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PSOMAS

Structural Design Calculations for

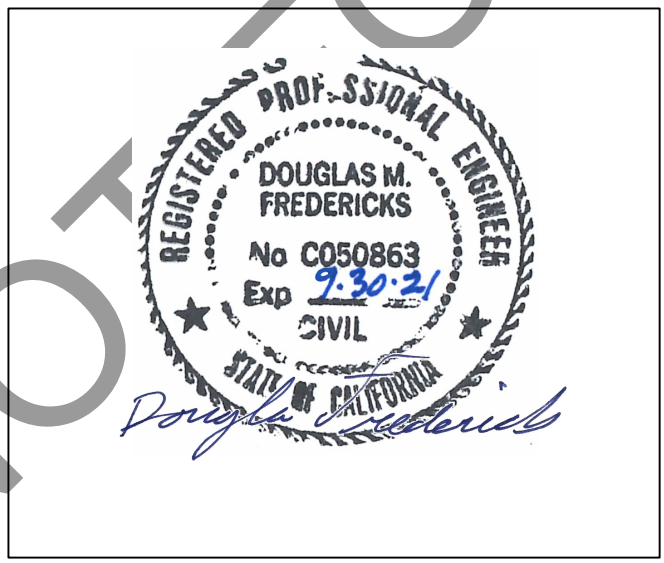
Generator and Tank Concrete Pad and Anchors

Prepared For

Victorville Fuel Station

Psomas Project Number

2OBR010100



Calculations by

Doug Fredericks

10/7/2020

PSOMAS

Client: Victorville Fuel Station
Project: Generator Concrete Pad
Project #: 2OBR010100
Date: 10/7/2020
Prepared by: Doug Fredericks

General Site Information

Type	Value	Description
S_S	1.288	MCE_R ground motion. (for 0.2 second period)
S_1	0.498	MCE_R ground motion. (for 1.0s period)
S_{MS}	1.545	Site-modified spectral acceleration value
S_{M1}	null -See Section 11.4.8	Site-modified spectral acceleration value
S_{DS}	1.03	Numeric seismic design value at 0.2 second SA
S_{D1}	null -See Section 11.4.8	Numeric seismic design value at 1.0 second SA

Type	Value	Description
SDC	null -See Section 11.4.8	Seismic design category
F_a	1.2	Site amplification factor at 0.2 second
F_v	null -See Section 11.4.8	Site amplification factor at 1.0 second
PGA	0.5	MCE_G peak ground acceleration
F_{PGA}	1.2	Site amplification factor at PGA
PGA_M	0.6	Site modified peak ground acceleration
T_L	12	Long-period transition period in seconds
SsRT	1.288	Probabilistic risk-targeted ground motion. (0.2 second)
SsUH	1.38	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration
SsD	1.5	Factored deterministic acceleration value. (0.2 second)
S1RT	0.498	Probabilistic risk-targeted ground motion. (1.0 second)
S1UH	0.544	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration.
S1D	0.6	Factored deterministic acceleration value. (1.0 second)
PGAd	0.5	Factored deterministic acceleration value. (Peak Ground Acceleration)
C_{RS}	0.933	Mapped value of the risk coefficient at short periods
C_{R1}	0.915	Mapped value of the risk coefficient at a period of 1 s

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Generator CIP Concrete Pad and Anchors

ASCE 7-16 Section 15 for Rigid Non-Building Structure

Dead Loads

	Component W		z to Component CG	
Generator Open Set	2.425	k	5.375	ft
Enclosure	0.625	k	5.375	ft
Tank	1.365	k	1.792	ft
W_{top}	3.05	kip		
W_{bot}	1.365	kip	*(total weight of components)*	

Wind Load

ASCE 7-16 Section 29.4

V	110	mph
Exposure Cat =	C	
Kz =	0.85	
Kzt =	1	
Ke =	1	
Kd	0.85	
qz =	22.38	
GCpi =	0.85	
Cf	1.45	
F	27.58	x Af
Width of Unit	10.667	ft
Height of Unit	7.167	ft
Af	76.44	ft^2
F	2108.61	p
Wind OM	7.56	k-ft

Seismic Calculations

ASCE 7-16 Section 15 for Rigid Non-Building Structure; 0.3 x Ie x Sds

Risk Category	III		
Ie	1.25		*(importance factor)*
S_{DS}	1.036	g	*(design short period spectral acceleration)*
V	0.388	x W	*(ASCE 15.4-5) (S1 is not > 0.6g)*
Vertical: 0.2 x Sds			
Vert	0.207	x W	

