Plum Point Energy Station
Osceola, Arkansas
Individual and Combined Load Cases (IBC 2000 & ASCE 7-98)
Elevator Design and Analysis

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Project Specifications

Customer: Plum Point Energy Station
Location: Osceola, Arkansas
Customer Job Number:
Project Number:
TESI Job Number:
Type: Permanent Rack and Pinion Elevator
Manufacturer: Tower Elevator Systems, Inc.
Model: Trac-Cab TC1K R&P Elevator
Code: ASCE 7-98
Rated Load: 1000 lbs.
Design Load: 1500 lbs.
Classification: Special Purpose Personnel
Rated Speed: 110 feet per minute (nominal)
Height: Approximately 436 feet of travel
Landings: 3 Levels 4'-0", 236'-0", 436'-0"
Internal Cab Size: 2'-10" W X 3'-9"L X 7' – 01/2" H
Cab Doors: 1
Controls: Single Automatic
Drive System: Dual SEW Eurodrive 7.5 Horsepower Electric W/VFD
Overspeed Safety: Dual Independent R&P Safeties
Rack Sections 45 + Base Required
Rail Attachment Brackets – 46 Required, Positioned on 9' 11 5/16" centers

Reference Drawings

PPPP M100 GA – 100 – 11

Reference Documents

01400 Technical Supplemental Specifications (Plum Point Energy Station 143574.61.1001)

Scope

This document summarizes the design and analysis of the Plum Point Energy Station Trac-Cab TC1K R&P Elevator cab and rail system due to individual and combined load cases defined in Chapter 2 of ASCE 7-98 and in the 01400 Technical Supplemental Specifications issued by Plum Point Energy Station, document no. 143574.61.1001.

Conclusions

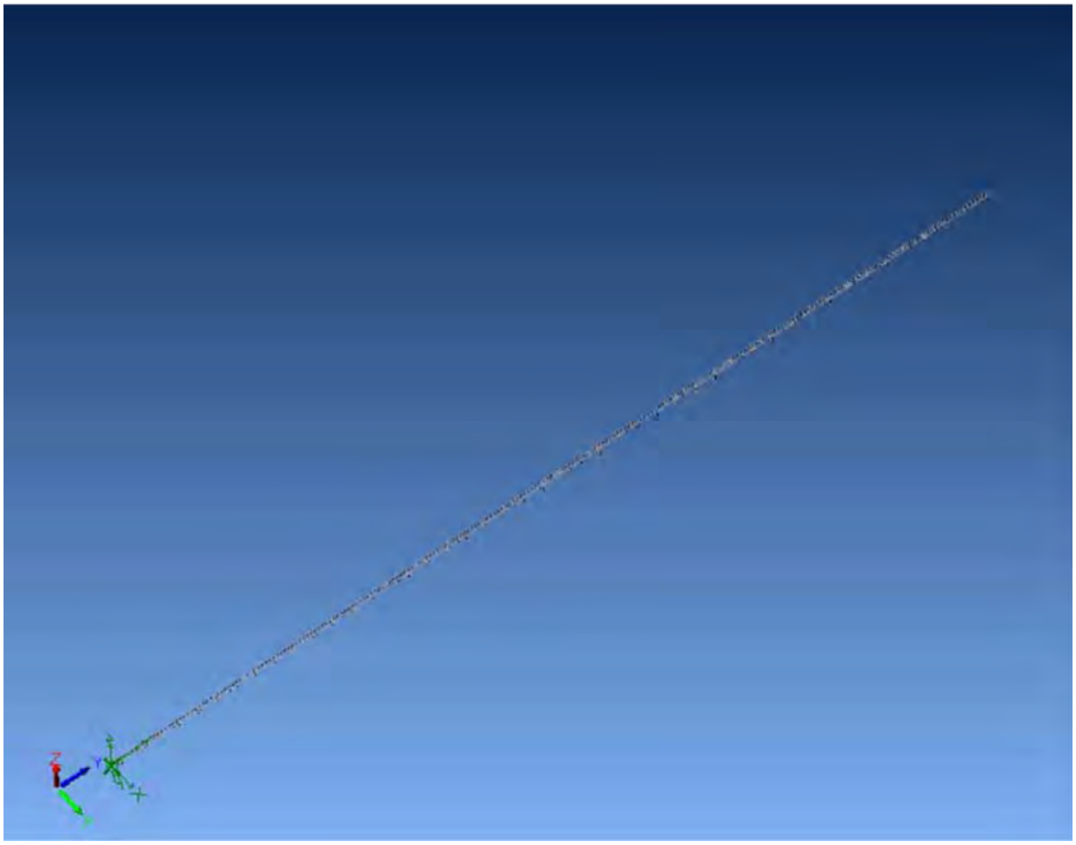
The Plum Point Energy Station Trac-Cab TC1K R&P Elevator cab and rail system meet the requirements of ASCE 7-98 and the 01400 Technical Supplemental Specifications issued by Plum Point Energy Station, document no. 143574.61.1001.

The rated load of the elevator wheels is slightly exceeded during a maximum seismic event. This is considered acceptable on the basis that this is not a catastrophic event and the wheels are easily replaceable if it becomes required to do so.

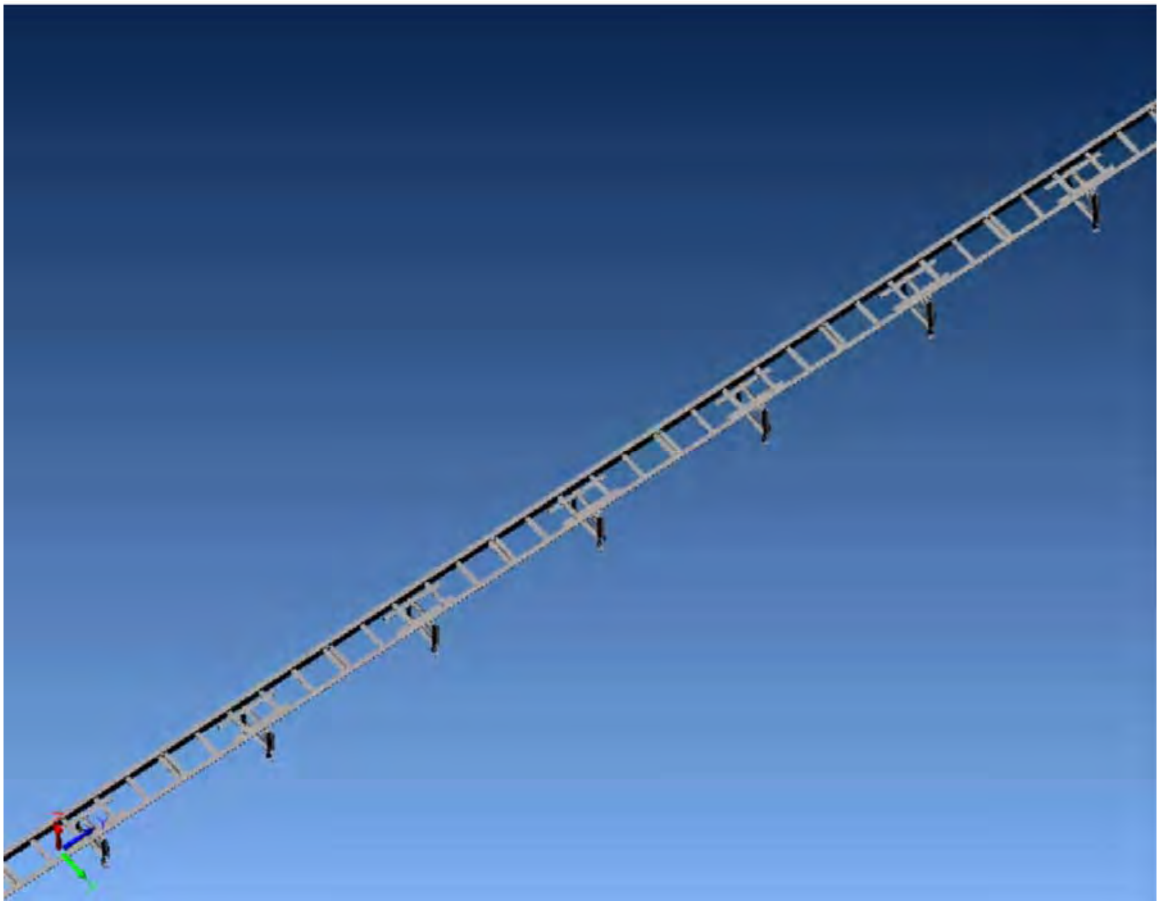
The wheel housing flange bolting and the rail splice bolting should be inspected along with the wheels subsequent to a major seismic event.

Introduction

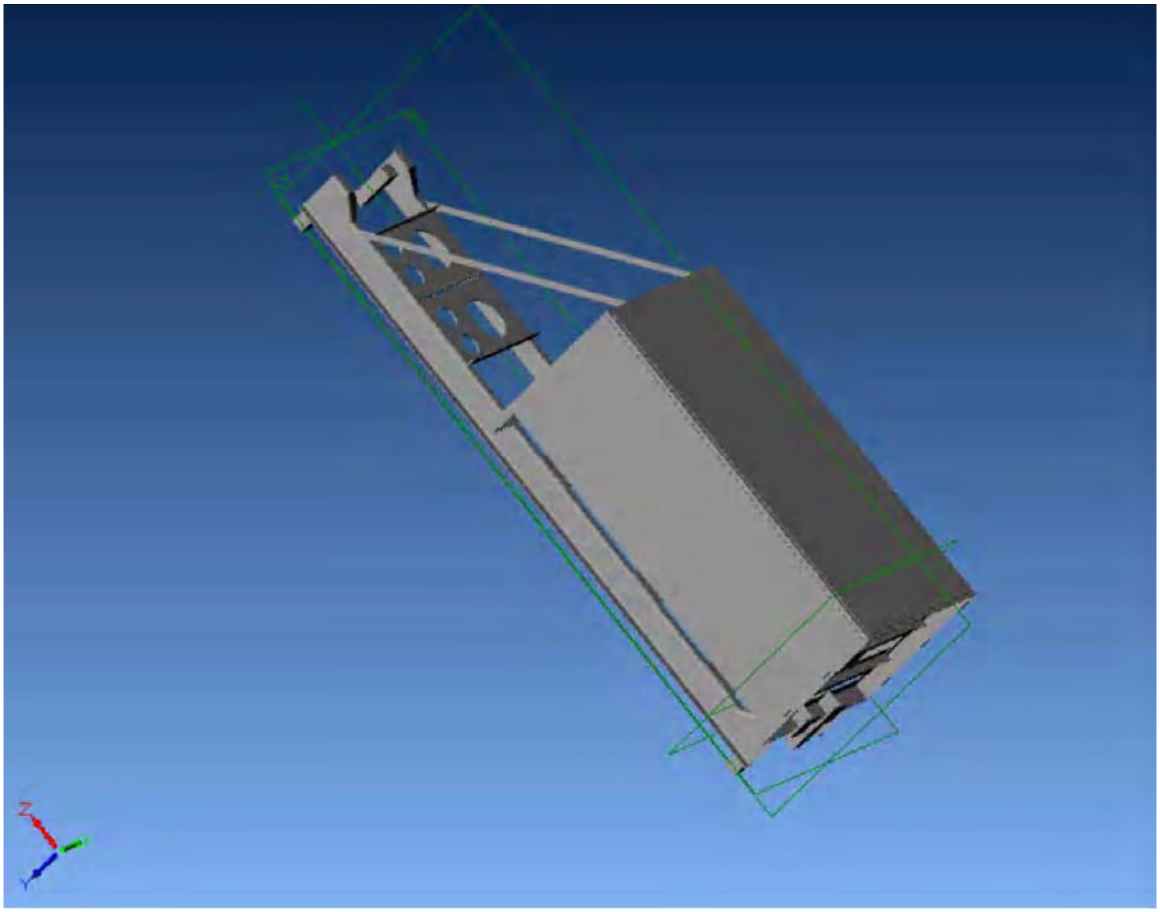
The mechanical and structural design and analysis of the Plum Point Energy Station Trac-Cab TC1K R&P Elevator system is initiated by creating CAD models of the elevator components using the Alibre CAD code and the geometry provided by drawing PPPP M100 GA – 100 – 11. Some reference illustrations of the CAD models follow.



Plum Point Energy Station
Trac-Cab TC1K R&P Elevator Rail and Support System

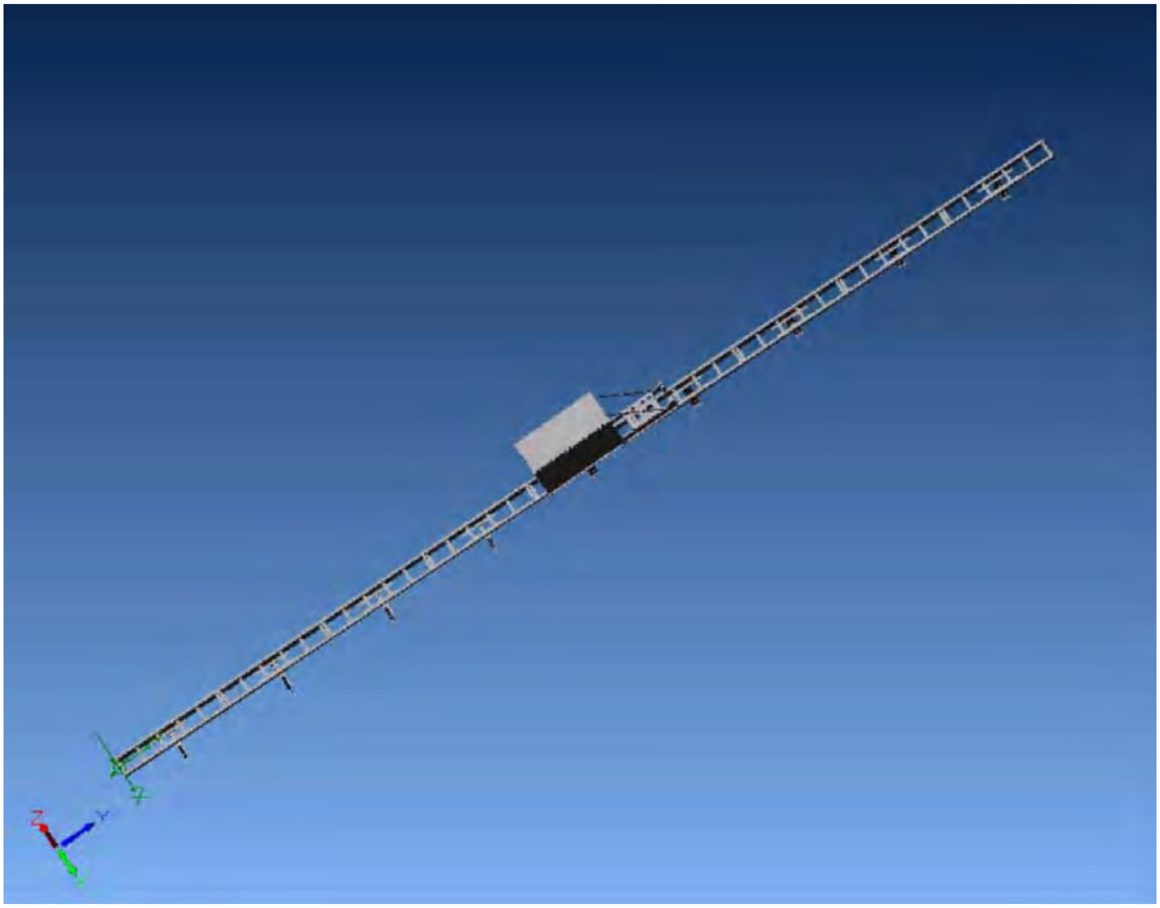


Plum Point Energy Station
Trac-Cab TC1K R&P Elevator Rail and Support System
Detail View

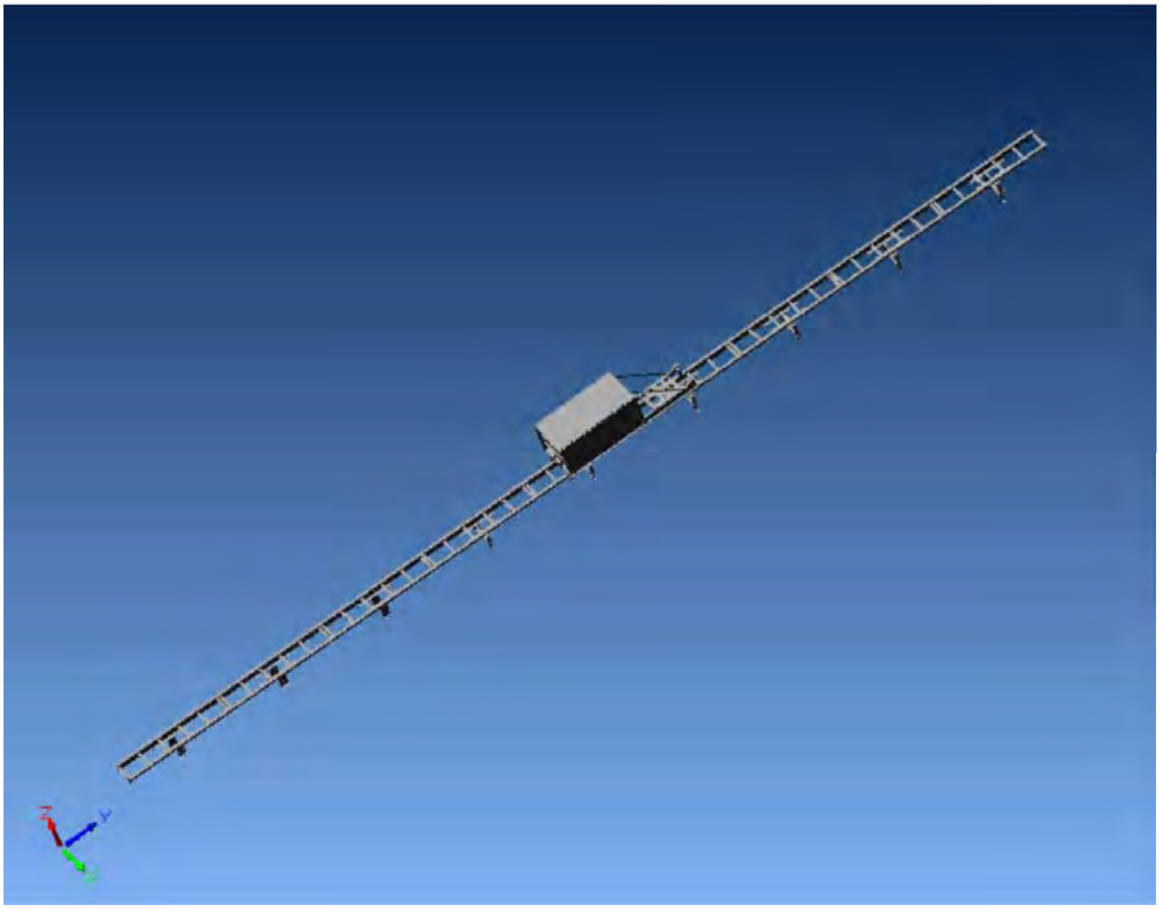


Plum Point Energy Station
Trac-Cab TC1K R&P Elevator Cab
CAD Representation for Analysis Purposes

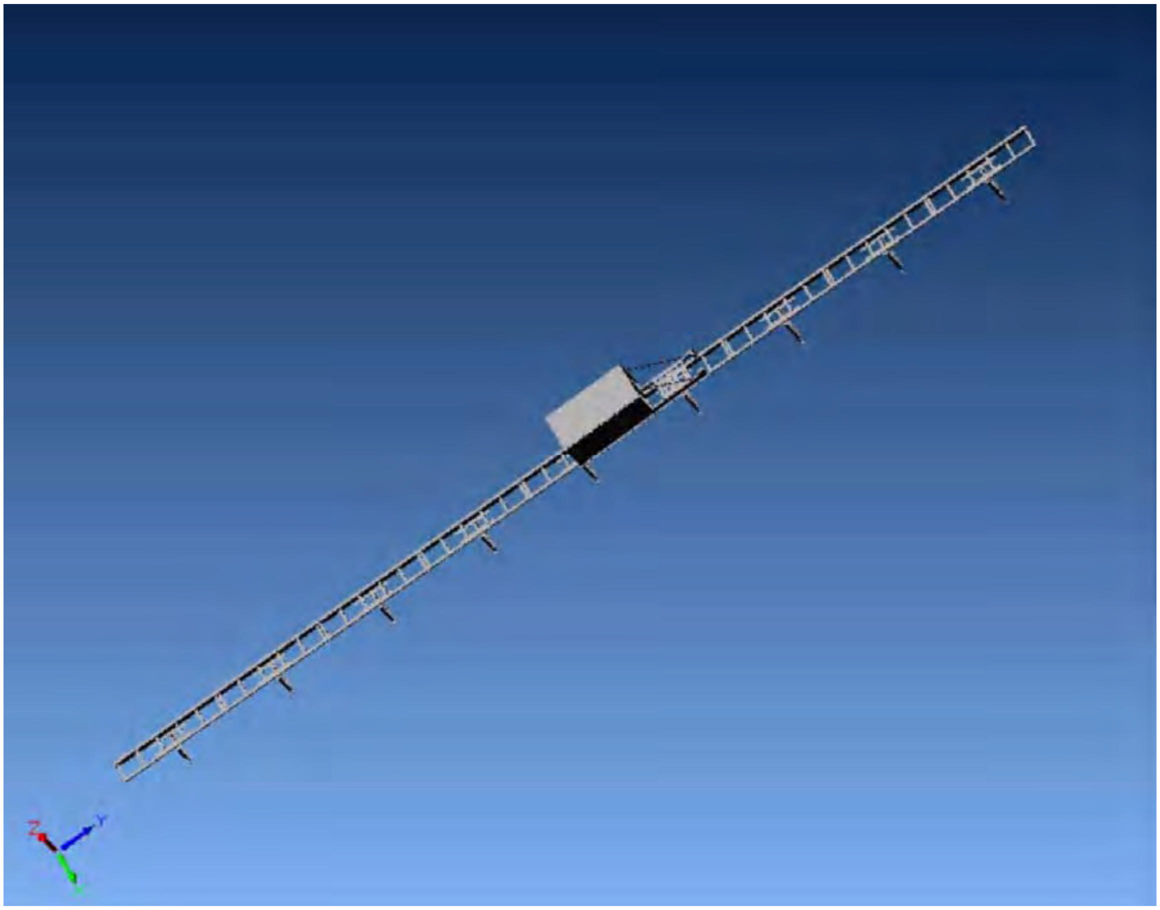
In order to more efficiently analyze the elevator cab/rail structure, the 460 foot rail assembly is broken down into five-nine segment rail sections, each approximately 90 feet long. Each segment of rail sections contains a model of an elevator cab. These CAD models are later input into an Algor finite element program. Illustrations of the five rail segments follow.



