MSC ENGINEERS

CONSULTING
STRUCTURAL
ENGINEERS

Structural Calculations for EOU Inlow Hall Generator

Job Number: 230928

Codes: 2022 OSSC / 2021 IBC

Date: 2/6/24

Location: One University Blvd.
La Grande, OR 97850

Client: Fluent Engineering
2110 State St.
Salem, OR 97301
Phone: 503-447-5030

Engineer: John Carstensen, P.E., S.E.
MSC Engineers, Inc.
3470 Pipebend Place NE, Suite 120
Salem, OR 97301
Phone: 503-399-1399

Scope of Services: Calculation of anchorage forces and foundation design for Kohler 500REZXD with steel weather enclosure.

Contents:

LIMITATIONS: Engineer was retained in a limited capacity for this project. Design is based upon the information provided by the client, who is solely responsible for accuracy of same. No responsibility and/or liability is assumed by, or is to be assigned to the Engineer for items beyond those shown on these sheets.

MSC ENGINEERS

FILE NO.	230928	**DATE:**	1/29/2024
PROJECT:	EOU Inlow Hall Generator	**MADE BY:**	JAC
CLIENT:	Fluent	**SHEET NO.**	\ , \

GENERATOR ANCHORAGE

Reference: 2022 OSSC, ASCE 7-16

Generator Design Info: Weight = **19122** lbs. *(Generator + Enclosure)*

Length =	248.1	in	*or*	20.68 ft
Width =	86.3	in	*or*	7.19 ft
Height =	106.2	in	*or*	8.85 ft
Center of Gravity (H_{CG}) =	53.5	in	*or*	4.46 ft

Loads - WIND

V =	102	mph	Wind Speed, 3 Sec. Gust	*(2019 OSSC: Table 1609.3)*
Exposure =	C		Wind Exposure Category	*(ASCE 7-16: Section 26.7.3)*
K_d =	0.85		Wind Directionality Factor	*(ASCE 7-16: Section 26.6)*
K_{zt} =	1.0		Topographic Factor	*(ASCE 7-16: Section 26.8.2)*
K_e =	1.0		Ground Elevation Factor	*(ASCE 7-16: Section 26.9)*
G =	0.85		Gust Factor	*(ASCE 7-16: Section 26.11)*
Cf =	1.30		Force Coefficient	*(ASCE 7-16: Figure 29.4-1)*
k_h =	0.85		Velocity Pressure Coeff.	*(ASCE 7-16: Table 26.10-1)*
q_h =	19.24	psf	Velocity pressure at avg. roof height	*(ASCE 7-16: Equation 26.10-1)*
F =	21.26	psf	Design Wind Pressure	*(ASCE 7-16: Equation 29.4-1)*
A =	110.10	sf	Largest Cross Sectional Area	

Ftotal = 2,341 lbs **Design Wind Force**

Loads - SEISMIC

Site Class =	D		Soil Site Class	*(2019 OSSC: Table 1609.3)*
Risk Category =	II		Occupancy Risk Category	*(2019 OSSC: Table 1604.5)*
S_{DS} =	0.339		Design spectal accel. (T = 0.2s)	
Ip =	1.5		Component Importance Factor	*(ASCE 7-16: Section 13.1.3)*
ap =	1.0		Component Amplification Factor	*(ASCE 7-16: Table 13.6-1)*
Rp =	2.50		Component Response Modification Factor	*(ASCE 7-16: Table 13.6-1)*
Ωo=	2.00		Overstrength Factor	*(ASCE 7-16: Table 13.6-1)*
z/h =	0.0		Height ratio for attachment	

$Fp_{,max.}$=	0.81	*Wp	= 1.6 Sds Ip Wp	*(ASCE 7-16: Equation 13.3-2)*
$Fp_{,min.}$=	0.15	*Wp	= 0.3 Sds Ip Wp	*(ASCE 7-16: Equation 13.3-4)*
Fp =	0.08	*Wp	= (0.4 Sds Ip ap / Rp)(1+ 2 z/h)	*(ASCE 7-16: Equation 13.3-1)*