Seismic Overturning Moment about Anchors

Item	W (k)	V (k)	z (ft)	Mmt (k-ft)
Generator Open Set	2.425	0.942	5.375	13.034
Enclosure	0.625	0.243	5.375	3.359
Tank	1.365	0.530	1.792	2.446
Total	4.415	1.714		18.839

Seismic Vertical Overturning Moment about One Row of Anchors

Item	W (k)	Vert (k)	b/2 (ft)	Mmt (k-ft)
Total	4.415	0.914	1.667	1.372

Resisting Overturning Moment about One Row of Anchors

Item	W (k)	b/2 (ft)	0.9*Mmt (k-ft)
Total	4.415	1.667	6.623

Anchor Tie Down Force

Resisting Mmt	6.623	k-ft
Total Seismic Mmt	20.211	k-ft
Remainder	13.588	k-ft
Tu	4.077	kips per row

Concrete Pad

W	5.50	ft	*(width)*
L	12.00	ft	*(length)*
t	1.25	ft	*(thickness)*
A	66.00	ft^2	*(area of pad)*
I	166.38	ft4	*(Mmt of Inertia of pad)*
γ	0.15	kcf	*(unit weight of concrete)*
P	82.50	kip	*(weight of pad)*

Slab Overturning Moment Check

Slab OT Mmt	20.02	k-ft	*(Slab weight x Seismic factor x thickness/2)*
Equipment OT Mmt	9.46	k-ft	*(Equip weight x seismic factor x (z+thickness)*
OM	29.48	k-ft	*(overturning moment)*
Wind OM	7.56	k-ft	*(overturning moment)*
RM	239.02	k-ft	*(resisting moment)*
OT Factor of Safety	8.11		

OK

Soil Pressures at Seismic Overturning

P/A	1.3	ksf	*Sum of Weight / Area of pad*
Mc/I	0.49	ft	*(eccentricity)*
q_{max}	1.804	ksf	*(maximum soil pressure)*
q_{max}	0.830	ksf	*(minimum soil pressure)*
Max Allow Soil Pressure	2.000	ksf	*Use 1500 psf for non-seismic allowable and apply 1.333*
	OK		

Concrete Pad Capacity

f'_c	4	ksi	*(compressive strength of concrete)*
f_y	60	ksi	*(yield strength of steel)*
b	12	in	*(effective width for 1' strip)*
bar	#6		*(bar size)*
dbar	0.75	in	*(diameter of bar)*
clr	3	in	*(clear to rebar)*
s	12	in	*(rebar spacing)*
A_s	0.44	in^2	*(area of steel)*
d	11.25	in	*(effective depth)*
$\rho_{prov'd}$	0.0033		*(reinforcement ratio)*
ρ_{min}	0.0032		*(min reinforcement ratio)*
ϕV_c	**6.40**	kip/ft	*(shear capacity of concrete)*
ϕM_n	267.3	k-in	*(moment capacity)*
	22.28	k-ft/ft	*(moment capacity)*

Concrete Slab Loading Demand

L	2.5	ft	*(Length of slab overhanging equipment base)*
V_u	4.51	k	*(qmax applied to overhang)*
	OK, No Shear Reinforcement Needed		
M_u	5.64	k-ft	*(qmax applied to overhang)*
	OK, Flexural Reinforcement Adequate		

Anchor Bolts Load Demand

Tu	4.08	k-ft	
# of anchors / row	5		*(number of anchors per side)*
Tu per anchor	**0.815**	kip	*(max tension for bolts to resist)*
V of Equipment	1.714	kip	*(Seismic shear of equipment)*
Sliding Resistance	0.915	kip	*(Use 0.3 friction factor)*
V Remainder	0.799	kip	
Vu per anchor	**0.080**	kip	

Anchor Bolts Resistance

Type Stainless Steel KB-TZ Hilti anchors

Design Strength per Manufacturer

f'c	4000	psi	
Anchor diameter	0.50	in	
Nominal Embedment	3.25	in	
Tension	2.735	k	< OK >
Shear	6.880	k	< OK >
Unity check	0.134		< OK >

