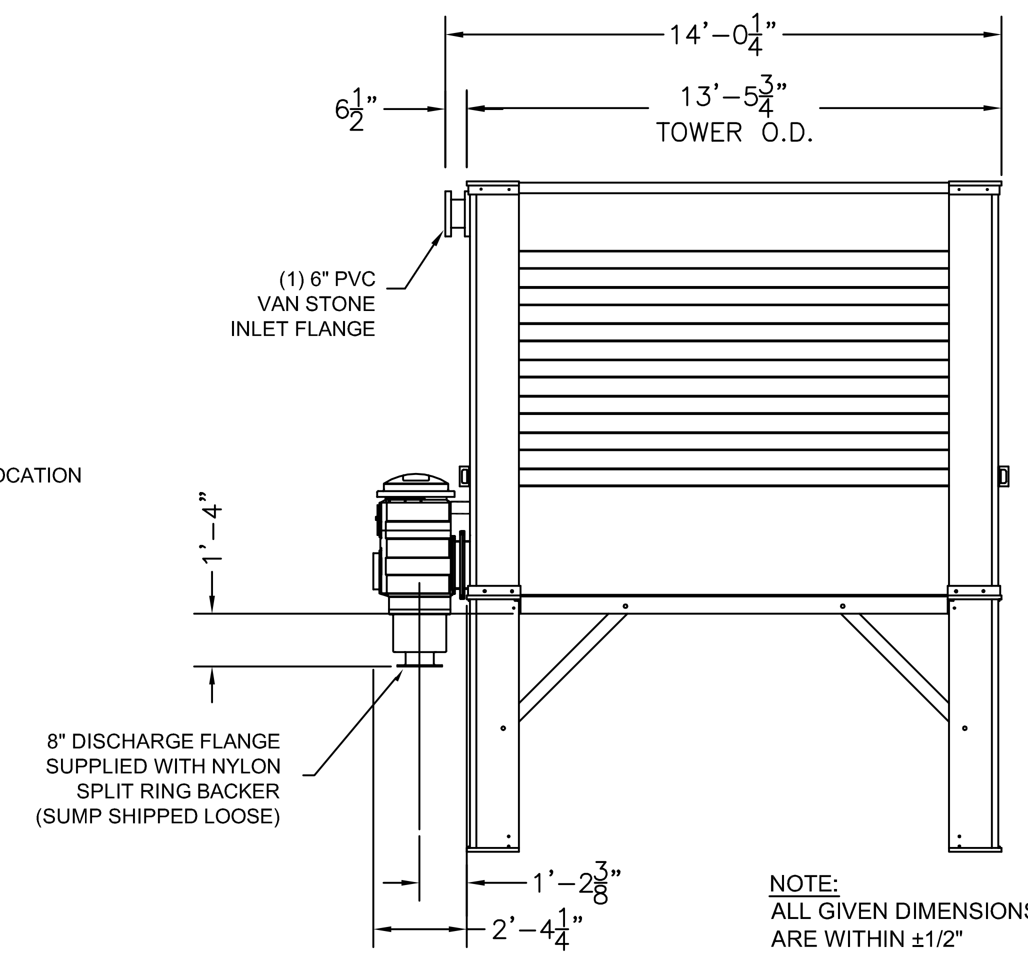

NOTE:
ALL GIVEN DIMENSIONS ARE WITHIN ±1/2"

"DRAWING IS FOR REFERENCE PURPOSES ONLY AND NOT TO BE USED FOR CONSTRUCTION"

TOWER TECH, Inc.
THE TECHNOLOGY COMPANY

TELEPHONE: (405) 290-7788
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E-MAIL: cad@towertechinc.com
WEBPAGE: http://www.towertechinc.com
5400 NW 5th
OKLAHOMA CITY, OKLAHOMA 73127

Modular Fiberglass Cooling Tower
Model # TTXL-i219XX

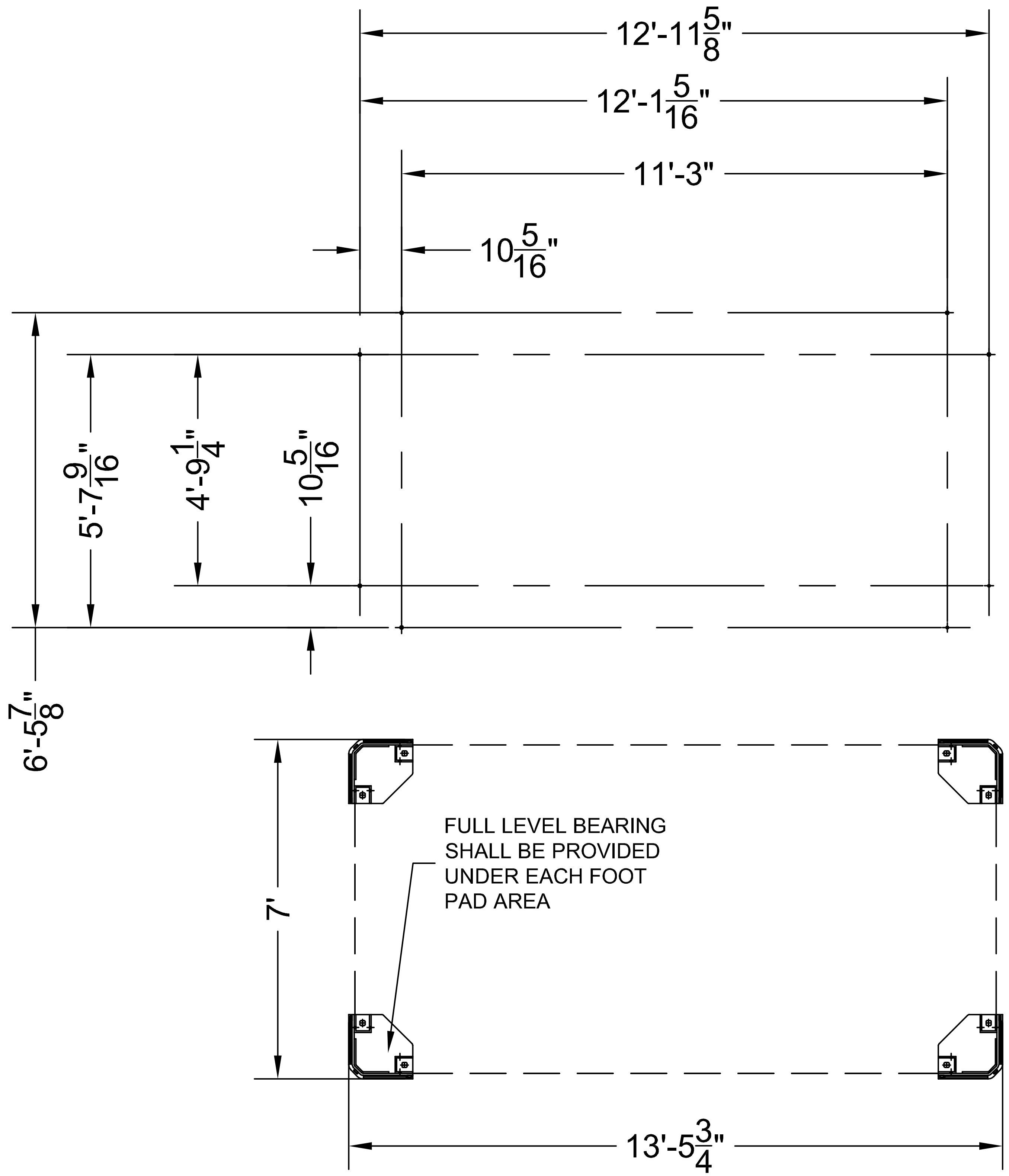
1-Unit Installation
TTXL-i2 Plan & Elevation

