ADVANCED MANUFACTURING & POWER SYSTEMS INC.
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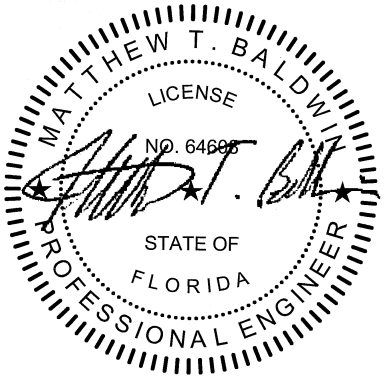
ENGINEERING STRUCTURAL CALCULATIONS
For
Gillette 110" Frame Genset

September 8, 2016

110" Frame Genset Models:

SP-1200	**SPJD-1550**
SP-1500	**SPJD-2100**
SPJD-1250	

Designed with reference from: **2014 Florida Building Code 5th Edition with 2016 Supplements**
ASCE 7 - Minimum Design Loads for Buildings and Other Structures
2005 Aluminum Association Design Manual
ANSI/AISC 360-05 Specifications for Structural Steel Buildings



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Project Information

Project Name/Model #	- Gillette 110" Frame Genset
Project Number	-
Project Description	- 180mph Windload Calculations
Project Location	-
Customer	-
Mounting Location	- Ground

Enclosure Materials

Roof Beam	- 14 Gage Truss - CRS
Roof Panels	- 0.080 Aluminum Panel - 5052-H34
Wall Panels	- 0.080 Aluminum Panel - 5052-H34

Components

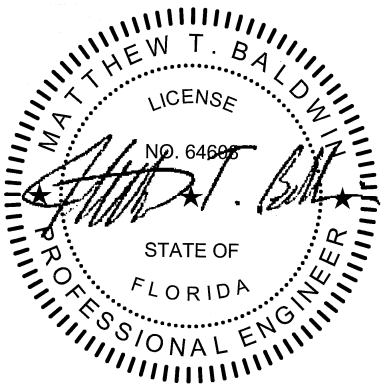
GenSet Manufacturer	- Gillette Generators, Inc.		
GenSet Size and Model	- 110" Frame	Supported by -	Base
Base	- Bent Aluminum Frame		

Fasteners/Hardware

		Bolt Size	Grade/Finish
Panels	-	5/16" - 18	Grade 18-8/SS
Enclosure to Base	-	5/16" - 18	Grade 18-8/SS

Specification Requirements

Wind Speed	-	180	mph (Greater of Design or Site)
Exposure Category	-	D	



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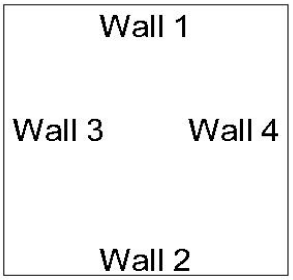
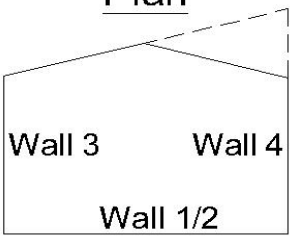
Enclosure Dimensions & Component Weights

Gillette 110" Frame Genset

Roof Style- Flat



Plan



Elevation

Enclosure Dimensions (ft)

Wall	Length (ft)		Height (ft)
1	4.02	x	5.36
2	4.02	x	5.36
3	12.18	x	5.36
4	12.18	x	5.36

Base Dimensions

Width (Wall 1/2 Side)	=	48	in
Length (Wall 3/4 Side)	=	110	in
Height	=	7	in

Roof/Eave Information

Roof Pitch Angle - *(θ)*	=	0.0	Degrees
Eave/Roof Height - *h*	=	5.36	

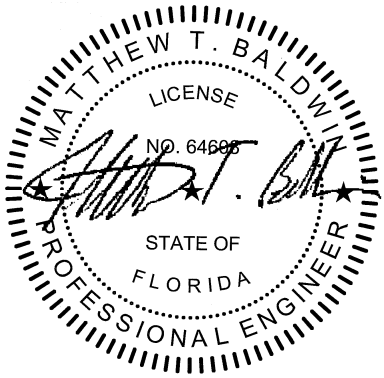
Structure Areas

Walls 1/2 Area -	*(w1)*	=	21.5	ft^2	=	3,103	in^2
Walls 3/4 Area -	*(w3)*	=	65.3	ft^2	=	9,401	in^2
Roof Area -	*(R)*	=	49.0	ft^2	=	7,051	in^2

