ADVANCED MANUFACTURING & POWER SYSTEMS INC.
1965 BENNETT DRIVE, DELAND, FL 32724
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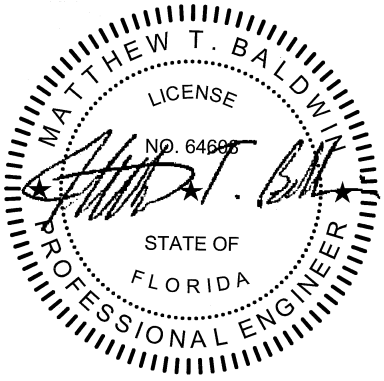
ENGINEERING STRUCTURAL CALCULATIONS
For
Gillette 168" Frame Genset

October 19, 2016

168" Frame Genset Models:

PR-3000	**SP-4250**
PR-3500	**SPMD-5500**
SP-3500	**SPMD-6000**
SP-4000	**SP-4500**

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 168" Frame Genset
Project Number	-
Project Description	- 180mph Windload Calculations
Project Location	-
Customer	-
Mounting Location	- Ground

Enclosure Materials

Roof Beam	- 11 Gage CRS
Roof Panels	- 0.080 Aluminum Panel - 5052-H34
Wall Panels	- 0.080 Aluminum Panel - 5052-H34

Components

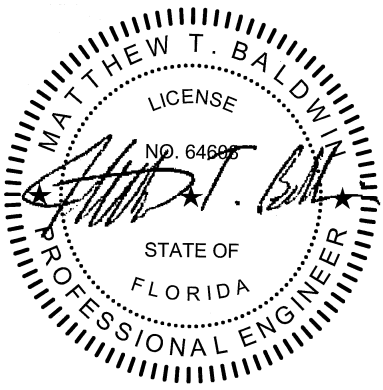
GenSet Manufacturer	- Gillette Generators, Inc.		
GenSet Size and Model	- 168" Frame	Supported by -	Base
Base	- Bent Aluminum Frame		

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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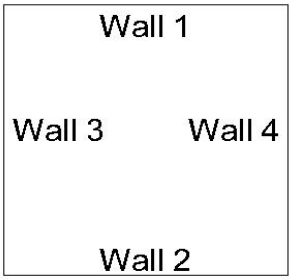
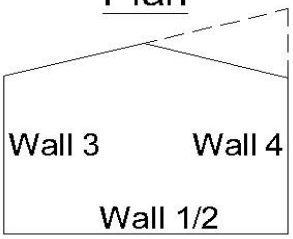
Enclosure Dimensions & Component Weights

Gillette 168" Frame Genset

Roof Style- Flat



Plan



Elevation

Enclosure Dimensions (ft)

Wall	Length (ft)		Height (ft)
1	6	x	8.5625
2	6	x	8.5625
3	6.83	x	8.5625
4	6.83	x	8.5625

Base Dimensions

Width (Wall 1/2 Side)	=	82	in
Length (Wall 3/4 Side)	=	168	in
Height	=	8	in

Roof/Eave Information

Roof Pitch Angle - *(θ)*	=	0.0	Degrees
Eave/Roof Height - *h*	=	8.5625	

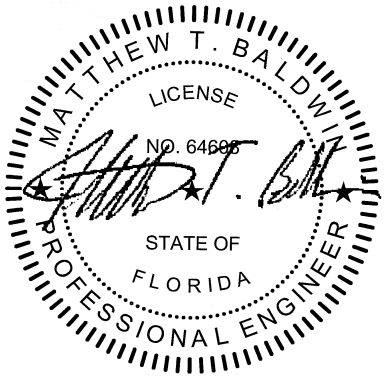
Structure Areas

Walls 1/2 Area -	*(w1)*	=	51.4	ft^2	=	7,398	in^2
Walls 3/4 Area -	*(w3)*	=	58.5	ft^2	=	8,421	in^2
Roof Area -	*(R)*	=	41.0	ft^2	=	5,901	in^2

Base Side 1/2	*(T1)*	=	656.0 in2
Base Side 3/4	*(T3)*	=	1,344.0 in2

Component Weights

Genset	=	0	lbs	(Varies, so will use zero to be conservative/most uplift to resist)
Enclosure	=	350	lbs	(Based on Aluminum to be conserative/most uplift to resist)
Base Frame	=	300	lbs	(Based on Aluminum to be conserative/most uplift to resist)