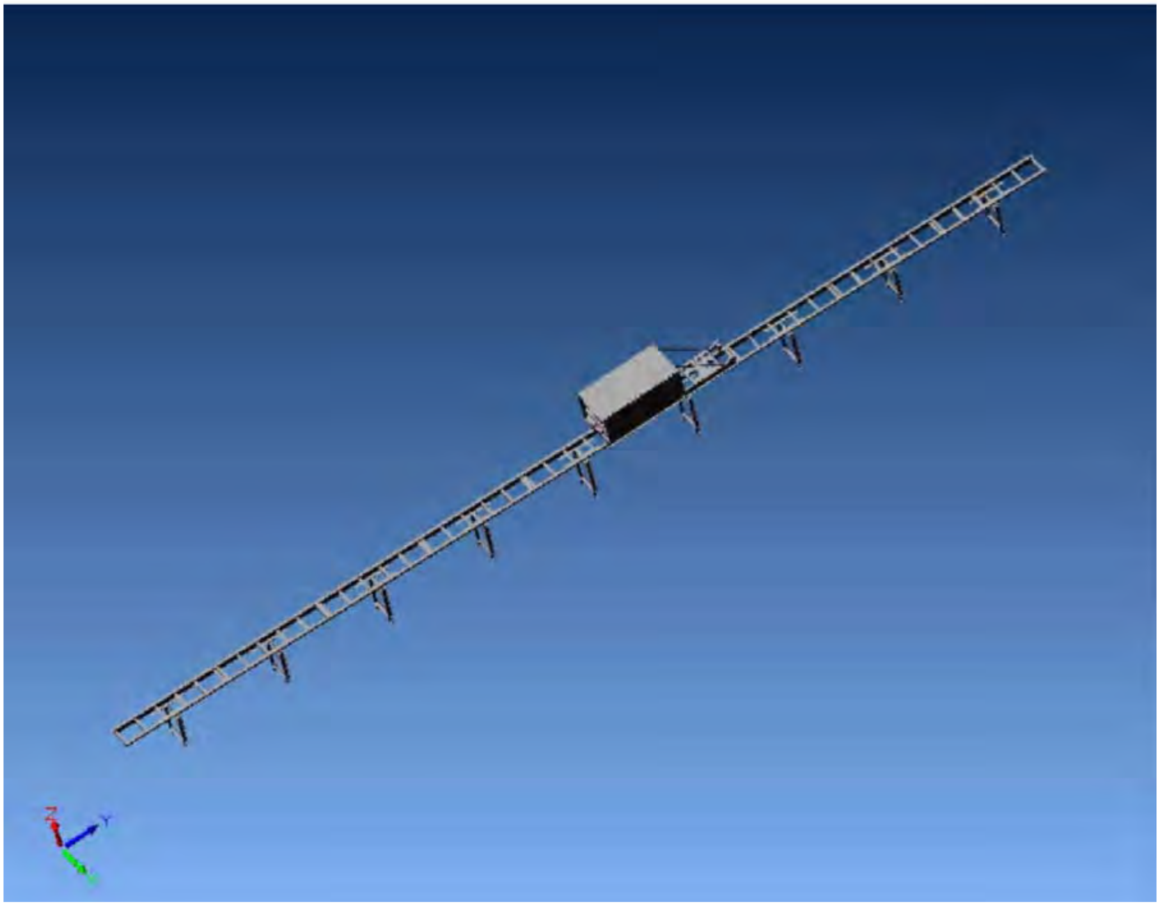
Plum Point Energy Station
Trac-Cab TC1K R&P Elevator Cab & Rail Segment
CAD Representation for Analysis Purposes
Base Section



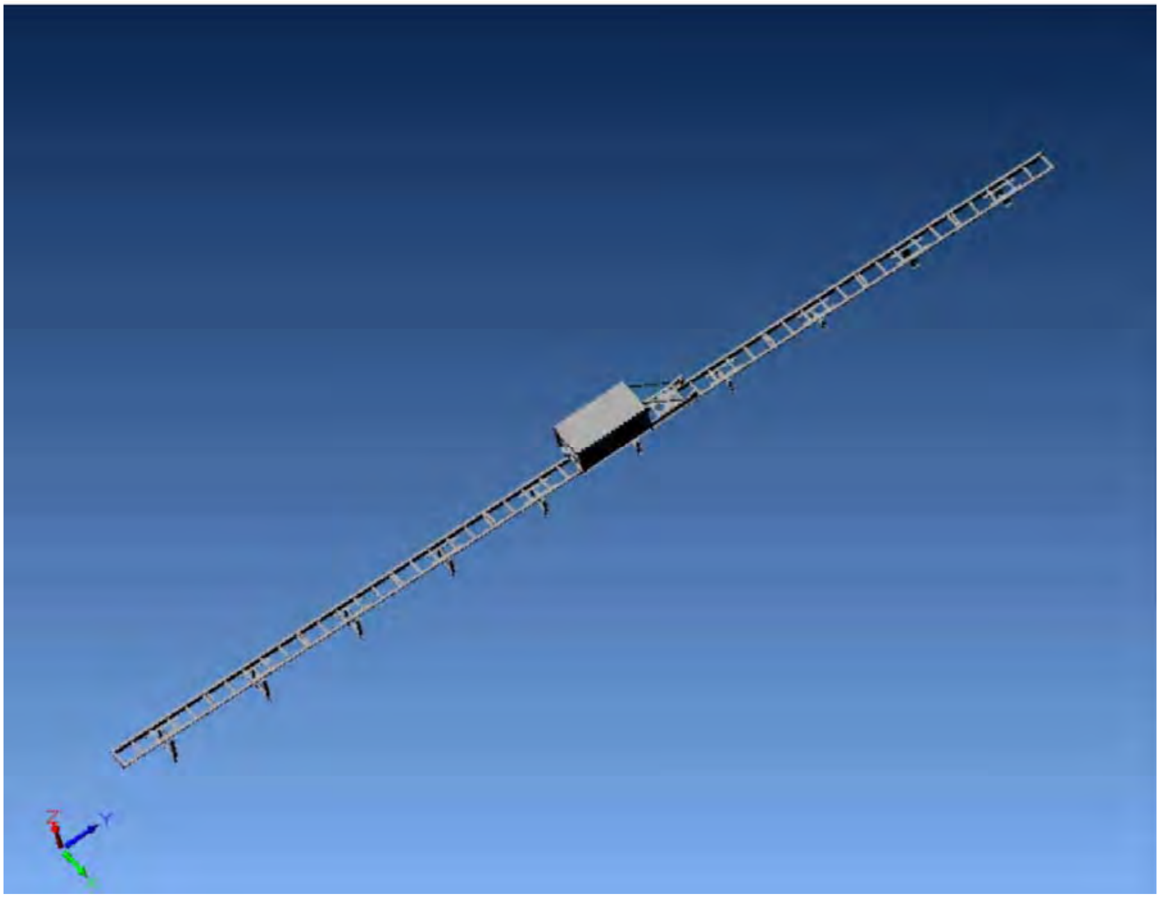
Plum Point Energy Station
Trac-Cab TC1K R&P Elevator Cab & Rail Segment
CAD Representation for Analysis Purposes
2nd from Base Section



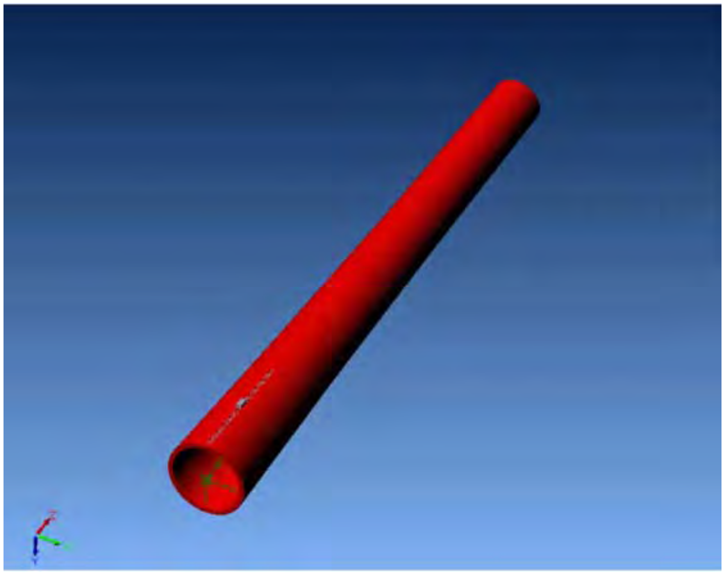
Plum Point Energy Station
Trac-Cab TC1K R&P Elevator Cab & Rail Segment
CAD Representation for Analysis Purposes
3rd from Base Section

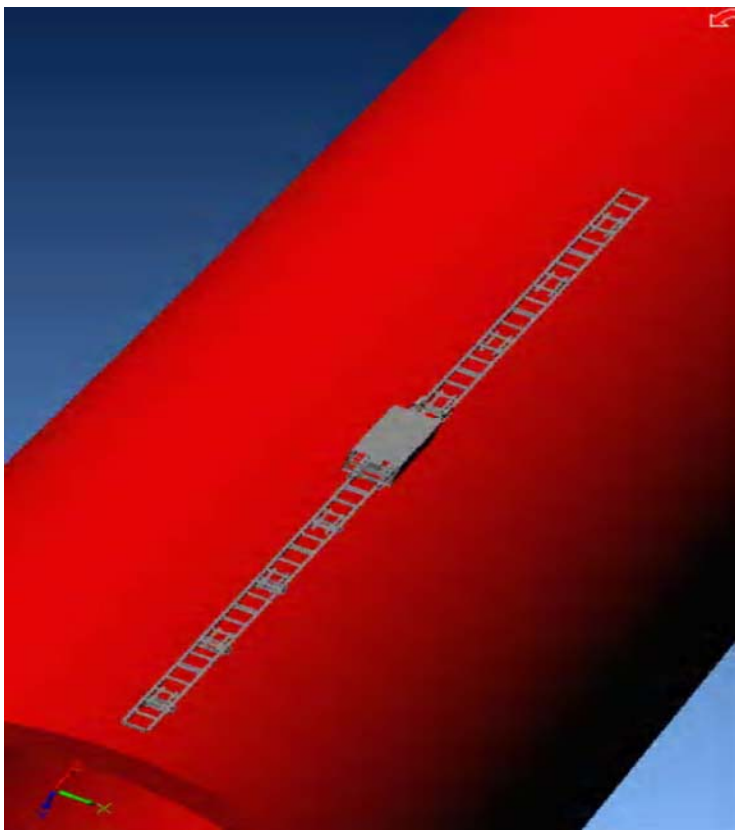


Plum Point Energy Station
Trac-Cab TC1K R&P Elevator Cab & Rail Segment
CAD Representation for Analysis Purposes
4th from Base Section

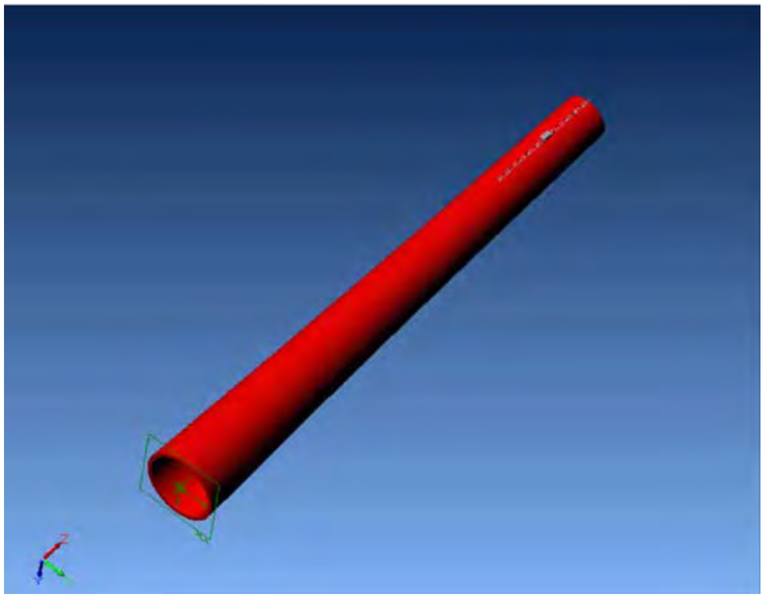


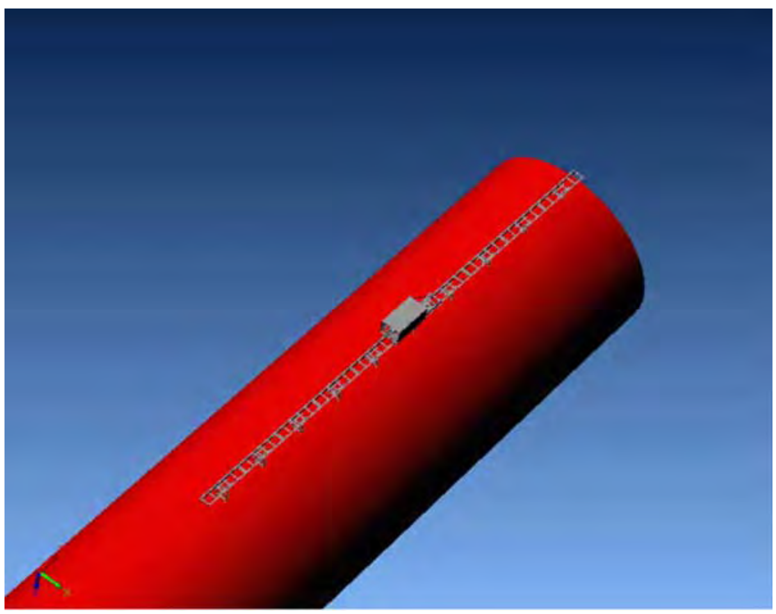
Plum Point Energy Station
Trac-Cab TC1K R&P Elevator Cab & Rail Segment
CAD Representation for Analysis Purposes
Top Section





Plum Point Energy Station
Trac-Cab TC1K R&P Elevator Cab & Rail Segment on Chimney
CAD Representation for Analysis Purposes
Bottom Section



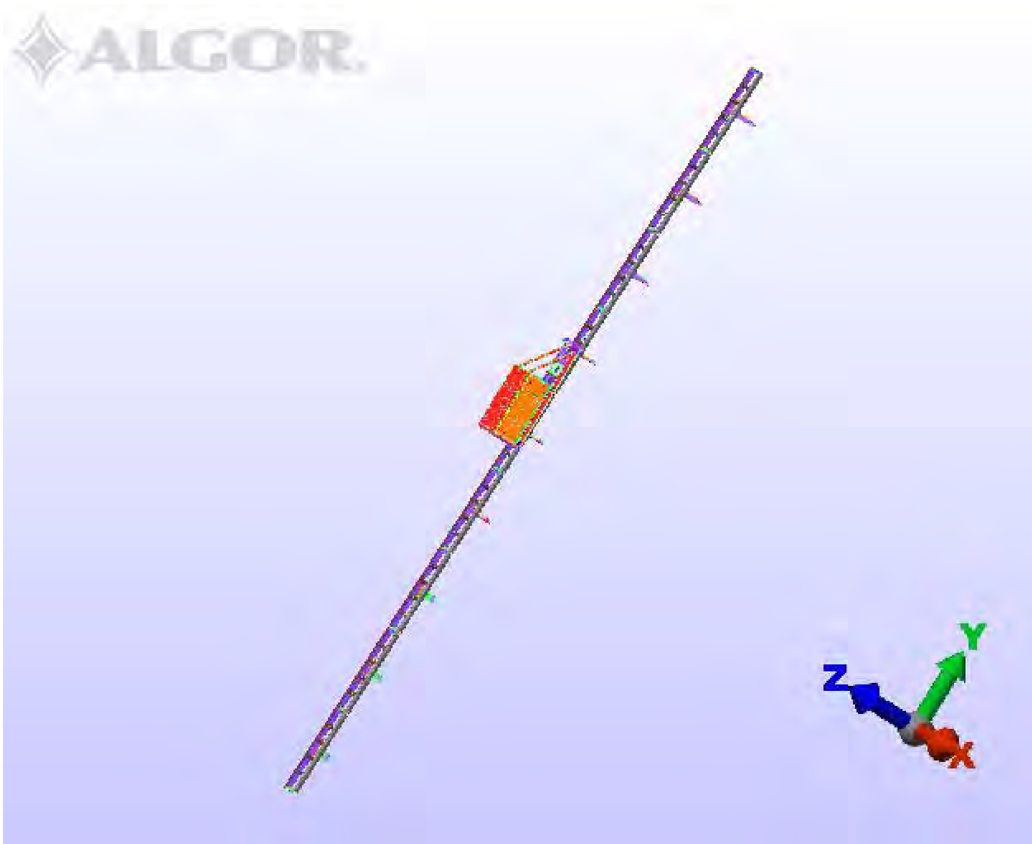


Plum Point Energy Station
Trac-Cab TC1K R&P Elevator Cab & Rail Segment on Chimney
CAD Representation for Analysis Purposes
Top Section

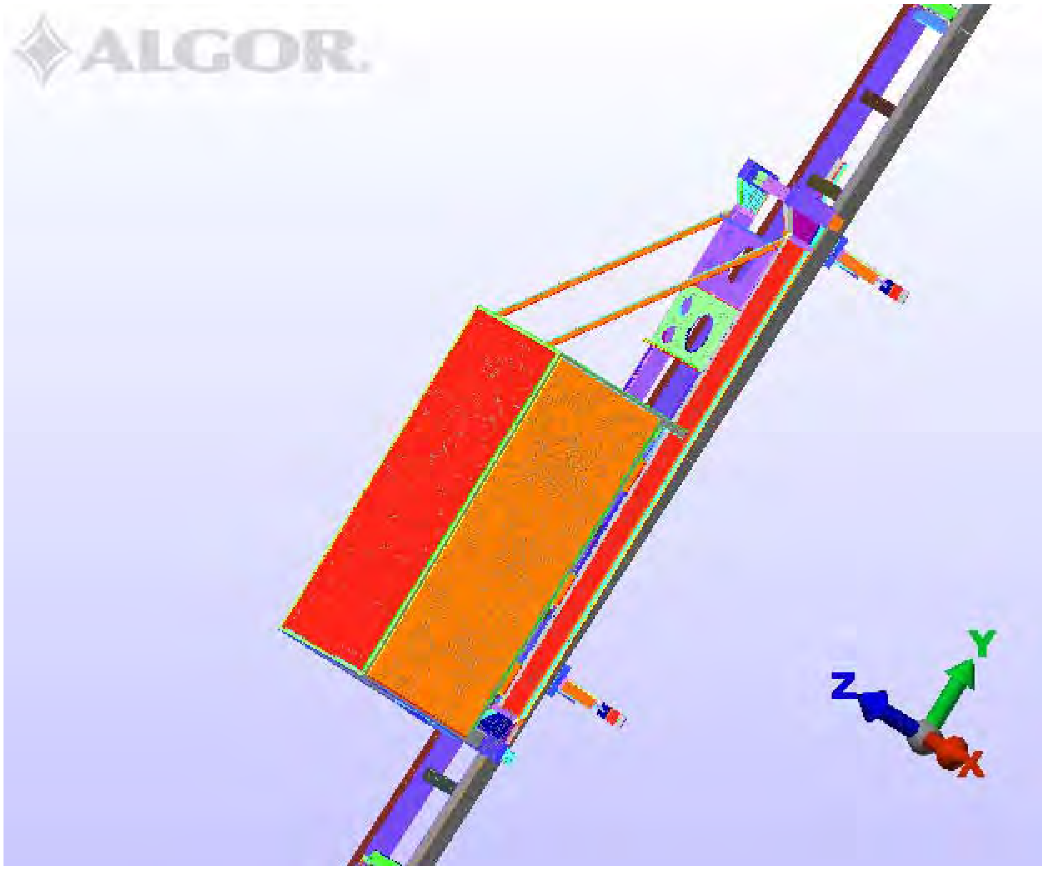
Analysis of the General Cab and Rail Structure

The CAD models shown above are imported into the Algor finite element code for analysis. In the Algor program, the models are meshed, boundary conditions added, material properties defined, calculated loads applied, and the structure analyzed. Each of the five segments of rail section is unique due to the different standoff and support configuration combinations required to secure the elevator assembly to the chimney. An illustration of one the five rail segments and associated details follow. All five segments are created, modeled, and analyzed in a similar manner.

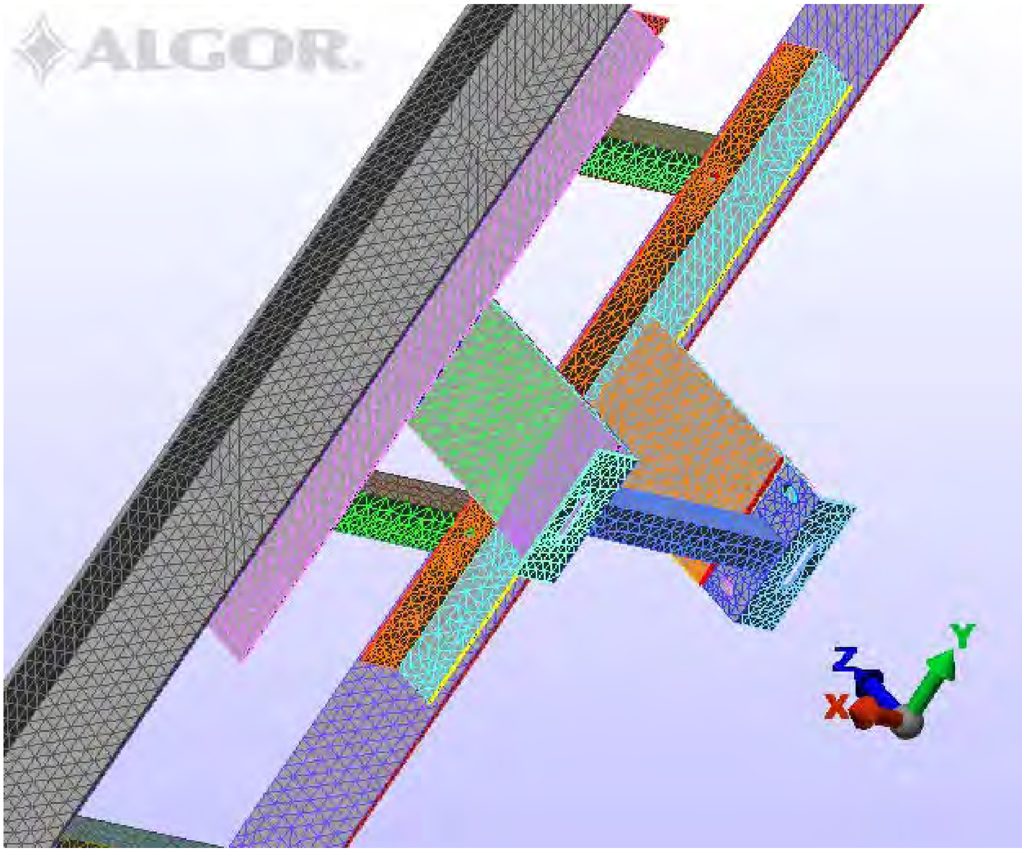
Also included are some details of the chimney model with a segment of the rail and cab which is used in the response spectrum analysis.



