Hanford Double-Shell Tank Thermal and Seismic Project - Seismic Analysis in support of Increased Liquid Level in 241-AP Tank Farms

Author: TC Mackey

WRPS

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Abstract: The essential difference between Revision 1 and the original issue of this report is in the spring constants used to model the anchor bolt response for the anchor bolts that tie the steel dome of the primary tank to the concrete tank dome. Consequently, focus was placed on the changes in the anchor bolt responses, and a full reevaluation of all tank components was judged to be unnecessary. To confirm this judgment, primary tank stresses from the revised analysis of the BES-BEC case are compared to the original analysis and it was verified that the changes are small, as expected. .

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F. G. Abatt
M. W. Rinker

January 2008

Prepared for
CH2M HILL Hanford Group, Inc.
in Support of the
Double-Shell Tank Integrity Program

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Pacific Northwest National Laboratory
Richland, Washington 99352

(a) M&D Professional Services, Richland, Washington.

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Seismic Analysis in Support of Increased Liquid Level in 241-AP Tank Farm

F.G. Abatt

January 2008

Prepared by
M&D Professional Services, Inc.
for
Pacific Northwest National Laboratory

Prepared by: F.G. Abatt 1/9/08
F.G. Abatt

Checked by: C. Hendrix 1/9/08
C. Hendrix

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Executive Summary

The work presented in this report is an extension of the baseline seismic analysis documented in Deibler et al. (2007a) and Rinker et al. (2006c). The baseline analysis was for a bounding generic tank configuration based on the 241-AY tanks having a bulk waste specific gravity of 1.7 and a waste level of 422 inches. In this analysis, the bulk specific gravity and waste level were increased to 1.83 and 460 inches, respectively. The previously developed models were used with minor modifications to represent the 241-AP tanks. Earlier studies documented in Rinker and Abatt (2006a, 2006b) and Rinker et al. (2006a, 2006b) provide the justification for the basic models and analysis techniques.

The fundamental difference between this analysis and the baseline liquid level analysis reported in Deibler et al. (2007a) and Rinker et al. (2006c) is increased interaction between the liquid waste and the tank dome (i.e., more complex sloshing response). To address the more complex fluid-structure interaction analysis at the increased liquid level, sub-models of the primary tank were created in both Dytran[®] and ANSYS^{®1} and the results were compared. The Dytran^{®2} sub-model analysis served as an alternate calculation for evaluating the stresses in the primary tank due to fluid-structure interaction. However, the seismic evaluation of all tank components was based directly on the results of the global ANSYS[®] model, just as in the baseline seismic analysis.

In the concrete shell, the ANSYS[®] global model showed that forces and moments are generally highest for the lower bound soil load case. Due to the higher relative stiffness of the tank as compared to the soil for the lower bound soil, loads are transmitted through the stiffer path. The lowest forces and moments are generally found in the fully cracked concrete case. In this case, the concrete is much more compliant and the load path is retained through the soil.

In the primary tank, the highest stresses occur for the upper bound soil case near the middle of the primary tank wall. The lowest stresses in the primary tank occur for the lower bound soil case. Primary tank stresses correlate well to the free-field soil response at the bottom of the double-shell tank (57 ft below grade). The free-field soil seismic response at the level of the bottom of the tank shows a pronounced drop in the lower bound soil for frequencies corresponding to the impulsive natural frequency of the tank/fluid system.

The primary tank sub-model study showed that the stresses in the primary tank are very similar for the Dytran[®] and ANSYS[®] sub-models except near the liquid-free surface, which was the expected result based on earlier studies. Some differences also existed in the knuckle region of the primary tank, but these were at least partly due to a configurational difference between the two models in the knuckle region.

Agreement between the ANSYS[®] and Dytran[®] sub-models occurs in the majority of the tank because the total stresses are dominated by gravity loading, which should be captured sufficiently by either model, and the seismic stresses are dominated by the impulsive response, which is adequately captured by either model. Although the ANSYS[®] model is deficient in its ability to properly simulate the convective effects of the contained liquid, this convective response is not a major contributor to the demands on the primary

¹ ANSYS[®] is a registered trademark of ANSYS, Inc., Canonsburg, Pennsylvania.

² Dytran[®] is a registered trademark of MSC Software Corporation, Santa Ana, California.

tank. Moreover, ANSYS® tends to overpredict the stress magnitudes near the free surface, so the results are conservative relative to the more accurate Dytran® solution. Given the available stress margins in the primary tank, it was acceptable to use the seismic demands from the global ANSYS® model for the ASME code evaluation of the 241-AP primary tank reported in Deibler et al. (2008).

The essential difference between Revision 1 and the original issue of this report is in the spring constants used to model the anchor bolt response for the anchor bolts that tie the steel dome of the primary tank to the concrete tank dome. In the original report (Revision 0), the nominal values of the anchor bolt shear and axial stiffness were 139,000 lbf/in. and 189,800 lbf/in., respectively. In the current revision, the stiffnesses have been reduced to 65,000 lbf/in. for both shear and axial response. The motivation for modifying the anchor bolt properties and the development of the new values is discussed in Appendix B of Deibler et al. (2008).

The four seismic cases of best-estimate soil, best-estimate concrete (BES-BEC), lower-bound soil, best-estimate concrete (LBS-BEC), upper-bound soil, best-estimate concrete (UBS-BEC), and best-estimate soil, fully cracked concrete (BES-FCC) were rerun using the modified anchor bolt response. Because the significant change to the models consisted of reducing the anchor bolt stiffnesses, the significant effects on the response of the overall tank model are expected to be limited local changes. That is, the forces and displacements of the anchor bolts are expected to change, but the differences in the response of the other tank components such as the primary tanks stresses, secondary liner strains, and concrete tank forces and moments are expected to be small.

Consequently, focus was placed on the changes in the anchor bolt responses, and a full reevaluation of all tank components was judged to be unnecessary. To confirm this judgment, primary tank stresses from the revised analysis of the BES-BEC case are compared to the original analysis and it was verified that the changes are small, as expected.

Acronyms and Abbreviations

B	Bulk Modulus
BEC	Best-Estimate Concrete
BES	Best-Estimate Soil
BNL	Brookhaven National Laboratory
DST	Double-Shell Tank
E	Elastic Modulus
FCC	Fully Cracked Concrete
G	Shear Modulus
g	Acceleration of Gravity
Hz	Hertz (cycles per second)
LBS	Lower Bound Soil
M&D	M&D Professional Services, Inc
PNNL	Pacific Northwest National Laboratory
psi	Pound per Square Inch
SRSS	Square Root of the Sum of the Squares
SSI	Soil Structure Interaction
TOLA	Thermal and Operating Loads Analysis
UBS	Upper Bound Soil
ϕ	Soil Internal Angle of Friction
ρ	Mass Density
ν	Poisson's Ratio
σ	Stress

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1.0 Introduction

A seismic analysis of the Hanford double-shell tanks (DSTs) for a bounding generic configuration at the baseline liquid level of 422 inches was reported in Deibler et al. (2007a) and Rinker et al. (2006c). This analysis extends that work and was performed in support of a proposed liquid level increase for the 241-AP tanks. The baseline seismic analysis was for a bounding generic tank configuration based on the 241-AY tanks having a bulk waste specific gravity of 1.7 and a waste level of 422 inches. In this analysis, the bulk specific gravity and waste level were increased to 1.83 and 460 inches, respectively. The previously developed models were used with minor modifications to represent the 241-AP tanks.

The biggest difference between the baseline seismic analysis and the original seismic analysis for the proposed increased liquid level that was reported on Revision 0 of this document is the increased interaction between the waste and tank dome during a seismic event (i.e., more complex sloshing response). To address this more complex fluid-structure interaction behavior, sub-models of the primary tank were created and analyzed using both Dytran^{®1} and ANSYS^{®2}. Development of the supporting methodologies and benchmarking of solutions is documented in Rinker and Abatt (2006a, 2006b) and Rinker et al. (2006a, 2006b, 2006c).

As in the baseline seismic analysis, the following four load cases were considered:

- Lower Bound Soil Properties, Best-Estimate Concrete (LBS-BEC)
- Best-Estimate Soil Properties, Best-Estimate Concrete (BES-BEC)
- Upper Bound Soil Properties, Best-Estimate Concrete (UBS-BEC)
- Best-Estimate Soil Properties, Fully Cracked Concrete (BES-FCC)

The significant difference between the current revision (Revision 1) of this report and the original issue (Revision 0) is that the stiffnesses of the anchor bolts that tie the steel dome of the primary tank to the concrete tank dome have been reduced. The original values of the shear and axial stiffnesses were 139,000 lbf/in. and 189,800 lbf/in., respectively. The current anchor bolt stiffness is 65,000 lbf/in. in all directions. The reduced stiffnesses represent the secant shear stiffness (equivalent linear shear stiffness) of the embedded anchor bolts. The reduced shear stiffness was introduced into the models to credit the finite shear deformation that occurs in the connection prior to failure. It also serves to distribute the shear load more evenly between the outer and inner rows of anchor bolts. The motivation for modifying the anchor bolt properties and the development of the new values is discussed in Appendix B of Deibler et al. (2008).

The reduced stiffnesses simulate the secant shear modulus (equivalent linear shear modulus) of the anchor bolts. Setting the axial stiffness of the anchor bolts equal to the shear stiffness in the seismic models is insignificant because the anchor bolts essentially remain in compression under the combination of seismic and thermal and operating loads (Deibler et al. 2008), and the active load path in compression is the contact elements at the steel and concrete dome interface.

¹ Dytran[®] is a registered trademark of MSC Software Corporation, Santa Ana, California.

² ANSYS[®] is a registered trademark of ANSYS, Inc., Canonsburg, Pennsylvania.

The four seismic cases of best-estimate soil, best-estimate concrete (BES-BEC), lower-bound soil, best-estimate concrete (LBS-BEC), upper-bound soil, best-estimate concrete (UBS-BEC), and best-estimate soil, fully cracked concrete (BES-FCC) were rerun using the modified anchor bolt response. Because the significant change to the models was a reduction in the anchor bolt stiffnesses, the significant effects on the response of the overall tank model are expected to be limited local changes. That is, the forces and displacements of the anchor bolts are expected to change, but the differences in the response of the other tank components such as the primary tanks stresses, secondary liner strains, and concrete tank forces and moments are expected to be small. The second change to the analysis in the current revision (Revision 1) relative to the original issue (Revision 0) is a slight increase in the normal contact stiffness between the steel and concrete dome. This is described in more detail in Section 2.1.7.

Consequently, focus was placed on the changes in the anchor bolt responses, and a full reevaluation of all tank components was judged to be unnecessary. To confirm this judgment, primary tank stresses from the revised analysis of the BES-BEC case are compared to the original analysis, and it was verified that the changes are small, as expected.

The significant updates to Revision 1 of this report appear in Sections 1.0, 1.1, 1.2, 2.1.4, 9.3, 9.4, and 10.3. Sections 3.0 through 8.0 and the associated sub-sections are unchanged except for a few minor editorial corrections.

1.1 Discussion

The work presented in Revision 0 of this report was an extension of the baseline seismic analysis documented in Deibler et al. (2007a) and Rinker et al. (2006c). Earlier studies documented in Rinker and Abatt (2006a, 2006b) and Rinker et al. (2006a, 2006b) provide the justification for the basic models and analysis techniques. The fundamental difference between this analysis and the baseline liquid level analysis reported in Deibler et al. (2007a) and Rinker et al. (2006c) is interaction between the liquid waste and the tank dome.

Based on the earlier studies, the global ANSYS® model is expected to give sufficiently accurate results for all tank components except for portions of the primary tank. The limit on the ability of the global ANSYS® model to accurately predict the convective response of the tank waste is recognized and has been documented in the earlier reports.

The earlier reports also contain extensive benchmarking of the ability of Dytran® to adequately capture the fluid-structure interaction behavior in the tanks including convective effects. To address the more complex fluid-structure interaction analysis at the increased liquid level, sub-models of the primary tank were created in both Dytran® and ANSYS® and the results were compared.

As discussed in Section 1.0 of this report, the anchor bolt stiffnesses were reduced in the reanalysis performed in support of the current revision (Revision 1) of this report. Because this modification did not require a complete reevaluation of the seismic demand on all tank components, the remainder of this Section (Section 1.1) is unchanged from Revision 0, except that the maximum displacement reported between the primary tank and concrete dome has been increased from 0.063 inch to 0.096 inch to reflect the softer anchor bolts.

Forces and moments in the concrete shell are generally highest for the lower bound soil case. Due to the higher stiffness of the concrete shell compared to the soil for the lower bound soil, loads are transmitted through the stiffer path. The lowest forces and moments in the concrete shell are generally found in the fully cracked concrete case. In this case, the concrete is much more compliant and the load path is retained through the soil.

The highest stresses occur in the primary tank for the upper bound soil case near the middle of the primary tank wall. The lowest stresses in the primary tank occur for the lower bound soil case. Primary tank stresses correlate well to the free-field soil response at the bottom of the DST (57 ft below grade). The free-field soil seismic response at the level of the bottom of the tank shows a pronounced drop in the lower bound soil case for frequencies corresponding to the impulsive natural frequency of the tank/fluid system.

Of the contact surfaces used in the model, only two were shown to be important. The first is the contact interface between the soil and the concrete shell, which controls how the forces and displacements of the surrounding soil are transferred to the concrete shell. The second is the interface between the primary tank and the inside face of the concrete dome, where the presence of the contact interface is critical to obtaining the correct load path. Where the concrete dome and primary tank are in contact and the load path is in compression, the contact elements are in compression and transmit the load between these surfaces. Where separation occurs, the forces are transmitted through the anchor bolt connections only.

The results also show that the displacement between the bottom of concrete wall and the tank footing (basemat) due to seismic loading is insignificant. The reason is twofold: the axial load in the wall generates a significant normal force between the wall and the footing, and the wall cylinder is stiff enough to prevent local displacements where higher shear forces occur (i.e., the average shear at the interface does not exceed the friction capacity, even though localized shear forces may exceed localized friction capacities).

No significant sliding occurs at the interfaces between the concrete wall and the footing, primary tank and concrete dome, primary tank and insulating concrete, or insulating concrete and secondary liner. The maximum displacements are as follows:

• Concrete Wall/Footing	0.00103 inch
• Primary Tank/Concrete Dome	0.096 inch
• Primary Tank/Insulating Concrete	0.076 inch
• Insulating Concrete/Secondary Liner	0.025 inch

While the sliding displacement between the primary tank and concrete dome is small, the inclusion of this contact surface is critical to obtaining the correct load path.

The primary tank sub-model study showed that the stresses in the primary tank are very similar for the Dytran[®] and ANSYS[®] sub-models except near the liquid-free surface, which was the expected result based on earlier studies. Some differences also existed in the knuckle region of the primary tank, but these were at least partly due to a configurational difference between the two models in the knuckle region.

Near the liquid-free surface, the ANSYS® sub-model consistently predicted hoop stresses and meridional stresses of higher magnitude than the Dytran® sub-model. The shear stresses from the two models were very similar and of low magnitude.

Agreement between the ANSYS® and Dytran® sub-models occurs in the majority of the tank because the total stresses are dominated by gravity loading, which should be captured sufficiently by either model, and the seismic stresses are dominated by the impulsive response, which is adequately captured by either model. Although the ANSYS® model is deficient in its ability to properly simulate the convective effects of the contained liquid, this convective response is not a major contributor to the demands on the primary tank. Moreover, ANSYS® tends to overpredict the stress magnitudes near the free surface, so the results are conservative relative to the more accurate Dytran® solution. Given the available stress margins in the primary tank, it was acceptable to use the seismic demands from the global ANSYS® model for the ASME code evaluation of the primary tank reported in Deibler et al. (2007b).

1.2 Conclusions

Conclusions on the behavior of the DST to seismic and combined dead load and seismic loading are presented in this section. Overall conclusions regarding the evaluation of the 241-AP tanks for the proposed liquid level increase are presented in Deibler et al. (2007b).

1. Two of the contact surfaces used in the global ANSYS® model were shown to be important. The first is the contact interface between the soil and the concrete shell, which controls how the forces and displacements of the surrounding soil are transferred to the concrete shell. The second is the interface between the primary tank and the inside face of the concrete dome, where the presence of the contact interface is critical to obtaining the correct load path.
2. Other contact surfaces included in the model did not show significant non-linear behavior such as sliding; however, their behavior under higher loading cannot be predicted based on the current excitation levels.
3. The primary tank stresses are adequately predicted by the global ANSYS® model, except near the waste-free surface, where the stress predictions were conservative.
4. Given the generally low stresses in the primary tank near the waste-free surface, the primary tank can be successfully qualified for service using the conservative stresses reported by ANSYS®.
5. The stresses in the primary tank are dominated by gravity loading.
6. The reduction of anchor bolt stiffnesses had the expected effect of decreasing peak shear loads on the anchor bolts, increasing peak shear displacements of the anchor bolts, and more evenly spreading the load among the anchor bolts.
7. The reduction of the anchor bolt stiffness had very little effect on the primary tank stresses.

2.0 ANSYS® Global Model Description

The model used for the evaluation of the 241-AP tank configuration and increased liquid level is based on the model developed for the 241-AY tank and a liquid level of 422 inches (Rinker et al. 2006c). Key differences in the increased liquid level and the 241-AY model are as follows:

- 241-AP tank geometry used (geometry and wall thicknesses)
- Waste level increased to 460 inches
- Waste specific gravity increased to 1.83
- Number of contact areas used for waste/primary tank interface increased.

For completeness, a detailed description of the model development is provided below.

A model of a Hanford DST was created and analyzed using version 8.1 of the general-purpose finite element program ANSYS®. A half-symmetry model of the DST, including the concrete shell, primary tank, secondary liner, anchor bolts, waste, and surrounding soil was developed to evaluate the seismic loading on the DST. Figure 2-1 shows the complete model. Details for each part of the model are discussed in the following sections.

The tank model geometry was based on the 241-AP tank configuration shown in Hanford Drawing Number H-2-90534. The primary tank has a 450-inch radius, and a nominal height of the vertical wall is 422.3125 inches. The nominal dome apex is 561.5 inches above the bottom of the tank. The models were run using a waste depth of 460 inches. An excerpt from Drawing Number H-2-90534 is shown as Figure 2-2. The complete model, including the DST and surrounding soil is shown in Figure 2-1.

Figure 2-1. Composite Tank Model Detail

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Figure 2-2. 241-AP Primary Tank Dimensions

The detailed ANSYS® model was developed based on coordinates used in the Thermal and Operating Loads Analysis (TOLA) model. A series of input files were used to break the model creation into manageable parts. The files used and a short description is provided in Table 2-1. Files that are common to all load cases are provided in Appendix E. Files that are unique to a specific load case are provided in the appendix for each load case.

Table 2-1. ANSYS® Model Input File Description

File Name	Description
Run-Tank.txt	Calls each input for development of model.
Tank-Coordinates-AP.txt	Defines key geometry and model parameters. Concrete geometry set to match PNNL section cut locations.
Tank-Props-####.txt	Defines concrete material and real properties for model. Uses properties based on best-estimate or fully cracked conditions. Each tank layer can be assigned unique properties.
Tank-Mesh1.txt	Creates concrete shell mesh. Foundation and wall are separate entities
Primary-Props-AP.txt	Defines primary tank material and real properties.
Primary.txt	Creates primary tank mesh. Primary tank is not connected to concrete shell.
Insulate.txt	Creates insulating concrete mesh. Uses existing geometry from concrete and primary tanks, but is not connected.
Waste-Solid-AP.txt	Creates model of waste. Uses Solid45 elements with low shear modulus. Uses primary tank geometry.
Interface1.txt	Creates interface connections or contacts between pieces of model.
Interface-gap1.txt	Creates interface connections or contacts between pieces of model.
Bolts-friction.txt	Creates elements for anchor bolts and contact surface between the primary tank and concrete shell in the dome.
Liner.txt	Creates elements for Secondary Liner.
Near-Soil-1.txt	Creates soil model for excavated region around tank. Merges coincident nodes with concrete shell.
Soil-Props-####-Geo.txt	Defines all soil geometry and material properties. Excavated region and native soil have different material properties. Unique files are used for each soil condition (UB, BE, LB).
Far-Soil.txt	Creates far-field/native soil to a radius of 320 ft and depth of 266 ft. Merges coincident nodes with near soil and concrete shell. Places large mass at bottom of model for excitation force.
Fix-Soil.txt	Creates the contact interface between the excavated soil and native soil portions of the model.
Slave.txt	Creates slaved boundary conditions around exterior of model.
Boundary.txt	Creates boundary conditions for symmetry. Does not set boundary conditions for solution phase.
Live_Load.txt	Applies surface concentrated load over center of dome.
Outer-Spar.txt	Creates spar elements at edge of soil model to control shear behavior.

All components of the model are based on 9° slices over the half model, for a total of twenty slices. The following model description will address the tank components first, then the surrounding soil.

2.1 Tank Model

2.1.1 Concrete Shell

The first component developed in the model is the concrete shell and footing. Thirty-three sections are used between the dome and center of the floor for each 9° slice. In the detailed TOLA model documented

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in Rinker et al. (2004), seventy sections were identified and used for extracting forces and moments. Using the profile coordinates for these seventy sections, a subset of 33 sections was developed for the profile of the ANSYS® seismic model (see Table 2-2). Based on the need to allow for connecting other portions of the full model, some coordinates were adjusted relative to the TOLA model.

Table 2-2. Concrete Shell Centerline Coordinates

	Section	Coordinates			ANSYS®		
		R (in.)	H (in.)	t (in.)	X	Z	Set #
		0	568.6	15	0	568.8	1
Dome	1	30.2	568.6	15			
				15	45	568	2
Dome	2	61.4	567.5	15			
Dome	3	90.4	565.8	15	90.4	565.8	3
Dome	4	120.72	563.21	15	120.72	563.21	4
Dome	5	152.9	559.7	15	152.9	559.7	5
Dome	6	184.14	555.34	15			
Dome	7	211.4	550.7	15	211.4	550.7	6
Dome	8	239.1	545.2	15	239.1	545.2	7
Dome	9	271.85	537.45	15			
Dome	10	306.63	527.68	15	306.63	527.68	8
Dome	11	316.22	524.68	15			
Dome	12	335.6	518.2	15	335.6	518.2	9
Dome	13	356.7	510.37	15			
Dome	14	371.86	504.24	15			
Dome	15	393.7	494.5	15	393.7	494.5	10
Dome	16	404.5	489.3	18.92			
Haunch	17	415.2	483.7	20.31			
Haunch	18	428.7	476.2	22.58	428.7	476.2	11
Haunch	19	441.8	468.2	25.56			
Haunch	20	454.5	459.5	29.46			
Haunch	21	469.9	447.4	36.36	469.9	447.4	12
Haunch	22	483.8	423.18	29.71			
Haunch	23	486.9	407.1	22.52	486.9	407.1	13
Haunch	24	488.47	393.5	19.07			
Wall	25	489	382.1	18	489	374.1	14
Wall	26	489	360.8	18			
Wall	27	489	345.6	18			
Wall	28	489	335	18	489	327	15
Wall	29	489	321	18			
Wall	30	489	306	18			
Wall	31	489	300	18			
Wall	32	489	281	18	489	273	16
Wall	33	489	260.5	18			
Wall	34	489	236	18	489	228.5	17

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Table 2-2. (contd)

	Section	Coordinates			ANSYS®		
		R (in.)	H (in.)	t (in.)	X	Z	Set #
Wall	35	489	210.5	18			
Wall	36	489	201	18			
Wall	37	489	186.8	18	489	178.8	18
Wall	38	489	171	18			
Wall	39	489	150.5	18			
Wall	40	489	145.5	18	489	137.5	19
Wall	41	489	120.5	18			
Wall	42	489	100.5	18			
Wall	43	489	80	18			
Wall	44	489	60	18	489	62.0	20
Wall	45	489	39.9	18			
Wall	46	489	21	18	489	12	21
Wall	47	489	-4.5	18			
					489	-12.0	22
					531	-12.0	23
Slab	48	517	-18.4	23.5			
Slab	49	508.5	-18.4	23.5			
Slab	50	503	-18.4	23.5			
Slab	51	496.8	-19.1	23.5			
Slab	52	493	-19.1	23.5			
Slab	53	489	-19.1	22	489	-12.0	24
Slab	54	485.1	-19.1	22			
Slab	55	481	-19.1	22			
Slab	56	477	-19.1	22			
Slab	57	471	-19.1	22			
Slab	58	465	-19.1	22			
Slab	59	440	-19.1	19.38	438	-12.0	25
Slab	60	421.4	-17.9	17.05	423		
					400	-12.0	26
Slab	61	390	-15.9	13.12			
Slab	62	358	-13.9	9.13	340	-12.0	27
Slab	63	338	-13.4	8			
Slab	64	277.7	-13.4	8	280	-12.0	28
Slab	65	218.5	-13.4	8	220	-12.0	29
Slab	66	180	-13.4	8	160	-12.0	30
Slab	67	129.9	-13.4	8		-12.0	31
Slab	68	95.7	-13.4	8	100	-12.0	32
Slab	69	54	-17.1	15.43			
					36	-12.0	33
Slab	70	20	-20.1	21.5			
					0	-12.0	34

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The geometry of the concrete shell is based on a combination of data from drawings and the TOLA model. The basic geometry is based on drawings H-2-90534 and H-2-64306. Nodal locations were selected to correspond reasonably well to the TOLA model. This was done to simplify load combinations. Table 2-2 provides a listing comparison of nodal coordinates for the ANSYS® seismic model and TOLA model.

Input file “Tank-Coordinates-AP.txt” is used to read coordinate data for the concrete shell.

Element stiffnesses are also based on the TOLA model for best-estimate concrete conditions for a maximum temperature of 250°F. Common properties for all concrete sections are provided below.

Poisson’s Ratio (ν) = 0.18

Damping = 7%

Input file “Tank-Props-BEC-250.txt” defines the concrete shell material properties and real constants (thickness) for the best-estimate concrete. Input file “Tank-Props-BEC-Crack.txt” defines the concrete shell material properties and real constants (thickness) for the fully cracked concrete. Table 2-3 provides a complete listing of section properties based on the TOLA model. Table 2-4 provides concrete section properties assuming all sections are cracked.

Table 2-3. Best-Estimate Concrete Properties, 250°F

Is Section Cracked?	Eshl		Shell Thickness t-shl		Shell Density, Rho-shl		M&D Section No.	PNNL Section No.
	(psi)	(ksf)	(in.)	(ft)	(lb/in ³)	(lb/ft ³)		
N	4.502E+06	648,297	15.35	1.28	0.08484	147		1
N	4.352E+06	626,754	15.18	1.26	0.08578	148	1	2
N	4.306E+06	620,114	15.12	1.26	0.08609	149	2	3
N	4.282E+06	616,594	15.09	1.26	0.08627	149	3	4
N	4.262E+06	613,774	15.15	1.26	0.08595	149		5
N	4.243E+06	610,922	15.13	1.26	0.08609	149	4	6
N	4.315E+06	621,305	15.21	1.27	0.08559	148	5	7
N	4.295E+06	618,475	15.19	1.27	0.08572	148		8
N	4.216E+06	607,093	15.17	1.26	0.08583	148	6	9
N	4.201E+06	604,939	15.15	1.26	0.08594	148		10
N	4.439E+06	639,237	15.39	1.28	0.08463	146	7	11
N	4.425E+06	637,265	15.34	1.28	0.08487	147		12
N	4.405E+06	634,338	15.32	1.28	0.08497	147	8	13
N	4.392E+06	632,441	15.31	1.28	0.08504	147		14
N	4.316E+06	621,503	15.30	1.28	0.08510	147		15
N	4.406E+06	634,531	19.32	1.61	0.08499	147		16
N	4.366E+06	628,756	20.73	1.73	0.08505	147	9	17
N	4.323E+06	622,528	22.99	1.92	0.08527	147		18
Y	1.655E+06	238,350	26.72	2.23	0.08302	143		19
Y	1.345E+06	193,677	26.78	2.23	0.09548	165	10	20
N	4.000E+06	575,959	37.86	3.15	0.08337	144	11	21

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Table 2-3. (contd)

Is Section Cracked?	Eshl		Shell Thickness t-shl		Shell Density, Rho-shl		M&D Section No.	PNNL Section No.
	(psi)	(ksf)	(in.)	(ft)	(lb/in ³)	(lb/ft ³)		
N	3.960E+06	570,283	30.93	2.58	0.08339	144		22
Y	1.264E+06	182,025	21.60	1.80	0.09052	156		23
Y	1.409E+06	202,953	18.00	1.50	0.09197	159	12	24
Y	1.120E+06	161,221	15.28	1.27	0.10227	177		25
Y	1.093E+06	157,426	15.36	1.28	0.10170	176	13	26
Y	1.076E+06	155,010	15.42	1.28	0.10133	175		27
Y	1.068E+06	153,784	14.00	1.17	0.11163	193		28
Y	1.068E+06	153,784	14.00	1.17	0.11163	193		29
Y	1.068E+06	153,784	14.00	1.17	0.11163	193	14	30
Y	9.490E+05	136,651	13.53	1.13	0.11552	200		31
Y	9.490E+05	136,651	13.53	1.13	0.11552	200		32
Y	9.490E+05	136,651	13.53	1.13	0.11552	200	15	33
Y	9.490E+05	136,651	13.53	1.13	0.11552	200		34
Y	9.490E+05	136,651	13.53	1.13	0.11552	200	16	35
Y	9.490E+05	136,651	13.53	1.13	0.11552	200		36
Y	9.490E+05	136,651	13.53	1.13	0.11552	200		37
N	9.589E+05	138,084	14.89	1.24	0.10496	181	17	38
N	3.467E+06	499,310	18.08	1.51	0.08644	149		39
Y	3.435E+06	494,646	18.06	1.50	0.08652	150		40
Y	8.568E+05	123,378	12.89	1.07	0.12123	209	18	41
Y	8.568E+05	123,378	12.89	1.07	0.12123	209		42
Y	8.655E+05	124,633	14.21	1.18	0.10997	190	19	43
Y	8.655E+05	124,633	14.21	1.18	0.10997	190		44
Y	8.568E+05	123,378	12.89	1.07	0.12123	209		45
Y	8.638E+05	124,388	12.86	1.07	0.12149	210	20	46
Y	8.871E+05	127,746	14.12	1.18	0.11067	191		47
N	3.810E+06	548,683	23.64	1.97	0.09606	166	21	48
N	3.764E+06	542,010	23.65	1.97	0.09604	166		49
Y	1.038E+06	149,405	20.05	1.67	0.10680	185		50
Y	1.054E+06	151,733	20.06	1.67	0.10674	184		51
Y	1.075E+06	154,870	20.12	1.68	0.10643	184	22	52
Y	7.157E+05	103,055	14.04	1.17	0.13627	235		53
N	3.571E+06	514,287	17.19	1.43	0.09959	172	23	54
N	3.570E+06	514,043	13.20	1.10	0.10383	179		55
Y	1.140E+06	164,113	6.14	0.51	0.16690	288	24	56
N	3.632E+06	522,946	7.94	0.66	0.11656	201	25	57
Y	1.349E+06	194,254	4.96	0.41	0.18649	322	26	58
Y	1.387E+06	199,783	7.02	0.58	0.16289	281	27	59
Y	1.129E+06	162,553	6.61	0.55	0.17280	299	28	60
Y	1.393E+06	200,531	5.01	0.42	0.22800	394	29	61
Y	1.163E+06	167,538	4.81	0.40	0.23765	411	30	62
Y	8.719E+05	125,560	12.28	1.02	0.14557	252		63

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Table 2-4. Fully Cracked Concrete Properties

Is Section Cracked?	Eshl		Shell Thickness t-shl		Shell Density, Rho-shl		M&D Section No.	PNNL Section No.
	(psi)	(ksf)	(in.)	(ft)	(lb/in ³)	(lb/ft ³)		
Y	1.435E+06	206,708	14.64	1.22	0.08893	154		1
Y	1.084E+06	156,131	13.21	1.10	0.09854	170	1	2
Y	9.438E+05	135,907	12.40	1.03	0.10504	182	2	3
Y	8.552E+05	123,148	11.78	0.98	0.11053	191	3	4
Y	9.951E+05	143,289	12.81	1.07	0.10168	176		5
Y	9.318E+05	134,181	12.41	1.03	0.10491	181	4	6
Y	1.141E+06	164,239	13.58	1.13	0.09590	166	5	7
Y	1.089E+06	156,781	13.32	1.11	0.09774	169		8
Y	1.029E+06	148,115	13.08	1.09	0.09951	172	6	9
Y	9.768E+05	140,657	12.53	1.04	0.10391	180		10
Y	1.512E+06	217,769	14.64	1.22	0.08897	154	7	11
Y	1.482E+06	213,340	14.39	1.20	0.09048	156		12
Y	1.443E+06	207,751	14.28	1.19	0.09119	158	8	13
Y	1.417E+06	204,062	14.20	1.18	0.09168	158		14
Y	1.371E+06	197,485	14.12	1.18	0.09219	159		15
Y	1.544E+06	222,339	18.42	1.53	0.08916	154		16
Y	1.474E+06	212,206	19.67	1.64	0.08962	155	9	17
Y	1.394E+06	200,772	21.66	1.81	0.09047	156		18
Y	1.531E+06	220,469	27.13	2.26	0.08177	141		19
Y	1.240E+06	178,532	27.37	2.28	0.09343	161	10	20
Y	1.046E+06	150,644	34.88	2.91	0.09050	156	11	21
Y	1.270E+06	182,924	32.31	2.69	0.07982	138		22
Y	1.163E+06	167,483	22.03	1.84	0.08873	153		23
Y	1.302E+06	187,438	18.31	1.53	0.09041	156	12	24
Y	1.028E+06	147,988	15.59	1.30	0.10025	173		25
Y	1.004E+06	144,559	15.67	1.31	0.09972	172	13	26
Y	9.887E+05	142,377	15.72	1.31	0.09937	172		27
Y	9.808E+05	141,234	14.29	1.19	0.10936	189		28
Y	9.808E+05	141,234	14.29	1.19	0.10936	189		29
Y	9.808E+05	141,234	14.29	1.19	0.10936	189	14	30
Y	8.690E+05	125,131	13.83	1.15	0.11297	195		31
Y	8.690E+05	125,131	13.83	1.15	0.11297	195		32
Y	8.690E+05	125,131	13.83	1.15	0.11297	195	15	33
Y	8.690E+05	125,131	13.83	1.15	0.11297	195		34
Y	8.690E+05	125,131	13.83	1.15	0.11297	195	16	35
Y	8.690E+05	125,131	13.83	1.15	0.11297	195		36
Y	8.690E+05	125,131	13.83	1.15	0.11297	195		37
Y	8.782E+05	126,463	15.21	1.27	0.10273	178	17	38
Y	8.690E+05	125,131	13.83	1.15	0.11297	195		39
Y	7.828E+05	112,717	13.20	1.10	0.11839	205		40
Y	7.828E+05	112,717	13.20	1.10	0.11839	205	18	41
Y	7.828E+05	112,717	13.20	1.10	0.11839	205		42
Y	7.908E+05	113,881	14.54	1.21	0.10747	186	19	43
Y	7.908E+05	113,881	14.54	1.21	0.10747	186		44
Y	7.828E+05	112,717	13.20	1.10	0.11839	205		45
Y	7.891E+05	113,629	13.17	1.10	0.11864	205	20	46

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Table 2-4. (contd)

Is Section Cracked?	Eshl		Shell Thickness t-shl		Shell Density, Rho-shl		M&D Section No.	PNNL Section No.
	(psi)	(ksf)	(in.)	(ft)	(lb/in ³)	(lb/ft ³)		
Y	8.104E+05	116,693	14.45	1.20	0.10813	187		47
Y	9.322E+05	134,235	21.54	1.79	0.10546	182	21	48
Y	9.324E+05	134,263	21.66	1.80	0.10488	181		49
Y	9.504E+05	136,857	20.46	1.71	0.10463	181		50
Y	9.659E+05	139,096	20.46	1.71	0.10465	181		51
Y	9.861E+05	141,998	20.52	1.71	0.10436	180	22	52
Y	6.510E+05	93,743	14.43	1.20	0.13263	229		53
Y	7.229E+05	104,097	14.13	1.18	0.12109	209	24	54
Y	8.420E+05	121,245	11.21	0.93	0.12227	211		55
Y	1.048E+06	150,866	6.25	0.52	0.16372	283	24	56
Y	1.147E+06	165,097	4.93	0.41	0.18777	324	25	57
Y	1.246E+06	179,441	5.05	0.42	0.18346	317	26	58
Y	1.283E+06	184,804	7.11	0.59	0.16072	278	27	59
Y	1.038E+06	149,438	6.73	0.56	0.16977	293	28	60
Y	1.288E+06	185,420	5.09	0.42	0.22441	388	29	61
Y	1.070E+06	154,101	4.90	0.41	0.23326	403	30	62
Y	7.964E+05	114,687	12.57	1.05	0.14218	246		63

Input file “Tank-Mesh1.txt” develops the concrete shell model. Element type SHELL143 is used for the concrete shell to be able to extract through-wall shear forces.

Figure 2-3 and Figure 2-4 show the profile and full concrete shell model, respectively.

Figure 2-3. Concrete Shell Profile Including Shell Thickness

Figure 2-4. Concrete Shell Model Detail

2.1.2 Primary Tank

The geometry of the primary tank is based on drawing H-2-90534. To ensure that the anchor bolt elements are perpendicular to the primary tank, the primary tank dome coordinates were calculated based on the location of the corresponding concrete shell coordinate, taking into account the concrete shell thickness, and normal to the primary tank (see Figure 2-5). The concrete shell thickness used is based on the nominal concrete thickness.

Figure 2-5. Primary/Concrete Shell Node Geometry

The location of the primary tank nodes was iteratively determined as follows:

Select a value for x (radial distance from center of the tank).

Calculate the respective location for y' based on the defined shape of the primary tank. The primary tank is an ellipse with a major axis of 80 ft and minor axis of 30 ft. The equation for the location of y' is as follows:

$$y' = a\sqrt{1 - \frac{x^2}{b^2}} - a, \text{ where}$$

$$a = \text{Minor Radius} = 180 \text{ inches}$$

$$b = \text{Major Radius} = 480 \text{ inches}$$

$$x = \text{Test Location for } x$$

$$\text{For } x = 61.0398, y' = 180\sqrt{1 - \frac{61.0398^2}{480^2}} - 180 = -1.46$$

The slope of the ellipse can be calculated by taking the derivative of the equation for y' .

$$\frac{d}{dx} \left(a\sqrt{1 - \frac{x^2}{b^2}} \right) = -\frac{x \frac{a}{b}}{\sqrt{b^2 - x^2}}$$

For $x = 61.0398$ inches, the slope of the ellipse is -0.048 radians. The corresponding angle is the arctangent of the slope, or in this case, -0.048 radians. The length of line connecting the centerline of the concrete to the primary tank is half the thickness of the tank at that point. Therefore, to check the accuracy of the assumed x -location of the primary tank, back-calculate the location of the concrete coordinates. If the back-calculated concrete location is the same as the known location, the x -location of the primary tank must be correct, otherwise, reselect x until it is correct.

Following the example, for concrete location of (61.4 inches), the x -location of the primary tank is 61.0398 inches. y' was determined to be -1.46 inches. Adjusting this to value for the vertical location of the center of the ellipse, add 561.45 inches (elevation of the primary tank at the apex). For this case, $y = 559.99$ inches. The check is as follows:

$$X_{conc} = X_{primary} + \frac{t}{2} \sin(\theta), \text{ where } \theta \text{ is the angle of the slope from horizontal}$$

$$X_{conc} = 61.0398 + \frac{15}{2} \sin(0.048) = 61.39966 \approx 61.4 \text{ inches}$$

$$Y_{conc} = Y_{primary} + \frac{t}{2} \cos(\theta) = 559.99 + \frac{15}{2} \cos(0.048) = 567.48136 \approx 567.5 \text{ inches}$$

The primary tank dome coordinates are listed in Table 2-5.

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Table 2-5. Primary Tank Dome Coordinate Calculation

Concrete				Primary Tank							
x	y	t		x	y	y'	Slope	Angle (rad)	Angle (Deg)		
0	568.95	15	0%	0	561.30	0.00	0.000	0.000	0.000	7.500	0.000
45	568.2	15	0%	44.7369	560.50	-0.78	-0.035	-0.035	-2.010	7.495	-0.263
90.4	565.8	15	0%	89.8653	558.32	-1.46	-0.048	-0.048	-2.753	7.491	-0.360
120.72	563.21	15	0%	119.9972	555.74	-5.72	-0.097	-0.097	-5.530	7.465	-0.723
152.9	559.7	15	0%	151.9685	552.26	-9.26	-0.125	-0.125	-7.134	7.442	-0.931
211.4	550.7	15	0%	210.0535	543.32	-18.15	-0.183	-0.181	-10.343	7.378	-1.347
239.1	545.2	15	0%	237.5336	537.86	-23.59	-0.214	-0.210	-12.055	7.335	-1.566
306.63	527.68	15	0%	304.4248	520.51	-40.83	-0.308	-0.298	-17.099	7.169	-2.205
335.6	518.2	15	0%	333.0513	511.15	-50.38	-0.361	-0.347	-19.866	7.054	-2.549
393.7	494.5	15	0%	390.2214	487.86	-75.18	-0.524	-0.482	-27.633	6.645	-3.479
428.7	476.2	22.58	0%	422.2643	466.93	-94.41	-0.694	-0.607	-34.752	9.276	-6.436
				432	460.20	-101.54	-0.774	-0.659	-37.750	0.000	0.000
				440	453.39	-108.06	-0.860	-0.710	-40.700	0.000	0.000
a	180										
b	480										

Note: Y Coordinates (Vertical) are 8 in. higher in the ANSYS® Model

Element thicknesses are based on the drawing H-2-90534 but with reduction of 0.06 inch for corrosion.
General steel properties are used and are as follows:

Elastic Modulus (E) = 4,176,200 kip/ft²

Poisson's Ratio (ν) = 0.30

Mass Density (ρ) = 0.001522 kip-sec²/ft⁴ = ((0.490 kip/ft³)/(32.2 ft/sec²))

Damping = 2%

Tank coordinates are developed in the model from input file "Tank-Coordinates-AP.txt." Tank element properties are from input file "Primary-Props-AP." The tank mesh is generated using "Primary.txt" and uses SHELL143 elements.

Figure 2-6 shows the full primary tank model, and Figure 2-7 shows the detail in the knuckle region at the bottom of the tank.

Figure 2-6. Primary Tank Model Detail

Figure 2-7. Primary Tank Model Detail – Knuckle Region

2.1.3 Insulating Concrete

The insulating concrete uses the geometry defined for the concrete and primary tanks and fills in the open volume with solid element (SOLID45). Concrete properties are taken from Rinker et al. (2004).

Elastic Modulus (E) = 23,760 kip/ft²

Poisson's Ratio (ν) = 0.15

Mass Density (ρ) = 0.00155 kip-sec²/ft⁴ = ((0.050 kip/ft³)/(32.2 ft/sec²))

Damping = 7%

Material properties for the insulating concrete are in the file "Tank-Props-BEC-250.txt." The element mesh is generated using "Insulate.txt." Figure 2-8 shows the insulating concrete elements.

Figure 2-8. Insulating Concrete Model Detail

2.1.4 Anchor Bolts

The anchor bolts connecting the primary tank to the concrete shell are modeled using beam elements (BEAM4) and spring elements (COMBIN14). Based on drawing H-2-64310, the anchor bolts are spaced on an average of 2 ft in each direction. Therefore, the contributing area of the bolts in the model is based on the number of 4 ft² areas associated with the element. The required area is calculated based on the number of bolts to be represented and the thickness of the concrete at the bolt location. The anchor bolt area calculations are presented in Table 2-6.

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Table 2-6. Anchor Bolt Area Calculations

Ring No.	1	2	3	4	5	6	7	8	9	10	11
x	0.00	44.72	89.87	120.00	151.97	210.05	237.53	304.42	333.05	390.22	422.26
y	561.45	560.77	558.37	555.83	552.29	543.40	537.96	520.72	511.17	486.37	467.14
	0.00	0.68	3.08	5.62	9.16	18.05	23.49	40.73	50.28	75.08	94.31
Delta Y	0.00	0.68	2.40	2.53	3.54	8.89	5.43	17.25	9.55	24.80	19.23
x'	0.00	44.72	89.92	120.13	152.24	210.83	238.69	307.14	336.83	397.38	432.67
x''	0.00	44.72	89.93	120.17	152.34	211.10	239.11	308.19	338.37	400.69	438.06
Horizontal Midpoint	22.36	67.33	105.05	136.26	181.72	225.11	273.65	323.28	369.53	419.37	443.88
Ring Area	785.52	6335.32	10214.81	11827.27	22708.34	27726.13	38033.10	46534.03	50329.54	61766.66	41420.22
Number of Bolts in Ring	1.36	11.00	17.73	20.53	39.42	48.14	66.03	80.79	87.38	107.23	71.91
Bolts per element (20 Sections)	1.36	0.55	0.89	1.03	1.97	2.41	3.30	4.04	4.37	5.36	3.60

The BEAM4 elements are modeled as essentially rigid, and are oriented normal to the tank dome. Attached to the base of each beam element are three orthogonal springs oriented in the directions of the global coordinate system. Because the beams are rigid, the springs define the response of the anchor bolts in the model.

The stiffness of a single anchor bolt was set to 780 kip/ft (65,000 lbf/in.) in all three directions. This stiffness represents the secant shear modulus for the anchor bolts that is documented in Deibler et al. (2008). This formulation will underestimate the axial stiffness of an anchor bolt and thus conservatively overestimate the total deformation of the bolt. Not only does this modeling assumption err on the conservative side, but the axial response of the anchor bolts in the seismic model is essentially inconsequential when combined with the results of the TOLA model.

The anchor bolt model is developed using input file "Bolt-Friction.txt". See Figure 2-9 for the distribution of anchor bolts. Figure 2-10 shows the locations of spring elements connecting the end of each anchor bolt to the primary tank.

Figure 2-9. Anchor Bolt Model Detail

Figure 2-10. Spring Elements – Anchor Bolts to Primary Tank

2.1.5 Secondary Liner

The secondary liner is modeled using SHELL143 elements and its geometry is taken from drawing H-2-64449. The steel thickness is 0.25 inch throughout the liner. The model stops after the first full wall element coincident with the liner (Figure 2-11).

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Input file “Liner.txt” develops the model for the liner using the geometry defined for the concrete shell in “Tank-Coordinates.txt.” The following material properties are used for the steel liner.

Elastic Modulus (E) = 4,176,200 kip/ft²

Poisson's Ratio (ν) = 0.30

Mass Density (ρ) = 0.001522 kip-sec²/ft⁴ = ((0.490 kip/ft³)/(32.2 ft/sec²))

Damping = 2%

Figure 2-11. Secondary Liner Model Detail

2.1.6 Waste

The waste is modeled using solid elements (SOLID45) with material properties defined to simulate a liquid. The waste elements are meshed such that there are no common nodes with the primary tank; however, those on the exterior (at the primary tank) are coincident with the primary tank nodes. Contact elements are used for the interface between the waste and the primary tank. The material properties are as follows:

Elastic Modulus (E) = 2.592 kip/ft²

Poisson's Ratio (ν) = 0.49999

Mass Density (ρ) = 0.00355 kip-sec²/ft⁴ = ((1.83*0.0624 kip/ft³)/(32.2 ft/sec²))

Damping = 0

Shear Modulus (G) = 0.216 kip/ft²

The elastic modulus was calculated based on the bulk modulus of water (~300,000 psi). Using a value of ν close to 0.5 (0.49990), the value of E can be calculated.

$$B = E / [3(1 - 2\nu)] \text{ or}$$
$$E = B[3(1 - 2\nu)] = 300,000[3(1 - 2(0.49999))] = 18 \text{ lb/in}^2 = 2.592 \text{ k/ft}^2$$

The shear modulus can then be calculated based on E and ν , $G = E/[2(1+\nu)]$. For the values shown above, this gives a value for G of 0.864 kip/ft². However, because a fluid cannot carry shear, a smaller value is used. The value was selected such that the solution remains mathematically stable, but does not transmit significant shear energy. Plots of the waste elements are shown in Figure 2-12 and Figure 2-13.

Figure 2-12. Waste Model Detail

Figure 2-13. Waste Model Detail, Interface with Tank Dome

2.1.7 Primary Tank and Concrete Dome Interface

A combination of TARGET170 and CONTA173 elements are used to model the interface between the top of the primary tank and the inside face of the concrete dome. Key-option controls are used to place the interface location at the inside face of the concrete (or bottom of the concrete shell element). A coefficient of friction of 0.01 was used for the contact surface. A low friction value results in the primary load path for shear between the primary tank and the dome to be through the anchor bolts. The small positive value is used to improve model solution stability without significantly affecting the solution.

The contact normal stiffness was set to 0.025, which is consistent with the value used in Rinker et al. (2006c) for the AY Tank baseline analysis, but is greater than the value of 0.01 used in Revision 0 of this report for the AP Tank Liquid Level Increase. The increase in the contact stiffness was inadvertent, and had the effect of introducing some unwanted contact “chatter” back into the solution. This is a rather unimportant technical detail, and it was verified that this discrepancy had essentially no effect on any significant results.

The contact surface is developed using input file “bolt-friction.txt.” Figure 2-14 shows the contact and target elements comprising the dome contact surface.

Figure 2-14. Contact Elements – Primary Tank to Concrete Dome

2.1.8 Primary Tank/Insulating Concrete Interface

A combination of TARGE170 and CONTA173 elements are used to model the interface between the bottom of the primary tank and the top of the insulating concrete. The contact and target surfaces are modeled as coincident (i.e., no offsets are included for shell thicknesses). A coefficient of friction of 0.4 was used for the contact surface. The contact surface is developed using input file “interface1.txt.” Figure 2-15 shows the contact elements (top layer of elements).

2.1.9 Insulating Concrete/Secondary Liner Interface

A combination of TARGE170 and CONTA173 elements are used to model the interface between the bottom of the primary tank and the top of the insulating concrete. The contact and target surfaces are modeled as coincident (i.e., no offsets are included for shell thicknesses). A coefficient of friction of 0.4 was used for the contact surface. The contact surface is developed using input file “interface1.txt.” Figure 2-15 shows the contact elements (bottom layer of elements).

Figure 2-15. Contact Elements – Insulating Concrete Top and Bottom

2.1.10 Interface Between Concrete Shell and Soil

A combination of TARGE170 and CONTA173 elements are used to model the interface between the soil and the concrete shell, and for the interface plane between the native and excavated soils. A coefficient of friction of 0.2 was used for the contact surface between the soil and the concrete shell during the static gravity loading to realistically simulate the distribution of geostatic loads. The friction coefficient was then increased to 0.6 for the transient portion of the solution to simulate the dynamic frictional response at this interface (see Rinker et al. [2006c] for additional discussion of soil friction). See Figure 2-16 for the contact surface model.

For the interface between the bottom of the footing and the native soil, COMBIN14 (spring) elements were used. Arbitrary high stiffness values were applied to these springs because the flexibility at the interface is already included in the material properties for the concrete and soil. See Figure 2-17.

Figure 2-16. Contact Elements – Soil to Concrete Shell

Figure 2-17. Spring Elements – Concrete Footing to Soil

2.1.11 Interface Between Excavated Soil and Native Soil

A combination of TARGE170 and CONTA173 elements are used to model the interface between the native and excavated soils. An initial coefficient of friction for the soil-to-soil interface of 0.3 is used for the gravity (static) analysis. The coefficient of friction is changed to 0.7 for the transient analysis. This surface is included to improve the initial conditions for the transient analysis by allowing an initial displacement between the native and excavated soil but located far enough away that it does not have a significant affect on the tank behavior. The soil contact elements are shown in Figure 2-18.

This surface is developed using the input file “fix-soil.txt”.

Figure 2-18. Contact Elements – Near Soil to Far Soil

2.1.12 Interface Between Primary Tank and Waste

A combination of TARGE170 and CONTA173 elements are used to model the interface between waste and primary tank. No friction is included for this surface. A high stiffness was defined for this contact to obtain the correct hydrostatic pressure on the tank. The high stiffness of the contact was needed because the waste model was very soft. Excessive displacements occur without modifying the contact stiffness. The contact surface is divided into multiple zones to enhance the performance of the contacts. This approach captures more realistic waste pressures in areas of higher curvature (dome and knuckle regions). The contact between the primary tank and waste is shown in Figure 2-19. The contact surface is developed using input file “Waste-Soild-AP.txt.”

Figure 2-19. Contact Elements – Waste to Primary Tank

2.1.13 Interface Between Concrete Wall and Tank Footing

The contact at the bottom of the wall was modeled using CONTA178 elements (see Figure 2-20). A friction coefficient of 0.2 was used for this contact to reflect the steel on steel interface. Use of contact elements for this interface will be used to establish if displacement can occur during a seismic event. The contact elements allow only normal and shear forces (no moments) to be transferred to the footing.

Figure 2-20. Contact Elements – Concrete Wall to Footing

2.1.14 Surface Loads

MASS21 elements (see Figure 2-21) were added to the soil surface over the center of the dome to create a “live load” over the tank dome. The mass provides an equivalent weight of 200,000 lbf. Mass elements were used in lieu of forces to capture the dynamic participation of equipment that creates this load.

Figure 2-21. Mass Elements – Soil Surface

2.2 Soil Model

2.2.1 Soil Properties

The soil surrounding the tank is modeled in two groups, the excavated soil and the far-field soil. The excavated soil fills the volume outside the concrete shell and bounded by the slope matching the soil removed during construction. The far-field soil is comprised of all other soil out to a radius of 320 ft and a depth of 266 ft. Both regions are modeled using SOLID45 elements.

Two SHAKE analyses were performed for each soil condition to obtain soil properties for the layering used in the model described in Rinker et al. (2006a). One run used the native soil properties and is used for the far-field soil material properties. The second run used material properties associated with structural backfill, and the results are used for the material properties in the excavated soil region.