Ftotal = 2,917 lbs **Design Seismic Force** **<- CONTROLS DESIGN**

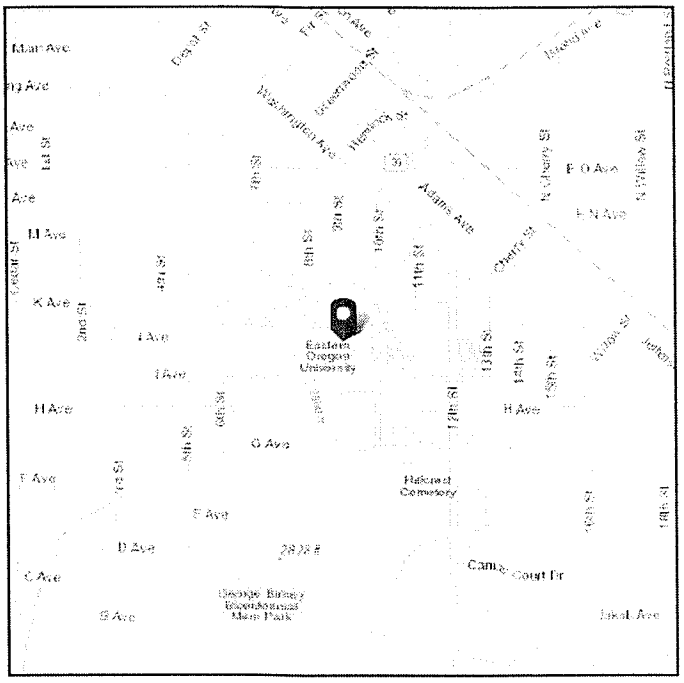
ASCE Hazards Report

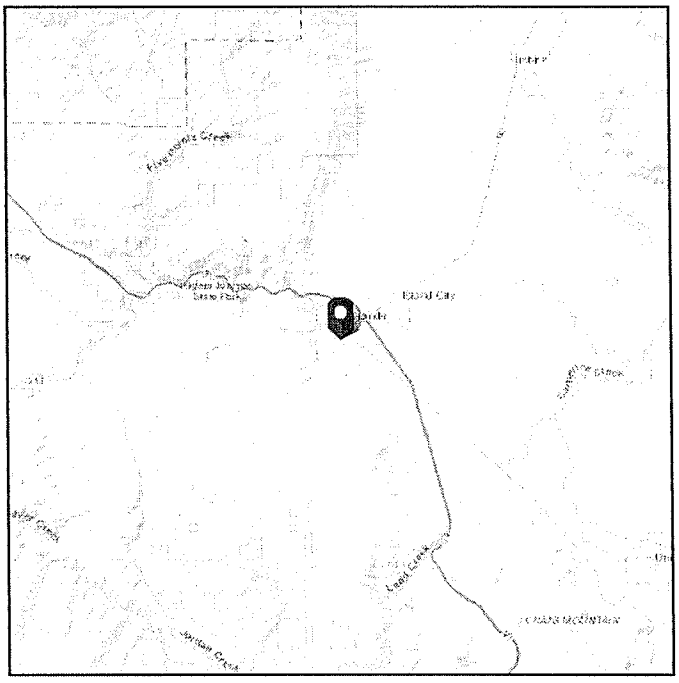
1.2

Address:
No Address at This Location

Standard: ASCE/SEI 7-16
Risk Category: II
Soil Class: D - Default (see Section 11.4.3)

Latitude: 45.320253
Longitude: -118.090177
Elevation: 2805.2521649649166 ft (NAVD 88)





Wind

Results:

Wind Speed	~~101 Vmph~~ →	USE 102 MPH PER OSSC TABLE 1609.3
10-year MRI	70 Vmph	
25-year MRI	77 Vmph	
50-year MRI	81 Vmph	
100-year MRI	86 Vmph	

Data Source: ASCE/SEI 7-16, Fig. 26.5-1B and Figs. CC.2-1–CC.2-4, and Section 26.5.2
Date Accessed: Mon Jan 29 2024

Value provided is 3-second gust wind speeds at 33 ft above ground for Exposure C Category, based on linear interpolation between contours. Wind speeds are interpolated in accordance with the 7-16 Standard. Wind speeds correspond to approximately a 7% probability of exceedance in 50 years (annual exceedance probability = 0.00143, MRI = 700 years).

Site is not in a hurricane-prone region as defined in ASCE/SEI 7-16 Section 26.2.

Seismic

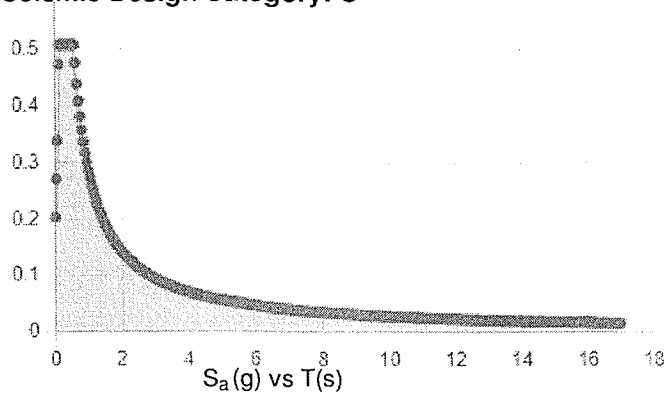
Site Soil Class: D - Default (see Section 11.4.3)

Results:

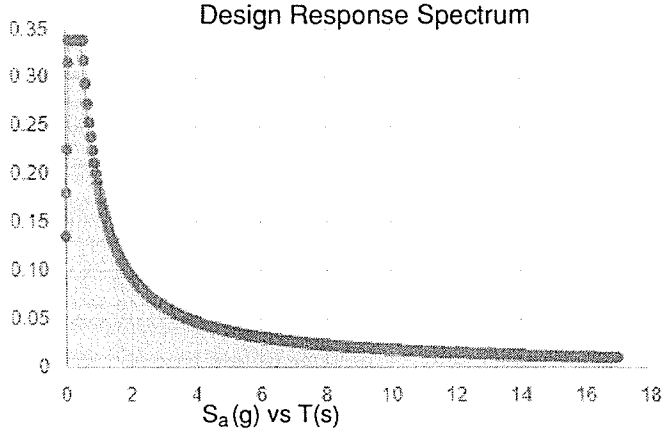
S_S :	0.331	S_{D1} :	0.191
S_1 :	0.121	T_L :	16
F_a :	1.535	PGA :	0.148
F_v :	2.357	PGA_M :	0.223
S_{MS} :	0.509	F_{PGA} :	1.504
S_{M1} :	0.286	I_e :	1
S_{DS} :	0.339	C_v :	0.921