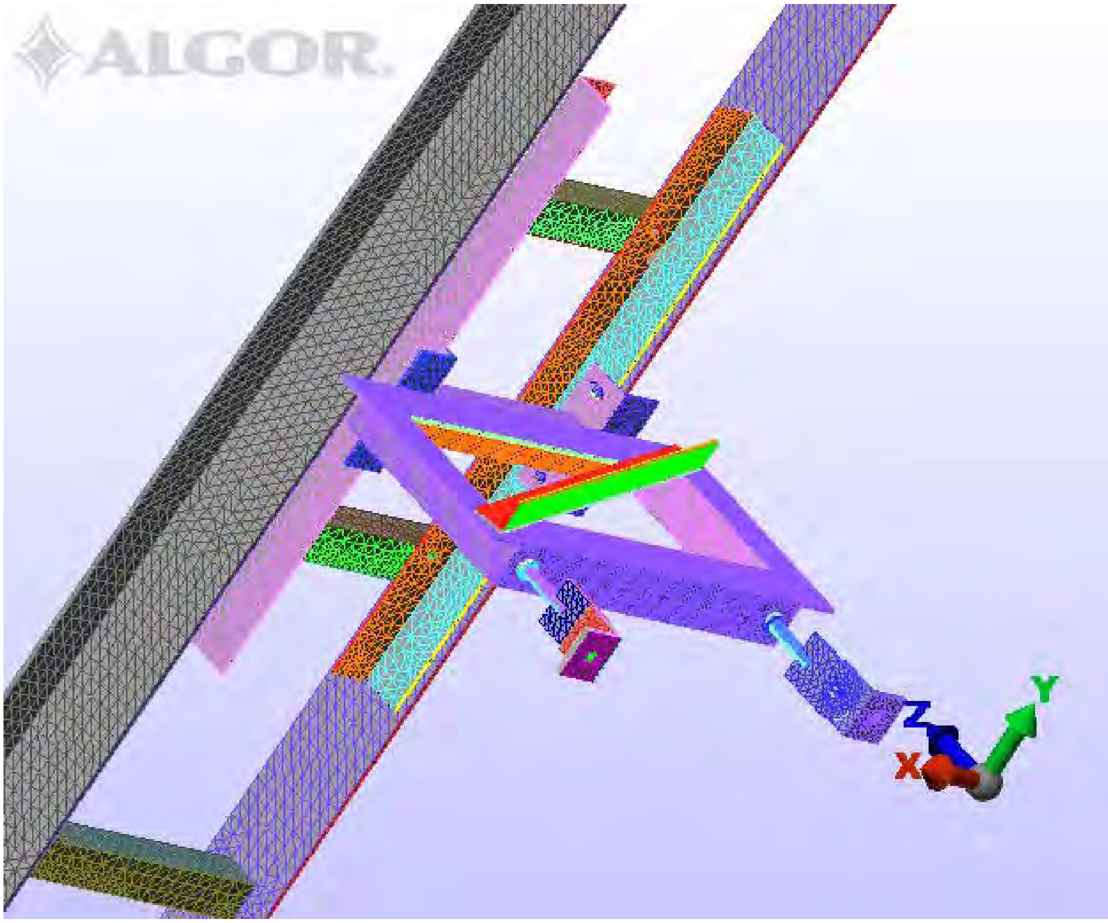
Plum Point Energy Station
Trac-Cab TC1K R&P Elevator Cab & Rail Segment
Finite Element Representation for Analysis Purposes
Typical Section



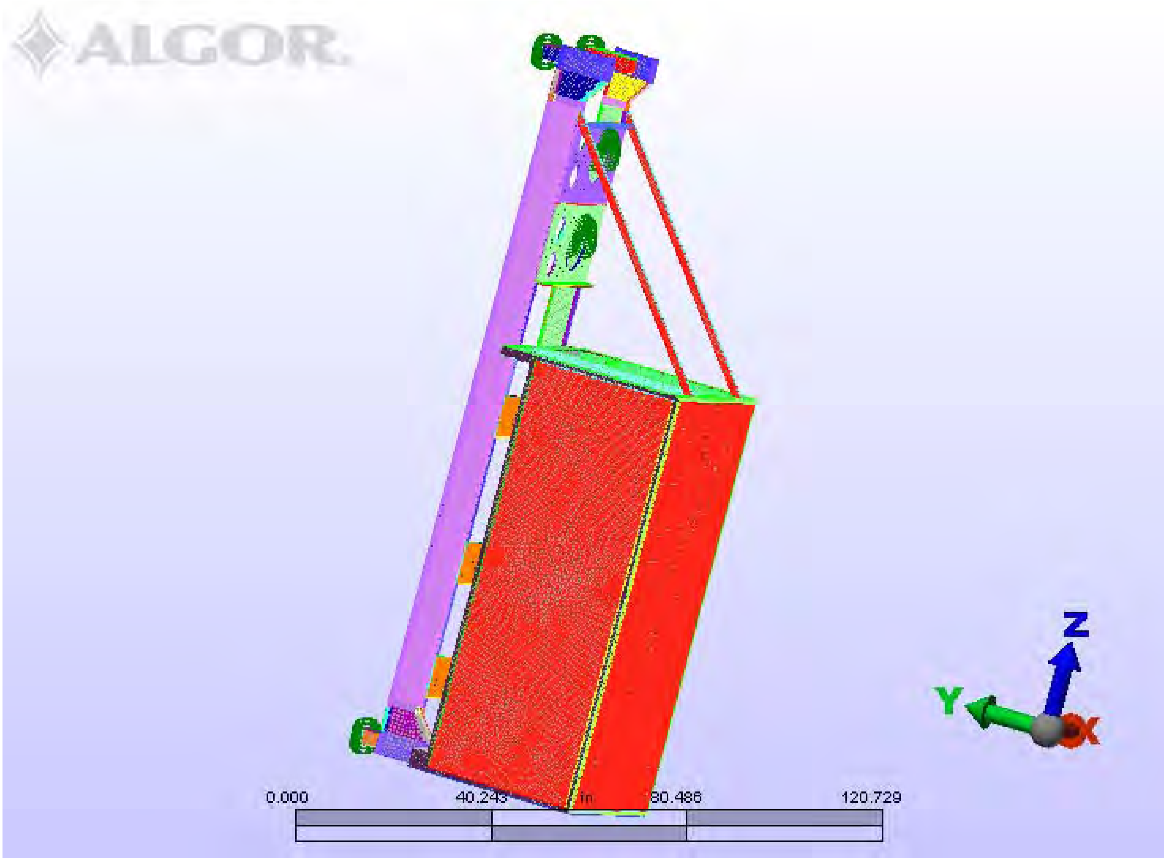
Plum Point Energy Station
Trac-Cab TC1K R&P Elevator Cab & Rail Segment
Finite Element Representation for Analysis Purposes
Typical Section – Cab Detail



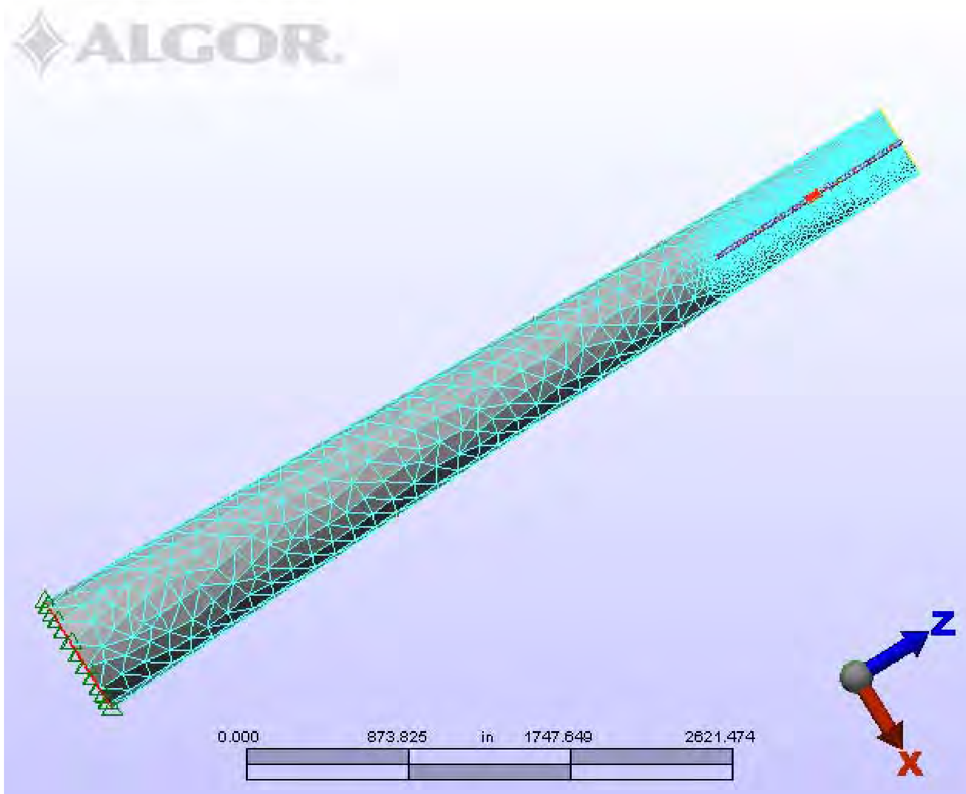
Plum Point Energy Station
Trac-Cab TC1K R&P Elevator Cab & Rail Segment
Finite Element Representation for Analysis Purposes
Typical Section – Standoff Detail



Plum Point Energy Station
Trac-Cab TC1K R&P Elevator Cab & Rail Segment
Finite Element Representation for Analysis Purposes
Typical Section – Standoff Detail



Plum Point Energy Station
Trac-Cab TC1K R&P Elevator Cab & Rail Segment
Finite Element Representation for Analysis Purposes
Detail of Elevator Cab



Plum Point Energy Station
Trac-Cab TC1K R&P Elevator Cab, Rail Segment, and Chimney
Finite Element Representation for Analysis Purposes

Elevator and Rail Load Scenarios

Chapter 2 of the ASCE 7-98 code describes combinations of loads to which buildings and other structures are to be designed to. Since the elevator is designed to "Allowable Stress Design" criteria, the basic load combinations listed in Section 2.4.1 are considered:

1. D
2. D + F = H = T = (Lr or S or R)
3. D + (W or 0.7E) + L + (Lr or S or R)
4. 0.6D + W + H
5. 0.6D + 0.7E + H

Where:

D = Dead Load
E = Earthquake Load
F = Load due to fluids with well-defined pressures and maximum heights
Fa = Flood Load

H = Load due to lateral earth pressure, ground water pressure, or pressure of bulk materials
L = Live load
R = Rain Load
S = Snow load
T = Self-straining force
W = Wind load

Note that E is a “Strength Level” force used in analysis of structures designed to Strength Design criteria. The 0.7 factor brings the load down to that which is used when designing to Allowable Stress Design criteria and it is not a reduction as a result of combination of multiple transient loads.

Section 2.4.3 discusses a 0.75 reduction factor for the above load cases. When the “structural effects due to two or more loads in combination with dead load, but excluding earthquake load, are investigated in load combinations of Sections 2.4.1 and 2.4.2, the combined effects due to the two or more loads multiplied by 0.75 plus effects due to dead loads shall not be less than the effects from the load combination of the dead load plus the load producing the largest effects.” The exclusion on earthquake load was eliminated in ASCE 7-98, Errata dated April 19, 2001. This means that the loading combinations (ignoring F, H, T, and P loads for simplicity) that are required to be checked are:

1. D
2. D + L
3. D + (Lr or S or R)
4. D + 0.75(L + (Lr or S or R))
5. D + (W or 0.75E)
6. D + 0.75((W or 0.7E) + L + (Lr or S or R)
7. 0.6D + W
8. 0.6D +.7E
9.

The Commentary to ASCE 7-98 2.3.4 states,”….simultaneous use of both the one-third stress increase in allowable stress and the addition of the 25% reduction in combined loads is unsafe and is not permitted.” ASCE 7-98 A9.88.1.2 states,” the one-third increase in allowable stress given (in the ASD Specification)…for use with seismic loads is permitted. The load combination adjustment factors of Section 2.4.3 shall not be used.” Unlike previous versions of ASCE 7, ASCE 7-98 also states in A9.8.1.2,” The increase in allowable stress given in AISC Seismic Provisions for Structural Steel Buildings including Supplement No. 1)….shall not be used in conjunction with the load combinations of Section 2.4.1.” Section 2.4.3 states, ”Increases in allowable stress shall not be used with these loads or load combinations unless it can be demonstrated that such an increase is justified by structural behavior caused by rate or duration of load.” Therefore it is determined that the one-third stress increase is not applicable when the ASD load combinations given in ASCE 7-98 are used and are not applied in this analysis.

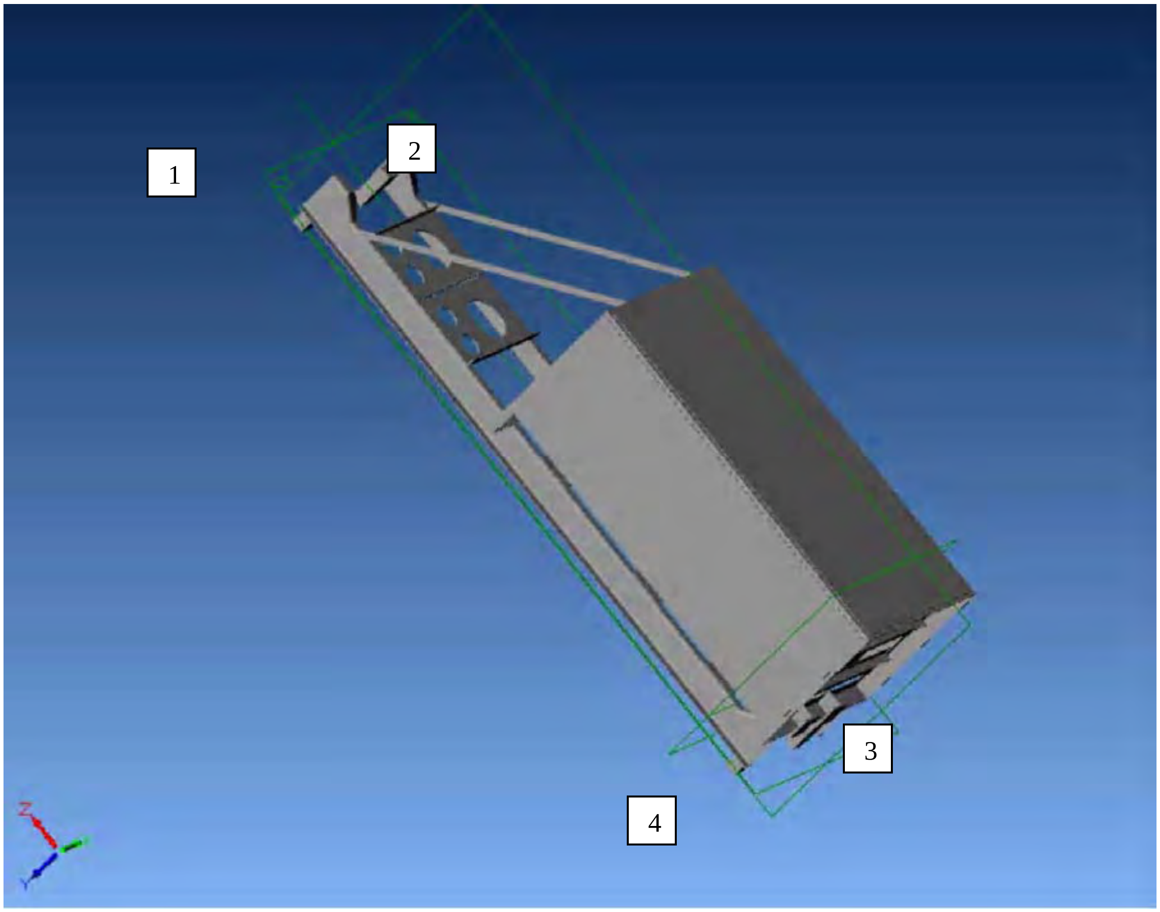
Elevator Cab Wheel Loads:

In order to determine the magnitude of the loads imposed on the wheels supporting the elevator cab and the consequential load these wheels impose upon the rail structure, the CAD model of the elevator cab shown above is constructed using the Alibre CAD program. This model is then imported into the Algor finite element program and meshed, the model also shown above.

The boundary conditions for the model consist of restraints at the wheel locations in the transverse and fore-aft directions. The model is restrained in vertical motion by the application of restraints at the motor attachment location.

The loads described above, conforming to ASCE 7-98 Section 2. requirements, are applied to the cab on a case-by-case basis. Gravity and emergency stop loads take the form of an acceleration vector of 386.4 inches per second squared in the vertical direction and the density of the cab material varied to produce a 4000 lb. and 4791 lb. cab, respectively. Wind loads take the form of a pressure load on the side panels and the front panel of the cab. Seismic loads take the form of lateral and fore/aft forces applied at the approximate locations of the cab center of gravity. Snow and ice loads are represented by a downward vertical force distributed over the roof of the cab. The loads are combined in a manner described by the code.

The cab material properties are those of A36 50,000 psi. yield steel, with the modified as described above.



CAD Representation of Elevator Cab and Wheels
With Wheel Location Key

Elevator Wheel Loads - Individual Load Case Summary

	Wheel Load, lbs.							
Wheel Location	1		2		3		4	
Load Case	X	Y	X	Y	X	Y	X	Y
Dead Weight	22	205	31	238	34	233	20	210
Emergency Stop	5	40	6	47	7	46	4	41
Snow	1	8	2	10	1	10	1	8
Ice	1	11	2	14	2	14	2	12
Lateral Wind	72	15	67	16	132	383	232	383
Fore-Aft Wind	9	112	9	125	18	242	18	238
Seismic – Lateral	482	104	448	107	882	2557	1547	2554
Seismic – Fore-Aft	41	535	42	524	86	1163	84	1140

Elevator Wheel Loads - Combined Load Case Summary

	Wheel Load, lbs.							
Wheel Location	1		2		3		4	
Load Case	X	Y	X	Y	X	Y	X	Y
1. D	22	205	31	238	33	233	20	210
2. D + L	28	244	38	284	41	278	25	250
3. D + S	23	219	33	243	35	248	21	213
4. D + 0.75L + 0.75S	25	252	39	289	39	283	25	253
5. D + (W or 0.7E)								
a. Lateral Wind	25	252	39	289	39	283	25	253
b. Fore-Aft Wind	14	317	40	348	52	10	2	28
c. Lateral Earthquake	460	308	416	131	1580	2787	902	2346
d. Fore-Aft Earthquake	19	739	74	762	119	929	64	930
6. D + 0.75(W or 0.7E) + 0.75L + 0.75S								
a. Lateral Wind	29	258	11	277	213	571	125	-35
b. Fore-Aft Wind	19	330	46	371	53	101	12	74
c. Lateral Earthquake	336	324	297	209	1199	2198	687	1664
d. Fore-Aft Earthquake	5	647	70	682	103	589	38	602
7. 0.6D + W								
a. Lateral Wind	59	138	48.3	126	252	523	145	258
b. Fore-Aft Wind	5	234	28	252	38	103	5	112
8. 0.6D + 0.7E								
a. Lateral Earthquake	469	222	429	35	1567	2693	894	2430
b. Fore-Aft Earthquake	27	657	61	667	106	1023	72	1014

X = Lateral Direction Y = Forward/Aft Direction

Drawing B-TC1K-E1 specifies TREW A04020X4-08-R14-426/X26 and TREW ST04020X4-R14-006-STAINLS wheels. The wheels themselves are rated for 900 lbs. and 1600 lbs. respectively. From the above table it is seen that, with the exception of seismic loads, the maximum fore/aft wheel load is 571 lbs. and the maximum lateral wheel load is 232 lbs. The rated operating loads are exceeded in the case of a maximum seismic event. It is not known if a short duration overload such as presented by an earthquake would destroy the wheels. This is a non-catastrophic event and any damage is repairable. The specified wheels are adequate for their intended purpose during “normal” operating conditions.

Attachment Point Loads

The wheels transmit the cab load to the rail system which in turn transmits this load to the attachment points where the rail system is fastened to the chimney. The cab-rail segment models shown above are used here to determine these loads.

The boundary conditions in this model consist of tractions which represent the attachment point bolts within the attachment point holes on the standoff brackets where they contact the chimney. These are restrained in three degrees of freedom, X, Y, and Z. As in the elevator cab model, the cab is restrained at the motor mount from vertical translation. The footing end of the base rail set is restrained in six degrees of freedom.

The loads on the elevator cab are as described for the wheel loads. For the seismic case, in addition to the seismic load being applied to the elevator cab, the seismic load due to the elevator rail is applied in the lateral and fore/aft directions at the approximate location of the rail assembly center of gravity as well.

The rail material properties are those of A36 - 50,000 psi. yield steel.

The following tables summarize the maximum attachment point load on the chimney as a result of wheel loads on the rails.

Individual Load Case Summary Table

Load Case	Max. Attachment Point Load, lbs.		
	X	Y	Z
Dead Weight	102	255	275
Emergency Stop(incl. cab wt)	122	290	329
Snow	4.6	7.5	9.1
Ice	5.8	9.9	18.1
Lateral Wind	44	39	119
Fore-Aft Wind	72	210	187
Seismic – Lateral	480	282	1042
Seismic – Fore-Aft	938	271	846

X = Lateral Direction Y = Vertical Direction Z = Forward Direction

Combined Load Case Summary Table:

Combination	Max. Attachment Point Load, lbs.		
	X	Y	Z
1. D	102	255	275
2. D + L	122	290	329
3. D + S	106	379	356
4. D + 0.75L + 0.75S	123	410	386
5. D + (W or 0.7E)			
a. Lateral Wind	118	373	348
b. Fore-Aft Wind	150	307	686
c. Lateral Earthquake	522	419	1006
d. Fore-Aft Earthquake	980	391	960
6. D 0.75(W or 0.7E) + 0.75L + 0.75S			
a. Lateral Wind	455	410	385
b. Fore-Aft Wind	165	415	385
c. Lateral Earthquake	406	445	769
d. Fore-Aft Earthquake	379	424	597
7. 0.6D + W			
a. Lateral Wind	75	286	263
b. Fore-Aft Wind	188	280	315
8. 0.6D + 0.7E			
a. Lateral Earthquake	511	332	988
b. Fore-Aft Earthquake	969	304	917

X = Lateral Direction Y = Vertical Direction Z = Forward Direction

An estimate of the maximum attachment point load component based upon the results of combined load calculations is 1042 lbs. pull out, 980 lbs. lateral shear, and 445 lbs. vertical shear. The drawing requirement of a1500 lb. attachment point strength provides an adequate safety factor for securing the elevator to the chimney.

Stress Analysis of the General Cab and Rail Structure

The general cab and rail structure is analyzed in accordance with the method described in the “Manual of Steel Construction, Allowable Stress Design, 9th Edition”. (ASD) The required calculations are performed using the “Static Stress with Linear Material Models” module of the Algor Finite Element Code.

In order to use this analysis code, a brick-tetrahedron based model of the entire rail structure and cab is constructed as shown in the above illustrations. One cab-rail segment is constructed for each one-fifth of the total elevator height, using actual standoff geometries determined for that segment. Boundary conditions, material properties, and load conditions are applied as described in the wheel and attachment point analysis sections of this report. Stress results are obtained for each load case for each of the five rail-cab segments and the results summarized in the following table.