FOR APPROVAL BY	DATE
Tower Tech Design Team	

REVISIONS

NO.	DATE	REVISION

DATE:	15 JAN 15
DRAWING#:	XL-i2-2
PROJECT#:	
CUST PO#:	
DRAWN BY:	RFB
CHECKED BY:	
PLAN & ELEVATION	2



NOTE: ALL MEASUREMENTS ARE OD TO OD OF FOOTPAD.
ALL GIVEN DIMENSIONS ARE WITHIN ±1/8".

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Modular
Fiberglass
Cooling Tower
Model # TTXL-i219XX

1-Unit Installation
TTXL-i2 Anchor Pad Layout

FOR APPROVAL BY	DATE
Tower Tech Design Team	

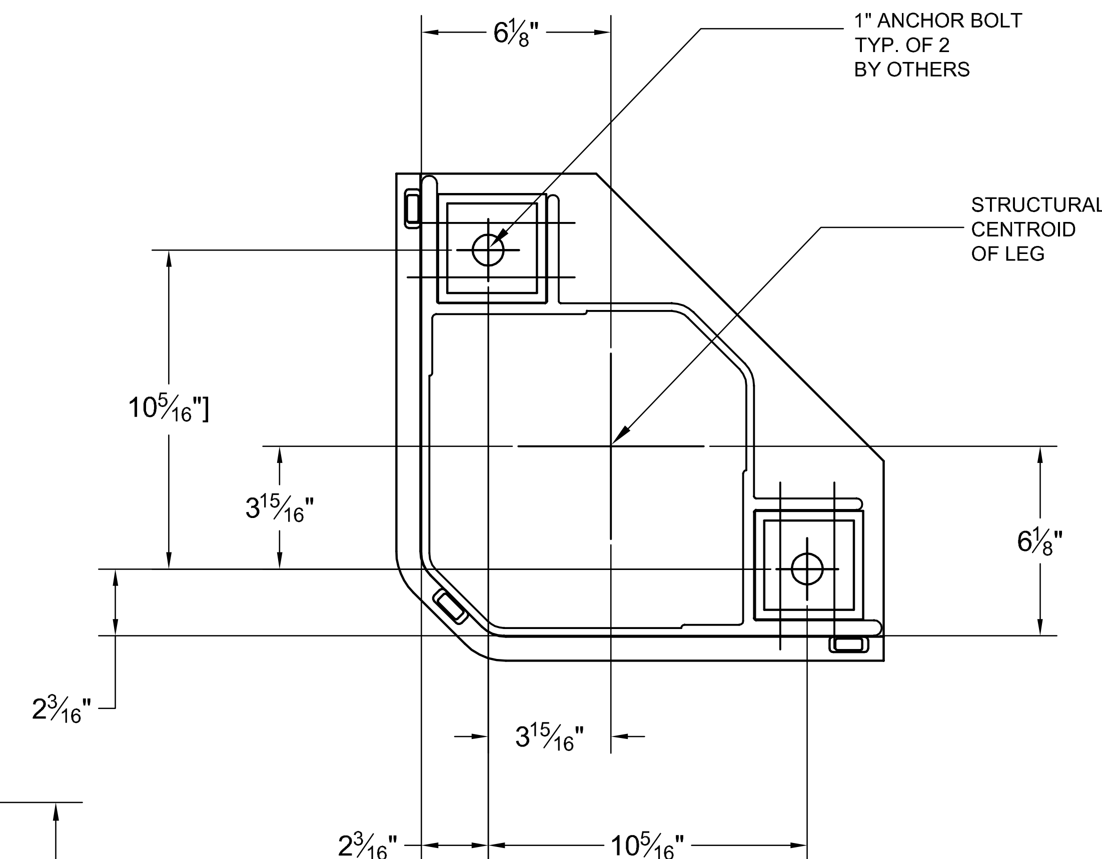
REVISIONS

NO.	DATE	REVISION

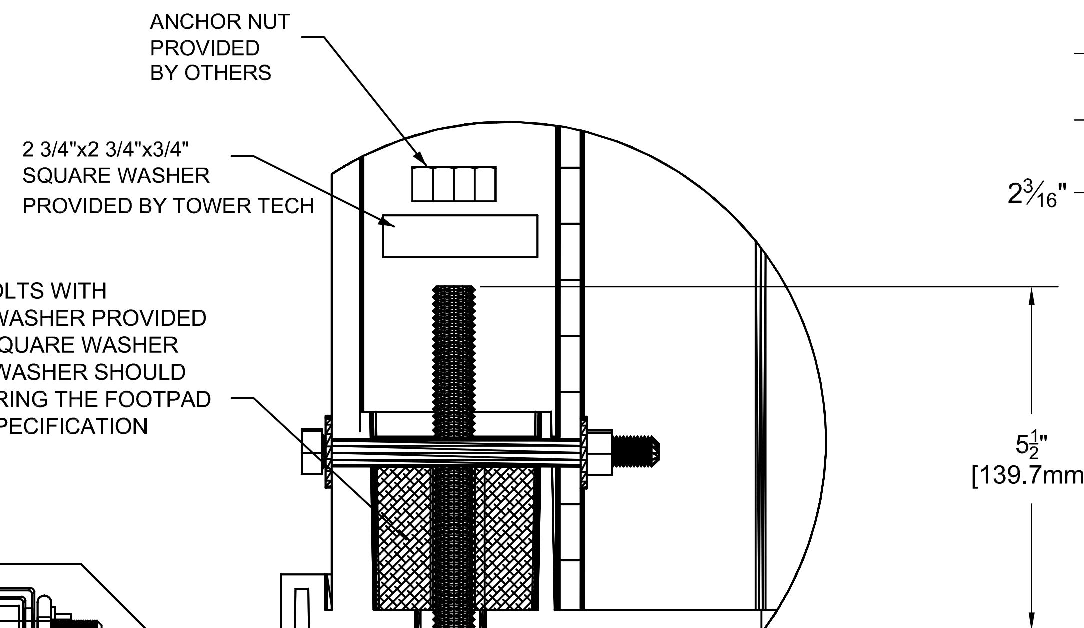
DATE:	15 JAN 15
DRAWING#:	XL-i2-3
PROJECT#:	
CUST PO#:	
DRAWN BY:	RFB
CHECKED BY:	
FOOTPRINT & ANCHOR PAD LAYOUT	3

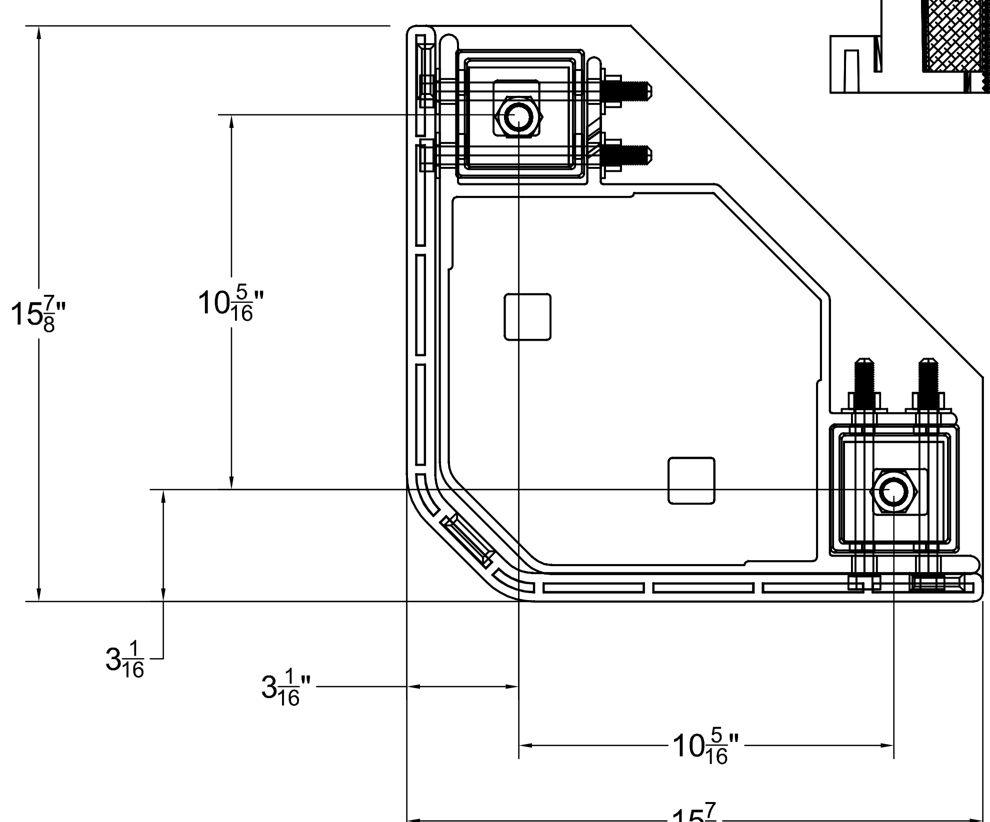
--------- LEG GEOMETRIC PROPERTIES --------