TABLE 4—DESIGN INFORMATION, STAINLESS STEEL KB-TZ

DESIGN INFORMATION	Symbol	Units	Nominal anchor diameter								
			3/8		1/2				5/8		
Anchor O.D.	d_a	in. (mm)	0.375 (9.5)		0.5 (12.7)				0.625 (15.9)		
Effective min. embedment[1]	h_{ef}	in. (mm)	2 (51)		2 (51)		3 1/4 (83)		3 1/8 (79)	4 (102)	
Min. member thickness	h_{min}	in. (mm)	4 (102)	5 (127)	4 (102)	6 (152)	6 (152)	8 (203)	5 (127)	6 (152)	8 (203)
Critical edge distance	c_{ac}	in. (mm)	4 3/8 (111)	3 7/8 (98)	5 1/2 (140)	4 1/2 (114)	7 1/2 (191)	6 (152)	7 (178)	8 7/8 (225)	6 (152)
Min. edge distance	c_{min}	in. (mm)	2 1/2 (64)		2 7/8 (73)		2 1/8 (54)		3 1/4 (83)	2 3/8 (60)	
	for $s \geq$	in. (mm)	5 (127)		5 3/4 (146)		5 1/4 (133)		5 1/2 (140)	5 1/2 (140)	
Min. anchor spacing	s_{min}	in. (mm)	2 1/4 (57)		2 7/8 (73)		2 (51)		2 3/4 (70)	2 3/8 (60)	
	for $c \geq$	in. (mm)	3 1/2 (89)		4 1/2 (114)		3 1/4 (83)		4 1/8 (105)	4 1/4 (108)	
Min. hole depth in concrete	h_o	in. (mm)	2 3/8 (67)		2 5/8 (67)		4 (102)		3 3/4 (98)	4 3/4 (121)	
Min. specified yield strength	f_y	lb/in² (N/mm²)	92,000 (634)		92,000 (634)				92,000 (634)		
Min. specified ult. Strength	f_{uta}	lb/in² (N/mm²)	115,000 (793)		115,000 (793)				115,000 (793)		
Effective tensile stress area	$A_{se,N}$	in² (mm²)	0.052 (33.6)		0.101 (65.0)				0.162 (104.6)		
Steel strength in tension	N_{sa}	lb (kN)	5,968 (26.6)		11,554 (51.7)				17,880 (82.9)		
Steel strength in shear	V_{sa}	lb (kN)	4,720 (21.0)		6,880 (30.6)				9,870 (43.9)		
Pullout strength in tension, seismic[2]	$N_{p,eq}$	lb (kN)	2,340 (10.4)		2,735 (12.2)		NA		NA	5,840 (26.0)	
Steel strength in shear, seismic[2]	$V_{sa,eq}$	lb (kN)	2,825 (12.6)		6,880 (30.6)				9,350 (41.6)		
Pullout strength uncracked concrete[3]	$N_{p,uncr}$	lb (kN)	2,630 (11.7)		NA		5,760 (25.6)		NA		
Pullout strength cracked concrete[3]	$N_{p,cr}$	lb (kN)	2,340 (10.4)		3,180 (14.1)		NA		NA	5,840 (26.0)	

PSOMAS

Client: Victorville Fuel Station
Project: Generator Concrete Pad
Project #: 2OBR010100
Date: 10/7/2020
Prepared by: Doug Fredericks

Above Ground Tank CIP Concrete Pad and Anchors

ASCE 7-16 Section 15 for Rigid Non-Building Structure

Dead Loads

	Component W		z to Component CG	
Each Tank Shell	45	k	6.6666667	ft
Diesel	66.5	k	6.6666667	ft
Other	0	k	0.000	ft
W_{top}	111.5	kip		
W_{bot}	0	kip	*(total weight of components)*	

Wind Load

ASCE 7-16 Section 29.4

V	110	mph
Exposure Cat =	C	
Kz =	0.85	
Kzt =	1	
Ke =	1	
Kd	0.85	
qz =	22.38	
GCpi =	0.85	
Cf	1.45	
F	27.58	x Af
Width of Unit	20.250	ft
Height of Unit	12.000	ft
Af	243.00	ft^2
F	6702.80	p
Wind OM	40.22	k-ft

Seismic Calculations

ASCE 7-16 Section 15 for Rigid Non-Building Structure; 0.3 x Ie x Sds

Risk Category	III		
Ie	1.25		*(importance factor)*
S_{DS}	1.294	g	*(design short period spectral acceleration)*
V	0.485	x W	*(ASCE 15.4-5) (S1 is not > 0.6g)*
Vertical: 0.2 x Sds			
Vert	0.259	x W	

Seismic Overturning Moment about Anchors

Item	W (k)	V (k)	z (ft)	Mmt (k-ft)
Each Tank Shell	45.000	21.844	6.667	145.625
Diesel	66.500	32.280	6.667	215.201
Other	0.000	0.000	0.000	0.000
Total	111.500	54.124		360.825