Seismic Design Category: C

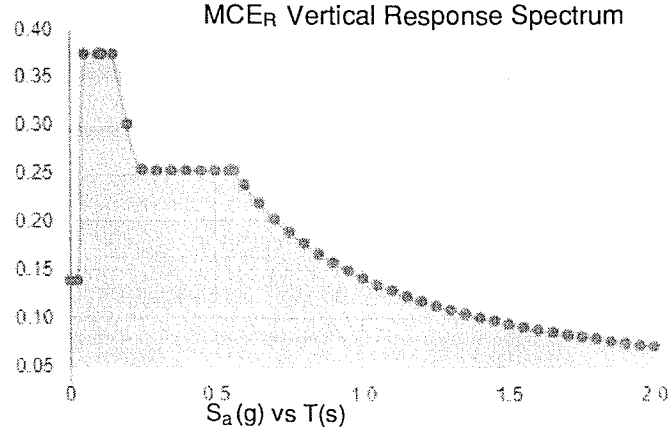
MCE_R Response Spectrum



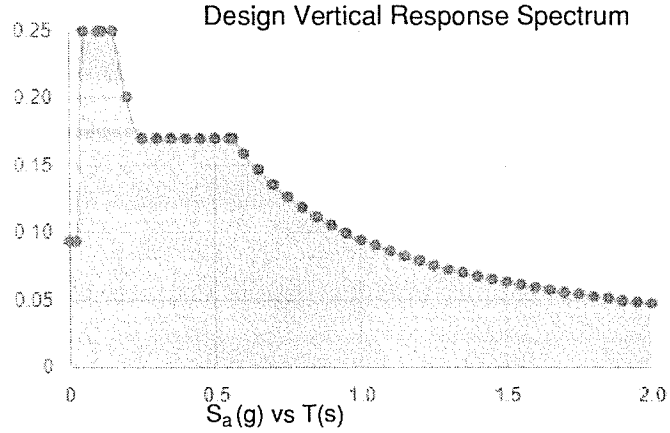
Design Response Spectrum



MCE_R Vertical Response Spectrum



Design Vertical Response Spectrum



Data Accessed: Mon Jan 29 2024

Date Source:
USGS Seismic Design Maps based on ASCE/SEI 7-16 and ASCE/SEI 7-16 Table 1.5-2. Additional data for site-specific ground motion procedures in accordance with ASCE/SEI 7-16 Ch. 21 are available from USGS.

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CLIENT:	Fluent	SHEET NO.	1.4

Overturning Moment

M_{wind} =	11,395	ft-lbs	Overturning Moment (1.0W * 0.55H)
$M_{seismic}$ =	13,010	ft-lbs	Overturning Moment (1.0E * Hcg)

Resisting Moment

DL Factor =	0.932		= 1.0 - 0.2Sds
$M_{resisting}$ =	64,083	ft-lbs	= (P_{DL} * width / 2)*DL_{factor}

Design Footing

	no		Use resisting moment for overturning?
M_a =	9107	ft-lbs	Max Service Overturning Moment = (0.6W or 0.7E) - 0.6D
p_{allow} =	1500	psf	Allowable bearing pressure
$p_{passive}$ =	150	psf/ft	Lateral bearing pressure
$\sigma_{friction}$ =	0.25		Coeff. of friction
Width =	8.19	ft	Minimum footing width (assume 6" edge distance)
Length =	21.68	ft	Minimum footing length (assume 6" edge distance)
Thickness =	8	in	Slab Thickness
A =	177.56	ft^2	Area (width x length)
S =	242.37	ft^3	Section Modulus (bh^2 / 6)
q_{max} =	145	psf	Max bearing pressure w/ rigid slab (P/A + M/S)

USE 8'-2" WIDE x 21'-8" LONG x 8" THICK SLAB
W/ #5 BARS @ 16" OC (MAX) EA. WAY

Design Anchorage

	yes		Use resisting moment for overturning?
Ωo=	2.00		Overstrength Factor
	yes		Seismic controlled? (Is ΩE > W)
M_u =	(38,063)	ft-lbs	Ultimate Overturning Moment (LRFD - ΩE or 1.0W)
V_u =	5,834	ft-lbs	Ultimate Base Shear (LRFD - ΩE or 1.0W)
n =	5		Number of anchors each side.
x =	6.83	ft	Distance between anchors
Nu,i =	-1115.4	lbs	Ultimate Tension on Single Anchor (negative means no uplift)
Vu,i =	583.4	lbs	Ultimate Shear on Single Anchor

USE (10) 5/8" DIA. SIMPSON TITEN HD (MECH. GALV.)
OR APPROVED EQUAL (EMBED = 4" MIN).

(see attached for anchorage design)

SIMPSON Strong-Tie®

Anchor Designer™ Software
Version 3.1.2209.3

Company:	MSC Engineers Inc	Date:	9/8/2022
Engineer:	JAC	Page:	1/5
Project:	EOU Inlow Hall Generator		
Address:	3470 Pipebend Place NE		
Phone:	503-399-1399		
E-mail:	johnc@mscengineersinc.com		

1.Project information

Customer company:
Customer contact name:
Customer e-mail:
Comment:

Project description:
Location: La Grande, OR
Fastening description: Generator Anchorage

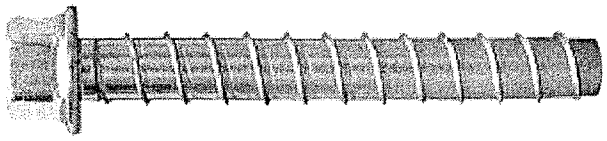
2. Input Data & Anchor Parameters

General
Design method:ACI 318-19
Units: Imperial units

Anchor Information:
Anchor type: Concrete screw
Material: Carbon Steel
Diameter (inch): 0.625
Nominal Embedment depth (inch): 4.000
Effective Embedment depth, h_{ef} (inch): 2.970
Code report: ICC-ES ESR-2713
Anchor category: 1
Anchor ductility: No
h_{min} (inch): 6.00
c_{ac} (inch): 4.50
C_{min} (inch): 1.75
S_{min} (inch): 3.00