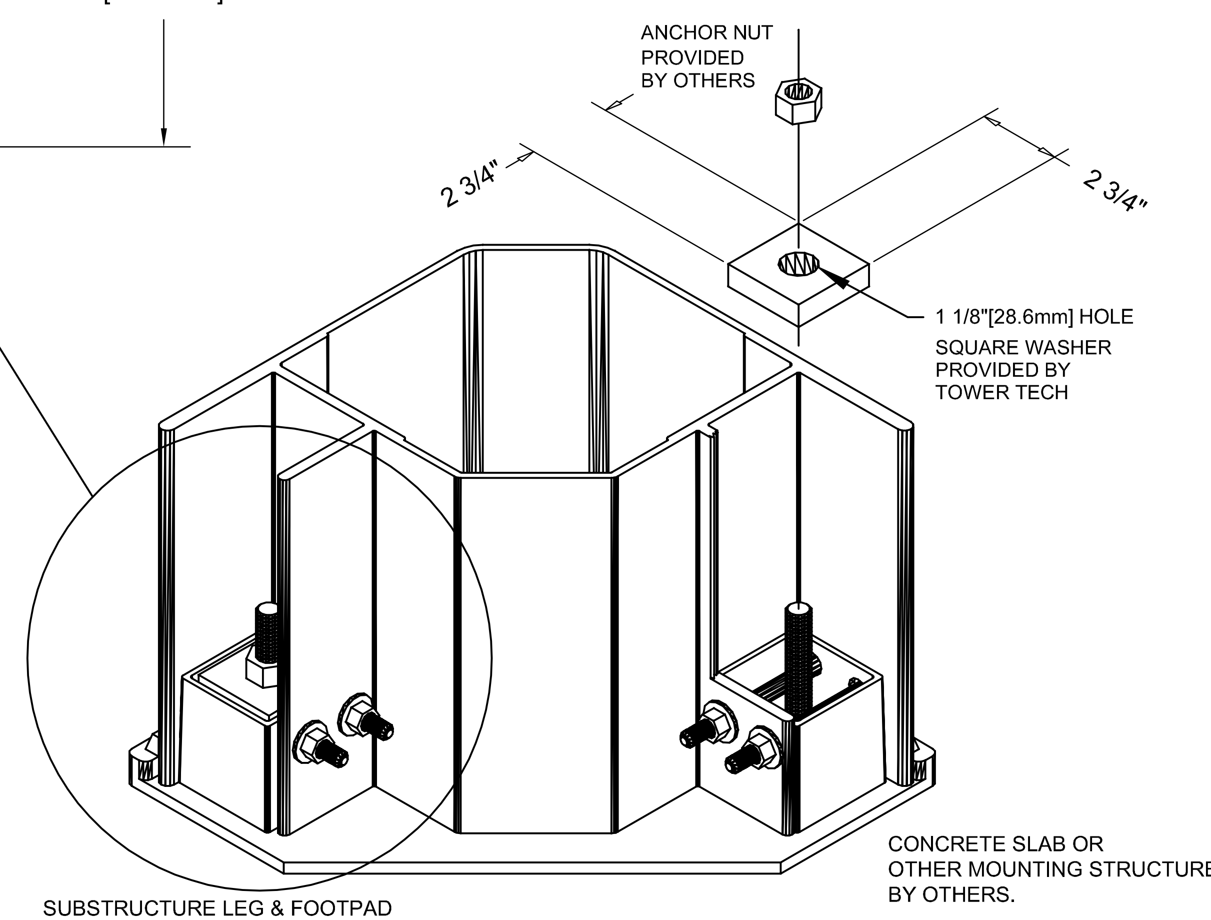
AREA: 17.9141
PERIMETER: 107.9072
BOUNDING BOX: X: -6.1274 -- 8.7476
Y: -6.1274 -- 8.7476
CENTROID: X: 0.0000
Y: 0.0000
MOMENTS OF INERTIA X: 422.8851
Y: 422.8847
PRODUCT OF INERTIA: XY: -229.38880
RADII OF GYRATION: X: 48586
Y: 48586
PRINCIPAL MOMENTS AND X-Y DIRECTIONS ABOUT CENTROID:
I: 193.4960 ALONG [0.7071 -0.7071]
J: 652.2729 ALONG [0.7071 0.7071]



FILL POCKET AROUND ANCHOR BOLTS TO TOP OF LEG BOLTS WITH NON-SHRINK GROUT, BEFORE INSTALLING THE SQUARE WASHER PROVIDED WITH THE MODULE. BEFORE THE GROUT SETS INSTALL SQUARE WASHER AND ANCHOR NUT AND TORQUE TO 50 FT.-LBS. SQUARE WASHER SHOULD ENGAGE ON TOP OF THE TWO HORIZONTAL BOLTS SECURING THE FOOTPAD TO THE LEG. RE-TORQUE TO STRUCTURAL ENGINEERS SPECIFICATION AFTER GROUT HAS SET.







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OKLAHOMA CITY, OKLAHOMA 73127

Modular
Fiberglass
Cooling Tower
Model # TTXL-i219XX

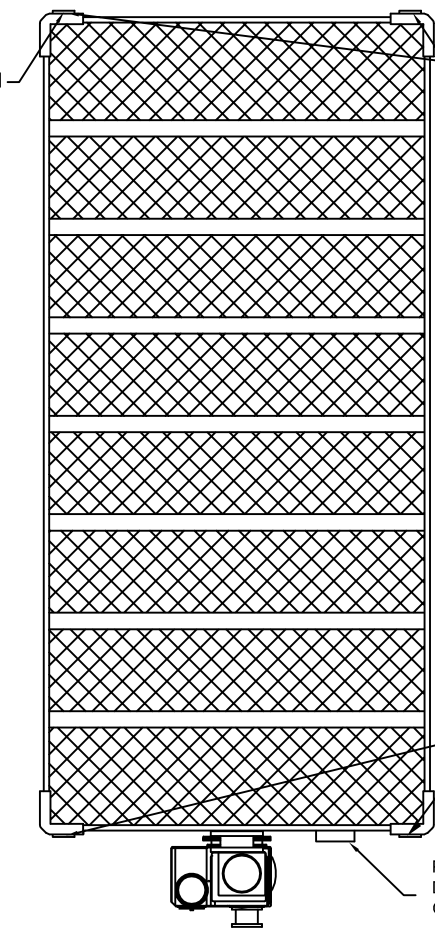
1-Unit Installation
TTXL-i2 Footpad Detail

FOR APPROVAL BY	DATE
Tower Tech Design Team	

REVISIONS

NO.	DATE	REVISION

DATE:	16 JUN 15
DRAWING#:	XL-i2-4
PROJECT#:	
CUST PO#:	
DRAWN BY:	RFB
CHECKED BY:	
FOOTPAD DETAIL	4



GENERAL NOTES

BASIN DATA (PER MODULE):

MIN/MAX GPM RANGE	-	800/2400
ACTUAL GPM	-	
HOT WATER TEMP F°	-	
COLD WATER TEMP F°	-	
WET BULB TEMP F°	-	

MOTOR DATA (PER MODULE):