Maximum Von Mises Stress for Various Load Combinations
Plum Point energy Cab and Rail Assembly

Single Load Cases	Stress, psi
Dead Weight	12532
Emergency Stop - (incl. Cab Wt)	14999
Snow	727
Ice	958
Lateral Wind	5550
Fore-Aft Wind	7258
Seismic - Lateral	19505
Seismic - Fore/Aft	12978
Combined Load Cases	
Dead Weight	12532
Dead Weight + Live Load	14999
Dead Weight + Snow	12546
Dead Weight + 0.75 (Live Load + Snow)	12602
Dead Weight + (Wind or 0.7Earthquake)	
Lateral Wind	12648
Fore/Aft Wind	12519
Lateral Earthquake	20961
Fore/Aft Earthquake	20313
Dead Weight + 0.75(Wind or 0.7Earthquake) + 0.75(Live Load + Snow)	
Lateral Wind	14134
Fore/Aft Wind	12592
Lateral Earthquake	17346
Fore/Aft Earthquake	18363
0.6 Dead Weight + Wind	
Lateral Wind	7647
Fore/Aft Wind	7543
0.6 Dead Weight + 0.7Earthquake	
Lateral Earthquake	20761
Fore/Aft Earthquake	17762

The stress results vary among the several rail segment models due to the difference in flexibility offered by the different combinations of standoff geometries. Also, some of the stress values are those found in regions of stress concentration. Because of these differences in the various rail segment models analyzed, it does not always follow that an increase in load results in an increase in stress when looking at the overall combination of structures involved. A lower load may result in a higher stress in one geometry as compared to another configuration and another geometry may withstand a higher load at a lower stress due to increased flexibility or lower stress concentration, for example.

The Allowable Stress Design Code, (ASD – F1-1) designates the maximum allowable Von Mises stress as 0.66 X Yield Stress or 0.66 X 50,000psi = 33,000 psi. The elevator and rail assembly comply with these requirements.

Discussion

Dead Weight Load

The total gross load of the elevator cab used in the dead load calculations is 4000. lbs.

Emergency Stop Load

The total gross load of the elevator cab used in the emergency stop calculations is 4000. lbs. The rated speed of the cab is 110 ft/min, thus at over speed emergency stop conditions, 137.5 ft/min (125% increase) is used in calculations. The calculations assume a stop in 5 inches, conservative with respect to the code which specifies a 10 inch maximum. The load on the brackets specified in the summary table is exclusive of the elevator gross weight.

$S = 0.5*a*t^2 + Vo*t$
$a = V/t$
$s = 0.5*(V/t)* t^2 + Vo*t$
$s = 0.5 * V*t + Vo*t$
137.5 ft/min * min/60sec * 12in/ft = 27.5 in/sec
5 in = 27.5 in/sec * t/2 + 0
t = 0.36 sec
(27.5 in/sec) / (0.36 sec) = 76.4 in/sec^2

$F = m*a$
$= (4000 \text{ lb}/386.4 \text{ in/sec}^2) * 76.4 \text{ in/sec}^2 = 790.89 \text{ lb.}$

where

S = distance traveled, in.
a = acceleration, in/sec^2
V = velocity, in/sec
Vo = initial velocity, in/sec
t = time, sec
F = force, lbs.

The emergency stop load, exclusive of the 4000 lb. gross elevator weight, is 790.89 lbs.

Snow Load

ASCE 7-98 Section 7.0 defines the method of calculation of snow load for the elevator roof. Since the roof is flat, Section 7.3 applies.

The flat roof snow load, $p_f = 0.7CeCtIp_g$ (lb/ft^2)

$Ce = 0.9$ ASCE 7-98 Table 7-2
$Ct = 1.2$ ASCE 7-98 Table 7-3
$I = 1.1$ ASCE 7-98 Table 7-4
$p_g = 10$ ASCE 7-98 Fig 7-1, Ref Docs

$$p_f = 8.316 \text{ lb/ ft}^2$$

But the minimum value is to be taken as $p_f = Ip_g = 1.1 * 10 = 11 \text{ lb/ ft}^2$.

where:

Ce = exposure factor
Ct = thermal factor
I = importance factor
pg = ground snow load

The elevator roof snow load is 11 lb/ ft^2

Ice Load

ASCE 7-98 Section 10 defines the method of calculation of ice load for the elevator roof. Since the ice accretion data are not available, the ice loads are estimated from ASCE 7-05, Section 10.4

$Vi = \pi * t_d * As$ (for flat plates) (10.4.1)

$t_d = 2.0 * t * Ii * f_z * (Kzt)^{0.35}$ (10.4.6)

$t = 1$ in Fig 10-2

$f_z = (z/33)^{0.1}$ (10.4.3)

$f_z = (438/33)^{0.1} = 1.295$

For Cat III, $Ii = 1.25$, $Iw = 1.0$ Table 10-1

$Kzt = 1.0$ Chapt 6

` $t_d = 2.0*1*1.25*1.295*(1)^{0.35}$

$t_d = 3.2375$ in.

$As = 12.698 \text{ ft}^2$

Ice Density = 56 lb/ ft^3

Weight of Ice = 12.698 ft^2 * 3.2375 in * ft/12in* 56 lb/ ft^3 = 191.85 lb.

where

Vi = volume of ice, ft^3
t_d = design ice thickness, in.
t = nominal ice thickness, in
f_z = ice thickness factor
I = importance factor
Kzt = topographic factor

The flat roof ice load is 191.85 lb.

Wind Load

Wind loads for the elevator cab are determined in accordance with the provisions of ASCE 7-98, Section 6. Specifically, the procedures of section 6.4 are utilized.

V = 90 mph (6.5.4)
I = 1.15 (6.5.5)
Exposure Category = C (6.5.6)
Enclosure Classification = Partially Enclosed (6.5.9)
Design Wind Pressure = 14 lb/ft^2 (Table 6-2)
Factor = 1.4 (Table 6-2)

Design Wind Pressure = 1.15*14 lb/ft^2 * 1.4 = 22.54 lb/ft^2

A general textbook formula which yielded a wind load of 26.73 lb/ft^2 is used in the calculations presented here for conservatism.

Seismic Load

Seismic load of the elevator cab and rack/rail structure on the support structure is determined in accordance with ASCE 7-98 Chapter 9. Specifically, the procedures

specified in Section 9.6 for Architectural, Mechanical, and Electrical Components and Systems are applied here. Also applied are site-specific parameters provided by Plum Point Energy in their Technical Supplemental Specification 01400, a copy which is reproduced in the Appendix of this document.

Occupancy Category = III	(01400-D100)
Occupancy Classification = Group F	(01400-D100)
Seismic Importance Factor Ie = 1.25	(01400-D100)
Seismic Site Class = F	(01400-D100)

Seismic Design Category = E (01400-D100)
Seismic Use Group = II (01400-D100)
Importance Factor, Ip = 1.0 (01400-100.3.3)
Spectral acceleration, S_{DS} = 1.30 (01400-D100)
Spectral acceleration, S_{D1} = 1.15 (01400-D100)

Component Operating Weight, Wp
Elevator Cab, Wp = 4000 lb.
Rack & Rail, Wp = 18000 lb.
Height of Structure, h = 438 ft.

A vertical component of seismic force is not required on this project for components (01400-100.3.3)

Seismic forces are based on Strength Design Criteria and may be factored by 0.7 when analysis and design are based on Allowable Stress Design (01400-Table 1)

The calculated values of support point load vary with elevator position. The maximum values are presented in the summary table.

The governing equation for seismic force on the elevator system is ASCE 7-98, equation 9.6.1.3-1:

$$Fp = ((0.4*a_p*Sds) /(Rp/Ip)) *Wp* (1+2*(z/h))$$

This equation is reduced to

$$Fp = 0.62*Wp$$

When data provided in the 01400 Table-1 Technical Supplemental Specifications document provided by Plum Point energy is applied and the height adjustment multiplier, (1+2*(z/h)), is set = 3.0, i.e. ((z/h)) = 1.0 This maximum force is reduced as the height of the elevator along the chimney decreases by a factor of ((1+2(z/h))/3.). These forces are based on Strength Design Criteria and are factored by 0.7 since the analysis and design of the elevator are based on Allowable Stress Design.

The governing equation for seismic design force at various elevator heights for the elevator components becomes:

$$Fp = 0.62*Wp*((1+2*(z/h))/3.)*0.7$$

or, $$Fp = 0.295*Wp*(1+2*(z/h))$$

where

Fp = Seismic design force, lb.

Coeff = coefficient from 01400-Table 1
Wp = Elevator component gross weight, lb.
z = height in structure at point of attachment, in.
h = roof height of structure relative to grade elevation

The seismic design force is determined using the above formula for the rail system and for the elevator cab at various elevations and applied to the finite element model for analysis. The loads are applied in the lateral and fore/aft directions. A vertical component of seismic force is not included in the calculations as it is not required by the Technical Supplemental Specification.

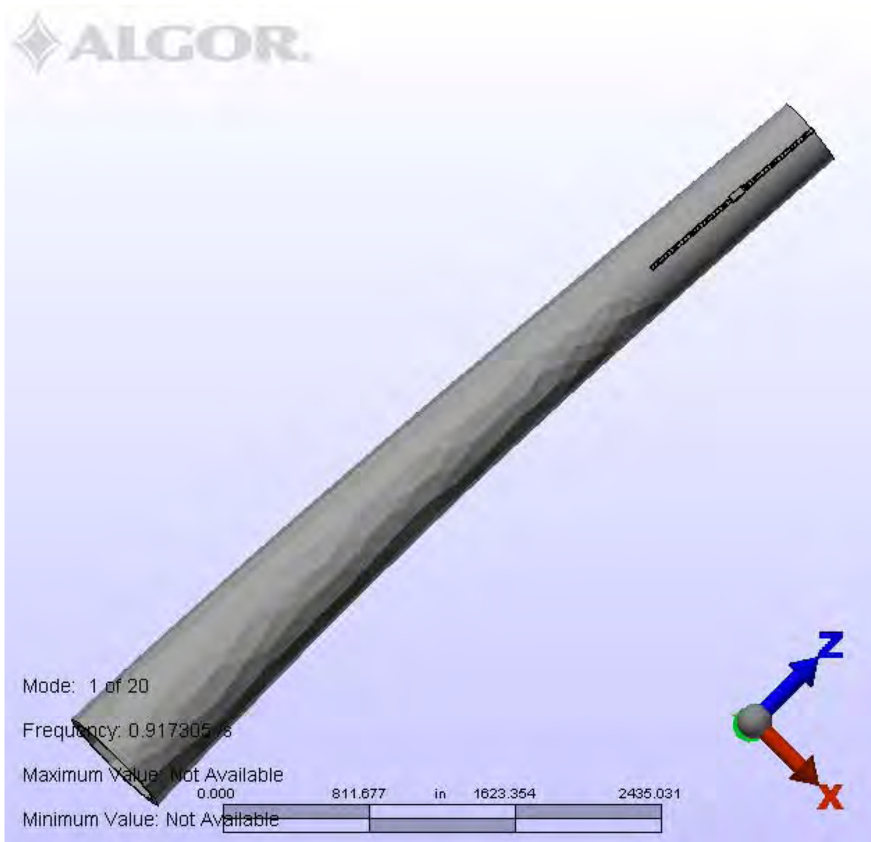
Response Spectrum Analysis

The 01400 Technical Supplemental Specifications document, Section 100.3.3.2 states that, “Seismic displacements shall be limited to 3 inches in each of two horizontal orthogonal directions and one vertical direction. (But in 100.3.3.1 it is stated that, “Vertical Earthquake loads are not required on this project for components”, and in the footnotes of Table 1 of the same document it is stated that, “Vertical seismic forces are negligible”. Therefore only orthogonal horizontal seismic forces and the structure response is considered in this analysis. Response due to vertical forces is not considered. Furthermore, the three inch design limit was defined in a subsequent E-mail response to an inquiry, “….. Measure from points on the elevator to the attachment point to the chimney shell.”

The response spectrum analysis used here is a method whereby the responses of a group of single-degree-of-freedom bodies to a dynamic excitation can be related to a similar response of a complex, multi-degree-of-freedom system in the frequency domain. This differs from a time history solution where the solution is solved for in the time domain instead of the frequency domain. This is used during the simulation of an earthquake loading, when part of the model is fixed to the ground and another part is attached to the fixed structure. The structure will filter the earthquake movement attenuating some frequency response and accentuating others. The part of the model attached to the structure will have a different response spectrum than the part of the model attached directly to the round.

The response spectrum is a plot of the maximum response of a group of single-degree-of-freedom bodies to a specified load function. The abscissa of the spectrum is the frequency or period of the responding single-degree-of-freedom body, and the ordinate is the maximum response. The maximum response may be given in terms of displacement, velocity, or acceleration. Each is related to the other by the frequency, or frequency squared. [1]

Since response spectrum analysis used the results from a modal analysis, a finite element model of the chimney is first created as shown earlier in this report. The chimney geometry is approximated from that given on drawing PPPP M100 GA – 100 – 11. The geometry of the steel chimney liner is not given. The period of the chimney vibration is given in an E-mail correspondence as approximately 1.1 seconds, which corresponds to approximately 0.91 Hz. The chimney modulus is adjusted in this model to provide a 0.91 Hz fundamental mode frequency without the elevator attached. When the topmost elevator segment is attached to the chimney, the frequency reduces to 0.917 Hz. A plot of the fundamental mode shape follows.



Plum Point Energy Station
Trac-Cab TC1K R&P Elevator Cab & Rail Segment
Fundamental Mode of Chimney-Elevator Segment Assembly
For Response Spectrum Analysis

It was necessary to calculate twenty modes in order to obtain the required modal participation factor in the excited orthogonal directions as required by ASCE 7-98, Section 9.5.4.3. The frequencies of the modes and their associated participation factors are listed:

```
 **** Participation Factor Calculation

      Weight available in X direction:  1.9058E+07
      Percent used in this direction:   92.78%
      Modes used in this direction: 20
```

**** Modal Effective Mass & Participation Factor X Direction

Mode	Frequency (HZ)	Modal eff. mass (weight)	(%)	Cumulative mass (weight)	(%)	Participat. Factor
1	9.17305E-1	8.4220E+06	44.19	8.4220E+06	44.19	1.4764E+02
2	9.55680E-1	2.4163E+04	0.13	8.4462E+06	44.32	7.9078E+00
3	3.53603E+0	4.5816E+06	24.04	1.3028E+07	68.36	1.0889E+02
4	3.60829E+0	1.7946E+04	0.09	1.3046E+07	68.45	-6.8151E+00
5	6.86973E+0	2.1237E+03	0.01	1.3048E+07	68.46	-2.3444E+00
6	7.81298E+0	1.8495E+06	9.70	1.4897E+07	78.17	6.9185E+01
7	7.85708E+0	3.5507E+05	1.86	1.5252E+07	80.03	3.0314E+01
8	9.32367E+0	1.7999E+01	0.00	1.5252E+07	80.03	2.1583E-01
9	1.19686E+1	4.6242E+02	0.00	1.5253E+07	80.03	1.0940E+00
10	1.30271E+1	5.9969E+05	3.15	1.5853E+07	83.18	3.9395E+01
11	1.30389E+1	6.5240E+05	3.42	1.6505E+07	86.60	4.1090E+01
12	1.51617E+1	8.4916E+02	0.00	1.6506E+07	86.61	1.4824E+00
13	1.86510E+1	2.3119E+02	0.00	1.6506E+07	86.61	7.7351E-01
14	1.89342E+1	9.0357E+02	0.00	1.6507E+07	86.62	1.5292E+00
15	1.89859E+1	6.9061E+05	3.62	1.7198E+07	90.24	-4.2277E+01
16	2.09421E+1	5.6901E-02	0.00	1.7198E+07	90.24	1.2135E-02
17	2.33627E+1	1.6364E+03	0.01	1.7199E+07	90.25	-2.0579E+00
18	2.44808E+1	1.1734E+05	0.62	1.7317E+07	90.86	-1.7427E+01
19	2.46752E+1	1.4255E+04	0.07	1.7331E+07	90.94	6.0738E+00
20	2.48465E+1	3.5087E+05	1.84	1.7682E+07	92.78	-3.0134E+01

Weight available in Y direction: 1.9058E+07
Percent used in this direction: 92.67%
Modes used in this direction: 20

**** Modal Effective Mass & Participation Factor Y Direction

Mode	Frequency (HZ)	Modal eff. mass (weight)	(%)	Cumulative mass (weight)	(%)	Participat. Factor
1	9.17305E-1	2.2424E+04	0.12	2.2424E+04	0.12	7.6180E+00
2	9.55680E-1	8.5556E+06	44.89	8.5781E+06	45.01	-1.4880E+02
3	3.53603E+0	2.0768E+04	0.11	8.5988E+06	45.12	7.3312E+00
4	3.60829E+0	4.4570E+06	23.39	1.3056E+07	68.51	1.0740E+02
5	6.86973E+0	3.2649E+03	0.02	1.3059E+07	68.52	-2.9068E+00
6	7.81298E+0	3.5000E+05	1.84	1.3409E+07	70.36	-3.0097E+01
7	7.85708E+0	1.8035E+06	9.46	1.5213E+07	79.82	6.8320E+01
8	9.32367E+0	3.6698E+04	0.19	1.5249E+07	80.02	-9.7454E+00
9	1.19686E+1	5.7252E+01	0.00	1.5249E+07	80.02	-3.8492E-01
10	1.30271E+1	6.5234E+05	3.42	1.5902E+07	83.44	-4.1088E+01
11	1.30389E+1	5.9766E+05	3.14	1.6499E+07	86.58	3.9328E+01
12	1.51617E+1	3.3652E+00	0.00	1.6499E+07	86.58	9.3322E-02
13	1.86510E+1	6.7602E+04	0.35	1.6567E+07	86.93	1.3227E+01
14	1.89342E+1	6.2079E+05	3.26	1.7188E+07	90.19	4.0082E+01
15	1.89859E+1	1.0369E+03	0.01	1.7189E+07	90.19	1.6381E+00
16	2.09421E+1	1.3044E+04	0.07	1.7202E+07	90.26	5.8101E+00
17	2.33627E+1	8.3789E+02	0.00	1.7203E+07	90.27	-1.4726E+00
18	2.44808E+1	4.4682E+03	0.02	1.7207E+07	90.29	3.4005E+00
19	2.46752E+1	4.4049E+05	2.31	1.7648E+07	92.60	3.3764E+01
20	2.48465E+1	1.4120E+04	0.07	1.7662E+07	92.67	6.0450E+00

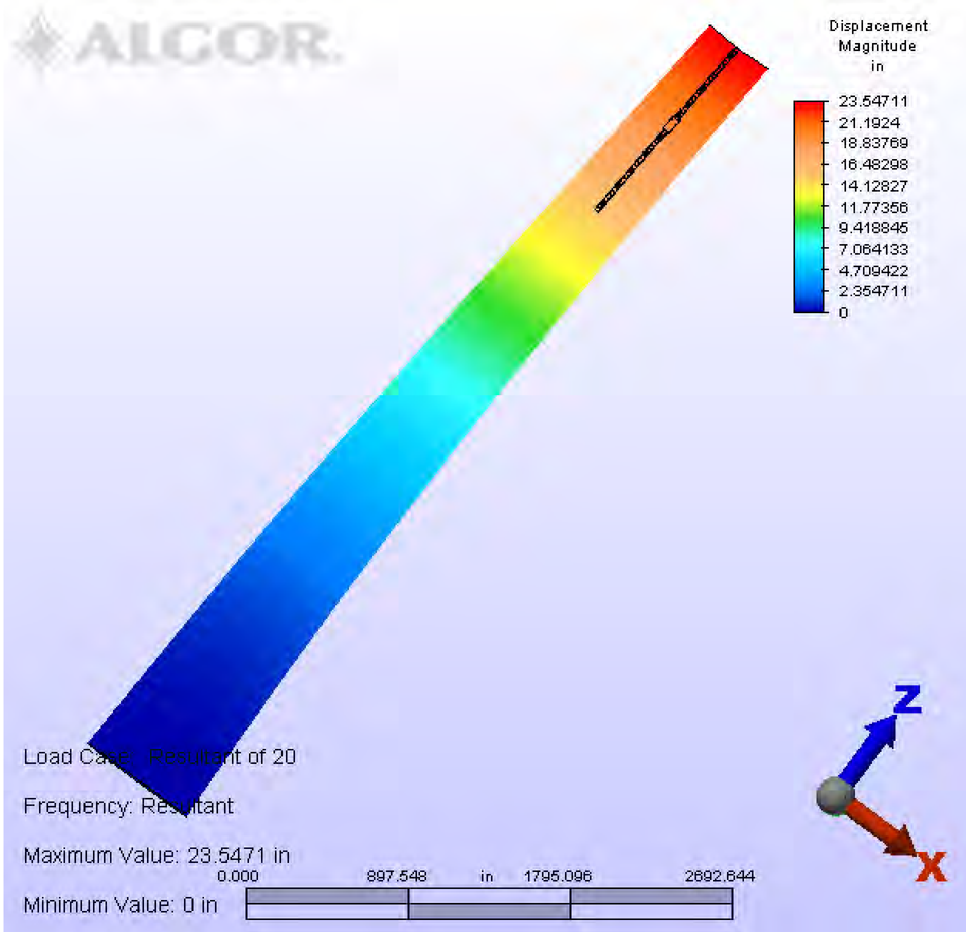
```
Weight available in Z direction:  1.9058E+07
      Percent used in this direction:   82.58%
      Modes used in this direction: 20

 **** Modal Effective Mass & Participation Factor Z Direction
```

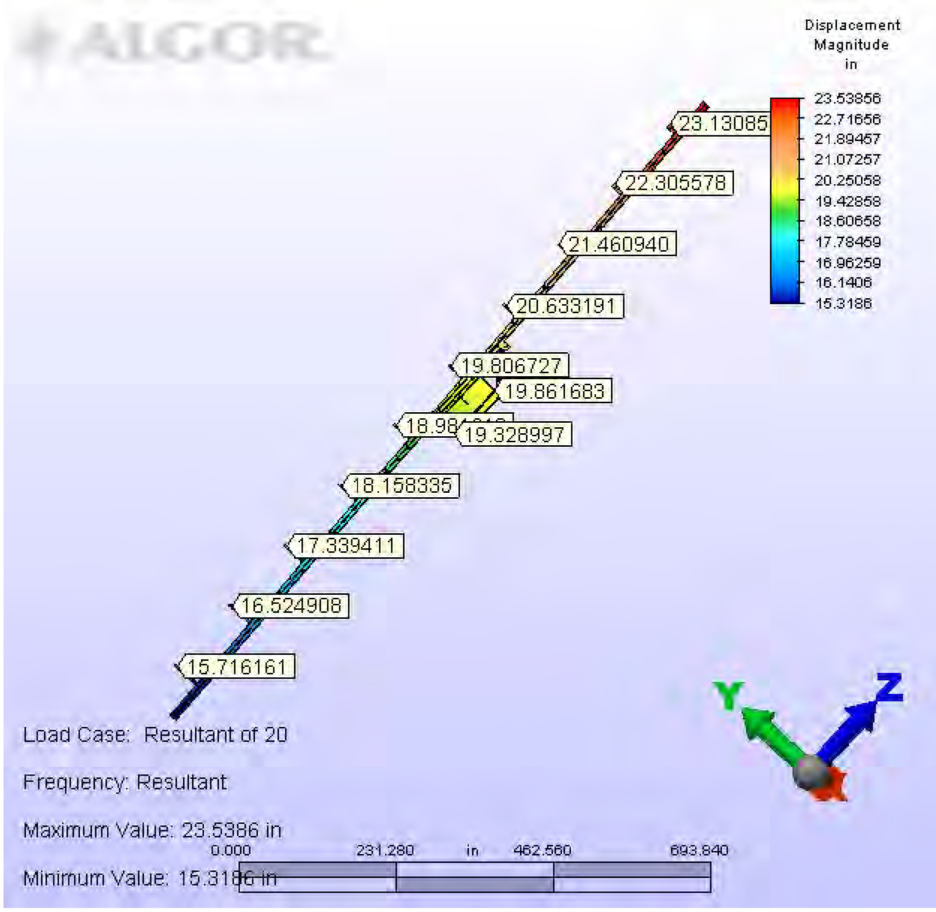
Mode	Frequency (HZ)	Modal eff. mass (weight)	(%)	Cumulative mass (weight)	(%)	Participat. Factor
1	9.17305E-1	3.4399E+00	0.00	3.4399E+00	0.00	-9.4352E-02
2	9.55680E-1	3.1037E+02	0.00	3.1381E+02	0.00	8.9623E-01
3	3.53603E+0	2.7111E-01	0.00	3.1408E+02	0.00	-2.6488E-02
4	3.60829E+0	6.5710E+03	0.03	6.8850E+03	0.04	4.1238E+00
5	6.86973E+0	3.5331E+01	0.00	6.9204E+03	0.04	3.0238E-01
6	7.81298E+0	3.8954E+04	0.20	4.5875E+04	0.24	1.0041E+01
7	7.85708E+0	1.6314E+05	0.86	2.0902E+05	1.10	-2.0548E+01
8	9.32367E+0	1.2888E+07	67.63	1.3097E+07	68.72	-1.8263E+02
9	1.19686E+1	3.6655E+01	0.00	1.3097E+07	68.72	-3.0800E-01
10	1.30271E+1	2.0116E+04	0.11	1.3118E+07	68.83	7.2152E+00
11	1.30389E+1	1.6352E+04	0.09	1.3134E+07	68.92	-6.5054E+00
12	1.51617E+1	2.2635E+00	0.00	1.3134E+07	68.92	-7.6538E-02
13	1.86510E+1	3.1024E+03	0.02	1.3137E+07	68.93	2.8335E+00
14	1.89342E+1	5.8671E+04	0.31	1.3196E+07	69.24	1.2322E+01
15	1.89859E+1	6.4425E+01	0.00	1.3196E+07	69.24	4.0833E-01
16	2.09421E+1	2.5343E+06	13.30	1.5730E+07	82.54	-8.0986E+01
17	2.33627E+1	3.3462E+02	0.00	1.5730E+07	82.54	-9.3058E-01
18	2.44808E+1	3.5780E+02	0.00	1.5731E+07	82.54	9.6228E-01
19	2.46752E+1	7.0317E+03	0.04	1.5738E+07	82.58	4.2659E+00
20	2.48465E+1	9.8212E+01	0.00	1.5738E+07	82.58	5.0416E-01

The site-specific response spectrum parameters are given by Plum Point Energy in the D100 supplement to the 01400 Technical Supplemental Specification Document, a copy of which is presented in the appendix.