Base Material
Concrete: Normal-weight
Concrete thickness, h (inch): 8.00
State: Cracked
Compressive strength, f'_c (psi): 3000
$\Psi_{c,V}$: 1.0
Reinforcement condition: Supplementary reinforcement not present
Supplemental edge reinforcement: Not applicable
Reinforcement provided at corners: No
Ignore concrete breakout in tension: No
Ignore concrete breakout in shear: No
Ignore 6do requirement: Not applicable
Build-up grout pad: No

Recommended Anchor
Anchor Name: Titen HD® - 5/8"Ø Titen HD, hnom:4" (102mm)
Code Report: ICC-ES ESR-2713



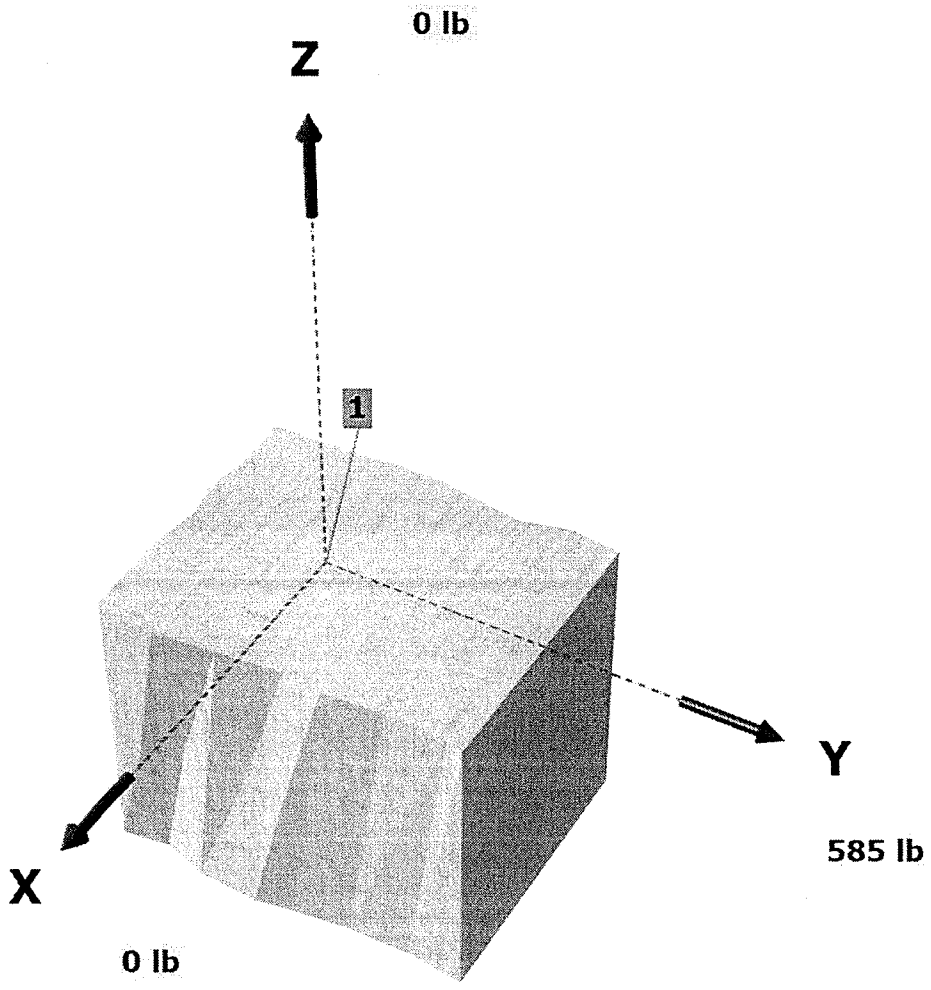
Company:	MSC Engineers Inc	Date:	9/8/2022
Engineer:	JAC	Page:	2/5
Project:	EOU Inlow Hall Generator		
Address:	3470 Pipebend Place NE		
Phone:	503-399-1399		
E-mail:	johnc@mscengineersinc.com		

Load and Geometry
Load factor source: ACI 318 Section 5.3
Load combination: not set
Seismic design: Yes
Anchors subjected to sustained tension: Not applicable
Ductility section for tension: 17.10.5.3 (d) is satisfied
Ductility section for shear: 17.10.6.3 (c) is satisfied
Ω_0 factor: not set
Apply entire shear load at front row: No
Anchors only resisting wind and/or seismic loads: No

Strength level loads:

N_{ua} [lb]: 0
V_{uax} [lb]: 0
V_{uay} [lb]: 585

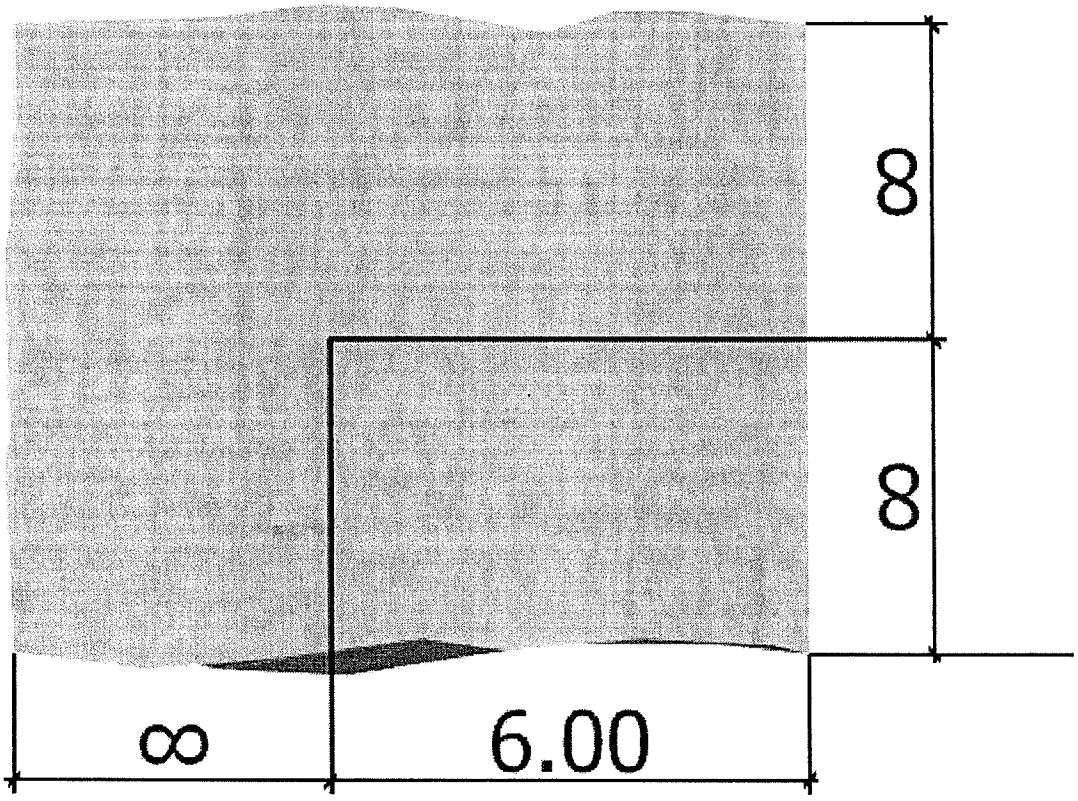
<Figure 1>



1. 6

Company:	MSC Engineers Inc	Date:	9/8/2022
Engineer:	JAC	Page:	3/5
Project:	EOU Inlow Hall Generator		
Address:	3470 Pipebend Place NE		
Phone:	503-399-1399		
E-mail:	johnc@mscengineersinc.com		

<Figure 2>



1.7

3. Resulting Anchor Forces

Anchor	Tension load, N_{ua} (lb)	Shear load x, V_{uax} (lb)	Shear load y, V_{uay} (lb)	Shear load combined, $\sqrt{(V_{uax})^2+(V_{uay})^2}$ (lb)
1	0.0	0.0	585.0	585.0
Sum	0.0	0.0	585.0	585.0

Maximum concrete compression strain (‰): 0.00
Maximum concrete compression stress (psi): 0
Resultant tension force (lb): 0
Resultant compression force (lb): 0
Eccentricity of resultant tension forces in x-axis, e'_{Nx} (inch): 0.00
Eccentricity of resultant tension forces in y-axis, e'_{Ny} (inch): 0.00
Eccentricity of resultant shear forces in x-axis, e'_{Vx} (inch): 0.00
Eccentricity of resultant shear forces in y-axis, e'_{Vy} (inch): 0.00

8. Steel Strength of Anchor in Shear (Sec. 17.7.1)

V_{sa} (lb)	ϕ_{grout}	ϕ	$\phi_{grout}\phi V_{sa}$ (lb)
8000	1.0	0.60	4800

9. Concrete Breakout Strength of Anchor in Shear (Sec. 17.7.2)

Shear perpendicular to edge in y-direction:

$V_{by} = \min|7(l_e / d_a)^{0.2}\sqrt{d_a}\lambda_a\sqrt{f'_c}c_{a1}^{1.5};\ 9\lambda_a\sqrt{f'_c}c_{a1}^{1.5}|$ (Eq. 17.7.2.2.1a & Eq. 17.7.2.2.1b)

l_e (in)	d_a (in)	λ_a	f'_c (psi)	c_{a1} (in)	V_{by} (lb)
2.97	0.625	1.00	3000	6.00	6084

$\phi V_{cby} = \phi\,(A_{Vc} / A_{Vco})\,\Psi_{ed,V}\Psi_{c,V}\Psi_{h,V}V_{by}$ (Sec. 17.5.1.2 & Eq. 17.7.2.1a)

A_{Vc} (in²)	A_{Vco} (in²)	$\Psi_{ed,V}$	$\Psi_{c,V}$	$\Psi_{h,V}$	V_{by} (lb)	ϕ	ϕV_{cby} (lb)
144.00	162.00	1.000	1.000	1.061	6084	0.70	4015

10. Concrete Pryout Strength of Anchor in Shear (Sec. 17.7.3)

$\phi V_{cp} = \phi k_{cp} N_{cb} = \phi k_{cp}(A_{Nc} / A_{Nco})\,\Psi_{ed,N}\Psi_{c,N}\Psi_{cp,N}N_b$ (Sec. 17.5.1.2 & Eq. 17.7.3.1a)

k_{cp}	A_{Nc} (in²)	A_{Nco} (in²)	$\Psi_{ed,N}$	$\Psi_{c,N}$	$\Psi_{cp,N}$	N_b (lb)	ϕ	ϕV_{cp} (lb)
2.0	79.39	79.39	1.000	1.000	1.000	4766	0.70	6672

11. Results

Interaction of Tensile and Shear Forces (Sec. 17.8)

Shear	Factored Load, V_{ua} (lb)	Design Strength, ϕV_n (lb)	Ratio	Status

Steel	585	4800	0.12	Pass
T Concrete breakout y+	**585**	**4015**	**0.15**	**Pass (Governs)**
Pryout	585	6672	0.09	Pass

5/8"Ø Titen HD, hnom:4" (102mm) meets the selected design criteria.