BRAND	-	BALDOR (OR EQUIV.)
EFFICIENCY	-	HIGH
HP	-	3.0 / 5.0 / 7.5
kW	-	2.2 / 3.7 / 5.6
VOLTAGE	-	200 / 230 / 460 / 575
HZ	-	60
PHASE	-	3
NUMBER	-	8
POWER FACTOR	-	.61 / .63 / .68

WEIGHTS (PER MODULE):

DRY SHIPPING WEIGHT	-	13,750 lbs, - 6,737 kg
OPERATING WEIGHT	-	24,780 lbs, - 11,264 kg

NOTES:

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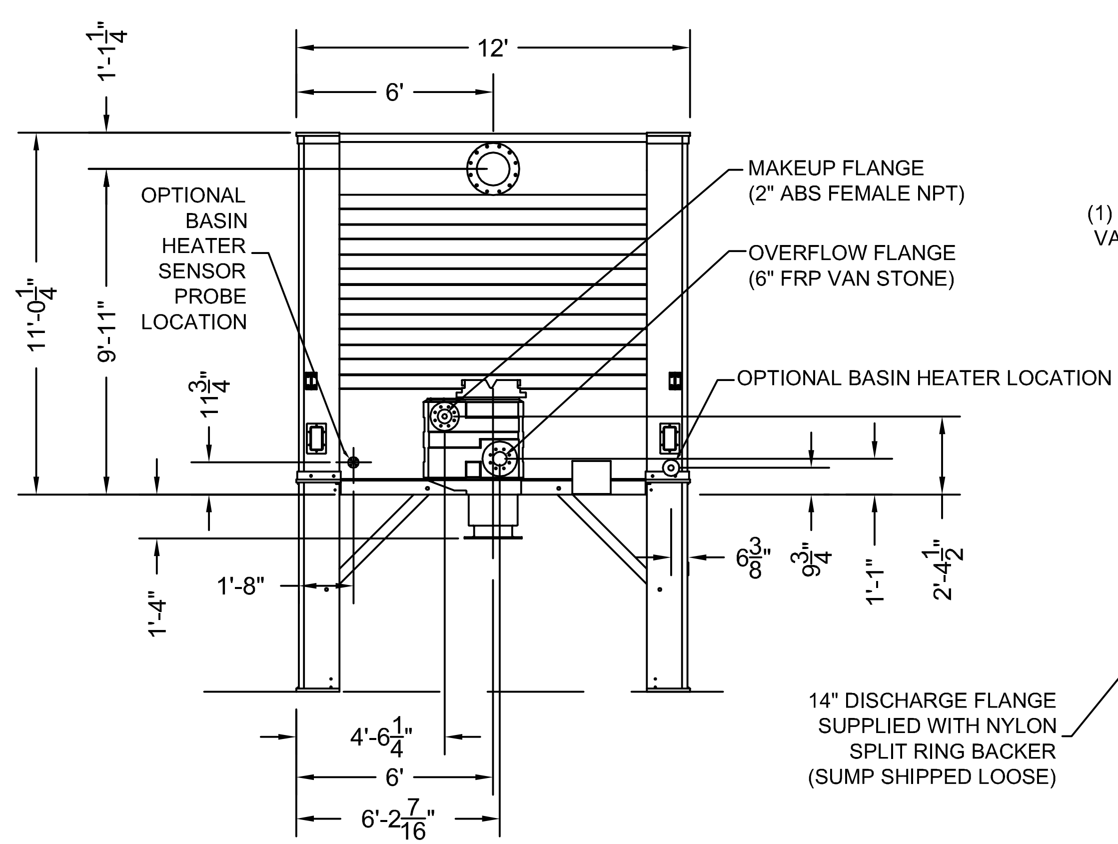

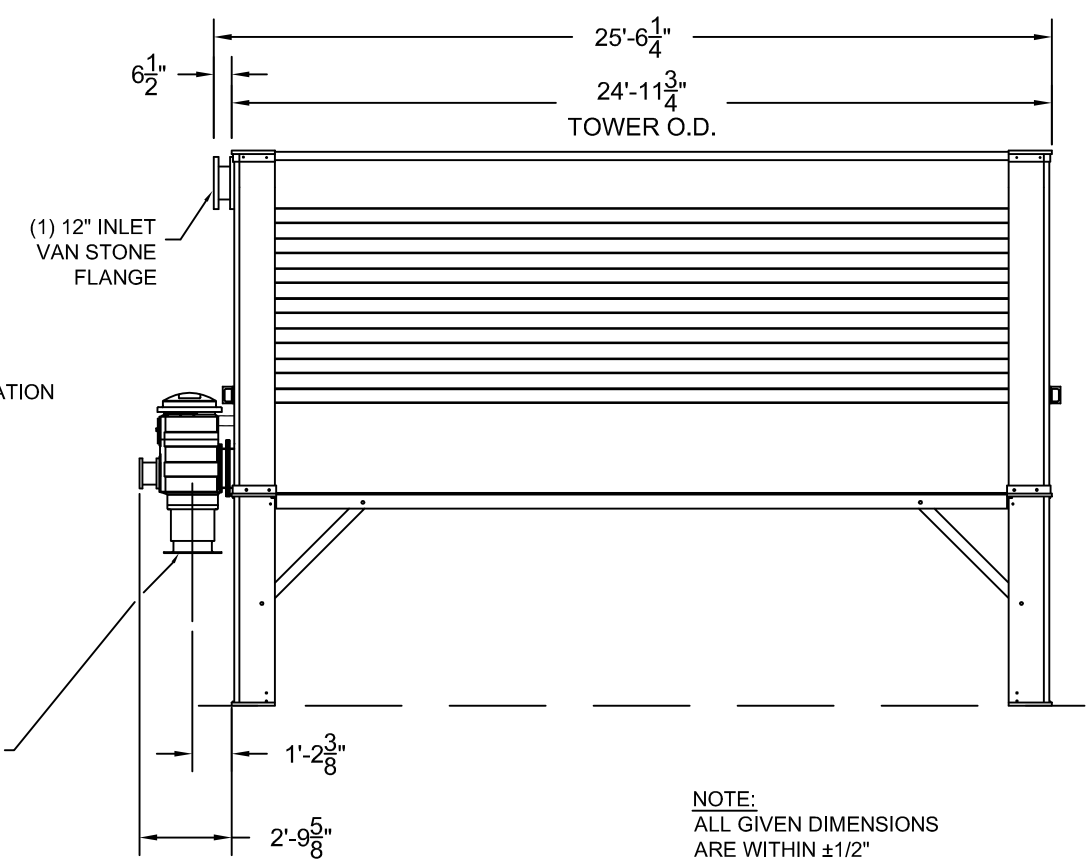

NOTE:
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OKLAHOMA CITY, OKLAHOMA 73127