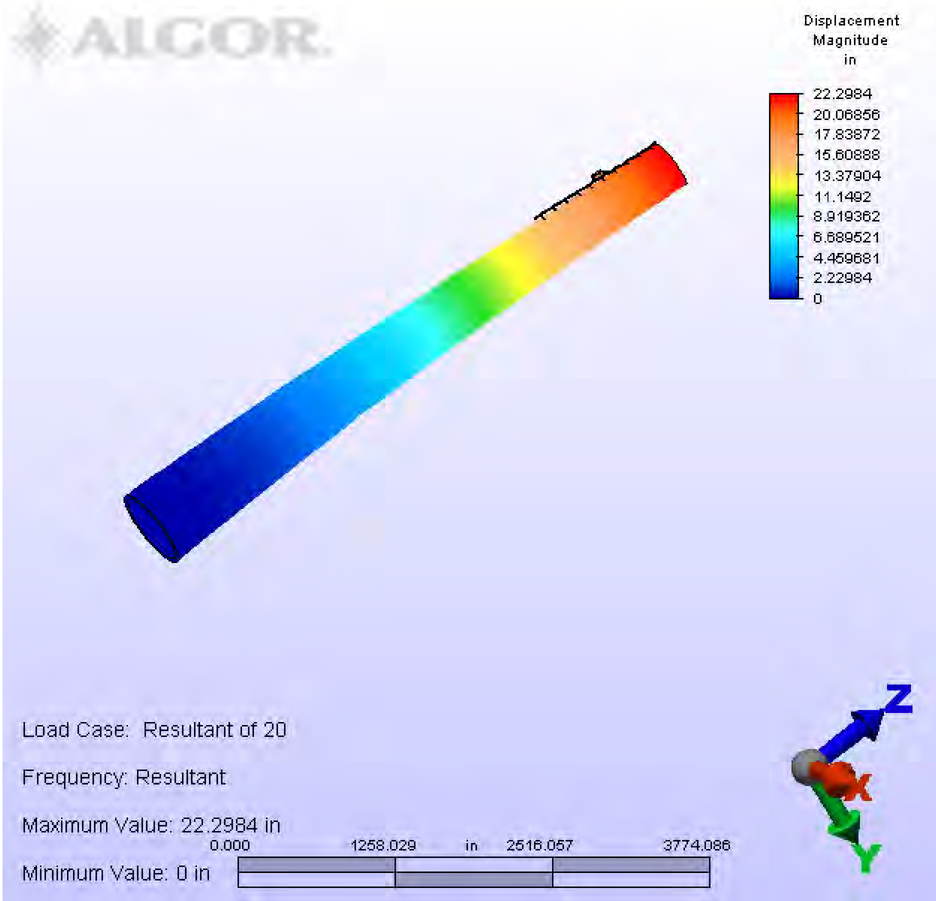
Upon performing the response spectrum analysis for the chimney-rail segment-cab model, the following displacement results are obtained. Displacements results are relative to the ground excitations (input spectrum).



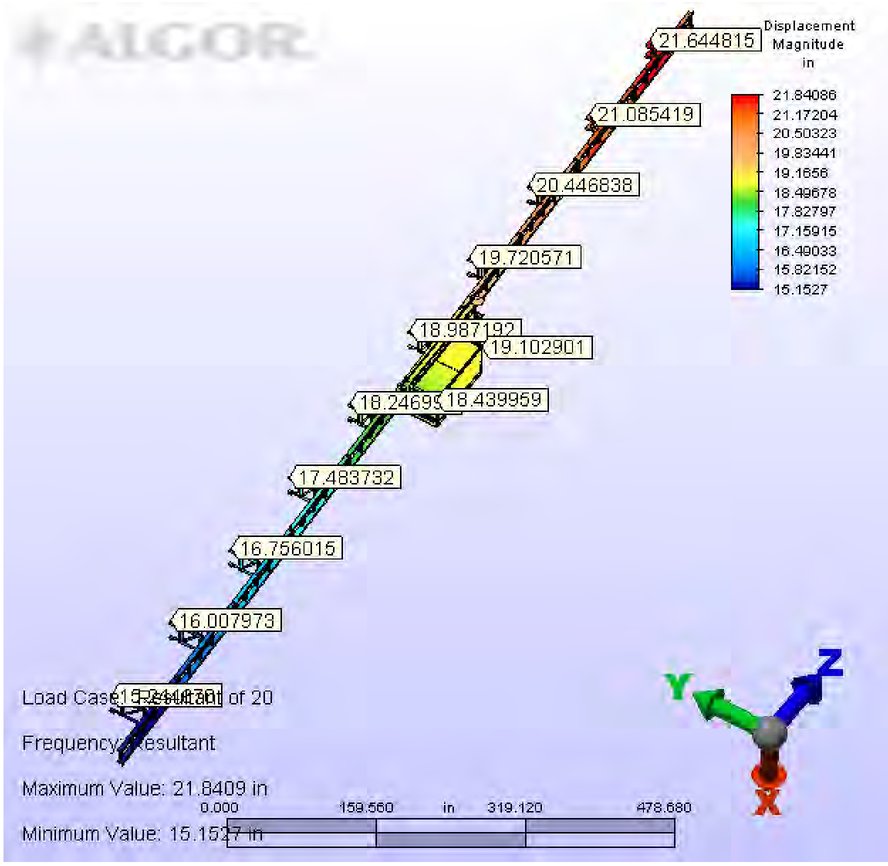
Plum Point Energy Station
Trac-Cab TC1K R&P Elevator Cab, Rail Segment, and Chimney
Response Spectrum Analysis Results – Lateral Excitation
Displacements



Plum Point Energy Station
Trac-Cab TC1K R&P Elevator Cab, Rail Segment, and Chimney
Response Spectrum Analysis Results – Lateral Excitation
Displacements (Chimney Not Shown)

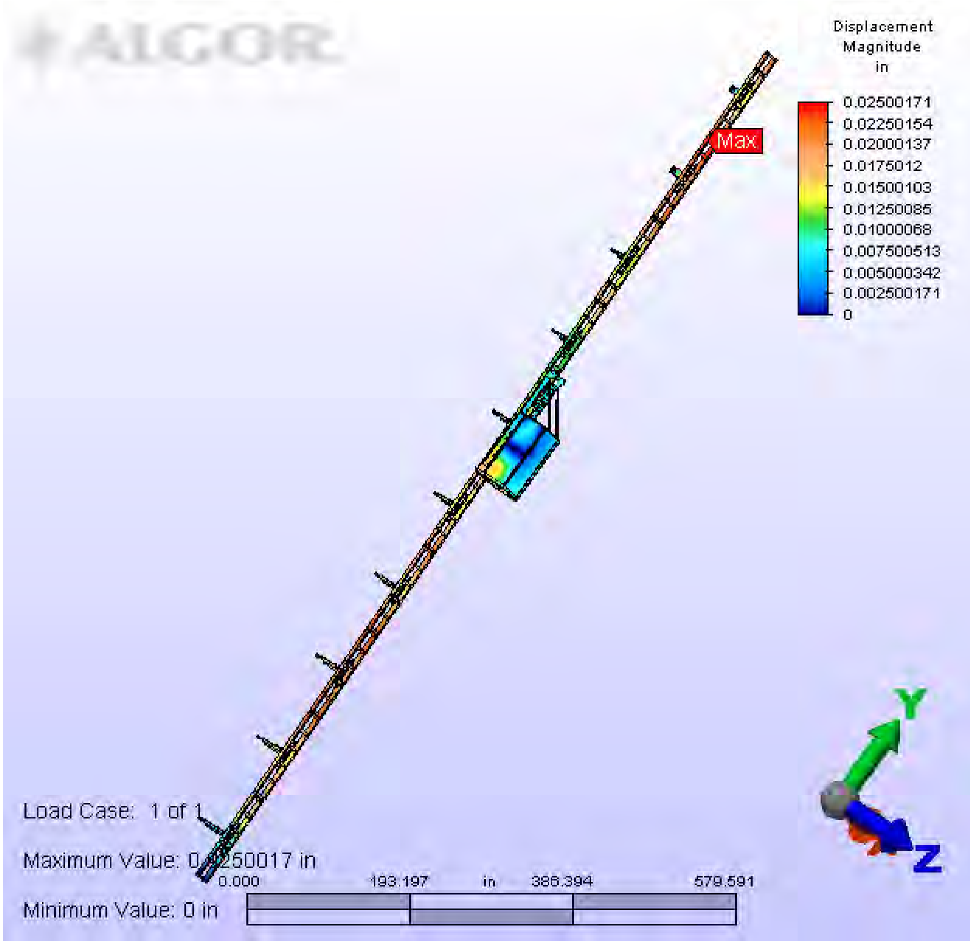


Plum Point Energy Station
Trac-Cab TC1K R&P Elevator Cab, Rail Segment, and Chimney
Response Spectrum Analysis Results – Fore/Aft Excitation
Displacements

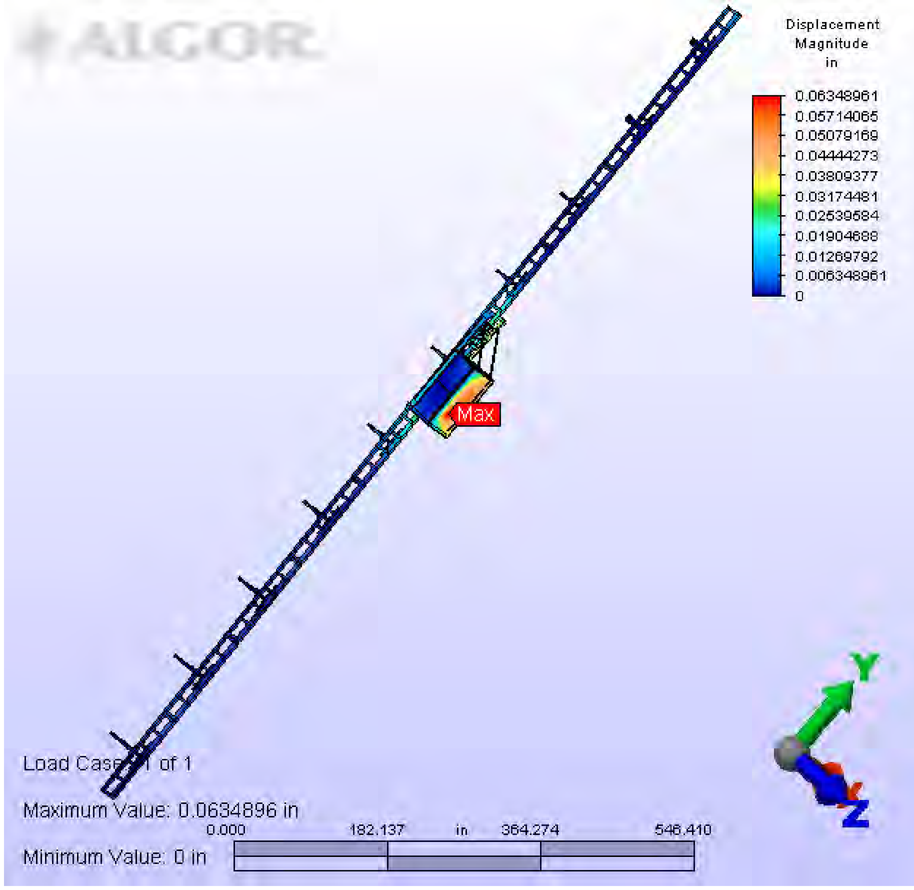


Plum Point Energy Station
Trac-Cab TC1K R&P Elevator Cab, Rail Segment, and Chimney
Response Spectrum Analysis Results – Fore/Aft Excitation
Displacements (Chimney Not Shown)

The Response Spectrum Analysis is supplemented with an Equivalent Static Force Analysis procedure described in ASCE 7-98 Section 9.6.1.3. This method does not include the dynamic effects of the structure response to an earthquake excitation, but the results do provide additional confidence in the integrity of the general elevator rail and cab structure. The model is constructed as described above in the attachment point loads and stress sections. Displacement results obtained using this method for both lateral and fore/aft loads are shown.



Plum Point Energy Station
Trac-Cab TC1K R&P Elevator Cab, Rail Segment, and Chimney
Equivalent Static Force Procedure Analysis Results – Lateral Excitation
Displacements (Chimney Not Shown)



Plum Point Energy Station
Trac-Cab TC1K R&P Elevator Cab, Rail Segment, and Chimney
Equivalent Static Force Procedure Analysis Results – Fore/Aft Excitation
Displacements (Chimney Not Shown)

The three inch limit on maximum seismic displacements in each of two horizontal orthogonal directions defined in the 01400 Technical Supplemental Specification issued by Plum Point Energy is not exceeded by the elevator cab and rail structure.

Rack and Pinion

The rack and pinion system was designed by Universal Technical Systems. It is rated at 4736 lbs (two pinions) for infinite life with a safety factor of 8:1 at 10.76 horsepower and 150 ft/min. speed. The rack and pinion are designated as a 24T pinion meshing with a 25 degree PA rack.
The rack face is 1.5 inches wide. This is adequate capacity for a 4000 lb gross weight elevator under normal use conditions.

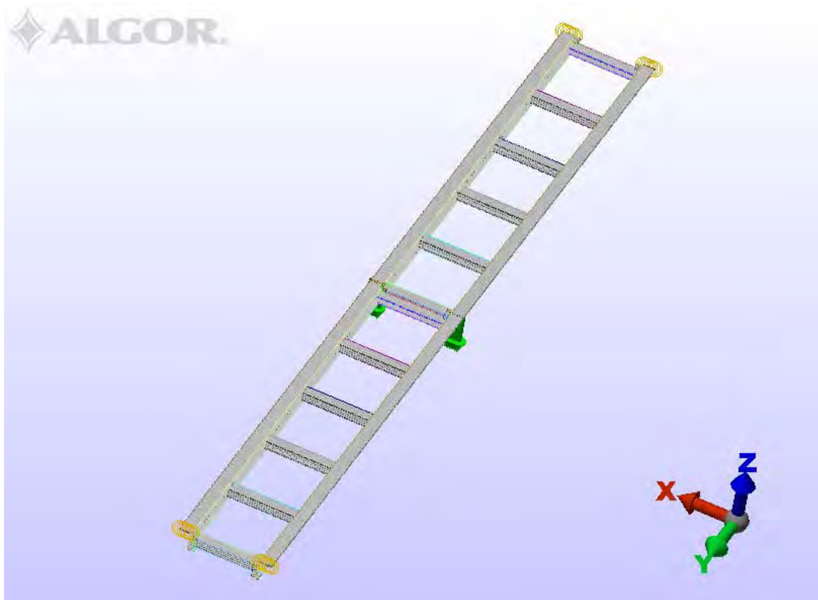
Analysis of the rack body when subjected to emergency stop loads (4791 lbs) load indicates there is a safety factor of approximately 56 in stress based on yield strength and that it would take approximately 107 times the load encountered due to dead weight plus emergency stop conditions to buckle the rack section.

Rail Splice

The rail segments are joined together at their ends using six ½ inch diameter A325 bolts which are inserted through two 5 1/2 " x 1 ½" x 1" A36 steel splice plates welded to the longitudinal and horizontal rail members by ¼" and 3/16" welds. A 5 1/2 " x 1 ½" x 1/32" A36 steel shim plate is inserted in between each mating splice plate pair.

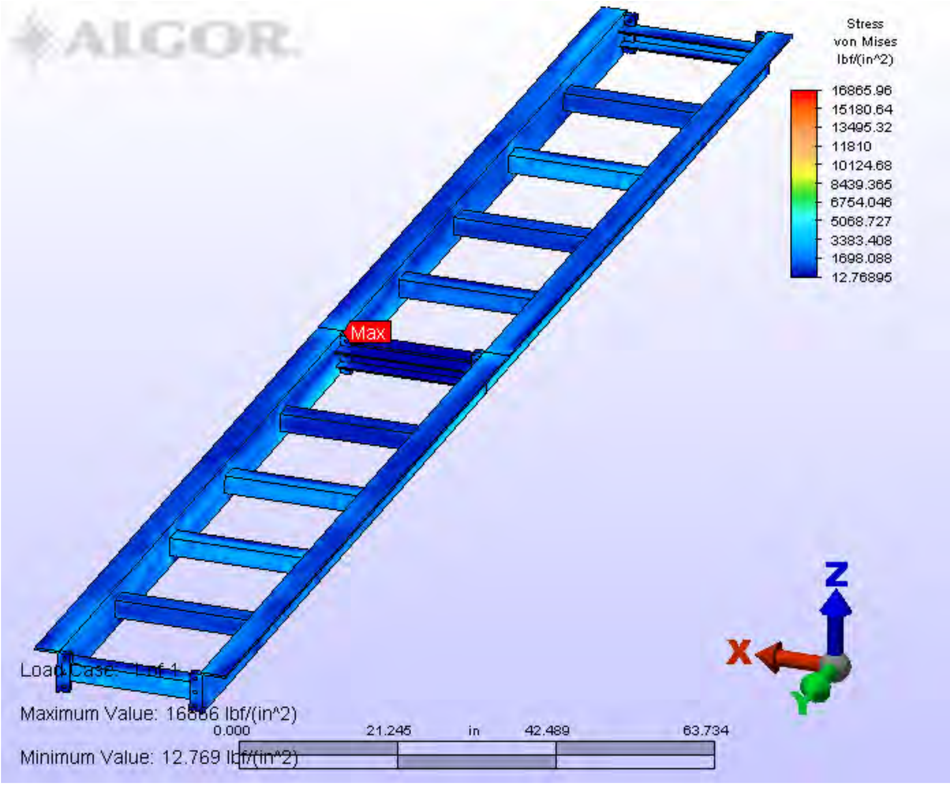
In order to check the overall splice plate structure, a CAD model of two adjacent rail segments which include the splice plate details is created. This model is imported into the Algor finite element program, meshed, loads and constraints added, and analyzed.