12. Warnings

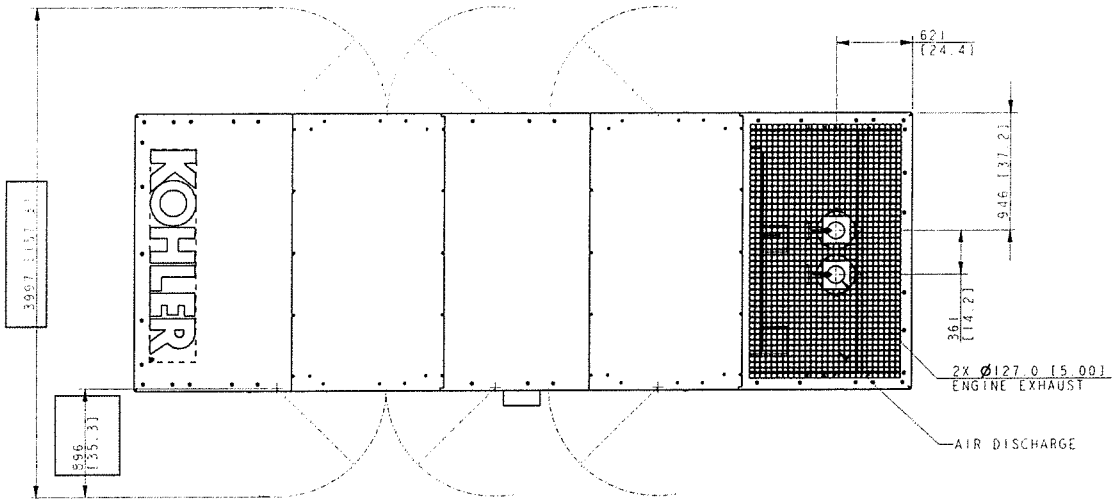
- Per designer input, ductility requirements for tension have been determined to be satisfied – designer to verify.

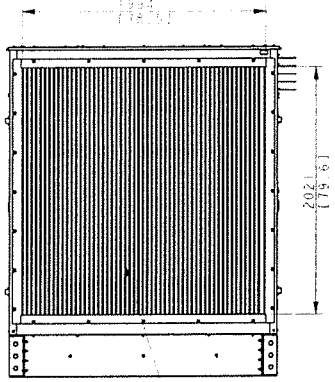
- Per designer input, ductility requirements for shear have been determined to be satisfied – designer to verify.

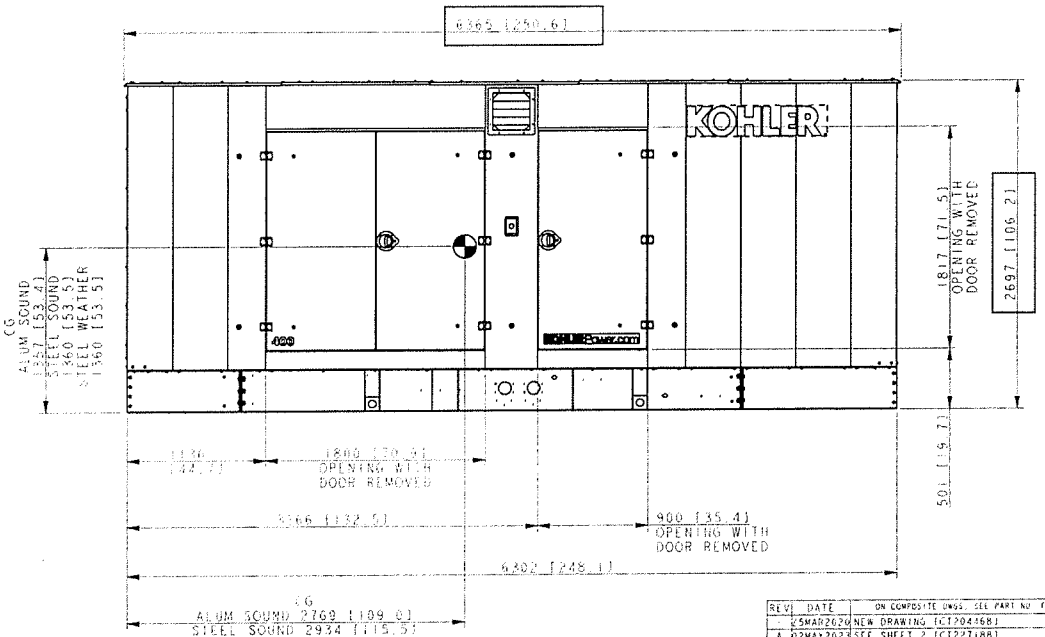
- Designer must exercise own judgement to determine if this design is suitable.