Base Side 1/2	*(T1)*	=	336.0 in2
Base Side 3/4	*(T3)*	=	770.0 in2

Component Weights

Genset	=	0	lbs	(Varies, so will use zero to be conservative/most uplift to resist)
Enclosure	=	225	lbs	(Based on Aluminum to be conserative/most uplift to resist)
Base Frame	=	175	lbs	(Based on Aluminum to be conserative/most uplift to resist)



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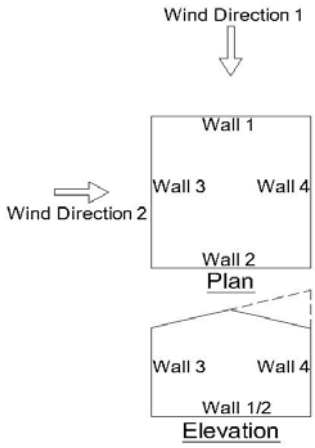
MWFRS Net Pressures

Gillette 110" Frame Genset

Wind

Directional Procedure method from
ASCE 7 are utilized in these calculations.

Enclosure Classification	-	Enclosed	
Exposure Category	-	D	
Basic Wind Speed	(V)	180	mph
Wind Directionality Factors	(K_d)	0.85	
Internal Pressure Coefficients	(GC_{pi})	± 0.18	
Velocity Pressure Exposure Coefficient	(K_z)	1.03	
Roof Mean Height Above Ground Level	(z)	5.94	ft
Velocity Pressure	(q)	72.63	psf



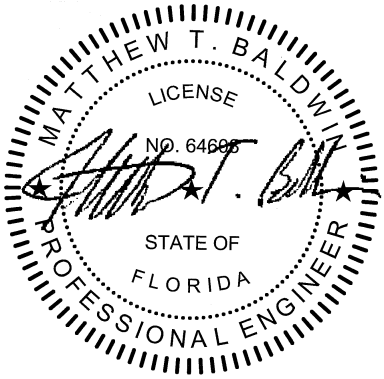
Wind Direction 1

		Enclosure							
		Wall #			Roof				
		1	2	3&4	Parallel to Ridge				
					$(C_p)1$ (Distance From Windward Edge)				$(C_p)2$
		Windward	Leeward	Side	0 to 2.7	2.7 to 5.4	5.4 to 10.7	> 10.7	
Background Response Factor	(Q)	0.98	0.98	0.96	0.98				
Gust Effect Factors	(G)	0.91	0.91	0.91	0.91				
External Pressure Coefficients	(C_p)	0.80	-0.249	-0.70	-0.90	-0.90	-0.50	-0.3	-0.18
Net Pressures with + (GC_{pi}) - psf	(Net_{p+})	40.0	-29.6	-59.2	-72.8	-72.8	-46.2	-33.0	-25.0
Net Pressures with - (GC_{pi}) - psf	(Net_{p-})	66.1	-3.4	-33.1	-46.6	-46.6	-20.1	-6.8	1.1

Wind Direction 2

		Enclosure								
		Wall #			Roof - Normal To Ridge					
		3	4	1&2	$(C_p)1$ (Distance From Windward Edge)				$(C_p)2$	
		Windward	Leeward	Side	0 to 2.7	> 2.7				
Background Response Factor	(Q)	0.96	0.96	0.98	0.96					
Gust Effect Factors	(G)	0.91	0.91	0.91	0.91					
External Pressure Coefficients	(C_p)	0.80	-0.5	-0.70	-1.04	-0.70			-0.18	
Net Pressures with + (GC_{pi}) - psf	(Net_{p+})	39.7	-46.0	-59.5	-81.6	-59.2			-24.9	
Net Pressures with - (GC_{pi}) - psf	(Net_{p-})	65.8	-19.9	-33.4	-55.5	-33.1			1.2	

Plus and minus signs signify pressures acting toward or away from the surfaces, respectively.