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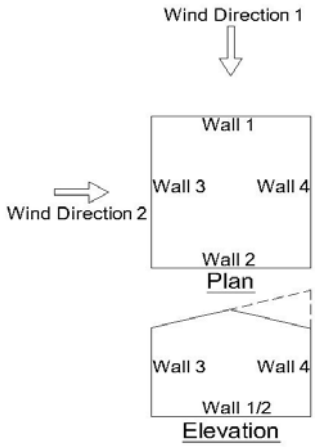
MWFRS Net Pressures

Gillette 168" 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)	9.23	ft
Velocity Pressure	(q)	72.63	psf



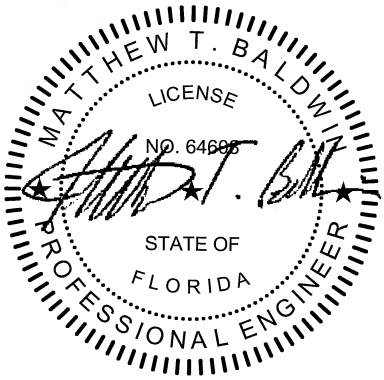
Wind Direction 1

		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 4.3	> 4.3			
Background Response Factor	(Q)	0.97	0.97	0.97	0.97				
Gust Effect Factors	(G)	0.91	0.91	0.91	0.91				
External Pressure Coefficients	(C_p)	0.80	-0.472	-0.70	-1.04	-0.70			-0.18
Net Pressures with + (GC_{pi}) - psf	(Net_{p+})	39.8	-44.3	-59.3	-81.8	-59.3			-25.0
Net Pressures with - (GC_{pi}) - psf	(Net_{p-})	65.9	-18.1	-33.1	-55.6	-33.2			1.2

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 4.3	> 4.3				
Background Response Factor	(Q)	0.97	0.97	0.97	0.97					
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	-46.1	-59.3	-81.7	-59.3			-25.0	
Net Pressures with - (GC_{pi}) - psf	(Net_{p-})	65.9	-19.9	-33.2	-55.6	-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 168" Frame Genset

Critical Loads & Pressures

Wind Pressures

Downforce	1.189	psf	=	0.01 psi
Uplift	-81.78	psf	=	-0.57 psi

Section Properties

11 Gage CRS

Cross Sectional Area	(A)	=	1.23	in^2
Moment of Inertia - x	(I_x)	=	1.85	in^4
Moment of Inertia - y	(I_y)	=	N/A	in^4
Section Modulus - x	(S_x)	=	1.34	in^3
Section Modulus - y	(S_y)	=	N/A	in^3
Radius of Gyration - x	(r_x)	=	1.23	in
Radius of Gyration - y	(r_y)	=	N/A	in
Polar Moment of Inertia	(J)	=	N/A	in^4
Weight of Beam	(ω)	=	0.17	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

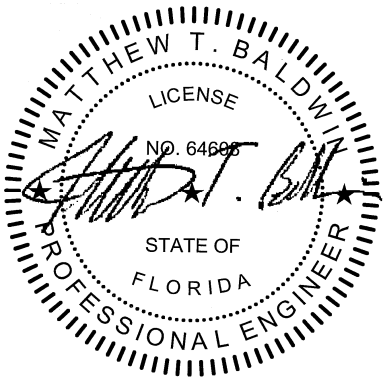
Interior Beam Critical Member Dimensions

Interior Beam Length	(L_i)	=	81.75	in
Load Spanned Width	(W_i)	=	56.1	in

Interior Beam Calculated Forces

Distributed Loads

Weight of Beam	(ω)	=	0.170	lbs/in
Wind Load Downforce	(w_d)	=	0.463	lbs/in
Wind Load Uplift Force	(w_u)	=	-31.861	lbs/in



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Shear Forces (Maximum at End)

Beam Weight Shear	(V_b)	=	6.95	lbs
Wind DownForce Shear	(V_{wd})	=	18.9	lbs
Wind Uplift Shear	(V_{wu})	=	-1302.3	lbs
Total Shear Downward		=	25.9	lbs
Total Shear Upward		=	1,295.4	lbs
Design Shear	(V_{bi})	=	1295.4	lbs

Stress Forces (Bending)

Beam Weight Moment	(M_b)	=	95	lb·in
Wind Downforce Moment	(M_d)	=	193	lb·in
Wind Uplift Moment	(M_u)	=	-13,308	lb·in
Total Moments Downward		=	288	lb·in
Total Moments Upward		=	13,213	lb·in
Design Moment	(M_T)	=	13,213	lb·in
Design Stress	(σ_{bi})	=	9,861	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)	=	12,135	lbs

Conclusion

(V_{bi}) 1,295 lbs < (V_n) 12,135 lbs **OK**

Allowable Stresses For Tension And Compression (Bending)