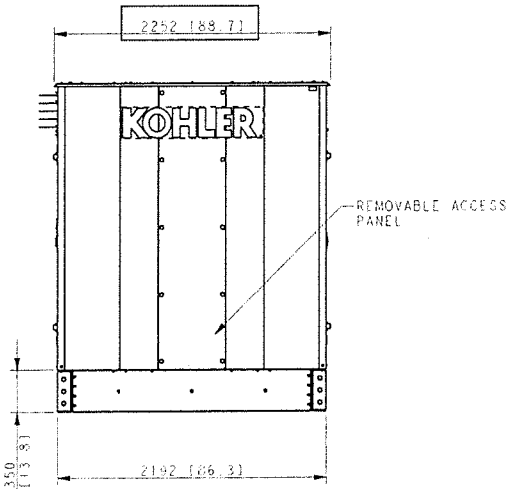
- Refer to manufacturer's product literature for hole cleaning and installation instructions.

MODEL	ENCLOSURE WEIGHT	
400-500 REZXD	STEEL SOUND	2087 Kg [4600 LBS]
	STEEL WEATHER	1882 Kg [4150 LBS]
	ALUM SOUND	1656 Kg [3650 LBS]









REV	DATE	ON COMPOSITE DWGS, SEE PART NO. FOR REVISION LEVEL	BY
	25MAR2020	NEW DRAWING [CT204468]	TAR
A	02MAY2023	SEE SHEET 2 [CT227188]	APM

DO NOT SCALE, REFERENCE THE MODEL FOR ALL UNSPECIFIED DIMENSIONS

UNLESS OTHERWISE SPECIFIED: ALL DIMENSIONS IN MILLIMETERS GENERAL TOLERANCES N/A

THIRD ANGLE PROJECTION

APPROVALS	DATE
DRAWN TAR	25MAR2020
CHECKED KJB	25MAR2020
APPROVED JM	25MAR2020

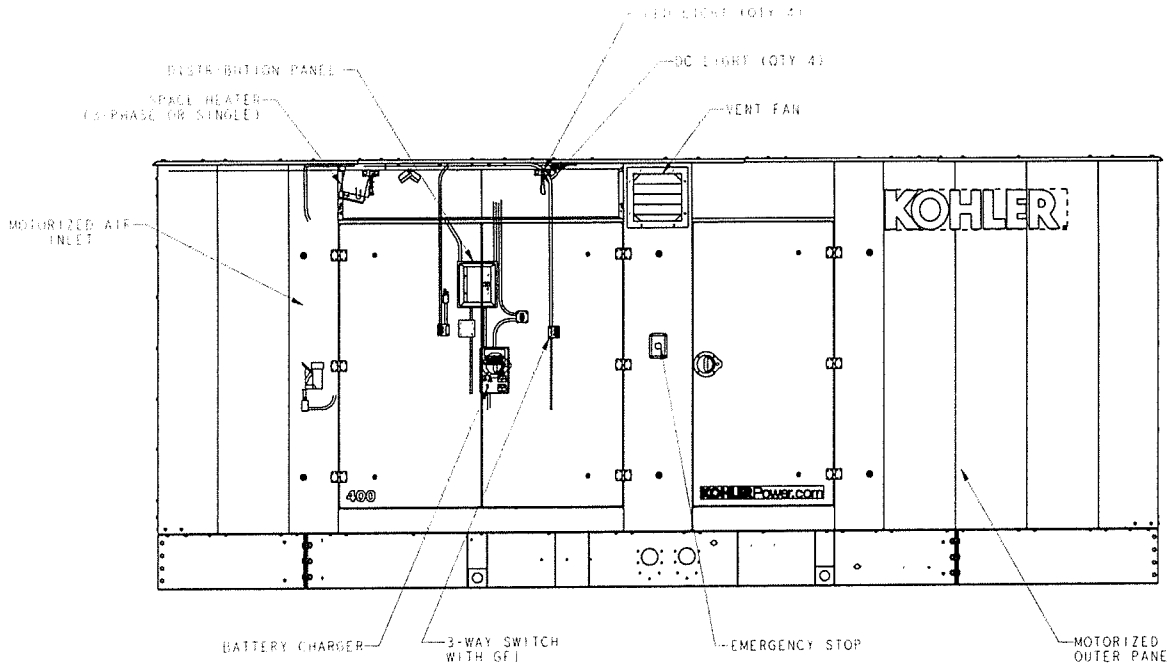
KOHLER
KOHLER, WISCONSIN 53044

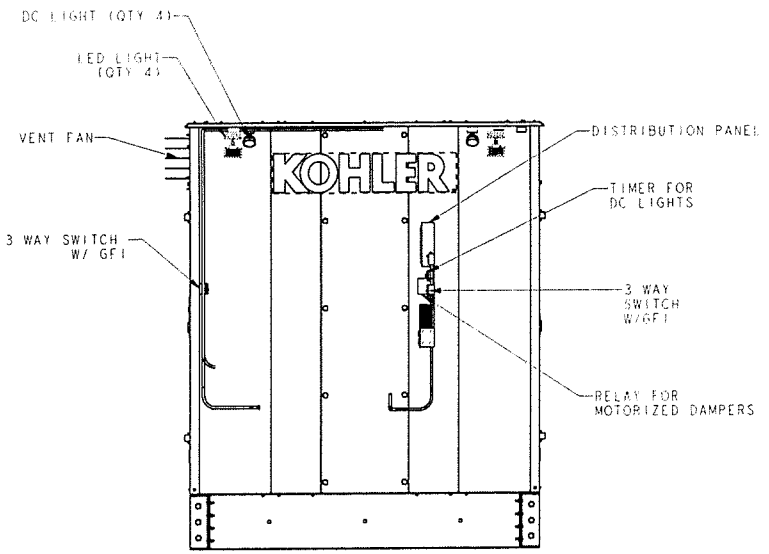
DIMENSION PRINT, 400-500 DOOSAN ENCL

SCALE 0.05 | CAD NO | SHEET 1 OF 3

DWG NO ADV-9200 | D

A.1





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-	25MAR2021	(NEW DRAWING [CT-044681])	TAK
A	02MAY2023	(C-3.61 LED LIGHT WAS INCANDESCENT LIGHT [CT-027188])	APM