Modular Fiberglass Cooling Tower
Model # TTXL-0819XX

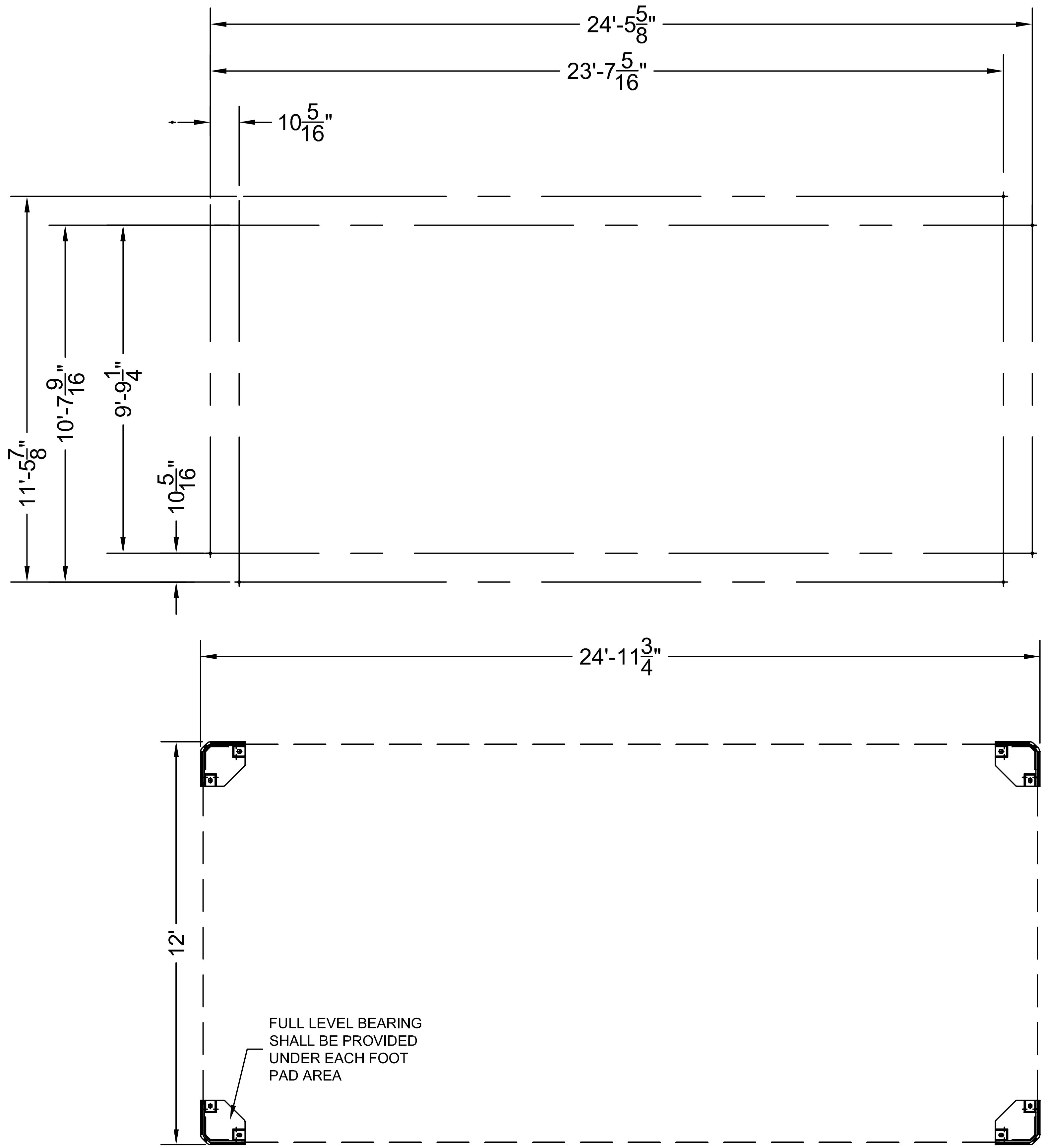
1-Unit Installation
TTXL-08 Plan & Elevation

FOR APPROVAL BY	DATE
Tower Tech Design Team	

REVISIONS

NO.	DATE	REVISION

DATE:	16 NOV 15
DRAWING#:	XL-08-2
PROJECT#:	
CUST PO#:	
DRAWN BY:	RFB
CHECKED BY:	
PLAN & ELEVATION	2



NOTE: ALL MEASUREMENTS ARE OD TO OD OF FOOTPAD.
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Modular
Fiberglass
Cooling Tower
Model # TTXL-0819XX