Soil properties used for the model are listed in the following tables:

- Table 2-7. Best-Estimate Native Soil Iterated Soil Properties
- Table 2-8. Best-Estimate Excavated Soil Iterated Soil Properties
- Table 2-9. Upper Bound Native Soil Iterated Soil Properties
- Table 2-10. Upper Bound Excavated Soil Iterated Soil Properties

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- Table 2-11. Lower Bound Native Soil Iterated Soil Properties
- Table 2-12. Lower Bound Excavated Soil Iterated Soil Properties

Table 2-7. Best-Estimate Native Soil Iterated Soil Properties

Layer Depth (ft)	Damping	G (kip/ft²)	Poisson's Ratio	E (kip/ft²)	Density (lb/ft³)	Material Property No.
2.5	0.017	6622.3	0.24	16,423	110	901
9.2	0.025	6241.7	0.24	15,479	110	902
16.4	0.034	5839.1	0.24	14,481	110	903
22.1	0.028	5930.4	0.24	14,707	110	904
29	0.032	5724.9	0.19	13,625	110	905
37.2	0.033	6494.2	0.19	15,456	110	906
44.7	0.033	7366.4	0.19	17,532	110	907
52.9	0.025	8811.9	0.19	20,972	110	908
65.5	0.026	9851.5	0.19	23,447	110	909
82	0.027	9721.9	0.19	23,138	110	910
98.8	0.029	9560.1	0.19	22,753	110	911
115.5	0.033	9272.5	0.19	22,069	110	912
132	0.025	10831.8	0.19	25,780	110	913
148.3	0.027	10644	0.19	25,333	110	914
167.5	0.022	13867.4	0.28	35,501	120	915
189.5	0.021	15416	0.28	39,465	120	916
211.5	0.023	15064.3	0.28	38,565	120	917
233.5	0.025	14732.5	0.28	37,715	120	918
255.5	0.024	16209.2	0.28	41,496	120	919

Table 2-8. Best-Estimate Excavated Soil Iterated Soil Properties

Layer Depth (ft)	Damping	G (kip/ft²)	Poisson's Ratio	E (kip/ft²)	Density (lb/ft³)	Material Property No.
2.5	0.019	3920.4	0.27	9,958	125	801
9.2	0.035	3463.4	0.27	8,797	125	802
16.4	0.048	3088.5	0.27	7,845	125	803
22.1	0.039	3231.8	0.27	8,209	125	804
29	0.048	3005.6	0.27	7,634	125	805
37.2	0.055	2829.8	0.27	7,188	125	806
44.7	0.059	2729.6	0.27	6,933	125	807
52.9	0.045	3018.4	0.27	7,667	125	808

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Table 2-9. Upper Bound Native Soil Iterated Soil Properties

Layer Depth (ft)	Damping	G (kip/ft ²)	Poisson's Ratio	E (kip/ft ²)	Density (lb/ft ³)	Material Property No.
2.5	0.016	10004.3	0.24	24,811	110	901
9.2	0.022	9607.3	0.24	23,826	110	902
16.4	0.027	9268.4	0.24	22,986	110	903
22.1	0.022	9383.3	0.24	23,271	110	904
29	0.026	9068.8	0.19	21,584	110	905
37.2	0.027	10289.2	0.19	24,488	110	906
44.7	0.028	11649.1	0.19	27,725	110	907
52.9	0.022	13709.7	0.19	32,629	110	908
65.5	0.022	15284.2	0.19	36,376	110	909
82	0.024	15035.4	0.19	35,784	110	910
98.8	0.025	14863.1	0.19	35,374	110	911
115.5	0.026	14746.3	0.19	35,096	110	912
132	0.02	16982.4	0.19	40,418	110	913
148.3	0.021	16838.8	0.19	40,076	110	914
167.5	0.019	21821.5	0.28	55,863	120	915
189.5	0.019	23910.6	0.28	61,211	120	916
211.5	0.02	23673.5	0.28	60,604	120	917
233.5	0.02	23525	0.28	60,224	120	918
255.5	0.019	25917.8	0.28	66,350	120	919

Table 2-10. Upper Bound Excavated Soil Iterated Soil Properties

Layer Depth (ft)	Damping	G (kip/ft ²)	Poisson's Ratio	E (kip/ft ²)	Density (lb/ft ³)	Material Property No.
2.5	0.017	5956.9	0.27	15,131	125	801
9.2	0.027	5554.3	0.27	14,108	125	802
16.4	0.039	5041.9	0.27	12,806	125	803
22.1	0.031	5191.5	0.27	13,186	125	804
29	0.035	5005.7	0.27	12,714	125	805
37.2	0.042	4747.8	0.27	12,059	125	806
44.7	0.047	4551.9	0.27	11,562	125	807
52.9	0.037	4864.9	0.27	12,357	125	808

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Table 2-11. Lower Bound Native Soil Iterated Soil Properties

Layer Depth (ft)	Damping	G (kip/ft ²)	Poisson's Ratio	E (kip/ft ²)	Density (lb/ft ³)	Material Property No
2.5	0.018	4382.9	0.24	10,870	110	901
9.2	0.03	4004	0.24	9,930	110	902
16.4	0.043	3590.3	0.24	8,904	110	903
22.1	0.034	3739.6	0.24	9,274	110	904
29	0.04	3551.3	0.19	8,452	110	905
37.2	0.042	4004.4	0.19	9,530	110	906
44.7	0.042	4561.5	0.19	10,856	110	907
52.9	0.03	5629.7	0.19	13,399	110	908
65.5	0.03	6331	0.19	15,068	110	909
82	0.035	6066.4	0.19	14,438	110	910
98.8	0.039	5831.4	0.19	13,879	110	911
115.5	0.043	5633.7	0.19	13,408	110	912
132	0.032	6786.7	0.19	16,152	110	913
148.3	0.032	6763.3	0.19	16,097	110	914
167.5	0.028	8619.5	0.28	22,066	120	915
189.5	0.028	9445.3	0.28	24,180	120	916
211.5	0.029	9314.8	0.28	23,846	120	917
233.5	0.029	9320.7	0.28	23,861	120	918
255.5	0.026	10588.1	0.28	27,106	120	919
279	0.014	29929.7	0.3	77,817	125	920
304	0.014	29856.3	0.3	77,626	125	921
329	0.015	29714.3	0.3	77,257	125	922
354	0.015	29602.2	0.3	76,966	125	923

Table 2-12. Lower Bound Excavated Soil Iterated Soil Properties

Layer Depth (ft)	Damping	G (kip/ft ²)	Poisson's Ratio	E (kip/ft ²)	Density (lb/ft ³)	Material Property No
2.5	0.023	2547.2	0.27	6,470	125	801
9.2	0.044	2126.7	0.27	5,402	125	802
16.4	0.066	1782.2	0.27	4,527	125	803
22.1	0.053	1910.9	0.27	4,854	125	804
29	0.061	1777	0.27	4,514	125	805
37.2	0.067	1689.3	0.27	4,291	125	806
44.7	0.07	1628.4	0.27	4,136	125	807
52.9	0.056	1815.9	0.27	4,612	125	808

2.2.2 Excavated Soil

The excavated soil portion of the soil is developed using the input file “Near-Soil-1.txt.” Figure 2-22 shows the detail of the excavated region of soil. Two zones in the soil above the dome are softened (see Figure 2-23) to break the potential arching that can occur in the soil model. This arching effect can occur because linear elastic properties are used for soil, which means that the soil as modeled can carry tension. For a detailed discussion of the development of these softened zones, see Rinker et al. (2006c). The global soil model with the tank in place is shown in Figure 2-24.

Figure 2-22. Excavated Soil Model Detail

Figure 2-23. Excavated Soil – Softened Soil Zones

Figure 2-24. Detail Plot of ANSYS® Global Model Showing Soil Zones

2.2.3 Native Soil

The native soil region of the model is developed using input file “Far-Soil.txt.” SOLID45 elements are used, and the material properties are discussed above. Figure 2-25 shows the native soil portion of the model.

Figure 2-25. Far-Field Soil Model Detail

LINK8 elements are used to connect the native soil slaved nodes on each layer to the symmetry plane. These are required because the slaved node of a couple cannot have a boundary condition applied to it. Therefore, to maintain the desired soil behavior, the link elements effectively complete the coupling of the outside soil node at each layer. Figure 2-26 shows the locations of the link elements. Input file “Outer-Spar.txt” develops these elements.

Figure 2-26. Link Elements – Edges of Soil Model

2.3 Boundary Conditions

2.3.1 Soil Boundary Conditions

All nodes on the outside edge (radius = 320 ft) have been “slaved” to a single node at each layer. Couples are used in each of the three translations to force the soil to behave essentially as a shear beam. This approach is used to create the appropriate conditions for vertical and horizontal waves to pass through the model (see Figure 2-28 and Figure 2-29). The effectiveness of this approach is documented in Rinker et al. (2006a). All nodes on the bottom of the model (-266 ft) are coupled together to create a rigid foundation (see Figure 2-27). The symmetry plane for the soil has all nodes fixed for y-translation, see Figure 2-30.

Figure 2-27. Boundary Conditions – Soil Base

Figure 2-28. Boundary Conditions – Typical Soil Layer

Figure 2-29. Boundary Conditions – Slaved Boundary Conditions

Figure 2-30. Boundary Conditions – Symmetry Plane

2.3.2 Tank Boundary Conditions

The tank model has all nodes on the symmetry plane fixed in the y-translation, x-rotation and z-rotation (see Figure 2-31 and Figure 2-32). Couples have been used between some components to ensure that compatible displacements occur. Where no common nodes exist between the concrete shell and secondary liner, couples are used to control the deformation of the secondary liner where it is in contact with the concrete shell. This ensures that the secondary liner does not “pass through” the concrete on the footing and on the walls (See Figure 2-33).

Figure 2-31. Boundary Condition – Concrete Shell

Figure 2-32. Boundary Conditions – Primary Tank

Figure 2-33. Boundary Conditions – Secondary Liner

2.4 Seismic Input

The time histories used as input to the global ANSYS® model are the same as used for the baseline analysis described in Deibler et al. (2007a) and Rinker et al. (2006c). As in the baseline analyses, the time histories are applied at the base of the model corresponding to a depth of 266 ft below grade. Horizontal and vertical time histories are applied at the base of the global model, and different time histories are used to represent mean, lower bound, and upper bound soil properties. A large mass element is located at the bottom of the soil model (-266 ft) and a force is applied to that node. The force is the product of the point mass and the acceleration for that time step of the time history. The point mass used is greater than 100 times the mass of the full global model to faithfully reflect the seismic input.

2.5 Load Cases

Four separate load cases have been considered in this analysis. These cases are:

- Lower Bound Soil (LBS), Best-Estimate Concrete (BEC) Properties
- Best-Estimate Soil (BES), Best-Estimate Concrete Properties
- Upper Bound Soil (UBS), Best-Estimate Concrete Properties
- Best-Estimate Soil, Fully Cracked Concrete (FCC) Properties

These four cases are intended to cover the most significant areas of uncertainty for response of the DSTs to seismic loading. The three variations in soil properties address the variability and uncertainty in soil properties. The fully cracked concrete case addresses uncertainty in the concrete condition.

Each load case consists of two analyses. First a gravity case is analyzed. Results from the gravity-only case will be used to determine the seismic-only results from the non-linear transient analysis. The second analysis for each case is a non-linear time history analysis. Two input motions (horizontal and vertical) have been defined as acceleration time histories consisting of 2,048 time steps to simulate the seismic motion.

2.6 Results Extraction

The following data are recorded for the gravity and transient analyses using the global model.

• Nodes	All active degrees of freedom
• Reactions	All reactions
• Concrete Shell	All element results
• Primary Tank	Element stresses
• Secondary Liner	Element strains
• Insulating Concrete	Element stresses
• Anchor bolts	All element results
• Soil Contacts	All element results
• Waste Contacts	All element results
• Primary tank contacts	All element results
• Liner contacts	All element results
• Footing contact	All element results
• Excavated Soil	Element stresses
• Excavated Soil Contacts	All element results
• Native Soil	Element stresses near tank
• Waste	Displacements Only

The following results have been extracted from the global ANSYS® model.

• Nodes	Displacements at selected locations
• Reactions	None
• Concrete Shell	Element Forces and Moment and Selected Strains
• Primary Tank	Element stresses (top, middle, bottom)
• Secondary Liner	Element strains (top, middle bottom)
• Insulating Concrete	None
• Anchor bolts	Selected element forces
• Soil Contacts	Pressures, displacements, status
• Waste Contacts	Pressures, displacements, status
• Primary tank contacts	Pressures, displacements, status
• Liner contacts	Pressures, displacements, status
• Footing contact	Pressures, displacements, status
• Excavated Soil	None
• Excavated Soil Contacts	None
• Native Soil	None
• Waste	Displacements at free surface

For each of the results listed above, all time history results have been extracted into text files. Minima and maxima data were also obtained for all the above-listed results. In general, only the result minima and maxima data are used in this report. Results are obtained throughout the model and then summarized around the circumference for presentation.

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3.0 Dytran[®] Primary Tank Sub-Model Description

A simplified sub-model of a Hanford double-shell tank (DST) primary tank was created using the 2005 version of MSC.Patran[®], and was analyzed using the Dytran[®] 2006 Development Version.

The purpose of the Dytran[®] sub-model analysis was to investigate the fluid-structure interaction behavior within the primary tank during seismic excitation. Based on earlier studies (Rinker and Abatt 2006a, 2006b; Rinker et al. 2006c) it is expected that the global ANSYS[®] model will not accurately capture the convective response of the fluid within the primary tank during a seismic event. In particular, the pressures and stresses in the region of the primary tank near the liquid-free surface may not be accurately predicted with the global ANSYS[®] model. However, the Dytran[®] sub-model is expected to give accurate results for the stresses in the tank, and the Dytran[®] sub-model analysis serves as an alternate calculation for evaluating the stresses in the primary tank due to fluid-structure interaction.

The fundamental difference between this analysis and the earlier analysis at the baseline liquid level of 422 inches (Rinker et al. 2006c) is increased interaction between the contained waste and the curved dome area of the primary tank. Thus, the stresses induced by the interaction of the liquid and the dome are of particular interest. The results from the Dytran[®] sub-model analysis are compared to the results of a similar ANSYS[®] sub-model of a primary tank, as well as to the results from the global ANSYS[®] models.

The Dytran[®] models are full three-dimensional (3D) representations of the tanks. Applied loads include gravity loading and seismic loading, with seismic loading applied in the horizontal and vertical directions both as separate load cases and simultaneously.

3.1 Model Geometry

The Dytran[®] sub-model geometry was based on the 241-AY tank configuration shown in Hanford Drawing Number H-2-64449. However, the primary tank wall thicknesses were representative of the 241-AP tank configuration shown in Hanford Drawing Number H-2-90534. The rationale for using the 241-AY tank configuration as a bounding idealization is discussed in Chapter 2 of Rinker et al. (2004) and also in Deibler et al. (2007a). However, the primary tank thicknesses and material properties for the 241-AP tanks were incorporated into the models because those are the tanks being considered for an increased operating liquid level.

The primary tank has a 450-inch radius and the height of the vertical wall is 424 inches. The dome apex is 561.5 inches above the bottom of the tank. Excerpts from drawings H-2-64449 and H-2-90534 are shown as Figure 3-1 and Figure 3-2, respectively. Two dimensions of interest for the Dytran[®] primary tank sub-model are the elevation of the primary tank tangent line at 424.3125 inches above the bottom of the primary tank (drawing H-2-64449), and the elevation of the first row of anchor bolts at 467 inches above the bottom of the primary tank (estimated from drawings H-2-64449 and H-2-90534).

Figure 3-1. 241-AY Tank Dimensions

When the Dytran® model is subjected to horizontal excitation only, the bottom of the primary tank is supported vertically by a fixed rigid base plate in contact with the tank bottom as shown in Figure 3-3. The purpose of the base plate is to provide the vertical support to the bottom of the primary tank model that is provided by the insulating concrete in the actual tank. The base is not present in the model when vertical excitation is applied.

A notable difference between the Dytran® primary tank model and the actual tank as shown in Figure 3-3 is that the junction between the vertical wall and the tank bottom is modeled as a right angle. Consequently, the details of the tank lower knuckle region and its support by the insulating concrete have not been captured by this simplified Dytran® sub-model.

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Figure 3-2. 241-AP Tank Dimensions

The relative height of the waste to the tank for the 460-inch waste level is shown in Figure 3-4. The tank floor and walls form what is known as a Dytran[®] coupling surface with the water. The coupling surface allows the Eulerian waste mesh to interact with the Lagrangian structural mesh, and although the Eulerian mesh extends beyond the tank boundary, all the fluid dynamics occur inside the tank.

Figure 3-3. Plot of Dytran® Primary Tank and Base Model (base not present when vertical excitation is applied)

Figure 3-4. Plot of Dytran® Tank, Waste, and Air Elements at 460-Inch Waste Level

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Dynamic waste pressures are a function of depth, angular location and radial location of the fluid element. Waste pressures were extracted from five sets of fluid elements throughout the tank as shown in Figure 3-5. The element set “plusx_els” is located near the tank wall in the positive x-direction ($\theta=0$) in the plane of the seismic excitation. Note that the angle θ is measured from the positive x-axis to the positive z-axis to describe the angular position of elements in the model. Element sets “press_45” and “plusz_els” are located near the tank wall at 45° (approximately) and 90° from the excitation direction. Element set “minusx_els” is near the tank wall in the negative x-direction, and the set “cent_press” is near the center of the tank at a radial location of approximately zero. As can be seen in Figure 3-5, there are 40 elements circumferentially in the tank wall, or 10 elements in each 90° sector.

Figure 3-6 and Figure 3-7 are elevation views that show the location and numbering of fluid element sets “plusx_els”, “cent_press” and “minusx_els”. Figure 3-8 and Figure 3-9 are elevation views showing the location and numbering of fluid element sets “press_45” and “plusz_els”.

Figure 3-5. Top View of Dytran[®] Primary Tank Sub-Model Showing the Angular Locations of Fluid Elements at Which Pressures Were Monitored

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Figure 3-6. Elevation View of Dytran® Tank Mesh Showing the Locations of “Plusx_els”, “Cent_press”, and “Minusx_els” Fluid Element Sets at Which Pressures Were Monitored

Figure 3-7. Waste Element Numbering for Element Sets “Plusx_els”, “Minusx_els”, and “Cent_press”

Figure 3-8. Elevation View of Dytran® Tank Mesh Showing the Locations of “Press45” and “Plusz_els”, Fluid Element Sets at Which Pressures Were Monitored

Figure 3-9. Waste Element Numbering for Dytran® Element Sets “Press_45” and “Plusz_els”

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Tank wall stresses were extracted at angular locations of $\theta=0$, 45 , 90 , and 180° . The shell element numbering for the $\theta=0^\circ$ and $\theta=90^\circ$ sets is shown in Figure 3-10, with the elements at $\theta=0^\circ$ and on the right, and the elements at $\theta=90^\circ$ on the left. The numbering for the $\theta=45^\circ$ and $\theta=180^\circ$ sets is shown in Figure 3-11, with the elements at $\theta=45^\circ$ and on the right, and the elements at $\theta=180^\circ$ on the left.

Figure 3-10. Shell Element Numbering for Dytran[®] Tank Wall Stress Results at $\theta=0^\circ$ and $\theta=90^\circ$

Figure 3-11. Shell Element Numbering for Dytran[®] Tank Wall Stress Results at $\theta=45^\circ$ and $\theta=180^\circ$

3.2 Material Properties and Element Types

The primary tank was modeled in Dytran[®] using CQUAD4 shell elements. The elastic modulus, Poisson's ratio, and specific weight of the steel walls were set to 28.8×10^6 lbf/in², 0.3, and 0.284 lbf/in³, respectively. The steel properties are for the 241-AP tanks per Section 3.3 of Rinker et al. (2004). The tank wall thicknesses are for the 241-AP tanks and are from Drawing H-2-90534, Rev. 4. The general configuration of the primary tank wall thickness is shown in Figure 3-12. In that plot, the blue band at the bottom represents the 7/8-inch-thick portion of the wall, the green band represents the 3/4-inch-thick portion of the wall, the red represents the 9/16-inch-thick portion of the wall, and the light blue represents the 1/2-inch-thick portion of the wall. The black portion of the dome is modeled as rigid. It can be seen in Figure 3-12 that there are 16 elements vertically in the flexible portion of the tank wall giving an average element height of approximately 29 inches.

Figure 3-12. Plot of Dytran[®] Primary Tank Mesh with Different Colors Representing Different Wall Thicknesses

The dome was kept rigid above the attachment point of the first row of anchor bolts (estimated at 467 inch above the floor of the primary tank per Drawing H-2-90534, Rev. 4). A rigid region was also defined for the bottom of the tank. In the case of horizontal excitation only, the central portion of the primary tank bottom was kept rigid and the outer ring of elements in the tank bottom was left flexible and assigned normal steel properties with a thickness of 1/2 inch. Both of the rigid regions were assigned artificially high mass density to faithfully reflect the applied seismic motion. In the case of horizontal excitation only, the rigid regions are those shown in black in Figure 3-13. The flexible outer ring of elements in the tank floor is shown in blue. For the cases of vertical excitation only and two-component motion with horizontal and vertical excitation, the outer ring of elements in the floor was also specified as

rigid, and the rigid base shown in blue in Figure 3-3 was removed from the model to allow for vertical motion. With the rigid base present, there are 1,100 CQUAD4 elements in the model. Without the rigid base, the number of CQUAD4 elements is reduced to 960.

Figure 3-13. Rigid Regions of the Dytran® Primary Tank Model (shown in black) for Horizontal Excitation Only

The waste and air in the dome space were modeled using 107,200 8-node CHEXA Eulerian solid elements. Because two fluids are present, the Eulerian elements were assigned multi-material hydrodynamic material properties (MMHYDRO). Both the air and the waste were modeled as homogeneous, inviscid, fluids.

The waste was modeled using a polynomial equation of state (EOSPOL) that requires the initial mass density and the bulk modulus of the fluid as input. The initial density of the waste was set to 1.71×10^{-4} lbf-sec²/in⁴ (specific gravity=1.83). The bulk modulus of the waste was set to 305,000 lbf/in², which is a typical bulk modulus for water. However, the results are expected to be insensitive to the value of the bulk modulus since fluid compressibility is not critical to the response in this problem.

The air was modeled using the gamma law equation of state (EOSGAM), where the pressure is a function of the mass density ρ , the specific internal energy per unit mass e , and the ideal gas ratio of specific heats γ via $p = (\gamma - 1)\rho e$. The mass density of air is 1.167×10^{-7} lbf-sec²/in⁴, and the ratio of constant-pressure specific heat to constant-volume specific heat is 1.4. The specific internal energy per unit mass of the air was set to 3.15×10^8 in²/sec², which corresponds to an air pressure of 14.7 lbf/in².

3.3 Boundary Conditions

In the case of horizontal seismic excitation only, the rigid regions were free in the x-direction, and fixed in the other five degrees-of-freedom. The rigid regions are those shown in black in Figure 3-13 and the rigid base shown in blue in Figure 3-3 was present in the model. In the cases of vertical excitation only and two-component motion (simultaneous horizontal and vertical excitation), the rigid regions included all elements shown in Figure 3-13. In these two cases, the rigid base shown in Figure 3-3 was removed from the model to allow for vertical motions. In the case of vertical motion, the rigid regions were excited in the vertical direction and were fixed in the other five degrees-of-freedom. For two-component motion, the rigid regions were excited in the x and y-directions and fixed in the other four degrees-of-freedom.

The Dytran[®] general coupling algorithm was used to allow the Eulerian waste mesh to interact with the Lagrangian structural mesh. The problem was set up to take advantage of the “fast coupling” option in Dytran[®].

3.4 Initial Conditions

All Dytran[®] simulations were performed at absolute pressure so that the initial air pressure was set to the atmospheric pressure of 14.7 lbf/in² in the parameters section of the input file. The specific internal energy per unit mass of the air was set to 3.15×10^8 in²/sec² according to the gamma law equation of state

$$e = \frac{p}{(\gamma - 1)\rho}.$$

As a convenience, a balancing pressure of 14.7 lbf/in² was applied to the outside of the tank using the Dytran[®] COUOPT command (MSC 2005) to keep the tank stresses in terms of gage pressures.

3.5 Seismic Input

The seismic time histories used to excite the primary tank sub-models (both Dytran[®] and ANSYS[®]) were output from the global ANSYS[®] model of the DST and surrounding soil described in Section 2.0. The time histories used as input to the primary tank sub-models were taken from node 495 in the concrete basemat of the global ANSYS[®] model as shown in Figure 3-14 and Figure 3-15. As shown in those figures, node 495 lies at the junction between the bottom of the concrete wall and the basemat 90° from the plane of horizontal excitation in the negative y-direction. Note that in Figure 3-14 and Figure 3-15, the tank wall elements near node 495 have been unselected for ease of visualization.

The extracted time histories consisted of 2,048 points defined at 0.01-second intervals giving seismic records with durations of 20.48 second. In all three cases, the seismic excitation was preceded by a 6-second quiet period to allow sufficient time for the gravity loading to equilibrate.

In the case of horizontal (x-direction) excitation, the seismic time histories were applied as body force accelerations per unit mass on the nodes of the rigid portions of the tank that have artificially high mass. The vertical seismic time history was applied as a velocity time history to the rigid portions of the tank. The reason that the vertical input was applied as a velocity rather than an acceleration time history is that

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Figure 3-14. Plot of Junction of Concrete Wall and Concrete Basemat from Global ANSYS® Model Showing Node 495 from Which Sub-Model Input Time Histories Were Extracted

Figure 3-15. Detailed Plot of Junction of Concrete Wall and Concrete Basemat from Global ANSYS® Model Showing Node 495 from Which Sub-Model Input Time Histories Were Extracted

this approach precludes having to exactly balance the vertical gravity load with the vertical acceleration time history, thus preventing any vertical drift. In all cases, the same excitations were applied to all rigid elements simultaneously. That is, the top and bottom of the tank were excited together with the same seismic time histories. This represents the hinged top boundary condition discussed in BNL (1995) and shown in Figure 3-16.

Figure 3-16. Tank With Hinged Top Boundary Condition per BNL (1995)

The horizontal acceleration, vertical acceleration, and the velocity and displacement time histories for horizontal and vertical input are shown in Figure 3-17, Figure 3-18, Figure 3-19, and, Figure 3-20, respectively. The 4% damped response spectra for the horizontal and vertical time histories are shown in Figure 3-21.

Figure 3-17. Horizontal Acceleration Time History Used as Input to the Primary Tank Sub-Models

Figure 3-18. Vertical Acceleration Time History Used as Input to the Primary Tank Sub-Models

Figure 3-19. Velocity Time Histories – Vertical Time History Used as Input to the Dytran[®] Primary Tank Sub-Model

Figure 3-20. Displacement Time Histories Corresponding to Primary Tank Sub-Model Input

Figure 3-21. 4% Damped Response Spectra for Acceleration Time Histories Extracted from ANSYS® Model

3.6 Differences from Earlier Dytran[®] Models

The Dytran[®] models described in this report differ from the Dytran[®] flexible primary tank sub-models at the 460-inch liquid level described in Rinker and Abatt (2006a) in the following respects:

1. The non-uniform wall thickness representative of the 241-AP tanks is incorporated in the present models.
2. The transition from flexible elements to rigid elements has been shifted up from approximately 458 inches to 467 inches to more accurately represent the elevation of the first row of anchor bolts.
3. The time history input records used are different having been extracted from the tank base of the global ANSYS[®] model at the 460-inch waste level instead of from the dome of the global ANSYS[®] model at the 422-inch waste level.
4. The dynamic relaxation parameter was increased from 0.02 to 0.025 to achieve the desired effective damping.
5. The boundary conditions at the bottom of the tank in the presence of vertical excitation have been changed as described in Section 3.3.
6. Two-component motion (simultaneous horizontal and vertical seismic excitation) is incorporated in the present models.
7. The elastic modulus was reduced from 29.0×10^6 lbf/in² to 28.8×10^6 lbf/in².

4.0 Results from Dytran[®] Primary Tank Sub-Models

Results from horizontal seismic excitation only, vertical seismic excitation only, and simultaneous application of horizontal and vertical seismic excitation (two-component motion) are described in this chapter.

Impulsive and convective frequencies, global reaction forces, waste pressures, maximum slosh heights, and primary tank stresses will be reported. Extensive benchmarking of Dytran[®] tank models was performed and reported in Rinker and Abatt (2006a, 2006b). In those reports, much emphasis was placed on documenting that the frequencies, reaction forces and waste pressures matched well to known solutions. In this report, there is less emphasis on frequencies, reaction forces, and waste pressures, and more emphasis on primary tank stresses. Thus, although frequencies, reaction forces, waste pressures, and slosh heights are reported to provide a basic check of the results, the primary tank stresses are of the most interest. Furthermore, due to the extensive data produced by the Dytran[®] simulations, not all results are shown in the body of this report. Additional results are included in Appendix B.

4.1 Characterization of Damping in Dytran[®] Sub-Model

The intent of introducing dynamic relaxation (damping) into the solution is to achieve realistic effective damping values for the impulsive and convective response of the tank and waste system.

The target values are 2-4% for the impulsive response and 0.5% for the convective response of the tank and liquid system per DOE (2002). The value of the dynamic relaxation factor was set to 0.025 based on the initial decay of the vertical coupling surface reaction force during gravity loading. The initial decay of the vertical reaction force actually represents the effective damping of the breathing mode response of the system, but this was expected to be a good indicator of the impulsive response of the system. Based on the decay of the breathing mode response, the effective impulsive damping is approximately 3.5% of critical.

A more direct (but much more time-consuming) way of determining the effective damping for the impulsive response is to quantify the decay of the horizontal reaction force immediately following the cessation of the seismic excitation. With this approach, the effective damping for the impulsive response is approximately 4.3% of critical damping. Based on the data displayed in Figure 4-2 and Figure 4-5, the effective damping for the convective response is approximately 0.6%. Both values are slightly higher than desired, but further reductions in the dynamic relaxation parameter introduced undesired noise and instabilities into the solution.

The artificial viscosities implemented in Dytran[®] are referred to as the linear (BULKL) and quadratic (BULKQ) bulk viscosities. The bulk viscosities act to control the formation of shock waves by introducing viscosity to the bulk straining of the fluid. Experience with earlier models (Rinker and Abatt 2006a, 2006b) has shown that it is necessary to increase the bulk viscosity coefficients relative to the default values in order to properly calibrate the models. Consequently, all Dytran[®] simulations were run with the linear and quadratic bulk viscosity parameters set to 0.2 and 1.1, respectively. The default values for the bulk viscosity coefficients are 0.0 for the linear coefficient and 1.0 for the quadratic coefficient.

4.2 Hydrodynamic Forces from Dytran[®] Sub-Model

4.2.1 Horizontal Excitation Only

The horizontal displacement of node 523 near the mid-height of the tank wall shown in Figure 4-1 during the initial equilibration phase exhibits a breathing mode frequency of 5.07 Hz. Also shown in the plot are decay curves representing 3%, 3.5%, and 4% critical damping. The best match appears to be from the 3.5% damping curve.

The peak horizontal hydrodynamic force is 3.05×10^6 lbf, as shown in Figure 4-2, along with the convective response, which shows a fundamental frequency of 0.207 Hz. The convective response in Figure 4-2 shows an approximately 10% decay during the three cycles, from 29 to 44 seconds, giving an effective damping of approximately 0.6% for the convective response. The “noise” in the horizontal reaction force trace between approximately 32 and 43 seconds is numerically spurious data, with no significant effect on the solution. The signal could have been smoothed by increasing the dynamic relaxation (damping), but this would have been counterproductive, since the effective damping for the impulsive response is already slightly greater than desired.

Figure 4-3 shows the horizontal reaction force time history during the second free vibration period beginning at 26.5 seconds. According to that plot, the impulsive frequency is approximately 5.7 Hz, and the effective damping for the impulsive response is slightly greater than 4% of critical.

Figure 4-1. Horizontal Displacement of Tank Wall Node 523 (Mid-Height) vs. Time During Initial Gravity Loading

Figure 4-2. Horizontal Coupling Surface Reaction Force vs. Time for Horizontal Seismic Excitation

Figure 4-3. Horizontal Coupling Surface Reaction Force vs. Time for Horizontal Seismic Excitation During the Final Free Vibration Phase

4.2.2 Vertical Excitation Only

As shown in Figure 4-4, the vertical reaction force varies between -1.65×10^7 lbf and -2.28×10^7 lbf. The weight of the contained fluid is 1.92×10^7 lbf, so that the maximum dynamic component of the vertical reaction force is 3.6×10^6 lbf (difference between peak reaction force and weight of fluid), which is greater than for horizontal excitation only.

Figure 4-4. Vertical Coupling Surface Reaction Force vs. Time for Vertical Seismic Excitation

4.2.3 Two-Component Motion

The horizontal reaction force time history for two-component motion is shown in Figure 4-5. The maximum horizontal reaction force is 3.7×10^6 lbf, which is 21% greater than for horizontal motion only. The fundamental convective frequency is 0.207 Hz – the same as for horizontal excitation only.

The impulsive response and decay for the system is shown in Figure 4-6. In contrast to the case of horizontal motion only, the apparent impulsive frequency has increased from 5.7 Hz to 5.88 Hz. Depending on how peaks are counted, the effective damping for the impulsive response is between 3.9% and 5.2% of critical.

In the case of two-component motion, Figure 4-7 shows that the vertical reaction force varies between -1.65×10^7 lbf and -2.28×10^7 lbf – exactly the same as for vertical seismic excitation only. Based on the reaction forces, the presence of the vertical input couples in such a way as to increase the maximum horizontal reaction force, but the presence of the horizontal input has no effect on the peak vertical reaction force.

Figure 4-5. Horizontal Coupling Surface Reaction Force vs. Time for Two-Component Seismic Excitation

Figure 4-6. Horizontal Coupling Surface Reaction Force vs. Time for Two-Component Seismic Excitation During the Final Free Vibration Phase

Figure 4-7. Vertical Coupling Surface Reaction Force vs. Time for Two-Component Seismic Excitation

4.3 Waste Pressures from Dytran[®] Sub-Model

The total pressures are the sum of the hydrostatic pressures and the hydrodynamic pressures. The theoretical hydrostatic pressures for the elements in the sets “plusx_els”, “press_45”, “plusz_els”, “cent_press” and “minusx_els” are shown in Table 4-1.

Table 4-1. Theoretical Hydrostatic Pressures for Selected Fluid Elements from the Dytran® Primary Tank Sub-Model

“Plusx_els”	“Press_45”	“Plusz_els”	“Cent_press”	“Minusx_els”	Theoretical Hydrostatic Pressure (psi absolute)
Element	Element	Element	Element	Element	
5143	5588	5799	89959	86776	15.0
3543	3988	4199	86759	5176	15.7
1943	2388	2599	3559	3576	16.4
25943	26388	26599	25959	1976	17.0
22743	23188	23399	22759	22776	18.3
19543	19988	20199	19559	19576	19.7
16343	16788	16999	16359	16376	21.0
13143	13588	13799	13159	13176	22.3
9943	10388	10599	9959	9976	23.6
6743	7188	7399	6759	6776	24.9
72343	72788	72399	72359	72376	26.3
69143	69588	69799	69159	69176	27.6
65943	66388	66599	65959	65876	28.9
62743	63188	63399	62759	62776	30.2
59543	59988	60199	59559	59576	31.6
56343	56788	56999	56359	56376	32.9
53143	53588	53799	53159	53176	34.2
49943	50388	50599	49959	49876	35.5
46743	47188	47399	46759	46776	36.9
43543	43988	44199	43559	43576	38.2
40343	40788	40999	40359	40376	39.5
37143	37588	37799	37159	37176	40.9
33943	34388	34599	33959	33876	42.2
30743	31188	31399	30759	30776	43.5
27543	27988	28199	27559	27576	44.8

4.3.1 Horizontal Excitation Only

The pressure time histories for the elements adjacent to the tank wall at $\theta=0$, 45 , and 90° are shown in Figure 4-8, Figure 4-9, and Figure 4-10, respectively. In each plot, the hydrostatic pressures are stable and fall between approximately 16 and 44 lbf/in², in agreement with the values in Table 4-1. It is apparent that the pressure in the elements near the bottom of the tank is dominated by impulsive effects while the pressure in fluid elements near the free surface is dominated by convective effects, as expected.

It may also be observed that the highest dynamic pressures occur in the plane of excitation ($\theta=0^\circ$), and the minimum dynamic pressures occur normal to the plane of excitation ($\theta=90^\circ$), as expected. The dynamic pressures at $\theta=45^\circ$ lie between the two extremes.

Figure 4-8. Waste Pressure Time Histories for Fluid Elements at $\theta=0^\circ$ (Plusx_els) Subjected to Horizontal Seismic Excitation Only

Figure 4-9. Waste Pressure Time Histories for Fluid Elements at $\theta=45^\circ$ (Press_45) Subjected to Horizontal Seismic Excitation Only

Figure 4-10. Waste Pressure Time Histories for Fluid Elements at $\theta=90^\circ$ (Plusz_els) Subjected to Horizontal Seismic Excitation Only

4.3.2 Vertical Excitation Only

The pressure time histories for the waste elements adjacent to the tank wall at $\theta=0^\circ$ and at $\theta=45^\circ$ are shown in Figure 4-11 and Figure 4-12, respectively. The two plots are essentially the same, indicating that the solution for vertical excitation is independent of the angular position, as expected.

Figure 4-11. Waste Pressure Time Histories for Fluid Elements at $\theta=0^\circ$ (Plusx_els) Subjected to Vertical Seismic Excitation Only

Figure 4-12. Waste Pressure Time Histories for Fluid Elements at $\theta=45^\circ$ (Press_45) Subjected to Vertical Seismic Excitation Only

4.3.3 Two-Component Motion

Waste pressure time histories for fluid elements located along the tank wall at $\theta=0^\circ$, 45° , and 90° when subjected to two-component seismic excitation are shown in Figure 4-13, Figure 4-14, and Figure 4-15, respectively. The plots show that the peak dynamic pressures are greater for the case of two-component motion than for either horizontal or vertical motion acting alone. The dynamic pressures for two-component motion appear to be consistent with square-root-sum-of-the squares (SRSS) combination of the dynamic pressures from the horizontal and vertical cases. For example, the peak dynamic pressure (difference between peak total pressure and hydrostatic pressure) for element 30473 shown in Figure 4-8 for horizontal excitation only is approximately 5.5-6 lbf/in². The peak dynamic pressure for that element for vertical excitation only is also approximately 5.5-6 lbf/in² (Figure 4-11). The peak dynamic pressure for that element for two-component motion is approximately 8 lbf/in² as shown in Figure 4-13, which is consistent with an SRSS directional combination.

The traces show that the peak pressures for two-component motion occur later in the event than the peaks for horizontal or vertical motion acting alone. That is, the timing of the peaks changes when horizontal and vertical motion are combined. As expected, the magnitude of the dynamic pressures decreases as the angle from the plane of excitation increases. The data also illustrate that the waste pressure time history at $\theta=90^\circ$ for two-component motion (Figure 4-15) is very similar to the pressure time histories for vertical excitation only (Figure 4-11 and Figure 4-12). This also is expected since the contribution from the horizontal component of motion should be negligible in the plane normal to the plane of excitation.

In Figure 4-14 and Figure 4-15 a few isolated peaks occur that are characteristic of a high-frequency response that may be due to spurious numerics, and that in any case are unimportant to the structural analysis. This phenomenon is discussed in greater detail in Rinker and Abatt (2006a, 2006b).

Figure 4-13. Waste Pressure Time Histories for Fluid Elements at $\theta=0^\circ$ (Plusx_els) Subjected to Two-Component Seismic Excitation

Figure 4-14. Waste Pressure Time Histories for Fluid Elements at $\theta=45^\circ$ (Press_45) Subjected to Two-Component Seismic Excitation

Figure 4-15. Waste Pressure Time Histories for Fluid Elements at $\theta=90^\circ$ (Plusz_els) Subjected to Two-Component Seismic Excitation

4.4 Maximum Slosh Height Results from Dytran[®] Sub-Model

Plots of the maximum free-surface height vs. time for horizontal, vertical, and two-component motion are presented in Figure 4-16. The traces for the vertical motion and two-component motion input have had the vertical displacement of the tank subtracted out so that the net slosh height is depicted. The peak slosh height for horizontal or two-component motion is approximately 25 inches. The maximum slosh height associated with vertical motion only is less than 1 inch.

The maximum theoretical slosh height for an open top tank without a dome is also shown in the plot. Note that the presence of the curved dome acts to increase the maximum slosh height in the tank relative to the open top solution.

Figure 4-16. Maximum Slosh Height Time-History for Horizontal, Vertical, and Two-Component Seismic Excitation

4.5 Primary Tank Stresses from Dytran[®] Sub-Model

The following three sections present primary tank stress distributions for the Dytran[®] sub-model when subjected to horizontal, vertical, and two-component motion. The plots show maximum and minimum stresses vs. path length from the dome apex. Important values of the path length are the beginning of the flexible portion of the tank at 438.1 inches, the top of the vertical portion of the tank wall at 490.9 inches, and the bottom of the tank wall at 915.2 inches (zero elevation). A summary of the tank regions by path length and elevation is provided in Table 4-2.

Table 4-2. Primary Tank Regions Parameterized by Path Length from Dome Apex and Elevation from Tank Bottom

Path Length from Dome Apex (in.)	Elevation from Tank Bottom (in.)	Tank Region	Wall Thickness (in.)
0 to 438.1	467.0 to 561.5	Rigid dome	Rigid
438.1 to 490.9	424.3 to 467.0	Haunch portion of flexible wall	1/2
490.9 to 677.3	237.9 to 424.3	Vertical portion of wall	1/2
677.3 to 770.3	144.9 to 237.9	Vertical portion of wall	9/16
770.3 to 878.3	36.9 to 144.9	Vertical portion of wall	3/4
878.3 to 915.2	0 to 36.9	Vertical portion of wall	7/8

4.5.1 Horizontal Excitation Only

Hoop, meridional, and shear stress distributions for the tank shell elements at $\theta=0^\circ$ are presented as Figure 4-17, Figure 4-18, and Figure 4-19, respectively. The hoop stresses shown in Figure 4-17 indicate that the hoop response is dominated by membrane stresses with little contribution from bending. The meridional stress distributions shown in Figure 4-18 indicate that the meridional stresses are low in the majority of the tank wall, but higher in the haunch and bottom of the wall. The meridional response is dominated by bending in the haunch and bottom of the wall, but consists primarily of membrane stress in the majority of the wall. The mid-surface in-plane shear stresses are low, as shown in Figure 4-19.

The hoop stresses at 45° from the plane of excitation are approximately 10% lower than at $\theta=0^\circ$, as shown in Figure 4-20. Likewise, the meridional stresses at $\theta=45^\circ$ are 5 to 10% lower than at $\theta=0^\circ$, as seen in Figure 4-21. In contrast, the mid-surface shear stresses are approximately 10 times higher at $\theta=45^\circ$ than at $\theta=0^\circ$ (Figure 4-22), and the peak shear stresses occur at $\theta=90^\circ$, as expected and shown Figure 4-23.

Figure 4-17. Maximum and Minimum Hoop Stress vs. Path Length for Element Set “Plusx_Outstrip” at $\theta=0^\circ$ for Horizontal Seismic Excitation Only

Figure 4-18. Maximum and Minimum Meridional Stress vs. Path Length for Element Set “Plusx_Outstrip” at $\theta=0^\circ$ for Horizontal Seismic Excitation Only

Figure 4-19. Maximum and Minimum Shear Stress vs. Path Length for Element Set “Plusx_Outstrip” at $\theta=0^\circ$ for Horizontal Seismic Excitation Only

Figure 4-20. Maximum and Minimum Hoop Stress vs. Path Length for Element Set “Press45_Outstrip” at $\theta=45^\circ$ for Horizontal Seismic Excitation Only

Figure 4-21. Maximum and Minimum Meridional Stress vs. Path Length for Element Set “Press45_Outstrip” at $\theta=45^\circ$ for Horizontal Seismic Excitation Only

Figure 4-22. Maximum and Minimum Shear Stress vs. Path Length for Element Set “Press45_Outstrip” at $\theta=45^\circ$ for Horizontal Seismic Excitation Only

Figure 4-23. Maximum and Minimum Shear Stress vs. Path Length for Element Set “Plusz_Outstrip” at $\theta=90^\circ$ for Horizontal Seismic Excitation Only

4.5.2 Vertical Excitation

The hoop, meridional, and shear stress distributions at $\theta=0^\circ$ for vertical excitation only are shown in Figure 4-24, Figure 4-25, and Figure 4-26, respectively. The plots indicate that the hoop stress is dominated by the membrane response, the hoop and meridional stress distributions and magnitudes are similar to that for horizontal excitation, and the shear stress is negligible. Plots at other angular locations are not shown due to the axisymmetric response for vertical excitation.

Figure 4-24. Maximum and Minimum Hoop Stress vs. Path Length for Element Set “Plusx_Outstrip” at $\theta=0^\circ$ for Vertical Seismic Excitation Only

Figure 4-25. Maximum and Minimum Meridional Stress vs. Path Length for Element Set “Plusx_Outstrip” at $\theta=0^\circ$ for Vertical Seismic Excitation Only

Figure 4-26. Maximum and Minimum Shear Stress vs. Path Length for Element Set “Plusx_Outstrip” at $\theta=0^\circ$ for Vertical Seismic Excitation Only

4.5.3 Two-Component Motion

Hoop, meridional, and shear stress distributions at $\theta=0^\circ$ are presented in Figure 4-27, Figure 4-28, and Figure 4-29, respectively. The stress distributions at $\theta=45^\circ$ are shown in Figure 4-30, Figure 4-31, and Figure 4-32. The shear stress distribution at $\theta=90^\circ$ is shown in Figure 4-33.

In general, the hoop stress distributions for two-component motion are similar to those for horizontal excitation only, but the magnitudes are somewhat higher. As in the cases of horizontal motion and vertical motion only, the hoop stress is dominated by the membrane response. The meridional stress distributions for two-component motion also are similar to those for horizontal excitation only, but with somewhat higher peak stress, especially near the bottom of the tank wall.

Figure 4-27. Maximum and Minimum Hoop Stress vs. Path Length for Element Set “Plusx_Outstrip” at $\theta=0^\circ$ for Two-Component Seismic Excitation

Figure 4-28. Maximum and Minimum Meridional Stress vs. Path Length for Element Set “Plusx_Outstrip” at $\theta=0^\circ$ for Two-Component Seismic Excitation

Figure 4-29. Maximum and Minimum Shear Stress vs. Path Length for Element Set “Plusx_Outstrip” at $\theta=0^\circ$ for Two-Component Seismic Excitation

Figure 4-30. Maximum and Minimum Hoop Stress vs. Path Length for Element Set "Press45_Outstrip" at $\theta=45^\circ$ for Two-Component Seismic Excitation

Figure 4-31. Maximum and Minimum Meridional Stress vs. Path Length for Element Set "Press45_Outstrip" at $\theta=45^\circ$ for Two-Component Seismic Excitation

Figure 4-32. Maximum and Minimum Shear Stress vs. Path Length for Element Set "Press45_Outstrip" at $\theta=45^\circ$ for Two-Component Seismic Excitation

Figure 4-33. Maximum and Minimum Shear Stress vs. Path Length for Element Set "Plusz_Outstrip" at $\theta=90^\circ$ for Two-Component Seismic Excitation

Inspection of the primary tank stresses for the previous cases shows that the hoop and meridional stresses are similar in magnitude and distribution for horizontal, vertical, and two-component motion. The shear stresses are similar for horizontal and two-component motion, but negligible for vertical. These observations support the conclusion that the stresses in the primary tank sub-models are dominated by dead weight loading.

5.0 ANSYS® Primary Tank Sub-Model Description

The global ANSYS® model was used as the starting point for the development of the primary tank sub-model. Those features not needed for the sub-model were unselected. For the elements used, properties and element options were changed as needed to obtain a model with geometry and dynamic characteristic similar to the Dytran® sub-model. The key modifications to the full model are described below.

All elements related to the modeling of the soil were unselected for the sub-model. This includes the soil (element types 8, 9, 90, and 91), contact elements between the soil and the concrete shell (element types, 60 through 63), spring elements between the concrete basemat and the underlying soil (element types 21, 22, and 23), the links used at the exterior surface of the soil (element type 30), and the mass elements used for applying the surface load (element type 10).

For the concrete shell elements, the modulus of elasticity was increased by a factor of 10,000 to obtain “rigid” behavior. The same increase in stiffness was also applied to the insulating concrete elements. This will ensure that the full sub-model is excited uniformly top and bottom, consistent with the Dytran® sub-model.

The geometry and properties for the majority of the primary tank were not changed in the sub-model. The only changes were to the elements in the dome region, where the modulus of elasticity was increased by a factor of 10,000. The geometry of the knuckle region for the ANSYS® and Dytran® models is different. The ANSYS® model explicitly includes the curvature of the knuckle, whereas the Dytran® model does not. Retaining the curvature in the ANSYS® model provided a better match of the impulsive frequencies of the two models than using a square corner. It also improved the solution behavior for the contact element in the knuckle region.

The liner, anchor bolts, and contact elements associated with the dome, primary tank to insulating concrete, and insulating concrete to liner were all modified to obtain “rigid” behavior. For the liner and anchor bolt elements, the modulus of elasticity was increased by a factor of 10,000. The contact element key options were modified to obtain bonded behavior (i.e., they are “locked” together). Bonding the contact surfaces creates the same condition as if the nodes on the two surfaces were merged.

No changes were made to the waste elements or to the waste to primary tank contact elements.

A large mass is required at the location of excitation to properly simulate the seismic excitation. This mass was located at the apex of the concrete shell. The boundary conditions of the node at the apex are adjusted depending on the direction of excitation.

5.1 Model Geometry

A plot of the ANSYS® primary tank sub-model is shown in Figure 5-1. Although the concrete portion of the DST is shown in the plot, the concrete was effectively rigid as stated in the previous section. A slice plot of the rigid regions of the model is shown in Figure 5-2. Flexible portions of the primary tank are shown in Figure 5-3, though the portion of the primary tank bottom in contact with the underlying insulation concrete is effectively rigid.

Figure 5-1. Plot of ANSYS® Primary Tank Sub-Model

Figure 5-2. Slice Plot Showing Rigid Regions of the ANSYS® Primary Tank Sub-Model

Figure 5-3. Plot of Flexible Primary Tank of ANSYS® Sub-Model

Shell element numbers at locations for which primary tank stresses are extracted are shown in Figure 5-4 and Figure 5-5.

Figure 5-4. Shell Element Numbering for Tank Wall Stress Results at $\theta=0^\circ$ and $\theta=90^\circ$

Figure 5-5. Shell Element Numbering for Tank Wall Stress Results at $\theta=45^\circ$ and $\theta=180^\circ$

5.2 Damping Characterization and Frequency Tuning with the Dytran[®] Model

The objective of frequency tuning was to obtain an impulsive frequency for the tank/waste system as close as practical to that of the Dytran[®] sub-model so that the input time histories would have essentially the same effect on both models. That is, the goal was that both sub-models should be experiencing the same spectral accelerations.

Tuning of the ANSYS[®] sub-model was performed by activating or de-activating various features from the full global model. Model features tested included the anchor bolts, contact behavior in the dome and at the bottom, presence of the radius on the knuckle, and the inclusion of tank floor flexibility.

The configuration providing the best match was essentially the same as the Dytran[®] sub-model except for the inclusion of the knuckle curvature at the bottom of the primary tank, as shown in Figure 5-3, Figure 5-4, and Figure 5-5. In this configuration, the ANSYS[®] sub-model displayed a horizontal impulsive frequency of 5.78 Hz, and an associated effective damping of 3.77%.

The convective and impulsive fundamental frequencies were determined in a two-step process. A rigid primary tank model is used in the first step and a flexible primary tank model is used in the second. For each step, the sub-model was solved in the initial time step with a 0.05g lateral acceleration applied. This induced an initial displacement in the sub-model. The lateral acceleration was then removed and the sub-model allowed to oscillate freely. The total hydrodynamic response is tracked for each step. The waste convective frequency was determined with the primary tank modeled as “rigid.” A combined response, convective and impulsive, is determined with the flexible model. The impulsive portion of the total response is the difference between the flexible model total response and the rigid model total response.

Figure 5-6 shows the total hydrodynamic response for free oscillation initiated by the 0.05g horizontal accelerations with the primary tank modeled as “rigid.” From this, a fundamental convective frequency of 0.21 Hz can be determined ($2/(13.9-4.45) = 0.21$ Hz).

Figure 5-6. Free Horizontal Oscillation Total Reaction

Figure 5-7 shows the total hydrodynamic response for free oscillation initiated by the 0.05g horizontal acceleration for the flexible-wall model. The response shows 5 cycles in 0.87 seconds, for a frequency of 5.78 Hz.

Figure 5-7. Total Reaction from ANSYS® Primary Tank Sub-Model for Free Horizontal Oscillation

Figure 5-8 shows three lines, the total hydrodynamic response of the flexible-wall sub-model, the response of the rigid sub-model, and the difference between the two – that is, the impulsive portion of the reaction. From this difference, the damping can be calculated based on the decrease in response over three cycles. A damping value of 3.77% corresponds well with the Dytran® damping of 4.3%.

Figure 5-8. Total Reaction Force Comparison Between Rigid and Flexible ANSYS® Primary Tank Sub-Models for Free Horizontal Oscillation

Figure 5-9 shows the total hydrodynamic response for free oscillation initiated by a 0.05g vertical acceleration. The response shows 3 cycles in 0.8 seconds, for a frequency of 5.0 Hz (vs. 5.07 Hz for Dytran®). The damping associated with the “breathing” mode can be calculated based on the decrease in response over three cycles. A damping value of 2.6% is less than shown in Dytran® with a damping of 3.5%.

Figure 5-9. Total Reaction Force for ANSYS® Primary Tank Sub-Model for Free Vertical Oscillation

6.0 Results from ANSYS® Primary Tank Sub-Models

Results from horizontal seismic excitation only, vertical seismic excitation only, and simultaneous application of horizontal and vertical seismic excitation (two-component motion) are described in this chapter.