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Structural Calculations - Roof

Gillette 110" Frame Genset

Critical Loads & Pressures

Wind Pressures

Downforce	1.206	psf	=	0.01 psi
Uplift	-81.65	psf	=	-0.57 psi

Section Properties

14 Gage Truss - CRS

Cross Sectional Area	(A)	=	0.48	in^2
Moment of Inertia - x	(I_x)	=	0.62	in^4
Moment of Inertia - y	(I_y)	=	N/A	in^4
Section Modulus - x	(S_x)	=	0.64	in^3
Section Modulus - y	(S_y)	=	N/A	in^3
Radius of Gyration - x	(r_x)	=	1.13	in
Radius of Gyration - y	(r_y)	=	N/A	in
Polar Moment of Inertia	(J)	=	N/A	in^4
Weight of Beam	(ω)	=	0.12	lbs/in
Modulus of Elasticity	(E)	=	2.90E+04	ksi
Safety Factor	(n_u)	=	1.95	
Safety Factor	(n_y)	=	1.65	
Coefficient	(k_t)	=	1.00	
Tensile Ultimate Strength	(F_{tu})	=	58	ksi
Tensile Yield Strength	(F_{ty})	=	36	ksi
Compressive Yield Strength	(F_{cy})	=	22	ksi
Shear Ultimate Strength	(F_{su})	=	36	ksi

Roof Frame Calculations

Member Designed for Forces Acting on the Strong Axis

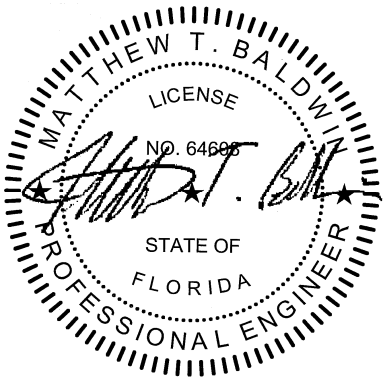
Interior Beam Critical Member Dimensions

Interior Beam Length	(L_i)	=	47.75	in
Load Spanned Width	(W_i)	=	54.88	in

Interior Beam Calculated Forces

Distributed Loads

Weight of Beam	(ω)	=	0.120	lbs/in
Wind Load Downforce	(w_d)	=	0.460	lbs/in
Wind Load Uplift Force	(w_u)	=	-31.113	lbs/in



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Shear Forces (Maximum at End)

Beam Weight Shear	(V_b)	=	2.87	lbs
Wind DownForce Shear	(V_{wd})	=	11.0	lbs
Wind Uplift Shear	(V_{wu})	=	-742.8	lbs
Total Shear Downward		=	13.8	lbs
Total Shear Upward		=	740.0	lbs
Design Shear	(V_{bi})	=	740.0	lbs

Stress Forces (Bending)

Beam Weight Moment	(M_b)	=	23	lb·in
Wind Downforce Moment	(M_d)	=	65	lb·in
Wind Uplift Moment	(M_u)	=	-4,434	lb·in
Total Moments Downward		=	88	lb·in
Total Moments Upward		=	4,411	lb·in
Design Moment	(M_T)	=	4,411	lb·in
Design Stress	(σ_{bi})	=	6,892	psi

Interior Beam Design Calculations

Allowable Shear Strength

Slenderness Limit 1	(S_1)	=	-20.08	
Slenderness Limit 2	(S_2)	=	102.40	
Slenderness Ratio	(S)	=	18.0	
Allowable Shear Stress		=	9,856	psi
Allowable Shear Strength	(V_n)	=	4,751	lbs

Conclusion

(V_{bi}) 740 lbs < (V_n) 4,751 lbs **OK**

Allowable Stresses For Tension And Compression (Bending)

Tension

Allowable Tensile Stress (F_t) = 16,000 psi

Compression

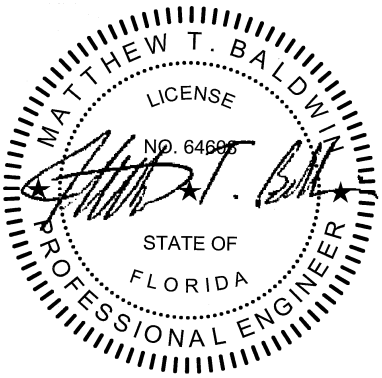
Slenderness Limit 1	(S_1)	=	25.0	
Slenderness Limit 2	(S_2)	=	125.0	
Slenderness Ratio	(S)	=	42.3	

Allowable Compressive Stress (F_c) = 13,039 psi

The Allowable Compressive Stress is the controlling
Therefore, (F_b) = 13,039 psi failure design

Conclusion

(σ_{bi}) 6,892 psi < (F_b) 13,039 psi **OK**



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Entire Roof Uplift Calculations

Roof Area

Area of Roof Subjected to Uplift (R) = 7,051 in^2

Roof Uplift Calculated Forces

To be conservative, the weight of the roof frame and panels is neglected.