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THIRD ANGLE PROJECTION

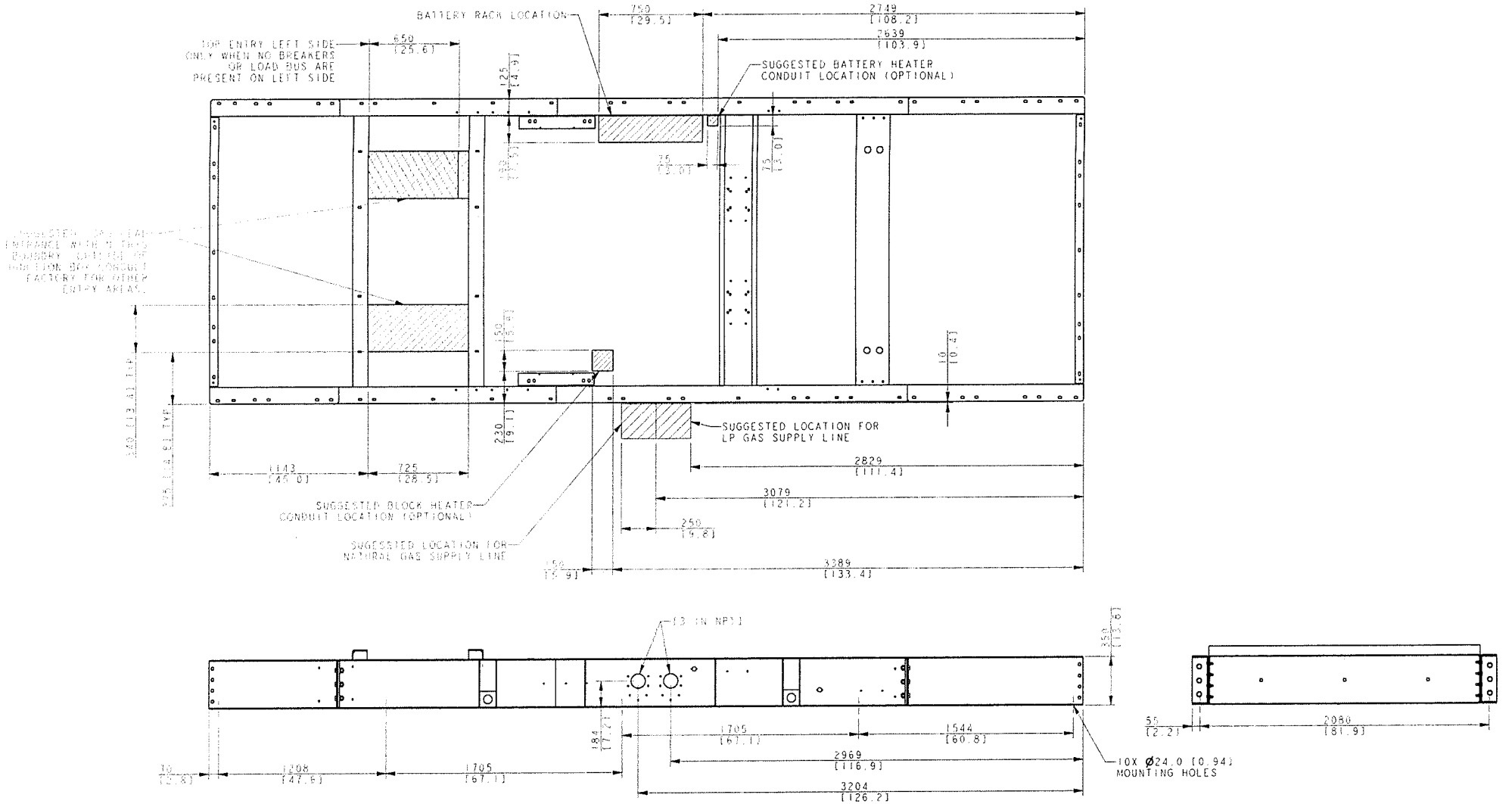
APPROVALS		DATE
DRAWN	TAK	25MAR2021
CHECKED	KJB	25MAR2021
APPROVED	JM	25MAR2021

DIMENSION PRINT, 400-500 DDOSAN ENCL

SCALE: 0.07 | CAD NO. | SHEET 2 OF 3

DWG NO. ADV-9200 | D

A.2



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A	02MAY2023	SEE SHEET 2 [CT227188]	APM

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UNLESS OTHERWISE SPECIFIED: ALL DIMENSIONS IN MILLIMETERS; GENERAL TOLERANCES: N/A

THIRD ANGLE PROJECTION

APPROVALS		DATE
DRAWN	TAR	25MAR2020
CHECKED	KJB	25MAR2020
APPROVED	JM	25MAR2020

KOHLER
KOHLER, WISCONSIN 53044

DIMENSION PRINT, 400-500 DOOSAN ENCL

SCALE 0.08 | SHEET 3 OF 3

DWG NO ADV-9200 | D

A.3