Impulsive and convective frequencies, global reaction forces, waste pressures, maximum slosh heights, and primary tank stresses will be reported. Benchmarking of ANSYS® primary tank sub-models was performed and reported in Rinker et al. (2006b). Thus, although frequencies, reaction forces, waste pressures, and slosh heights are reported to provide a basic check of the results, the primary tank stresses are of the most interest. Furthermore, due to the extensive data produced by the ANSYS® simulations, some results appear in Appendix D rather than in the main body of this report.

6.1 Hydrodynamic Forces from ANSYS® Sub-Model

The total horizontal and vertical reaction forces for horizontal excitation, vertical excitation, and two-component motion are presented in the following sections.

6.1.1 Horizontal Excitation Only

The maximum reaction force for horizontal excitation only is 3.47×10^6 lbf, as shown in Figure 6-1. This is approximately 14% greater than the value of 3.05×10^6 lbf from the Dytran® model. This is consistent with a reduced convective response and increased impulsive response for the ANSYS® sub-model.

Figure 6-1. Horizontal Coupling Surface Reaction Force vs. Time from ANSYS® Primary Tank Sub-Model for Horizontal Seismic Excitation

6.1.2 Vertical Excitation Only

According to Figure 6-2, the vertical reaction force varies between -1.65×10^7 lbf and -2.29×10^7 lbf. The weight of the contained fluid is 1.92×10^7 lbf, so that the maximum dynamic component of the vertical reaction force is 3.7×10^6 lbf, which is greater than for horizontal excitation only, and nearly the same as the value of 3.6×10^6 lbf from the Dytran® model. Good agreement between the ANSYS® and Dytran® sub-models is expected for vertical excitation since the response does not involve fluid sloshing.

Figure 6-2. Vertical Reaction Force vs. Time from ANSYS® Primary Tank Sub-Model for Vertical Seismic Excitation

6.1.3 Two-Component Motion

The horizontal reaction force time-history plot presented as Figure 6-3 shows that the maximum horizontal force is 3.47×10^6 lbf, exactly the same as for horizontal motion only. Similarly, Figure 6-4 shows that the vertical reaction force varies between -1.65×10^7 lbf and -2.29×10^7 lbf – the same as for vertical excitation only, giving a maximum dynamic component of the vertical reaction force of 3.7×10^6 lbf, as before. That is, the peak reaction forces for two-component motion are the same as for the individual component directions run separately.

Figure 6-3. Horizontal Reaction Force vs. Time from ANSYS® Primary Tank Sub-Model for Two-Component Seismic Excitation

Figure 6-4. Vertical Reaction Force vs. Time from ANSYS® Primary Tank Sub-Model for Two-Component Seismic Excitation

6.2 Waste Pressures from ANSYS® Sub-Model

The theoretical hydrostatic pressures for the waste elements at $\theta=0$, 45, and 90° from the plane of excitation are shown in Table 6-1. The hydrostatic pressures from the sub-model simulations are reflected in the initial portion of the waste pressure time-history plots.

Table 6-1. Theoretical Hydrostatic Pressures for Selected Fluid Elements from ANSYS® Primary Tank Sub-Model

$\theta=0^\circ$	$\theta=45^\circ$	$\theta=90^\circ$	Theoretical Hydrostatic Pressure (psi absolute)
Element	Element	Element	
7722	7727	7732	15.1
8382	8387	8392	15.8
9042	9047	9052	16.6
9702	9707	9712	17.7
10362	10367	10372	19.3
11022	11027	11032	20.9
12482	12557	12632	22.5
12487	12562	12637	24.1
12492	12567	12642	25.6
12497	12572	12647	27.1
12502	12577	12562	28.6
12507	12582	12657	30.2
12512	12587	12662	31.7
12517	12592	12667	33.2
12522	12597	12672	34.8
12527	12602	12677	36.2
12532	12607	12682	37.7
12537	12612	12687	39.1
12542	12617	12692	40.5
12547	12622	12697	41.9
12552	12627	12702	43.5
13102	13107	13112	44.6
13522	13527	13532	45.0

6.2.1 Horizontal Excitation Only

Pressure time histories and maximum and minimum pressure plots for horizontal excitation only are shown in Figure 6-5 through Figure 6-10. The hydrostatic pressures match well with the theoretical values shown in Table 6-1. Comparisons to the pressure time history plots from the Dytran® sub-model are presented in Section 7.3.

Figure 6-5. Waste Pressure Time Histories from ANSYS® Primary Tank Sub-Model for Fluid Elements at $\theta=0^\circ$ Subjected to Horizontal Seismic Excitation Only

Figure 6-6. Maximum and Minimum Waste Pressures vs. Normalized Height from Tank Bottom from ANSYS® Primary Tank Sub-Model for Waste Elements at $\theta=0^\circ$ Subjected to Horizontal Seismic Excitation Only

Figure 6-7. Waste Pressure Time Histories from ANSYS® Primary Tank Sub-Model for Fluid Elements at $\theta=45^\circ$ Subjected to Horizontal Seismic Excitation Only

Figure 6-8. Waste Pressure Variation from ANSYS® Primary Tank Sub-Model for Waste Elements at $\theta=45^\circ$ Subjected to Horizontal Seismic Excitation Only

Figure 6-9. Waste Pressure Time Histories from ANSYS® Primary Tank Sub-Model for Fluid Elements at $\theta=90^\circ$ Subjected to Horizontal Seismic Excitation Only

Figure 6-10. Waste Pressure Variation from ANSYS® Primary Tank Sub-Model for Waste Elements at $\theta=90^\circ$ Subjected to Horizontal Seismic Excitation Only

6.2.2 Vertical Excitation Only

Plots of waste pressure time histories and maximum and minimum stresses at $\theta=0^\circ$ and $\theta=45^\circ$ are shown in Figure 6-11, Figure 6-12, Figure 6-13, and Figure 6-14. The stress distributions are independent of the angular location and the dynamic pressures increase with depth, both of which are required for vertical excitation only. Figure 6-11 and Figure 6-13 appear very similar to Figure 4-11 and Figure 4-12 from the Dytran[®] sub-model simulation for vertical excitation.

Figure 6-11. Waste Pressure Time Histories from ANSYS[®] Primary Tank Sub-Model for Fluid Elements at $\theta=0^\circ$ Subjected to Vertical Seismic Excitation Only

Figure 6-12. Waste Pressure Variation from ANSYS® Primary Tank Sub-Model for Waste Elements at $\theta=0^\circ$ Subjected to Vertical Seismic Excitation Only

Figure 6-13. Waste Pressure Time Histories from ANSYS® Primary Tank Sub-Model for Fluid Elements at $\theta=45^\circ$ Subjected to Vertical Seismic Excitation Only

Figure 6-14. Waste Pressure Variation from ANSYS® Primary Tank Sub-Model for Waste Elements at $\theta=45^\circ$ Subjected to Vertical Seismic Excitation Only

6.2.3 Two-Component Motion

Waste pressure time histories for fluid elements located along the tank wall at $\theta=0^\circ$, 45° , and 90° when subjected to two-component seismic excitation are shown in Figure 6-15, Figure 6-17, and Figure 6-19, respectively. Maximum and minimum pressure distributions are shown in Figure 6-16, Figure 6-18, and Figure 6-20, respectively. The peak pressures are higher for two-component motion than for either horizontal motion or vertical motion separately and the timing of the peaks is different. The waste pressure time histories at $\theta=90^\circ$ are nearly the same as for vertical motion only, as expected, since the contribution to dynamic pressure from horizontal excitation is nearly zero at $\theta=90^\circ$.

Figure 6-15. Waste Pressure Time Histories from ANSYS® Primary Tank Sub-Model for Fluid Elements at $\theta=0^\circ$ Subjected to Two-Component Seismic Excitation

Figure 6-16. Waste Pressure Variation from ANSYS® Primary Tank Sub-Model for Waste Elements at $\theta=0^\circ$ Subjected to Two-Component Seismic Excitation

Figure 6-17. Waste Pressure Time Histories from ANSYS® Primary Tank Sub-Model for Fluid Elements at $\theta=45^\circ$ Subjected to Two-Component Seismic Excitation

Figure 6-18. Waste Pressure Variation from ANSYS® Primary Tank Sub-Model for Waste Elements at $\theta=45^\circ$ Subjected to Two-Component Seismic Excitation

Figure 6-19. Waste Pressure Time Histories from ANSYS® Primary Tank Sub-Model for Fluid Elements at $\theta=90^\circ$ Subjected to Two-Component Seismic Excitation

Figure 6-20. Waste Pressure Variation from ANSYS® Primary Tank Sub-Model for Waste Elements at $\theta=90^\circ$ Subjected to Two-Component Seismic Excitation

6.3 Primary Tank Stresses from ANSYS® Sub-Model

Primary tank stresses from the ANSYS® sub-model for horizontal excitation, vertical excitation, and two-component excitation are presented and discussed in the next three sections.

6.3.1 Horizontal Excitation Only

Maximum and minimum stresses in the primary tank for horizontal excitation only are plotted in Figure 6-21 through Figure 6-27. The plots show that there is very little bending in the hoop response at $\theta=0^\circ$ and 45° except near the free-surface. The data also show that the meridional stresses are fairly low and are dominated by membrane response, except near free surface and knuckle. The shear stresses are low in the plane of excitation and increase with increasing angle from the plane of excitation, as expected.

Figure 6-21. Maximum and Minimum Hoop Stress vs. Path Length at $\theta=0^\circ$ for Horizontal Seismic Excitation Only

Figure 6-22. Maximum and Minimum Meridional Stress vs. Path Length at $\theta=0^\circ$ for Horizontal Seismic Excitation Only

Figure 6-23. Maximum and Minimum Shear Stress vs. Path Length at $\theta=0^\circ$ for Horizontal Seismic Excitation Only

Figure 6-24. Maximum and Minimum Hoop Stress vs. Path Length at $\theta=45^\circ$ for Horizontal Seismic Excitation Only

Figure 6-25. Maximum and Minimum Meridional Stress vs. Path Length at $\theta=45^\circ$ for Horizontal Seismic Excitation Only

Figure 6-26. Maximum and Minimum Shear Stress vs. Path Length at $\theta=45^\circ$ for Horizontal Seismic Excitation Only

Figure 6-27. Maximum and Minimum Shear Stress vs. Path Length at $\theta=90^\circ$ for Horizontal Seismic Excitation Only

6.3.2 Vertical Excitation Only

In the case of vertical excitation only, maximum and minimum stress distributions for hoop, meridional, and shear components at $\theta=0^\circ$ are shown in Figure 6-28, Figure 6-29, and Figure 6-30. The stress distributions for vertical excitation only are very similar to those for horizontal excitation only, except that shear stresses are negligible for the vertical case. This indicates that primary tank stresses are dominated by gravity loading.

Figure 6-28. Maximum and Minimum Hoop Stress vs. Path Length at $\theta=0^\circ$ for Vertical Seismic Excitation Only

Figure 6-29. Maximum and Minimum Meridional Stress vs. Path Length at $\theta=0^\circ$ for Vertical Seismic Excitation Only

Figure 6-30. Maximum and Minimum Shear Stress vs. Path Length at $\theta=0^\circ$ for Vertical Seismic Excitation Only

6.3.3 Two-Component Motion

Maximum and minimum stress distributions for the case of two-component motion are shown in Figure 6-31 through Figure 6-37. In general, the plots show that the hoop and meridional stress distributions are very similar in character to those for horizontal and vertical excitation only, but the magnitudes are slightly higher. The shear stresses are essentially the same as for the horizontal case, which makes sense because the shear stresses were negligible in the case of vertical excitation only.

Figure 6-31. Maximum and Minimum Hoop Stress vs. Path Length at $\theta=0^\circ$ for Two-Component Seismic Excitation

Figure 6-32. Maximum and Minimum Meridional Stress vs. Path Length at $\theta=0^\circ$ for Two-Component Seismic Excitation

Figure 6-33. Maximum and Minimum Shear Stress vs. Path Length at $\theta=0^\circ$ for Two-Component Seismic Excitation

Figure 6-34. Maximum and Minimum Hoop Stress vs. Path Length at $\theta=45^\circ$ for Two-Component Seismic Excitation

Figure 6-35. Maximum and Minimum Meridional Stress vs. Path Length at $\theta=45^\circ$ for Two-Component Seismic Excitation

Figure 6-36. Maximum and Minimum Shear Stress vs. Path Length at $\theta=45^\circ$ for Two-Component Seismic Excitation

Figure 6-37. Maximum and Minimum Shear Stress vs. Path Length at $\theta=90^\circ$ for Two-Component Seismic Excitation

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7.0 ANSYS® to Dytran® Comparisons for Primary Tank Sub-Models

In the following sections, comparisons of frequencies, hydrodynamic forces, waste pressures, and tank stresses are presented for the ANSYS® and Dytran® sub-models. Comparisons with stresses predicted by the global ANSYS® model are presented in Section 7.4.4. The intent of the comparisons is to show that the stresses predicted by the ANSYS® models are either nearly the same as the Dytran® model, are small in magnitude, or small relative to the available margin.

7.1 Frequency Comparisons

A summary of fundamental frequencies predicted by both ANSYS® and Dytran® is given in Table 7-1. The convective, impulsive, and breathing mode frequencies are within approximately 1% between the ANSYS® and Dytran® models.

Table 7-1. Comparison of ANSYS® and Dytran® Frequencies for Primary Tank Sub-Models

First Convective Mode Frequency (Hz)		Impulsive Mode Frequency (Hz)			Breathing Mode Frequency (Hz)	
Dytran®	ANSYS®	Dytran® Horizontal Excitation	Dytran® Two- Component Motion	ANSYS®	Dytran®	ANSYS®
0.207	0.21	5.7	5.88	5.78	5.07	5.0

7.2 Hydrodynamic Force Comparisons

Comparisons of hydrodynamic reaction forces for the ANSYS® and Dytran® sub-models subjected to horizontal excitation, vertical excitation, and two-component excitation are presented in the following three sections.

7.2.1 Horizontal Excitation Only

Figure 7-1 and Figure 7-2 show a comparison of Dytran® and ANSYS® horizontal reaction force time histories for horizontal excitation only. The Dytran® and ANSYS® traces are quite similar with the ANSYS® reaction force time history tending to have slightly higher peaks than the Dytran® time history.

Figure 7-1. Comparison of Horizontal Reaction Forces Between ANSYS® and Dytran® Primary Tank Sub-Models for Horizontal Excitation Only – ES-BEC Time History

Figure 7-2. Comparison of Horizontal Reaction Forces Between ANSYS® and Dytran® Primary Tank Sub-Models for Horizontal Excitation During Strong Motion Portion of Excitation – BES-BEC Time History

7.2.2 Vertical Excitation Only

The time history comparisons of the vertical reaction force for vertical excitation only are shown in Figure 7-3 and Figure 7-4. As in the case of the horizontal reaction forces, the Dytran[®] and ANSYS[®] reaction force time histories are quite similar. Neither the Dytran[®] nor the ANSYS[®] model exhibits peaks that are consistently higher than the other model.

Figure 7-3. Comparison of Vertical Reaction Forces Between ANSYS[®] and Dytran[®] Primary Tank Sub-Models for Vertical Excitation Only – BES-BEC Time History

Figure 7-4. Comparison of Vertical Reaction Forces Between ANSYS® and Dytran® Primary Tank Sub-Models for Vertical Excitation During Strong Motion Portion of Excitation – BES-BEC Time History

7.2.3 Two-Component Motion

In the case of two-component motion, both the horizontal and vertical reaction forces are compared for the Dytran® and ANSYS® sub-models. The comparisons of the horizontal reaction forces are shown in Figure 7-5 and Figure 7-6, and the comparisons of the vertical reaction force are presented in Figure 7-7 and Figure 7-8.

The peak reaction forces indicate that directional coupling exists in the Dytran® model in the sense that the peak horizontal reaction force for two-component motion is higher than for the case of horizontal excitation only. That is, the presence of vertical motion increases the peak horizontal reaction force. However, the presence of horizontal motion has no effect on the peak vertical reaction force, since that value is the same for two-component motion as it is in the case of vertical excitation only.

On the other hand, the results from the ANSYS® sub-model show that the peak horizontal and vertical reaction forces are the same for two-component motion as they are when the seismic excitations are applied in one direction at a time. The complete independence of the horizontal and vertical responses in two-component motion does not seem plausible, and it suggests an inability of the ANSYS® model to resolve the responses in sufficient detail to capture any directional coupling in the reaction forces.

Because of the directional coupling in Dytran®, the peak horizontal reaction force from the Dytran® model subjected to two-component excitation is higher than for ANSYS®, even though the individual direction components are higher from the ANSYS® model when the excitations are applied separately.

Figure 7-5. Comparison of Horizontal Reaction Forces Between ANSYS® and Dytran® Primary Tank Sub-Models for Two-Component Seismic Excitation – BES-BEC Time History

Figure 7-6. Comparison of Horizontal Reaction Forces Between ANSYS® and Dytran® Primary Tank Sub-Models for Two-Component Seismic Excitation During Strong Motion Portion of Excitation – BES-BEC Time History

Figure 7-7. Comparison of Vertical Reaction Forces Between ANSYS® and Dytran® Primary Tank Sub-Models for Two-Component Seismic Excitation – BES-BEC Time History

Figure 7-8. Comparison of Vertical Reaction Forces Between ANSYS® and Dytran® Primary Tank Sub-Models for Two-Component Seismic Excitation During Strong Motion Portion of Excitation – BES-BEC Time History

A summary of the peak reaction forces from the various simulations is given as Table 7-2.

Table 7-2. Summary of Peak Reaction Forces from Primary Tank Sub-Models

Excitation Direction(s)	Peak Horizontal Reaction Force (lbf)		Peak Vertical Reaction Force (lbf)	
	Dytran®	ANSYS®	Dytran®	ANSYS®
Horizontal Only	3.05×10^6	3.47×10^6	Not Calculated	Not Calculated
Vertical Only	Not Calculated	Not Calculated	3.6×10^6	3.7×10^6
Two-Component Motion	3.7×10^6	3.47×10^6	3.6×10^6	3.7×10^6

7.3 Waste Pressure Comparisons

Comparisons of selected waste pressure time histories from the ANSYS® and Dytran® sub-models for horizontal excitation only, vertical excitation only, and two-component excitation are shown in Figure 7-9, Figure 7-10, and Figure 7-11, respectively. The centroidal elevation of the upper two elements (Dytran® element 5143 and ANSYS® element 7722) is approximately 455 inches from the tank bottom, giving a normalized height of 0.99. The centroidal elevation of the lower two elements (Dytran® element 30743 and ANSYS® element 12552) is approximately 24 inches from the tank bottom, giving a normalized height of 0.05.

In the case of horizontal excitation only, the pressures predicted by ANSYS® near the bottom of the tank appear to be slightly higher than those predicted by Dytran® as shown in Figure 7-9. In the case of vertical motion only, the pressures predicted by ANSYS® near the bottom of the tank appear to be slightly less than those predicted by Dytran® (Figure 7-10). In the case of two-component motion, the peak pressures near the bottom of the tank are similar from the two models, but the character of the time histories is noticeably different.

The most striking difference between the ANSYS® and Dytran® results is the pressures near the free-surface when horizontal excitation is present. In those two cases the peak pressures predicted by ANSYS® are significantly higher than those predicted by Dytran® as shown in Figure 7-9 and Figure 7-11. Some of the difference between the pressures in Dytran® element 5143 and ANSYS® element 7722 can be attributed to the fact that the Dytran® pressure results are in the Eulerian formulation, while the ANSYS® results are in the Lagrangian formulation—but the two results are still significantly different.

In the case of vertical motion only, the ANSYS® sub-model predicts nearly zero dynamic pressure near the free surface, while the Dytran® sub-model shows dynamic pressures of approximately $\pm 1 \text{ lbf/in}^2$ as shown in Figure 7-10.

Figure 7-9. Comparison of Selected ANSYS® and Dytran® Waste Pressures at $\theta=0^\circ$ for Horizontal Excitation Only

Figure 7-10. Comparison of Selected ANSYS® and Dytran® Waste Pressures at $\theta=0^\circ$ for Vertical Excitation Only

Figure 7-11. Comparison of Selected ANSYS® and Dytran® Waste Pressures at $\theta=0^\circ$ for Two-Component Seismic Excitation

7.4 Stress Comparisons

The following three sections include comparisons of maximum and minimum stress distributions for the ANSYS® and Dytran® primary tank sub-models. Section 7.4.4 also includes stress results from the global ANSYS® model. The data show that the stresses predicted by the two sub-models are very similar except near the free surface and to some degree near the tank knuckle.

Based on earlier studies documented in Rinker and Abatt (2006a) and in Rinker et al. (2006b), it is expected that the convective response of the contained liquid will not be captured properly by the ANSYS® model. Thus, differences in the stresses near the liquid-free surface are expected. Some differences in the stresses between the ANSYS® and Dytran® models are also expected in the tank knuckle if for no other reason than the fact that in the Dytran® sub-model the junction of the wall with the floor is a right angle, as shown in Figure 3-10 and Figure 3-11, while in the ANSYS® sub-model the knuckle radius is approximated with two elements, as shown in Figure 5-3, Figure 5-4, and Figure 5-5.

Although the convective response may not be captured properly by the ANSYS® sub-model, it is expected that the impulsive response will be represented with sufficient accuracy, and will tend to be overpredicted by the ANSYS® model due to the constitutive model for the waste. Because the total response is dominated by the impulsive response, it is expected that the stresses from the ANSYS® sub-model should be very similar to those from the Dytran® sub-model in the majority of the tank wall. Another point to note is that the stresses from the primary tank sub-models are due to combined effects of gravity loading and seismic loading. Because the demands from gravity loading tend to dominate those

from seismic loading only, and the models are expected to give very similar results for gravity loading, the differences in the predictions for seismic stresses only will be less apparent in the stress plots.

In the stress comparison plots, only mid-surface stresses are plotted for the hoop and shear components, since bending is not a significant contributor to these components. In the case of the meridional component, the stresses on the inside and outside surface of the primary tank are plotted.

7.4.1 Horizontal Excitation Only

Comparison plots of the maximum and minimum hoop, meridional, and shear stress distributions in the plane of excitation at $\theta=0^\circ$ for horizontal excitation only are shown in Figure 7-12, Figure 7-13, and Figure 7-14, respectively. Plots of the same stress components at $\theta=45^\circ$ are shown in Figure 7-15, Figure 7-16, and Figure 7-17. The mid-surface shear stress distribution at $\theta=90^\circ$ is shown as Figure 7-18.

The plots show that the hoop stresses from the two sub-models are very similar, except at the waste-free surface, as expected. The meridional stresses are similar in the majority of the tank wall, but differ somewhat in the knuckle region, and especially near the waste-free surface. The shear stresses are nearly the same or are of negligible magnitude.

Figure 7-12. Comparison of Dytran® and ANSYS® Mid-Surface Hoop Stresses at $\theta=0^\circ$ for Horizontal Seismic Excitation

Figure 7-13. Comparison of Dytran® and ANSYS® Outside and Inside Surface Meridional Stresses at $\theta=0^\circ$ for Horizontal Seismic Excitation

Figure 7-14. Comparison of Dytran® and ANSYS® Mid-Surface In-Plane Shear Stresses at $\theta=0^\circ$ for Horizontal Seismic Excitation

Figure 7-15. Comparison of Dytran® and ANSYS® Mid-Surface Hoop Stresses at $\theta=45^\circ$ for Horizontal Seismic Excitation

Figure 7-16. Comparison of Dytran® and ANSYS® Outside and Inside Surface Meridional Stresses at $\theta=45^\circ$ for Horizontal Seismic Excitation

Figure 7-17. Comparison of Dytran® and ANSYS® Mid-Surface In-Plane Shear Stresses at $\theta=45^\circ$ for Horizontal Seismic Excitation

Figure 7-18. Comparison of Dytran® and ANSYS® Mid-Surface In-Plane Shear Stresses at $\theta=90^\circ$ for Horizontal Seismic Excitation

7.4.2 Vertical Excitation Only

Plots of the hoop, meridional, and shear stress distributions at $\theta=0^\circ$ for vertical excitation only are shown in Figure 7-19, Figure 7-20, and Figure 7-21, respectively. The same observations made for the case of horizontal excitation only apply in this case.

Figure 7-19. Comparison of Dytran® and ANSYS® Mid-Surface Hoop Stresses at $\theta=0^\circ$ for Vertical Seismic Excitation

Figure 7-20. Comparison of Dytran® and ANSYS® Outside and Inside Surface Meridional Stresses at $\theta=0^\circ$ for Vertical Seismic Excitation

Figure 7-21. Comparison of Dytran® and ANSYS® Mid-Surface In-Plane Shear Stresses at $\theta=0^\circ$ for Vertical Seismic Excitation

7.4.3 Two-Component Motion

Comparison plots of the maximum and minimum hoop, meridional, and shear stress distributions in the plane of excitation at $\theta=0^\circ$ for horizontal excitation only are shown in Figure 7-22, Figure 7-23, and Figure 7-24, respectively. Plots of the same stress components at $\theta=45^\circ$ are shown in Figure 7-25, Figure 7-26, and Figure 7-27. The mid-surface shear stress distribution at $\theta=90^\circ$ is shown as Figure 7-28.

The same observations made for the cases of horizontal excitation only and vertical excitation only apply to the case of two-component excitation.

Figure 7-22. Comparison of Dytran® and ANSYS® Mid-Surface Hoop Stresses at $\theta=0^\circ$ for Two-Component Seismic Excitation

Figure 7-23. Comparison of Dytran® and ANSYS® Outside and Inside Surface Meridional Stresses at $\theta=0^\circ$ for Two-Component Seismic Excitation

Figure 7-24. Comparison of Dytran® and ANSYS® Mid-Surface In-Plane Shear Stresses at $\theta=0^\circ$ for Two-Component Seismic Excitation

Figure 7-25. Comparison of Dytran® and ANSYS® Mid-Surface Hoop Stresses at $\theta=45^\circ$ for Two-Component Seismic Excitation

Figure 7-26. Comparison of Dytran® and ANSYS® Outside and Inside Surface Meridional Stresses at $\theta=45^\circ$ for Two-Component Seismic Excitation

Figure 7-27. Comparison of Dytran® and ANSYS® Mid-Surface In-Plane Shear Stresses at $\theta=45^\circ$ for Two-Component Seismic Excitation

Figure 7-28. Comparison of Dytran® and ANSYS® Mid-Surface In-Plane Shear Stresses at $\theta=90^\circ$ for Two-Component Seismic Excitation

7.4.4 Two-Component Motion Comparisons for Various Models

The data in this section are presented to illustrate the differences in stress results that are attributable to the differences between the global model and the sub-models, and to differences in primary tank stresses due to different soil and concrete conditions. Differences between the global ANSYS® model and the sub-models include the method of excitation, a slight shifting of fundamental impulsive frequency between the models, and model configuration differences including anchor bolts, soil, and the lack of or presence of rigid regions.

A minor point that was considered while reviewing the ANSYS® data presented in Figure 7-29 and Figure 7-30 is that the maximum stresses shown actually represent the maximum signed magnitude of the stresses extracted from the ANSYS® model. That is, in regions where the ANSYS® stresses are negative, the ANSYS® traces could represent the minimum rather than the maximum stress. This potential inconsistency does not appear in the stress distributions used for the actual primary tank evaluation, and it does not affect the data in Figure 7-31 because all those stresses are positive.

Figure 7-29. Primary Tank Maximum Mid-Surface Hoop Stress Comparisons for Various Models at $\theta=0^\circ$

Figure 7-30. Primary Tank Maximum Mid-Surface Meridional Stress Comparisons for Various Models at $\theta=0^\circ$

Figure 7-31. Primary Tank Maximum Mid-Surface Shear Stress Comparisons for Various Models at $\theta=0^\circ$

7.5 Uncertainties Associated with Waste Characterization

In the Dytran[®] analysis of the AP tanks, the waste was modeled as a homogeneous, nearly incompressible, inviscid liquid with a bulk specific gravity of 1.83. In the ANSYS[®] analysis, the waste was modeled as a homogeneous, nearly incompressible deformable solid with very low shear resistance, also with a bulk specific gravity of 1.83. During a project review meeting held in June 2007, one review comment stated that there are fundamental uncertainties in idealizing the tank waste as a homogeneous liquid (see Appendix A of Deibler et al. 2008). The technical issue of concern is that hydrodynamic effects for a tank storing a solid-like material may be larger than for a liquid-containing tank.

The potential for an increased response from a tank containing a solid-like material relative to a tank containing a liquid arises from two mechanisms. First, the solid-like material will have reduced sloshing response relative to a liquid, so a higher portion of the mass responds impulsively, thereby increasing some response parameters. Second, depending on the excitation, as well the structural characteristics and geometrical configuration of the tank and contained waste, it is possible for the response of the tank to amplify the response of the tank walls (Veletsos and Younan [1998]).

The second phenomenon can occur when the natural frequencies of contained material are “in tune” with the natural frequencies of the tank. This also depends on the ratio of the waste height to the tank radius (slenderness ratio), and the characteristics of the forcing function. For this to occur, the contained material must be “solid” in the sense that it has structural frequencies and mode shapes independent of the tank itself. This characterization appears to be inconsistent with Hanford DST waste properties and will not be discussed further. Depending on the DST waste composition, the first phenomenon may occur to some degree.

When the waste is completely liquid, the mass of the waste in the DSTs that responds in the impulsive and convective modes is roughly the same, with somewhat greater than half the waste mass responding in the impulsive mode (BNL 1995).

If it is assumed conservatively that the lower one-third of the waste is a sludge layer of specific gravity of 1.83 that responds 100% impulsively, and that the upper two-thirds of the waste is liquid specific gravity of 1.83, which responds equally in the impulsive and convective modes, then two-thirds of the total waste mass responds impulsively. This gives an approximate increase of 1/6 (16.7%) in the portion of the waste responding impulsively. The increase in impulsive mass will affect both the demands on the anchor bolts and the waste pressures in the primary tank.

Some simple conservative estimates of the effects of a sludge layer at the bottom of the tank can be made based on the equations in Chapter 4 of BNL (1995) and Rinker and Abatt (2006b).

As a first approximation, it is assumed that the increase in the maximum horizontal hydrodynamic reaction force is proportional to the increase in the impulsive mass of the waste. That is, the increase in the maximum horizontal reaction force is estimated to be 16.7%. The increased shear reaction is split between the bottom of the primary tank (contact interface with the insulating concrete) and the top of the primary tank (anchor bolts and normal and shear forces between steel and concrete dome).

With several load paths available to accommodate the increased shear force, not all of the additional shear will be reacted by the anchor bolts. Moreover, a significant portion of the anchor bolt demand (roughly

one-third) is from thermal and operating loads, which are largely unaffected by the presence of a sludge layer. With the above considerations in mind, the increase in the anchor bolt demands from this conservative estimate appears to be less than 10%. This upper bound estimate of the increase in anchor bolt loads is exclusive of several other notable conservative factors in the analysis, including the following:

- The most recent site response analyses performed at the Hanford Site Waste Treatment Plant (WTP) show that the currently published design spectra for the WTP Site are significantly lower than the interim spectra published in 2005 (PNNL 2007). This indicates that the governing spectra being used for the DST analysis are likely to be conservative.
- The TOLA and seismic demands reported for the AP tanks do not credit any friction between the concrete dome and the steel tank. Initial indications are that the benefit of friction may reduce the demands by approximately 5%.
- So far, a simplified routine that smears spatial and temporal results has been used to calculate peak seismic demands. Use of a more refined methodology is estimated to reduce the seismic demand by approximately 5-10%.
- The assumption of a bulk modulus of 1.83 is conservative.

In lieu of further, more detailed analysis, it appears that for a sludge height not exceeding one-third of the primary tank height, the potential increase in anchor bolt loads due to increased impulsive response is offset by the increase in capacity associated with the conservatisms inherent to the analysis.

Due to the margins available in the primary tank stresses that are shown in Deibler et al. (2008), an even more conservative argument suffices to show that the increased dynamic pressures in the primary tank are acceptable. For this estimate, assume that *all of the tank waste responds impulsively*. In this case, the peak hydrodynamic wall is independent of the vertical position along the tank wall and is given by

$$p_{wall}(\theta) = \rho_w \cdot R \cdot (S_A)_i \cdot \cos(\theta) .$$

The spectral acceleration for the impulsive mode of the primary tank and waste can be estimated from the impulsive mode frequency and in-structure response spectrum at the base of the primary tank.

The ANSYS® simulation for the increase liquid level shows an impulsive frequency of 5.78 Hz. The Dytran® simulations show 5.7 and 5.88 Hz, depending on whether the input is single- or two-component motion. The effective impulsive damping from either model is in the range of 4% of critical damping. Based on the horizontal response spectrum shown in Figure 3-20, an upper bound estimate of the spectral acceleration for the impulsive mode of the primary tank is 0.35g. The corresponding peak dynamic wall pressure along the plane of excitation ($\theta=0$) is 10.4 lbf/in².

Figure 7-32 is a reproduction of Figure 6-6 with the predicted waste pressures for the 100% impulsive response included. In the critical middle third of the primary tank, the increase in *total gage pressure* (stress-producing pressure) is 10-15%. Although the percentage increase in the dynamic pressure is higher, the waste pressures are dominated by the gravity-induced hydrostatic pressure over the majority of the tank, and the increase in dynamic pressures associated with the increase in the impulsive response is

mitigated by the superimposed static pressure. Thus, even with highly conservative assumptions, increases in the AP tank waste pressures and tank stresses are easily accommodated with the present analysis.

Figure 7-32. Comparison of Maximum Waste from the ANSYS® Primary Tank Sub-Model for Waste Elements at $\theta=0^\circ$ Subjected to Horizontal Seismic Excitation Only to Maximum Waste Pressures for the 100% Impulsive Case

8.0 ANSYS® Global Model Free-Field Spectra

This section presents a comparison between response spectra extracted at the lateral boundary of the global model and the free-field spectra from SHAKE. The intent is to demonstrate that the spectra extracted from the global ANSYS® model meet the spectral requirements discussed in Deibler et al. (2007a) and Rinker et al. (2006a, 2006c) and that the lateral boundary of the global model is sufficiently far from the tank structure to essentially reproduce the free-field response. Further discussion of the extent of the lateral boundary of the model is presented in Rinker et al. (2006a).

Similar spectral comparisons are presented in Rinker et al. (2006c) for the baseline liquid level of 422 inches at a specific gravity of 1.7, but the spectra shown in the following sections are from the global model with the increased liquid level of 460 inches and the increased specific gravity of 1.83.

Due to the large amount of data, only plots summarizing the results are presented in this section. For more detailed results, see the following appendixes:

• Lower Bound Soil, Best-Estimate Concrete	Appendix F
• Best-Estimate Soil, Best-Estimate Concrete	Appendix G
• Upper Bound Soil, Best-Estimate Concrete	Appendix H
• Best-Estimate Soil, Fully Cracked Concrete	Appendix I

All data were extracted for the full transient analysis (gravity loading plus 2,048 step seismic loading) and summarized using ANSYS® to obtain the minimum and maximum values. Both the full-time history data and summary data are available electronically.

As discussed in Section 2.5, four separate load cases have been run. One check to ensure that the correct loading was applied during the transient analysis is to compare the response spectra at the edge of the model to the free-field, or design basis response spectra. For each load case, horizontal and vertical spectra have been extracted at both the surface and at -57 ft (base of tank) for comparison.

8.1 Lower Bound Soil, Best-Estimate Concrete

For the lower bound soil case, the ANSYS® spectra are compared to the SHAKE spectra at the surface and tank base. In the lower bound soil, the time histories at the base of the model have been increased by scale factors of 1.175 and 1.12 for horizontal and vertical accelerations respectively in order to meet the minimum spectral requirements. Further discussion of scale factors and requirements for the response spectra is presented in the baseline seismic analysis reported in Deibler et al. (2007a) and Rinker et al. (2006a, 2006c). As can be seen in Figure 8-1 through Figure 8-4, there is a good match between the ANSYS® model free-field response and the free-field response from SHAKE. This demonstrates that the desired ground motions occur in the ANSYS® model.

Figure 8-1. 5% Damped Horizontal Response Spectra Comparison, Surface (LBS-BEC)

Figure 8-2. 5% Damped Horizontal Response Spectra, Tank Bottom (LBS-BEC)

Figure 8-3. 5% Damped Vertical Response Spectra Comparison, Surface (LBS-BEC)

Figure 8-4. 5% Damped Vertical Response Spectra, Tank Bottom (LBS-BEC)

8.2 Best-Estimate Soil, Best-Estimate Concrete

For the best-estimate soil, no scale factors have been applied to the base acceleration time histories. As can be seen in Figure 8-5 through Figure 8-8, there is a good match between the free-field response from the ANSYS® model and the free-field response from SHAKE.

Figure 8-5. 5% Damped Horizontal Response Spectra Comparison, Surface (BES-BEC)

Figure 8-6. 5% Damped Horizontal Response Spectra, Tank Bottom (BES-BEC)

Figure 8-7. 5% Damped Vertical Response Spectra Comparison, Surface (BES-BEC)

Figure 8-8. 5% Damped Vertical Response Spectra, Tank Bottom (BES-BEC)

8.3 Upper Bound Soil, Best-Estimate Concrete

For the upper bound soil case, the ANSYS® spectra are compared to the SHAKE spectra at the surface and tank base. In the upper bound soil, the time histories at the base of the model have been increased by scale factors of 1.12 and 1.19 for horizontal and vertical accelerations respectively in order to meet the minimum spectral requirements. Further discussion of scale factors and requirements for the response spectra is presented in the baseline seismic analysis reported in Deibler et al. (2007a) and Rinker et al. (2006a, 2006c). As can be seen in Figure 8-9 through Figure 8-12, there is a good match between the ANSYS® model free-field response and the free-field response from SHAKE. This demonstrates that the desired ground motions occur in the ANSYS® model.

Figure 8-9. 5% Damped Horizontal Response Spectra Comparison, Surface (UBS-BEC)

Figure 8-10. 5% Damped Horizontal Response Spectra, Tank Bottom (UBS-BEC)

Figure 8-11. 5% Damped Vertical Response Spectra Comparison, Surface (UBS-BEC)

Figure 8-12. 5% Damped Vertical Response Spectra, Tank Bottom (UBS-BEC)

8.4 Best-Estimate Soil, Fully Cracked Concrete

For the best-estimate soil case, the spectra are compared against the surface and tank base spectra with the appropriate scale factors applied. For the best-estimate soil, no scale factors have been applied to the base acceleration time history. As can be seen in Figure 8-13 through Figure 8-16, there is a good match between the model response and the response of the free field as developed by SHAKE. This demonstrates that the size of the soil model is sufficient to capture appropriate behavior and that the desired ground motions occur throughout the model.

Figure 8-13. 5% Damped Horizontal Response Spectra Comparison, Surface (BES-FCC)

Figure 8-14. 5% Damped Horizontal Response Spectra, Tank Bottom (BES-FCC)

Figure 8-15. 5% Damped Vertical Response Spectra Comparison, Surface (BES-FCC)

Figure 8-16. 5% Damped Vertical Response Spectra, Tank Bottom (BES-FCC)

9.0 Tank Results

9.1 Concrete Shell Results for Revision 0 Model

Concrete shell forces and moments are extracted from the model in 9° slices, starting near the top of the dome and moving down the wall and across the footing from the outside to the center of the tank. Figure 9-1 show the first slice, with element numbers. Each of the subsequent figures shows one component of force or moment, comparing the results from each load case. The results presented for the concrete forces and moments are enveloped minima/maxima around the circumference of the tank.

The following forces/moments for SHELL143 elements were extracted from the model

- SMISC1 Hoop force (Meridional in footing)
- SMISC2 Meridional force (Hoop in footing)
- SMISC3 In-Plane shear force
- SMISC4 Hoop Moment (Meridional in footing)
- SMISC5 Meridional Moment (Hoop in footing)
- SMISC6 Twisting Moment
- SMISC7 Through Wall Shear Force (XZ)
- SMISC8 Through Wall Shear Force (YZ)

Figures are grouped in sets showing the force or moment for gravity only first, total demand from the transient analysis (gravity plus seismic), and then only the seismic portion. The seismic only load is simply the difference between the full transient loading and gravity only. The forces and moments are plotted against a “path” which starts at 0 at the top of the dome, increasing to the center of the footing. Forces and moment have been enveloped circumferentially for these plots. Concrete force/moment plots are as follows:

- Figure 9-1. Concrete Shell Element Retrieval Sequence Starting Numbers
- Figure 9-2. Concrete Shell Hoop Forces – Gravity Only
- Figure 9-3. Concrete Shell Hoop Forces – Gravity Plus Seismic
- Figure 9-4. Concrete Shell Hoop Forces – Seismic Only
- Figure 9-5. Concrete Shell Meridional Forces – Gravity Only
- Figure 9-6. Concrete Shell Meridional Forces – Gravity Plus Seismic
- Figure 9-7. Concrete Shell Meridional Forces – Seismic Only
- Figure 9-8. Concrete Shell Hoop Moments – Gravity Only
- Figure 9-9. Concrete Shell Hoop Moments – Gravity Plus Seismic
- Figure 9-10. Concrete Shell Hoop Moments – Seismic Only
- Figure 9-11. Concrete Shell Meridional Moments – Gravity Only
- Figure 9-12. Concrete Shell Meridional Moments – Gravity Plus Seismic
- Figure 9-13. Concrete Shell Meridional – Seismic Only
- Figure 9-14. Concrete Shell In-Plane Shear Forces – Gravity Only
- Figure 9-15. Concrete Shell In-Plane Shear Forces – Gravity Plus Seismic

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- Figure 9-16. Concrete Shell In-Plane Shear Forces – Seismic Only
- Figure 9-17. Concrete Shell Through-Wall Shear Forces – Gravity Only
- Figure 9-18. Concrete Shell Through-Wall Shear Forces – Gravity Plus Seismic
- Figure 9-19. Concrete Shell Through-Wall Shear Forces – Seismic Only

Results for Through-Wall Shear Forces are the envelope of SMISC7 and SMISC8. No results are presented for SMISC6, the element XY moment.

Figure 9-1. Concrete Shell Element Retrieval Sequence Starting Numbers

Figure 9-2. Concrete Shell Hoop Forces – Gravity Only

Figure 9-3. Concrete Shell Hoop Forces – Gravity Plus Seismic

Figure 9-4. Concrete Shell Hoop Forces – Seismic Only

Figure 9-5. Concrete Shell Meridional Forces – Gravity Only

Figure 9-6. Concrete Shell Meridional Forces – Gravity Plus Seismic

Figure 9-7. Concrete Shell Meridional Forces – Seismic Only

Figure 9-8. Concrete Shell Hoop Moments – Gravity Only

Figure 9-9. Concrete Shell Hoop Moments – Gravity Plus Seismic

Figure 9-10. Concrete Shell Hoop Moments – Seismic Only

Figure 9-11. Concrete Shell Meridional Moments – Gravity Only

Figure 9-12. Concrete Shell Meridional Moments – Gravity Plus Seismic

Figure 9-13. Concrete Shell Meridional – Seismic Only

Figure 9-14. Concrete Shell In-Plane Shear Forces – Gravity Only

Figure 9-15. Concrete Shell In-Plane Shear Forces – Gravity Plus Seismic

Figure 9-16. Concrete Shell In-Plane Shear Forces – Seismic Only

Figure 9-17. Concrete Shell Through-Wall Shear Forces – Gravity Only

Figure 9-18. Concrete Shell Through-Wall Shear Forces – Gravity Plus Seismic

Figure 9-19. Concrete Shell Through-Wall Shear Forces – Seismic Only

9.2 Primary Tank Results for Revision 0 Model

Primary tank stresses are extracted from the model in 9° slices, starting near the top of the dome and moving down the wall and around the lower knuckle to the center of the tank. Stresses were extracted for the top, middle, and bottom of each shell element. Figure 9-20 shows the first slice, with element numbers. Each of the subsequent figures shows one component of stress, comparing the results from each load case. The results presented for the primary tank stresses are enveloped minima/maxima around the circumference of the tank. The gravity comparison includes a comparison to the TOLA model. This comparison demonstrates that for the majority of the primary tank, the model provides very similar results to the more detailed model. The meridional stresses in the knuckle are under-predicted in the global model. This is due to the lack of resolution in the knuckle.

The following stresses are extracted for the primary tank SHELL143 elements at the top, middle, and bottom for each element.

- SX Hoop Stress (Meridional in floor)
- SY Meridional Stress (Hoop in floor)
- SINT Stress Intensity
- SXY In-Plane Shear Stress
- SYZ Shear Stress
- SXZ Shear Stress

Figures are grouped in sets showing the stress for gravity only first, total demand from the transient analysis (gravity plus seismic), and then only the seismic portion. The seismic only load is simply the

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difference between the full transient loading and gravity only. For the primary tank, hoop stresses at the shell middle, Meridional stresses at the shell top and bottom, and in-plane shear stresses at the shell middle are presented in the following figures.

- Figure 9-21. Primary Hoop Stress (Middle) – Gravity Only
- Figure 9-22. Primary Tank Hoop Stress (Middle) – Gravity Plus Seismic
- Figure 9-23. Primary Tank Hoop Stress (Middle) – Seismic Only
- Figure 9-24. Primary Meridional Stress (Inside) – Gravity Only
- Figure 9-25. Primary Tank Meridional Stress (Inside) – Gravity Plus Seismic
- Figure 9-26. Primary Tank Meridional Stress (Inside) – Seismic Only
- Figure 9-27. Primary Meridional Stress (Outside) – Gravity Only
- Figure 9-28. Primary Tank Meridional Stress (Outside) – Gravity Plus Seismic
- Figure 9-29. Primary Tank Meridional Stress (Outside) – Seismic Only
- Figure 9-30. Primary Tank In-Plane Shear Stress (Middle) – Gravity Only
- Figure 9-31. Primary Tank In-Plane Shear Stress (Middle) – Gravity Plus Seismic
- Figure 9-32. Primary Tank In-Plane Shear Stress (Middle) – Seismic Only

Figure 9-20. Primary Tank Element Retrieval Sequence Starting Numbers

Figure 9-21. Primary Hoop Stress (Middle) – Gravity Only

Figure 9-22. Primary Tank Hoop Stress (Middle) – Gravity Plus Seismic

Figure 9-23. Primary Tank Hoop Stress (Middle) – Seismic Only

Figure 9-24. Primary Meridional Stress (Inside) – Gravity Only

Figure 9-25. Primary Tank Meridional Stress (Inside) – Gravity Plus Seismic

Figure 9-26. Primary Tank Meridional Stress (Inside) – Seismic Only

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Figure 9-27. Primary Meridional Stress (Outside) – Gravity Only

Figure 9-28. Primary Tank Meridional Stress (Outside) – Gravity Plus Seismic

Figure 9-29. Primary Tank Meridional Stress (Outside) – Seismic Only

Figure 9-30. Primary Tank In-Plane Shear Stress (Middle) – Gravity Only

Figure 9-31. Primary Tank In-Plane Shear Stress (Middle) – Gravity Plus Seismic

Figure 9-32. Primary Tank In-Plane Shear Stress (Middle) – Seismic Only

9.3 Comparison of Primary Tank Stresses Between the Revision 0 and Revision 1 Models for the BES-BEC Case

Figure 9-33 through Figure 9-41 show comparisons of stress components in the primary tank under seismic loading only for the updated (Revision 1) model with the secant stiffness for the anchor bolts and the original (Revision 0) model in the BES-BEC case. As expected, the plots show that the differences in the primary tank stress components are minor and that a full reevaluation of all tank components is not required.

Figure 9-33. Comparison of Hoop Stresses at the Outside Surface of the Primary Tank for the Updated and Original Models – Seismic Only

Figure 9-34. Comparison of Hoop Stresses at the Mid-Surface of the Primary Tank for the Updated and Original Models – Seismic Only

Figure 9-35. Comparison of Hoop Stresses at the Inside Surface of the Primary Tank for the Updated and Original Models – Seismic Only

Figure 9-36. Comparison of Meridional Stresses at the Outside Surface of the Primary Tank for the Updated and Original Models – Seismic Only

Figure 9-37. Comparison of Meridional Stresses at the Mid-Surface of the Primary Tank for the Updated and Original Models – Seismic Only

Figure 9-38. Comparison of Meridional Stresses at the Inside Surface of the Primary Tank for the Updated and Original Models – Seismic Only

Figure 9-39. Comparison of In-Plane Shear Stresses at the Outside Surface of the Primary Tank for the Updated and Original Models – Seismic Only

Figure 9-40. Comparison of In-Plane Shear Stresses at the Mid-Surface of the Primary Tank for the Updated and Original Models – Seismic Only

Figure 9-41. Comparison of In-Plane Shear Stresses at the Inside Surface of the Primary Tank for the Updated and Original Models – Seismic Only

9.4 Anchor Bolt Results for the Revision 1 Model

Axial and shear forces were extracted for the anchor bolt elements. Figure 9-42 shows the element numbers for the first five sets of anchor bolts. Because anchor bolt elements are placed at the edges of each slice, a total of twenty-one sets are extracted, but are extracted by radius instead of angle as was done for the concrete and primary tank. The following forces were extracted from the BEAM4 element results.

- SMISC7 Axial force (Element X)
- SMISC8 Shear force (Element Y)
- SMISC9 Shear force (Element Z)

After enveloping the forces around the circumference of the tank, the forces are reallocated on a per-bolt basis using the information from Figure 2-6. The total shear force is calculated by combining the two orthogonal shears extracted from the model by the SRSS method. The results are presented in the following figures:

- Figure 9-43. Anchor Bolts – Maximum Axial Force – Gravity Only
- Figure 9-44. Anchor Bolts – Minimum Axial Force – Gravity Only
- Figure 9-45. Anchor Bolts – Maximum Axial Force – Gravity Plus Seismic
- Figure 9-46. Anchor Bolts – Minimum Axial Force – Gravity Plus Seismic
- Figure 9-47. Anchor Bolts – Maximum Axial Force – Seismic Only
- Figure 9-48. Anchor Bolts – Minimum Axial Force – Seismic Only
- Figure 9-49. Anchor Bolts – Shear Force – Gravity Only
- Figure 9-50. Anchor Bolts – Shear Force – Gravity Plus Seismic
- Figure 9-51. Anchor Bolts – Shear Force – Seismic Only
- Figure 9-52. Anchor Bolt Maximum Shear Displacement Seismic Only

Figure 9-42. Anchor Bolt Element Retrieval Sequence Starting Numbers

Figure 9-43. Anchor Bolts – Maximum Axial Force – Gravity Only

Figure 9-44. Anchor Bolts – Minimum Axial Force – Gravity Only

Figure 9-45. Anchor Bolts – Maximum Axial Force – Gravity Plus Seismic

Figure 9-46. Anchor Bolts – Minimum Axial Force – Gravity Plus Seismic

Figure 9-47. Anchor Bolts – Maximum Axial Force – Seismic Only

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Figure 9-48. Anchor Bolts – Minimum Axial Force – Seismic Only

Figure 9-49. Anchor Bolts – Shear Force – Gravity Only

Figure 9-50. Anchor Bolts – Shear Force – Gravity Plus Seismic

Figure 9-51. Anchor Bolts – Shear Force – Seismic Only

Figure 9-52. Anchor Bolt Maximum Shear Displacement Seismic Only

9.5 Comparison of Anchor Bolt Results Between the Revision 0 and Revision 1 Models for the BES-BEC Case

Figure 9-53 and Figure 9-54 show comparisons of anchor bolt demands under seismic loading only for the updated (Revision 1) model with the secant stiffness for the anchor bolts and the original (Revision 0) model in the BES-BEC case. Figure 9-55 and Figure 9-56 show only minor differences between the anchor bolt axial forces for the updated and original models. Of more interest is the comparisons of shear forces and shear displacements in Figure 9-57 and Figure 9-58. The reduction in the anchor bolt stiffnesses had the expected effect of reducing the peak shear forces and more evenly distributing the shear force among the anchor bolts. The change also resulted in higher shear displacements as shown in Figure 9-59.

Figure 9-53. Comparison of Anchor Bolt Maximum Axial Force for the Updated and Original Models – Seismic Only BES-BEC

Figure 9-54. Comparison of Anchor Bolt Minimum Axial Force for the Updated and Original Models – Seismic Only BES-BEC

Figure 9-55. Comparison of Anchor Bolt Maximum Shear Force for the Updated and Original Models – Seismic Only BES-BEC

Figure 9-56. Comparison of Anchor Bolt Maximum Shear Displacement for the Updated and Original Models – Seismic Only BES-BEC

9.6 Concrete Backed Steel

Concrete backed steel strains are extracted from the model in 9° slices, starting near the center of the dome, down the wall and across the footing from the outside to the center of the liner. However, to obtain strains for all concrete backed steel, results were extracted from different groups of elements, including the primary tank, concrete, and liner elements. Principal strains were extracted for the top, middle, and bottom of each shell element representing the primary tank in the dome region. Principal strains were extracted for the inside face of the concrete shell elements in the haunch, wall, and floor. These strains will be considered to be mid-plane strains for the liner. Principal strains were extracted from the secondary liner where it was explicitly modeled at the footing/wall interface. Figure 9-57 and Figure 9-58 show the first slice, with element numbers.

The following strains were extracted for the SHELL143 primary tank dome and the secondary liner elements for the top, middle, and bottom of each element.