1-Unit Installation
TTXL-08 Anchor Pad Layout

FOR APPROVAL BY	DATE
Tower Tech Design Team	

REVISIONS

NO.	DATE	REVISION

DATE:	15 JAN 15
DRAWING#:	XL-08-3
PROJECT#:	
CUST PO#:	
DRAWN BY:	RFB
CHECKED BY:	
FOOTPRINT & ANCHOR PAD LAYOUT	3

--------- LEG GEOMETRIC PROPERTIES --------

AREA:	17.9141
PERIMETER:	107.9072
BOUNDING BOX:	X: -6.1274 -- 8.7476
	Y: -6.1274 -- 8.7476
CENTROID:	X: 0.0000
	Y: 0.0000
MOMENTS OF INERTIA	X: 422.8851
	Y: 422.8847
PRODUCT OF INERTIA:	XY: -229.38880
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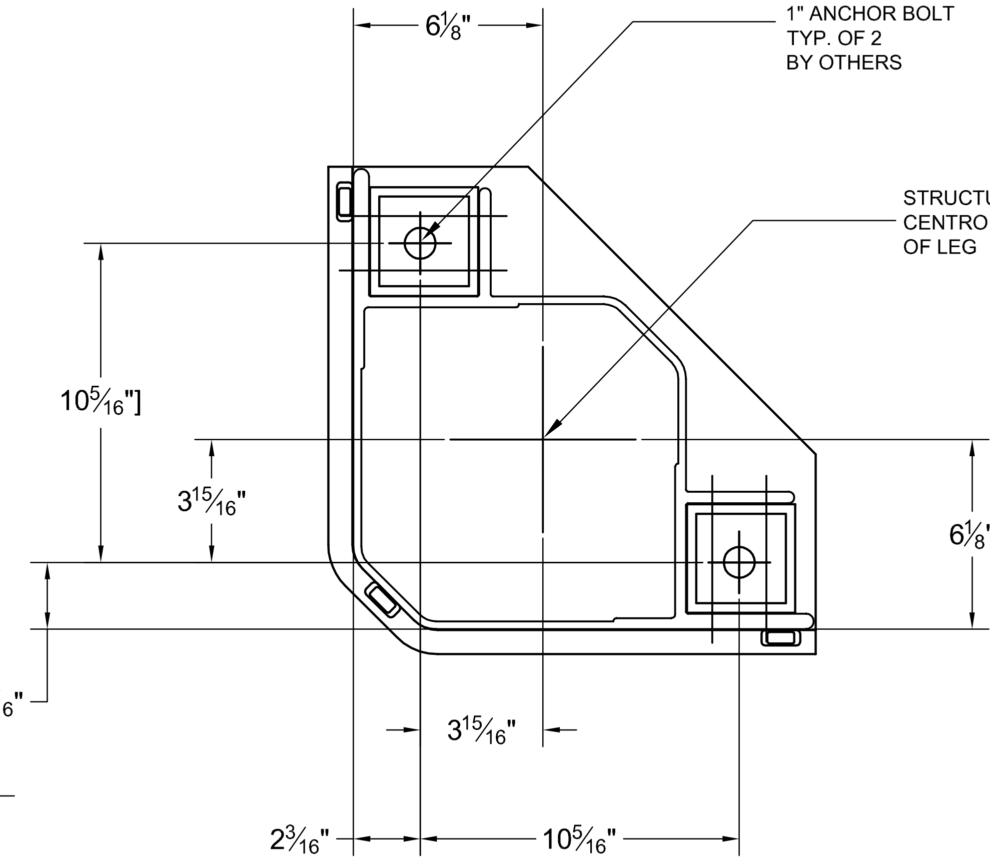
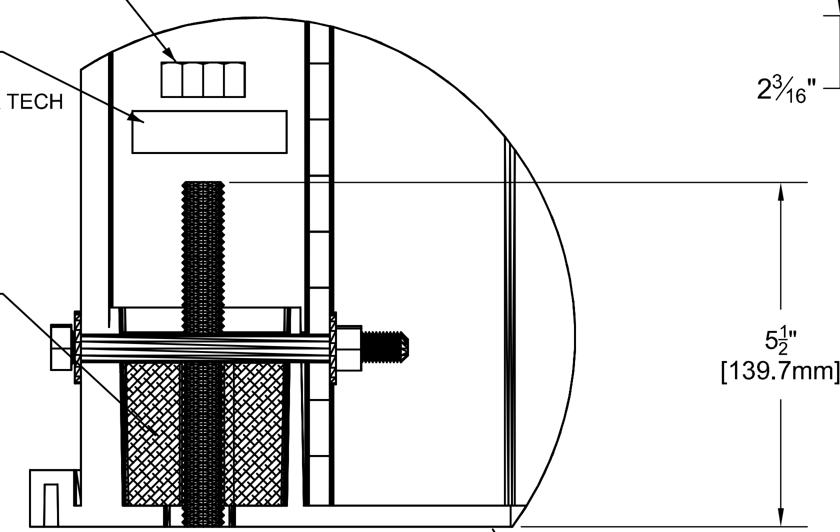
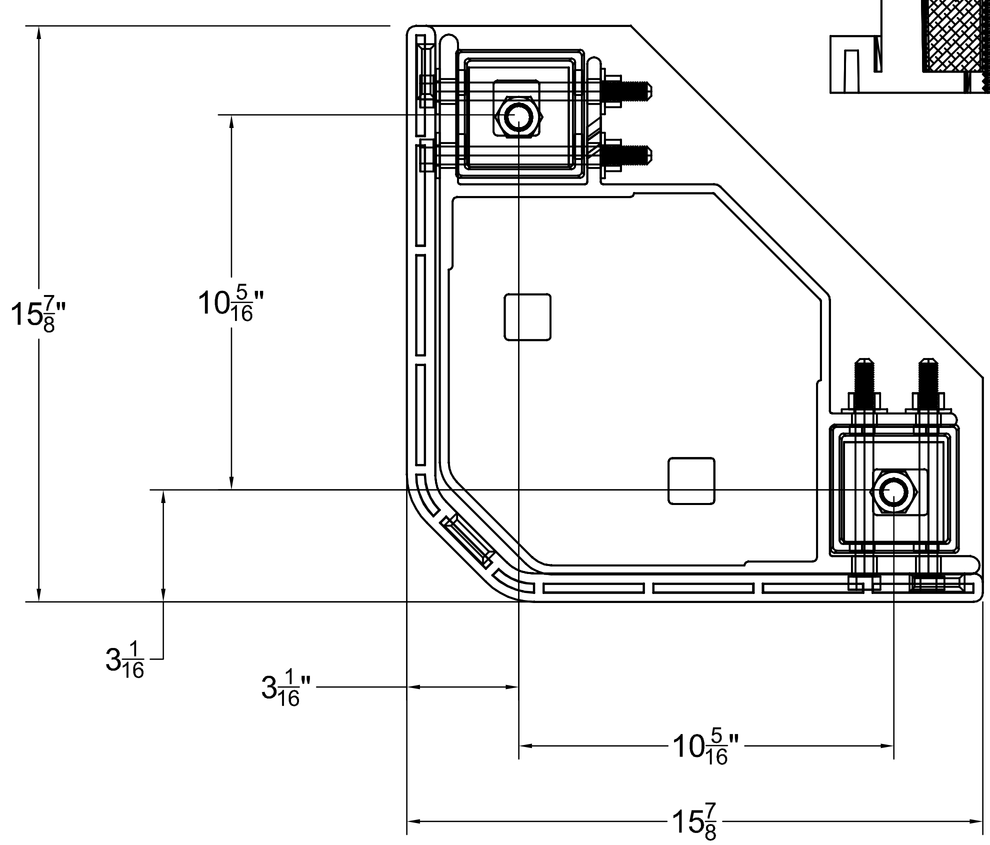
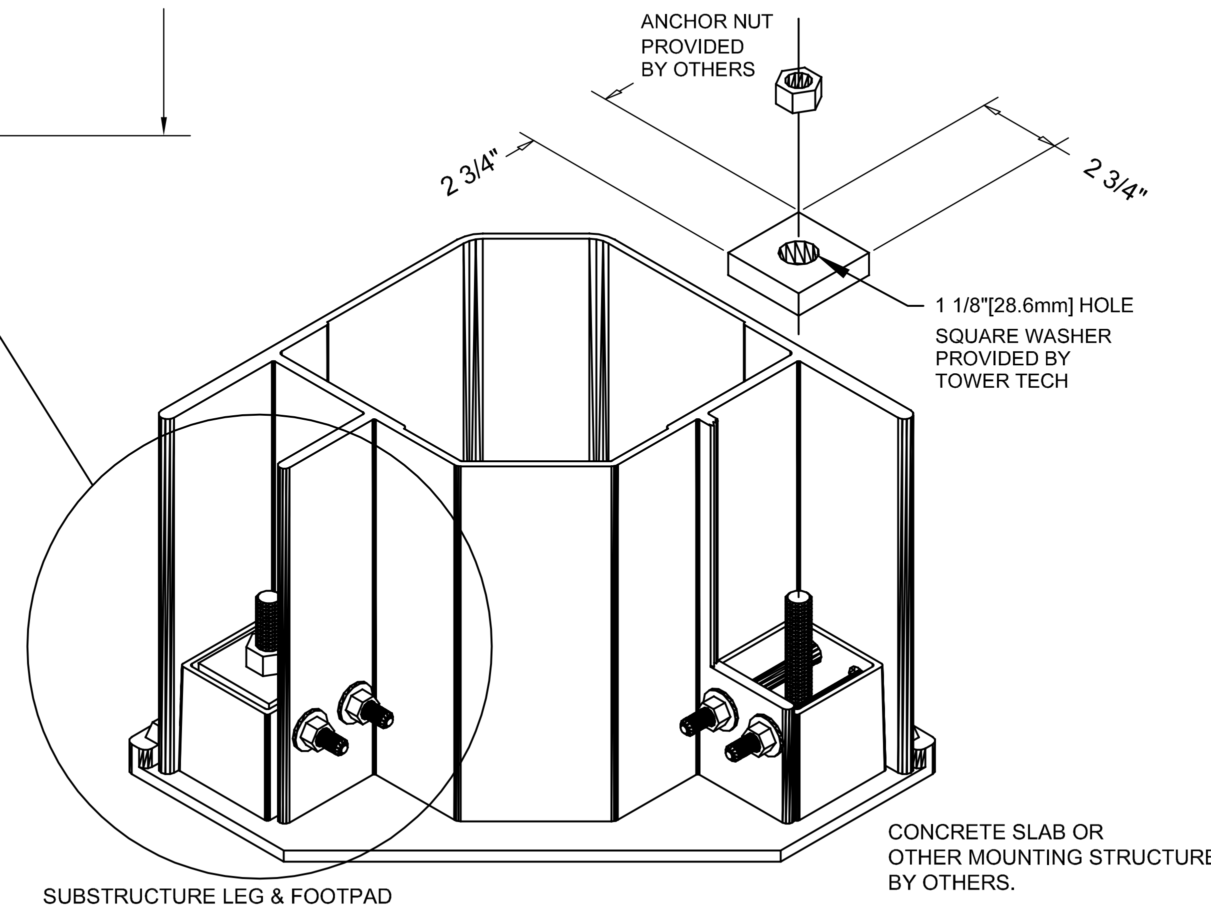
J: 652.2729 ALONG [0.7071 0.7071]



FILL POCKET AROUND ANCHOR BOLTS TO TOP OF LEG BOLTS WITH NON-SHRINK GROUT, BEFORE INSTALLING THE SQUARE WASHER PROVIDED WITH THE MODULE. BEFORE THE GROUT SETS INSTALL SQUARE WASHER AND ANCHOR NUT AND TORQUE TO 50 FT.-LBS. SQUARE WASHER SHOULD ENGAGE ON TOP OF THE TWO HORIZONTAL BOLTS SECURING THE FOOTPAD TO THE LEG. RE-TORQUE TO STRUCTURAL ENGINEERS SPECIFICATION AFTER GROUT HAS SET.







SUBSTRUCTURE LEG & FOOTPAD

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Modular
Fiberglass
Cooling Tower
Model # TTXL-0819XX

1-Unit Installation
TTXL-08 Footpad Detail

FOR APPROVAL BY: Tower Tech Design Team | DATE

REVISIONS

NO.	DATE	REVISION

DATE:	16 JUN 15
DRAWING#:	XL-08-4
PROJECT#:	
CUST PO#:	
DRAWN BY:	RFB
CHECKED BY:	
FOOTPAD DETAIL	4