Tension

Allowable Tensile Stress (F_t) = 16,000 psi

Compression

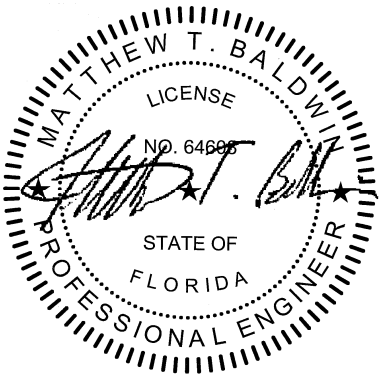
Slenderness Limit 1	(S_1)	=	25.0	
Slenderness Limit 2	(S_2)	=	125.0	
Slenderness Ratio	(S)	=	66.5	

Allowable Compressive Stress (F_c) = 10,885 psi

The Allowable Compressive Stress is the controlling
Therefore, (F_b) = 10,885 psi failure design

Conclusion

(σ_{bi}) 9,861 psi < (F_b) 10,885 psi **OK**



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Entire Roof Uplift Calculations

Roof Area

Area of Roof Subjected to Uplift (R) = 5,901 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})	=	-3,351	lbs
Total Roof Design Uplift	(W_{ru})	=	-2,011	lbs

Mounting Hardware - Roof Frame to Wall Panels

Screws Along Length - 1 Side	= 12	5/16" - 18	- Grade 18-8/SS
Screws Along Width - 1 Side	= 4	5/16" - 18	- Grade 18-8/SS
Total Mounting Screws	= 32	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})	=	13,074	lbs

Conclusion

(W_{ru}) 2,011 lbs < (P_{ts}) 13,074 lbs **OK**

Roof Panel Uplift Calculations

Roof Panel Critical Member Dimensions

Critical Panel Length	(L_p)	=	58.13	in
Critical Panel Width	(W_p)	=	82	in

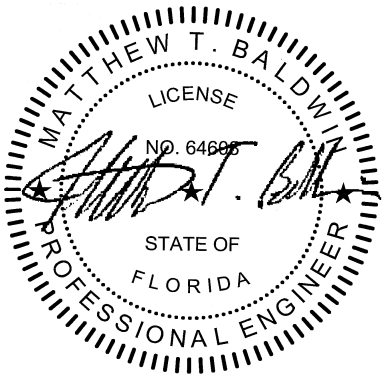
Roof Panel Uplift Calculated Forces

Distributed Loads

Wind Load Uplift Force (w_{pu}) = 1,624.1 lbs

Mounting Hardware - Roof Panel to Roof Frame

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



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Roof Panel Uplift Design Calculations

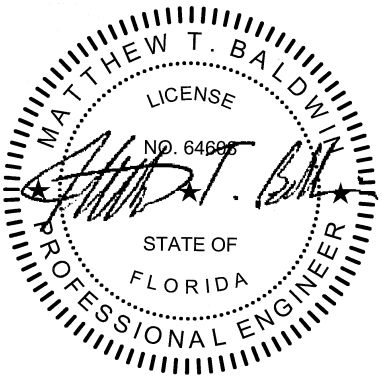
Grade 410 Ultimate Strength	=	150,000	psi
5/16 Bolt Nominal Diameter	=	0.255	in
5/16 Bolt Effective Area	=	0.051	in^2
5/16 Bolt Threads per Inch	=	18	
Washer Nominal Diameter	=	0.875	in
Roof Panel Tensile Ult. Strength	=	34	ksi
Roof Panel Tensile Yield Strength	=	26	ksi
Safety Factor	=	3	
Roof Panel 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}) = 6,537 lbs

Conclusion

(w_{pu}) 1,624 lbs < (P_{ts}) 6,537 lbs **OK**



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Structural Calculations - Walls/Columns

Gillette 168" Frame Genset

Critical Wind Load Pressures and Roof Forces

Walls 1 & 2

Maximum Pressures Acting:

Toward	65.9	psf	=	0.4578	psi
Away	-59.3	psf	=	-0.4119	psi

Walls 3 & 4

Maximum Pressures Acting:

Toward	65.9	psf	=	0.4576	psi
Away	-59.3	psf	=	-0.4118	psi

Critical Wall Panel Dimensions

Critical/Maximum Panel Width	=	46	in
Critical/Maximum Panel Height	=	92.5	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	=	0.4578	psi
Maximum - Wind Pressure	=	-0.4119	psi

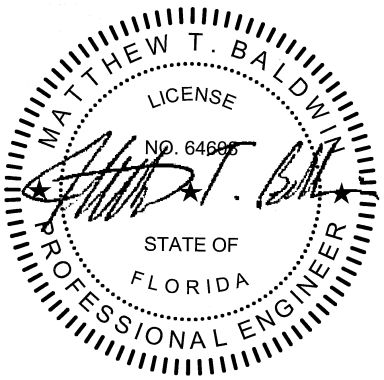
Plus and minus signs signify pressures acting toward or away from the surfaces, respectively.