Weight of Accessories	(ω_a)	=	0	lbs
Wind Load Uplift Force	(w_{ru})	=	-3,998	lbs
Total Roof Design Uplift	(W_{ru})	=	-2,399	lbs

Mounting Hardware - Roof Frame to Wall Panels

Screws Along Length - 1 Side	=	6	5/16" - 18 - Grade 18-8/SS
Screws Along Width - 1 Side	=	3	5/16" - 18 - Grade 18-8/SS
Total Mounting Screws	=	18	5/16" - 18 - Grade 18-8/SS

Entire Roof Uplift Design Calculations

Grade 18-8 Ultimate Strength	=	150,000	psi
5/16 Bolt Nominal Diameter	=	0.255	in
5/16 Bolt Effective Area	=	0.051	in^2
5/16 SBolt Threads per Inch	=	18	
Washer Nominal Diameter	=	0.875	in
Wall Panel Tensile Ult. Strength	=	34	ksi
Wall Panel Tensile Yield Strength	=	26	ksi
Safety Factor	=	3	
Wall Panel Nominal Thickness	=	0.062	in
Maximum Tensile Strength	=	439.2	lbs
Maximum Shear/Bearing Strength	=	408.6	lbs
Max. Tensile Load per Screw	=	408.6	lbs
Max. Total Screws Tensile Strength (P_{ts})	=	7,354	lbs

Conclusion

(W_{ru}) 2,399 lbs < (P_{ts}) 7,354 lbs **OK**

Roof Panel Uplift Calculations

Roof Panel Critical Member Dimensions

Critical Panel Length	(L_p)	=	54.88 in
Critical Panel Width	(W_p)	=	48 in

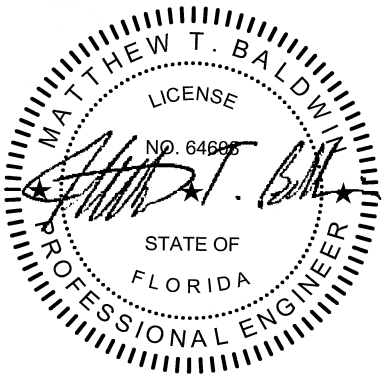
Roof Panel Uplift Calculated Forces

Distributed Loads

Wind Load Uplift Force	(w_{pu})	=	896.1 lbs

Mounting Hardware - Roof Panel to Roof Frame

Screws Along Length - 1 Side	=	3	5/16" - 18 - Grade 18-8/SS
Screws Along Width - 1 Side	=	3	5/16" - 18 - Grade 18-8/SS



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Roof Panel Uplift Design Calculations

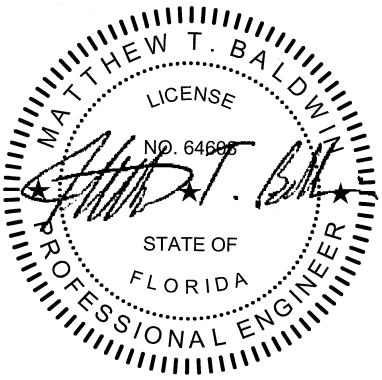
Grade 410 Ultimate Strength	=	150,000	psi
5/16 Bolt Nominal Diameter	=	0.255	in
5/16 Bolt Effective Area	=	0.051	in^2
5/16 Bolt Threads per Inch	=	18	
Washer Nominal Diameter	=	0.875	in
Roof Panel Tensile Ult. Strength	=	34	ksi
Roof Panel Tensile Yield Strength	=	26	ksi
Safety Factor	=	3	
Roof Panel Nominal Thickness	=	0.080	in

		Roof Frame		
Maximum Tensile Strength	=	439.2	lbs	(Accounts for screw pull-over strength)
Maximum Shear/Bearing Strength	=	408.6	lbs	
Max. Tensile Load per Screw	=	408.6	lbs	

Max. Total Screws Tensile Strength (P_{ts}) = 4,903 lbs

Conclusion

(w_{pu}) 896 lbs < (P_{ts}) 4,903 lbs **OK**



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Structural Calculations - Walls/Columns

Gillette 110" Frame Genset

Critical Wind Load Pressures and Roof Forces

Walls 1 & 2

Maximum Pressures Acting:

Toward	66.1	psf	=	0.4593	psi
Away	-59.5	psf	=	-0.4132	psi

Walls 3 & 4

Maximum Pressures Acting:

Toward	65.8	psf	=	0.4571	psi
Away	-59.2	psf	=	-0.4113	psi

Critical Wall Panel Dimensions

Critical/Maximum Panel Width		=	45.5	in
Critical/Maximum Panel Height		=	64.0	in

Section Properties

0.080 Aluminum Panel - 5052-H34

Cross Sectional Area	(A)	=	3.79	in^2
Moment of Inertia - x	(I_x)	=	0.05	in^4
Section Modulus - x	(S_x)	=	0.80	in^3
Radius of Gyration - x	(r_x)	=	0.11	in
Modulus of Elasticity	(E)	=	1.02E+04	ksi
Safety Factor	(n_u)	=	1.95	
Factor of Safety	(n_y)	=	1.65	
Coefficient - Tension Member	(k_t)	=	1.0	
Tensile Ultimate Strength	(F_{tu})	=	34	ksi
Tensile Yield Strength	(F_{ty})	=	26	ksi
Shear Ultimate Strength	(F_{su})	=	20	ksi
Compressive Yield Strength	(F_{cy})	=	24	ksi

Critical Wall Panel Calculated Forces

Maximum Wind Pressure on Walls

Maximum + Wind Pressure	=	0.4593	psi
Maximum - Wind Pressure	=	-0.4132	psi

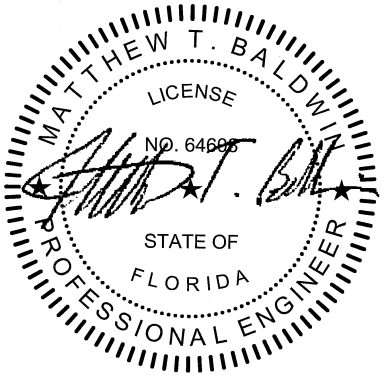
Plus and minus signs signify pressures acting toward or away from the surfaces, respectively.

Wind Shear Distributed Loads on Critical Panel

Maximum + Wind Shear	=	20.9	lbs/in
Maximum - Wind Shear	=	-18.8	lbs/in

Total Wind Shear on Critical Panel

Total Panel Design Shear	(V_{ww})	=	1,337.4	lbs



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Critical Panel Roof Load (Roof to Wall)

Axial Roof Load (W_{wr}) = 0.0 lbs

Mounting Hardware - Wall Panel to Wall Panel

To be conservative, the 'wall to roof' and 'wall to floor' connections are negleted.

Bolts Along Length - 1 Side = 4 5/16" - 18 - Grade 18-8/SS

Total Mounting Screws = 8 5/16" - 18 - Grade 18-8/SS

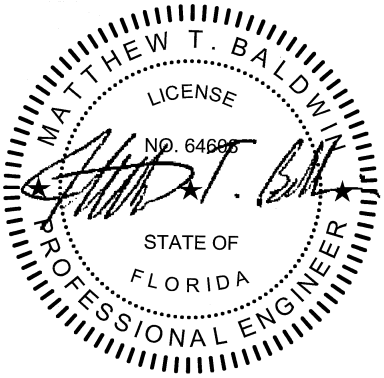
Wall Panel Design Calculations

Mounting Hardware - Shear and Tension

Grade 18-8/SS	=	150,000	psi	
Grade 18-8/SS Shear Strength	=	30,000	psi	(Includes Reduction Factor)
Grade 18-8/SS Tensile Strength	=	57,000	psi	(Includes Reduction Factor)
5/16" Bolt Effective Area	=	0.0510	in^2	
Shear Strength per Bolt	=	1,530	lbs	
Tensile Strength per Bolt	=	2,907	lbs	
Total Bolts Shear Strength (R_{vb})	=	12,240	lbs	
Total Bolts Tensile Strength (R_{tb})	=	23,256	lbs	

Conclusion

(V_{ww}) 1,337 lbs < (R_{vb}) 12,240 lbs **OK**



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Structural Calculations - Enclosure to Base/Tank or Pad

Gillette 110" Frame Genset

Critical Pressures & Loads

To determine maximum moment forces, pressures are algebraically combined relative to toward or away forces (+ & -) and each wind direction.