The finite element model of the rail section pair is shown:

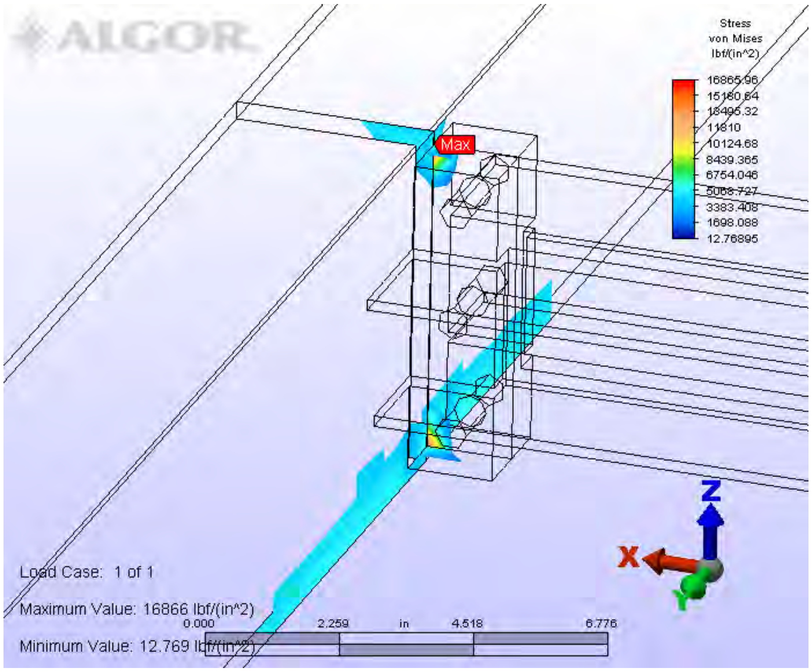


Plum Point Rail Segment Pair
Splice Plate Analysis
Finite Element Model

The model is meshed using brick elements. The ends of the rails have pinned boundary conditions imposed. For conservatism, the support brackets are not included in the analysis. The maximum normal operating wheel load obtained from the "wheel load analysis – combined load cases" described above (+383 lbs. and -383 lbs on each rail respectively) is applied as a line load to each end of the rails at their junction. Material properties are those of A36 steel. Initially the two splice plates are "bonded" to each other and bolts are not included in the structure. This provides a more conservative analysis of the splice plate region by elimination of the effects of the flexibility of the bolts on the structure. The results obtained are summarized in the following views:

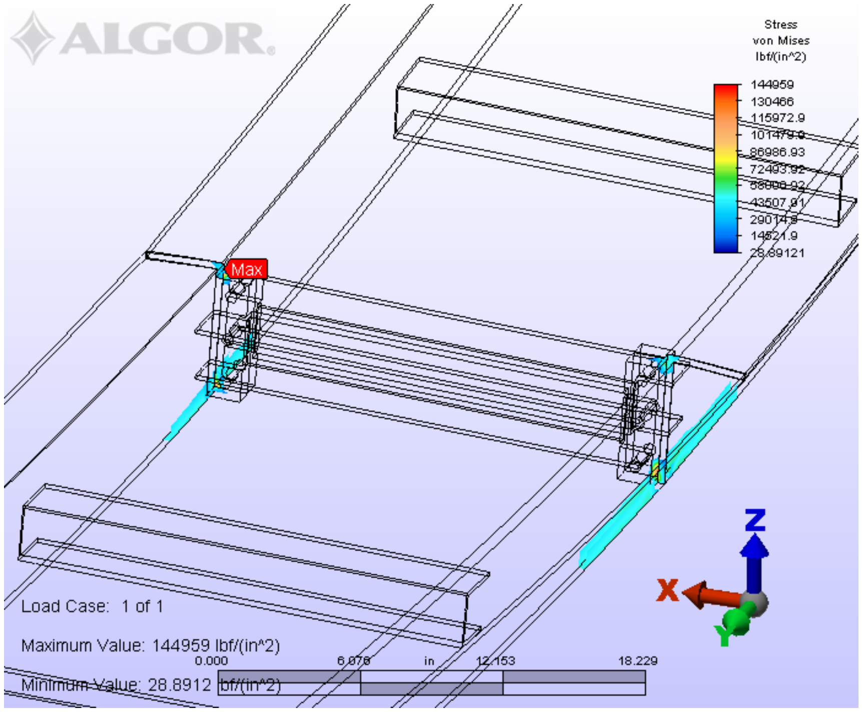


Plum Point Rail Segment Pair
Splice Plate Analysis
Maximum Von Mises Stress – “Normal” Running Condition



Audubon Bridge Rail Segment Pair
Splice Plate Analysis – Stress Concentration Area
Maximum Von Mises Stress – “Normal” Running Condition

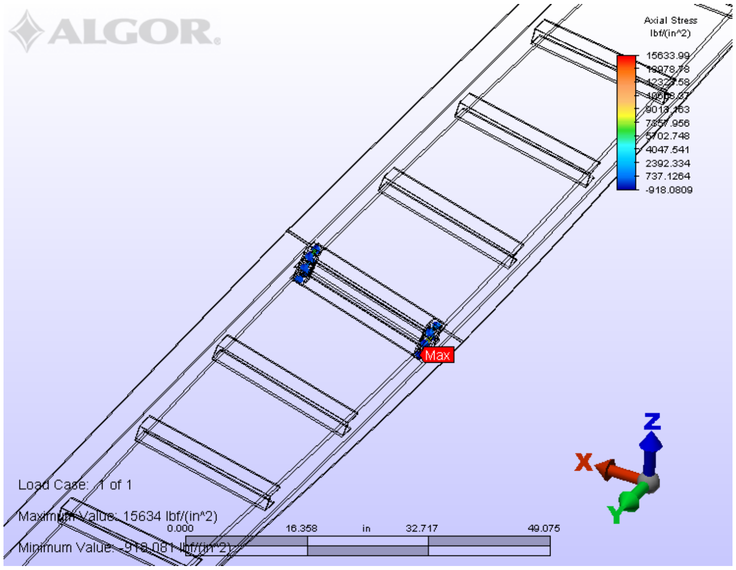
The calculated Von Mises stress does not exceed the 33,000 psi allowable stress anywhere in the splice joint under “normal” running conditions.



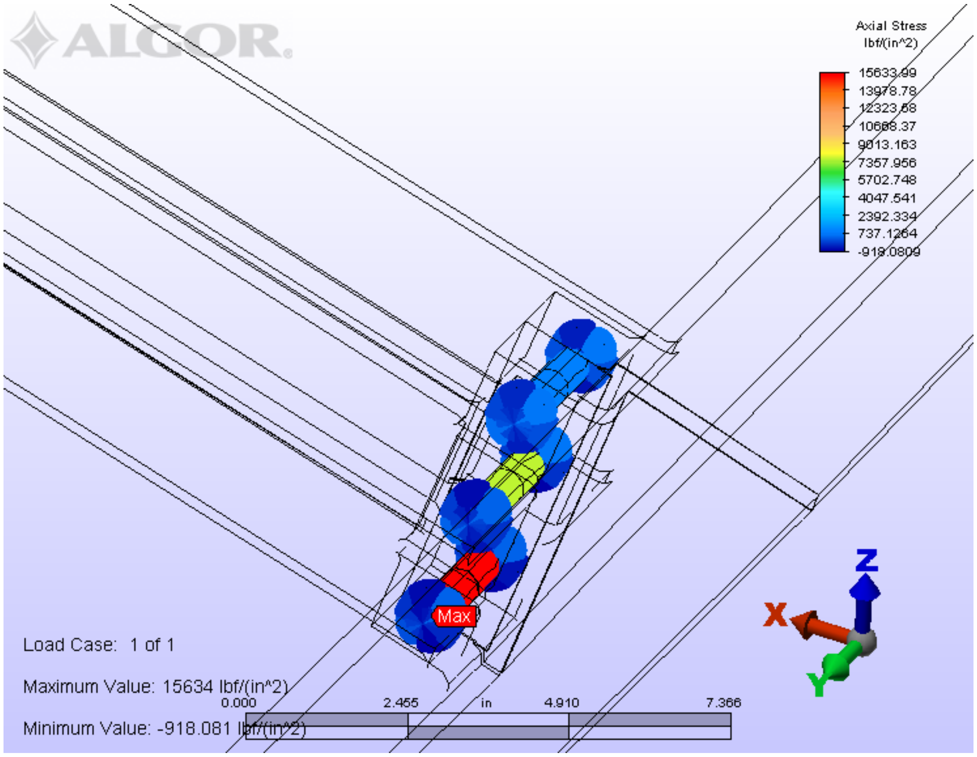
Audubon Bridge Rail Segment Pair
Splice Plate Analysis – Stress Concentration Area
Maximum Von Mises Stress – Lateral Earthquake Condition

During a lateral earthquake event, the Von Mises stress in the structure exceeds the yield stress of 50,000 psi at two very corners of the splice plate located at the higher-loaded rail junction and at the edge of the rails in the proximity of the splice plate. The stresses in the rest of the structure are significantly lower than this value. Localized stress concentrations such as these are permitted by code (i.e. for example, Section B9 of the ASD manual). Again, the model being analyzed, without the restraint of building supports, is a very conservative one.

The same finite element model is used to verify the adequacy of the splice plate bolting. Here the contacting surfaces of the adjacent splice plates are set to that of “surface”. This allows contact pressure to be transferred between the splice plates where it occurs while at the same time the plates are allowed to separate where tensile forces occur. The bolts are modeled as beam elements through their respective holes and the bolt heads and nuts are modeled by 6 beams each originating radially from the bolt centerline to be attached at the circle on the splice plates describing the head and nut diameters. The bolts are ASTM A325. The results of the analysis are shown:



Plum Point Rail Segment Pair
Splice Plate Analysis – Normal Running Condition
Location and Magnitude of Maximum Axial Bolt Stress



Audubon Bridge Rail Segment Pair
Splice Plate Analysis – Normal Running Condition
Location and Magnitude of Maximum Axial Bolt Stress
Amplified Detail

The guideline for safe bolting design is taken as AISC "Allowable Stress Design, Specification for Structural Joints using ASTM A325 or A490 Bolts". In accordance with this specification, (Table 1 – Nominal Hole Dimensions) the bolt holes are 9/16" diameter and the bolts ½" diameter. As seen above, the maximum axial stress in the bolt under this very conservative loading condition is 15634 psi, to be compared to an allowable maximum of 44,000 psi stress. (Table 2 – Allowable Working Stress on Fasteners or Connected Material) The maximum shear stress in the bolt is calculated to be 1665 psi, to be compared to a maximum allowable of 21000 psi (Table 2 – Allowable Working Stress on Fasteners or Connected Material). The bearing stress of the bolt-hole interface is calculated to be 654 psi, to be compared to an allowable stress of 70,000 psi. (Table 2 – Allowable Working Stress on Fasteners or Connected Material). These stress values are determined as the maximums for the bolt/bolt bearing surfaces for all normal running conditions and load combinations experienced by the elevator except for the seismic event.

During a maximum seismic event, it is determined from this very conservatively loaded model (wheels on splice joint, no chimney supports, pinned rail ends, etc.) that two of the three bolts in each splice block may deform plastically, but the axial stress does not exceed the tensile strength of the bolt. Therefore some deformation may occur during a seismic event, but the rail will not separate catastrophically.

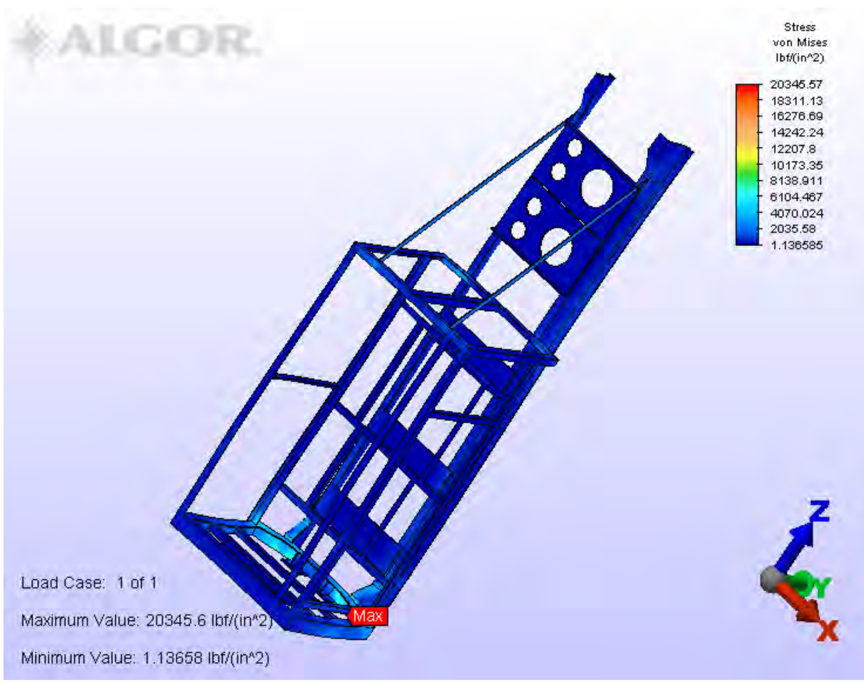
The splice plate joint design is adequately strong for its intended purpose, even under very conservative loading conditions.

Weld Joints

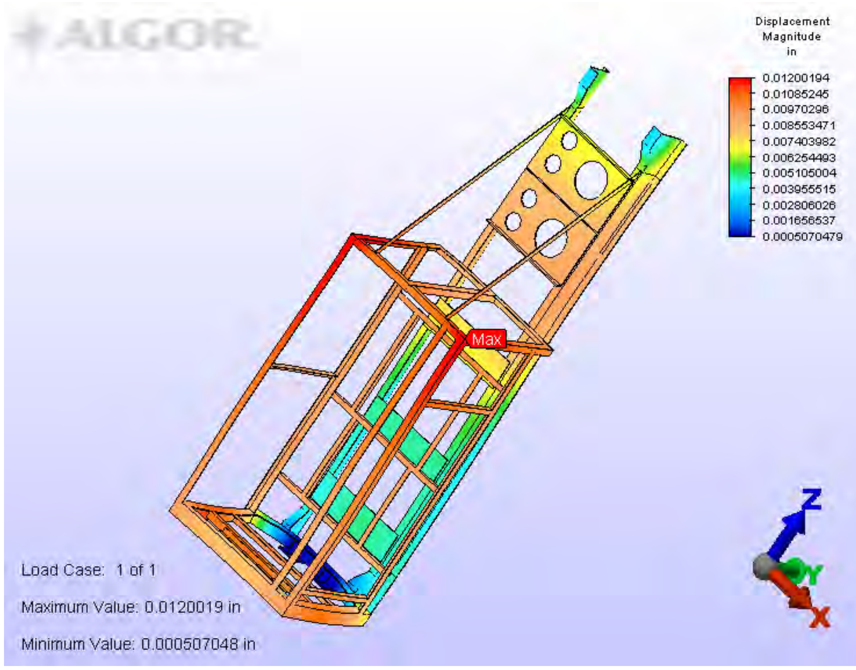
Section J2 – b of the AISC "Allowable Stress Design" manual specifies required weld parameters. The parameters applicable to the rail components are: Table J2.4, Minimum Size of Fillet Welds, which specify that for a material thickness of the thicker part joined of ¼" a minimum size of fillet weld required is 1/8". For a thicker part over ¼" to ½", the minimum size of fillet weld is 3/16". In both cases the weld size need not exceed the thickness of the thinner part. Section J2-b also specifies the maximum size of fillet weld: For material less than ¼" thick, the weld is to be not greater than the thickness of the material; for material ¼" or more in thickness, the weld is not to be greater than the thickness of the material minus 1/16" unless the weld is especially designated on the drawings to be built out to obtain full throat thickness. ON the rail, the 3/16" thick horizontal members are welded with 3/16" weld. The splice plates are welded to the 3/16" thick horizontal members and the 5/16" thick vertical members using 3/16" weld and ¼" weld respectively. The weld size is in compliance with the specification.

Elevator Cab – Impact Stop

In addition to the single and combined load sets described above, the Elevator Code (A17.1-2004 Part 2.1.2.3a) requires that the pit floor and car members be designed for impact at 125% of the rated speed, with the full rated load. The Audubon bridge elevator has a design gross weight of 4000 lbs. and a maximum design speed of 1.25 X 110 ft./min. Two Spring Model BUF with ID = 3 3/8", OD = 5 ½", wire size 1 1/16" rated 4288 lb./in. with 2 ½" stroke springs are installed in the pit floor. Using potential energy = kinetic energy principals, the finite element model of the elevator cab is loaded to simulate an impact with the pair of buffer springs. The calculated results are shown in the following two illustrations:



Plum Point Energy Elevator Cab
Simulated Buffer Spring Impact
Von Mises Stress



Plum Point Energy Elevator Cab
Simulated Buffer Spring Impact
Displacements

The allowable stresses are the same as described above (.66 x 50,000 psi = 33000 psi) ; these design targets are not exceeded in any cab member under conditions of simulated impact with the buffer springs.

Wheel Housing

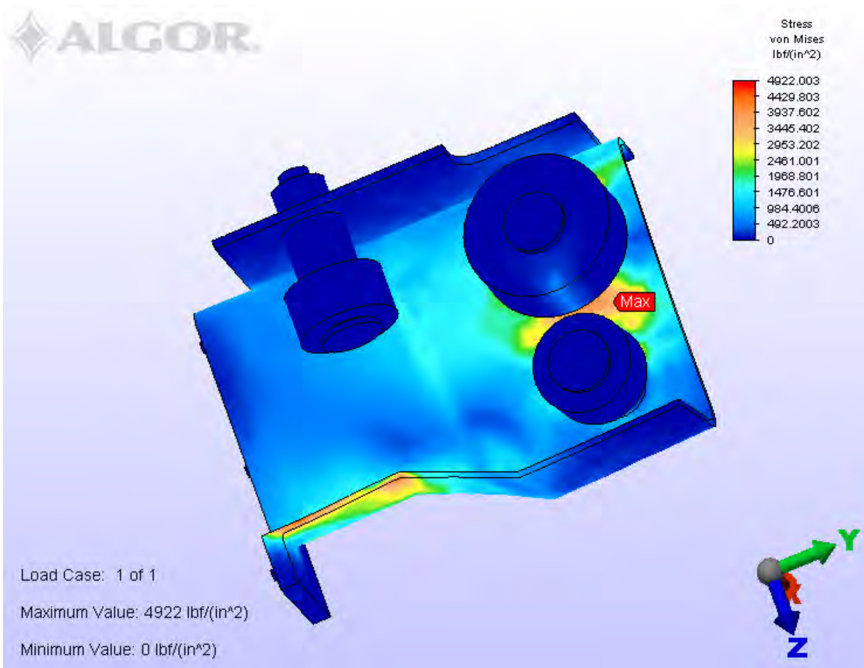
In order to analyze the wheel housings, an Alibre CAD model of the wheel housing is constructed and this model sent to the Algor finite element program for analysis. The model used here is slightly different in geometry from that shown on the Plum Point Energy drawing PPPP M100 GA – 100 – 11, yet it is close enough in dimension to provide a representative stress/deflection picture of the wheel housing under load. The upper and lower wheel housings are similar enough in geometry that only the upper housing need be analyzed.

For the stress/deflection calculation, the housing is assumed fixed in translation and rotation at the splice plate. The material properties used are those of A36 50,000 yield stress steel.

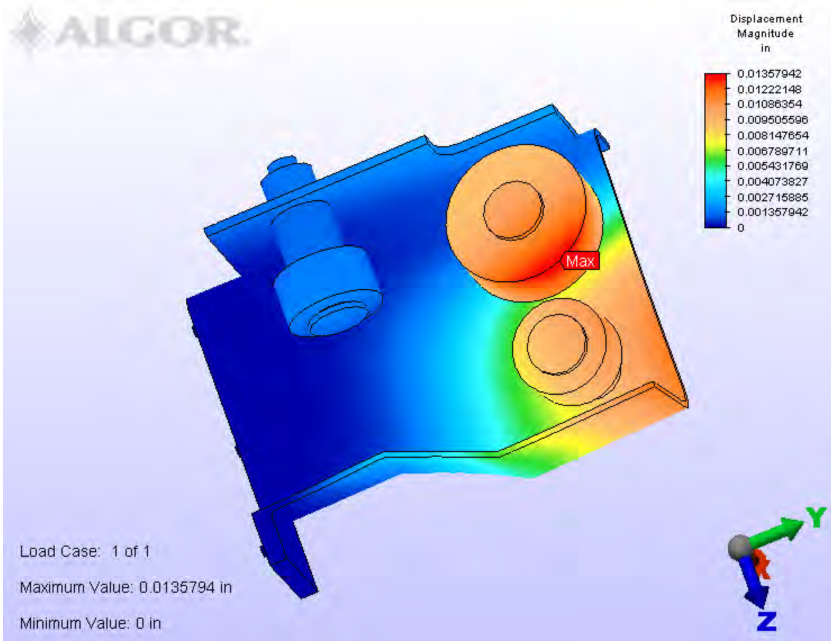
Six load cases are considered: (1) Combined Load Case 6a with 571 lbs. applied to the back wheel in the “-Z” direction, (2) Combined Load Case 6a with 571 lbs. applied to the front wheel in the “+Z” direction, (3) Lateral Wind with 232 lbs applied to the side wheel in the “+X” direction (4) Lateral wind with 232 lbs applied to the side wheel in the “-X” direction,

(5) Combined Load Case 5c (Lateral Earthquake) with 1580 lbs applied to the side wheel in the "+X" direction plus 2787 lbs applied to the back wheel in the "-Z" direction, and (6) Combined Load Case 5c (Lateral Earthquake) with 1580 lbs applied to the side wheel in the "+X" direction plus 2787 lbs applied to the front wheel in the "+Z" direction.

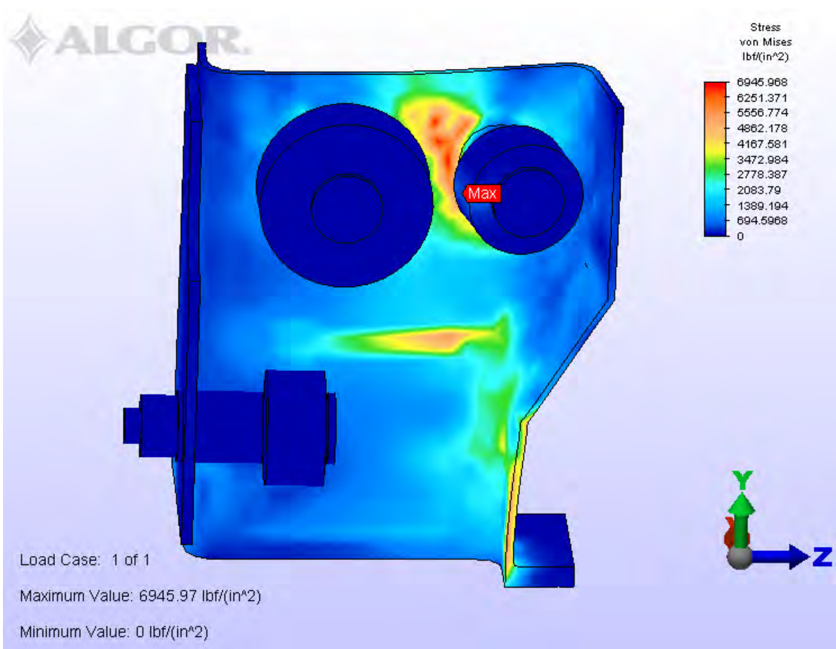
Stress/Deflection results calculated for the four load cases described follow:



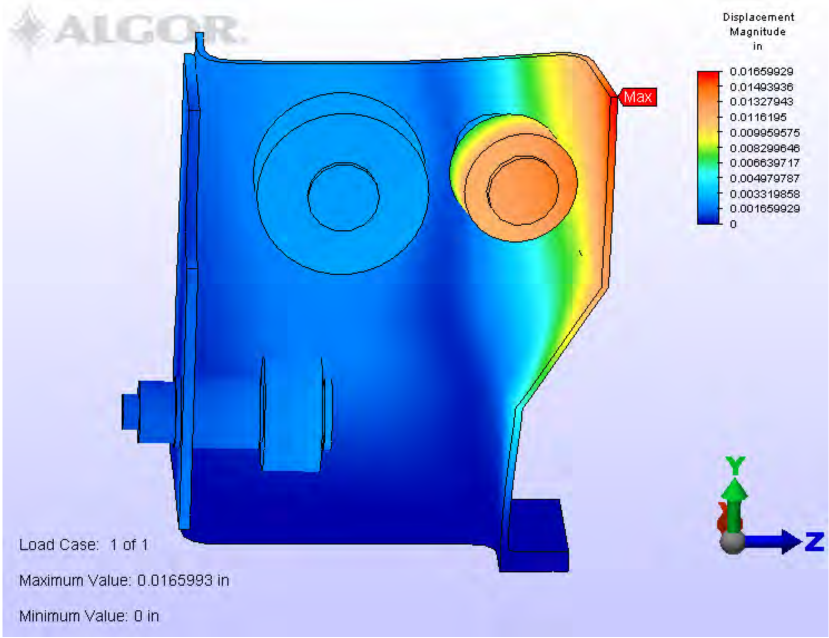
Plum Point Energy Elevator Wheel Housing
Combined Load Case 6a Load Applied to Back Wheel
Von Mises Stress