Wind Shear Distributed Loads on Critical Panel

Maximum + Wind Shear	=	21.1	lbs/in
Maximum - Wind Shear	=	-18.9	lbs/in

Total Wind Shear on Critical Panel

Total Panel Design Shear	(V_{ww})	=	1,948.0	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 = 3 5/16" - 18 - Grade 18-8/SS

Total Mounting Screws = 6 5/16" - 18 - Grade 18-8/SS

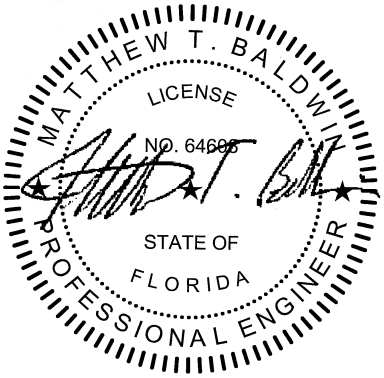
Wall Panel Design Calculations

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})	=	9,180	lbs	
Total Bolts Tensile Strength (R_{tb})	=	17,442	lbs	

Conclusion

(V_{ww}) 1,948 lbs < (R_{vb}) 9,180 lbs **OK**



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Structural Calculations - Enclosure to Base/Tank or Pad

Gillette 168" 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	-	84.1	psf =	0.5837	psi
Wall 3 or 4	-	59.3	psf =	0.4118	psi
Roof Uplift	-	81.8	psf =	0.5679	psi

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

Walls 1 & 2	-	84.1	psf =	0.5837	psi
Wall 3 or 4	-	33.1	psf =	0.2302	psi
Roof Uplift	-	55.6	psf =	0.3863	psi

Wind Direction 2

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

Walls 3 & 4	-	85.8	psf =	0.5961	psi
Wall 1 or 2	-	59.3	psf =	0.4119	psi
Roof Uplift	-	81.7	psf =	0.5677	psi

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

Walls 3 & 4	-	85.8	psf =	0.5961	psi
Wall 1 or 2	-	33.2	psf =	0.2304	psi
Roof Uplift	-	55.6	psf =	0.3861	psi

Enclosure Critical Dimensions & Weights

Total Enclosure Weight		(W_t)	=	350	lbs	(Includes all components)
Walls 1/2 Area	-	*(w1)*	=	7398.0	in^2	
Walls 3/4 Area	-	*(w3)*	=	8421.4	in^2	
Roof Area	-	*(R)*	=	5901.1	in^2	

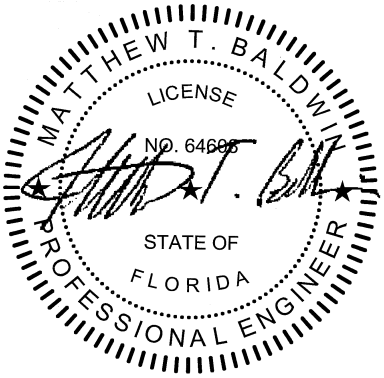
Enclosure Calculated Forces

Maximum Wind Load Forces on Walls

Wind Direction 1

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

Walls 1/2	-	=	4,318	lbs
Wall 3 or 4	-	=	3,468	lbs
Roof Uplift	-	=	3,351	lbs



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

Walls 1/2	-	=	4,318	lbs
Wall 3 or 4	-	=	1,938	lbs
Roof Uplift	-	=	2,280	lbs

Wind Direction 2

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

Walls 3/4	-	=	5,020	lbs
Wall 1 or 2	-	=	3,048	lbs
Roof Uplift	-	=	3,350	lbs

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

Walls 3/4	-	=	5,020	lbs
Wall 1 or 2	-	=	1,704	lbs
Roof Uplift	-	=	2,278	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	=	2,280	lbs
Overturn on Walls 3/4	=	2,140	lbs

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

Overturn on Walls 1/2	=	1,958	lbs
Overturn on Walls 3/4	=	1,164	lbs

Wind Direction 2

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

Overturn on Walls 3/4	=	2,804	lbs
Overturn on Walls 1/2	=	1,976	lbs

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

Overturn on Walls 3/4	=	2,483	lbs
Overturn on Walls 1/2	=	974	lbs

Design Overturn Force (O_E) = 2,804 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 = 8 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}) = 12,240 lbs

Conclusion

(O_E) 2,804 lbs < (R_v) 12,240 lbs **OK**

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