- EPEL1 1st Principal Strain (Top, Middle, Bottom)
- EPEL2 2nd Principal Strain (Top, Middle, Bottom)
- EPEL3 3rd Principal Strain (Top, Middle, Bottom)

The following strains were extracted for the SHELL143 concrete shell elements for the bottom of each element in the wall and the top of each element in the floor

- EPEL1 1st Principal Strain
- EPEL2 2nd Principal Strain
- EPEL3 3rd Principal Strain

Figures are grouped in sets showing the strain for gravity only first, total demand from the transient analysis (gravity plus seismic), and then only the seismic portion. The seismic only load is simply the difference between the full transient loading and gravity only. For the concrete backed steel, each of the three principal strains is shown in the following figures:

- Figure 9-57. Element Retrieval Sequence Starting Numbers for Strain
- Figure 9-58. Element Retrieval Sequence Starting Numbers for Strain (Detail)
- Figure 9-59. Concrete Backed Steel Strain, Principal 1, Gravity Only
- Figure 9-60. Concrete Backed Steel Strain, Principal 1, Min, Gravity Plus Seismic
- Figure 9-61. Concrete Backed Steel Strain, Principal 1, Max, Gravity Plus Seismic
- Figure 9-62. Concrete Backed Steel Strain, Principal 1, Min, Seismic Only
- Figure 9-63. Concrete Backed Steel Strain, Principal 1, Max, Seismic Only
- Figure 9-64. Concrete Backed Steel Strain, Principal 2, Gravity Only
- Figure 9-65. Concrete Backed Steel Strain, Principal 2, Min, Gravity Plus Seismic
- Figure 9-66. Concrete Backed Steel Strain, Principal 2, Max, Gravity Plus Seismic
- Figure 9-67. Concrete Backed Steel Strain, Principal 2, Min, Seismic Only
- Figure 9-68. Concrete Backed Steel Strain, Principal 2, Max, Seismic Only
- Figure 9-69. Concrete Backed Steel Strain, Principal 3, Gravity Only
- Figure 9-70. Concrete Backed Steel Strain, Principal 3, Min, Gravity Plus Seismic
- Figure 9-71. Concrete Backed Steel Strain, Principal 3, Max, Gravity Plus Seismic

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- Figure 9-72. Concrete Backed Steel Strain, Principal 3, Min, Seismic Only
- Figure 9-73. Concrete Backed Steel Strain, Principal 3, Max, Seismic Only

Figure 9-57. Element Retrieval Sequence Starting Numbers for Strain

Figure 9-58. Element Retrieval Sequence Starting Numbers for Strain (Detail)

Figure 9-59. Concrete Backed Steel Strain, Principal 1, Gravity Only

Figure 9-60. Concrete Backed Steel Strain, Principal 1, Min, Gravity Plus Seismic

Figure 9-61. Concrete Backed Steel Strain, Principal 1, Max, Gravity Plus Seismic

Figure 9-62. Concrete Backed Steel Strain, Principal 1, Min, Seismic Only

Figure 9-63. Concrete Backed Steel Strain, Principal 1, Max, Seismic Only

Figure 9-64. Concrete Backed Steel Strain, Principal 2, Gravity Only

Figure 9-65. Concrete Backed Steel Strain, Principal 2, Min, Gravity Plus Seismic

Figure 9-66. Concrete Backed Steel Strain, Principal 2, Max, Gravity Plus Seismic

Figure 9-67. Concrete Backed Steel Strain, Principal 2, Min, Seismic Only

Figure 9-68. Concrete Backed Steel Strain, Principal 2, Max, Seismic Only

Figure 9-69. Concrete Backed Steel Strain, Principal 3, Gravity Only

Figure 9-70. Concrete Backed Steel Strain, Principal 3, Min, Gravity Plus Seismic

Figure 9-71. Concrete Backed Steel Strain, Principal 3, Max, Gravity Plus Seismic

Figure 9-72. Concrete Backed Steel Strain, Principal 3, Min, Seismic Only

Figure 9-73. Concrete Backed Steel Strain, Principal 3, Max, Seismic Only

10.0 Contact Element Results

10.1 Concrete Footing Contact Results for the Revision 0 Model

Contact normal and shear forces, and other contact data were extracted for the interface between the bottom of the concrete wall and the footing. Data for each of the twenty-one contact elements were extracted. Figure 10-1 shows the location and element numbers for each contact element.

The following contact data were extracted for each of the CONTACT178 elements.

- SMISC1 Normal contact force
- CONT-SLIDE Contact lateral displacement
- CONT-GAP Contact gap distance
- CONT-STAT Contact status (open, closed, sliding)
- SMISC2 Shear force (element Y)
- SMISC3 Shear force (element Z)

Results for the contacts were then calculated on a force-per-foot basis for evaluation and plotting. The following figures present the footing contact data.

- Figure 10-1. Footing Contact Element Retrieval Numbers
- Figure 10-2. Concrete Footing Contact Force – Gravity Only
- Figure 10-3. Maximum Concrete Footing Contact Force – Gravity Plus Seismic
- Figure 10-4. Minimum Concrete Footing Contact Force – Gravity Plus Seismic
- Figure 10-5. Maximum Concrete Footing Contact Force – Seismic Only
- Figure 10-6. Minimum Concrete Footing Contact Force – Seismic Only
- Figure 10-7. Concrete Footing Contact Shear – Gravity Only
- Figure 10-8. Concrete Footing Contact Shear – Gravity Plus Seismic
- Figure 10-9. Concrete Footing Contact Shear – Seismic Only

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Figure 10-1. Footing Contact Element Retrieval Numbers

Figure 10-2. Concrete Footing Contact Force – Gravity Only

Figure 10-3. Maximum Concrete Footing Contact Force – Gravity Plus Seismic

Figure 10-4. Minimum Concrete Footing Contact Force – Gravity Plus Seismic

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Figure 10-5. Maximum Concrete Footing Contact Force – Seismic Only

Figure 10-6. Minimum Concrete Footing Contact Force – Seismic Only

Figure 10-7. Concrete Footing Contact Shear – Gravity Only

Figure 10-8. Concrete Footing Contact Shear – Gravity Plus Seismic

Figure 10-9. Concrete Footing Contact Shear – Seismic Only

Time history results were evaluated for the contact elements located at 9° and 180° . The resultant shear and normal forces were compared over the full-time history to determine the potential for sliding. There were no cases in which ANSYS[®] showed any sliding to occur. It is noted that at times during the transient analysis, the shear force exceeded the friction capacity of the contact element. This is because the total displacement occurring at any time did not meet the ANSYS[®] criteria for sliding to occur. The maximum elastic displacement for any load case was 0.00009 inch (Best-Estimate Soil, Fully Cracked Concrete). Each plot comparing the shear force and normal force includes the contact normal force (pr# in plots), the shear force, and the ratio of the shear to normal force (V/N). The following figures are provided for the time histories.

- Figure 10-10. Concrete Footing Time History, $\theta=9^\circ$ – LBS-BEC
- Figure 10-11. Concrete Footing Time History, $\theta=90^\circ$ – LBS-BEC
- Figure 10-12. Concrete Footing Displacement Time History, $\theta=90^\circ$ – BES-FCC
- Figure 10-13. Concrete Footing Time History, $\theta=9^\circ$ – BES-BEC
- Figure 10-14. Concrete Footing Time History, $\theta=90^\circ$ – BES-BEC
- Figure 10-15. Concrete Footing Time History, $\theta=9^\circ$ – UBS-BEC
- Figure 10-16. Concrete Footing Time History, $\theta=90^\circ$ – UBS-BEC
- Figure 10-17. Concrete Footing Time History, $\theta=9^\circ$ – BES-FCC
- Figure 10-18. Concrete Footing Time History, $\theta=90^\circ$ – BES-FCC

Figure 10-10. Concrete Footing Time History, $\theta=9^\circ$ - LBS-BEC

Figure 10-11. Concrete Footing Time History, $\theta=90^\circ$ - LBS-BEC

Figure 10-12. Concrete Footing Displacement Time History, $\theta=90^\circ$ – BES-FCC

Figure 10-13. Concrete Footing Time History, $\theta=9^\circ$ – BES-BEC

Figure 10-14. Concrete Footing Time History, $\theta=90^\circ$ – BES-BEC

Figure 10-15. Concrete Footing Time History, $\theta=9^\circ$ – UBS-BEC

Figure 10-16. Concrete Footing Time History, $\theta=90^\circ$ – UBS-BEC

Figure 10-17. Concrete Footing Time History, $\theta=9^\circ$ – BES-FCC

Figure 10-18. Concrete Footing Time History, $\theta=90^\circ$ – BES-FCC

Based on the results presented above for the contact interface between the concrete wall and footing, no displacements are expected to occur. Therefore, future models of the DSTs do not need to incorporate this feature.

10.2 Soil Contact Results for the Revision 0 Model

Soil contact data are extracted from the model in 9° slices, starting near the top of the dome and moving down the wall. Contact normal and shear forces, and other contact data were extracted for the interface between soil and the concrete shell. Figure 10-19 shows the location and element numbers for first slice of contact elements. The following data were extracted for each CONTA173 element:

- CONT-PRES Normal Contact Pressure
- CONT-SLIDE Contact Lateral Displacement
- CONT-GAP Contact Gap Distance
- CONT-STAT Contact Status (Open, Closed, Sliding)
- SMISC8 Tangential Friction (Element Y)
- SMISC12 Tangential Friction (Element Z)

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For each load case, the minimum and maximum contact pressure, tangential shear pressures, and lateral displacements are compared. The figures for each component are grouped by gravity only, gravity plus seismic, and seismic only. For the soil contact interface, the following figures are provided.

- Figure 10-20. Soil/Concrete Contact Element Normal Pressure – Gravity Only
- Figure 10-21. Soil/Concrete Contact Element Maximum Normal Pressure – Gravity Plus Seismic
- Figure 10-22. Soil/Concrete Contact Element Minimum Normal Pressure – Gravity Plus Seismic
- Figure 10-23. Soil/Concrete Contact Element Maximum Normal Pressure – Seismic Only
- Figure 10-24. Soil/Concrete Contact Element Minimum Normal Pressure – Seismic Only
- Figure 10-25. Soil/Concrete Contact Element Meridional Shear – Gravity Only
- Figure 10-26. Soil/Concrete Contact Element Meridional Shear – Gravity Plus Seismic
- Figure 10-27. Soil/Concrete Contact Element Meridional Shear – Seismic Only
- Figure 10-28. Soil/Concrete Contact Element Tangential Shear – Gravity Only
- Figure 10-29. Soil/Concrete Contact Element Tangential Shear – Gravity Plus Seismic
- Figure 10-30. Soil/Concrete Contact Element Gap Tangential Shear – Seismic Only
- Figure 10-31. Soil/Concrete Contact Element Gap Lateral Displacement (Slide) – Gravity Only
- Figure 10-32. Soil/Concrete Contact Element Gap Lateral Displacement (Slide) – Gravity Plus Seismic
- Figure 10-33. Soil/Concrete Contact Element Gap Lateral Displacement (Slide) – Seismic Only

Figure 10-19. Soil/Concrete Contact Element Retrieval Sequence Starting Numbers

Figure 10-20. Soil/Concrete Contact Element Normal Pressure – Gravity Only

Figure 10-21. Soil/Concrete Contact Element Maximum Normal Pressure – Gravity Plus Seismic

Figure 10-22. Soil/Concrete Contact Element Minimum Normal Pressure – Gravity Plus Seismic

Figure 10-23. Soil/Concrete Contact Element Maximum Normal Pressure – Seismic Only

Figure 10-24. Soil/Concrete Contact Element Minimum Normal Pressure – Seismic Only

Figure 10-25. Soil/Concrete Contact Element Meridional Shear – Gravity Only

Figure 10-26. Soil/Concrete Contact Element Meridional Shear – Gravity Plus Seismic

Figure 10-27. Soil/Concrete Contact Element Meridional Shear – Seismic Only

Figure 10-28. Soil/Concrete Contact Element Tangential Shear – Gravity Only

Figure 10-29. Soil/Concrete Contact Element Tangential Shear – Gravity Plus Seismic

Figure 10-30. Soil/Concrete Contact Element Gap Tangential Shear – Seismic Only

Figure 10-31. Soil/Concrete Contact Element Gap Lateral Displacement (Slide) – Gravity Only

Figure 10-32. Soil/Concrete Contact Element Gap Lateral Displacement (Slide) – Gravity Plus Seismic

Figure 10-33. Soil/Concrete Contact Element Gap Lateral Displacement (Slide) – Seismic Only

To evaluate the soil loads on the concrete dome due to seismic loading, a comparison was made between the seismic soil pressure and gravity only soil pressures scaled by accelerations taken from the dome. For this comparison, soil pressures due to gravity load only were scaled by the vertical spectral accelerations at a frequency of 20 Hz taken at the haunch and center of the dome. The scaled gravity pressures provide an approximation of the pressure on the dome due to vertical excitation. The center of the dome can be expected to see a pressure associated with the acceleration at the center of the dome, decreasing toward the haunch. At the haunch and on the vertical wall, the pressures should correspond to the spectral acceleration at the haunch. Figure 10-34 through Figure 10-37 show this comparison for each load case. These comparisons demonstrate that there is not significant arching in the soil.

Figure 10-34. Seismic Soil Pressure Comparison to Scaled Gravity Soil Pressures, LBS-BEC

Figure 10-35. Seismic Soil Pressure Comparison to Scaled Gravity Soil Pressures, BES-BEC

Figure 10-36. Seismic Soil Pressure Comparison to Scaled Gravity Soil Pressures, UBS-BEC

Figure 10-37. Seismic Soil Pressure Comparison to Scaled Gravity Soil Pressures, BES-FCC

10.3 Dome Contact Results for the Revision 1 Model

Dome contact data are extracted from the model in 9° slices, starting near the top of the dome and moving out to the tangent point of the primary tank. Contact normal and other contact data were extracted for the interface between primary tank and concrete dome. Figure 10-38 shows the location and element numbers for first slice of contact elements. The following data were extracted for each CONTA173 element

- CONT-PRES Normal Contact Pressure
- CONT-SLIDE Contact Lateral Displacement
- CONT-GAP Contact Gap Distance
- CONT-STAT Contact Status (Open, Closed, Sliding)

For each load case, the minimum and maximum contact pressure, lateral displacements, and gaps are compared. The figures for each component are grouped by gravity only, gravity plus seismic, and seismic only. For the dome contact interface, the following figures are provided.

- Figure 10-39. Primary Tank/Concrete Dome Contact Element Maximum Contact Pressure – Gravity Only
- Figure 10-40. Primary Tank/Concrete Dome Contact Element Maximum Contact Pressure – Gravity Plus Seismic
- Figure 10-41. Primary Tank/Concrete Dome Contact Element Maximum Contact Pressure – Seismic

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- Figure 10-42. Primary Tank/Concrete Dome Contact Element Maximum Contact Gap – Gravity Only
- Figure 10-43. Primary Tank/Concrete Dome Contact Element Maximum Contact Gap – Gravity Plus Seismic
- Figure 10-44. Primary Tank/Concrete Dome Contact Element Maximum Contact Gap – Seismic Only
- Figure 10-45. Primary Tank/Concrete Dome Contact Element Maximum Contact Lateral Displacement (Slide) – Gravity Only
- Figure 10-46. Primary Tank/Concrete Dome Contact Element Maximum Contact Lateral Displacement (Slide) – Gravity Plus Seismic
- Figure 10-47. Primary Tank/Concrete Dome Contact Element Maximum Contact Lateral Displacement (Slide) – Seismic Only

Figure 10-38. Primary Tank Dome Contact Element Retrieval Sequence Starting Numbers

Figure 10-39. Primary Tank/Concrete Dome Contact Element Maximum Contact Pressure – Gravity Only

Figure 10-40. Primary Tank/Concrete Dome Contact Element Maximum Contact Pressure – Gravity Plus Seismic

Figure 10-41. Primary Tank/Concrete Dome Contact Element Maximum Contact Pressure – Seismic Only

Figure 10-42. Primary Tank/Concrete Dome Contact Element Maximum Contact Gap – Gravity Only

Figure 10-43. Primary Tank/Concrete Dome Contact Element Maximum Contact Gap – Gravity Plus Seismic

Figure 10-44. Primary Tank/Concrete Dome Contact Element Maximum Contact Gap – Seismic Only

Figure 10-45. Primary Tank/Concrete Dome Contact Element Maximum Contact Lateral Displacement (Slide) – Gravity Only

Figure 10-46. Primary Tank/Concrete Dome Contact Element Maximum Contact Lateral Displacement (Slide) – Gravity Plus Seismic

Figure 10-47. Primary Tank/Concrete Dome Contact Element Maximum Contact Lateral Displacement (Slide) – Seismic Only

10.4 Primary Tank/Insulating Concrete Contact Results for the Revision 0 Model

Primary Tank/Insulating Concrete contact data are extracted from the model in 9° slices, starting at the outside radius of the primary tank, moving in toward the center. Contact normal and other contact data were extracted for the interface between primary tank and insulating concrete. Figure 10-48 shows the location and element numbers for first slice of contact elements. The following data were extracted for each CONTA173 element

- CONT-PRES Normal Contact Pressure
- CONT-SLIDE Contact Lateral Displacement
- CONT-GAP Contact Gap Distance
- CONT-STAT Contact Status (Open, Closed, Sliding)

For each load case, the minimum and maximum contact pressure, lateral displacements, and gaps are compared. The figures for each component are grouped by gravity only, gravity plus seismic, and seismic only. For the primary tank/insulating concrete contact interface, the following figures are provided.

- Figure 10-49. Primary Tank/Insulating Concrete Contact Element Contact Pressure – Gravity Only
- Figure 10-50. Primary Tank/Insulating Concrete Contact Element Maximum Contact Pressure – Gravity Plus Seismic

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- Figure 10-51. Primary Tank/Insulating Concrete Contact Element Minimum Contact Pressure – Gravity Plus Seismic
- Figure 10-52. Primary Tank/Insulating Concrete Contact Element Maximum Contact Pressure – Seismic Only
- Figure 10-53. Primary Tank/Insulating Concrete Contact Element Minimum Contact Pressure – Seismic Only
- Figure 10-54. Primary Tank/Insulating Concrete Contact Element Maximum Contact Gap – Gravity Only
- Figure 10-55. Primary Tank/Insulating Concrete Contact Element Maximum Contact Gap – Gravity Plus Seismic
- Figure 10-56. Primary Tank/Insulating Concrete Contact Element Maximum Contact Gap – Seismic Only
- Figure 10-57. Primary Tank/Insulating Concrete Contact Element Maximum Contact Lateral Displacement (Slide) – Gravity Only
- Figure 10-58. Primary Tank/Insulating Concrete Contact Element Maximum Contact Lateral Displacement (Slide) – Gravity Plus Seismic
- Figure 10-59. Primary Tank/Insulating Concrete Contact Element Maximum Contact Lateral Displacement (Slide) – Seismic Only

Figure 10-48. Primary Tank Bottom Contact Element Retrieval Sequence Starting Numbers

Figure 10-49. Primary Tank/Insulating Concrete Contact Element Contact Pressure – Gravity Only

Figure 10-50. Primary Tank/Insulating Concrete Contact Element Maximum Contact Pressure – Gravity Plus Seismic

Figure 10-51. Primary Tank/Insulating Concrete Contact Element Minimum Contact Pressure – Gravity Plus Seismic

Figure 10-52. Primary Tank/Insulating Concrete Contact Element Maximum Contact Pressure – Seismic Only

Figure 10-53. Primary Tank/Insulating Concrete Contact Element Minimum Contact Pressure – Seismic Only

Figure 10-54. Primary Tank/Insulating Concrete Contact Element Maximum Contact Gap – Gravity Only

Figure 10-55. Primary Tank/Insulating Concrete Contact Element Maximum Contact Gap – Gravity Plus Seismic

Figure 10-56. Primary Tank/Insulating Concrete Contact Element Maximum Contact Gap – Seismic Only

Figure 10-57. Primary Tank/Insulating Concrete Contact Element Maximum Contact Lateral Displacement (Slide) – Gravity Only

Figure 10-58. Primary Tank/Insulating Concrete Contact Element Maximum Contact Lateral Displacement (Slide) – Gravity Plus Seismic

Figure 10-59. Primary Tank/Insulating Concrete Contact Element Maximum Contact Lateral Displacement (Slide) – Seismic Only

Figure 10-58 and Figure 10-59 show high sliding displacements for a radius of 384 inches. These displacements are very localized and occur in regions of low contact pressures. When separation occurs on an ANSYS® contact element, relative displacements, or sliding is not tracked. The apparent high local displacements are due to separation, not to real relative displacements.

10.5 Insulating Concrete/Secondary Liner Contact Results from the Revision 0 Model

Insulating concrete/secondary liner contact data are extracted from the model in 9° slices, starting at the outside radius of the insulating concrete, moving in toward the center. Contact normal and other contact data were extracted for the interface between insulating concrete and secondary liner. Figure 10-60 shows the location and element numbers for first slice of contact elements. The following data were extracted for each CONTA173 element:

- CONT-PRES Normal Contact Pressure
- CONT-SLIDE Contact Lateral Displacement
- CONT-GAP Contact Gap Distance
- CONT-STAT Contact Status (Open, Closed, Sliding)

For each load case, the minimum and maximum contact pressure, lateral displacements, and gaps are compared. The figures for each component are grouped by gravity only, gravity plus seismic, and seismic only. For the insulating concrete/secondary liner contact interface, the following figures are provided.

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- Figure 10-61. Insulating Concrete/Secondary Liner Contact Element Contact Pressure – Gravity Only
- Figure 10-62. Insulating Concrete/Secondary Liner Contact Element Maximum Contact Pressure – Gravity Plus Seismic
- Figure 10-63. Insulating Concrete/Secondary Liner Contact Element Minimum Contact Pressure – Gravity Plus Seismic
- Figure 10-64. Insulating Concrete/Secondary Liner Contact Element Maximum Contact Pressure – Seismic Only
- Figure 10-65. Insulating Concrete/Secondary Liner Contact Element Minimum Contact Pressure – Seismic Only
- Figure 10-66. Insulating Concrete/Secondary Liner Contact Element Maximum Contact Lateral Displacement (Slide) – Gravity Only
- Figure 10-67. Insulating Concrete/Secondary Liner Contact Element Maximum Contact Lateral Displacement (Slide) – Gravity Plus Seismic
- Figure 10-68. Insulating Concrete/Secondary Liner Contact Element Maximum Contact Lateral Displacement (Slide) – Seismic Only

Figure 10-60. Insulating Concrete Contact Element Retrieval Sequence Starting Numbers

Figure 10-61. Insulating Concrete/Secondary Liner Contact Element Contact Pressure – Gravity Only

Figure 10-62. Insulating Concrete/Secondary Liner Contact Element Maximum Contact Pressure – Gravity Plus Seismic

Figure 10-63. Insulating Concrete/Secondary Liner Contact Element Minimum Contact Pressure – Gravity Plus Seismic

Figure 10-64. Insulating Concrete/Secondary Liner Contact Element Maximum Contact Pressure – Seismic Only

Figure 10-65. Insulating Concrete/Secondary Liner Contact Element Minimum Contact Pressure – Seismic Only

Figure 10-66. Insulating Concrete/Secondary Liner Contact Element Maximum Contact Lateral Displacement (Slide) – Gravity Only

Figure 10-67. Insulating Concrete/Secondary Liner Contact Element Maximum Contact Lateral Displacement (Slide) – Gravity Plus Seismic

Figure 10-68. Insulating Concrete/Secondary Liner Contact Element Maximum Contact Lateral Displacement (Slide) – Seismic Only

11.0 Waste Results from the Revision 0 Model

Waste pressure distributions were extracted from the model for comparison against a theoretical solution. This comparison helps demonstrate that the seismic motions were correctly transmitted to the waste. Theoretical waste pressures were calculated using a horizontal spectral acceleration for the impulsive mode of the tank/waste system using a horizontal response spectrum from the center bottom of the concrete wall at 90°. Theoretical vertical waste pressures were calculated using a vertical spectral acceleration for the impulsive mode of the tank/waste system using a vertical response spectrum from the bottom of the concrete shell wall. Theoretical waste pressures were developed for an open-top tank with a radius of 450 inches, a waste depth of 460 inches, and a uniform wall thickness of 0.65 inch (average thickness for AY tank used). While the theoretical solution does not address the influence of the interaction with the dome or the variable primary tank wall thickness, it does provide a reasonable basis for comparison to see that the hydrodynamic forces are correct.

Waste/Primary tank contact data are extracted from the model in 9° slices, starting at the free surface of the waste, moving down the wall and then in toward the center. Contact normal and other contact data were extracted for the interface between waste and the primary tank. Figure 11-1 shows the location and element numbers for first slice of contact elements. The following data were extracted for each CONTA173 element

- CONT-PRES Normal Contact Pressure
- CONT-SLIDE Contact Lateral Displacement
- CONT-GAP Contact Gap Distance
- CONT-STAT Contact Status (Open, Closed, Sliding)

Figure 11-1. Waste Contact Element Retrieval Sequence Starting Element Numbers

The hydrodynamic pressures in the tank are caused by impulsive and convective components and depend on the location of the fluid element within the tank. In the case of horizontal excitation, both the impulsive and convective components vary in the circumferential direction as the cosine of the angle θ , with the maximum values occurring at $\theta=0$ measured from the plane of excitation, and decreasing to zero hydrodynamic pressure at $\theta=90^\circ$ to the plane of excitation. The impulsive hydrodynamic pressure increases with depth, while the convective dynamic pressure is a maximum at the top of the waste.

In the case of an open-top tank with no dome, the theoretical peak hydrodynamic pressures due to horizontal excitation are given by Equation 4.24 of BNL (1995). The maximum hydrodynamic pressures induced by the waste on the tank wall due to vertical excitation depend on the vertical location in the waste and are given by Equation 4.52 of BNL (1995). The total pressures are the sum of the hydrostatic pressures and the hydrodynamic pressures. Details for the calculation of theoretical waste pressures are provided in Appendixes F through I.

For comparison, the theoretical hydrodynamic pressures for an open-top tank with a waste depth of 460 inches and a radius of 450 inches are shown. The hydrostatic, peak hydrodynamic, and peak total pressures for the elements located on the plane of excitation are shown in Table 11-1 through Table 11-4. The waste pressure distribution is shown in Figure 11-2, Figure 11-4, Figure 11-6, and Figure 11-8 for each load case.

The maximum slosh height over all surface waste elements is evaluated. According to Equation 4.60 of BNL (1995), the maximum predicted slosh height due to horizontal excitation is 23.7 inches for all load cases. Plots of the surface free-field response are provided for both horizontal and vertical excitation for each load case in Figure 11-3, Figure 11-5, Figure 11-7, and Figure 11-9.

11.1 Lower Bound Soil

$S_{ah} = 0.32g$ (Horizontal Spectral Acceleration)

$S_{av} = 0.29g$ (Vertical Spectra Acceleration)

Table 11-1. Theoretical Waste Pressures, LBS-BEC

Waste Height	nu	Horiz Conv (psi)	Horiz Imp (psi)	Vert (psi)	SRSS (psi)	Static (psi)	Theor Min (psi)	Theor Max (psi)
454.35	0.99	1.58	0.84	0.14	1.79	0.37	0	2.16
443.05	0.96	1.51	1.30	0.41	2.03	1.12	0	3.15
431.7625	0.94	1.44	1.73	0.68	2.35	1.87	0	4.21
414.125	0.90	1.34	2.33	1.10	2.91	3.03	0.13	5.94
390.125	0.85	1.22	3.05	1.67	3.69	4.62	0.93	8.30
366.125	0.80	1.12	3.68	2.22	4.44	6.20	1.77	10.64
342	0.74	1.02	4.22	2.77	5.15	7.80	2.65	12.94
318.325	0.69	0.94	4.68	3.28	5.80	9.36	3.57	15.16
295.225	0.64	0.86	5.08	3.76	6.38	10.89	4.50	17.27
272.125	0.59	0.80	5.43	4.22	6.93	12.41	5.49	19.34
248.975	0.54	0.74	5.74	4.65	7.43	13.94	6.52	21.37
225.825	0.49	0.69	6.01	5.06	7.89	15.47	7.59	23.36
202.725	0.44	0.65	6.25	5.43	8.30	17.00	8.70	25.30
179.625	0.39	0.61	6.45	5.77	8.67	18.53	9.85	27.20
156.475	0.34	0.57	6.62	6.07	9.00	20.06	11.06	29.05
134.075	0.29	0.55	6.76	6.33	9.28	21.54	12.26	30.81
112.475	0.24	0.53	6.88	6.54	9.50	22.96	13.46	32.46
90.875	0.20	0.51	6.97	6.71	9.69	24.39	14.70	34.08
69.275	0.15	0.49	7.04	6.86	9.84	25.82	15.98	35.66
47.7375	0.10	0.48	7.09	6.96	9.95	27.24	17.29	37.19
24.5	0.05	0.48	7.13	7.03	10.02	28.78	18.76	38.79
7.755	0.02	0.47	7.14	7.05	10.04	29.88	19.84	39.92
1.755	0.00	0.47	7.14	7.05	10.04	30.28	20.23	40.32
See Appendix F, Table 41, for calculation of theoretical waste pressures.								

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Figure 11-2. Waste Pressure Distribution, LBS-BEC

Figure 11-3. Waste-Free Surface Displacement, LBS-BEC

11.2 Best-Estimate Soil

$$S_{ah} = 0.28g$$

$$S_{av} = 0.26g$$

Table 11-2. Theoretical Waste Pressures, BES-BEC

Waste Height	nu	Horiz Conv (psi)	Horiz Imp (psi)	Vert (psi)	SRSS (psi)	Static (psi)	Theor Min (psi)	Theor Max (psi)
454.35	0.99	1.58	0.73	0.12	1.74	0.37	0	2.12
443.05	0.96	1.51	1.14	0.37	1.92	1.12	0	3.04
431.7625	0.94	1.44	1.51	0.61	2.17	1.87	0	4.04
414.125	0.90	1.34	2.04	0.99	2.63	3.03	0.40	5.66
390.125	0.85	1.22	2.67	1.49	3.30	4.62	1.32	7.91
366.125	0.80	1.12	3.22	1.99	3.94	6.20	2.26	10.15
342	0.74	1.02	3.69	2.48	4.56	7.80	3.23	12.36
318.325	0.69	0.94	4.10	2.94	5.13	9.36	4.23	14.49
295.225	0.64	0.86	4.45	3.37	5.65	10.89	5.24	16.54
272.125	0.59	0.80	4.75	3.78	6.13	12.41	6.29	18.54
248.975	0.54	0.74	5.02	4.17	6.57	13.94	7.37	20.52
225.825	0.49	0.69	5.26	4.53	6.98	15.47	8.49	22.45
202.725	0.44	0.65	5.46	4.87	7.35	17.00	9.65	24.35
179.625	0.39	0.61	5.64	5.17	7.68	18.53	10.85	26.20
156.475	0.34	0.57	5.79	5.44	7.97	20.06	12.09	28.02
134.075	0.29	0.55	5.92	5.67	8.21	21.54	13.32	29.75
112.475	0.24	0.53	6.02	5.86	8.42	22.96	14.55	31.38
90.875	0.20	0.51	6.10	6.02	8.58	24.39	15.81	32.97
69.275	0.15	0.49	6.16	6.15	8.72	25.82	17.10	34.53
47.7375	0.10	0.48	6.20	6.24	8.81	27.24	18.43	36.05
24.5	0.05	0.48	6.23	6.30	8.88	28.78	19.90	37.65
7.755	0.02	0.47	6.24	6.32	8.90	29.88	20.98	38.78
1.755	0.00	0.47	6.25	6.32	8.90	30.28	21.38	39.18
See Appendix G, Table 41, for calculation of theoretical waste pressures.

Figure 11-4. Waste Pressure Distribution, BES-BEC

Figure 11-5. Waste-Free Surface Displacement, BES-BEC

11.3 Upper Bound Soil

$$S_{ah} = 0.36g$$

$$S_{av} = 0.32g$$

Table 11-3. Theoretical Waste Pressures, UBS-BEC

Waste Height	nu	Horiz Conv (psi)	Horiz Imp (psi)	Vert (psi)	SRSS (psi)	Static (psi)	Theor Min (psi)	Theor Max (psi)
454.35	0.99	1.58	0.94	0.15	1.84	0.37	0	2.22
443.05	0.96	1.51	1.46	0.45	2.15	1.12	0	3.27
431.7625	0.94	1.44	1.94	0.75	2.53	1.87	0	4.40
414.125	0.90	1.34	2.62	1.21	3.19	3.03	0.00	6.22
390.125	0.85	1.22	3.43	1.84	4.08	4.62	0.53	8.70
366.125	0.80	1.12	4.13	2.45	4.93	6.20	1.27	11.14
342	0.74	1.02	4.75	3.05	5.73	7.80	2.06	13.53
318.325	0.69	0.94	5.27	3.62	6.46	9.36	2.90	15.82
295.225	0.64	0.86	5.72	4.15	7.12	10.89	3.77	18.01
272.125	0.59	0.80	6.11	4.66	7.73	12.41	4.69	20.14
248.975	0.54	0.74	6.46	5.13	8.28	13.94	5.66	22.23
225.825	0.49	0.69	6.76	5.58	8.79	15.47	6.68	24.27
202.725	0.44	0.65	7.03	5.99	9.26	17.00	7.74	26.25
179.625	0.39	0.61	7.25	6.36	9.67	18.53	8.86	28.19
156.475	0.34	0.57	7.45	6.70	10.03	20.06	10.02	30.09
134.075	0.29	0.55	7.61	6.98	10.34	21.54	11.20	31.87
112.475	0.24	0.53	7.74	7.21	10.59	22.96	12.37	33.55
90.875	0.20	0.51	7.84	7.41	10.80	24.39	13.59	35.19
69.275	0.15	0.49	7.92	7.56	10.96	25.82	14.85	36.78
47.7375	0.10	0.48	7.98	7.68	11.08	27.24	16.16	38.32
24.5	0.05	0.48	8.02	7.75	11.16	28.78	17.61	39.94
7.755	0.02	0.47	8.03	7.78	11.19	29.88	18.69	41.07
1.755	0.00	0.47	8.03	7.78	11.19	30.28	19.09	41.47
See Appendix H, Table 41, for calculation of theoretical waste pressures.								

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Figure 11-6. Waste Pressure Distribution, UBS-BEC

Figure 11-7. Waste-Free Surface Displacement, UBS-BEC

11.4 Best-Estimate Soil, Fully Cracked Concrete

$$S_{ah} = 0.29g$$

$$S_{av} = 0.25g$$

Table 11-4. Theoretical Waste Pressures, BES-FCC

Waste Height	nu	Horiz Conv (psi)	Horiz Imp (psi)	Vert (psi)	SRSS (psi)	Static (psi)	Theor Min (psi)	Theor Max (psi)
454.35	0.99	1.58	0.76	0.12	1.75	0.37	0	2.13
443.05	0.96	1.51	1.18	0.35	1.94	1.12	0	3.06
431.7625	0.94	1.44	1.56	0.59	2.20	1.87	0	4.07
414.125	0.90	1.34	2.11	0.95	2.68	3.03	0.35	5.71
390.125	0.85	1.22	2.77	1.44	3.35	4.62	1.27	7.97
366.125	0.80	1.12	3.33	1.92	4.00	6.20	2.20	10.20
342	0.74	1.02	3.82	2.38	4.62	7.80	3.18	12.42
318.325	0.69	0.94	4.25	2.83	5.19	9.36	4.17	14.55
295.225	0.64	0.86	4.61	3.24	5.70	10.89	5.19	16.59
272.125	0.59	0.80	4.92	3.64	6.17	12.41	6.24	18.59
248.975	0.54	0.74	5.20	4.01	6.61	13.94	7.33	20.56
225.825	0.49	0.69	5.45	4.36	7.01	15.47	8.46	22.48
202.725	0.44	0.65	5.66	4.68	7.37	17.00	9.63	24.37
179.625	0.39	0.61	5.84	4.97	7.70	18.53	10.83	26.22
156.475	0.34	0.57	6.00	5.23	7.98	20.06	12.07	28.04
134.075	0.29	0.55	6.13	5.45	8.22	21.54	13.31	29.76
112.475	0.24	0.53	6.23	5.64	8.42	22.96	14.54	31.38
90.875	0.20	0.51	6.31	5.79	8.58	24.39	15.81	32.97
69.275	0.15	0.49	6.38	5.91	8.71	25.82	17.11	34.53
47.7375	0.10	0.48	6.43	6.00	8.80	27.24	18.44	36.04
24.5	0.05	0.48	6.46	6.06	8.87	28.78	19.91	37.64
7.755	0.02	0.47	6.47	6.08	8.89	29.88	20.99	38.77
1.755	0.00	0.47	6.47	6.08	8.89	30.28	21.39	39.17
See Appendix I, Table 41, for calculation of theoretical waste pressures.								

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Figure 11-8. Waste Pressure Distribution, BES-FCC

Figure 11-9. Waste-Free Surface Displacement, BES-FCC

12.0 Computer Run List

Computer File Listing

Program Used: ANSYS®

Version Used: 8.1

V&V Reference: M&D-V&V-ANS-81-001, Revision 2

Workstation used: F14Tomcat, P52 Mustang, Challenger, Gemini

Error Report Reviewed for Applicability: YES ☒ NO ☐

Due to the large number of input and output files associated with each run, file listings are included in the appendix containing load case or study results data. The appendixes are as follows:

- Appendix F Lower Bound Soil, Best-Estimate Concrete
- Appendix G Best-Estimate Soil, Best-Estimate Concrete
- Appendix H Upper Bound Soil, Best-Estimate Concrete
- Appendix I Best-Estimate Soil, Fully Cracked Concrete

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13.0 Calculation Review Checklist

Calculation Review Checklist

Yes	No	N/A	
X			1. Objective is clearly stated.
X			2. Design inputs and their sources are clearly identified, including revision and date of the source.
X			3. Assumptions are listed and identified as unverified as appropriate.
X			4. Analytical approach is described and appropriate to satisfy the stated objectives.
X			5. Software used is identified, including revision and workstation used.
X			6. Computer File Listing has been included and completed if software has been used (separate listing for each program and version used).
X			7. Results are technically correct and consistent with design input and assumptions.
X			8. Calculations are sufficiently detailed that a technically qualified person can understand and verify the methodology without requiring outside or unreferenced information.
X			9. Results and conclusions address all points in the objective.
		X	10. Each page in body of calculation identifies the calculation number, page number, preparer and checker. (Preparer and Checker have signed or initialed each page.)
		X	11. Each page in appendixes or attachments identifies the calculation number and page number, and the first page identifies the preparer and checker. (Preparer and Checker have signed or initialed first page.)
X			12. Total number of pages, including attachments or appendixes has been included.
		X	13. Alternate calculations, if used by the checker, have been included.
		X	14. Revised information has been clearly identified by use of markers such as clouds or revision bars, and a revision history included that describes the changes made and identifies pages changed.

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Appendix A

Dytran[®] Input Files for Primary Tank Sub-Models

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Appendix A

Dytran[®] Input Files for Primary Tank Sub-Models

Dytran Input File Horizontal Excitation Only

```
$ Direct Text Input for File Management Section
$ 460 Liquid Level, 1 Component Motion, VISCDMP=0.025
START
MEMORY-SIZE=15000000,15000000
CEND
$ Direct Text Input for Case Control Data
$
$ -----
$ special setting for the calculation of fmatplt of the water
$ fmatplt of the water - FMATPLT2 = FMAT2*FVUNC
$ active the special output variables
$
PARAM,VARACTIV,MULTIEULHYDRO,ELEM,FMATPLT2,FLT,ACTIVE,FMATPLT2
$
$ -----
$ Call eexout routine for the calculation of fmatplt2
$ Call this routine at every timestep is requested
$
ELEXOUT (FP2)
ELEMENTS(FP2) = 101
SET 101 = 1140 THRU 5939 21940 THRU 26739 85940 THRU 95539
TIMES (FP2) = 0 THRU END BY 0.1
$ Output result for request: HEIGHT
TYPE (HEIGHT) = ARCHIVE
ELEMENTS (HEIGHT) = 100
SET 100 = 1140 THRU 5939 21940 THRU 26739 85940 THRU 95539
ELOUT (HEIGHT) = FMAT2,FMATPLT2
TIMES (HEIGHT) = 0 THRU END BY 0.1
SAVE (HEIGHT) = 10000
ENDTIME=46.5
ENDSTEP=9999999
CHECK=NO
TITLE= Jobname is: 460_1CM_025
TLOAD=1
TIC=1
SPC=1
$ Output result for request: Bot_Ctr_TH
TYPE (Bot_Ctr_TH) = TIMEHIS
GRIDS (Bot_Ctr_TH) = 1
SET 1 = 1146
GPOUT (Bot_Ctr_TH) = XPOS YPOS ZPOS XVEL YVEL ZVEL XACC YACC ZACC
TIMES (Bot_Ctr_TH) = 0 THRU END BY 0.01
SAVE (Bot_Ctr_TH) = 10000
$ Output result for request: cent_press
TYPE (cent_press) = TIMEHIS
ELEMENTS (cent_press) = 2
SET 2 = 3559 6759 9959 13159 16359 19559 22759 25959 27559 30759 33959 37159 ,
      40359 43559 46759 49959 53159 56359 59559 62759 65959 69159 72359 ,
      86759 89959 93159 96359 99559 101159 102759 104359 105959 107559
ELOUT (cent_press) = PRESSURE
TIMES (cent_press) = 0 THRU END BY 0.001
SAVE (cent_press) = 100000
$ Output result for request: couple_rxns
```

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```

TYPE (couple_rxns) = TIMEHIS
CPLSURFS (couple_rxns) = 3
SET 3 = 1
CPLSOUT (couple_rxns) = XFORCE YFORCE ZFORCE
TIMES (couple_rxns) = 0 THRU END BY 0.01
SAVE (couple_rxns) = 10000
$ Output result for request: couple_rxns_001
TYPE (couple_rxns_001) = TIMEHIS
CPLSURFS (couple_rxns_001) = 4
SET 4 = 1
CPLSOUT (couple_rxns_001) = XFORCE YFORCE
TIMES (couple_rxns_001) = 0 THRU END BY 0.001
SAVE (couple_rxns_001) = 100000
$ Output result for request: euler_height_out
TYPE (euler_height_out) = ARCHIVE
ELEMENTS (euler_height_out) = 5
SET 5 = 1140 THRU 5939 21940 THRU 26739 85940 THRU 95539
ELOUT (euler_height_out) = FMATPLT
TIMES (euler_height_out) = 0 THRU END BY 0.1
SAVE (euler_height_out) = 10000
$ Output result for request: minusx_outstrip
TYPE (minusx_outstrip) = TIMEHIS
ELEMENTS (minusx_outstrip) = 6
SET 6 = 201 211 221 281 311 581 582 583 584 585 741 742 743 881 882 883 884
ELOUT (minusx_outstrip) = TXX-MID TXX-OUT TXX-IN TYY-MID TYY-OUT TYY-IN
TIMES (minusx_outstrip) = 0 THRU END BY 0.01
SAVE (minusx_outstrip) = 10000
$ Output result for request: minusx_press
TYPE (minusx_press) = TIMEHIS
ELEMENTS (minusx_press) = 7
SET 7 = 1976 3576 5176 6776 9976 13176 16376 19576 22776 25976 27576 30776 ,
      33976 37176 40376 43576 46776 49976 53176 56376 59576 62776 65976 ,
      69176 72376 86776 88376 89976 91576 93176
ELOUT (minusx_press) = PRESSURE
TIMES (minusx_press) = 0 THRU END BY 0.001
SAVE (minusx_press) = 100000
$ Output result for request: minusx_shear
TYPE (minusx_shear) = TIMEHIS
ELEMENTS (minusx_shear) = 8
SET 8 = 201 211 221 281 311 581 582 583 584 585 741 742 743 881 882 883 884
ELOUT (minusx_shear) = TXY-MID
TIMES (minusx_shear) = 0 THRU END BY 0.01
SAVE (minusx_shear) = 10000
$ Output result for request: plusx_outstrip
TYPE (plusx_outstrip) = TIMEHIS
ELEMENTS (plusx_outstrip) = 9
SET 9 = 240 250 260 300 310 676 677 678 679 680 798 799 800 957 958 959 960
ELOUT (plusx_outstrip) = TXX-MID TXX-OUT TXX-IN TYY-MID TYY-OUT TYY-IN
TIMES (plusx_outstrip) = 0 THRU END BY 0.01
SAVE (plusx_outstrip) = 10000
$ Output result for request: plusx_press
TYPE (plusx_press) = TIMEHIS
ELEMENTS (plusx_press) = 10
SET 10 = 1943 3543 5143 6743 9943 13143 16343 19543 22743 25943 27543 30743 ,
      33943 37143 40343 43543 46743 49943 53143 56343 59543 62743 65943 ,
      69143 72343 86743 88343 89943 91543 93143
ELOUT (plusx_press) = PRESSURE
TIMES (plusx_press) = 0 THRU END BY 0.01
SAVE (plusx_press) = 10000
$ Output result for request: plusx_press_001
TYPE (plusx_press_001) = TIMEHIS
ELEMENTS (plusx_press_001) = 11
SET 11 = 1943 3543 5143 6743 9943 13143 16343 19543 22743 25943 27543 30743 ,
      33943 37143 40343 43543 46743 49943 53143 56343 59543 62743 65943 ,
      69143 72343 86743 88343 89943 91543 93143

```

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```
ELOUT (plusx_press_001) = PRESSURE
TIMES (plusx_press_001) = 0 THRU END BY 0.001
SAVE (plusx_press_001) = 100000
$ Output result for request: plusx_shear
TYPE (plusx_shear) = TIMEHIS
ELEMENTS (plusx_shear) = 12
SET 12 = 240 250 260 300 310 676 677 678 679 680 798 799 800 957 958 959 960
ELOUT (plusx_shear) = TXY-MID
TIMES (plusx_shear) = 0 THRU END BY 0.01
SAVE (plusx_shear) = 10000
$ Output result for request: plusx_strip_001
TYPE (plusx_strip_001) = TIMEHIS
ELEMENTS (plusx_strip_001) = 13
SET 13 = 240 250 260 300 310 676 677 678 679 680 798 799 800 957 958 959 960
ELOUT (plusx_strip_001) = TYY-MID TYY-OUT TYY-IN
TIMES (plusx_strip_001) = 0 THRU END BY 0.001
SAVE (plusx_strip_001) = 100000
$ Output result for request: plusx_strip_arc
TYPE (plusx_strip_arc) = ARCHIVE
GRIDS (plusx_strip_arc) = 14
SET 14 = 1 161 162 173 184 263 272 281 282 321 322 361 371 372 ,
        523 524 525 526 527 718 THRU 725 840 THRU 845 960 961 962
GPOUT (plusx_strip_arc) = XPOS XDIS RDIS
TIMES (plusx_strip_arc) = 0 THRU END BY 0.01
SAVE (plusx_strip_arc) = 10000
$ Output result for request: plusz_outstrip
TYPE (plusz_outstrip) = TIMEHIS
ELEMENTS (plusz_outstrip) = 15
SET 15 = 231 241 251 291 301 631 632 633 634 635 771 772 773 921 922 923 924
ELOUT (plusz_outstrip) = TXX-MID TXX-OUT TXX-IN TYY-MID TYY-OUT TYY-IN
TIMES (plusz_outstrip) = 0 THRU END BY 0.01
SAVE (plusz_outstrip) = 10000
$ Output result for request: plusz_press
TYPE (plusz_press) = TIMEHIS
ELEMENTS (plusz_press) = 16
SET 16 = 2599 4199 5799 7399 10599 13799 16999 20199 23399 26599 28199 31399 ,
        34599 37799 40999 44199 47399 50599 53799 56999 60199 63399 66599 ,
        69799 72999 87399 88999 90599 92199 93799
ELOUT (plusz_press) = PRESSURE
TIMES (plusz_press) = 0 THRU END BY 0.001
SAVE (plusz_press) = 100000
$ Output result for request: plusz_shear
TYPE (plusz_shear) = TIMEHIS
ELEMENTS (plusz_shear) = 17
SET 17 = 231 241 251 291 301 631 632 633 634 635 771 772 773 921 922 923 924
ELOUT (plusz_shear) = TXY-MID
TIMES (plusz_shear) = 0 THRU END BY 0.01
SAVE (plusz_shear) = 10000
$ Output result for request: press_45_out
TYPE (press_45_out) = TIMEHIS
ELEMENTS (press_45_out) = 18
SET 18 = 2388 3988 5588 7188 10388 13588 16788 19988 23188 26388 27988 31188 ,
        34388 37588 40788 43988 47188 50388 53588 56788 59988 63188 66388 ,
        69588 72788 87188 88788 90388 91988 93588
ELOUT (press_45_out) = PRESSURE
TIMES (press_45_out) = 0 THRU END BY 0.01
SAVE (press_45_out) = 10000
$ Output result for request: press45_outstrip
TYPE (press45_outstrip) = TIMEHIS
ELEMENTS (press45_outstrip) = 19
SET 19 = 235 245 255 295 305 651 652 653 654 655 783 784 785 937 938 939 940
ELOUT (press45_outstrip) = TXX-MID TXX-OUT TXX-IN TYY-MID TYY-OUT TYY-IN
TIMES (press45_outstrip) = 0 THRU END BY 0.01
SAVE (press45_outstrip) = 10000
$ Output result for request: press45_shear
```


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```

TYPE (press45_shear) = TIMEHIS
ELEMENTS (press45_shear) = 20
SET 20 = 235 245 255 295 305 651 652 653 654 655 783 784 785 937 938 939 940
ELOUT (press45_shear) = TXY-MID
TIMES (press45_shear) = 0 THRU END BY 0.01
SAVE (press45_shear) = 10000
$ Output result for request: restart
TYPE (restart) = RESTART
TIMES (restart) = 0 THRU END BY 1
SAVE (restart) = -1
$ Output result for request: Tank_TH_out
TYPE (Tank_TH_out) = TIMEHIS
GRIDS (Tank_TH_out) = 21
SET 21 = 47 402
GPOUT (Tank_TH_out) = XVEL YVEL ZVEL XACC YACC ZACC XDIS YDIS ZDIS
TIMES (Tank_TH_out) = 0 THRU END BY 0.01
SAVE (Tank_TH_out) = 10000
$ Output result for request: Wall_Node_001
TYPE (Wall_Node_001) = TIMEHIS
GRIDS (Wall_Node_001) = 22
SET 22 = 1 162 173 184 523 524 525 526 527
GPOUT (Wall_Node_001) = XVEL YVEL XACC YACC XDIS YDIS
TIMES (Wall_Node_001) = 0 THRU END BY 0.001
SAVE (Wall_Node_001) = 100000
$ Output result for request: Wall_Node_01
TYPE (Wall_Node_01) = TIMEHIS
GRIDS (Wall_Node_01) = 23
SET 23 = 1 162 173 184 523 524 525 526 527
GPOUT (Wall_Node_01) = XVEL YVEL XACC YACC XDIS YDIS
TIMES (Wall_Node_01) = 0 THRU END BY 0.01
SAVE (Wall_Node_01) = 10000
$----- Parameter Section -----
PARAM,BULK,0.2
PARAM,BULKQ,1.1
PARAM,CONTACT,THICK,0.0
PARAM,FASTCOUP
PARAM,INISTEP,1e-5
PARAM,MINSTEP,5.0e-7
PARAM,RBE2INFO,GRIDON
$----- BULK DATA SECTION -----
BEGIN BULK
$ Direct Text Input for Bulk Data
PARAM,EXTRAS,NOR-DIR,+2
PARAM,EXTRAS,RHOREF,1.71E-4
PARAM,EXTRAS,ACCG,386.4
PARAM,EXTRAS,FSURF,460
PARAM,EXTRAS,PATM,14.7
PARAM,EXTRAS,BULK,305000
PARAM,EXTRAS,TOLFMAT,0.01
PARAM,EULER-BOUNDARY,EXTRAPOLATION
PARAM,TOLCHK,6.0E-11
PARAM,ELDLTH,10
INCLUDE BaseTH.bdf
$INCLUDE vertvel.bdf
INCLUDE LL_460_1.bdf
$ ----- VISCDMP -----
VISCDMP,,,,,,,,+
+      ,,,0.025,,,,,+
+      ,,,,,,,,,+
+      ,,,,,,,,,+
+      ,,,,,,,,,+
+      ,,,,,,,,,+
+      ,,,,,,,,,
$ ----- GRAVITATION -----
TLOAD1,1,444,,0
GRAV,444,,386.4,0,-1,0

```

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```

$
$ ===== PROPERTY SETS =====
$
$           * Rigid_Prop *
$
PSHELL,1,1,1
$
$           * Rigid_Prop_Base *
$
PSHELL,6,3,0.375
$
$           * waste_prop *
$
PEULER,7,2, MMHYDRO
$
$           * air_prop *
$
PEULER,8,4, MMHYDRO
$
$           * Rigid_Prop_Bot_Ctr *
$
PSHELL,10,6,0.375
$
$           * 78_Steel *
$
PSHELL,12,7,0.815
$
$           * 34_Steel *
$
PSHELL,13,7,0.69
$
$           * 916_Steel *
$
PSHELL,14,7,0.5025
$
$           * 12_Steel *
$
PSHELL,15,7,0.44
$
$
$ ===== MATERIAL DEFINITIONS =====
$
$
$ ----- Material Rigid_Dome_Material id =1
MATRIG,1,735,2.9e+007,0.3,
$
$ ----- Material Water_Mat id =2
DMAT,2,0.000171,2
EOSPOL,2,305000
$
$ ----- Material Rigid_Base_Material id =3
MATRIG,3,0.000735,2.9e+007,0.3,
$
$ ----- Material air_mat id =4
DMAT,4,1.167e-007,4
EOSGAM,4,1.4,,,
$
$ ----- Material Rigid_Bot_Ctr_Material id =6
MATRIG,6,735,2.9e+007,0.3,
$
$ ----- Material steel_mat id =7
MAT1,7,2.88e+007,,0.3,0.000735
$
$ ===== Load Cases =====
$