Seismic Vertical Overturning Moment about One Row of Anchors

Item	W (k)	Vert (k)	b/2 (ft)	Mmt (k-ft)
Total	111.500	28.866	5.333	138.557

Resisting Overturning Moment about One Row of Anchors

Item	W (k)	b/2 (ft)	0.9*Mmt (k-ft)
Total	111.500	5.333	535.200

Anchor Tie Down Force

Resisting Mmt	535.200	k-ft	
Total Seismic Mmt	998.764	k-ft	*Omega = 2*
Remainder	463.564	k-ft	
Tu	43.459	kips per row	

Concrete Pad

W	16.00	ft	*(width)*
L	20.00	ft	*(length)*
t	1.00	ft	*(thickness)*
A	320.00	ft^2	*(area of pad)*
I	6826.67	ft4	*(Mmt of Inertia of pad)*
γ	0.15	kcf	*(unit weight of concrete)*
P	320.00	kip	*(weight of pad)*

Slab Overturning Moment Check

Slab OT Mmt	77.67	k-ft	*(Slab weight x Seismic factor x thickness/2)*
Equipment OT Mmt	414.95	k-ft	*(Equipment weight x seismic factor x (z+thickness)*
OM	492.62	k-ft	*(overturning moment)*
Wind OM	40.22	k-ft	*(overturning moment)*
RM	3452.00	k-ft	*(resisting moment)*
OT Factor of Safety	7.01		
	OK		

Soil Pressures at Seismic Overturning

P/A	1.3	ksf	*Sum of Weight / Area of pad*
Mc/I	0.58	ft	*(eccentricity)*
q_{max}	1.926	ksf	*(maximum soil pressure)*
q_{max}	0.771	ksf	*(minimum soil pressure)*
Max Allow Soil Pressure	2.000	ksf	*Use 1500 psf for non-seismic allowable*
	OK		*and apply 1.333*

Concrete Pad Capacity

f'_c	4	ksi	*(compressive strength of concrete)*
f_y	60	ksi	*(yield strength of steel)*
b	12	in	*(effective width for 1' strip)*
bar	#6		*(bar size)*
dbar	0.75	in	*(diameter of bar)*
clr	3	in	*(clear to rebar)*
s	12	in	*(rebar spacing)*
A_s	0.44	in^2	*(area of steel)*
d	8.25	in	*(effective depth)*
$\rho_{prov'd}$	0.0044		*(reinforcement ratio)*
ρ_{min}	0.0032		*(min reinforcement ratio)*
ϕV_c	**4.70**	kip/ft	*(shear capacity of concrete)*
ϕM_n	196.02	k-in	*(moment capacity)*
	16.34	k-ft/ft	*(moment capacity)*

Concrete Slab Loading Demand

L	2	ft	*(Length of slab overhanging equipment base)*
V_u	3.85	k	*(qmax applied to overhang)*
	OK, No Shear Reinforcement Needed		
M_u	3.85	k-ft	*(qmax applied to overhang)*
	OK, Flexural Reinforcement Adequate		

Anchor Bolts Load Demand

Tu	43.46	k-ft	
# of anchors / row	8		*(number of anchors per side)*
Tu per anchor	**5.432**	kip	*(max tension for bolts to resist)*
V of Equipment	54.124	kip	*(Seismic shear of equipment)*
Sliding Resistance	33.450	kip	*(Use 0.3 friction factor)*
V Remainder	20.674	kip	
Vu per anchor	**1.292**	kip	

Anchor Bolts Resistance

Type Stainless Steel KB-TZ Hilti anchors

Design Strength per Manufacturer

f'c	4000	psi	
Anchor diameter	0.75	in	
Nominal Embedment	4.75	in	
Tension	8.11	k	< OK >
Shear	12.890	k	< OK >
Unity check	0.534		< OK >