Wind Direction 1

Net Pressures with + Internal Pressure *(+Gcpi)*

Walls 1 & 2	-	69.5	psf =	0.4829	psi
Wall 3 or 4	-	59.2	psf =	0.4113	psi
Roof Uplift	-	72.8	psf =	0.5053	psi

Net Pressures with - Internal Pressure *(-Gcpi)*

Walls 1 & 2	-	69.5	psf =	0.4829	psi
Wall 3 or 4	-	33.1	psf =	0.2297	psi
Roof Uplift	-	46.6	psf =	0.3238	psi

Wind Direction 2

Net Pressures with + Internal Pressure *(+Gcpi)*

Walls 3 & 4	-	85.7	psf =	0.5952	psi
Wall 1 or 2	-	59.5	psf =	0.4132	psi
Roof Uplift	-	81.6	psf =	0.5670	psi

Net Pressures with - Internal Pressure *(-Gcpi)*

Walls 3 & 4	-	85.7	psf =	0.5952	psi
Wall 1 or 2	-	33.4	psf =	0.2316	psi
Roof Uplift	-	55.5	psf =	0.3854	psi

Enclosure Critical Dimensions & Weights

Total Enclosure Weight		(W_t)	=	225	lbs	(Includes all components)
Walls 1/2 Area	-	*(w1)*	=	3102.8	in^2	
Walls 3/4 Area	-	*(w3)*	=	9401.0	in^2	
Roof Area	-	*(R)*	=	7050.8	in^2	

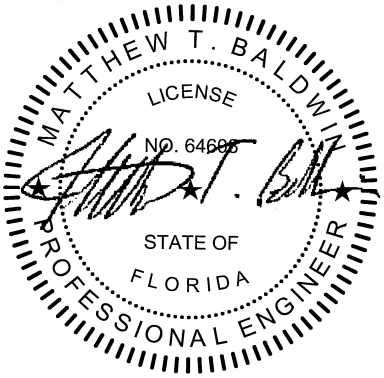
Enclosure Calculated Forces

Maximum Wind Load Forces on Walls

Wind Direction 1

Net Forces with + Internal Pressure *(+Gcpi)*

Walls 1/2	-	=	1,498	lbs
Wall 3 or 4	-	=	3,867	lbs
Roof Uplift	-	=	3,563	lbs



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Net Forces with - Internal Pressure*(-Gcpi)*

Walls 1/2	-	=	1,498	lbs
Wall 3 or 4	-	=	2,160	lbs
Roof Uplift	-	=	2,283	lbs

Wind Direction 2

Net Forces with + Internal Pressure*(+Gcpi)*

Walls 3/4	-	=	5,596	lbs
Wall 1 or 2	-	=	1,282	lbs
Roof Uplift	-	=	3,998	lbs

Net Forces with - Internal Pressure*(-Gcpi)*

Walls 3/4	-	=	5,596	lbs
Wall 1 or 2	-	=	719	lbs
Roof Uplift	-	=	2,717	lbs

Enclosure Overturn Forces

(Postive forces act upward, negative forces act downward)

Wind Direction 1

Net Forces with + Internal Pressure*(+Gcpi)*

Overturn on Walls 1/2	=	1,042	lbs
Overturn on Walls 3/4	=	2,391	lbs

Net Forces with - Internal Pressure*(-Gcpi)*

Overturn on Walls 1/2	=	658	lbs
Overturn on Walls 3/4	=	1,324	lbs

Wind Direction 2

Net Forces with + Internal Pressure*(+Gcpi)*

Overturn on Walls 3/4	=	3,213	lbs
Overturn on Walls 1/2	=	1,256	lbs

Net Forces with - Internal Pressure*(-Gcpi)*

Overturn on Walls 3/4	=	2,829	lbs
Overturn on Walls 1/2	=	685	lbs

Design Overturn Force (O_E) = 3,213 lbs Acting On Wall 3/4

Mounting Hardware - Enclosure to Base/Tank or Pad

To be conservative, half the bolt connections along the adjacent walls are neglected.

No. of Bolt Connections Along Wall 3/4 = 7 5/16" - 18 - Grade 18-8/SS

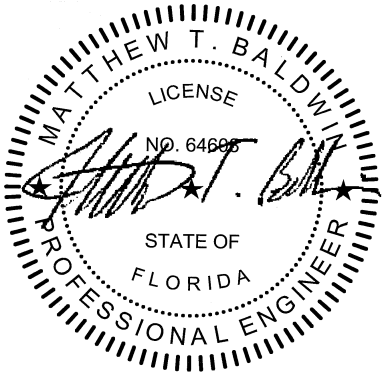
Enclosure Overturn Design Calculations

Grade 18-8 Ultimate Strength	=	150,000	psi
Grade 18-8 Shear Strength	=	30,000	psi (Includes Reduction Factor)
5/16" Bolt Effective Area	=	0.051	in^2
Shear Strength per Bolt	=	1,530	lbs

Total Bolts Shear Strength (R_{vb}) = 10,710 lbs

Conclusion

(O_E) 3,213 lbs < (R_v) 10,710 lbs **OK**



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