```

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```
$
$ ----- Rigid Body Object Rigid_Tank -----
$ ---- No reference node is used.
TLOAD1,1,2,,12
FORCE,2,MR1,,0,,0,0
TLOAD1,1,1002,,12
MOMENT,1002,MR1,,0,0,0,0
$
$ ----- TICEL BC air_init_set -----
SET1,24,85940,THRU,86466,107985,THRU,108339,107579,+
+ ,THRU,107984,107173,THRU,107578,106767,THRU,107172,+
+ ,106361,THRU,106766,105955,THRU,106360,105549,THRU,+
+ ,105954,105143,THRU,105548,104737,THRU,105142,104331,+
+ ,THRU,104736,103925,THRU,104330,103519,THRU,103924,+
+ ,103113,THRU,103518,102707,THRU,103112,102301,THRU,+
+ ,102706,101895,THRU,102300,101489,THRU,101894,101083,+
+ ,THRU,101488,100677,THRU,101082,100271,THRU,100676,+
+ ,99865,THRU,100270,99459,THRU,99864,99053,THRU,+
+ ,99458,98647,THRU,99052,98241,THRU,98646,97835,+
+ ,THRU,98240,97429,THRU,97834,97023,THRU,97428,+
+ ,96617,THRU,97022,96211,THRU,96616,95805,THRU,+
+ ,96210,95399,THRU,95804,94993,THRU,95398,94587,+
+ ,THRU,94992,94181,THRU,94586,93775,THRU,94180,+
+ ,93369,THRU,93774,92963,THRU,93368,92557,THRU,+
+ ,92962,92151,THRU,92556,91745,THRU,92150,91339,+
+ ,THRU,91744,90933,THRU,91338,90527,THRU,90932,+
+ ,90121,THRU,90526,89715,THRU,90120,89309,THRU,+
+ ,89714,88903,THRU,89308,88497,THRU,88902,88091,+
+ ,THRU,88496,87685,THRU,88090,87279,THRU,87684,+
+ ,86873,THRU,87278,86467,THRU,86872
TICEL,1,24,DENSITY,1.167e-007,SIE,3.15e+008
$
$ ----- TICEL BC wat_init_set -----
SET1,25,44227,THRU,44632,10529,THRU,10934,28799,+
+ ,THRU,29204,28393,THRU,28798,27987,THRU,28392,+
+ ,27581,THRU,27986,27175,THRU,27580,26769,THRU,+
+ ,27174,26363,THRU,26768,25957,THRU,26362,25551,+
+ ,THRU,25956,25145,THRU,25550,24739,THRU,25144,+
+ ,24333,THRU,24738,23927,THRU,24332,23521,THRU,+
+ ,23926,23115,THRU,23520,22709,THRU,23114,22303,+
+ ,THRU,22708,21897,THRU,22302,21491,THRU,21896,+
+ ,21085,THRU,21490,20679,THRU,21084,20273,THRU,+
+ ,20678,19867,THRU,20272,19461,THRU,19866,19055,+
+ ,THRU,19460,18649,THRU,19054,18243,THRU,18648,+
+ ,17837,THRU,18242,17431,THRU,17836,17025,THRU,+
+ ,17430,16619,THRU,17024,16213,THRU,16618,15807,+
+ ,THRU,16212,15401,THRU,15806,14995,THRU,15400,+
+ ,14589,THRU,14994,14183,THRU,14588,13777,THRU,+
+ ,14182,13371,THRU,13776,12965,THRU,13370,12559,+
+ ,THRU,12964,12153,THRU,12558,11747,THRU,12152,+
+ ,11341,THRU,11746,10935,THRU,11340,10123,THRU,+
+ ,10528,9717,THRU,10122,9311,THRU,9716,8905,+
+ ,THRU,9310,8499,THRU,8904,8093,THRU,8498,+
+ ,7687,THRU,8092,7281,THRU,7686,6875,THRU,+
+ ,7280,6469,THRU,6874,6063,THRU,6468,5657,+
+ ,THRU,6062,5251,THRU,5656,4845,THRU,5250,+
+ ,4439,THRU,4844,4033,THRU,4438,3627,THRU,+
+ ,4032,3221,THRU,3626,2815,THRU,3220,2409,+
+ ,THRU,2814,2003,THRU,2408,1597,THRU,2002,+
+ ,1191,THRU,1596,1140,THRU,1190,43821,THRU,+
+ ,44226,43415,THRU,43820,43009,THRU,43414,42603,+
+ ,THRU,43008,42197,THRU,42602,41791,THRU,42196,+
+ ,41385,THRU,41790,40979,THRU,41384,40573,THRU,+
+ ,40978,40167,THRU,40572,39761,THRU,40166,39355,+
+ ,THRU,39760,38949,THRU,39354,38543,THRU,38948,+
```

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```

+      ,38137,THRU,38542,37731,THRU,38136,37325,THRU,+
+      ,37730,36919,THRU,37324,36513,THRU,36918,36107,+
+      ,THRU,36512,35701,THRU,36106,35295,THRU,35700,+
+      ,34889,THRU,35294,34483,THRU,34888,34077,THRU,+
+      ,34482,33671,THRU,34076,33265,THRU,33670,32859,+
+      ,THRU,33264,32453,THRU,32858,32047,THRU,32452,+
+      ,31641,THRU,32046,31235,THRU,31640,30829,THRU,+
+      ,31234,30423,THRU,30828,30017,THRU,30422,29611,+
+      ,THRU,30016,29205,THRU,29610,44633,THRU,85939
$ TICEL,1,25,DENSITY,0.000171
TICEEX,1,25,INEL1
$
$ ----- General Coupling: couple -----
$
COUPLE,7,1,OUTSIDE,ON,ON,,7,STANDARD,+
+      ,,,,,
$
COUOPT,1,7,,,,,,+
+      ,CONSTANT,14.7
$
SURFACE,1,,ELEM,26
SET1,26,1,THRU,105,918,THRU,960,512,+
+      ,THRU,917,106,THRU,511
$
$ ----- Rigid Body: Seismic_Accel
$
BODYFOR,9,GRID,27,,,,,,+
+      ,0,TABLE,1,1,0,0
SET1,27,1,THRU,161,362,THRU,522
$
$ ----- Contact : Bot_Contact
$
CONTACT,10,SURF,SURF,2,3,0,0,,+
+      ,V4,BOTTOM,,,,,
$
$ Slave contact surface for Bot_Contact
$
SURFACE,2,,ELEM,28
SET1,28,301,THRU,480
$
$ Master contact surface for Bot_Contact
$
SURFACE,3,,ELEM,29
SET1,29,1000,THRU,1139
$
$ ----- Rigid Body Object Rigid_Base -----
$ ---- Reference Node for Rigid body is 1146
TLOAD1,1,12,,12
FORCE,12,MR3,,1,0,0,0
TLOAD1,1,1012,,12
MOMENT,1012,MR3,,1,0,0,0
$
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$ ----- Rigid Body Object Rigid_Tank_Vert_Vel -----
$ ---- No reference node is used.
$ TLOAD1,1,14,,12
$ FORCE,14,MR1,,1,,1,
$
$
$
ENDDATA

```

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Dytran Input File Vertical Excitation Only

```
$ Direct Text Input for File Management Section

START
MEMORY-SIZE=15000000,15000000
CEND
$ Direct Text Input for Case Control Data
$
$ -----
$ special setting for the calculation of fmatplt of the water
$ fmatplt of the water - FMATPLT2 = FMAT2*FVUNC
$ active the special output variables
$
PARAM,VARACTIV,MULTIEULHYDRO,ELEM,FMATPLT2,FLT,ACTIVE,FMATPLT2
$
$ -----
$ Call eexout routine for the calculation of fmatplt2
$ Call this routine at every timestep is requested
$
ELEXOUT (FP2)
ELEMENTS(FP2) = 101
SET 101 = 1140 THRU 5939 21940 THRU 26739 85940 THRU 95539
TIMES (FP2) = 0 THRU END BY 0.1
$ Output result for request: HEIGHT
TYPE (HEIGHT) = ARCHIVE
ELEMENTS (HEIGHT) = 100
SET 100 = 1140 THRU 5939 21940 THRU 26739 85940 THRU 95539
ELOUT (HEIGHT) = FMAT2,FMATPLT2
TIMES (HEIGHT) = 0 THRU END BY 0.1
SAVE (HEIGHT) = 10000
ENDTIME=30.0
ENDSTEP=9999999
CHECK=NO
TITLE= Jobname is: 1CM_025_Vert
TLOAD=1
TIC=1
SPC=1
$ Output result for request: cent_press
TYPE (cent_press) = TIMEHIS
ELEMENTS (cent_press) = 1
SET 1 = 3559 6759 9959 13159 16359 19559 22759 25959 27559 30759 33959 37159 ,
      40359 43559 46759 49959 53159 56359 59559 62759 65959 69159 72359 ,
      86759 89959 93159 96359 99559 101159 102759 104359 105959 107559
ELOUT (cent_press) = PRESSURE
TIMES (cent_press) = 0 THRU END BY 0.001
SAVE (cent_press) = 100000
$ Output result for request: couple_rxns
TYPE (couple_rxns) = TIMEHIS
CPLSURFS (couple_rxns) = 2
SET 2 = 1
CPLSOUT (couple_rxns) = XFORCE YFORCE ZFORCE
TIMES (couple_rxns) = 0 THRU END BY 0.01
SAVE (couple_rxns) = 10000
$ Output result for request: couple_rxns_001
TYPE (couple_rxns_001) = TIMEHIS
CPLSURFS (couple_rxns_001) = 3
SET 3 = 1
CPLSOUT (couple_rxns_001) = XFORCE YFORCE
TIMES (couple_rxns_001) = 0 THRU END BY 0.001
SAVE (couple_rxns_001) = 100000
$ Output result for request: euler_height_out
TYPE (euler_height_out) = ARCHIVE
ELEMENTS (euler_height_out) = 4
```


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```

SET 4 = 1140 THRU 5939 21940 THRU 26739 85940 THRU 95539
ELOUT (euler_height_out) = FMATPLT
TIMES (euler_height_out) = 0 THRU END BY 0.1
SAVE (euler_height_out) = 10000
$ Output result for request: minusx_outstrip
TYPE (minusx_outstrip) = TIMEHIS
ELEMENTS (minusx_outstrip) = 5
SET 5 = 201 211 221 281 311 581 582 583 584 585 741 742 743 881 882 883 884
ELOUT (minusx_outstrip) = TXX-MID TXX-OUT TXX-IN TYY-MID TYY-OUT TYY-IN
TIMES (minusx_outstrip) = 0 THRU END BY 0.01
SAVE (minusx_outstrip) = 10000
$ Output result for request: minusx_press
TYPE (minusx_press) = TIMEHIS
ELEMENTS (minusx_press) = 6
SET 6 = 1976 3576 5176 6776 9976 13176 16376 19576 22776 25976 27576 30776 ,
      33976 37176 40376 43576 46776 49976 53176 56376 59576 62776 65976 ,
      69176 72376 86776 88376 89976 91576 93176
ELOUT (minusx_press) = PRESSURE
TIMES (minusx_press) = 0 THRU END BY 0.01
SAVE (minusx_press) = 10000
$ Output result for request: minusx_press_001
TYPE (minusx_press_001) = TIMEHIS
ELEMENTS (minusx_press_001) = 7
SET 7 = 1976 3576 5176 6776 9976 13176 16376 19576 22776 25976 27576 30776 ,
      33976 37176 40376 43576 46776 49976 53176 56376 59576 62776 65976 ,
      69176 72376 86776 88376 89976 91576 93176
ELOUT (minusx_press_001) = PRESSURE
TIMES (minusx_press_001) = 0 THRU END BY 0.001
SAVE (minusx_press_001) = 100000
$ Output result for request: minusx_shear
TYPE (minusx_shear) = TIMEHIS
ELEMENTS (minusx_shear) = 8
SET 8 = 201 211 221 281 311 581 582 583 584 585 741 742 743 881 882 883 884
ELOUT (minusx_shear) = TXY-MID
TIMES (minusx_shear) = 0 THRU END BY 0.01
SAVE (minusx_shear) = 10000
$ Output result for request: plusx_outstrip
TYPE (plusx_outstrip) = TIMEHIS
ELEMENTS (plusx_outstrip) = 9
SET 9 = 240 250 260 300 310 676 677 678 679 680 798 799 800 957 958 959 960
ELOUT (plusx_outstrip) = TXX-MID TXX-OUT TXX-IN TYY-MID TYY-OUT TYY-IN
TIMES (plusx_outstrip) = 0 THRU END BY 0.01
SAVE (plusx_outstrip) = 10000
$ Output result for request: plusx_press
TYPE (plusx_press) = TIMEHIS
ELEMENTS (plusx_press) = 10
SET 10 = 1943 3543 5143 6743 9943 13143 16343 19543 22743 25943 27543 30743 ,
      33943 37143 40343 43543 46743 49943 53143 56343 59543 62743 65943 ,
      69143 72343 86743 88343 89943 91543 93143
ELOUT (plusx_press) = PRESSURE
TIMES (plusx_press) = 0 THRU END BY 0.01
SAVE (plusx_press) = 10000
$ Output result for request: plusx_press_001
TYPE (plusx_press_001) = TIMEHIS
ELEMENTS (plusx_press_001) = 11
SET 11 = 1943 3543 5143 6743 9943 13143 16343 19543 22743 25943 27543 30743 ,
      33943 37143 40343 43543 46743 49943 53143 56343 59543 62743 65943 ,
      69143 72343 86743 88343 89943 91543 93143
ELOUT (plusx_press_001) = PRESSURE
TIMES (plusx_press_001) = 0 THRU END BY 0.001
SAVE (plusx_press_001) = 100000
$ Output result for request: plusx_shear
TYPE (plusx_shear) = TIMEHIS
ELEMENTS (plusx_shear) = 12
SET 12 = 240 250 260 300 310 676 677 678 679 680 798 799 800 957 958 959 960

```

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```
ELOUT (plusx_shear) = TXY-MID
TIMES (plusx_shear) = 0 THRU END BY 0.01
SAVE (plusx_shear) = 10000
$ Output result for request: plusx_strip_001
TYPE (plusx_strip_001) = TIMEHIS
ELEMENTS (plusx_strip_001) = 13
SET 13 = 240 250 260 300 310 676 677 678 679 680 798 799 800 957 958 959 960
ELOUT (plusx_strip_001) = TYY-MID TYY-OUT TYY-IN
TIMES (plusx_strip_001) = 0 THRU END BY 0.001
SAVE (plusx_strip_001) = 100000
$ Output result for request: plusx_strip_arc
TYPE (plusx_strip_arc) = ARCHIVE
ELEMENTS (plusx_strip_arc) = 14
SET 14 = 240 250 260 300 310 676 677 678 679 680 798 799 800 957 958 959 960
ELOUT (plusx_strip_arc) = EFFST-MID EFFST-OUT EFFST-IN TXX-MID TXX-OUT TXX-IN ,
    TYY-MID TYY-OUT TYY-IN TXY-MID TXY-OUT TXY-IN
TIMES (plusx_strip_arc) = 0 THRU END BY 0.1
SAVE (plusx_strip_arc) = 10000
$ Output result for request: plusz_outstrip
TYPE (plusz_outstrip) = TIMEHIS
ELEMENTS (plusz_outstrip) = 15
SET 15 = 231 241 251 291 301 631 632 633 634 635 771 772 773 921 922 923 924
ELOUT (plusz_outstrip) = TXX-MID TXX-OUT TXX-IN TYY-MID TYY-OUT TYY-IN
TIMES (plusz_outstrip) = 0 THRU END BY 0.01
SAVE (plusz_outstrip) = 10000
$ Output result for request: plusz_press
TYPE (plusz_press) = TIMEHIS
ELEMENTS (plusz_press) = 16
SET 16 = 2599 4199 5799 7399 10599 13799 16999 20199 23399 26599 28199 31399 ,
    34599 37799 40999 44199 47399 50599 53799 56999 60199 63399 66599 ,
    69799 72999 87399 88999 90599 92199 93799
ELOUT (plusz_press) = PRESSURE
TIMES (plusz_press) = 0 THRU END BY 0.001
SAVE (plusz_press) = 100000
$ Output result for request: plusz_shear
TYPE (plusz_shear) = TIMEHIS
ELEMENTS (plusz_shear) = 17
SET 17 = 231 241 251 291 301 631 632 633 634 635 771 772 773 921 922 923 924
ELOUT (plusz_shear) = TXY-MID
TIMES (plusz_shear) = 0 THRU END BY 0.01
SAVE (plusz_shear) = 10000
$ Output result for request: press_45_out
TYPE (press_45_out) = TIMEHIS
ELEMENTS (press_45_out) = 18
SET 18 = 2388 3988 5588 7188 10388 13588 16788 19988 23188 26388 27988 31188 ,
    34388 37588 40788 43988 47188 50388 53588 56788 59988 63188 66388 ,
    69588 72788 87188 88788 90388 91988 93588
ELOUT (press_45_out) = PRESSURE
TIMES (press_45_out) = 0 THRU END BY 0.01
SAVE (press_45_out) = 10000
$ Output result for request: press45_outstrip
TYPE (press45_outstrip) = TIMEHIS
ELEMENTS (press45_outstrip) = 19
SET 19 = 235 245 255 295 305 651 652 653 654 655 783 784 785 937 938 939 940
ELOUT (press45_outstrip) = TXX-MID TXX-OUT TXX-IN TYY-MID TYY-OUT TYY-IN
TIMES (press45_outstrip) = 0 THRU END BY 0.01
SAVE (press45_outstrip) = 10000
$ Output result for request: press45_shear
TYPE (press45_shear) = TIMEHIS
ELEMENTS (press45_shear) = 20
SET 20 = 235 245 255 295 305 651 652 653 654 655 783 784 785 937 938 939 940
ELOUT (press45_shear) = TXY-MID
TIMES (press45_shear) = 0 THRU END BY 0.01
SAVE (press45_shear) = 10000
$ Output result for request: restart
```

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```

TYPE (restart) = RESTART
TIMES (restart) = 0 THRU END BY 1
SAVE (restart) = -1
$ Output result for request: Tank_TH_out
TYPE (Tank_TH_out) = TIMEHIS
GRIDS (Tank_TH_out) = 21
SET 21 = 47 361 402
GPOUT (Tank_TH_out) = XVEL YVEL ZVEL XACC YACC ZACC XDIS YDIS ZDIS
TIMES (Tank_TH_out) = 0 THRU END BY 0.01
SAVE (Tank_TH_out) = 10000
$ Output result for request: Wall_Node_001
TYPE (Wall_Node_001) = TIMEHIS
GRIDS (Wall_Node_001) = 22
SET 22 = 1 162 173 184 523 524 525 526 527
GPOUT (Wall_Node_001) = XVEL YVEL XACC YACC XDIS YDIS
TIMES (Wall_Node_001) = 0 THRU END BY 0.001
SAVE (Wall_Node_001) = 100000
$ Output result for request: Wall_Node_01
TYPE (Wall_Node_01) = TIMEHIS
GRIDS (Wall_Node_01) = 23
SET 23 = 1 162 173 184 523 524 525 526 527
GPOUT (Wall_Node_01) = XVEL YVEL XACC YACC XDIS YDIS
TIMES (Wall_Node_01) = 0 THRU END BY 0.01
SAVE (Wall_Node_01) = 10000
$----- Parameter Section -----
PARAM,BULK,0.2
PARAM,BULKQ,1.1
PARAM,CONTACT,THICK,0.0
PARAM,FASTCOUP
PARAM,INISTEP,1e-5
PARAM,MINSTEP,5.0e-7
PARAM,RBE2INFO,GRIDON
$----- BULK DATA SECTION -----
BEGIN BULK
$ Direct Text Input for Bulk Data
PARAM,EXTRAS,NOR-DIR,+2
PARAM,EXTRAS,RHOREF,1.71E-4
PARAM,EXTRAS,ACCG,386.4
PARAM,EXTRAS,FSURF,460
PARAM,EXTRAS,PATM,14.7
PARAM,EXTRAS,BULK,305000
PARAM,EXTRAS,TOLFMAT,0.01
PARAM,EULER-BOUNDARY,EXTRAPOLATION
PARAM,TOLCHK,6.0E-11
PARAM,ELDLTH,10
INCLUDE BaseVertVel.bdf
INCLUDE 1CM_025_Vert.bdf
$ ----- VISCDMP -----
VISCDMP,,,,,,,,+,
+      ,,,,0.025,,,,+,
+      ,,,,,,,+,
+      ,,,,,,,+,
+      ,,,,,,,+,
+      ,,,,,,,+,
$ ----- GRAVITATION -----
TLOAD1,1,444,,0
GRAV,444,,386.4,0,-1,0
$
$ ===== PROPERTY SETS =====
$
$      * Rigid_Prop *
$
PSHELL,1,1,1
$
$      * waste_prop *

```

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```

$
PEULER,7,2, MMHYDRO
$
$          * air_prop *
$
PEULER,8,4, MMHYDRO
$
$          * 78_Steel *
$
PSHELL,12,7,0.815
$
$          * 34_Steel *
$
PSHELL,13,7,0.69
$
$          * 916_Steel *
$
PSHELL,14,7,0.5025
$
$          * 12_Steel *
$
PSHELL,15,7,0.44
$
$
$ ===== MATERIAL DEFINITIONS =====
$
$
$ ----- Material Rigid_Material id =1
MATRIG,1,735,2.9e+007,0.3,
$
$ ----- Material Water_Mat id =2
DMAT,2,0.000171,2
EOSPOL,2,305000
$
$ ----- Material air_mat id =4
DMAT,4,1.167e-007,4
EOSGAM,4,1.4,,,
$
$ ----- Material steel_mat id =7
MAT1,7,2.88e+007,,0.3,0.000735
$
$ ===== Load Cases =====
$
$
$ ----- Rigid Body Object Rigid_Tank -----
$ ---- No reference node is used.
TLOAD1,1,2,,12
FORCE,2,MR1,,0,,,0
TLOAD1,1,1002,,12
MOMENT,1002,MR1,,0,0,0,0
$
$ ----- TICEL BC air_init_set -----
SET1,24,85940,THRU,86466,107985,THRU,108339,107579,+
+      ,THRU,107984,107173,THRU,107578,106767,THRU,107172,+
+      ,106361,THRU,106766,105955,THRU,106360,105549,THRU,+
+      ,105954,105143,THRU,105548,104737,THRU,105142,104331,+
+      ,THRU,104736,103925,THRU,104330,103519,THRU,103924,+
+      ,103113,THRU,103518,102707,THRU,103112,102301,THRU,+
+      ,102706,101895,THRU,102300,101489,THRU,101894,101083,+
+      ,THRU,101488,100677,THRU,101082,100271,THRU,100676,+
+      ,99865,THRU,100270,99459,THRU,99864,99053,THRU,+
+      ,99458,98647,THRU,99052,98241,THRU,98646,97835,+
+      ,THRU,98240,97429,THRU,97834,97023,THRU,97428,+
+      ,96617,THRU,97022,96211,THRU,96616,95805,THRU,+
+      ,96210,95399,THRU,95804,94993,THRU,95398,94587,+

```

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```

+      ,THRU,94992,94181,THRU,94586,93775,THRU,94180,+
+      ,93369,THRU,93774,92963,THRU,93368,92557,THRU,+
+      ,92962,92151,THRU,92556,91745,THRU,92150,91339,+
+      ,THRU,91744,90933,THRU,91338,90527,THRU,90932,+
+      ,90121,THRU,90526,89715,THRU,90120,89309,THRU,+
+      ,89714,88903,THRU,89308,88497,THRU,88902,88091,+
+      ,THRU,88496,87685,THRU,88090,87279,THRU,87684,+
+      ,86873,THRU,87278,86467,THRU,86872
TICEL,1,24,DENSITY,1.167e-007,SIE,3.15e+008
$
$ ----- TICEL BC wat_init_set -----
SET1,25,44227,THRU,44632,10529,THRU,10934,28799,+
+      ,THRU,29204,28393,THRU,28798,27987,THRU,28392,+
+      ,27581,THRU,27986,27175,THRU,27580,26769,THRU,+
+      ,27174,26363,THRU,26768,25957,THRU,26362,25551,+
+      ,THRU,25956,25145,THRU,25550,24739,THRU,25144,+
+      ,24333,THRU,24738,23927,THRU,24332,23521,THRU,+
+      ,23926,23115,THRU,23520,22709,THRU,23114,22303,+
+      ,THRU,22708,21897,THRU,22302,21491,THRU,21896,+
+      ,21085,THRU,21490,20679,THRU,21084,20273,THRU,+
+      ,20678,19867,THRU,20272,19461,THRU,19866,19055,+
+      ,THRU,19460,18649,THRU,19054,18243,THRU,18648,+
+      ,17837,THRU,18242,17431,THRU,17836,17025,THRU,+
+      ,17430,16619,THRU,17024,16213,THRU,16618,15807,+
+      ,THRU,16212,15401,THRU,15806,14995,THRU,15400,+
+      ,14589,THRU,14994,14183,THRU,14588,13777,THRU,+
+      ,14182,13371,THRU,13776,12965,THRU,13370,12559,+
+      ,THRU,12964,12153,THRU,12558,11747,THRU,12152,+
+      ,11341,THRU,11746,10935,THRU,11340,10123,THRU,+
+      ,10528,9717,THRU,10122,9311,THRU,9716,8905,+
+      ,THRU,9310,8499,THRU,8904,8093,THRU,8498,+
+      ,7687,THRU,8092,7281,THRU,7686,6875,THRU,+
+      ,7280,6469,THRU,6874,6063,THRU,6468,5657,+
+      ,THRU,6062,5251,THRU,5656,4845,THRU,5250,+
+      ,4439,THRU,4844,4033,THRU,4438,3627,THRU,+
+      ,4032,3221,THRU,3626,2815,THRU,3220,2409,+
+      ,THRU,2814,2003,THRU,2408,1597,THRU,2002,+
+      ,1191,THRU,1596,1140,THRU,1190,43821,THRU,+
+      ,44226,43415,THRU,43820,43009,THRU,43414,42603,+
+      ,THRU,43008,42197,THRU,42602,41791,THRU,42196,+
+      ,41385,THRU,41790,40979,THRU,41384,40573,THRU,+
+      ,40978,40167,THRU,40572,39761,THRU,40166,39355,+
+      ,THRU,39760,38949,THRU,39354,38543,THRU,38948,+
+      ,38137,THRU,38542,37731,THRU,38136,37325,THRU,+
+      ,37730,36919,THRU,37324,36513,THRU,36918,36107,+
+      ,THRU,36512,35701,THRU,36106,35295,THRU,35700,+
+      ,34889,THRU,35294,34483,THRU,34888,34077,THRU,+
+      ,34482,33671,THRU,34076,33265,THRU,33670,32859,+
+      ,THRU,33264,32453,THRU,32858,32047,THRU,32452,+
+      ,31641,THRU,32046,31235,THRU,31640,30829,THRU,+
+      ,31234,30423,THRU,30828,30017,THRU,30422,29611,+
+      ,THRU,30016,29205,THRU,29610,44633,THRU,85939
$ TICEL,1,25,DENSITY,0.000171
TICEEX,1,25,INEL1
$
$ ----- General Coupling: couple -----
$
COUPLE,7,1,OUTSIDE,ON,ON,,7,STANDARD,+
+      ,,,,,,
$
COUOPT,1,7,,,,,,+
+      ,CONSTANT,14.7
$
SURFACE,1,,ELEM,26
SET1,26,1,THRU,105,918,THRU,960,512,+

```


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```

+          ,THRU,917,106,THRU,511
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$
$$ ----- Rigid Body: Seismic_Accel
$$
$ BODYFOR,9,GRID,27,,,,,+
$ +          ,0,CONSTANT,1,1,0,0
$ SET1,27,1,THRU,161,362,THRU,522
$ Note that body force grid point set will have to be modified for two-comp. motion.
$$
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$ ----- Rigid Body Object Rigid_Tank_Vert_Vel -----
$ ---- No reference node is used.
TLOAD1,1,14,,12,2
FORCE,14,MR1,,1,0,1,
$
$
ENDDATA

```

Dytran Input File Two-Component Motion (Horizontal and Vertical)

```

$ Direct Text Input for File Management Section

START
MEMORY-SIZE=15000000,15000000
CEND
$ Direct Text Input for Case Control Data
$
$ -----
$ special setting for the calculation of fmatplt of the water
$ fmatplt of the water - FMATPLT2 = FMAT2*FVUNC
$ active the special output variables
$
PARAM,VARACTIV,MULTIEULHYDRO,ELEM,FMATPLT2,FLT,ACTIVE,FMATPLT2
$
$ -----
$ Call eexout routine for the calculation of fmatplt2
$ Call this routine at every timestep is requested
$
ELEXOUT (FP2)
ELEMENTS(FP2) = 101
SET 101 = 1140 THRU 5939 21940 THRU 26739 85940 THRU 95539
TIMES (FP2) = 0 THRU END BY 0.1
$ Output result for request: HEIGHT
TYPE (HEIGHT) = ARCHIVE
ELEMENTS (HEIGHT) = 100
SET 100 = 1140 THRU 5939 21940 THRU 26739 85940 THRU 95539
ELOUT (HEIGHT) = FMAT2,FMATPLT2
TIMES (HEIGHT) = 0 THRU END BY 0.1
SAVE (HEIGHT) = 10000
ENDTIME=46.5
ENDSTEP=9999999
CHECK=NO
TITLE= Jobname is: 2CM_025
TLOAD=1
TIC=1
SPC=1
$ Output result for request: cent_press
TYPE (cent_press) = TIMEHIS
ELEMENTS (cent_press) = 1
SET 1 = 3559 6759 9959 13159 16359 19559 22759 25959 27559 30759 33959 37159 ,
      40359 43559 46759 49959 53159 56359 59559 62759 65959 69159 72359 ,
      86759 89959 93159 96359 99559 101159 102759 104359 105959 107559
ELOUT (cent_press) = PRESSURE

```

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```

TIMES (cent_press) = 0 THRU END BY 0.001
SAVE (cent_press) = 100000
$ Output result for request: couple_rxns
TYPE (couple_rxns) = TIMEHIS
CPLSURFS (couple_rxns) = 2
SET 2 = 1
CPLSOUT (couple_rxns) = XFORCE YFORCE ZFORCE
TIMES (couple_rxns) = 0 THRU END BY 0.01
SAVE (couple_rxns) = 10000
$ Output result for request: couple_rxns_001
TYPE (couple_rxns_001) = TIMEHIS
CPLSURFS (couple_rxns_001) = 3
SET 3 = 1
CPLSOUT (couple_rxns_001) = XFORCE YFORCE
TIMES (couple_rxns_001) = 0 THRU END BY 0.001
SAVE (couple_rxns_001) = 100000
$ Output result for request: euler_height_out
TYPE (euler_height_out) = ARCHIVE
ELEMENTS (euler_height_out) = 4
SET 4 = 1140 THRU 5939 21940 THRU 26739 85940 THRU 95539
ELOUT (euler_height_out) = FMATPLT
TIMES (euler_height_out) = 0 THRU END BY 0.1
SAVE (euler_height_out) = 10000
$ Output result for request: minusx_outstrip
TYPE (minusx_outstrip) = TIMEHIS
ELEMENTS (minusx_outstrip) = 5
SET 5 = 201 211 221 281 311 581 582 583 584 585 741 742 743 881 882 883 884
ELOUT (minusx_outstrip) = TXX-MID TXX-OUT TXX-IN TYY-MID TYY-OUT TYY-IN
TIMES (minusx_outstrip) = 0 THRU END BY 0.01
SAVE (minusx_outstrip) = 10000
$ Output result for request: minusx_press
TYPE (minusx_press) = TIMEHIS
ELEMENTS (minusx_press) = 6
SET 6 = 1976 3576 5176 6776 9976 13176 16376 19576 22776 25976 27576 30776 ,
      33976 37176 40376 43576 46776 49976 53176 56376 59576 62776 65976 ,
      69176 72376 86776 88376 89976 91576 93176
ELOUT (minusx_press) = PRESSURE
TIMES (minusx_press) = 0 THRU END BY 0.01
SAVE (minusx_press) = 10000
$ Output result for request: minusx_press_001
TYPE (minusx_press_001) = TIMEHIS
ELEMENTS (minusx_press_001) = 7
SET 7 = 1976 3576 5176 6776 9976 13176 16376 19576 22776 25976 27576 30776 ,
      33976 37176 40376 43576 46776 49976 53176 56376 59576 62776 65976 ,
      69176 72376 86776 88376 89976 91576 93176
ELOUT (minusx_press_001) = PRESSURE
TIMES (minusx_press_001) = 0 THRU END BY 0.001
SAVE (minusx_press_001) = 100000
$ Output result for request: minusx_shear
TYPE (minusx_shear) = TIMEHIS
ELEMENTS (minusx_shear) = 8
SET 8 = 201 211 221 281 311 581 582 583 584 585 741 742 743 881 882 883 884
ELOUT (minusx_shear) = TXY-MID
TIMES (minusx_shear) = 0 THRU END BY 0.01
SAVE (minusx_shear) = 10000
$ Output result for request: plusx_outstrip
TYPE (plusx_outstrip) = TIMEHIS
ELEMENTS (plusx_outstrip) = 9
SET 9 = 240 250 260 300 310 676 677 678 679 680 798 799 800 957 958 959 960
ELOUT (plusx_outstrip) = TXX-MID TXX-OUT TXX-IN TYY-MID TYY-OUT TYY-IN
TIMES (plusx_outstrip) = 0 THRU END BY 0.01
SAVE (plusx_outstrip) = 10000
$ Output result for request: plusx_press
TYPE (plusx_press) = TIMEHIS
ELEMENTS (plusx_press) = 10

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SET 10 = 1943 3543 5143 6743 9943 13143 16343 19543 22743 25943 27543 30743 ,
        33943 37143 40343 43543 46743 49943 53143 56343 59543 62743 65943 ,
        69143 72343 86743 88343 89943 91543 93143
ELOUT (plusx_press) = PRESSURE
TIMES (plusx_press) = 0 THRU END BY 0.01
SAVE (plusx_press) = 10000
$ Output result for request: plusx_press_001
TYPE (plusx_press_001) = TIMEHIS
ELEMENTS (plusx_press_001) = 11
SET 11 = 1943 3543 5143 6743 9943 13143 16343 19543 22743 25943 27543 30743 ,
        33943 37143 40343 43543 46743 49943 53143 56343 59543 62743 65943 ,
        69143 72343 86743 88343 89943 91543 93143
ELOUT (plusx_press_001) = PRESSURE
TIMES (plusx_press_001) = 0 THRU END BY 0.001
SAVE (plusx_press_001) = 100000
$ Output result for request: plusx_shear
TYPE (plusx_shear) = TIMEHIS
ELEMENTS (plusx_shear) = 12
SET 12 = 240 250 260 300 310 676 677 678 679 680 798 799 800 957 958 959 960
ELOUT (plusx_shear) = TXY-MID
TIMES (plusx_shear) = 0 THRU END BY 0.01
SAVE (plusx_shear) = 10000
$ Output result for request: plusx_strip_001
TYPE (plusx_strip_001) = TIMEHIS
ELEMENTS (plusx_strip_001) = 13
SET 13 = 240 250 260 300 310 676 677 678 679 680 798 799 800 957 958 959 960
ELOUT (plusx_strip_001) = TYY-MID TYY-OUT TYY-IN
TIMES (plusx_strip_001) = 0 THRU END BY 0.001
SAVE (plusx_strip_001) = 100000
$ Output result for request: plusx_strip_arc
TYPE (plusx_strip_arc) = ARCHIVE
ELEMENTS (plusx_strip_arc) = 14
SET 14 = 240 250 260 300 310 676 677 678 679 680 798 799 800 957 958 959 960
ELOUT (plusx_strip_arc) = EFFST-MID EFFST-OUT EFFST-IN TXX-MID TXX-OUT TXX-IN ,
        TYY-MID TYY-OUT TYY-IN TXY-MID TXY-OUT TXY-IN
TIMES (plusx_strip_arc) = 0 THRU END BY 0.1
SAVE (plusx_strip_arc) = 10000
$ Output result for request: plusz_outstrip
TYPE (plusz_outstrip) = TIMEHIS
ELEMENTS (plusz_outstrip) = 15
SET 15 = 231 241 251 291 301 631 632 633 634 635 771 772 773 921 922 923 924
ELOUT (plusz_outstrip) = TXX-MID TXX-OUT TXX-IN TYY-MID TYY-OUT TYY-IN
TIMES (plusz_outstrip) = 0 THRU END BY 0.01
SAVE (plusz_outstrip) = 10000
$ Output result for request: plusz_press
TYPE (plusz_press) = TIMEHIS
ELEMENTS (plusz_press) = 16
SET 16 = 2599 4199 5799 7399 10599 13799 16999 20199 23399 26599 28199 31399 ,
        34599 37799 40999 44199 47399 50599 53799 56999 60199 63399 66599 ,
        69799 72999 87399 88999 90599 92199 93799
ELOUT (plusz_press) = PRESSURE
TIMES (plusz_press) = 0 THRU END BY 0.001
SAVE (plusz_press) = 100000
$ Output result for request: plusz_shear
TYPE (plusz_shear) = TIMEHIS
ELEMENTS (plusz_shear) = 17
SET 17 = 231 241 251 291 301 631 632 633 634 635 771 772 773 921 922 923 924
ELOUT (plusz_shear) = TXY-MID
TIMES (plusz_shear) = 0 THRU END BY 0.01
SAVE (plusz_shear) = 10000
$ Output result for request: press_45_out
TYPE (press_45_out) = TIMEHIS
ELEMENTS (press_45_out) = 18
SET 18 = 2388 3988 5588 7188 10388 13588 16788 19988 23188 26388 27988 31188 ,
        34388 37588 40788 43988 47188 50388 53588 56788 59988 63188 66388 ,

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69588 72788 87188 88788 90388 91988 93588
ELOUT (press_45_out) = PRESSURE
TIMES (press_45_out) = 0 THRU END BY 0.01
SAVE (press_45_out) = 10000
$ Output result for request: press45_outstrip
TYPE (press45_outstrip) = TIMEHIS
ELEMENTS (press45_outstrip) = 19
SET 19 = 235 245 255 295 305 651 652 653 654 655 783 784 785 937 938 939 940
ELOUT (press45_outstrip) = TXX-MID TXX-OUT TXX-IN TYY-MID TYY-OUT TYY-IN
TIMES (press45_outstrip) = 0 THRU END BY 0.01
SAVE (press45_outstrip) = 10000
$ Output result for request: press45_shear
TYPE (press45_shear) = TIMEHIS
ELEMENTS (press45_shear) = 20
SET 20 = 235 245 255 295 305 651 652 653 654 655 783 784 785 937 938 939 940
ELOUT (press45_shear) = TXY-MID
TIMES (press45_shear) = 0 THRU END BY 0.01
SAVE (press45_shear) = 10000
$ Output result for request: restart
TYPE (restart) = RESTART
TIMES (restart) = 0 THRU END BY 1
SAVE (restart) = -1
$ Output result for request: Tank_TH_out
TYPE (Tank_TH_out) = TIMEHIS
GRIDS (Tank_TH_out) = 21
SET 21 = 47 361 402
GPOUT (Tank_TH_out) = XVEL YVEL ZVEL XACC YACC ZACC XDIS YDIS ZDIS
TIMES (Tank_TH_out) = 0 THRU END BY 0.01
SAVE (Tank_TH_out) = 10000
$ Output result for request: Wall_Node_001
TYPE (Wall_Node_001) = TIMEHIS
GRIDS (Wall_Node_001) = 22
SET 22 = 1 162 173 184 523 524 525 526 527
GPOUT (Wall_Node_001) = XVEL YVEL XACC YACC XDIS YDIS
TIMES (Wall_Node_001) = 0 THRU END BY 0.001
SAVE (Wall_Node_001) = 100000
$ Output result for request: Wall_Node_01
TYPE (Wall_Node_01) = TIMEHIS
GRIDS (Wall_Node_01) = 23
SET 23 = 1 162 173 184 523 524 525 526 527
GPOUT (Wall_Node_01) = XVEL YVEL XACC YACC XDIS YDIS
TIMES (Wall_Node_01) = 0 THRU END BY 0.01
SAVE (Wall_Node_01) = 10000
$----- Parameter Section -----
PARAM,BULK,0.2
PARAM,BULKQ,1.1
PARAM,CONTACT,THICK,0.0
PARAM,FASTCOUP
PARAM,INISTEP,1e-5
PARAM,MINSTEP,5.0e-7
PARAM,RBE2INFO,GRIDON
$----- BULK DATA SECTION -----
BEGIN BULK
$ Direct Text Input for Bulk Data
PARAM,EXTRAS,NOR-DIR,+2
PARAM,EXTRAS,RHOREF,1.71E-4
PARAM,EXTRAS,ACCG,386.4
PARAM,EXTRAS,FSURF,460
PARAM,EXTRAS,PATM,14.7
PARAM,EXTRAS,BULK,305000
PARAM,EXTRAS,TOLFMAT,0.01
PARAM,EULER-BOUNDARY,EXTRAPOLATION
PARAM,TOLCHK,6.0E-11
PARAM,ELDLTH,10
INCLUDE BaseVertVel.bdf

```

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```

INCLUDE BaseTH.bdf
INCLUDE 2CM_025.bdf
$ ----- VISCDMP -----
VISCDMP,,,,,,,,+,
+,
+,0.025,,,,+,
+,
+,
+,
+,
+,
+,
$ ----- GRAVITATION -----
TLOAD1,1,444,,0
GRAV,444,,386.4,0,-1,0
$
$ ===== PROPERTY SETS =====
$
$           * Rigid_Prop *
$
PSHELL,1,1,1
$
$           * waste_prop *
$
PEULER,7,2, MMHYDRO
$
$           * air_prop *
$
PEULER,8,4, MMHYDRO
$
$           * 78_Steel *
$
PSHELL,12,7,0.815
$
$           * 34_Steel *
$
PSHELL,13,7,0.69
$
$           * 916_Steel *
$
PSHELL,14,7,0.5025
$
$           * 12_Steel *
$
PSHELL,15,7,0.44
$
$
$ ===== MATERIAL DEFINITIONS =====
$
$
$ ----- Material Rigid_Material id =1
MATRIG,1,735,2.9e+007,0.3,
$
$ ----- Material Water_Mat id =2
DMAT,2,0.000171,2
EOSPOL,2,305000
$
$ ----- Material air_mat id =4
DMAT,4,1.167e-007,4
EOSGAM,4,1.4,,,
$
$ ----- Material steel_mat id =7
MAT1,7,2.88e+007,,0.3,0.000735
$
$ ===== Load Cases =====
$
$
$ ----- Rigid Body Object Rigid_Tank -----

```

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```
$ ---- No reference node is used.
TLOAD1,1,2,,12
FORCE,2,MR1,,0,,,0
TLOAD1,1,1002,,12
MOMENT,1002,MR1,,0,0,0,0
$
$ ----- TICEL BC air_init_set -----
SET1,24,85940,THRU,86466,107985,THRU,108339,107579,+
+      ,THRU,107984,107173,THRU,107578,106767,THRU,107172,+
+      ,106361,THRU,106766,105955,THRU,106360,105549,THRU,+
+      ,105954,105143,THRU,105548,104737,THRU,105142,104331,+
+      ,THRU,104736,103925,THRU,104330,103519,THRU,103924,+
+      ,103113,THRU,103518,102707,THRU,103112,102301,THRU,+
+      ,102706,101895,THRU,102300,101489,THRU,101894,101083,+
+      ,THRU,101488,100677,THRU,101082,100271,THRU,100676,+
+      ,99865,THRU,100270,99459,THRU,99864,99053,THRU,+
+      ,99458,98647,THRU,99052,98241,THRU,98646,97835,+
+      ,THRU,98240,97429,THRU,97834,97023,THRU,97428,+
+      ,96617,THRU,97022,96211,THRU,96616,95805,THRU,+
+      ,96210,95399,THRU,95804,94993,THRU,95398,94587,+
+      ,THRU,94992,94181,THRU,94586,93775,THRU,94180,+
+      ,93369,THRU,93774,92963,THRU,93368,92557,THRU,+
+      ,92962,92151,THRU,92556,91745,THRU,92150,91339,+
+      ,THRU,91744,90933,THRU,91338,90527,THRU,90932,+
+      ,90121,THRU,90526,89715,THRU,90120,89309,THRU,+
+      ,89714,88903,THRU,89308,88497,THRU,88902,88091,+
+      ,THRU,88496,87685,THRU,88090,87279,THRU,87684,+
+      ,86873,THRU,87278,86467,THRU,86872
TICEL,1,24,DENSITY,1.167e-007,SIE,3.15e+008
$
$ ----- TICEL BC wat_init_set -----
SET1,25,44227,THRU,44632,10529,THRU,10934,28799,+
+      ,THRU,29204,28393,THRU,28798,27987,THRU,28392,+
+      ,27581,THRU,27986,27175,THRU,27580,26769,THRU,+
+      ,27174,26363,THRU,26768,25957,THRU,26362,25551,+
+      ,THRU,25956,25145,THRU,25550,24739,THRU,25144,+
+      ,24333,THRU,24738,23927,THRU,24332,23521,THRU,+
+      ,23926,23115,THRU,23520,22709,THRU,23114,22303,+
+      ,THRU,22708,21897,THRU,22302,21491,THRU,21896,+
+      ,21085,THRU,21490,20679,THRU,21084,20273,THRU,+
+      ,20678,19867,THRU,20272,19461,THRU,19866,19055,+
+      ,THRU,19460,18649,THRU,19054,18243,THRU,18648,+
+      ,17837,THRU,18242,17431,THRU,17836,17025,THRU,+
+      ,17430,16619,THRU,17024,16213,THRU,16618,15807,+
+      ,THRU,16212,15401,THRU,15806,14995,THRU,15400,+
+      ,14589,THRU,14994,14183,THRU,14588,13777,THRU,+
+      ,14182,13371,THRU,13776,12965,THRU,13370,12559,+
+      ,THRU,12964,12153,THRU,12558,11747,THRU,12152,+
+      ,11341,THRU,11746,10935,THRU,11340,10123,THRU,+
+      ,10528,9717,THRU,10122,9311,THRU,9716,8905,+
+      ,THRU,9310,8499,THRU,8904,8093,THRU,8498,+
+      ,7687,THRU,8092,7281,THRU,7686,6875,THRU,+
+      ,7280,6469,THRU,6874,6063,THRU,6468,5657,+
+      ,THRU,6062,5251,THRU,5656,4845,THRU,5250,+
+      ,4439,THRU,4844,4033,THRU,4438,3627,THRU,+
+      ,4032,3221,THRU,3626,2815,THRU,3220,2409,+
+      ,THRU,2814,2003,THRU,2408,1597,THRU,2002,+
+      ,1191,THRU,1596,1140,THRU,1190,43821,THRU,+
+      ,44226,43415,THRU,43820,43009,THRU,43414,42603,+
+      ,THRU,43008,42197,THRU,42602,41791,THRU,42196,+
+      ,41385,THRU,41790,40979,THRU,41384,40573,THRU,+
+      ,40978,40167,THRU,40572,39761,THRU,40166,39355,+
+      ,THRU,39760,38949,THRU,39354,38543,THRU,38948,+
+      ,38137,THRU,38542,37731,THRU,38136,37325,THRU,+
+      ,37730,36919,THRU,37324,36513,THRU,36918,36107,+
```


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+      ,THRU,36512,35701,THRU,36106,35295,THRU,35700,+
+      ,34889,THRU,35294,34483,THRU,34888,34077,THRU,+
+      ,34482,33671,THRU,34076,33265,THRU,33670,32859,+
+      ,THRU,33264,32453,THRU,32858,32047,THRU,32452,+
+      ,31641,THRU,32046,31235,THRU,31640,30829,THRU,+
+      ,31234,30423,THRU,30828,30017,THRU,30422,29611,+
+      ,THRU,30016,29205,THRU,29610,44633,THRU,85939
$ TICEL,1,25,DENSITY,0.000171
TICEEX,1,25,INEL1
$
$ ----- General Coupling: couple -----
$
COUPLE,7,1,OUTSIDE,ON,ON,,7,STANDARD,+
+      ,,,,,
$
COUOPT,1,7,,,,,,+
+      ,CONSTANT,14.7
$
SURFACE,1,,ELEM,26
SET1,26,1,THRU,105,918,THRU,960,512,+
+      ,THRU,917,106,THRU,511
$
$ ----- Rigid Body: Seismic_Accel
$
BODYFOR,9,GRID,27,,,,,+
+      ,0,TABLE,1,1,0,0
SET1,27,1,THRU,161,322,THRU,522
$
$ ----- Rigid Body Object Rigid_Tank_Vert_Vel -----
$ ---- No reference node is used.
TLOAD1,1,14,,12,2
FORCE,14,MR1,,1,1,
$
$
ENDDATA

```

Appendix B

Stress Time History Plots for Dytran[®] Primary Tank Sub-Models

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Appendix B

Stress Time History Plots for Dytran[®] Primary Tank Sub-Models

Figures

B.1	Mid-Plane Hoop Stress Time Histories for Element Set “Plusx_Outstrip” at $\theta=0^\circ$ for Horizontal Seismic Excitation Only	B.3
B.2	Mid-Plane Meridional Stress Time Histories for Element Set “Plusx_Outstrip” at $\theta=0^\circ$ for Horizontal Excitation Only	B.3
B.3	Shear Stress Time Histories for Element Set “Plusx_Outstrip” at $\theta=0^\circ$ for Horizontal Excitation Only	B.4
B.4	Mid-Plane Hoop Stress Time Histories for Element Set “Press45” at $\theta=45^\circ$ for Horizontal Seismic Excitation Only	B.4
B.5	Mid-Plane Meridional Stress Time Histories for Element Set “Press45” at $\theta=45^\circ$ for Horizontal Seismic Excitation Only	B.5
B.6	Shear Stress Time Histories for Element Set “Press45” at $\theta=45^\circ$ for Horizontal Seismic Excitation Only	B.5
B.7	Mid-Plane Hoop Stress Time Histories for Element Set “Plusz_Outstrip” at $\theta=90^\circ$ for Horizontal Seismic Excitation Only	B.6
B.8	Mid-Plane Meridional Stress Time Histories for Element Set “Plusz_Outstrip” at $\theta=90^\circ$ for Horizontal Seismic Excitation Only	B.6
B.9	Shear Stress Time Histories for Element Set “Plusz_Outstrip” at $\theta=90^\circ$ for Horizontal Seismic Excitation Only	B.7
B.10	Mid-Plane Hoop Stress Time Histories for Element Set “Plusx_Outstrip” at $\theta=0^\circ$ for Vertical Seismic Excitation Only	B.7
B.11	Mid-Plane Meridional Stress Time Histories for Element Set “Plusx_Outstrip” at $\theta=0^\circ$ for Vertical Excitation Only	B.8
B.12	Shear Stress Time Histories for Element Set “Plusx_Outstrip” at $\theta=0^\circ$ for Vertical Excitation Only	B.8
B.13	Mid-Plane Hoop Stress Time Histories for Element Set “Plusx_Outstrip” at $\theta=0^\circ$ for Two-Component Seismic Excitation	B.9
B.14	Mid-Plane Meridional Stress Time Histories for Element Set “Plusx_Outstrip” at $\theta=0^\circ$ for Two-Component Seismic Excitation	B.9
B.15	Mid-Plane Shear Stress Time Histories for Element Set “Plusx_Outstrip” at $\theta=0^\circ$ for Two-Component Seismic Excitation	B.10
B.16	Mid-Plane Hoop Stress Time Histories for Element Set “Press45_Outstrip” at $\theta=45^\circ$ for Two-Component Seismic Excitation	B.10

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B.17	Mid-Plane Meridional Stress Time Histories for Element Set “Press45_Outstrip” at $\theta=45^\circ$ for Two-Component Seismic Excitation.....	B.11
B.18	Mid-Plane Shear Stress Time Histories for Element Set “Press45_Outstrip” at $\theta=45^\circ$ for Two-Component Seismic Excitation	B.11
B.19	Mid-Plane Hoop Stress Time Histories for Element Set “Plusz_Outstrip” at $\theta=90^\circ$ for Two-Component Seismic Excitation	B.12
B.20	Mid-Plane Meridional Stress Time Histories for Element Set “Plusz_Outstrip” at $\theta=90^\circ$ for Two-Component Seismic Excitation.....	B.12
B.21	Mid-Plane Shear Stress Time Histories for Element Set “Plusz_Outstrip” at $\theta=90^\circ$ for Two-Component Seismic Excitation	B.13
B.22	Mid-Plane Hoop Stress Time Histories for Element Set “Minusx_Outstrip” at $\theta=180^\circ$ for Two-Component Seismic Excitation	B.13
B.23	Mid-Plane Meridional Stress Time Histories for Element Set “Minusx_Outstrip” at $\theta=180^\circ$ for Two-Component Seismic Excitation.....	B.14
B.24	Mid-Plane Shear Stress Time Histories for Element Set “Minusx_Outstrip” at $\theta=180^\circ$ for Two-Component Seismic Excitation	B.14

Figure B.1. Mid-Plane Hoop Stress Time Histories for Element Set "Plusx_Outstrip" at $\theta=0^\circ$ for Horizontal Seismic Excitation Only

Figure B.2. Mid-Plane Meridional Stress Time Histories for Element Set "Plusx_Outstrip" at $\theta=0^\circ$ for Horizontal Excitation Only

Figure B.3. Shear Stress Time Histories for Element Set "Plusx_Outstrip" at $\theta=0^\circ$ for Horizontal Excitation Only

Figure B.4. Mid-Plane Hoop Stress Time Histories for Element Set "Press45" at $\theta=45^\circ$ for Horizontal Seismic Excitation Only

Figure B.5. Mid-Plane Meridional Stress Time Histories for Element Set “Press45” at $\theta=45^\circ$ for Horizontal Seismic Excitation Only

Figure B.6. Shear Stress Time Histories for Element Set “Press45” at $\theta=45^\circ$ for Horizontal Seismic Excitation Only

Figure B.7. Mid-Plane Hoop Stress Time Histories for Element Set "Plusz_Outstrip" at $\theta=90^\circ$ for Horizontal Seismic Excitation Only

Figure B.8. Mid-Plane Meridional Stress Time Histories for Element Set "Plusz_Outstrip" at $\theta=90^\circ$ for Horizontal Seismic Excitation Only

Figure B.9. Shear Stress Time Histories for Element Set "Plusz_Outstrip" at $\theta=90^\circ$ for Horizontal Seismic Excitation Only