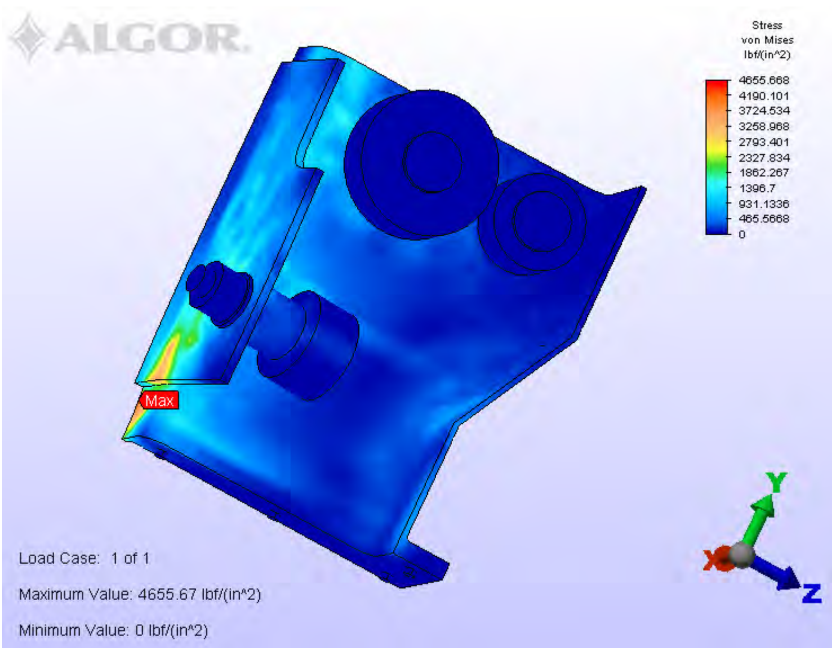
Plum Point Energy Elevator Wheel Housing
Combined Load Case 6a Load Applied to Back Wheel
Displacements



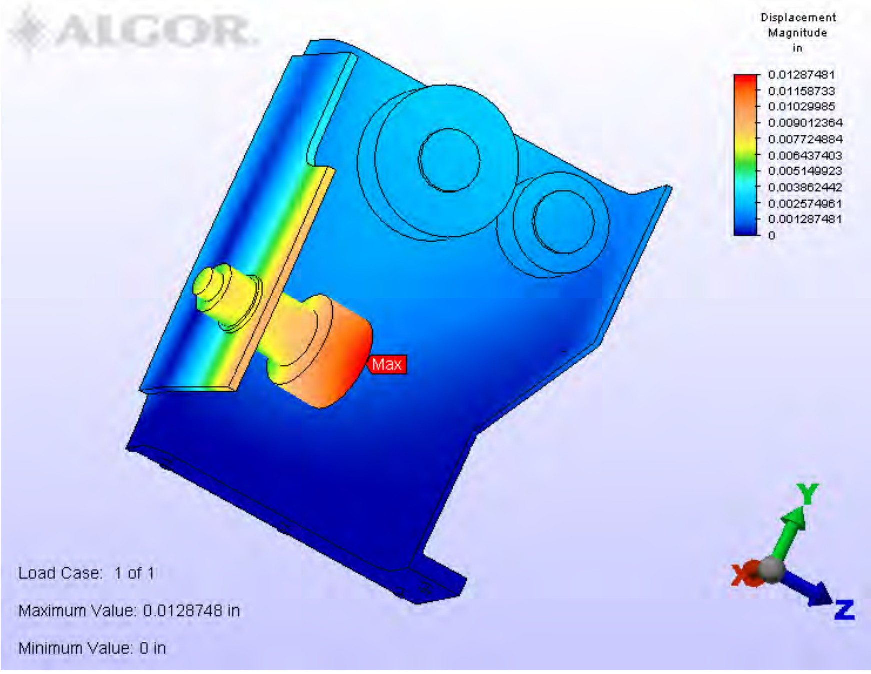
Plum Point Energy Elevator Wheel Housing
Combined Load Case 6a Load Applied to Front Wheel
Von Mises Stress



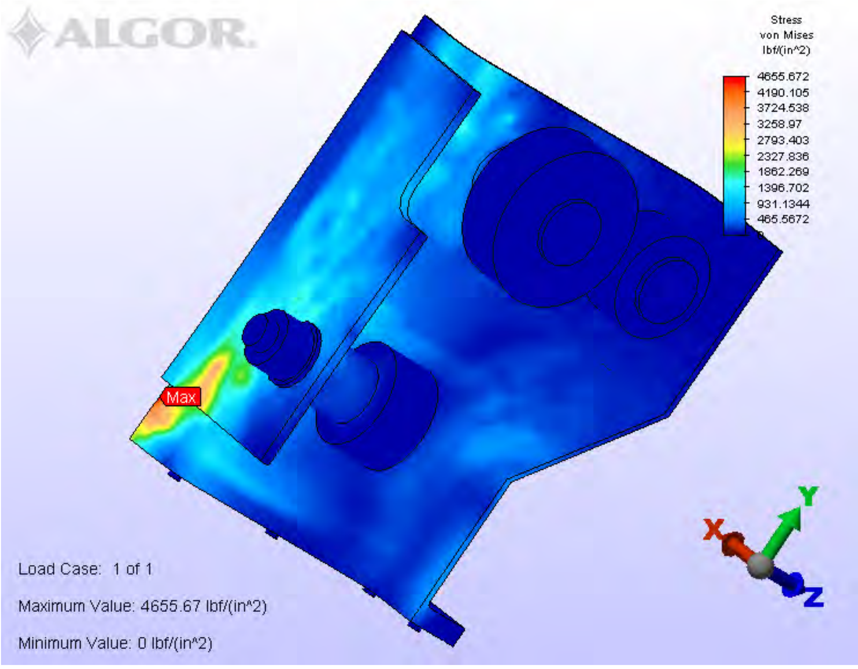
Plum Point Energy Elevator Wheel Housing
Combined Load Case 6a Load Applied to Front Wheel
Displacement



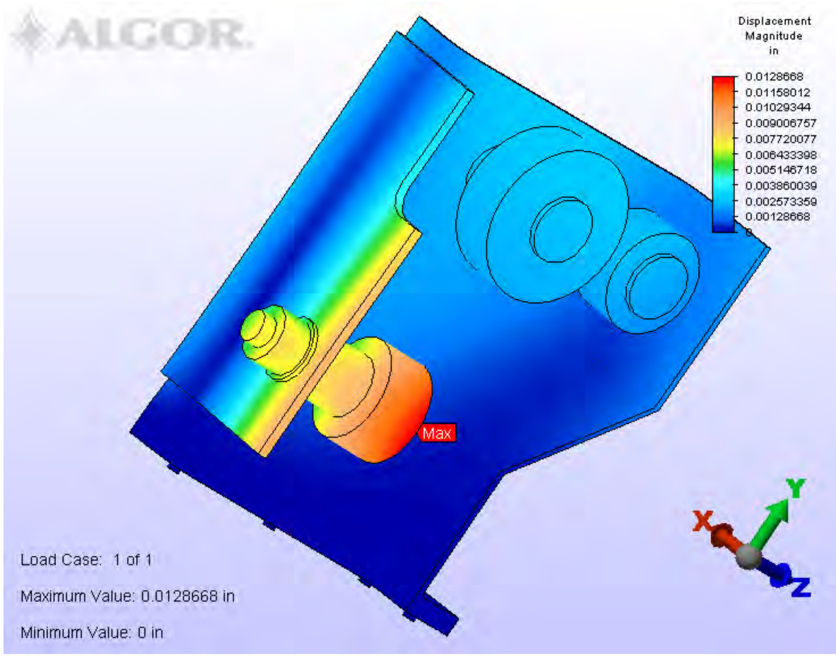
Plum Point Energy Elevator Wheel Housing
Lateral Wind Load (+X Direction) Applied to Side Wheel
Von Mises Stress



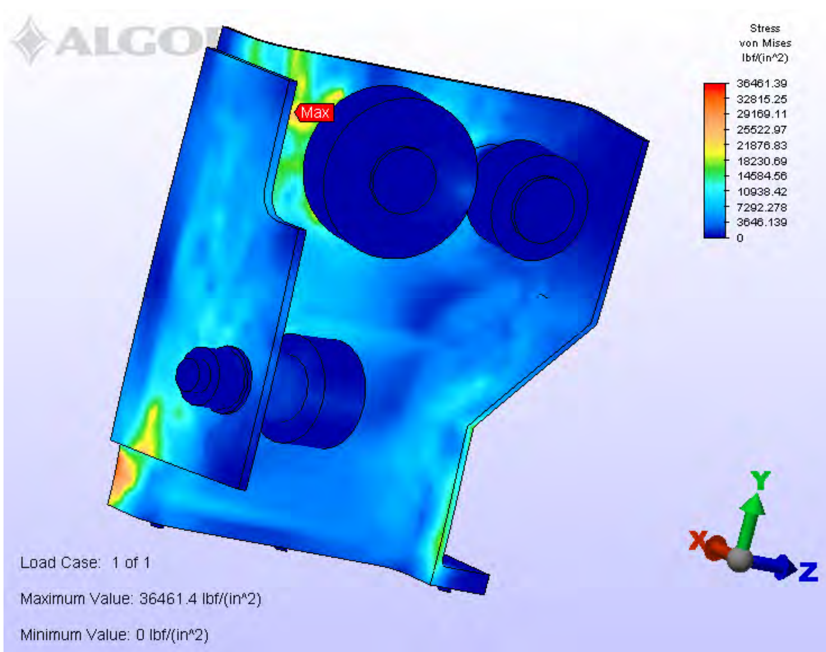
Plum Point Energy Elevator Wheel Housing
Lateral Wind Load (+X Direction) Applied to Side Wheel
Displacement



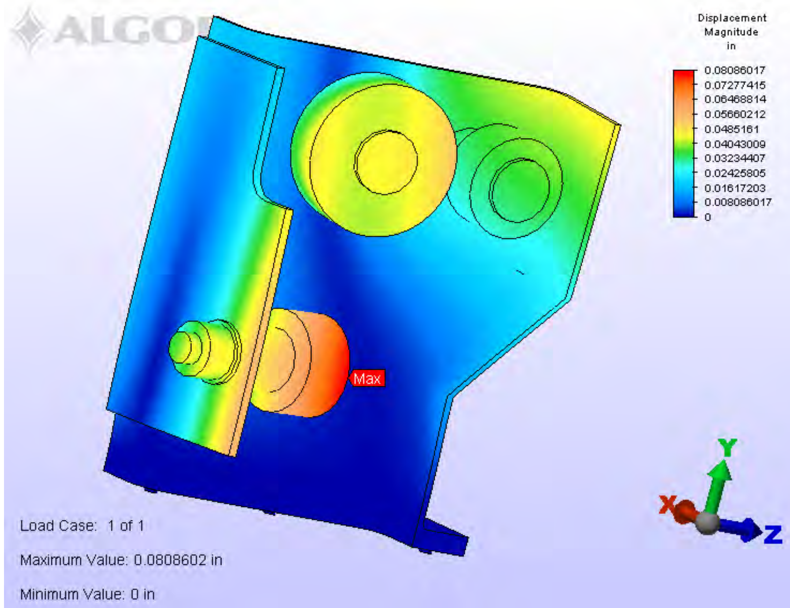
Plum Point Energy Elevator Wheel Housing
Lateral Wind Load (-X Direction) Applied to Side Wheel
Von Mises Stress



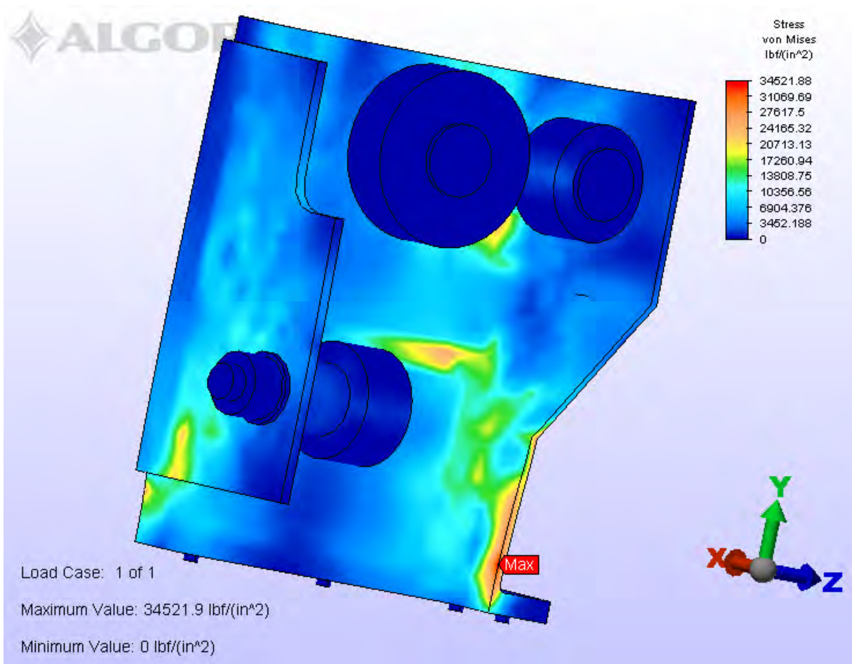
Plum Point Energy Elevator Wheel Housing
Lateral Wind Load (-X Direction) Applied to Side Wheel
Displacement



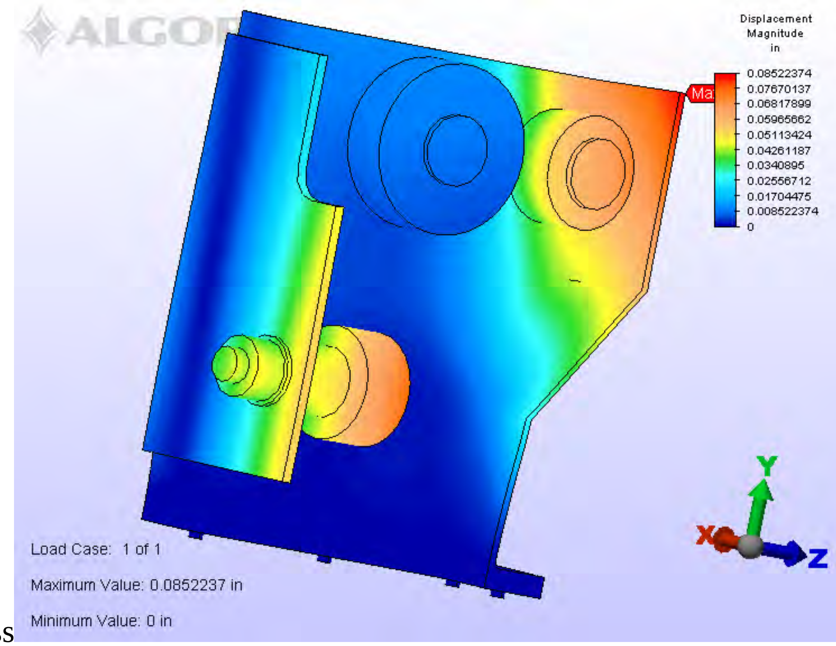
Plum Point Energy Elevator Wheel Housing
Combined Load Case 5c (Lateral E'quake) Load Applied to Side & Rear Wheels
Von Mises Stress



Plum Point Energy Elevator Wheel Housing
Combined Load Case 5c (Lateral E'quake) Load Applied to Side & Rear Wheels
Displacements



Plum Point Energy Elevator Wheel Housing
Combined Load Case 5c (Lateral E'quake) Load Applied to Side & Front Wheels
Von Mises Stress

Von Mises Stress 

Plum Point Energy Elevator Wheel Housing
Combined Load Case 5c (Lateral E'quake) Load Applied to Side & Front Wheels
Displacements

The stresses calculated for the wheel housing are low, well under the design allowable of 0.66*yield stress, or 0.66*50,000psi = 33,000psi. except for a few localized stress concentration locations where the stresses only slightly exceed (34,521 psi and 36,461 psi Vs target 33,000 psi) the design targets. These localized stresses calculated above the nominal maximum design target value of stress are permitted by code. There are no required deflection criteria for this elevator component.

Wheel Housing Bolting

The wheel housings are bolted to the elevator cab backbones using 1/2" bolts inserted through 9/16" holes in accordance with the AISC "Allowable Stress Design, Specification for Structural Joints using ASTM A325 or A490 Bolts" specification. (Table 1 – Nominal Hole Dimensions) For purposes of this analysis the above wheel housing analysis models are used with the bolts modeled as short cylinders located at positions specified for the bolting on the wheel housing attachment plate drawings. The cylinders are restrained from translation and rotation at one end to provide a conservative analysis. The same six load cases described in the wheel housing analysis (above) are used to determine the stresses in the bolts.

The results of the calculations indicate that the nominal axial stress in the bolts under the six loading conditions specified range from 15473psi to 27051psi., to be compared to an allowable maximum of 44,000 psi. stress. (Above Specification, Table 2 – Allowable Working Stress on Fasteners or Connected Material) The range of nominal shear stress in the bolts is calculated to be 1019 psi. to 6097 psi, to be compared to a maximum allowable of 21000 psi (Above Specification, Table 2 – Allowable Working Stress on Fasteners or Connected Material).

Upon examining the results further, beyond the requirements of the code, it is found that at the outer edge of the one of the four bolts used in the wheel housing flange attachment, the Von Mises stress may peak beyond the yield of the bolt material for the most extreme earthquake case. This indicates that, along with the examination of the elevator cab wheels after a severe seismic event, the wheel housing flange bolting should be examined as well.

The bearing stress of the bolt-hole interface is calculated to be approximately 5126 psi., to be compared to an allowable stress of 70,000 psi. (Above Specification, Table 2 – Allowable Working Stress on Fasteners or Connected Material).

The wheel housing bolting is adequately strong for its intended purpose, even under very conservative loading conditions.

Appendix

01400 - Technical Supplemental Specifications

This section contains technical supplemental specifications that provide additional requirements applicable to the work covered under the technical sections which follow this Section 01400.

01400.1 Summary of Applicable Supplementals

The technical supplementals applicable to each technical section are indicated below.

	Technical Section Number	Technical Section Name	Applicable Technical Supplementals
1	1500	Technical Scope and System Performance	
2	3311	Cast-in-place Concrete	Q001, Q500
3	3312	Concrete Chimney	D100, D200, E000, E100, E210, E230, E300, E400, E510, E520, E530, E640, E642, K100, M110, M120, M130, M140, M200, M400, M500, M801, M802, Q001, Q100, Q121, Q124, Q210, Q280, Q301, Q302, Q303, Q310, Q320, Q400, Q500, S100, S200, S210, V100

01400.2 Technical Supplemental Specifications

The technical supplemental specifications follow.

D100 Site Meteorological and Seismic Data

(Source: 27Jan04 - Revised by Project: 22May06)

Work shall be designed according to the following building code:

Building Code: 2002 Arkansas Fire Prevention Code (based on the IBC 2000 with supplements)	
Occupancy Category	Category III – Substantial Hazard
Occupancy Classification	Group F
Seismic Importance Factor, I_E	1.25
Snow Importance Factor, I_S	1.1
Wind Importance Factor, I_W	1.15
Meteorological Data:	
Basic Wind Speed, V, 3-second gust wind speeds at 33 ft above ground, mph	90
Exposure	Category C
Ground Snow Load, P_g, 50 year mean recurrence interval, psf	10
Site Elevation (mean sea level), ft	248
Seismic Design Data:	
Plum Point Horizontal Design Spectrum Values At Ground Surface.	Table D100-A
Plum Point Horizontal Design Spectrum At Ground Surface.	Figure D100-A

Plum Point Vertical Design Ground Motions	For Structural analysis, use the provisions of the building code.
Seismic Site Class	F
Seismic Design Category	E
Seismic Use Group	II

Table D100-A
Plum Point Horizontal Design Spectrum Values at Ground Surface

Periods (seconds)	Spectral Acceleration (g)
PGA	0.52
0.2	1.30
0.9	1.30
1.0	1.15
1.1	1.05
1.2	0.96
1.3	0.92
1.4	0.96
1.5	0.95
1.6	0.93
1.7	0.90
1.8	0.88
1.9	0.87
2.0	0.83
2.2	0.76
2.4	0.70
2.6	0.62
2.8	0.58
3.0	0.52
3.2	0.47
3.4	0.46
3.6	0.43
3.8	0.42
4.0	0.40

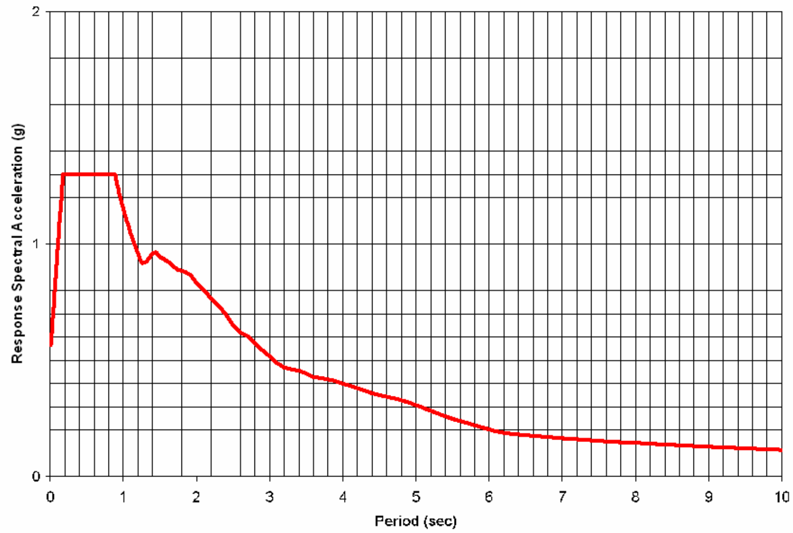


Figure D100-A
Plum Point Horizontal Design Spectrum at Ground Surface

D200 Design Ambients

(Source: 27Jan04 - Revised by Project: 25Apr06)

Area Specific Design. The general design ambient air conditions shall be used unless area specific or equipment specific conditions are indicated in the contract documents:

Outdoor Air Conditions					
	Temperature, °F			Relative Humidity, %	
	Minimum		Maximum	Minimum	Maximum
	10		110	0	100
Indoor Air Conditions					
Building/Area	**Indoor Temperature Max (°F)**	**Indoor Temperature Min (°F)**	**Humidity Control (%RH)**	**Min Ventilation Rate (ac/hr)**	**Minimum Particulate Filtration Efficiency (%,MERV)**
Turbine Area					
Below the Operating Floor	104	45	None	20	None
Above the Operating Floor	104	45	None	6	None
Sample Panel Room	78	70	Less than 65	NA	30, 7

SAMPLE TRANSMITTAL FORM

Enter Supplier Information Here	**TRANSMITTAL SHEET**	**Date:** XX/XX/XXXX **Sheet:** 1 OF XX

Project: Plum Point Energy Station

Contract: Concrete Chimney	Contract No.: 61.1001	Packet Designation: XX	Transmittal No. XXXX	New Submittal ___ Resubmittal ___

Supplier Drawing Data			Document Title:	PPPP Drawing No.	PPPP Document Data from the Schedule of Submittals		
Item No.	Doc No.	Rev No.			Doc Class	Drawing Series	Item No.