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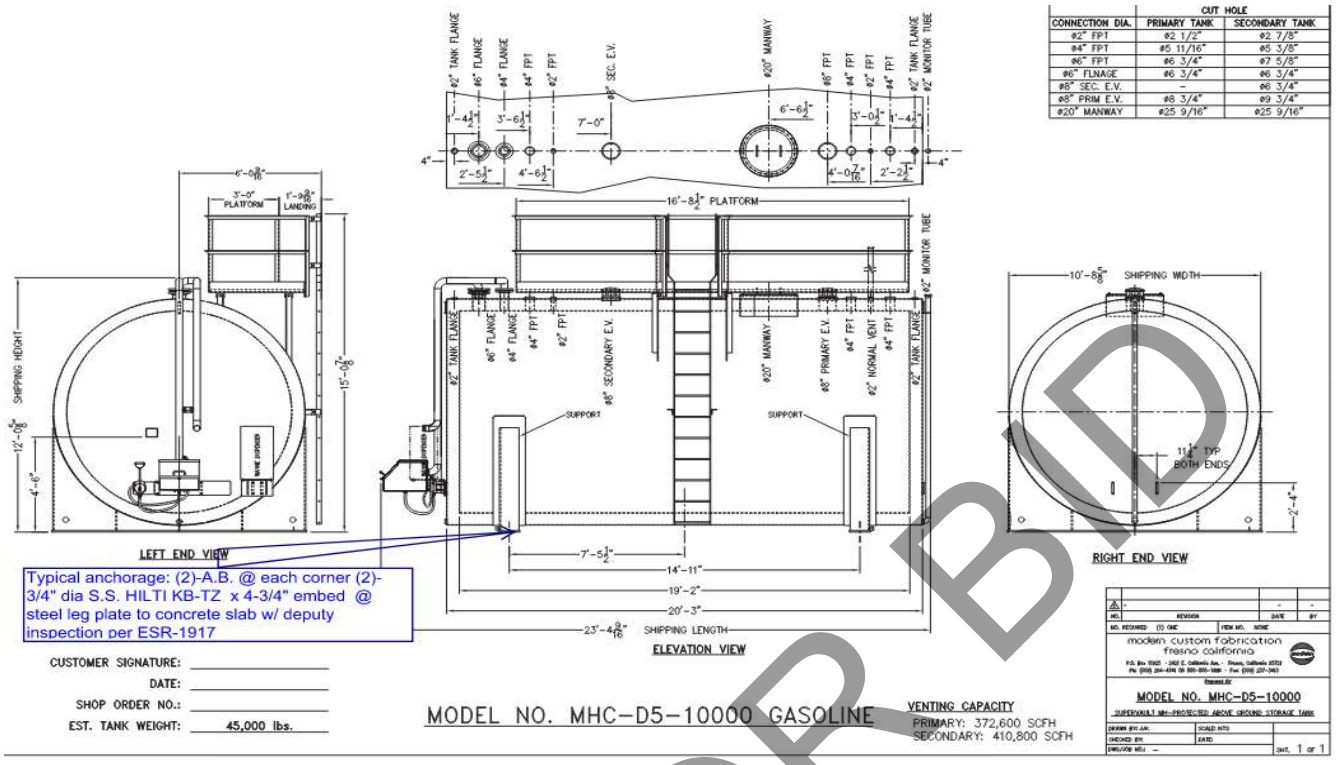
Steel strength in shear	V_{sa}	lb (kN)	4,720 (21.0)		6,880 (30.6)				9,870 (43.9)		
Pullout strength in tension, seismic[2]	$N_{p,eq}$	lb (kN)	2,340 (10.4)		2,735 (12.2)		NA		NA	5,840 (26.0)	
Steel strength in shear, seismic[2]	$V_{sa,eq}$	lb (kN)	2,825 (12.6)		6,880 (30.6)				9,350 (41.6)		
Pullout strength uncracked concrete[3]	$N_{p,uncr}$	lb (kN)	2,630 (11.7)		NA		5,760 (25.6)		NA		
Pullout strength cracked concrete[3]	$N_{p,cr}$	lb (kN)	2,340 (10.4)		3,180 (14.1)		NA		NA	5,840 (26.0)	



CUT HOLE		
CONNECTION DIA.	PRIMARY TANK	SECONDARY TANK
ø2" FPT	ø2 1/2"	ø2 7/8"
ø4" FPT	ø5 11/16"	ø5 3/8"
ø6" FPT	ø6 3/4"	ø7 5/8"
ø6" FLNAGE	ø6 3/4"	ø6 3/4"
ø8" SEC. E.V.	-	ø6 3/4"
ø8" PRIM E.V.	ø8 3/4"	ø9 3/4"
ø20" MANWAY	ø25 9/16"	ø25 9/16"

CUSTOMER SIGNATURE: _____

DATE: _____

SHOP ORDER NO.: _____

EST. TANK WEIGHT: 45,000 lbs.

MODEL NO. MHC-D5-10000 GASOLINE

VENTING CAPACITY
PRIMARY: 372,600 SCFH
SECONDARY: 410,800 SCFH

modern custom fabrication
fresno california

MODEL NO. MHC-D5-10000
SUPERVAULT MH-PROTECTED ABOVE GROUND STORAGE TANK

SHT. 1 or 1