Figure B.10. Mid-Plane Hoop Stress Time Histories for Element Set "Plusx_Outstrip" at $\theta=0^\circ$ for Vertical Seismic Excitation Only

Figure B.11. Mid-Plane Meridional Stress Time Histories for Element Set "Plusx_Outstrip" at $\theta=0^\circ$ for Vertical Excitation Only

Figure B.12. Shear Stress Time Histories for Element Set "Plusx_Outstrip" at $\theta=0^\circ$ for Vertical Excitation Only

Figure B.13. Mid-Plane Hoop Stress Time Histories for Element Set "Plusx_Outstrip" at $\theta=0^\circ$ for Two-Component Seismic Excitation

Figure B.14. Mid-Plane Meridional Stress Time Histories for Element Set "Plusx_Outstrip" at $\theta=0^\circ$ for Two-Component Seismic Excitation

Figure B.15. Mid-Plane Shear Stress Time Histories for Element Set "Plusx_Outstrip" at $\theta=0^\circ$ for Two-Component Seismic Excitation

Figure B.16. Mid-Plane Hoop Stress Time Histories for Element Set "Press45_Outstrip" at $\theta=45^\circ$ for Two-Component Seismic Excitation

Figure B.17. Mid-Plane Meridional Stress Time Histories for Element Set “Press45_Outstrip” at $\theta=45^\circ$ for Two-Component Seismic Excitation

Figure B.18. Mid-Plane Shear Stress Time Histories for Element Set “Press45_Outstrip” at $\theta=45^\circ$ for Two-Component Seismic Excitation

Figure B.19. Mid-Plane Hoop Stress Time Histories for Element Set "Plusz_Outstrip" at $\theta=90^\circ$ for Two-Component Seismic Excitation

Figure B.20. Mid-Plane Meridional Stress Time Histories for Element Set "Plusz_Outstrip" at $\theta=90^\circ$ for Two-Component Seismic Excitation

Figure B.21. Mid-Plane Shear Stress Time Histories for Element Set "Plusz_Outstrip" at $\theta=90^\circ$ for Two-Component Seismic Excitation

Figure B.22. Mid-Plane Hoop Stress Time Histories for Element Set "Minusx_Outstrip" at $\theta=180^\circ$ for Two-Component Seismic Excitation

Figure B.23. Mid-Plane Meridional Stress Time Histories for Element Set "Minusx_Outstrip" at $\theta=180^\circ$ for Two-Component Seismic Excitation

Figure B.24. Mid-Plane Shear Stress Time Histories for Element Set "Minusx_Outstrip" at $\theta=180^\circ$ for Two-Component Seismic Excitation

Appendix C

Common ANSYS® Sub-Model Files Listing

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Appendix C

Common ANSYS® Sub-Model Files Listing

All-Forces.txt

```
!/input,force-c.txt  
/input,stress-Primary.txt  
/input,Force-J_bolt.txt  
!/input,strain_liner.txt
```

Bolts-Friction.txt

```
pi=acos(-1)                ! Define PI  
  
!ET,4,BEAM44                ! Rigid Links  
!KEYOPT,4,8,111  
et,4,BEAM4  
keyopt,4,6,1  
  
et,31,combin14,,1  
et,32,combin14,,2  
et,33,combin14,,3  
  
et,34,targe170  
et,35,conta173  
!keyopt,35,2,3  
keyopt,35,5,3  
keyopt,35,9,1  
keyopt,35,11,1  
!keyopt,35,12,4  
r,701,0,0,0.01  
r,702,0,0,0.01  
r,703,0,0,0.01  
r,704,0,0,0.01  
r,705,0,0,0.01  
r,706,0,0,0.01  
r,707,0,0,0.01  
r,708,0,0,0.01  
r,709,0,0,0.01  
r,710,0,0,0.01  
r,711,0,0,0.01  
  
BX=33333/20  
BY=33333/20  
BZ=22777/10  
mp,mu,700,0.01  
  
/COM - Create Rigid Links for J-Bolts  
nj_bolt=11  
  
mp,ex,401,4176000  
mp,nuxy,401,0.30  
mp,dens,401,0  
r,401,1,10,10,2.5,2.5  
rmore,,1e-3  
r,402,1,10,10,2.5,2.5  
rmore,,1e-3  
r,403,1,10,10,2.5,2.5  
rmore,,1e-3  
r,404,1,10,10,2.5,2.5
```

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rmore,,1e-3
r,405,1,10,10,2.5,2.5
rmore,,1e-3
r,406,1,10,10,2.5,2.5
rmore,,1e-3
r,407,1,10,10,2.5,2.5
rmore,,1e-3
r,408,1,10,10,2.5,2.5
rmore,,1e-3
r,409,1,10,10,2.5,2.5
rmore,,1e-3
r,410,1,10,10,2.5,2.5
rmore,,1e-3
r,411,1,10,10,2.5,2.5
rmore,,1e-3

r,421,1/2,10,10,2.5,2.5
rmore,,1e-3
r,422,1/2,10,10,2.5,2.5
rmore,,1e-3
r,423,1/2,10,10,2.5,2.5
rmore,,1e-3
r,424,1/2,10,10,2.5,2.5
rmore,,1e-3
r,425,1/2,10,10,2.5,2.5
rmore,,1e-3
r,426,1/2,10,10,2.5,2.5
rmore,,1e-3
r,427,1/2,10,10,2.5,2.5
rmore,,1e-3
r,428,1/2,10,10,2.5,2.5
rmore,,1e-3
r,429,1/2,10,10,2.5,2.5
rmore,,1e-3
r,430,1/2,10,10,2.5,2.5
rmore,,1e-3
r,431,1/2,10,10,2.5,2.5
rmore,,1e-3

r,501,1.364*BX
r,502,0.550*BX
r,503,0.887*BX
r,504,1.027*BX
r,505,1.971*BX
r,506,2.407*BX
r,507,3.301*BX
r,508,4.039*BX
r,509,4.369*BX
r,510,5.362*BX
r,511,3.596*BX

r,521,1.364*BY
r,522,0.550*BY
r,523,0.887*BY
r,524,1.027*BY
r,525,1.971*BY
r,526,2.407*BY
r,527,3.301*BY
r,528,4.039*BY
r,529,4.369*BY
r,530,5.362*BY
r,531,3.596*BY

r,541,1.364*BZ
r,542,0.550*BZ
r,543,0.887*BZ
r,544,1.027*BZ
r,545,1.971*BZ
r,546,2.407*BZ
r,547,3.301*BZ
r,548,4.039*BZ

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```

r,549,4.369*BZ
r,550,5.362*BZ
r,551,3.596*BZ

R,601,1.364*BX/2
R,602,0.550*BX/2
R,603,0.887*BX/2
R,604,1.027*BX/2
R,605,1.971*BX/2
R,606,2.407*BX/2
R,607,3.301*BX/2
R,608,4.039*BX/2
R,609,4.369*BX/2
R,610,5.362*BX/2
R,611,3.596*BX/2

R,621,1.364*BY/2
R,622,0.550*BY/2
R,623,0.887*BY/2
R,624,1.027*BY/2
R,625,1.971*BY/2
R,626,2.407*BY/2
R,627,3.301*BY/2
R,628,4.039*BY/2
R,629,4.369*BY/2
R,630,5.362*BY/2
R,631,3.596*BY/2

R,641,1.364*BZ/2
R,642,0.550*BZ/2
R,643,0.887*BZ/2
R,644,1.027*BZ/2
R,645,1.971*BZ/2
R,646,2.407*BZ/2
R,647,3.301*BZ/2
R,648,4.039*BZ/2
R,649,4.369*BZ/2
R,650,5.362*BZ/2
R,651,3.596*BZ/2

cmsel,s,primary-tank
nsle
nsel,r,loc,z,ptz(1),ptz(11)
cm,bolt-primary-n,node
nsel,none
n,,0,0,ptz(1)
*do,i,2,nj_bolt
*do,j,0,180/arcsz
angle=-j*arcsz
n,,ptx(i),angle,ptz(i)
*enddo
*enddo
cm,bolt-node,node

/COM - Create link at top center of tanks
type,4
mat,401
real,401

nsel,s,loc,x,0                                ! Select nodes on model origin
nsel,r,loc,z,ptz(1),ctz(1)                    ! Reselect nodes on concrete and primary tanks
!nsel,u,node,,1
cmsel,u,bolt-primary-n
eintf,10                                       ! Place link at dome center

csys,1
/COM - Create links for J-Bolts
*do,i,2,nj_bolt                               ! Cycle by radius
REAL,400+i
*do,j,1,180/arcsz-1                           ! Cycle by model slice

```

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```

angley=-j*arcsize                ! Define angle for node selection
nset,s,loc,x,ctx(i),ptx(i)        ! Select nodes at radius
nset,r,loc,z,ctx(i),ptz(i)
nset,r,loc,y,angley              ! Reselect nodes at angle "angley"
cmsgel,u,bolt-primary-n
cmsgel,u,waste-n
eintf,10                          ! Create rigid link
*enddo
real,420+i
nset,s,loc,x,ctx(i),ptx(i)        ! Select nodes at radius
nset,r,loc,z,ctx(i),ptz(i)
nset,r,loc,y,0                  ! Reselect nodes at angle 0
cmsgel,u,bolt-primary-n
cmsgel,u,waste-n
eintf,10                          ! Create rigid link
nset,s,loc,x,ctx(i),ptx(i)        ! Select nodes at radius
nset,r,loc,z,ctx(i),ptz(i)
nset,r,loc,y,180                ! Reselect nodes at angle 180
cmsgel,u,bolt-primary-n
cmsgel,u,waste-n
eintf,10                          ! Create rigid link

*enddo

eset,s,type,,4
cm,j_bolts,elem                  ! Create component for J-Bolt rigid links
allset

/COM - Create link at top center of tanks
nset,R,loc,x,0                  ! Select nodes on model origin
nset,r,loc,z,ptz(1),ptz(1)      ! Reselect nodes on concrete and primary tanks
TYPE,31
REAL,501
eintf                            ! Place link at dome center
TYPE,32
REAL,521
eintf                            ! Place link at dome center
TYPE,33
REAL,541
eintf                            ! Place link at dome center

csys,1
/COM - Create links for J-Bolts
*do,j,0,2
type,31+j
*do,i,2,nj_bolt                 ! Cycle by radius
REAL,500+20*j+i
*do,k,1,180/arcsize-1           ! Cycle by model slice
angley=-k*arcsize              ! Define angle for node selection
nset,s,loc,x,ptx(i),ptx(i)      ! Select nodes at radius
nset,r,loc,z,ptz(i),ptz(i)      ! Select nodes at radius
nset,r,loc,y,angley             ! Reselect nodes at angle "angley"
cmsgel,u,waste-n
eintf                            ! Create rigid link
*enddo
real,600+j*20+i
nset,s,loc,x,ptx(i),ptx(i)      ! Select nodes at radius
nset,r,loc,z,ptz(i),ptz(i)      ! Select nodes at radius
nset,r,loc,y,0                  ! Reselect nodes at angle 0
cmsgel,u,waste-n
eintf                            ! Create rigid link
nset,s,loc,x,ptx(i),ptx(i)      ! Select nodes at radius
nset,r,loc,z,ptz(i),ptz(i)      ! Select nodes at radius
nset,r,loc,y,180                ! Reselect nodes at angle 180
cmsgel,u,waste-n
eintf                            ! Create rigid link

*enddo
*enddo

```

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```

esel,s,type,,31,33
cm,bolt-springs,elem

*do,i,1,10
cmsel,s,conc-tank
nsle
nsel,r,loc,x,ctx(i),ctx(i+1)
nsel,r,loc,z,ctz(i),ctz(i+1)
esln,r
real,700+i
type,34
esurf,,bottom
cmsel,s,primary-tank
nsle
nsel,r,loc,x,ptx(i),ptx(i+1)
nsel,r,loc,z,ptz(i),ptz(i+1)
esln,r
type,35
real,700+i
mat,700
esurf,,bottom
*enddo
esel,s,type,,35
cm,bolt-friction,elem

!*do,i,3,nj_bolt
!cmsel,s,primary-tank
!cmsel,a,conc-tank
!nsle
!nsel,r,loc,z,ptz(i),ctz(i)
!nsel,r,loc,x,ptx(i),ctx(i)
!type,35
!mat,700
!real,700
!eintf,1,high
!*enddo

*get,KMAXjb,KP,0,num,max      ! Get maximum keypoint number
*get,LMAXjb,LINE,0,num,max    ! Get maximum line number
*get,AMAXjb,AREA,0,num,max    ! Get maximum area number
*get,VMAXjb,volu,0,num,max    ! Get maximum volume number

```

Boundary.txt

```

/COM - Fix symmetry face
allsel
csys,0
nsel,s,loc,y,0
d,all,uy
csys,1

cmsel,s,conc-tank
cmsel,a,primary-tank
cmsel,a,liner
nsle
csys,0
nsel,r,loc,y,0
d,all,rotx
d,all,rotz
csys,1

allsel

!esel,s,type,,24
!nsle
!cmsel,u,conc-slab
!ddelete,all,uy

```


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!allsel

Contact-AP.txt

```
/input,waste-reaction,txt
/input,contact-waste-ap,txt
!/input,contact-insul,txt
!/input,contact-primary,txt
!/input,contact-j-bolts,txt
!/input,contact-soil,txt
!/input,waste-surface-ap,txt
!/input,contact-footing,txt
```

Contact-Waste-AP.txt

```
/post26
numvar,200
*do,z,2,200
VARDEL,z
*enddo

*do,i,1,20
*do,j,1,31
angley=-arcsize*(i-1)
cmsel,s,waste-surf
nsle
nsel,r,loc,y,angley,angley-arcsize
nsel,r,loc,x,ptx(j+wastet-1),ptx(j+wastet)
nsel,r,loc,z,ptz(j+wastet-1),ptz(j+wastet)
esln,r,1
*get,emax,elem,,num,max
esol,(2+j),(emax),,Cont,pres,pr%(emax)%
esol,(42+j),(emax),,Cont,slide,sl%(emax)%
esol,(82+j),(emax),,Cont,gap,gp%(emax)%
esol,(122+j),(emax),,Cont,stat,st%(emax)%
*enddo

LINES,2050
extrem
/OUT,Waste-Cont_%(9*i)%max,OUT
extrem,3,200
/OUT

/OUT,Waste-Cont_%(9*i)%th,OUT
*do,k,1,31
PRVAR,2+k,42+k,82+k,122+k
*enddo
/OUT

*enddo
```

Far-Soil.txt

```
et,9,solid45
et,10,mass21
r,1001,mass,mass,mass
type,9

! Use Element type SOLID45 for Far Soil

asel,none
vsel,none
lsel,none
nsel,none
ksel,none
esel,none

! unselect all reas
! unselect all volumes
```

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```

/COM - Generate Keypoints at full model radius
*do,i,1,tanksoil
k,kmaxns+i,soil_radius,0,soilz(i)
*enddo

*do,i,1,9
k,kmaxns+tanksoil+i,soilx(i),0,soilz(i)
*enddo

/COM - Generate areas outside excavated soil
*do,i,1,tanksoil-1
kp1=kp(soilx(i),0,soilz(i))
kp2=kp(soil_radius,0,soilz(i))
kp3=kp(soil_radius,0,soilz(i+1))
kp4=kp(soilx(i+1),0,soilz(i+1))
a,kp1,kp2,kp3,kp4
*enddo
ksel,a,kp,,1,ct_kps,ct_kps-1
vrotat,all,,,,,1,ct_kps,180,2
cm,far-soil-volu,volu
*do,i,1,tanksoil-1
cmsel,s,far-soil-volu
vsel,r,loc,z,soilz(i),soilz(i+1)
vatt,900+i,,9 ! Assign attributes
aslv
lsla
lsel,r,loc,x,soilx(i)
lesize,all,,arcsz ! Match excavated soil meshing
lsla
lsel,r,loc,x,soilx(i+1)
lesize,all,,arcsz ! Match excavated soil meshing
lsla
lsel,r,loc,x,soil_radius
lsel,r,loc,z,soilz(i)
lesize,all,,arcsz ! Match excavated soil meshing
lsla
lsel,r,loc,x,soil_radius
lsel,r,loc,z,soilz(i+1)
lesize,all,,arcsz ! Match excavated soil meshing
*enddo

/COM - Mesh soil outside excavated soil
cmsel,s,far-soil-volu
esize,30
vmesh,all
csys,1
esel,s,type,,9
nsle
!nrotat,all ! Rotate all nodes to cylindrical coordinates
cm,far-soil-top,elem

!/COM - Connect new soil elements to excavated soil at interface
!*do,i,1,tanksoil
!nsel,s,loc,x,soilx(i)
!nsel,r,loc,z,soilz(i)
!cmsel,u,excav-wall
!nummrg,node
!*enddo

*get,KMAXtemp,KP,0,num,max
*get,LMAXtemp,LINE,0,num,max
*get,AMAXtemp,AREA,0,num,max
*get,VMAXtemp,VOLU,0,num,max

ksel,u,kp,,all
asel,u,area,,all
vsel,u,volu,,all

/COM - Generate Keypoint below tank for five layers
*do,i,0,deepsoil-tanksoil-5
k,kmaxtemp+5*i+1,0,0,soilz(i+tanksoil) ! Keypoint on centerline

```

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```

k, kmaxtemp+5*i+2, ctx(ct_kps-1-i), 0, soilz(i+tanksoil) ! Keypoint to flare central area under tank
k, kmaxtemp+5*i+3, ctx(bm_kp+1), 0, soilz(i+tanksoil) ! Keypoint under edge of tank
k, kmaxtemp+5*i+4, soilx(tanksoil), 0, soilz(i+tanksoil) ! Keypoint under edge of excavated soil
k, kmaxtemp+5*i+5, soil_radius, 0, soilz(i+tanksoil) ! Keypoint at edge of model
*enddo

/COM - Generate Keypoint below tank to full depth
*do, i, 5, deepsoil-tanksoil
k, kmaxtemp+5*i+1, 0, 0, soilz(i+tanksoil) ! Keypoint on centerline
k, kmaxtemp+5*i+2, ctx(ct_kps-5), 0, soilz(i+tanksoil) ! Keypoint for central soil area
k, kmaxtemp+5*i+3, ctx(bm_kp+1), 0, soilz(i+tanksoil) ! Keypoint under edge of tank
k, kmaxtemp+5*i+4, soilx(tanksoil), 0, soilz(i+tanksoil) ! Keypoint under edge of excavated soil
k, kmaxtemp+5*i+5, soil_radius, 0, soilz(i+tanksoil) ! Keypoint at edge of model
*enddo

*do, i, 0, 3 ! Area pattern for 1st 4 layers under tank
a, kmaxtemp+5*i+1, kmaxtemp+5*i+2, kmaxtemp+5*(i+1)+2, kmaxtemp+5*(i+1)+1
a, kmaxtemp+5*i+2, kmaxtemp+5*i+3, kmaxtemp+5*(i+1)+3, kmaxtemp+5*(i+1)+2
a, kmaxtemp+5*i+3, kmaxtemp+5*i+4, kmaxtemp+5*(i+1)+4, kmaxtemp+5*(i+1)+3
a, kmaxtemp+5*i+4, kmaxtemp+5*i+5, kmaxtemp+5*(i+1)+5, kmaxtemp+5*(i+1)+4
*enddo

! Area pattern for transition layer
a, kmaxtemp+5*4+1, kmaxtemp+5*4+2, kmaxtemp+5*(4+1)+2, kmaxtemp+5*(4+1)+1
a, kmaxtemp+5*4+2, kmaxtemp+5*4+3, kmaxtemp+5*4+4, kmaxtemp+5*(4+1)+4, kmaxtemp+5*(4+1)+2
a, kmaxtemp+5*4+4, kmaxtemp+5*4+5, kmaxtemp+5*(4+1)+5, kmaxtemp+5*(4+1)+4

*do, i, 5, 10 ! Area pattern to bottom of model
a, kmaxtemp+5*i+1, kmaxtemp+5*i+2, kmaxtemp+5*(i+1)+2, kmaxtemp+5*(i+1)+1
a, kmaxtemp+5*i+2, kmaxtemp+5*i+4, kmaxtemp+5*(i+1)+4, kmaxtemp+5*(i+1)+2
a, kmaxtemp+5*i+4, kmaxtemp+5*i+5, kmaxtemp+5*(i+1)+5, kmaxtemp+5*(i+1)+4
*enddo

/COM - divide line interfacing with bottom of tank to match tank meshing
!sla
!sel, r, loc, z, soilz(tanksoil)
!sel, r, loc, x, ctx(ct_kps-1), ctx(bm_kp+1)
ratio=(ctx(ct_kps-1)-ctx(ct_kps-2))/(ctx(ct_kps-1)-ctx(bm_kp+1))
ldiv, all, ratio
*get, LMAXtemp, LINE, 0, num, max
*do, i, 1, 8
!sla
!sel, r, loc, z, soilz(tanksoil)
!sel, r, loc, x, ctx(ct_kps-1-i), ctx(bm_kp+1)
ratio=(ctx(ct_kps-1-i)-ctx(ct_kps-2-i))/(ctx(ct_kps-1-i)-ctx(bm_kp+1))
ldiv, all, ratio
*enddo

!/COM - Move Keypoints to match tank bottom vertical locations
!sla
!*do, i, 0, ct_kps-bm_kp-1
!kact=kp(ctx(ct_kps-i), 0, soilz(tanksoil))
!kmodif, kact, ctx(ct_kps-i), 0, ctz(ct_kps-i)
!*enddo

ksel, a, kp, , 1, ct_kps, ct_kps-1 ! Select Keypoints for rotation axis
vrotat, all, , , , 1, ct_kps, 180, 2 ! Develop volumes
cm, deep-soil-volu, volu
*do, i, tanksoil, deepsoil-1 ! Assign attributes
vsel, s, loc, z, soilz(i), soilz(i+1)
vatt, 900+i, , 9
*enddo

/COM - Control meshing to match model slices
cmsel, s, deep-soil-volu
aslv
!sla
!sel, r, loc, x, soil_radius
lesize, all, , , arcsize
!sla

```

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```

lsel,r,loc,x,soilx(tanksoil)
lesize,all,,arcsz
lsla
lsel,r,loc,x,ctx(bm_kp+1)
lesize,all,,arcsz

vsel,u,loc,x,0,soilx(tanksoil)
vmesh,all ! Mesh outside volumes
vsel,s,loc,x,ctx(ct_kps-5),soilx(tanksoil)
vsel,r,loc,z,soilz(tanksoil+5),soilz(deepsoil)
esize,22
vmesh,all ! Mesh under excavated soil and tank except for central
area

cmsel,s,deep-soil-volu
vsel,r,loc,x,0,ctx(ct_kps-3) ! Select volumes under center of tank
aslv
asel,r,loc,z,soilz(tanksoil) ! Select soil area at bottom of tank
lsla
lsel,r,loc,x,ctx(ct_kps-1) ! Select Lines on outside of center area
lesize,all,,arcsz ! Control mesh for slices
lsla
lsel,u,loc,x,ctx(ct_kps-1)
lesize,all,,midsize ! control mesh on inside of area
aslv
lsla
cmsel,s,deep-soil-volu
vsel,r,loc,x,0,ctx(ct_kps-3)
aslv
lsla
lsel,r,loc,z,soilz(tanksoil),soilz(tanksoil+1)
lsel,u,loc,z,soilz(tanksoil)
lsel,u,loc,z,soilz(tanksoil+1)
lesize,all,,,4 ! Control meshing under tank
cmsel,s,deep-soil-volu
vsel,r,loc,x,0,ctx(ct_kps-3)
aslv
lsla
lsel,r,loc,z,soilz(tanksoil+1),soilz(tanksoil+2)
lsel,u,loc,z,soilz(tanksoil+1)
lsel,u,loc,z,soilz(tanksoil+2)
lesize,all,,,2 ! Control meshing under tank
cmsel,s,deep-soil-volu
vsel,r,loc,x,0,ctx(ct_kps-3)
aslv
asel,r,loc,z,soilz(tanksoil)
type,1
amesh,all ! mesh area at tank/soil interface
vsweep,all ! Sweep mesh to bottom of model
aclear,all ! Clear Pattern

cmsel,s,deep-soil-volu
aslv
lsla
lsel,r,loc,z,soilz(tanksoil+1)
lsel,r,loc,x,ctx(ct_kps-2),ctx(bm_kp+1)
lsel,u,loc,x,ctx(ct_kps-2)
lsel,u,loc,x,ctx(bm_kp+1)
lesize,all,,,8 ! Control meshing under tank

lsla
lsel,r,loc,z,soilz(tanksoil+2)
lsel,r,loc,x,ctx(ct_kps-3),ctx(bm_kp+1)
lsel,u,loc,x,ctx(ct_kps-3)
lsel,u,loc,x,ctx(bm_kp+1)
lesize,all,,,6 ! Control meshing under tank

lsla
lsel,r,loc,z,soilz(tanksoil+3)
lsel,r,loc,x,ctx(ct_kps-4),ctx(bm_kp+1)

```

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```

lsel,u,loc,x,ctx(ct_kps-4)
lsel,u,loc,x,ctx(bm_kp+1)
lesize,all,,,4                                ! Control meshing under tank

lsla
lsel,r,loc,z,soilz(tanksoil+4)
lsel,r,loc,x,ctx(ct_kps-5),ctx(bm_kp+1)
lsel,u,loc,x,ctx(ct_kps-5)
lsel,u,loc,x,ctx(bm_kp+1)
lesize,all,,,2                                ! Control meshing under tank

*do,i,0,2
lsla
lsel,r,loc,z,soilz(tanksoil+i)
lsel,r,loc,x,ctx(bm_kp+1),soilx(tanksoil)
lsel,u,loc,x,ctx(bm_kp+1)
lsel,u,loc,x,soilx(tanksoil)
lesize,all,,,4-i                              ! Control meshing under tank
*enddo

cmsel,s,deep-soil-volu
aslv
lsla
lsel,r,loc,x,ctx(bm_kp+1)
lsel,r,loc,z,soilz(tanksoil),soilz(tanksoil+1)
lsel,u,loc,z,soilz(tanksoil)
lsel,u,loc,z,soilz(tanksoil+1)
ldiv,all,2                                    ! Control meshing under tank

cmsel,s,deep-soil-volu
aslv
lsla
lsel,r,loc,z,soilz(tanksoil)
lsel,r,loc,x,ctx(ct_kps-2),ctx(bm_kp+1)
lesize,all,,,arcsiz                              ! Control meshing for slices

*do,i,0,4
vsel,s,loc,z,soilz(tanksoil+i),soilz(tanksoil+1+i)
vsel,r,loc,x,ctx(ct_kps-1-i),soilx(tanksoil)
aslv
asel,r,loc,y,0
type,1
amesh,all                                     ! Mesh area for sweep pattern
vsweep,all                                   ! Mesh volumes
aclear,all                                   ! Clear pattern
*enddo

esel,s,type,,9
nsle
nummrg,node                                  ! Merge bottom soil to rest of model

esel,s,type,,9
nsle
nsel,s,loc,x,soilx(1)
nsel,r,loc,z,soilz(1)
cm,far-soil-face-node,node
*do,i,2,9
esel,s,type,,9
nsle
nsel,r,loc,x,soilx(i)
nsel,r,loc,z,soilz(i)
cmsel,a,far-soil-face-node
cm,far-soil-face-node,node
*enddo

esel,s,type,,9
nsle
nsel,r,loc,z,soilz(9)
nsel,r,loc,x,41,68
cm,far-soil-bot-node,node

```

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```

!nsel,s,loc,x,68,320
!nummrg,node

!esel,s,type,,8,9
!nsle
!nsel,r,loc,z,soilz(9)
!nsel,r,loc,x,41,67
!cpint,uz

type,10
real,1001

csys,0
nsel,s,loc,z,soilz(deepsoil)
csys,1
nsel,r,loc,x,320
csys,0
nsel,r,loc,x,0
*get,master_node,node,,num,max
d,master_node,all
allsel

e,master_node                                ! Large mass for excitation

csys,1
nsel,s,loc,z,soilz(9),soilz(10)
nsel,r,loc,x,0,soilx(9)
esln,1
esel,r,type,,9
cm,bottom-soil,elem

```

Fix-Soil.txt

```

!esel,s,type,,8,9
!nsle
!nsel,r,loc,z,soilz(9)
!nsel,r,loc,x,ctx(21)+1,68
!nummrg,node

et,90,target170
et,91,contal73
keyopt,91,9,1
mp,mu,90,0.3
mp,mu,91,0.7
mp,mu,92,0.7
r,90,,0.1
r,91,,0.1

esel,s,type,,9
cmsel,s,far-soil-face-node
esln,r
type,90
real,90
mat,90
esurf
esel,s,type,,8
cmsel,s,near-soil-face-node
esln,r
type,91
esurf

esel,s,type,,9
cmsel,s,far-soil-bot-node
esln,r
type,90
real,91
mat,91
esurf

```


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```
esel,s,type,,8
cmsel,s,near-soil-bot-node
esln,r
type,91
esurf
```

```
esel,s,type,,91
cm,far-soil-contact,elem
```

Insulate.txt

```
et,2,solid45    ! SOLID45 elements for insulating concrete

mp,ex,50,23760
mp,dens,50,0.05/g
mp,prxy,50,0.15
mp,damp,50,0.07/DF

/COM - Key Points for Insulating Concrete
*do,i,0,tw,1
k,kmaxpt+1+i,ptx(pt_kps-i),0,ptz(pt_kps-i)      ! Match Keypoint to Primary Tank
k,kmaxpt+2+tw+i,ctx(ct_kps-i),0,ctz(ct_kps-i)    ! Match Keypoint to Concrete Tank
*enddo

/COM - Areas for Insulating Concrete
*do,i,1,tw,1
a,kmaxpt+i,kmaxpt+tw+1+i,kmaxpt+tw+2+i,kmaxpt+1+i
*enddo

/COM - Assign Material Properties
*do,i,1,tw,1
asel,s,area,,amaxpt+i
aatt,50,i,2
*enddo

asel,s,area,,amaxpt+1,amaxpt+tw
vrotat,all,,,,,1,ct_kps,180,2

type,2
/COM - Elements in insulating concrete
*do,i,2,tw,1
vsel,s,volu,,i
vsel,a,volu,,tw+i
aslv
lsla
lsl,r,loc,x,ctx(ct_kps-i),ctx(ct_kps-i-1)
lesize,all,,arcsiz
vmesh,all
*enddo

/COM - Mesh center volume to match primary tank
vsel,s,volu,,1,tw+1,tw
aslv
asel,r,loc,z,ptz(pt_kps)
cm,a2,area
cmsel,a,a1
mshcopy,2,a1,a2
type,2
vsweep,all,,all

allsel
esel,s,type,,2
mpchg,50,all
cm,insul-conc,elem
cmsel,a,primary-tank
nsle
nsl,r,loc,z,ptz(pt_kps)
cm,primary-int,node
```

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```
allsel
cmsel,s,conc-tank
esel,a,type,,2
nsle
nsel,r,loc,z,ctz(ct_kps)
nsel,r,loc,x,ctx(ct_kps-tw),ctx(ct_kps)

cm,insul-vol,volu
cm,insul-int,node

cmsel,s,a2
aclear,all
allsel
*get,KMAXic,KP,0,num,max          ! Get maximum Keypoint Number
*get,LMAXic,LINE,0,num,max        ! Get maximum Line Number
*get,AMAXic,AREA,0,num,max        ! Get maximum Area Number
*get,VMAXic,VOLU,0,num,max        ! Get maximum Volume Number
```

```
cmsel,s,insul-conc
nsle
nsel,r,loc,z,ptz(pt_kps)
nsel,r,loc,x,ptx(pt_kps-tw)
csys,1
!nrotat,all
allsel
```

interface-gap1.txt

```
/COM, Create components for wall and dome of concrete tank and excavated soil for interface
coupling
csys,1
cmsel,s,conc-dome_wall-n
nsel,r,loc,x,ctx(12),ctx(14)+.1
esln,s,1
cmsel,u,liner
cm,conc-wall-e,elem
cm,conc-wall-n,node

cmsel,s,conc-dome_wall-e
cmsel,s,conc-dome_wall-n
cmsel,u,conc-wall-e
nsle,s,1
nsel,u,loc,z,ctz(13),ctz(14)
esln,r,1
cm,conc-dome-e,elem
cm,conc-dome-n,node

cmsel,s,excav-soil
nsle,s,1
nsel,r,loc,x,ctx(12),ctx(14)
nsel,r,loc,z,ctz(12),ctz(22)
esln,s
cm,excav-wall-e,elem
cm,excav-wall-n,node

cmsel,s,excav-soil
nsle,s,1
CM,EXCAV-SOIL-N,NODE
!nsel,r,loc,x,0,ctx(14)
!nsel,u,loc,z,0,soilz(3)
!nsel,u,loc,z,ctz(14),ctz(22)
!cm,ntemp,node
!nsel,r,loc,z,-11,-13.4
!nsel,u,loc,x,0,28
!cm,ntemp1,node
```

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```

!cmsel,s,ntemp
!cmsel,u,ntemp1
CMSEL,S,EXCAV-SOIL-N
NSEL,R,LOC,X,CTX(1),CTX(2)
NSEL,R,LOC,Z,CTZ(1),CTZ(2)
cm,excav-dome-n,node
*DO,I,3,12
CMSEL,S,EXCAV-SOIL-N
NSEL,R,LOC,X,CTX(I)
NSEL,R,LOC,Z,CTZ(I)
CMSEL,A,EXCAV-DOME-N
cm,excav-dome-n,node
*ENDDO
esln,
cm,excav-dome-e,elem

/COM, Create wall soil to concrete tank interface elements
cmsel,s,conc-wall-n
cmsel,a,excav-wall-n
cm,conc-excav-wall-int,node

cmsel,s,conc-dome-n
cmsel,a,excav-dome-n
cm,conc-excav-dome-int,node

/COM, Define contact properteis
et,61,contal73          ! Contact Surface - Concrete Tank
keyopt,61,5,3           ! Type of constraint - Shell/Solid contact normal direction
et,60,targel70          ! Contact Element - Excavated Soil
!keyopt,60,8,2          ! Asymmetric contact selection (all contact elements on one
surface and all target elements on the other surface)
keyopt,61,12,4          ! Behavior of contact surface (no seperation, sliding
permitted)
!keyopt,61,2,3

et,63,contal73
keyopt,63,5,3
et,62,targel70
!keyopt,62,8,2
!keyopt,63,12,4
!keyopt,63,2,3

mp,mu,60,0.2            ! Coefficient of Friction between excavated soil and
concrete tank wall
MP,damp,60,0.07/DF
r,60,,0.05

mp,mu,62,0.2            ! Coefficient of Friction between excavated soil and
concrete tank dome
MP,damp,62,0.07/DF
r,62,,0.05

r,61,,0.05
r,63,,0.025
mp,mu,64,0.6            ! Coefficient of Friction between excavated soil and
concrete tank dome
MP,damp,64,0.07/DF

! add wall interface elements
! concrete tank surface target
cmsel,s,conc-wall-e
nsle,s,1
type,60
real,60
mat,60
esurf
esel,s,type,,60
nsle
nsel,r,loc,z,ctz(12),ctz(14)
esln,r,1

```

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```
emodif,all,real,61
esel,s,type,,61
cmsel,u,conc-wall-e
cm,conc-target,elem

type,61
cmsel,s,excav-wall-e
cmsel,a,excav-wall-n
esurf
esel,s,type,,61
nsle
nsel,r,loc,z,ctz(12),ctz(14)
esln,r,1
emodif,all,real,61
esel,s,type,,61
cmsel,u,excav-wall-e
cmsel,u,excav-wall-n
cm,excav-contact,elem

cmsel,s,conc-target
cmsel,a,excav-contact
cm,conc-excav-wall-gap,elem

! add dome interface elements
! concrete tank surface target
cmsel,s,conc-dome-e
nsle,s,1
type,62
real,62
mat,62
esurf
esel,s,type,,62
nsle
nsel,r,loc,z,ctz(12),ctz(14)
esln,r,1
emodif,all,real,62
esel,s,type,,62
cmsel,u,conc-dome-e
cm,conc-dome-target,elem

type,63
cmsel,s,excav-dome-e
esel,u,type,,1
cmsel,s,excav-dome-n
esurf
cmsel,u,excav-dome-e
cm,excav-dome-contact,elem

cmsel,s,conc-dome-target
cmsel,a,excav-dome-contact
cm,conc-excav-dome-gap,elem
allsel

/COM, Create concrete slab to soil interface elements
! spring constants
! slab
r,307,1e8
r,308,1e8
r,309,1e8
esel,none

esel,s,type,,9
nsle
nsel,r,loc,z,ctz(23)
nsel,r,loc,x,0,ctx(23)
cm,soil-slab,node
allsel
esel,none
cmsel,s,conc-slab
cmsel,a,soil-slab
type,21
```

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```

real,307
eintf

type,22
real,308
eintf

type,23
real,309
eintf
cm,conc-soil-slab-spr,elem
esel,none
allsel

/COM - Create contact on top of footing slab

cmsel,s,conc-tank
nsle
nsel,r,loc,x,ctx(23)
esln,r
nsle
type,60
real,63
mat,64
esurf,top

cmsel,s,excav-soil
nsle
nsel,r,loc,z,soilz(9)
nsel,r,loc,x,ctx(22),ctx(23)
esln,r
type,61
esurf
esel,s,real,,63
esel,r,type,,61
cm,soil-contact-foot-elem,elem

```

interfac1.txt

```

et,21,combin14,,1
et,22,combin14,,2
et,23,combin14,,3

r,201,1e8
r,202,1e8
r,203,1e8

et,24,contal78
keyopt,24,2,1

R,204,,,,,,,,
RMORE,,1,,,,,

mp,mu,64,0.20          ! Coefficient of Friction between concrete tank wall and
concrete tank slab
mp,damp,64,0.07/DF

/COM, Define contact properteis
et,65,targel70          ! Target Surface
keyopt,65,5,3          ! Type of constraint - Shell/Solid contact normal direction
et,66,contal73          ! Contact Element
keyopt,66,9,1

r,65,,0.02

et,67,targel70          ! Target Surface - Concrete Tank
keyopt,67,5,3          ! Type of constraint - Shell/Solid contact normal direction
et,68,contal73          ! Contact Element - Secondary Line

```

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```

keyopt,68,9,1
r,67,,,0.01

mp,mu,65,0.40 ! Coefficient of Friction between primary tank and
insulating concrete (PNNL values)
MP,damp,65,0.3/DF

mp,mu,67,0.40 ! Coefficient of Friction between secondary liner and
concrete tank basemat (PNNL values)
MP,damp,67,0.3/DF

esel,none
/COM - Create Interface Elements at Bottom of Concrete Wall
cmsel,s,wall-int
type,24
real,204
mat,64
eintf,,,high
cm,wall-int-gap,elem

esel,none
/COM - Create Interface Elements between primary tank and insulating concrete
cmsel,s,primary-tank
csys,1
nsle
nsel,r,loc,z,ptz(40)
!nsel,r,loc,x,ptx(41),ptx(39)
cm,primary-int-n,node
esln,r,1
cm,primary-int-e,elem

cmsel,s,insul-conc
nsle
nsel,r,loc,z,ptz(40)
!nsel,r,loc,x,ptx(31),ptx(39)
cm,insul-int-n,node

cmsel,s,primary-int-e
cmsel,s,primary-int-n
type,66
real,65
mat,65
esurf,,bottom
cmsel,u,primary-int-e
cm,pri-target,elem

cmsel,s,insul-conc
cmsel,s,insul-int-n
type,65
real,65
esurf
cmsel,u,insul-conc
cm,insul-contact,elem

cmsel,s,pri-target
cmsel,a,insul-contact
cm,primary-int-gap,elem
esel,none

!nsel,s,loc,z,ptz(34)
!nsel,r,loc,x,ptx(39)-.1,ptx(40)
!cpint,uz

/COM - Create Interface Elements between concrete tank and insulating concrete
cmsel,s,conc-tank
cmsel,a,liner
cmsel,a,insul-int
esln,r,1
cm,etemp,elem

cmsel,s,etemp

```


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```
esel,u,real,,51
cm,conc-temp,elem

cmsel,s,etemp
esel,r,real,,51
cm,liner-temp,elem

cmsel,s,conc-temp
nsle
type,67
real,67
mat,67
esurf,,top
cmsel,u,conc-temp
cm,conc-target,elem

cmsel,s,liner-temp
nsle
type,68
real,67
esurf,,bottom
cmsel,u,liner-temp
cm,liner-contact,elem

cmsel,s,conc-target
cmsel,a,liner-contact
cm,conc-liner-gap,elem
```

Liner.txt

```
ksel,u,kp,,all           ! Clear active Keypoints
asel,u,area,,all        ! Clear active Areas
vsel,u,volu,,all        ! Clear active Volumes
ksel,s,kp,,1,ct_kps,ct_kps-1 ! Activate Keypoints for axis of rotation
esel,u,elem,,all
lsl,u,line,,all

et,21,combin14,,1
et,22,combin14,,2
et,23,combin14,,3

r,201,1e8
r,202,1e8
r,203,1e8

r,51,0.375/12
r,52,0.5/12
r,53,0.5625/12

cmsel,s,insul-vol
aslv
asel,r,loc,z,ctz(ct_kps)
cm,liner-a,area
aatt,101,51,1
asel,r,loc,x,ptx(pt_kps-tw),ptx(pt_kps-tw+1)
aatt,101,52,1
cmsel,s,liner-a

asel,none
k,kmaxic+1,ctx(bm_kp+3),0,ctz(bm_kp+3)
k,kmaxic+2,ctx(bm_kp)-1,0,ctz(bm_kp)
k,kmaxic+3,ctx(bm_kp)-0.2929,0,ctz(bm_kp)+0.2929
k,kmaxic+4,ctx(bm_kp),0,ctz(bm_kp)+1
k,kmaxic+5,ctx(bm_kp-1),0,ctz(bm_kp-1)
k,kmaxic+6,ctx(bm_kp-2),0,ctz(bm_kp-2)

l,kmaxic+1,kmaxic+2
```

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```

l, kmaxic+2, kmaxic+3
l, kmaxic+3, kmaxic+4
l, kmaxic+4, kmaxic+5
l, kmaxic+5, kmaxic+6

arotat, all, , , , , 1, ct_kps, 180, 2
aatt, 101, 52, 1
cm, liner-lines, line
cmsel, a, liner-a
cm, liner-a, area
asel, r, loc, x, ctx(bm_kp)-2, ctx(bm_kp)
asel, r, loc, z, ctz(bm_kp-1), ctz(bm_kp)
aatt, 101, 53, 1
cmsel, s, liner-a

lsel, r, loc, x, ctx(bm_kp)
lesize, all, , arsize
cmsel, s, liner-lines
lsel, r, loc, x, ctx(bm_kp+3)
lesize, all, , arsize
cmsel, s, liner-lines
lsel, r, loc, x, ctx(bm_kp)-1
lesize, all, , arsize
cmsel, s, liner-lines
lsel, r, loc, x, ctx(bm_kp)-0.2929
lesize, all, , arsize

amesh, all
nsle
nummrg, node

cm, liner, elem
nsle
nsel, r, loc, x, ctx(bm_kp+3), ctx(bm_kp)-1
cpint, uz, 3.5
cmsel, s, liner
nsle
nsel, r, loc, z, ctz(bm_kp-1), ctz(bm_kp)+1
cpintf, ux, 3
cpintf, uy, 3

allsel
nsel, s, loc, x, ctx(bm_kp)
nsel, r, loc, z, ctz(bm_kp-2), ctz(bm_kp-1)
cm, liner-wall, node

esel, none

/COM - Merge liner and concrete wall
nummrg, node

allsel
*get, KMAX1, KP, 0, num, max           ! Get maximum Keypoint Number
*get, LMAX1, LINE, 0, num, max         ! Get maximum Line Number
*get, AMAX1, AREA, 0, num, max         ! Get maximum Area Number
*get, VMAX1, VOLUME, 0, num, max       ! Get maximum Volume Number

```

live_load.txt

```

! select nodes to apply concentrated live load over - 10 ft radius
allsel
nsel, s, loc, z, 0
nsel, r, loc, x, 0, 11
cm, n-live, node
*get, nodes, node, , count             ! count the number of nodes selected
*get, nstart, node, , num, min         ! get min node number

```

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```
live_load=200000      ! live load 100 tons (lbs)
live_mass=live_load/(2*g*1000*nodes) ! convert live load to slugs/node selected

R,1002,live_mass,live_mass,live_mass
type,10
real,1002

cmsel,s,n-live
cm,nlive,node          ! temporary counter for nodes

*do,i,1,nodes
cmsel,s,nlive
*get,cnode,node,,num,min
e,cnode
nsel,u,node,,cnode
cm,nlive,node
*enddo

esel,s,real,,1002
cm,live-load,elem
allsel
```

Near-Soil-1.txt

```
et,8,solid45          ! Use Element SOLID45 for Near Soil Elements
/input,soil-prop-Mean-geo,txt ! Read Soil Properties

ksel,u,kp,,1,kmaxjb    ! Unselect existing Keypoints
asel,u,area,,1,amaxjb  ! Unselect existing Area
lsel,u,line,,1,lmaxjb  ! Unselect existing Lines
vsel,u,volu,,1,vmaxw   ! Unselect existing Volumes

/COM - Create Keypoints to match concrete tank profile
*do,i,1,bm_kp
k,kmaxjb+i,ctx(i),0,ctz(i)
*enddo

/COM - Create Keypoints above top of tank
k,kmaxjb+bm_kp+1,0,0,0 ! Keypoint at origin (surface)
k,kmaxjb+bm_kp+2,0,0,soilz(2) ! Keypoint at to divide soil above tank
*get,KMAXtemp1,KP,0,num,max ! Get maximum keypoint number for counter

/COM - Create Keypoints at outside of excavated soil
*do,i,1,tanksoil
k,kmaxtemp1+i,soilx(i),0,soilz(i)
*enddo
*get,KMAXtemp2,KP,0,num,max ! Get maximum keypoint number for counter

/COM - Create additional keypoint in soil above tank
k,kmaxtemp2+1,ctx(2),0,soilz(1)
k,kmaxtemp2+2,ctx(9),0,soilz(1)
k,kmaxtemp2+3,ctx(12),0,soilz(1)
k,kmaxtemp2+4,ctx(2),0,soilz(2)
k,kmaxtemp2+5,ctx(9),0,soilz(2)
k,kmaxtemp2+6,ctx(12),0,soilz(2)
k,kmaxtemp2+7,ctx(12),0,soilz(3)
k,kmaxtemp2+8,ctx(bm_kp+1),0,ctz(bm_kp+1)

a,kmaxtemp2+1,kmaxtemp2+2,kmaxtemp2+5,kmaxtemp2+4
a,kmaxtemp2+2,kmaxtemp2+3,kmaxtemp2+6,kmaxtemp2+5
a,kmaxtemp2+3,kmaxtemp1+1,kmaxtemp1+2,kmaxtemp2+6
a,kmaxtemp2+4,kmaxtemp2+5,kmaxjb+9,kmaxjb+8,kmaxjb+7,kmaxjb+6,kmaxjb+5,kmaxjb+4,kmaxjb+3,kmaxjb+2
!a,740,741,712,711,710,709,708,707,706,705
a,kmaxtemp2+5,kmaxtemp2+6,kmaxtemp2+7,kmaxjb+12,kmaxjb+11,kmaxjb+10,kmaxjb+9
a,kmaxtemp2+6,kmaxtemp1+2,kmaxtemp1+3,kmaxtemp2+7
a,kmaxtemp2+7,kmaxtemp1+3,kmaxtemp1+4,kmaxjb+12
a,kmaxjb+12,kmaxtemp1+4,kmaxtemp1+5,kmaxjb+14,kmaxjb+13
a,kmaxjb+14,kmaxtemp1+5,kmaxtemp1+6,kmaxjb+16,kmaxjb+15
```

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```

a, kmaxjb+16, kmaxtemp1+6, kmaxtemp1+7, kmaxjb+18, kmaxjb+17
a, kmaxjb+18, kmaxtemp1+7, kmaxtemp1+8, kmaxjb+20, kmaxjb+19
a, kmaxjb+20, kmaxtemp1+8, kmaxtemp1+9, kmaxtemp2+8, kmaxjb+22, kmaxjb+21

cm, top-soil-area, area
lsla
cm, top-soil, line
type, 1
real, 1

/COM - Define line divisions to control meshing
lsel, s, loc, z, soilz(1), soilz(2)
lsel, r, loc, x, ctx(3), ctx(8)
lesize, all, , , 14 ! soil above tank top, match tank meshing
lsel, s, loc, z, soilz(1), soilz(2)
lsel, r, loc, x, ctx(10), ctx(11)
lesize, all, , , 3 ! soil above tank top, match tank meshing
cmsel, s, top-soil ! Reselect lines in near soil
lsel, r, loc, x, ctx(2)
lesize, all, , , 2 ! Control vertical element size, above tank
cmsel, s, top-soil
lsel, s, loc, x, ctx(9)
lesize, all, , , 2 ! Control vertical element size, above tank
cmsel, s, top-soil
lsel, r, loc, x, ctx(12)
lesize, all, , , 2 ! Control vertical element size, above tank
cmsel, s, top-soil
lsel, r, loc, z, ctx(2), ctx(12)
lsel, r, loc, x, ctx(2), ctx(12)
lesize, all, , , 1 ! Control vertical element size, outside excavation mesh
lsel, s, line, , lmaxjb+8, lmaxjb+10, 2
lsel, a, line, , lmaxjb+26, lmaxjb+28, 2
lsel, a, line, , lmaxjb+30, lmaxjb+38, 4
lesize, all, , , 9
lsel, s, line, , lmaxjb+42, lmaxjb+42, 4
lesize, all, , , 7 ! Control horizontal meshing in soil
lsel, s, line, , lmaxjb+9
lsel, a, line, , lmaxjb+25, lmaxjb+27, 2
lsel, a, line, , lmaxjb+29, lmaxjb+45, 4
lesize, all, , , 1 ! Control horizontal meshing in soil
lsel, s, line, , lmaxjb+6
lsel, a, line, , lmaxjb+20, lmaxjb+21
lsel, a, line, , lmaxjb+32, lmaxjb+44, 4
lsel, a, line, , lmaxjb+31, lmaxjb+43, 4
lsel, a, line, , lmaxjb+47, lmaxjb+49
lesize, all, , , 1 ! Control meshing to match tank
lsel, s, line, , lmaxjb+46
lesize, all, , , 4 ! Control mesh size at bottom of excavated soil

cmsel, s, top-soil-area

amesh, all ! Mesh area to develop pattern for volume meshing

type, 8
ksel, a, kp, , 1 ! Select Keypoint for rotation axis
ksel, a, kp, , ct_kps ! Select Keypoint for rotation axis
vrotat, all, , , , 1, ct_kps, 180, 2 ! Generate Volumes for excavated soil
lsla
lsel, r, loc, x, ctx(2)
lesize, all, , , arsize ! Define meshing for slices
lsla
lsel, r, loc, x, ctx(9)
lesize, all, , , arsize ! Define meshing for slices
lsla
lsel, r, loc, x, ctx(12)
lesize, all, , , arsize ! Define meshing for slices
vsweep, all ! Sweep pattern into volume
aclear, all ! Delete elements used for sweep
cm, top-soil-vol, volu

```

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```

*get,VMAXtemp,VOLU,0,num,max
/COM - Generate element above top center of tank
asel,u,area,,all
vsel,u,volu,,all
a,kmaxjb+bm_kp+1,kmaxtemp2+1,kmaxtemp2+4,kmaxjb+bm_kp+2
a,kmaxjb+bm_kp+2,kmaxtemp2+4,kmaxjb+2,kmaxjb+1
vrotat,all,,,,,1,ct_kps,180,2
vsel,s,volu,,vmaxtemp+1,vmaxtemp+3,2
vatt,801,,8 ! Assign material properties
vsel,s,volu,,vmaxtemp+2,vmaxtemp+4,2
vatt,802,,8 ! Assign material properties
vsel,s,volu,,vmaxtemp+1,vmaxtemp+4
allsel
asel,s,loc,z,ctz(1),ctz(2)
type,1
asel,r,loc,x,0,4
asel,r,loc,z,ctz(1),ctz(2)
cmsel,u,conc-tank-a
*get,atemp,area,,num,max
*get,atempl,area,,num,min
asel,a,area,,1,22,21
mshcopy,2,1,atempl ! copy mesh top match top of concrete tank
mshcopy,2,22,atemp ! copy mesh top match top of concrete tank
asel,u,area,,1,22,21
vsel,s,volu,,vmaxtemp+1,vmaxtemp+4
vsweep,all ! Generate elements by sweeping area
aclear,atemp
aclear,atempl

/COM - Assign soil properties by layer
*do,i,1,tanksoil-1
cmsel,s,top-soil-vol
vsel,r,loc,z,soilz(i),soilz(i+1)
eslv
emodif,all,mat,800+i
esys,0
*enddo

cmsel,s,top-soil-vol
vsel,a,loc,z,soilz(1),ctz(2)
eslv
cm,excav-soil,elem
nsle
nummrg,node

/COM - Define component for excavated soil - tank walls only
cmsel,s,excav-soil
nsle,s,1
nsel,r,loc,z,soilz(5),soilz(9)
esln,r,1
cm,excav-wall,elem

/COM - Define component for excavated soil - tank dome only
cmsel,s,excav-soil
cmsel,u,excav-wall
cm,excav-dome,elem

csys,1
cmsel,s,excav-wall
nsle
nsel,r,loc,x,ctx(14)
cm,excav-wall-n,node

esel,s,type,,8
nsle
nsel,s,loc,x,soilx(1)
nsel,r,loc,z,soilz(1)
cm,near-soil-face-node,node
*do,i,2,9
esel,s,type,,8

```

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```

nsle
nsel,r,loc,x,soilx(i)
nsel,r,loc,z,soilz(i)
cm,sel,a,near-soil-face-node
cm,near-soil-face-node,node
*enddo

esel,s,type,,8
nsle
nsel,r,loc,z,soilz(9)
nsel,r,loc,x,41,68
cm,near-soil-bot-node,node

allsel
*get,KMAXns,KP,0,num,max           ! Get maximum Keypoint number
*get,LMAXns,LINE,0,num,max         ! Get maximum line number
*get,AMAXns,AREA,0,num,max         ! Get maximum Area number
*get,VMAXns,volu,0,num,max         ! Get maximum Volume number