Remarks:

S100 Seismic Design

(Source: 27Jan04 - Revised by Project: 09Jun06)

S100.1 General

This article specifies the general criteria and procedures that shall be used to ensure that structures, components, and equipment meet performance objectives during and following a seismic event. The intent of these procedures is to minimize the hazard to human life. Seismic design shall be completed in accordance with the IBC-2000, as referenced in the Arkansas Fire Code 2002, based on Seismic Use Group II and Seismic Design Category E. Structures, components, and equipment shall be designed based on Good Utility Practice and appropriate Occupancy Importance Factors (Ip) as indicated herein. Buildings and structures may be damaged but remain suitable for occupancy and use, albeit in an impaired condition. The damage is anticipated to be repairable. Components and equipment are expected to remain in place without collapsing or breaking away from supports, and to remain intact to the extent that they do not create an ignition hazard or release hazardous materials.

The building structural system shall provide a continuous load path or paths, with adequate strength and stiffness to transfer all seismic forces from the point of application to the final point of resistance.

Components and equipment shall be attached so that seismic forces are transferred to the structural system of the building. These attachments shall be bolted, welded, or otherwise positively fastened. Frictional resistance due to gravity shall not be considered in evaluating the required resistance to seismic forces.

For seismic design of vessels, tanks, and other components, contents that are flammable, explosive, corrosive, acidic, caustic, toxic, or that otherwise present a danger to the general public if released shall be considered hazardous materials.

Seismic design shall be performed in accordance with the building code specified in Supplemental Specification D100 Site Meteorological and Seismic Data in this Section 01400, along with the following references:

American Institute of Steel Construction (AISC), "Specification for Structural Steel Buildings - Allowable Stress Design and Plastic Design," 1989.

American Institute of Steel Construction (AISC), "Load and Resistance Factor Design Specification for Structural Steel Buildings," 1993.

American Institute of Steel Construction (AISC), "Seismic Provisions for Structural Steel Buildings," 1997.

American Concrete Institute (ACI), ACI 318-99, "Building Code Requirements for Structural Concrete," 1999.

American Society of Mechanical Engineers (ASME), "Boiler and Pressure Vessel Code," 1995, and all addenda.

ASME Boiler and Pressure Vessel Code, 2004, including 2005 Addenda and all applicable code cases.

ASME Code for Pressure Piping, ASME B31.1 – 2004, Power Piping, including the 2005 Addenda and all applicable code cases for nonboiler external piping.

Manufacturers Standardization Society of the Valve and Fitting Industry (MSS), MSS SP-58, "Pipe Hangers and Supports - Materials, Design, and Manufacture," 2001.

American Petroleum Institute (API), API 650, "Welded Steel Tanks for Oil Storage," 1993.

American Water Works Association (AWWA), AWWA D100, "Welded Steel Tanks for Water Storage," 1984.

National Fire Protection Association (NFPA), NFPA 13, "Standard for the Installation of Sprinkler Systems," 1990.

International Building Code (IBC), IBC 2000.

Other nationally recognized and accepted design standards and references as appropriate.

S100.2 Seismic Forces

Seismic forces shall be determined from the basic seismic parameters given in Supplemental D100. The design forces and their distribution over the height of the building or structure shall be determined using a dynamic analysis and the procedures listed in the specified building code. Load combinations, including seismic, shall be in accordance with the specified building code.

Hydrodynamic effects of contents shall be considered in the seismic design of vessels and tanks as required by the specified building code.

S100.3 Seismic Design

S100.3.1 Buildings

Buildings shall provide sufficient strength and ductility to resist the specified seismic effects and may use any of the basic structural systems permitted by the specified building code. Usage of structural systems shall be in accordance with the limitations prescribed in the specified building code. The effects of both plan and vertical irregularities shall be considered, as required by the specified building code.

Buildings shall be seismically analyzed using either Equivalent Lateral Forces or Dynamic Modal Analysis and shall meet all of the design, proportioning, detailing, inspection, and quality assurance provisions of the specified building code.

"W" for buildings shall include the total dead load, the total operating weight of permanent equipment and the effective contents of vessels, and applicable portions of other loads, as required by the specified building code.

S100.3.2 Nonbuilding Structures

Nonbuilding structures include all self-supporting structures, other than buildings, bridges, and dams, that are supported by the earth; that carry gravity loads; and that may be required to resist seismic effects. Design of nonbuilding structures shall provide sufficient strength and ductility, consistent with the requirements for buildings, to resist the specified seismic effects.

Nonbuilding structures shall be seismically analyzed using either Equivalent Lateral Forces or Dynamic Modal Analysis, and shall meet all of the design, proportioning, detailing, inspection, and quality assurance provisions of the specified building code.

"W" for nonbuilding structures shall include all dead load as defined for buildings, and shall also include all normal operating contents of tanks, vessels, bins, and piping.

Seismic design of reinforced concrete chimneys shall use the Dynamic Response Spectrum Analysis method of ACI 307-98. Seismic design of steel stacks shall also use the Dynamic Response Spectrum Analysis method. The analytical model used in the dynamic analysis of these structures shall be sufficiently refined to represent variations of chimney, stack, and liner masses; variations of stiffness; and the foundation support condition.

S100.3.3 Nonstructural Components

Nonstructural components shall be designed to withstand horizontal seismic loads and displacements.

Lateral horizontal loads shall be applied in two orthogonal directions. Loads shall be adjusted where applicable for components, based on actual attachment locations relative to elevation in a building and/or attachments to more than one structure.

Lateral horizontal displacements shall be determined from the building structural analysis. In general, displacements on components at the same floor elevations may be considered negligible. Components attaching over two or more floor elevations or between two or more structures shall be evaluated for seismic relative displacements.

Vertical earthquake loads are not required on this project for components.

Seismic forces for components and equipment shall be determined in accordance with the applicable codes and standards or as noted in Table 1 - Horizontal Seismic Forces.

The applicable Importance Factors (Ip) shall be determined as follows:

Ip = 1.5 for components that contain hazardous or flammable materials. All components in the following systems shall utilize an Ip of 1.5.

System Code	System Title
APK	Emergency Generation (fuel oil tank only)
BSV	Fuel Oil Unloading
CGA	Hydrogen Storage
CGE	Ammonia Storage
FOA	Fuel Oil Receiving and Storage
FOB	Fuel Oil Supply
FPA	Building Fire Protection
GTB	Generator Step-Up Transformers
PSB	Auxiliary Boiler Fuel
TGD	Turbine Lube Oil
TGH	Hydrogen Seal Oil
WSE	Fire Protection Water Supply and Storage (fuel oil tank only)

Ip = 1.0 for all components that are not indicated as 1.5.

S100.3.3.1 Equipment. Seismic design of mechanical and electrical equipment, attachments, and supports shall consider the dynamic effects of the equipment; its contents; piping attached to its nozzles; and, when appropriate, its supports.

Seismic design loads shall be applied to the total mass of the equipment, including all attachments. The loads shall be applied in two horizontal orthogonal directions simultaneously. The resultant stresses in each component within the equipment shall be combined by the square root sum of the squares. Due to the reversibility of seismic forces, the resultant stresses shall be considered both positive and negative (tension and compression).

Seismic displacements for equipment with attachments at the same elevation within the building may be ignored. Displacements between buildings shall be considered out-of-phase, and the displacement shall be applied to the piping system so that the values have a maximum range based on the actual movements at attachment elevations.

Stresses due to seismic loading and displacements shall be combined with operating loads and any external nozzle loads and compared to the appropriate Code allowable.

Anchorages shall be designed to resist the seismic forces for which the equipment is designed.

Equipment mounted on vibration isolation systems shall have a bumper restraint or snubber in each horizontal direction. These seismic restraints shall be designed for twice the seismic force acting on the equipment. Seismic supports shall maintain positive engagement with the equipment.

S100.3.3.2 Components. Components are architectural, mechanical, and electrical parts and portions that are attached to and supported by the building, but are not part of the building structural system, such as nonbearing walls and partitions, ceilings, storage racks, access floors, tanks, piping, HVAC ductwork, elevators, electrical panels, cable tray, and other nonstructural items. Components shall have the same Seismic Performance Category as the building to which they are attached.

W_p for tanks, bins, and silos shall represent the weight of the tank structure and appurtenances and the operating weight of the contents at maximum rated capacity.

W_p for piping systems shall represent the total distributed operating weight of the piping system, including, but not limited to, any insulation, fluids, and concentrated loads such as valves, condensate traps, and similar components.

Seismic effects that shall be analyzed in the design of piping systems include the dynamic effects of the piping system, contents, and, when appropriate, supports. The interaction between the piping system and the supporting structures, including other mechanical and electrical equipment, shall also be considered.

In addition to seismic loadings, piping systems shall be designed to withstand dead plus operating loading, occasional (wind or hydrotesting) loading, and thermal loadings. Wind loadings shall not be considered as acting concurrently with seismic loadings.

The design of piping systems, supports, and components shall be completed in accordance with the requirements of the ASME B31.1 Code. The following clarifications shall be utilized in the analysis of piping systems:

> Piping systems for this project, including supports, are considered to be high deformability elements due to the ductile nature of most steel utilized in piping systems. Where piping systems and support elements have limited or low deformability, appropriate values shall be used for the Component Response Modification Factor in determining seismic loading.
>
> Stresses due to seismic loading and building displacements shall be determined for each of the two orthogonal directions and compared to the allowable code separately. As allowed by the code, stresses due to displacements may be evaluated as primary loads and combined with other occasional loads or evaluated as secondary loads and combined with other displacements such as thermal expansion.
>
> Displacements within the same building may be assumed in phase and applied to the pipe based on actual movements at attachment elevations. Displacements between buildings shall be considered out-of-phase, and the displacement shall be applied to the piping system so that the values have a maximum range based on the actual movements at attachment elevations.
>
> Seismic loads shall be combined with other occasional loads, including but not limited to, turbine trip and relief valve thrust load cases.

In-line components shall be designed with the same loads as the piping system, taking into consideration the center of gravity and weight of the component and all attaching items such as operators. It is recommended that valve procurement specifications utilize the maximum seismic design load factors for allowable criteria so that valves may be installed at any elevation in the building.

Seismic displacements shall be limited to 3 inches in each of two horizontal orthogonal directions and one vertical direction.

Seismic supports shall be designed to withstand the effects of seismic loading in both tension and compression.

Dead weight supports shall be evaluated for bucking and uplift. Rod supports shall not be put in compression due to seismic loading.

Spring supports shall be evaluated to ensure that variable and constant support assemblies remain loaded during the seismic event.

Supports, attachments, and/or anchorages shall be designed for all loading conditions such as dead weight, occasional loads, displacements, and thermal expansion.

Seismic design is not required for piping meeting the following conditions:

Piping 1 inch nominal diameter and smaller with an Ip greater than 1.0 where provisions are made to protect adjacent piping from impact or to avoid impact of larger piping or other equipment.

Piping 3 inch nominal diameter and smaller having an Ip equal to 1.0.

Piping systems with limited and low deformability shall be evaluated to see if they meet the above criteria and shall be designed for seismic loading, if appropriate.

Exception, piping, and support systems required to be designed in accordance with NFPA 13 shall be seismically analyzed.

S100.4 Documentation

Complete structural support and anchorage details shall be shown on all drawings, including the size of members, details of connections, anchor bolt sizes, etc.

Since the specified building code is the 2002 Arkansas Fire Prevention Code (based on the IBC 2000 with supplements), the following seismic design data shall be indicated on the design drawings:

Description, drawing, or arrangement of item being analyzed.

Seismic Use Group.

Design Spectral Response Accelerations S_{DS} and S_{D1}.

Site Class.

Basic Seismic Force Resisting System.

Design Base Shear.

Analysis Procedure.

Equipment and component drawings shall indicate the total load and/or loads to be transmitted to the structure that must ultimately restrain the components, equipment, or structure. This information shall include the weight, dimensions locating the center of gravity of the component or equipment, or the seismic design forces (magnitude, direction, and location) acting on the supports.

If requested by the Purchaser, design calculations shall be submitted for all structures, equipment, or components which are designed in accordance with this Supplemental Specification. If requested by the Purchaser, these calculations shall be certified by a professional engineer registered in the appropriate jurisdiction.

Table 1 - Horizontal Seismic Forces (Fp)

Components and Equipment	Minimum Seismic Force	Maximum Seismic Force
Piping for Ip = 1.0	0.40 Wp	0.45 Wp
Piping for Ip = 1.5	0.59 Wp	0.67 Wp
Boiler	0.40 Wp	0.62 Wp
Turbine	0.52 Wp	1.56 Wp
Pressure Vessels	0.52 Wp	1.56 Wp
Pumps	0.40 Wp	0.62 Wp
Electrical Elements	0.40 Wp	0.62 Wp
HVAC Equipment	0.40 Wp	0.62 Wp
HVAC Equipment with Vibration Isolation	0.52 Wp	1.56 Wp
Electrical Raceway and Bus	0.40 Wp	0.45 Wp

Notes:

1) Where applicable, seismic forces minimum and maximum values may be adjusted based on attachment elevation.

2) Seismic forces may act in any horizontal direction. Vertical seismic forces are negligible.

3) Seismic forces are based on Strength Design Criteria and may be factored by 0.7 when analysis and design are based on Allowable Stress Design Criteria.

S200 Equipment Access Provisions

(Source: 27Jan04 - Revised by Project: 25Apr06)

This Supplemental Specification covers design and fabrication requirements for equipment access provisions.

Access provisions shall consist of stairs, platforms, walkways, handrails, guardrails, and ladders necessary to provide complete and convenient access for operation, inspection, testing, and maintenance. Arrangement drawings for access provisions shall be provided as part of the Technical Data.

S200.1 Design Criteria

Access provisions shall conform to all applicable codes and standards and the following minimum requirements.

As a minimum, all egress paths and provisions shall be designed to comply with OSHA and NFPA 101 Regulations, including all addenda and interpretations. Application of these regulations shall be based on their literal translation.

S200.1.1 Support Steel

Platform and walkway supporting steel shall be designed for a minimum live load of 75 pounds per square foot (3,590 Pa). Fixed stairways shall also be designed for a minimum live load of 100 pounds per square footand a minimum moving concentrated load of 1,000 pounds as specified in OSHA 29CFR-1910.24(c). Vertical live load deflection of steel framing members shall not exceed 1/300 of the span length or a maximum of 3/4 inch. The length of landing platforms, measured in direction of travel, shall be

Frank A Pisz

From: Freeland, Frederick H. (Fred) [FreelandFH@bv.com]
Sent: Wednesday, September 02, 2009 4:10 PM
To: Frank A Pisz
Cc: 'Todd Grovatt'; 'Gary Fletcher'; 'Dan Hynds'; Kohns, Larry R.; Wiley, F. Alan; Plum Point - 143574; Knudsen, Carlin C.
Subject: 61.1001.5 090902 Seismic Questions
Attachments: Concrete Chimney (Partial).pdf

Frank,
Please see responses to your questions provided by Alan Wiley (B&V) below.

Let me know if you have further questions.

Fred Freeland
913-458-2436

From: Wiley, F. Alan
Sent: Wednesday, September 02, 2009 4:01 PM
To: Freeland, Frederick H. (Fred)
Cc: Kohns, Larry R.
Subject: RE: More questions on Plum Point

I have attached the D100 & S100 supplements from the Chimney contract

Responses to queries from vendor:
1) Seismic acceleration values for design (S_{Dx}) are to be taken from table D100-A (Figure D100-A). They are based on a site specific seismic study.

2) The computed fundamental frequency of the chimney is approximately 1.1 second.

a) The building code to be used is the 2002 Arkansas Fire Prevention Code, which is based on IBC 2000 and ASCE 7-98). Do not use ASCE 7-05. Coefficients for elevator components are the same as those for boilers, so one can apply the values for boiler from Table 1.

b) If the elevator is free-standing, then yes the 3 inch limit would be measured from the foundation level. However, if it is attached to the chimney shell, then the limit would be measured from the attachment point to the chimney shell.

From: Frank A Pisz [mailto:fpisz@austin.rr.com]
Sent: Wednesday, September 02, 2009 1:12 PM
To: Freeland, Frederick H. (Fred)
Cc: 'Todd Grovatt'; 'Gary Fletcher'; 'Dan Hynds'
Subject: More questions on Plum Point

Hello Fred,

I'm Frank Pisz, working for Tower Elevators, and have a couple more questions for you, the response which will aid in our seismic analysis of the elevator structure.

1) What do you consider to be the correct "Maximum Considered Earthquake Ground Motion for Region 3 of 0.2 Sec Spectral Response acceleration (5% of critical damping), site class B" (Ss) as shown in figures 22-1 and 22-7 of ASCE 7-05? It is hard for me to put Osceola on the map exactly and the gradients for Ss are very steep

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in the figures in the code book. It appears to be somewhere between 200 and 300 percent g.

2) Would it be possible for you to give me the calculated value of frequency (1/T) which you obtained for the fundamental mode of the chimney?

Thank you,
Frank A Pisz

From: Dan Hynds [mailto:dhynds@towerelevators.com]
Sent: Monday, August 31, 2009 9:54 AM
To: Fred Freeland
Cc: Frank Pisz; Todd Grovatt; Gary Fletcher
Subject: FWD: re: Plum Point

Hi Fred,

Our structural engineer Frank Pisz is completing the structural analysis of the elevator and has a couple of questions listed below. Could you forward these questions to your engineers and get us the answers? Please let me know if you need any more information.

thx dan

Dan Hynds
Dir of Operations
Tower Elevator Systems, Inc.
(512) 266-6200 x222 Office
(512) 266-6210 fax
(512) 284-4978 cell
www.towerelevators.com <http://www.towerelevators.com>

Higher Technology for Safety's Sake

---------------------- Original Message ----------------------

From: "Frank A Pisz" <fpisz@austin.rr.com> <mailto:fpisz@austin.rr.com>
To: "'Todd Grovatt'" <todd@towerelevators.com> <mailto:todd@towerelevators.com>
Date: Mon, 31 Aug 2009 05:41:35 -0500
Subject: Plum Point

Good Morning Todd,

Could we meet sometime tomorrow afternoon or Weds morning to discuss?

Before then, could you ask the Plum Point contact a couple of questions:

a) Regarding the Technical Supplemental Specification for Plum Point Energy Station,

Section 100.3.3.2 Components, defines the elevator structure as a “component”

In table 1 on page 200 of 257, the Horizontal Seismic Forces (Fp) are listed

for several components, but the elevator structure is not included. Does this

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imply we are to obtain Fp from section 13.3 of ASCE/SEI 7-05?

b) On page 198 of this same document, there is a statement under section 100.3.3.2 Components that states that, "seismic displacements shall be limited to 3 inches in each of the two horizontal orthogonal directions and one vertical direction." Is this statement to be taken as meaning that when performing a Response Spectrum analysis that the displaced results relative to the ground excitation are limited to 3 inches in each of the horizontal directions?

Thanks,

Frank

9/6/2009

Frank A Pisz

From: Wiley, F. Alan [WileyFA@bv.com]

Sent: Wednesday, September 09, 2009 4:07 PM

To: Frank A Pisz

Cc: Freeland, Frederick H. (Fred); Knudsen, Carlin C.; Kohns, Larry R.; Plum Point - 143574; 'Todd Grovatt'; 'Gary Fletcher'; 'Dan Hynds'

Subject: RE: Seismic Questions

Minimum Seismic forces in Table 1 (Supplement S100) are based on AR 2002, Equation 16-69: $F_P = 0.3\ S_{DS}\ I_P\ W_P$, except for the 3 cases where $F_P = 0.52\ W_P$. These entries are based on Equation 16-67, using a height adjustment multiplier of 1 (z/h = 0), and I don't believe that they are applicable to the elevator.

All entries for Maximum Seismic forces in the same table are based on Equation 16-67, using a height adjustment multiplier of 3 (z/h =1). If z/h is less than 1, then it is permissible to reduce the maximums.

Note
AR 2002, Equation 16-67 is identical to ASCE 7-98, Eq. 9.6.1.3-1 and
AR 2002, Equation 16-69 is identical to ASCE 7-98, Eq. 9.6.1.3-3

From: Frank A Pisz [mailto:fpisz@austin.rr.com]
Sent: Tuesday, September 08, 2009 5:00 PM
To: Wiley, F. Alan; Freeland, Frederick H. (Fred)
Cc: 'Todd Grovatt'; 'Gary Fletcher'; 'Dan Hynds'; Kohns, Larry R.; Plum Point - 143574; Knudsen, Carlin C.
Subject: Seismic Questions

Hello Alan:

Re: Plum Point energy Station 143574.61.1001, Table 1 – Horizontal Seismic Forces (Fp)

As you suggested, we are working to the values listed in the table of the above listed document for the boiler in our application to the elevator analysis.

In the Notes section under the table, it is stated in note 1 that, "Where applicable, seismic forces minimum and maximum values may be adjusted based on attachment elevation."

Question: Are the values given in the table the maximum and minimums for the structure at ground elevation and are they to be "adjusted" by multiplying by the factor (1+(2z/h)) as given in Eq 9.6.1.3-1 of ASCE 07-98?

Or is there a different interpretation of this statement applicable?

Just want to make sure........

Thank you

Frank A Pisz

Tower Elevator Systems, Inc.

9/10/2009

Frank A Pisz

From: Wiley, F. Alan [WileyFA@bv.com]
Sent: Thursday, September 03, 2009 9:30 AM
To: Frank A Pisz; Freeland, Frederick H. (Fred)
Cc: 'Todd Grovatt'; 'Gary Fletcher'; 'Dan Hynds'; Kohns, Larry R.; Plum Point - 143574; Knudsen, Carlin C.
Subject: 61.1001.5 090903 Seismic Questions

My response should have read the fundamental period is approximately 1.1 seconds, so the frequency is about 0.9 Hz. Sorry for the confusion.

I believe that your first interpretation of the seismic deflection limit is the correct one. Measure from points on the elevator to the attachment point to the chimney shell.

F. Alan Wiley, P.E.
Special Structures Section Leader, B&V Energy Division
Black & Veatch Corporation
11401 Lamar Ave. Overland Park, KS 66211 USA
Tel: (913) 458-7441
wileyfa@bv.com
Building a World of Difference®

From: Frank A Pisz [mailto:fpisz@austin.rr.com]
Sent: Wednesday, September 02, 2009 7:44 PM
To: Freeland, Frederick H. (Fred)
Cc: 'Todd Grovatt'; 'Gary Fletcher'; 'Dan Hynds'; Kohns, Larry R.; Wiley, F. Alan; Plum Point - 143574; Knudsen, Carlin C.
Subject: RE: 61.1001.5 090902 Seismic Questions

Hello Fred!

Sorry to bother you again. Need some clarification.

Regarding the response to question 2 below, is the frequency 1.1 cycles per second (Hz) or is the period of the frequency 1.1 second. I know that the difference is small, but it does make a difference in the response calculation.

Since the elevator is attached at the foundation and along its length at many points to the chimney shell, is the deflection defined taken from any point on the elevator relative to the motion at the attachment point to the elevator shell or from any point on the elevator to the attachment point at the foundation?

We just wish to make sure we don't misunderstand.

Thanks,

Frank Pisz

From: Freeland, Frederick H. (Fred) [mailto:FreelandFH@bv.com]
Sent: Wednesday, September 02, 2009 4:10 PM
To: Frank A Pisz
Cc: 'Todd Grovatt'; 'Gary Fletcher'; 'Dan Hynds'; Kohns, Larry R.; Wiley, F. Alan; Plum Point - 143574; Knudsen,