```

outer-spar.txt

```

! deinf element type, material and real constants
et,30,link8           ! rigid link to be place between coupling and boundry conditions

mp,ex,300,10e9        ! high modulus to create a rigid link
mp,dens,300,0         ! massless rigid link
r,300,1               ! cross-sectional area of rigid link

! select elements and define rigid links
nsle
nsel,s,loc,x,soil_radius
nsel,u,loc,y,-10,-170
cm,ntemp,node

type,30
mat,300
real,300

*do,i,1,20
cm,sel,s,ntemp
nsel,r,loc,z,soilz(i)
eintf,51
*enddo

allsel

```

Post-Tank.txt

```

/input,contact-ap,txt
!/input,force-c,txt
/input,stress-Primary,txt
!/input,Force-J_bolt,txt

```

Primary-Props-AP.txt

```

/COM - Material Definitions
/COM - Material 101, Tank Steel
mp,ex,101,4248000*1e4
mp,nuxy,101,0.30
mp,dens,101,490/(1000*g)
mp,damp,101,0.00135

```


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```
/COM - Material 102, Tank Steel
mp,ex,102,4248000*1e4
mp,nuxy,102,0.30
mp,dens,102,490/(1000*g)
mp,damp,102,0.00135
```

```
/COM - Material 103, Tank Steel
mp,ex,103,4248000*1e4
mp,nuxy,103,0.30
mp,dens,103,490/(1000*g)
mp,damp,103,0.00135
```

```
/COM - Material 104, Tank Steel
mp,ex,104,4248000*1e4
mp,nuxy,104,0.30
mp,dens,104,490/(1000*g)
mp,damp,104,0.00135
```

```
/COM - Material 105, Tank Steel
mp,ex,105,4248000*1e4
mp,nuxy,105,0.30
mp,dens,105,490/(1000*g)
mp,damp,105,0.00135
```

```
/COM - Material 106, Tank Steel
mp,ex,106,4248000*1e4
mp,nuxy,106,0.30
mp,dens,106,490/(1000*g)
mp,damp,106,0.00135
```

```
/COM - Material 107, Tank Steel
mp,ex,107,4248000*1e4
mp,nuxy,107,0.30
mp,dens,107,490/(1000*g)
mp,damp,107,0.00135
```

```
/COM - Material 108, Tank Steel
mp,ex,108,4248000*1e4
mp,nuxy,108,0.30
mp,dens,108,490/(1000*g)
mp,damp,108,0.00135
```

```
/COM - Material 109, Tank Steel
mp,ex,109,4248000*1e4
mp,nuxy,109,0.30
mp,dens,109,490/(1000*g)
mp,damp,109,0.00135
```

```
/COM - Material,110, Tank Steel
mp,ex,110,4248000*1e4
mp,nuxy,110,0.30
mp,dens,110,490/(1000*g)
mp,damp,110,0.00135
```

```
/COM - Material,111, Tank Steel
mp,ex,111,4248000
mp,nuxy,111,0.30
mp,dens,111,490/(1000*g)
mp,damp,111,0.00135
```

```
/COM - Material,112, Tank Steel
mp,ex,112,4248000
mp,nuxy,112,0.30
mp,dens,112,490/(1000*g)
mp,damp,112,0.00135
```

```
/COM - Material,113, Tank Steel
mp,ex,113,4248000
mp,nuxy,113,0.30
mp,dens,113,490/(1000*g)
mp,damp,113,0.00135
```

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/COM - Material,114, Tank Steel
mp,ex,114,4248000
mp,nuxy,114,0.30
mp,dens,114,490/(1000*g)
mp,damp,114,0.00135

/COM - Material,115, Tank Steel
mp,ex,115,4248000
mp,nuxy,115,0.30
mp,dens,115,490/(1000*g)
mp,damp,115,0.00135

/COM - Material,116, Tank Steel
mp,ex,116,4248000
mp,nuxy,116,0.30
mp,dens,116,490/(1000*g)
mp,damp,116,0.00135

/COM - Material,117, Tank Steel
mp,ex,117,4248000
mp,nuxy,117,0.30
mp,dens,117,490/(1000*g)
mp,damp,117,0.00135

/COM - Material,118, Tank Steel
mp,ex,118,4248000
mp,nuxy,118,0.30
mp,dens,118,490/(1000*g)
mp,damp,118,0.00135

/COM - Material,119, Tank Steel
mp,ex,119,4248000
mp,nuxy,119,0.30
mp,dens,119,490/(1000*g)
mp,damp,119,0.00135

/COM - Material,120, Tank Steel
mp,ex,120,4248000
mp,nuxy,120,0.30
mp,dens,120,490/(1000*g)
mp,damp,120,0.00135

/COM - Material,121, Tank Steel
mp,ex,121,4248000
mp,nuxy,121,0.30
mp,dens,121,490/(1000*g)
mp,damp,121,0.00135

/COM - Material,122, Tank Steel
mp,ex,122,4248000
mp,nuxy,122,0.30
mp,dens,122,490/(1000*g)
mp,damp,122,0.03/df

/COM - Material,123, Tank Steel
mp,ex,123,4248000
mp,nuxy,123,0.30
mp,dens,123,490/(1000*g)
mp,damp,123,0.00135

/COM - Material,124, Tank Steel
mp,ex,124,4248000
mp,nuxy,124,0.30
mp,dens,124,490/(1000*g)
mp,damp,124,0.00135

/COM - Material,125, Tank Steel
mp,ex,125,4248000
mp,nuxy,125,0.30
mp,dens,125,490/(1000*g)

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mp,damp,125,0.00135

/COM - Material,126, Tank Steel
mp,ex,126,4248000
mp,nuxy,126,0.30
mp,dens,126,490/(1000*g)
mp,damp,126,0.00135

/COM - Material,127, Tank Steel
mp,ex,127,4248000
mp,nuxy,127,0.30
mp,dens,127,490/(1000*g)
mp,damp,127,0.00135

/COM - Material,128, Tank Steel
mp,ex,128,4248000
mp,nuxy,128,0.30
mp,dens,128,490/(1000*g)
mp,damp,128,0.00135

/COM - Material,129, Tank Steel
mp,ex,129,4248000
mp,nuxy,129,0.30
mp,dens,129,490/(1000*g)
mp,damp,129,0.00135

/COM - Material,130, Tank Steel
mp,ex,130,4248000
mp,nuxy,130,0.30
mp,dens,130,490/(1000*g)
mp,damp,130,0.00135

/COM - Material,131, Tank Steel
mp,ex,131,4248000
mp,nuxy,131,0.30
mp,dens,131,490/(1000*g)
mp,damp,131,0.00135

/COM - Material,132, Tank Steel
mp,ex,132,4248000
mp,nuxy,132,0.30
mp,dens,132,490/(1000*g)
mp,damp,132,0.00135

/COM - Material,133, Tank Steel
mp,ex,133,4248000
mp,nuxy,133,0.30
mp,dens,133,490/(1000*g)
mp,damp,133,0.00135

/COM - Material,134, Tank Steel
mp,ex,134,4248000
mp,nuxy,134,0.30
mp,dens,134,490/(1000*g)
mp,damp,134,0.00135

/COM - Material,135, Tank Steel
mp,ex,135,4248000
mp,nuxy,135,0.30
mp,dens,135,490/(1000*g)
mp,damp,135,0.00135

/COM - Material,136, Tank Steel
mp,ex,136,4248000
mp,nuxy,136,0.30
mp,dens,136,490/(1000*g)
mp,damp,136,0.00135

/COM - Material,137, Tank Steel
mp,ex,137,4248000
mp,nuxy,137,0.30

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```
mp,dens,137,490/(1000*g)
mp,damp,137,0.00135

/COM - Material,138, Tank Steel
mp,ex,138,4248000
mp,nuxy,138,0.30
mp,dens,138,490/(1000*g)
mp,damp,138,0.00135

/COM - Material,139, Tank Steel
mp,ex,139,4248000
mp,nuxy,139,0.30
mp,dens,139,490/(1000*g)
mp,damp,139,0.00135

/COM - Material,140, Tank Steel
mp,ex,140,4248000
mp,nuxy,140,0.30
mp,dens,140,490/(1000*g)
mp,damp,140,0.00135

/COM - Material,141, Tank Steel
mp,ex,141,4248000
mp,nuxy,141,0.30
mp,dens,141,490/(1000*g)
mp,damp,141,0.00135

/COM - Material,142, Tank Steel
mp,ex,142,4248000
mp,nuxy,142,0.30
mp,dens,142,490/(1000*g)
mp,damp,142,0.00135

/COM - Material,143, Tank Steel
mp,ex,143,4248000
mp,nuxy,143,0.30
mp,dens,143,490/(1000*g)
mp,damp,143,0.00135

r,101,(0.5-0.06)/12
r,102,(0.5-0.06)/12
r,103,(0.375-0.06)/12
r,104,(0.375-0.06)/12
r,105,(0.375-0.06)/12
r,106,(0.375-0.06)/12
r,107,(0.375-0.06)/12
r,108,(0.375-0.06)/12
r,109,(0.375-0.06)/12
r,110,(0.375-0.06)/12
r,111,(0.5-0.06)/12
r,112,(0.5-0.06)/12
r,113,(0.5-0.06)/12
r,114,(0.5-0.06)/12
r,115,(0.5-0.06)/12
r,116,(0.5-0.06)/12
r,117,(0.5-0.06)/12
r,118,(0.5-0.06)/12
r,119,(0.5-0.06)/12
r,120,(0.5-0.06)/12
r,121,(0.5-0.06)/12
r,122,(0.5-0.06)/12
r,123,(0.5625-0.06)/12
r,124,(0.5625-0.06)/12
r,125,(0.5625-0.06)/12
r,126,(0.5625-0.06)/12
r,127,(0.75-0.06)/12
r,128,(0.75-0.06)/12
r,129,(0.75-0.06)/12
r,130,(0.75-0.06)/12
r,131,(0.75-0.06)/12
r,132,(0.875-0.06)/12
```

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```
r,133,(0.9375-0.06)/12
r,134,(0.9375-0.06)/12
r,135,(0.875-0.06)/12
r,136,(0.875-0.06)/12
r,137,(0.5-0.06)/12
r,138,(0.5-0.06)/12
r,139,(0.5-0.06)/12
r,140,(0.5-0.06)/12
r,141,(0.5-0.06)/12
r,142,(0.5-0.06)/12
r,143,(0.5-0.06)/12
```

Primary.txt

```
/COM - Create KeyPoints for primarytank
*do,i,1,pt_kps,1
k,kmaxct+i,ptx(i),0,ptz(i)
*enddo

/COM - Create lines for primary tank
*do,i,1,pt_kps-1,1
l,kmaxct+i,kmaxct+i+1
*enddo

/COM - Create Areas for primary tank
lsel,s,line,,LMAXct+1,LMAXct+pt_kps-1
arotat,all,,,,,1,ct_kps,180,2

/COM - Assign Material and Real Properties to primary tank areas
csys,1
*do,i,1,pt_kps-1,1
asel,s,area,,AMAXct+i
asel,a,area,,AMAXct+pt_kps-1+i
aatt,100+i,100+i,1
*enddo
allsel

/COM - Elements at tank Top center
asel,s,loc,x,ptx(1),ptx(2)
asel,r,loc,z,ptz(1),ptz(2)
lsla
lsel,r,loc,x,ptx(2)
lesize,all,,arcsz
lsla
lsel,u,loc,x,ptx(2)
lesize,all,,midsz
amesh,all

/COM - Elements in primary tank
*do,i,2,pt_kps-2,1
asel,s,area,,AMAXct+i
asel,a,area,,AMAXct+pt_kps-1+i
lsla
lsel,s,loc,x,ptx(i),ptx(i+1)
lsel,r,loc,z,ptz(i),ptz(i+1)
lesize,all,,arcsz
amesh,all
*enddo

/COM - Elements at tank floor center
asel,s,loc,x,ptx(pt_kps-1),ptx(pt_kps)
asel,r,loc,z,ptz(pt_kps-1),ptz(pt_kps)
cm,al,area
lsla
lsel,r,loc,x,ptx(pt_kps-1),ptx(pt_kps)
lesize,all,,arcsz
lsla
lsel,u,loc,x,ptx(pt_kps-1),ptx(pt_kps)
lesize,all,,midsz
```

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```
amesh,all
asel,r,loc,y,0,-90
cm,ala,area                                ! Component for mesh mapping
cmsel,s,al
cmsel,u,ala
cm,alb,area                                ! Component for mesh mapping
allsel
cmsel,u,conc-tank
*get,emax,elem,,num,maxd
enorm,emax
cm,primary-tank,elem

allsel
*get,KMAXpt,KP,0,num,max                  ! Get maximum Keypoint number
*get,LMAXpt,LINE,0,num,max                ! Get maximum Line Number
*get,AMAXpt,AREA,0,num,max                ! Get maximum Area Number
```

Soil-Props-Mean-Geo.txt

```
Tanksoil=9
deepsoil=20
soil_radius=320
mass=1e8

*dim,soilx,,30
*dim,soilz,,30

soilz(1)=0
soilz(2)=-5
soilz(3)=ctz(9)
soilz(4)=ctz(12)
soilz(5)=ctz(14)
soilz(6)=ctz(16)
soilz(7)=ctz(18)
soilz(8)=ctz(20)
soilz(9)=ctz(23)
soilz(10)=-73.5
soilz(11)=-90.5
soilz(12)=-106.5
soilz(13)=-123.5
soilz(14)=-139.5
soilz(15)=-156
soilz(16)=-178
soilz(17)=-200
soilz(18)=-222
soilz(19)=-244
soilz(20)=-266

soilx(9)=68
soilx(8)=soilx(9)-(soilz(9)-soilz(8))/1.5
soilx(7)=soilx(9)-(soilz(9)-soilz(7))/1.5
soilx(6)=soilx(9)-(soilz(9)-soilz(6))/1.5
soilx(5)=soilx(9)-(soilz(9)-soilz(5))/1.5
soilx(4)=soilx(9)-(soilz(9)-soilz(4))/1.5
soilx(3)=soilx(9)-(soilz(9)-soilz(3))/1.5
soilx(2)=soilx(9)-(soilz(9)-soilz(2))/1.5
soilx(1)=soilx(9)-(soilz(9)-soilz(1))/1.5

/COM Excavated Soil Properties
mp,ex,801,18*144
mp,nuxy,801,0.27
mp,dens,801,125/(1000*g)
mp,damp,801,0.017/df

/COM - Material 802, Soil
mp,ex,802,22.5*144
```


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```
mp,nuxy,802,0.27
mp,dens,802,125/(1000*g)
mp,damp,802,0.027/df

/COM - Material 803, Soil
mp,ex,803,29.25*144
mp,nuxy,803,0.27
mp,dens,803,125/(1000*g)
mp,damp,803,0.039/df

/COM - Material 804, Soil
mp,ex,804,36*144
mp,nuxy,804,0.27
mp,dens,804,125/(1000*g)
mp,damp,804,0.031/df

/COM - Material 805, Soil
mp,ex,805,42*144
mp,nuxy,805,0.27
mp,dens,805,125/(1000*g)
mp,damp,805,0.035/df

/COM - Material 806, Soil
mp,ex,806,48.75*144
mp,nuxy,806,0.27
mp,dens,806,125/(1000*g)
mp,damp,806,0.042/df

/COM - Material 807, Soil
mp,ex,807,55.5*144
mp,nuxy,807,0.27
mp,dens,807,125/(1000*g)
mp,damp,807,0.047/df

/COM - Material 808, Soil
mp,ex,808,60*144
mp,nuxy,808,0.27
mp,dens,808,125/(1000*g)
mp,damp,808,0.037/df

/COM - Material 810, Soil
mp,ex,810,250
mp,nuxy,810,0.27
mp,dens,810,125/(1000*g)
mp,damp,810,0.037/df

/COM - Material Definitions
/COM - Material 811, Soil      (Top Layer)
mp,ex,811,9958
mp,nuxy,811,0.27
mp,dens,811,125/(1000*g)
mp,damp,811,0.019/df

/COM - Material 812, Soil
mp,ex,812,8797
mp,nuxy,812,0.27
mp,dens,812,125/(1000*g)
mp,damp,812,0.035/df

/COM - Material 813, Soil
mp,ex,813,7845
mp,nuxy,813,0.27
mp,dens,813,125/(1000*g)
mp,damp,813,0.048/df

/COM - Material 814, Soil
mp,ex,814,8209
mp,nuxy,814,0.27
mp,dens,814,125/(1000*g)
mp,damp,814,0.039/df
```

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```
/COM - Material 815, Soil
mp,ex,815,7634
mp,nuxy,815,0.27
mp,dens,815,125/(1000*g)
mp,damp,815,0.048/df
```

```
/COM - Material 816, Soil
mp,ex,816,7188
mp,nuxy,816,0.27
mp,dens,816,125/(1000*g)
mp,damp,816,0.055/df
```

```
/COM - Material 817, Soil
mp,ex,817,6933
mp,nuxy,817,0.27
mp,dens,817,125/(1000*g)
mp,damp,817,0.059/df
```

```
/COM - Material 818, Soil
mp,ex,818,7667
mp,nuxy,818,0.27
mp,dens,818,125/(1000*g)
mp,damp,818,0.045/df
```

```
/COM - Mean Soil Properties Geomatrix Soil Data
/COM - 19 Layer Mode
/COM - Material Definitions
```

```
/COM - Material 901, Soil      (Top Layer)
mp,ex,901,16423
mp,nuxy,901,0.24
mp,dens,901,110/(1000*g)
mp,damp,901,0.017/df
```

```
/COM - Material 902, Soil
mp,ex,902,15479
mp,nuxy,902,0.24
mp,dens,902,110/(1000*g)
mp,damp,902,0.025/df
```

```
/COM - Material 903, Soil
mp,ex,903,14481
mp,nuxy,903,0.24
mp,dens,903,110/(1000*g)
mp,damp,903,0.034/df
```

```
/COM - Material 904, Soil
mp,ex,904,14707
mp,nuxy,904,0.24
mp,dens,904,110/(1000*g)
mp,damp,904,0.028/df
```

```
/COM - Material 905, Soil
mp,ex,905,13625
mp,nuxy,905,0.19
mp,dens,905,110/(1000*g)
mp,damp,905,0.032/df
```

```
/COM - Material 906, Soil
mp,ex,906,15456
mp,nuxy,906,0.19
mp,dens,906,110/(1000*g)
mp,damp,906,0.033/df
```

```
/COM - Material 907, Soil
mp,ex,907,17532
mp,nuxy,907,0.19
mp,dens,907,110/(1000*g)
mp,damp,907,0.033/df
```

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/COM - Material 908, Soil
mp,ex,908,20972
mp,nuxy,908,0.19
mp,dens,908,110/(1000*g)
mp,damp,908,0.025/df

/COM - Material 909, Soil
mp,ex,909,23447
mp,nuxy,909,0.19
mp,dens,909,110/(1000*g)
mp,damp,909,0.026/df

/COM - Material 910, Soil
mp,ex,910,23138
mp,nuxy,910,0.19
mp,dens,910,110/(1000*g)
mp,damp,910,0.027/df

/COM - Material 911, Soil
mp,ex,911,22753
mp,nuxy,911,0.19
mp,dens,911,110/(1000*g)
mp,damp,911,0.029/df

/COM - Material 912, Soil
mp,ex,912,22069
mp,nuxy,912,0.19
mp,dens,912,110/(1000*g)
mp,damp,912,0.033/df

/COM - Material 913, Soil
mp,ex,913,25780
mp,nuxy,913,0.19
mp,dens,913,110/(1000*g)
mp,damp,913,0.025/df

/COM - Material 914, Soil
mp,ex,914,25333
mp,nuxy,914,0.19
mp,dens,914,110/(1000*g)
mp,damp,914,0.027/df

/COM - Material 915, Soil
mp,ex,915,35501
mp,nuxy,915,0.28
mp,dens,915,120/(1000*g)
mp,damp,915,0.022/df

/COM - Material 916, Soil
mp,ex,916,39465
mp,nuxy,916,0.28
mp,dens,916,120/(1000*g)
mp,damp,916,0.021/df

/COM - Material 917, Soil
mp,ex,917,38565
mp,nuxy,917,0.28
mp,dens,917,120/(1000*g)
mp,damp,917,0.023/df

/COM - Material 918, Soil
mp,ex,918,37715
mp,nuxy,918,0.28
mp,dens,918,120/(1000*g)
mp,damp,918,0.025/df

/COM - Material 919, Soil
mp,ex,919,41496
mp,nuxy,919,0.28
mp,dens,919,120/(1000*g)

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mp,damp,919,0.024/df

Slave.txt

```
/COM - Develop Slave Boundarz Conditions
/COM - 20 Layer Model

csys,1                                ! Set Cylindrical Coordinates
*get,CPMAX,CP,0,num,max               ! Counter for Couple Set Numbers
nsel,s,loc,x,soil_radius              ! Select soil exterior surface nodes
csys,0                                ! Set Cartesian Coordinates
nrotat,all                            ! Rotate into Global Cartesian Coordinates
nsel,s,loc,z,soilz(deepsoil)          ! Select all Base nodes
nrotat,all                            ! Rotate into Global Cartesian Coordinates

csys,1                                ! Set Cylindrical Coordinates
*do,i,1,deepsoil-1,1                 ! Cycle through each soil layer
nsel,s,loc,x,soil_radius              ! Select all exterior nodes
nsel,r,loc,z,soilz(i)                ! Select nodes by layer
cp,3*i-2+cpmax,ux,all                ! Couple in X
cp,3*i+cpmax,uz,all                  ! Couple in Z
nsel,u,loc,y,0                       ! Unselect nodes on Symmetry Plane
nsel,u,loc,y,180
cp,3*i-1+cpmax,uy,all                ! Couple in Y
*enddo

nsel,s,loc,z,soilz(deepsoil)          ! Select base nodes
nsel,u,loc,z,320-.1,320+.1
cp,deepsoil*10+1+cpmax,ux,all        ! Couple in X
cp,deepsoil*10+2+cpmax,uy,all        ! Couple in Y
cp,deepsoil*10+3+cpmax,uz,all        ! Couple in Z

allsel
```

stress-compb.txt

```
/post26

*do,z,2,200
VARDEL,z
*enddo
csys,1
*do,i,1,20
angley=-arcsin((i-1)/20)
*do,j,2,42
cmsel,s,primary-tank
nsle
nsel,r,loc,y,angley,angley-arcsin((i-1)/20)
nsel,r,loc,x,ptx(j),ptx(j+1)
nsel,r,loc,z,ptz(j)+.1,ptz(j+1)-.1
esln,r,1
*get,emax,elem,,num,max
esol,(1+j),(emax),,s,x,sx*(emax)%-b
esol,(44+j),(emax),,s,y,sy*(emax)%-b
esol,(87+j),(emax),,s,int,sint*(emax)%-b
esol,(130+j),(emax),,s,xy,sxy*(emax)%-b
*enddo

LINEs,2150
extrem
/OUT,Stress-pt_%(9*i)%max-b,OUT
extrem,2,200
/OUT

/OUT,Stress-pt_%(9*i)%th-b,OUT
*do,k,2,42
```

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```
PRVAR,1+k,44+k,87+k,130+k
*enddo
/OUT

*enddo
```

stress-compm.txt

```
/post26
numvar,200
*do,z,2,200
VARDEL,z
*enddo
csys,1
*do,i,1,20
angley=-arcsize*(i-1)
*do,j,2,42
cmsel,s,primary-tank
nsle
nsel,r,loc,y,angley,angley-arcsize
nsel,r,loc,x,ptx(j),ptx(j+1)
nsel,r,loc,z,ptz(j)+.1,ptz(j+1)-.1
esln,r,1
*get,emax,elem,,num,max
esol,(1+j),(emax),,s,x,sx%(emax)%-m
esol,(44+j),(emax),,s,y,sy%(emax)%-m
esol,(87+j),(emax),,s,int,sint%(emax)%-m
esol,(130+j),(emax),,s,xy,sxy%(emax)%-m
*enddo

LINES,2150
extrem
/OUT,Stress-pt_%(9*i)%max-m,OUT
extrem,2,200
/OUT

/OUT,Stress-pt_%(9*i)%th-m,OUT
*do,k,2,42
PRVAR,1+k,44+k,87+k,130+k
*enddo
/OUT

*enddo
```

stress-compt.txt

```
/post26

*do,z,2,200
VARDEL,z
*enddo
csys,1
*do,i,1,20
angley=-arcsize*(i-1)
*do,j,2,42
cmsel,s,primary-tank
nsle
nsel,r,loc,y,angley,angley-arcsize
nsel,r,loc,x,ptx(j),ptx(j+1)
nsel,r,loc,z,ptz(j)+.1,ptz(j+1)-.1
esln,r,1
*get,emax,elem,,num,max
esol,(1+j),(emax),,s,x,sx%(emax)%-t
esol,(43+j),(emax),,s,y,sy%(emax)%-t
esol,(87+j),(emax),,s,int,sint%(emax)%-t
esol,(130+j),(emax),,s,xy,sxy%(emax)%-t
*enddo
```

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```
LINES,2150
extrem
/OUT,Stress-pt_%(9*i)%max-t,OUT
extrem,2,200
/OUT

/OUT,Stress-pt_%(9*i)%th-t,OUT
*do,k,2,42
PRVAR,1+k,44+k,87+k,130+k
*enddo
/OUT

*enddo
```

Stress-Primary.txt

```
! extract primary tank stress components at the top, middel and bottom surface of the shell
/post26
numvar,200
shell,top
/input,stress-compt,txt

shell,mid
/input,stress-compm,txt

shell,bot
/input,stress-compb,txt
```

Tank-Coordinates-AP.txt

```
/COM - Definition of KeyPoints for Primary tank

ct_kps=34          ! Total number of Concrete tank Coordinate pairs
pt_kps=44          ! Total number of Primary Tank Coordinate pairs
bm_kp=22           ! Coordinate pair at bottom on concrete tank wall
tw=9               ! Rings in common for insulating concrete
arcsize=9          ! Control for meshing, section angle
Midsize=5          ! Control for meshing, center areas
z_off=57.31        ! Vertical offset for tank (bottom of primary tank is Z=0
for coordinates)
C_Floor=-4

*dim,ctx,,ct_kps   ! Concrete Tank Keypoint X Coordinates
*dim,ctz,,ct_kps   ! Concrete Tank Keypoint Z Coordinates
*dim,ptx,,pt_kps   ! Primary Tank Keypoint X Coordinates
*dim,ptz,,pt_kps   ! Primary Tank Keypoint Z Coordinates

/COM - Define Horizontal Keypoint Locations
ctx(1)=0
ctx(2)=45/12
ctx(3)=90.4/12
ctx(4)=120.72/12
ctx(5)=152.9/12
ctx(6)=211.4/12
ctx(7)=239.1/12
ctx(8)=306.63/12
ctx(9)=335.6/12
ctx(10)=393.7/12
ctx(11)=428.7/12
ctx(12)=469.9/12
ctx(13)=486.9/12
ctx(14)=489/12
ctx(15)=489/12
ctx(16)=489/12
ctx(17)=489/12
ctx(18)=489/12
ctx(19)=489/12
ctx(20)=489/12
```


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```
ctx(21)=489/12
ctx(22)=489/12
ctx(23)=531/12
ctx(24)=489/12
ctx(25)=438/12
ctx(26)=423/12
ctx(27)=400/12
ctx(28)=340/12
ctx(29)=280/12
ctx(30)=220/12
ctx(31)=160/12
ctx(32)=100/12
ctx(33)=36/12
ctx(34)=0
```

/COM - Define Vertical Keypoint Locations

```
ctz(1)=576.8/12-z_off
ctz(2)=576/12-z_off
ctz(3)=573.8/12-z_off
ctz(4)=571.21/12-z_off
ctz(5)=567.7/12-z_off
ctz(6)=558.7/12-z_off
ctz(7)=553.2/12-z_off
ctz(8)=535.68/12-z_off
ctz(9)=526.2/12-z_off
ctz(10)=502.5/12-z_off
ctz(11)=484.2/12-z_off
ctz(12)=455.4/12-z_off
ctz(13)=415.1/12-z_off
ctz(14)=382.1/12-z_off
ctz(15)=335/12-z_off
ctz(16)=281/12-z_off
ctz(17)=236.5/12-z_off
ctz(18)=186.8/12-z_off
ctz(19)=145.5/12-z_off
ctz(20)=70/12-z_off
ctz(21)=(c_Floor+24)/12-z_off
ctz(22)=C_Floor/12-z_off
ctz(23)=C_Floor/12-z_off
ctz(24)=C_Floor/12-z_off
ctz(25)=C_Floor/12-z_off
ctz(26)=C_Floor/12-z_off
ctz(27)=C_Floor/12-z_off
ctz(28)=C_Floor/12-z_off
ctz(29)=C_Floor/12-z_off
ctz(30)=C_Floor/12-z_off
ctz(31)=C_Floor/12-z_off
ctz(32)=C_Floor/12-z_off
ctz(33)=C_Floor/12-z_off
ctz(34)=C_Floor/12-z_off
```

```
ptx(1)=0
ptx(2)=44.73689/12
ptx(3)=89.86533/12
ptx(4)=119.99721/12
ptx(5)=151.96854/12
ptx(6)=210.05344/12
ptx(7)=237.53366/12
ptx(8)=304.42488/12
ptx(9)=333.05132/12
ptx(10)=390.22141/12
ptx(11)=422.26434/12
ptx(12)=432/12
ptx(13)=444.36/12
ptx(14)=448.66/12
ptx(15)=450/12
ptx(16)=450/12
ptx(17)=450/12
ptx(18)=450/12
ptx(19)=450/12
```

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ptx(20)=450/12
ptx(21)=450/12
ptx(22)=450/12
ptx(23)=450/12
ptx(24)=450/12
ptx(25)=450/12
ptx(26)=450/12
ptx(27)=450/12
ptx(28)=450/12
ptx(29)=450/12
ptx(30)=450/12
ptx(31)=450/12
ptx(32)=450/12
ptx(33)=450/12
ptx(34)=446.49/12
ptx(35)=438/12
ptx(36)=423/12
ptx(37)=400/12
ptx(38)=340/12
ptx(39)=280/12
ptx(40)=220/12
ptx(41)=160/12
ptx(42)=100/12
ptx(43)=36/12
ptx(44)=0

ptz(1)=569.30000/12-z_off
ptz(2)=568.50462/12-z_off
ptz(3)=566.31908/12-z_off
ptz(4)=563.74491/12-z_off
ptz(5)=560.25807/12-z_off
ptz(6)=551.32187/12-z_off
ptz(7)=545.86539/12-z_off
ptz(8)=528.51150/12-z_off
ptz(9)=519.14633/12-z_off
ptz(10)=495.85550/12-z_off
ptz(11)=474.92388/12-z_off
ptz(12)=468/12-z_off
ptz(13)=456.7/12-z_off
ptz(14)=445.4/12-z_off
ptz(15)=432.3125/12-z_off
ptz(16)=410.125/12-z_off
ptz(17)=386.125/12-z_off
ptz(18)=362.125/12-z_off
ptz(19)=337.875/12-z_off
ptz(20)=314.775/12-z_off
ptz(21)=291.675/12-z_off
ptz(22)=268.575/12-z_off
ptz(23)=245.375/12-z_off
ptz(24)=222.275/12-z_off
ptz(25)=199.175/12-z_off
ptz(26)=176.075/12-z_off
ptz(27)=152.875/12-z_off
ptz(28)=131.275/12-z_off
ptz(29)=109.675/12-z_off
ptz(30)=88.075/12-z_off
ptz(31)=66.475/12-z_off
ptz(32)=45/12-z_off
ptz(33)=20/12-z_off
ptz(34)=11.51/12-z_off
ptz(35)=8/12-z_off
ptz(36)=8/12-z_off
ptz(37)=8/12-z_off
ptz(38)=8/12-z_off
ptz(39)=8/12-z_off
ptz(40)=8/12-z_off
ptz(41)=8/12-z_off
ptz(42)=8/12-z_off
ptz(43)=8/12-z_off
ptz(44)=8/12-z_off

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Tank-Mesh1.txt

```

et,1,shell143                ! SHELL143 Elements for Concrete Tank
keyopt,1,3,2
keyopt,1,5,1

csys,1                        ! Cylindrical Coordinates
/COM - Create KeyPoints for concrete tank
*do,i,1,ct_kps,1
k,i,ctx(i),0,ctz(i)
*enddo

/COM - Create lines from top of tank to bottom of wall
*do,i,1,bm_kp-1,1
l,i,i+1
*enddo

/COM - Create lines from edge of foundation to center
/COM - Wall and Foundation do not have common lines
*do,i,bm_kp+1,ct_kps-1,1
l,i,i+1
*enddo

/COM - Create Areas for tank dome and walls
lsel,s,line,,1,bm_kp-1
arotat,all,,,,,1,ct_kps,180,2

/COM - Create areas for tank foundation/floor
lsel,s,line,,bm_kp,ct_kps-2
arotat,all,,,,,1,ct_kps,180,2

/COM - Assign Material and Real Properties to areas
csys,1
*do,i,1,bm_kp-1,1
asel,s,loc,x,ctx(i),ctx(i+1)
asel,r,loc,z,ctz(i),ctz(i+1)
aatt,i,i,1
*enddo

asel,s,area,,1,2*(bm_kp-1)
CM,ctank-u,area

*do,i,bm_kp,ct_kps-2,1
asel,s,area,,bm_kp-1+i
asel,a,area,,ct_kps-2+i
aatt,i,i,1
*enddo

/COM - Create Elements
/COM - Elements at dome apex
esize,7                        ! Define element maximum size
asel,s,loc,x,ctx(1),ctx(2)    ! Select area at top
asel,r,loc,z,ctz(1),ctz(2)
lsla                            ! Select lines from areas
lsel,r,loc,x,ctx(2)           ! Select line at a radius of CTX(2)
lesize,all,,arcsz            ! Divide line to match tank slices
lsla
lsel,u,loc,x,ctx(2)           ! Select only interior lines
lesize,all,,midsize          ! Define element resolution
amesh,all                    ! Mesh area

/COM - Elements in dome and wall
*do,i,2,bm_kp-1,1
asel,s,loc,x,ctx(i),ctx(i+1)
asel,r,loc,z,ctz(i),ctz(i+1)
lsla
lsel,s,loc,x,ctx(i),ctx(i+1)
lsel,r,loc,z,ctz(i),ctz(i+1)
lesize,all,,arcsz

```

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```

amesh,all
*enddo
cm,conc-dome_wall-n,node
cm,conc-dome_wall-e,elem

esel,none
nsel,none
*do,i,bm_kp+1,ct_kps-2,1
asel,s,area,,bm_kp-2+i
asel,a,area,,ct_kps-3+i
lsla
lsel,s,loc,x,ctx(i),ctx(i+1)
lsel,r,loc,z,ctz(i),ctz(i+1)
lesize,all,,arcsz
amesh,all
*enddo

/COM - Elements at floor center
asel,s,loc,x,ctx(ct_kps-1),ctx(ct_kps)
lsla
lsel,r,loc,x,ctx(ct_kps-1)
lesize,all,,arcsz
lsla
lsel,u,loc,x,ctx(ct_kps-1)
lesize,all,,midsz
amesh,all
cm,conc-slab,node
cm,conc-floor-e,elem
allsel
cm,conc-tank,elem
cm,conc-tank-a,area

/COM - Create Component for Concrete Wall/Floor Interface nodes
nsel,s,loc,z,ctz(bm_kp)
nsel,r,loc,x,ctx(bm_kp)
cm,Wall-int,node

allsel
*get,KMAXct,KP,0,num,max          ! Get Maximum Keypoint Number
*get,LMAXct,LINE,0,num,max        ! Get Maximum Line Number
*get,AMAXct,AREA,0,num,max        ! Get Maximum Area Number

```

Tank-Props-Rigid.txt

```

/COM - Tank Concrete Properties

/COM - Material Definitions
! EX - Youngs Modulus, (k/ft2)
! NUXY - Poisons ratio
! DENS - Density (1000*slugs/ft3)
! DAMP - Beta (Stiffness) Damping

/COM - Material 1, Tank Concrete
mp,ex,1,626754*1e4
mp,nuxy,1,0.18
mp,dens,1,148/(1000*g)
mp,damp,1,0.07/df

/COM - Material 2, Tank Concrete
mp,ex,2,620114*1e4
mp,nuxy,2,0.18
mp,dens,2,149/(1000*g)
mp,damp,2,0.07/df

/COM - Material 3, Tank Concrete
mp,ex,3,616594*1e4
mp,nuxy,3,0.18
mp,dens,3,149/(1000*g)

```

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mp,damp,3,0.07/df

/COM - Material 4, Tank Concrete
mp,ex,4,610922*1e4
mp,nuxy,4,0.18
mp,dens,4,149/(1000*g)
mp,damp,4,0.07/df

/COM - Material 5, Tank Concrete
mp,ex,5,612305*1e4
mp,nuxy,5,0.18
mp,dens,5,148/(1000*g)
mp,damp,5,0.07/df

/COM - Material 6, Tank Concrete
mp,ex,6,607093*1e4
mp,nuxy,6,0.18
mp,dens,6,148/(1000*g)
mp,damp,6,0.07/df

/COM - Material 7, Tank Concrete
mp,ex,7,639237*1e4
mp,nuxy,7,0.18
mp,dens,7,146/(1000*g)
mp,damp,7,0.07/df

/COM - Material 8, Tank Concrete
mp,ex,8,634338*1e4
mp,nuxy,8,0.18
mp,dens,8,147/(1000*g)
mp,damp,8,0.07/df

/COM - Material 9, Tank Concrete
mp,ex,9,628756*1e4
mp,nuxy,9,0.18
mp,dens,9,147/(1000*g)
mp,damp,9,0.07/df

/COM - Material,10, Tank Concrete
mp,ex,10,193677*1e4
mp,nuxy,10,0.18
mp,dens,10,165/(1000*g)
mp,damp,10,0.07/df

/COM - Material,11, Tank Concrete
mp,ex,11,575959*1e4
mp,nuxy,11,0.18
mp,dens,11,144/(1000*g)
mp,damp,11,0.07/df

/COM - Material,12, Tank Concrete
mp,ex,12,202953*1e4
mp,nuxy,12,0.18
mp,dens,12,159/(1000*g)
mp,damp,12,0.07/df

/COM - Material,13, Tank Concrete
mp,ex,13,157426*1e4
mp,nuxy,13,0.18
mp,dens,13,176/(1000*g)
mp,damp,13,0.07/df

/COM - Material,14, Tank Concrete
mp,ex,14,153784*1e4
mp,nuxy,14,0.18
mp,dens,14,193/(1000*g)
mp,damp,14,0.07/df

/COM - Material,15, Tank Concrete
mp,ex,15,136651*1e4
mp,nuxy,15,0.18

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```
mp,dens,15,200/(1000*g)
mp,damp,15,0.07/df

/COM - Material,16, Tank Concrete
mp,ex,16,136651*1e4
mp,nuxy,16,0.18
mp,dens,16,200/(1000*g)
mp,damp,16,0.07/df

/COM - Material,17, Tank Concrete
mp,ex,17,138084*1e4
mp,nuxy,17,0.18
mp,dens,17,181/(1000*g)
mp,damp,17,0.07/df

/COM - Material,18, Tank Concrete
mp,ex,18,123378*1e4
mp,nuxy,18,0.18
mp,dens,18,209/(1000*g)
mp,damp,18,0.07/df

/COM - Material,19, Tank Concrete
mp,ex,19,124633*1e4
mp,nuxy,19,0.18
mp,dens,19,190/(1000*g)
mp,damp,19,0.07/df

/COM - Material,20, Tank Concrete
mp,ex,20,124388*1e4
mp,nuxy,20,0.18
mp,dens,20,210/(1000*g)
mp,damp,20,0.07/df

/COM - Material,21, Tank Concrete
mp,ex,21,548683*1e4
mp,nuxy,21,0.18
mp,dens,21,166/(1000*g)
mp,damp,21,0.07/df

/COM - Material,22, Tank Concrete
mp,ex,22,154870*1e4
mp,nuxy,22,0.18
mp,dens,22,184/(1000*g)
mp,damp,22,0.07/df

/COM - Material,23, Tank Concrete
mp,ex,23,514287*1e4
mp,nuxy,23,0.18
mp,dens,23,172/(1000*g)
mp,damp,23,0.060/df

/COM - Material,24, Tank Concrete
mp,ex,24,164113*1e4
mp,nuxy,24,0.18
mp,dens,24,288/(1000*g)
mp,damp,24,0.07/df

/COM - Material,25, Tank Concrete
mp,ex,25,522946*1e4
mp,nuxy,25,0.18
mp,dens,25,201/(1000*g)
mp,damp,25,0.07/df

/COM - Material,26, Tank Concrete
mp,ex,26,194254*1e4
mp,nuxy,26,0.18
mp,dens,26,322/(1000*g)
mp,damp,26,0.07/df

/COM - Material,27, Tank Concrete
mp,ex,27,199783*1e4
```


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```
mp,nuxy,27,0.18
mp,dens,27,281/(1000*g)
mp,damp,27,0.07/df

/COM - Material,28, Tank Concrete
mp,ex,28,162553*1e4
mp,nuxy,28,0.18
mp,dens,28,299/(1000*g)
mp,damp,28,0.07/df

/COM - Material,29, Tank Concrete
mp,ex,29,200531*1e4
mp,nuxy,29,0.18
mp,dens,29,3894/(1000*g)
mp,damp,29,0.07/df

/COM - Material,30, Tank Concrete
mp,ex,30,167538*1e4
mp,nuxy,30,0.18
mp,dens,30,411/(1000*g)
mp,damp,30,0.07/df

/COM - Material,31, Tank Concrete
mp,ex,31,731952*1e4
mp,nuxy,31,0.18
mp,dens,31,150/(1000*g)
mp,damp,31,0.07/df

/COM - Material,32, Tank Concrete
mp,ex,32,731952*1e4
mp,nuxy,32,0.18
mp,dens,32,150/(1000*g)
mp,damp,32,0.07/df

!/COM - Material,33, Tank Concrete
!mp,ex,33,731952*1e4
!mp,nuxy,33,0.18
!mp,dens,33,150/(1000*g)
!mp,damp,33,0.07/df

!/COM - Material,34, Tank Concrete
!mp,ex,34,731952*1e4
!mp,nuxy,34,0.18
!mp,dens,34,150/(1000*g)
!mp,damp,34,0.07/df

!/COM - Material,35, Tank Concrete
!mp,ex,35,731952*1e4
!mp,nuxy,35,0.18
!mp,dens,35,150/(1000*g)
!mp,damp,35,0.07/df

!/COM - Material,36, Tank Concrete
!mp,ex,36,731952*1e4
!mp,nuxy,36,0.18
!mp,dens,36,150/(1000*g)
!mp,damp,36,0.07/df

!/COM - Material,37, Tank Concrete
!mp,ex,37,731952*1e4
!mp,nuxy,37,0.18
!mp,dens,37,150/(1000*g)
!mp,damp,37,0.07/df

/COM - Concrete Real Values, t in ft
r,1,1.26 ! 15 in
r,2,1.26 ! 15 in
r,3,1.26 ! 15 in
r,4,1.26 ! 15 in
r,5,1.27 ! 15 in
r,6,1.26 ! 15 in
```

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```

r,7,1.28                ! 15 in
r,8,1.28                ! 15 in
r,9,1.73                ! 15 in
r,10,1.73,1.73,2.23,2.23 ! 15 in to
r,11,2.23,2.22,3.15,3.15 !
r,12,3.15,3.15,1.50,1.50 !
r,13,1.50,1.50,1.28,1.28 !
r,14,1.17              ! 18 in
r,15,1.13              ! 18 in
r,16,1.13              ! 18 in
r,17,1.24              ! 18 in
r,18,1.07              ! 18 in
r,19,1.18              ! 18 in
r,20,1.07              ! 18 in
r,21,1.97              ! 18 in
r,22,1.68              ! 18 in
r,23,1.43              ! 18 in
r,24,1.43,1.43,0.51,0.51 !
r,25,0.51,0.51,0.66,0.66 !
r,26,0.66,0.66,0.41,0.41 !
r,27,0.58              ! 8 in
r,28,0.55              ! 8 in
r,29,0.42              ! 8 in
r,30,0.40              ! 8 in
r,31,0.40,0.40,1.02,1.02 ! 8 in to
r,32,1.02              !
!r,34,1
!r,35,1
!r,36,1
!r,37,1
!r,39,1

```

```

/COM - Material,50, Insulating Concrete
mp,ex,50,23760
mp,nuxy,50,0.15
mp,dens,50,50/(1000*g)
mp,damp,50,0.07/df

```

Waste-Reaction.txt

```

/post1
*dim,REACTX,,2149
*dim,REACTZ,,2149

cmsel,s,waste
cmsel,a,waste-surf
nsle
*do,i,1,2149
set,i
fsum,,cont
*get,REACTX(i),FSUM,0,ITEM,FX
*get,reactz(i),FSUM,0,ITEM,FZ
*enddo
/out,Waste-Reaction-460-SD3,out

*vwrite
('Total Waste Forces')
*vwrite
('      Fx      FZ')
*vwrite,reactx(1),reactz(1)
(f10.1,f10.1)
/out

```

Waste-solid-AP-S.txt

```

et,3,solid45          ! Solid45 Elements
Wastet=12             ! Primary tank coordinate for top of waste (460 in for AP Tanks)

```

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```

Wasteb=35                                ! Primary tank coordinate for bottom of waste

mp,ex,201,2.592                          ! Bulk Modulus = 300,000 psi
mp,ey,201,2.592
mp,ez,201,2.592
mp,prxy,201,0.49999
mp,pryz,201,0.49999
mp,prxz,201,0.49999
mp,gxy,201,0.464
mp,gyz,201,0.464
mp,gxz,201,0.464
mp,dens,201,1.83*62.4/(1000*g)           ! Waste Density
mp,damp,201,0.001

ksel,u,kp,,all                           ! Clear active Keypoints
asel,u,area,,all                         ! Clear active Areas
vsel,u,volu,,all                         ! Clear active Volumes
ksel,s,kp,,1,ct_kps,ct_kps-1            ! Activate Keypoints for center of rotation

/COM - Create KeyPoints for waste in tank
*do,i,0,Wasteb-Wastet,1                  ! Cycle on vertical Keypoints
*do,j,0,tw-1                             ! Cycle on horizontal Keypoints
k,kmaxl+i*(tw+1)+j+1,ptx(pt_kps-j),0,ptz(i+Wastet)
*enddo
k,kmaxl+i*(tw+1)+j+2,ptx(i+Wastet),0,ptz(i+Wastet) !
*enddo

/COM - Create Areas for waste in tank
*do,i,0,Wasteb-Wastet-1,1
*do,j,0,tw-1
a,kmaxl+i*(tw+1)+j+1,kmaxl+i*(tw+1)+j+2,kmaxl+(i+1)*(tw+1)+j+2,kmaxl+(i+1)*(tw+1)+j+1
*enddo
*enddo

/COM - Create Volumes for Waste
vrotat,all,,,,,1,ct_kps,180,2

/COM - Assign attributes
vatt,201,,3

wastevols=(tw)*(wasteb-wastet)
/COM - Elements in waste
*do,i,0,Wasteb-Wastet-1,1
*do,j,1,tw-1,1
vsel,s,volu,,vmaxl+i*tw+j+1
vsel,a,volu,,vmaxl+wastevols+i*tw+j+1
aslv
ls1a
lsel,r,loc,x,ptx(pt_kps-j),ptx(i+Wastet)
lesize,all,,arcsz
vmesh,all
*enddo
*enddo

allsel
/COM - Mesh center column to match primary tank center
asel,s,loc,x,ptx(pt_kps-1),ptx(pt_kps)
asel,r,loc,z,ptz(wastet)
asel,r,loc,y,0,-90
cm,a3a,area
cmsel,s,a3a
cmsel,a,ala
mshcopy,2,ala,a3a,,,ptz(wastet)-ptz(wasteb)
allsel
asel,s,loc,x,ptx(pt_kps-1),ptx(pt_kps)
asel,r,loc,z,ptz(wastet)
cmsel,u,a3a
cm,a3b,area

```

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```
cmsel,a,alb
mshcopy,2,alb,a3b,,,ptz(wastet)-ptz(wasteb)
vsel,s,volu,,vmax1+1,vmax1+2*wastevols+1,tw
vsweep,all,,all
cmsel,u,alb
cmsel,a,a3a
aclear,all
```

```
esel,s,type,,3
cm,waste,elem
nsle
cm,waste-n,node
```

```
/COM - Couple waste to primary tank
csys,1
allsel
```

```
et,44,target170
et,45,contal73
et,46,contal73
r,800,,,400/1.5
r,801,,,400/1.5
r,802,,,400/1.5
r,803,,,400/1.5
r,804,,,380/1.5
r,805,,,360/1.5
r,806,,,340/1.5
r,807,,,320/1.5
r,808,,,300/1.5
r,809,,,280/1.5
```

```
r,810,,,400/1.5
r,811,,,400/1.5
r,812,,,400/1.5
r,813,,,400/1.5
r,814,,,380/1.5
r,815,,,360/1.5
r,816,,,340/1.5
r,817,,,320/1.5
r,818,,,300/1.5
r,819,,,280/1.5
```

```
r,820,,,400/1.5
r,821,,,400/1.5
r,822,,,400/1.5
r,823,,,400/1.5
r,824,,,380/1.5
r,825,,,360/1.5
r,826,,,340/1.5
r,827,,,320/1.5
r,828,,,300/1.5
r,829,,,280/1.5
```

```
r,830,,,400/1.5
r,831,,,400/1.5
r,832,,,400/1.5
r,833,,,400/1.5
r,834,,,380/1.5
r,835,,,360/1.5
r,836,,,340/1.5
r,837,,,320/1.5
r,838,,,300/1.5
r,839,,,280/1.5
```

```
keyopt,45,12,4
keyopt,46,12,4
```

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```
! - Third Facet of Haunch
cmsel,s,primary-tank
nsle
nsel,r,loc,z,ptz(8),ptz(16)
nsel,r,loc,x,ptx(8),ptx(16)
esln,r,1
type,44
real,809
esurf
real,819
esurf
real,829
esurf
real,839
esurf
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(12),ptz(13)
nsel,r,loc,x,ptx(12),ptx(13)
nsel,r,loc,y,0,-45
esln,r
real,809
type,46
esurf

cmsel,s,waste
nsle
nsel,r,loc,z,ptz(12),ptz(13)
nsel,r,loc,x,ptx(12),ptx(13)
nsel,r,loc,y,-45,-90
esln,r
real,819
type,46
esurf

cmsel,s,waste
nsle
nsel,r,loc,z,ptz(12),ptz(13)
nsel,r,loc,x,ptx(12),ptx(13)
nsel,r,loc,y,-90,-135
esln,r
real,829
type,46
esurf

cmsel,s,waste
nsle
nsel,r,loc,z,ptz(12),ptz(13)
nsel,r,loc,x,ptx(12),ptx(13)
nsel,r,loc,y,-135,-180
esln,r
real,839
type,46
esurf

! - Second Facet of Haunch
cmsel,s,primary-tank
nsle
nsel,r,loc,z,ptz(9),ptz(17)
nsel,r,loc,x,ptx(9),ptx(17)
esln,r,1
type,44
real,808
esurf
real,818
esurf
real,828
esurf
real,838
esurf
cmsel,s,waste
```

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```
nsle
nsel, r, loc, z, ptz(13), ptz(14)
nsel, r, loc, x, ptx(13), ptx(14)
nsel, r, loc, y, 0, -45
esln, r
real, 808
type, 46
esurf
```

```
cmsel, s, waste
nsle
nsel, r, loc, z, ptz(13), ptz(14)
nsel, r, loc, x, ptx(13), ptx(14)
nsel, r, loc, y, -45, -90
esln, r
real, 818
type, 46
esurf
```

```
cmsel, s, waste
nsle
nsel, r, loc, z, ptz(13), ptz(14)
nsel, r, loc, x, ptx(13), ptx(14)
nsel, r, loc, y, -90, -135
esln, r
real, 828
type, 46
esurf
```

```
cmsel, s, waste
nsle
nsel, r, loc, z, ptz(13), ptz(14)
nsel, r, loc, x, ptx(13), ptx(14)
nsel, r, loc, y, -135, -180
esln, r
real, 838
type, 46
esurf
```

```
! - First Facet of Haunch
cmsel, s, primary-tank
nsle
nsel, r, loc, z, ptz(10), ptz(18)
nsel, r, loc, x, ptx(10), ptx(18)
esln, r, 1
type, 44
real, 807
esurf
real, 817
esurf
real, 827
esurf
real, 837
esurf
cmsel, s, waste
nsle
nsel, r, loc, z, ptz(14), ptz(15)
nsel, r, loc, x, ptx(14), ptx(15)
nsel, r, loc, y, 0, -45
esln, r
real, 807
type, 46
esurf
```

```
cmsel, s, waste
nsle
nsel, r, loc, z, ptz(14), ptz(15)
nsel, r, loc, x, ptx(14), ptx(15)
nsel, r, loc, y, -45, -90
esln, r
real, 817
```


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```
type,46
esurf

cmsel,s,waste
nsle
nsel,r,loc,z,ptz(14),ptz(15)
nsel,r,loc,x,ptx(14),ptx(15)
nsel,r,loc,y,-90,-135
esln,r
real,827
type,46
esurf

cmsel,s,waste
nsle
nsel,r,loc,z,ptz(14),ptz(15)
nsel,r,loc,x,ptx(14),ptx(15)
nsel,r,loc,y,-135,-180
esln,r
real,837
type,46
esurf

! - First Layer below Haunch
cmsel,s,primary-tank
nsle
nsel,r,loc,z,ptz(11),ptz(19)
nsel,r,loc,x,ptx(11),ptx(19)
esln,r,1
type,44
real,806
esurf
real,816
esurf
real,826
esurf
real,836
esurf
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(15),ptz(16)
nsel,r,loc,x,ptx(15),ptx(16)
nsel,r,loc,y,0,-45
esln,r
real,806
type,46
esurf

cmsel,s,waste
nsle
nsel,r,loc,z,ptz(15),ptz(16)
nsel,r,loc,x,ptx(15),ptx(16)
nsel,r,loc,y,-45,-90
esln,r
real,816
type,46
esurf

cmsel,s,waste
nsle
nsel,r,loc,z,ptz(15),ptz(16)
nsel,r,loc,x,ptx(15),ptx(16)
nsel,r,loc,y,-90,-135
esln,r
real,826
type,46
esurf

cmsel,s,waste
nsle
nsel,r,loc,z,ptz(15),ptz(16)
```

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```
nsel,r,loc,x,ptx(15),ptx(16)
nsel,r,loc,y,-135,-180
esln,r
real,836
type,46
esurf
```

```
! - First Facet of Haunch
cmsel,s,primary-tank
nsle
nsel,r,loc,z,ptz(12),ptz(20)
nsel,r,loc,x,ptx(12),ptx(20)
esln,r,1
type,44
real,805
esurf
real,815
esurf
real,825
esurf
real,835
esurf
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(16),ptz(17)
nsel,r,loc,x,ptx(16),ptx(17)
nsel,r,loc,y,0,-45
esln,r
real,805
type,46
esurf
```

```
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(16),ptz(17)
nsel,r,loc,x,ptx(16),ptx(17)
nsel,r,loc,y,-45,-90
esln,r
real,815
type,46
esurf
```

```
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(16),ptz(17)
nsel,r,loc,x,ptx(16),ptx(17)
nsel,r,loc,y,-90,-135
esln,r
real,825
type,46
esurf
```

```
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(16),ptz(17)
nsel,r,loc,x,ptx(16),ptx(17)
nsel,r,loc,y,-135,-180
esln,r
real,835
type,46
esurf
```

```
! - First Facet of Haunch
cmsel,s,primary-tank
nsle
nsel,r,loc,z,ptz(13),ptz(21)
nsel,r,loc,x,ptx(13),ptx(21)
esln,r,1
type,44
real,804
esurf
```

RPP-RPT-32239, Rev. 1
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```
real,814
esurf
real,824
esurf
real,834
esurf
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(17),ptz(18)
nsel,r,loc,x,ptx(17),ptx(18)
nsel,r,loc,y,0,-45
esln,r
real,804
type,46
esurf
```

```
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(17),ptz(18)
nsel,r,loc,x,ptx(17),ptx(18)
nsel,r,loc,y,-45,-90
esln,r
real,814
type,46
esurf
```

```
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(17),ptz(18)
nsel,r,loc,x,ptx(17),ptx(18)
nsel,r,loc,y,-90,-135
esln,r
real,824
type,46
esurf
```

```
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(17),ptz(18)
nsel,r,loc,x,ptx(17),ptx(18)
nsel,r,loc,y,-135,-180
esln,r
real,834
type,46
esurf
```

```
cmsel,s,primary-tank
nsle
nsel,r,loc,z,ptz(15),ptz(33)
esln,r,1
nsle
type,44
real,803
esurf
real,813
esurf
real,823
esurf
real,833
esurf
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(18),ptz(34)
nsel,r,loc,x,ptx(18)
nsel,r,loc,y,0,-45
esln,r
real,803
type,45
esurf
```

```
cmsel,s,waste
```

RPP-RPT-32239, Rev. 1
M&D-2008-005-CALC-001, Rev. 1

```
nsle
nsel, r, loc, z, ptz(18), ptz(34)
nsel, r, loc, x, ptx(18)
nsel, r, loc, y, -45, -90
esln, r
real, 813
type, 45
esurf
```

```
cmsel, s, waste
nsle
nsel, r, loc, z, ptz(18), ptz(34)
nsel, r, loc, x, ptx(18)
nsel, r, loc, y, -90, -135
esln, r
real, 823
type, 45
esurf
```

```
cmsel, s, waste
nsle
nsel, r, loc, z, ptz(18), ptz(34)
nsel, r, loc, x, ptx(18)
nsel, r, loc, y, -135, -180
esln, r
real, 833
type, 45
esurf
```

```
! - Second Facet of Knuckle
cmsel, s, primary-tank
nsle
nsel, r, loc, z, ptz(32), ptz(36)
nsel, r, loc, x, ptx(32), ptx(36)
esln, r, 1
type, 44
real, 802
esurf
real, 812
esurf
real, 822
esurf
real, 832
esurf
cmsel, s, waste
nsle
nsel, r, loc, z, ptz(33), ptz(34)
nsel, r, loc, x, ptx(33), ptx(34)
nsel, r, loc, y, 0, -45
esln, r
real, 802
type, 46
esurf
```

```
cmsel, s, waste
nsle
nsel, r, loc, z, ptz(33), ptz(34)
nsel, r, loc, x, ptx(33), ptx(34)
nsel, r, loc, y, -45, -90
esln, r
real, 812
type, 46
esurf
```

```
cmsel, s, waste
nsle
nsel, r, loc, z, ptz(33), ptz(34)
nsel, r, loc, x, ptx(33), ptx(34)
nsel, r, loc, y, -90, -135
esln, r
real, 822
```

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```
type,46
esurf

cmsel,s,waste
nsle
nsel,r,loc,z,ptz(33),ptz(34)
nsel,r,loc,x,ptx(33),ptx(34)
nsel,r,loc,y,-135,-180
esln,r
real,832
type,46
esurf
```

```
! - First Facet of Knuckle
cmsel,s,primary-tank
nsle
nsel,r,loc,z,ptz(32),ptz(37)
nsel,r,loc,x,ptx(32),ptx(37)
esln,r,1
type,44
real,801
esurf
real,811
esurf
real,821
esurf
real,831
esurf
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(34),ptz(35)
nsel,r,loc,x,ptx(34),ptx(35)
nsel,r,loc,y,0,-45
esln,r
real,801
type,46
esurf
```

```
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(34),ptz(35)
nsel,r,loc,x,ptx(34),ptx(35)
nsel,r,loc,y,-45,-90
esln,r
real,811
type,46
esurf
```

```
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(34),ptz(35)
nsel,r,loc,x,ptx(34),ptx(35)
nsel,r,loc,y,-90,-135
esln,r
real,821
type,46
esurf
```

```
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(34),ptz(35)
nsel,r,loc,x,ptx(34),ptx(35)
nsel,r,loc,y,-135,-180
esln,r
real,831
type,46
esurf
```

```
! - Bottom of Waste
cmsel,s,primary-tank
nsle
```

RPP-RPT-32239, Rev. 1
M&D-2008-005-CALC-001, Rev. 1

```
nsel,r,loc,z,ptz(33),ptz(36)
esln,r,1
type,44
real,800
esurf
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(36)
esln,r
type,45
esurf
```

```
esel,s,type,,45,46
cm,waste-surf,elem
```

```
!cmsel,s,waste-n
!nsel,r,loc,z,ptz(wastet+2),ptz(wastet)
!nsel,r,loc,x,ptx(36),ptx(21)
!esln,r,1
!emodif,mat,,202
```

```
!cmsel,s,waste
!nsle
!nsel,r,loc,z,ptz(wastet)
```

```
allsel
*get,KMAXw,KP,0,num,max           ! Get maximum Keypoint number
*get,LMAXw,LINE,0,num,max         ! Get maximum Line number
*get,AMAXw,AREA,0,num,max         ! Get maximum Area number
*get,VMAXw,VOLU,0,num,max         ! Get maximum Volume number
```

Horizontal Excitation Only

Run-Tank.txt

```
/batch
! PNNL DST Seismic Analysis, Gravity Inputs, Best Est Soil, Best Est Concrete Properties, AP
Primary Tank Geometry, Dome Friction=0.0
!
fini
/clear
/filename,AP-460-Sub-Model-H,1
/config,nres,3000                 ! Increase allowable number of results to 3000
!/config,nproc,2                  ! Activate 2 processors for solution
/config,fsplit,1024               ! Split binary file at 4.2GB
/pret7
g=32.2                            ! Gravity (ft/sec)

DF=40                             ! Factor for beta (stiffness) damping
ALPHA=0.4                         ! Alpha damping

/out,tank-out,out
! /sys,"X:\07.00 - Quality Assurance\ANSYS QA\usrcfg.bat" > QA.out
/out,QA,out,,append
/input,tank-coordinates-AP.txt     ! Run file defining tank coordinates (concrete and primary)
/input,tank-props-Rigid.txt       ! Run file defining fully cracked concrete properties (PNNL
Concrete Properties)
/input,tank-mesh1.txt              ! Develop concrete tank
/input,primary-props-AP.txt        ! Run file defining AP Primary tank properties
/input,primary.txt                 ! Develop Primary tank
/input,insulate.txt                ! Develop insulating concrete model
```


RPP-RPT-32239, Rev. 1
M&D-2008-005-CALC-001, Rev. 1

```

/input,liner,txt          ! Develop Liner model
/input,waste-solid-AP-S,txt ! Develop waste model
/input,bolts-friction,txt ! Develop J-Bolt model
/input,near-soil-1,txt    ! Develop excavated soil model
/input,far-soil,txt       ! Develop Far-Field soil model
/input,interfacel,txt     ! Develop Soil and Concrete Interfaces
/input,interface-gap1,txt ! Develop Primary Tank Interfaces
/input,slave,txt          ! Develop slaved boundary conditions
/input,boundary,txt       ! Place base and symmetry boundary conditions
/input,outer-spar,txt     ! Connect soil model to symmetry plane
/input,live_load,txt      ! Apply live load over a 10ft radius over dome center
/input,fix-soil,txt
/out
ALLSEL

/out,Tank-th,out

save

!/input,solve-slosh-flex,txt
/input,solve-sub-horiz,txt ! Run solution Phase!/input,post-sub,txt
/input,contact-waste-ap,txt
/input,waste-reaction,txt
/out
/exit

```

Solve-Sub-Horiz.txt

```

/prep7
master_node=1
massm_z=148414.59
d,master_node,all
allsel

cmsel,s,excav-soil
nsle
csys,0
nsel,r,loc,x,-ctx(6)-1,ctx(6)+1
nsel,r,loc,y,0,-ctx(6)-1
esln,r,1
mpchg,810,all

cmsel,s,excav-soil
nsle
csys,1
nsel,r,loc,x,ctx(11)-1,ctx(13)+1
nsel,r,loc,z,soilz(1),soilz(3)-1
esln,r,1
mpchg,810,all

*do,i,801,808
esel,s,mat,,i
mpchg,i+10,all
*enddo
allsel

/com - Create Reduced Model
esel,u,type,,8,10
esel,u,type,,21,24
esel,u,type,,30
esel,u,type,,60,63
esel,u,type,,90,91
esel,a,real,,1001

cm,slosh-model,elem
!cmsel,s,conc-tank
!nsle

```

RPP-RPT-32239, Rev. 1
M&D-2008-005-CALC-001, Rev. 1

```

!nsel,r,loc,z,ctz(34)
!d,all,all
allsel
cpdele,all
cmsel,s,conc-tank
nsle

cp,1001,ux,all
cp,1002,uy,all
cp,1003,uz,all

cmsel,s,slosh-model
nsle

/out,AP-460-Solve-Sub-Horiz,out
/solu
antype,trans
TRNOPT,FULL
lumpm,OFF
!nlgeom,on
NROPT,auto
NTIM=2048                      !NUMBER OF TIME STEPS
DT=0.01
TIM=1e-06
autots,on
KBC,on
TIMINT,ON,STRU
solcontrol,ON,off,,
ncnv,0,200
LNSRCH,OFF
PRED,on,,on

/COM - Time File

/COM - Dimension Horizontal Input
*DIM,A_1_x,,2048
*DIM,A_1_z,,2048

*VREAD,A_1_x(1),th-sub-model-h,txt
(8(F9.6))
!*VREAD,A_1_z(1),th-266-Mean-geo-v,txt
!(8(F9.6))

/Title,Load Case: AP-460-BES-BEC, Vertical Free Vibration
OUTPR,all,NONE,
OUTRES, ALL,NONE,
OUTRES,RSOL,last
OUTRES,NSOL,last
!OUTRES,ESOL,last,conc-tank
OUTRES, strs,last,Primary-tank
OUTRES,ESOL,last,J_bolts
!OUTRES,Epel,last,liner
!outres,esol,last,wall-int-gap
!outres,esol,last,conc-excav-wall-gap
!outres,esol,last,conc-excav-dome-gap
!outres, strs,last,excav-soil
!outres, strs,last,bottom-soil
outres,esol,last,bolt-friction
outres,esol,last,waste-surf
!outres, strs,last,insul-conc
outres,esol,last,primary-int-gap
outres,esol,last,conc-liner-gap
!outres,esol,last,far-soil-contact
!outres,esol,last,soil-contact-foot-elem

alphad,alpha
NSUBST,20,200,10,ON
TIME,100
TIMINT,off

```

RPP-RPT-32239, Rev. 1
M&D-2008-005-CALC-001, Rev. 1

```
acel,0,0,g
SOLVE
SAVE
TIMINT,on
ITIM=1
DS=TIM
NSUBST,1,20,1,ON

ddele,1,ux
acel,0,0,g
*DO,ITIM,1,NTIM,1

TIM=DT*ITIM

TIME,TIM+100

F,master_node,FX,A_1_X(itim)*mass*g
!F,master_node,Fz,(A_1_Z(itim)+1)*(mass+massm_z)*g

SOLVE
SAVE
*ENDDO
FINISH
/out
```

Vertical Excitation Only

Run-tank.txt

```
/batch
! PNNL DST Seismic Analysis, Gravity Inputs, Best Est Soil, Best Est Concrete
Properties, AP Primary Tank Geometry, Dome Friction=0.0
!
fini
/clear
/filename,AP-460-Sub-Model-V,1
/config,nres,3000          ! Increase allowable number of results to 3000
!/config,nproc,2           ! Activate 2 processors for solution
/config,fsplit,1024        ! Split binary file at 4.2GB
/prep7
g=32.2                     ! Gravity (ft/sec)

DF=40                      ! Factor for beta (stiffness) damping
ALPHA=0.4                  ! Alpha damping

/out,tank-out,out
!/sys,"X:\07.00 - Quality Assurance\ANSYS QA\usrcfg.bat" > QA.out
/out,QA,out,,append
/input,tank-coordinates-AP.txt ! Run file defining tank coordinates (concrete and
primary)
/input,tank-props-Rigid.txt   ! Run file defining fully cracked concrete properties
(PNNL Concrete Properties)
/input,tank-mesh1.txt         ! Develop concrete tank
/input,primary-props-AP.txt   ! Run file defining AP Primary tank properties
/input,primary.txt           ! Develop Primary tank
/input,insulate.txt          ! Develop insulating concrete model
/input,liner.txt             ! Develop Liner model
/input,waste-solid-AP-S.txt   ! Develop waste model
/input,bolts-friction.txt     ! Develop J-Bolt model
/input,near-soil-1.txt        ! Develop excavated soil model
/input,far-soil.txt           ! Develop Far-Field soil model
/input,interfacel.txt         ! Develop Soil and Concrete Interfaces
/input,interface-gap1.txt     ! Develop Primary Tank Interfaces
```

RPP-RPT-32239, Rev. 1
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```

/input,slave,txt          ! Develop slaved boundary conditions
/input,boundary,txt       ! Place base and symmetry boundary conditions
/input,outer-spar,txt     ! Connect soil model to symmetry plane
/input,live_load,txt      ! Apply live load over a 10ft radius over dome center
/input,fix-soil,txt
/out
ALLSEL

/out,Tank-th,out

save

!/input,solve-slosh-flex,txt
/input,solve-sub-vert,txt  ! Run solution Phase!/input,post-sub,txt
/input,contact-waste-ap,txt
/input,waste-reaction,txt
/input,stress-primary,txt
/out
/exit

```

Solve-Sub-Vert.txt

```

/prep7
master_node=1
massm_z=148414.59
d,master_node,all
allsel

cmsel,s,excav-soil
nsle
csys,0
nsel,r,loc,x,-ctx(6)-1,ctx(6)+1
nsel,r,loc,y,0,-ctx(6)-1
esln,r,1
mpchg,810,all

cmsel,s,excav-soil
nsle
csys,1
nsel,r,loc,x,ctx(11)-1,ctx(13)+1
nsel,r,loc,z,soilz(1),soilz(3)-1
esln,r,1
mpchg,810,all

*do,i,801,808
esel,s,mat,,i
mpchg,i+10,all
*enddo
allsel

/com - Create Reduced Model
esel,u,type,,8,10
esel,u,type,,21,24
esel,u,type,,30
esel,u,type,,60,63
esel,u,type,,90,91
esel,a,real,,1001

cm,slosh-model,elem
!cmsel,s,conc-tank
!nsle
!nsel,r,loc,z,ctx(34)
!d,all,all
allsel
cpdele,all

```

RPP-RPT-32239, Rev. 1
M&D-2008-005-CALC-001, Rev. 1

```

cmsgel,s,conc-tank
nsle

cp,1001,ux,all
cp,1002,uy,all
cp,1003,uz,all

cmsgel,s,slosh-model
nsle

/out,AP-460-Solve-Sub-Vert,out
/solu
antype,trans
TRNOPT,FULL
lumpm,OFF
!nlgeom,on
NROPT,auto
NTIM=2048          !NUMBER OF TIME STEPS
DT=0.01
TIM=1e-06
autots,on
KBC,on
TIMINT,ON,STRU
solcontrol,ON,off,,
ncnv,0,200
LNSRCH,OFF
PRED,on,,on

/COM - Time File

/COM - Dimension Horizontal Input
*DIM,A_1_x,,2048
*DIM,A_1_z,,2048

!*VREAD,A_1_x(1),th-sub-model-h,txt
!(8(F9.6))
*VREAD,A_1_z(1),th-sub-model-v,txt
(8(F9.6))

/Title,Load Case: AP-460-BES-BEC, Vertical Sub-Model
OUTPR,all,NONE,
OUTRES, ALL,NONE,
OUTRES,RSOL,last
OUTRES,NSOL,last
!OUTRES,ESOL,last,conc-tank
OUTRES, strs,last,Primary-tank
OUTRES,ESOL,last,J_bolts
!OUTRES,Epel,last,liner
!outres,esol,last,wall-int-gap
!outres,esol,last,conc-excav-wall-gap
!outres,esol,last,conc-excav-dome-gap
!outres, strs,last,excav-soil
!outres, strs,last,bottom-soil
outres,esol,last,bolt-friction
outres,esol,last,waste-surf
!outres, strs,last,insul-conc
outres,esol,last,primary-int-gap
outres,esol,last,conc-liner-gap
!outres,esol,last,far-soil-contact
!outres,esol,last,soil-contact-foot-elem

alphad,alpha
NSUBST,20,200,10,ON
TIME,100
TIMINT,off
acel,0,0,g
SOLVE
SAVE
TIMINT,on

```

RPP-RPT-32239, Rev. 1
M&D-2008-005-CALC-001, Rev. 1

```
ITIM=1
DS=TIM
NSUBST,1,20,1,ON

ddelete,1,uz
acel,0,0,g
*DO,ITIM,1,NTIM,1

TIM=DT*ITIM

TIME,TIM+100

!F,master_node,FX,A_1_X(itim)*mass*g
F,master_node,Fz,(A_1_Z(itim)+1)*(mass+massm_z)*g

SOLVE
SAVE
*ENDDO
FINISH
/out
```

Horizontal and Vertical Excitation

Run-Tank.txt

```
/batch
! PNNL DST Seismic Analysis, Gravity Inputs, Best Est Soil, Best Est Concrete Properties, AP
Primary Tank Geometry, Dome Friction=0.0
!
fini
/clear
/filename,AP-460-Sub-Model-HV,1
/config,nres,3000          ! Increase allowable number of results to 3000
!/config,nproc,2           ! Activate 2 processors for solution
/config,fsplit,1024        ! Split binary file at 4.2GB
/pret7
g=32.2                     ! Gravity (ft/sec)

DF=40                      ! Factor for beta (stiffness) damping
ALPHA=0.4                  ! Alpha damping

/out,tank-out,out
!/sys,"X:\07.00 - Quality Assurance\ANSYS QA\usrcfg.bat" > QA.out
/out,QA,out,,append
/input,tank-coordinates-AP.txt    ! Run file defining tank coordinates (concrete and primary)
/input,tank-props-Rigid.txt      ! Run file defining fully cracked concrete properties (PNNL
Concrete Properties)
/input,tank-mesh1.txt            ! Develop concrete tank
/input,primary-props-AP.txt      ! Run file defining AP Primary tank properties
/input,primary.txt               ! Develop Primary tank
/input,insulate.txt              ! Develop insulating concrete model
/input,liner.txt                 ! Develop Liner model
/input,waste-solid-AP-S.txt      ! Develop waste model
/input,bolts-friction.txt        ! Develop J-Bolt model
/input,near-soil-1.txt           ! Develop excavated soil model
/input,far-soil.txt              ! Develop Far-Field soil model
/input,interfacel.txt            ! Develop Soil and Concrete Interfaces
/input,interface-gap1.txt        ! Develop Primary Tank Interfaces
/input,slave.txt                 ! Develop slaved boundary conditions
/input,boundary.txt              ! Place base and symmetry boundary conditions
/input,outer-spar.txt            ! Connect soil model to symmetry plane
/input,live_load.txt             ! Apply live load over a 10ft radius over dome center
/input,fix-soil.txt
/out
ALLSEL

/out,Tank-th,out
```

RPP-RPT-32239, Rev. 1
M&D-2008-005-CALC-001, Rev. 1

save

```
!/input,solve-slosh-flex,txt
/input,solve-sub-HV,txt          ! Run solution Phase!/input,post-sub,txt
/input,contact-waste-ap,txt
/input,waste-reaction,txt
/input,stress-primary,txt
/out
/exit
```

Solve-Sub-HV.txt

```
/prep7
master_node=1
massm_z=148414.59
d,master_node,all
allsel

cmsel,s,excav-soil
nsle
csys,0
nsel,r,loc,x,-ctx(6)-1,ctx(6)+1
nsel,r,loc,y,0,-ctx(6)-1
esln,r,1
mpchg,810,all

cmsel,s,excav-soil
nsle
csys,1
nsel,r,loc,x,ctx(11)-1,ctx(13)+1
nsel,r,loc,z,soilz(1),soilz(3)-1
esln,r,1
mpchg,810,all

*do,i,801,808
esel,s,mat,,i
mpchg,i+10,all
*enddo
allsel

/com - Create Reduced Model
esel,u,type,,8,10
esel,u,type,,21,24
esel,u,type,,30
esel,u,type,,60,63
esel,u,type,,90,91
esel,a,real,,1001

cm,slosh-model,elem
!cmsel,s,conc-tank
!nsle
!nsel,r,loc,z,ctz(34)
!d,all,all
allsel
cpdele,all
cmsel,s,conc-tank
nsle

cp,1001,ux,all
cp,1002,uy,all
cp,1003,uz,all

cmsel,s,slosh-model
nsle
```


RPP-RPT-32239, Rev. 1
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```
/out,AP-460-Solve-Sub-HV,out
/solu
antype,trans
TRNOPT,FULL
lumpm,OFF
!nlgeom,on
NROPT,auto
NTIM=2048                !NUMBER OF TIME STEPS
DT=0.01
TIM=1e-06
autots,on
KBC,on
TIMINT,ON,STRU
solcontrol,ON,off,,
ncnv,0,200
LNSRCH,OFF
PRED,on,,on

/COM - Time File

/COM - Dimension Horizontal Input
*DIM,A_1_x,,2048
*DIM,A_1_z,,2048

*VREAD,A_1_x(1),th-sub-model-h,txt
(8(F9.6))
*VREAD,A_1_z(1),th-sub-model-v,txt
(8(F9.6))

/Title,Load Case: AP-460-BES-BEC, Sub-Model 2 Direction Input
OUTPR,all,NONE,
OUTRES, ALL,NONE,
OUTRES,RSOL,last
OUTRES,NSOL,last
!OUTRES,ESOL,last,conc-tank
OUTRES, strs,last,Primary-tank
OUTRES,ESOL,last,J_bolts
!OUTRES,Epel,last,liner
!outres,esol,last,wall-int-gap
!outres,esol,last,conc-excav-wall-gap
!outres,esol,last,conc-excav-dome-gap
!outres, strs,last,excav-soil
!outres, strs,last,bottom-soil
outres,esol,last,bolt-friction
outres,esol,last,waste-surf
!outres, strs,last,insul-conc
outres,esol,last,primary-int-gap
outres,esol,last,conc-liner-gap
!outres,esol,last,far-soil-contact
!outres,esol,last,soil-contact-foot-elem

alphad,alpha
NSUBST,20,200,10,ON
TIME,100
TIMINT,off
acel,0,0,g
SOLVE
SAVE
TIMINT,on
ITIM=1
DS=TIM
NSUBST,1,20,1,ON

ddele,1,ux
ddele,1,uz
acel,0,0,g
*DO,ITIM,1,NTIM,1

TIM=DT*ITIM

TIME,TIM+100
```

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```
F,master_node,FX,A_1_X(itim)*mass*g
F,master_node,Fz,(A_1_Z(itim)+1)*(mass+massm_z)*g

SOLVE
SAVE
*ENDDO
FINISH
/out
```

Horizontal Frequency Check

Run-Tank.txt

```
/batch
! PNNL DST Seismic Analysis, Gravity Inputs, Best Est Soil, Best Est Concrete Properties, AP
Primary Tank Geometry, Dome Friction=0.0
!
fini
/clear
/filename,AP-460-Sub-Model-H,1
/config,nres,3000          ! Increase allowable number of results to 3000
!/config,nproc,2          ! Activate 2 processors for solution
/config,fsplit,1024       ! Split binary file at 4.2GB
/prep7
g=32.2                   ! Gravity (ft/sec)

DF=40                    ! Factor for beta (stiffness) damping
ALPHA=0.4                ! Alpha damping

/out,tank-out,out
!/sys,"X:\07.00 - Quality Assurance\ANSYS QA\usrcfg.bat" > QA.out
/out,QA,out,,append
/input,tank-coordinates-AP,txt    ! Run file defining tank coordinates (concrete and primary)
/input,tank-props-Rigid,txt      ! Run file defining fully cracked concrete properties (PNNL
Concrete Properties)
/input,tank-mesh1,txt            ! Develop concrete tank
/input,primary-props-AP,txt      ! Run file defining AP Primary tank properties
/input,primary,txt              ! Develop Primary tank
/input,insulate,txt             ! Develop insulating concrete model
/input,liner,txt                ! Develop Liner model
/input,waste-solid-AP-S,txt      ! Develop waste model
/input,bolts-friction,txt        ! Develop J-Bolt model
/input,near-soil-1,txt           ! Develop excavated soil model
/input,far-soil,txt             ! Develop Far-Field soil model
/input,interfacel,txt           ! Develop Soil and Concrete Interfaces
/input,interface-gap1,txt        ! Develop Primary Tank Interfaces
/input,slave,txt                ! Develop slaved boundary conditions
/input,boundary,txt             ! Place base and symmetry boundary conditions
/input,outer-spar,txt           ! Connect soil model to symmetry plane
/input,live_load,txt            ! Apply live load over a 10ft radius over dome center
/input,fix-soil,txt
/out
ALLSEL

/out,Tank-th,out

save
/input,solve-slosh-flex,txt
!/input,solve-sub-horiz,txt      ! Run solution Phase!/input,post-sub,txt
!/input,contact-waste-ap,txt
/input,waste-reaction,txt
/out
/exit
```

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Solve-Slosh-Flex.txt

```
/prep7
massm_z=148414.59
d,master_node,all
allsel

cmsel,s,excav-soil
nsle
csys,0
nsel,r,loc,x,-ctx(6)-1,ctx(6)+1
nsel,r,loc,y,0,-ctx(6)-1
esln,r,1
mpchg,810,all

cmsel,s,excav-soil
nsle
csys,1
nsel,r,loc,x,ctx(11)-1,ctx(13)+1
nsel,r,loc,z,soilz(1),soilz(3)-1
esln,r,1
mpchg,810,all

*do,i,801,808
esel,s,mat,,i
mpchg,i+10,all
*enddo
allsel

/com - Create Reduced Model
esel,u,type,,8,10
esel,u,type,,21,23
esel,u,type,,30
esel,u,type,,60,63
esel,u,type,,90,91

cm,slosh-model,elem
cmsel,s,conc-tank
nsle
nsel,r,loc,z,ctz(34)
d,all,all
cmsel,s,slosh-model
nsle

/out,AP-460-Slosh-Flex-V,out
/solu
antype,trans
TRNOPT,FULL
lumpm,OFF
!nlgeom,on
NROPT,auto
NTIM=100 !NUMBER OF TIME STEPS
DT=0.01
TIM=1e-06
autots,on
KBC,on
TIMINT,ON,STRU
solcontrol,ON,off,,
ncnv,0,200
LNSRCH,OFF
PRED,on,,on

/COM - Time File

/COM - Dimension Horizontal Input
*DIM,A_1_x,,2048
*DIM,A_1_z,,2048

!*VREAD,A_1_x(1),th-266-Mean-geo,txt
!(8(F9.6))
```

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```
!*VREAD,A_1_Z(1),th-266-Mean-geo-v,txt
!(8(F9.6))

/Title,Load Case: AP-460-BES-BEC, Vertical Free Vibration
OUTPR,all,NONE,
OUTRES, ALL,NONE,
OUTRES,RSOL,last
OUTRES,NSOL,last
!OUTRES,ESOL,last,conc-tank
OUTRES, strs,last,Primary-tank
OUTRES,ESOL,last,J_bolts
!OUTRES,Epel,last,liner
!outres,esol,last,wall-int-gap
!outres,esol,last,conc-excav-wall-gap
!outres,esol,last,conc-excav-dome-gap
!outres, strs,last,excav-soil
!outres, strs,last,bottom-soil
outres,esol,last,bolt-friction
outres,esol,last,waste-surf
outres, strs,last,insul-conc
outres,esol,last,primary-int-gap
outres,esol,last,conc-liner-gap
!outres,esol,last,far-soil-contact
!outres,esol,last,soil-contact-foot-elem

alphad,alpha
NSUBST,20,200,10,ON
TIME,100
TIMINT,off
acel,0.05*g,0,g
SOLVE
SAVE
TIMINT,on
ITIM=1
DS=TIM
NSUBST,1,20,1,ON

acel,0,0,g
*DO,ITIM,1,NTIM,1

TIM=DT*ITIM

TIME,TIM+100

!F,master_node,FX,A_1_X(itim)*mass*g
!F,master_node,Fz,(A_1_Z(itim)+1)*(mass+massm_z)*g

SOLVE
SAVE
*ENDDO
FINISH
/out
```

Vertical Frequency Check

Run-Tank.txt

```
/batch
! PNNL DST Seismic Analysis, Gravity Inputs, Best Est Soil, Best Est Concrete Properties, AP
Primary Tank Geometry, Dome Friction=0.0
!
fini
/clear
/filename,AP-460-Sub-Model-V,1
/config,nres,3000
!/config,nproc,2
/config,fsplit,1024

! Increase allowable number of results to 3000
! Activate 2 processors for solution
! Split binary file at 4.2GB
```

RPP-RPT-32239, Rev. 1
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```

/prep7
g=32.2                                ! Gravity (ft/sec)

DF=40                                  ! Factor for beta (stiffness) damping
ALPHA=0.4                              ! Alpha damping

/out,tank-out,out
!/sys,"X:\07.00 - Quality Assurance\ANSYS QA\usrcfg.bat" > QA.out
/out,QA,out,,append
/input,tank-coordinates-AP,txt         ! Run file defining tank coordinates (concrete and primary)
/input,tank-props-Rigid,txt           ! Run file defining fully cracked concrete properties (PNNL
Concrete Properties)
/input,tank-mesh1,txt                 ! Develop concrete tank
/input,primary-props-AP,txt           ! Run file defining AP Primary tank properties
/input,primary,txt                    ! Develop Primary tank
/input,insulate,txt                   ! Develop insulating concrete model
/input,liner,txt                      ! Develop Liner model
/input,waste-solid-AP-S,txt           ! Develop waste model
/input,bolts-friction,txt             ! Develop J-Bolt model
/input,near-soil-1,txt                ! Develop excavated soil model
/input,far-soil,txt                  ! Develop Far-Field soil model
/input,interfacel,txt                 ! Develop Soil and Concrete Interfaces
/input,interface-gap1,txt             ! Develop Primary Tank Interfaces
/input,slave,txt                      ! Develop slaved boundary conditions
/input,boundary,txt                  ! Place base and symmetry boundary conditions
/input,outer-spar,txt                 ! Connect soil model to symmetry plane
/input,live_load,txt                 ! Apply live load over a 10ft radius over dome center
/input,fix-soil,txt
/out
ALLSEL

/out,Tank-th,out

save
/input,solve-slosh-vert,txt
!/input,solve-sub-horiz,txt           ! Run solution Phase!/input,post-sub,txt
!/input,contact-waste-ap,txt
/input,waste-reaction,txt
/out
/exit

```

Solve-Slosh-Vert.txt

```

/prep7
massm_z=148414.59
d,master_node,all
allsel

cmsel,s,excav-soil
nsle
csys,0
nsel,r,loc,x,-ctx(6)-1,ctx(6)+1
nsel,r,loc,y,0,-ctx(6)-1
esln,r,1
mpchg,810,all

cmsel,s,excav-soil
nsle
csys,1
nsel,r,loc,x,ctx(11)-1,ctx(13)+1
nsel,r,loc,z,soilz(1),soilz(3)-1
esln,r,1
mpchg,810,all

*do,i,801,808
esel,s,mat,,i
mpchg,i+10,all
*enddo
allsel

```

RPP-RPT-32239, Rev. 1
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```
/com - Create Reduced Model
esel,u,type,,8,10
esel,u,type,,21,23
esel,u,type,,30
esel,u,type,,60,63
esel,u,type,,90,91

cm,slosh-model,elem
cmsel,s,conc-tank
nsle
nsel,r,loc,z,ctz(34)
d,all,all
cmsel,s,slosh-model
nsle

/out,AP-460-Slosh-Flex-V,out
/solu
antype,trans
TRNOPT,FULL
lumpm,OFF
!nlgeom,on
NROPT,auto
NTIM=100                      !NUMBER OF TIME STEPS
DT=0.01
TIM=1e-06
autots,on
KBC,on
TIMINT,ON,STRU
solcontrol,ON,off,,
ncnv,0,200
LNSRCH,OFF
PRED,on,,on

/COM - Time File

/COM - Dimension Horizontal Input
*DIM,A_1_x,,2048
*DIM,A_1_z,,2048

!*VREAD,A_1_x(1),th-266-Mean-geo,txt
!(8(F9.6))
!*VREAD,A_1_z(1),th-266-Mean-geo-v,txt
!(8(F9.6))

/Title,Load Case: AP-460-BES-BEC, Vertical Free Vibration
OUTPR,all,NONE,
OUTRES, ALL,NONE,
OUTRES,RSOL,last
OUTRES,NSOL,last
!OUTRES,ESOL,last,conc-tank
OUTRES, strs,last,Primary-tank
OUTRES,ESOL,last,J_bolts
!OUTRES,Epel,last,liner
!outres,esol,last,wall-int-gap
!outres,esol,last,conc-excav-wall-gap
!outres,esol,last,conc-excav-dome-gap
!outres, strs,last,excav-soil
!outres, strs,last,bottom-soil
outres,esol,last,bolt-friction
outres,esol,last,waste-surf
outres, strs,last,insul-conc
outres,esol,last,primary-int-gap
outres,esol,last,conc-liner-gap
!outres,esol,last,far-soil-contact
!outres,esol,last,soil-contact-foot-elem

alphad,alpha
NSUBST,20,200,10,ON
TIME,100
TIMINT,off
```

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```
acel,0,0,0.95*g
SOLVE
SAVE
TIMINT,on
ITIM=1
DS=TIM
NSUBST,1,20,1,ON

acel,0,0,g
*DO,ITIM,1,NTIM,1

TIM=DT*ITIM

TIME,TIM+100

!F,master_node,FX,A_1_X(itim)*mass*g
!F,master_node,Fz,(A_1_Z(itim)+1)*(mass+massm_z)*g

SOLVE
SAVE
*ENDDO
FINISH
/out
```

Convective Mode Frequency Check

Run-Tank.txt

```
/batch
! PNNL DST Seismic Analysis, Gravity Inputs, Best Est Soil, Best Est Concrete Properties, AP
Primary Tank Geometry, Dome Friction=0.0
!
fini
/clear
/filename,AP-460-Slosh-Rigid,1
/config,nres,3000          ! Increase allowable number of results to 3000
/config,nproc,2            ! Activate 2 processors for solution
/config,fsplit,1024        ! Split binary file at 4.2GB
/prep7
g=32.2                    ! Gravity (ft/sec)

DF=40                     ! Factor for beta (stiffness) damping
ALPHA=0.4                 ! Alpha damping

/out,tank-out,out
/sys,"X:\07.00 - Quality Assurance\ANSYS QA\usrcfg.bat" > QA.out
/out,QA,out,,append
/input,tank-coordinates-AP.txt ! Run file defining tank coordinates (concrete and primary)
/input,tank-props-Rigid.txt    ! Run file defining fully cracked concrete properties (PNNL
Concrete Properties)
/input,tank-mesh1.txt          ! Develop concrete tank
/input,primary-props-AP-rigid.txt ! Run file defining AP Primary tank properties
/input,primary.txt            ! Develop Primary tank
/input,insulate.txt           ! Develop insulating concrete model
/input,liner.txt              ! Develop Liner model
/input,waste-solid-AP-S.txt    ! Develop waste model
/input,bolts-friction-rigid.txt ! Develop J-Bolt model

/input,near-soil-1.txt         ! Develop excavated soil model
/input,far-soil.txt           ! Develop Far-Field soil model
/input,interfacel.txt         ! Develop Soil and Concrete Interfaces
/input,interface-gap1.txt     ! Develop Primary Tank Interfaces
/input,slave.txt              ! Develop slaved boundary conditions
/input,boundary.txt           ! Place base and symmetry boundary conditions
/input,outer-spar.txt         ! Connect soil model to symmetry plane
/input,live_load.txt          ! Apply live load over a 10ft radius over dome center
```


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```
/input,fix-soil,txt
/out
ALLSEL

/out,Tank-th,out

save

/input,solve-Slosh-rigid,txt          ! Run solution Phase
/input,contact-waste-ap,txt
/input,waste-reaction,txt
/out
/exit
```

Solve-Slosh-Rigid.txt

```
/prep7
massm_z=148414.59
d,master_node,all
allsel

cmsel,s,excav-soil
nsle
csys,0
nsel,r,loc,x,-ctx(6)-1,ctx(6)+1
nsel,r,loc,y,0,-ctx(6)-1
esln,r,1
mpchg,810,all

cmsel,s,excav-soil
nsle
csys,1
nsel,r,loc,x,ctx(11)-1,ctx(13)+1
nsel,r,loc,z,soilz(1),soilz(3)-1
esln,r,1
mpchg,810,all

*do,i,801,808
esel,s,mat,,i
mpchg,i+10,all
*enddo
allsel

/com - Create Reduced Model
esel,u,type,,8,10
esel,u,type,,21,23
esel,u,type,,30
esel,u,type,,60,63
esel,u,type,,90,91

cm,slosh-model,elem
cmsel,s,conc-tank
nsle
nsel,r,loc,z,ctz(34)
d,all,all
cmsel,s,slosh-model
nsle

/out,AP-460-Slosh-Rigid,out
/solu
antype,trans
TRNOPT,FULL
lumpm,OFF
!nlgeom,on
NROPT,auto
NTIM=300          !NUMBER OF TIME STEPS
DT=0.05
TIM=1e-06
autots,on
```

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```

KBC, on
TIMINT, ON, STRU
solcontrol, ON, off, ,
ncnv, 0, 200
LNSRCH, OFF
PRED, on, , on

/COM - Time File

/COM - Dimension Horizontal Input
*DIM, A_1_x, , 2048
*DIM, A_1_z, , 2048

*VREAD, A_1_x(1), th-266-Mean-geo, txt
(8(F9.6))
*VREAD, A_1_z(1), th-266-Mean-geo-v, txt
(8(F9.6))

/Title, Load Case: AP-460-BES-BEC, Gravity, Dome Friction =0.00,
OUTPR, all, NONE,
OUTRES, ALL, NONE,
OUTRES, RSOL, last
OUTRES, NSOL, last
!OUTRES, ESOL, last, conc-tank
OUTRES, strs, last, Primary-tank
OUTRES, ESOL, last, J_bolts
!OUTRES, Epel, last, liner
!outres, esol, last, wall-int-gap
!outres, esol, last, conc-excav-wall-gap
!outres, esol, last, conc-excav-dome-gap
!outres, strs, last, excav-soil
!outres, strs, last, bottom-soil
outres, esol, last, bolt-friction
outres, esol, last, waste-surf
outres, strs, last, insul-conc
outres, esol, last, primary-int-gap
outres, esol, last, conc-liner-gap
!outres, esol, last, far-soil-contact
!outres, esol, last, soil-contact-foot-elem
alphad, alpha
NSUBST, 20, 200, 10, ON
TIME, 100
TIMINT, off
acel, 0.08*g, 0, g
SOLVE
SAVE
TIMINT, on
ITIM=1
DS=TIM
NSUBST, 1, 20, 1, ON

acel, 0, 0, g
*DO, ITIM, 1, NTIM, 1

TIM=DT*ITIM

TIME, TIM+100

!F, master_node, FX, A_1_X(itim) *mass*g
!F, master_node, Fz, (A_1_Z(itim)+1) * (mass+massm_z) *g

SOLVE
SAVE
*ENDDO
FINISH
/out

```

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TH-Sub-Model-h.txt

```
0.000000 0.000002 0.000003 0.000004 0.000002-0.000001-0.000003-0.000003
-0.000003-0.000003-0.000004-0.000007-0.000010-0.000009-0.000004 0.000000
0.000000 0.000000 0.000010 0.000022 0.000023 0.000009-0.000005-0.000012
.....
-0.005195-0.000793 0.003825 0.008090 0.011526 0.013842 0.014969 0.015061
0.014422 0.013381 0.012179 0.010972 0.009855 0.008877 0.008075 0.007461
0.006993 0.006573 0.006096 0.005832 0.005568
```

TH-Sub-Model-v.txt

```
0.000111 0.000169 0.000227 0.000328 0.000419 0.000509 0.000577 0.000610
0.000607 0.000572 0.000507 0.000424 0.000348 0.000292 0.000230 0.000127
-0.000002-0.000111-0.000210-0.000338-0.000471-0.000555-0.000602-0.000660
....
0.024820 0.024673 0.023320 0.020784 0.017191 0.012768 0.007795 0.002554
-0.002696-0.007745-0.012430-0.016604-0.020114-0.022805-0.024576-0.025395
-0.025246-0.024075-0.021803-0.020382-0.018960
```

Appendix D

Sub-Model Best Estimate Soil, Best Estimate Concrete Results File Listing

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Appendix D

Sub-Model Best Estimate Soil, Best Estimate Concrete Results File Listing

Tables

D.1	Sub-Model, Primary Tank Stresses, Shell Top, Gravity Plus Seismic Load, Horizontal and Vertical Excitation	D.2
D.2	Sub-Model, Primary Tank Stresses, Shell Middle, Gravity Plus Seismic Load, Horizontal and Vertical Excitation	D.3
D.3	Sub-Model, Primary Tank Stresses, Shell Bottom, Gravity Plus Seismic Load, Horizontal and Vertical Excitation	D.4
D.4	Sub-Model, Waste Contact Pressure, Gravity Plus Seismic, Horizontal and Vertical Excitation	D.5
D.5	Sub-Model, Primary Tank Stresses, Shell Top, Gravity Plus Seismic Load, Horizontal Excitation	D.6
D.6	Sub-Model, Primary Tank Stresses, Shell Middle, Gravity Plus Seismic Load, Horizontal Excitation	D.7
D.7	Sub-Model, Primary Tank Stresses, Shell Bottom, Gravity Plus Seismic Load, Horizontal Excitation	D.8
D.8	Sub-Model, Waste Contact Pressure, Gravity Plus Seismic, Horizontal Excitation	D.9
D.9	Sub-Model, Primary Tank Stresses, Shell Top, Gravity Plus Seismic Load, Vertical Excitation	D.10
D.10	Sub-Model, Primary Tank Stresses, Shell Middle, Gravity Plus Seismic Load, Vertical Excitation	D.11
D.11	Sub-Model, Primary Tank Stresses, Shell Bottom, Gravity Plus Seismic Load, Vertical Excitation	D.12
D.12	Sub-Model, Waste Contact Pressure, Gravity Plus Seismic, Vertical Excitation	D.13

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Table D.1. Sub-Model, Primary Tank Stresses, Shell Top, Gravity Plus Seismic Load, Horizontal and Vertical Excitation

AP Primary Tank Sub Model, Best Estimate Soil, Horizontal and Vertical Seismic, Best Estimate Tank Sub Model Concrete, 460 in. Waste Level at 1.83 SpG

M&D Starting M&D Element No.	Path (in.)	Shell Top Surface (inside - waste side)			
		AP-460-Sub-H&V Seismic Hoop Stress (lbs/in ²) Top	AP-460-Sub-H&V Seismic Meridional Stress (lbs/in ²) Top	AP-460-Sub-H&V Seismic Stress Intensity (lbs/in ²) Top	AP-460-Sub-H&V Seismic In-Plane Shear Stress (lbs/in ²) Top
762	67.33	172.01	-345.35	736.81	4.80
782	105.04	16.38	764.58	773.61	8.23
802	136.24	130.63	-324.65	684.03	9.26
822	181.83	-202.71	464.38	809.72	18.62
842	225.10	197.22	-434.72	909.03	58.49
862	273.66	-329.03	647.71	1204.17	179.03
882	323.27	661.18	-372.36	1365.28	523.06
902	369.20	354.24	1581.25	3368.75	1376.39
922	419.20	2385.42	497.29	6017.36	2769.44
942	444.31	-2311.81	-5249.31	8291.67	2269.44
962	458.66	-3703.47	7250.00	12937.50	2174.31
982	473.08	-4763.89	7750.00	14951.39	2160.42
1002	484.80	-2981.94	530.97	5456.94	2205.56
1022	502.48	3696.53	-648.61	5127.08	2192.36
1042	526.48	7965.28	1046.53	7965.28	2064.58
1062	550.48	10069.44	1206.94	10076.39	1885.42
1082	574.60	12305.56	1463.89	12305.56	1672.92
1102	598.28	14944.44	1178.47	14951.39	1440.28
1122	621.38	17312.50	1593.06	17312.50	1201.39
1142	644.48	19555.56	1427.78	19555.56	932.64
1162	667.63	20993.06	1006.94	20993.06	639.10
1182	690.78	21305.56	1884.72	21305.56	288.40
1202	713.88	22381.94	1505.56	22381.94	156.46
1222	736.98	23861.11	870.14	23861.11	417.43
1242	760.13	23347.22	381.04	23347.22	730.56
1262	782.53	21173.61	2177.78	21173.61	755.56
1282	804.13	20298.61	1253.47	20298.61	961.11
1302	825.73	21090.28	848.61	21090.28	1163.19
1322	847.33	22736.11	1261.11	22736.11	1374.31
1342	868.87	21993.06	-1872.92	25590.28	1606.94
1362	892.10	14291.67	-1284.72	16222.22	1539.58
1382	909.20	4289.58	-813.89	6965.28	1484.03
1402	918.38	4629.17	12270.83	12277.78	1496.53
1460	930.48	2353.47	7513.89	7576.39	718.75
1442	949.48	-755.56	-2779.86	3830.56	605.00
1462	990.98	302.64	959.72	965.28	-36.31
1482	1050.98	-156.46	-556.81	733.33	47.53
1502	1110.98	221.32	729.86	733.33	-29.83
1522	1170.98	-137.71	-516.25	708.33	41.53
1542	1230.98	199.38	684.72	687.92	-31.23
1562	1292.98	-88.06	-450.00	618.89	59.04

Note 1: Meridional, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)

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Table D.2. Sub-Model, Primary Tank Stresses, Shell Middle, Gravity Plus Seismic Load, Horizontal and Vertical Excitation

AP Primary Tank Sub Model, Best Estimate Soil, Horizontal and Vertical Seismic, Best Estimate Tank Sub Model Concrete, 460 in. Waste Level at 1.83 SpG

M&D Starting M&D Element No.	Path (in.)	Shell Mid-Plane			
		AP-460-Sub-H&V Seismic Hoop Stress (lbs/in ²) Mid	AP-460-Sub-H&V Seismic Meridional Stress (lbs/in ²) Mid	AP-460-Sub-H&V Seismic Stress Intensity (lbs/in ²) Mid	AP-460-Sub-H&V Seismic In-Plane Shear Stress (lbs/in ²) Mid
762	67.33	332.64	45.22	333.33	5.94
782	105.04	-120.63	104.31	302.43	8.02
802	136.24	326.88	128.47	329.58	9.27
822	181.83	-271.46	134.17	542.15	18.58
842	225.10	417.71	202.57	426.18	58.26
862	273.66	-404.72	327.92	931.94	178.96
882	323.27	932.64	550.28	1165.97	523.19
902	369.20	-470.07	946.53	3223.61	1375.69
922	419.20	2729.86	1300.69	5913.89	2770.83
942	444.31	-454.10	1136.81	4988.89	2276.39
962	458.66	-4741.67	1056.94	8541.67	2187.50
982	473.08	-6043.06	1002.08	10180.56	2154.86
1002	484.80	-2661.81	939.58	5865.97	2178.47
1022	502.48	4202.78	1001.39	4595.83	2168.06
1042	526.48	8006.94	1121.53	8006.94	2053.47
1062	550.48	10118.06	1238.89	10125.00	1878.47
1082	574.60	12326.39	1339.58	12333.33	1665.97
1102	598.28	14965.28	1425.69	14965.28	1433.33
1122	621.38	17236.11	1497.22	17236.11	1195.83
1142	644.48	19527.78	1547.92	19527.78	927.78
1162	667.63	21104.17	1581.25	21104.17	638.75
1182	690.78	21083.33	1395.83	21083.33	289.38
1202	713.88	22270.83	1386.81	22270.83	150.76
1222	736.98	23951.39	1362.50	23951.39	416.60
1242	760.13	23590.28	1318.75	23590.28	723.61
1262	782.53	20694.44	920.83	20694.44	746.53
1282	804.13	20111.11	866.67	20111.11	959.72
1302	825.73	21034.72	802.08	21034.72	1164.58
1322	847.33	22548.61	727.08	22548.61	1377.08
1342	868.87	23236.11	637.99	23236.11	1593.75
1362	892.10	14979.17	463.19	14986.11	1501.39
1382	909.20	4998.61	430.35	5109.72	1443.06
1402	918.38	938.89	535.28	3014.58	1477.78
1460	930.48	363.13	621.04	2371.53	1039.58
1442	949.48	182.78	333.61	958.33	416.46
1462	990.98	62.43	156.74	200.49	72.36
1482	1050.98	3.44	6.33	39.64	12.40
1502	1110.98	0.86	2.30	39.64	2.10
1522	1170.98	0.34	2.35	44.50	0.20
1542	1230.98	0.23	2.11	57.35	0.32
1562	1292.98	0.07	1.65	95.00	0.27

Note 1: Meridional, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)

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Table D.3. Sub-Model, Primary Tank Stresses, Shell Bottom, Gravity Plus Seismic Load, Horizontal and Vertical Excitation

AP Primary Tank Sub Model, Best Estimate Soil, Horizontal and Vertical Seismic, Best Estimate Tank Sub Model Concrete, 460 in. Waste Level at 1.83 SpG

M&D Starting M&D Element No.	Path (in.)	Shell Bottom Surface (outside - away from waste)			
		AP-460-Sub-H&V Seismic Hoop Stress (lbs/in ²) Bot	AP-460-Sub-H&V Seismic Meridional Stress (lbs/in ²) Bot	AP-460-Sub-H&V Seismic Stress Intensity (lbs/in ²) Bot	AP-460-Sub-H&V Seismic In-Plane Shear Stress (lbs/in ²) Bot
762	67.33	494.86	653.47	653.61	7.57
782	105.04	-242.08	-346.04	582.57	7.88
802	136.24	523.68	765.97	766.67	9.28
822	181.83	-340.28	-168.06	576.46	18.53
842	225.10	683.13	1009.03	1011.81	58.05
862	273.66	-480.28	86.74	877.78	178.89
882	323.27	1206.25	1542.36	1655.56	523.33
902	369.20	-607.01	506.18	3106.94	1375.00
922	419.20	3073.61	2749.31	5907.64	2772.22
942	444.31	2163.19	10465.28	10472.22	2283.33
962	458.66	-5780.56	-3004.17	9263.89	2201.39
982	473.08	-7319.44	-3680.56	11375.00	2149.31
1002	484.80	-2355.56	2975.00	6375.00	2150.69
1022	502.48	4709.03	2770.83	4834.72	2143.75
1042	526.48	8048.61	1204.17	8048.61	2043.06
1062	550.48	10166.67	1270.83	10166.67	1871.53
1082	574.60	12354.17	1253.47	12354.17	1659.03
1102	598.28	15041.67	1672.92	15048.61	1426.39
1122	621.38	17222.22	1401.39	17229.17	1190.28
1142	644.48	19555.56	1668.06	19555.56	923.61
1162	667.63	21270.83	2155.56	21270.83	638.40
1182	690.78	20937.50	906.94	20937.50	290.35
1202	713.88	22243.06	1267.36	22243.06	147.29
1222	736.98	24104.17	1854.86	24104.17	415.83
1242	760.13	23875.00	2269.44	23875.00	715.97
1262	782.53	20298.61	-512.78	20861.11	737.50
1282	804.13	19972.22	482.92	19972.22	958.33
1302	825.73	20979.17	755.56	20986.11	1166.67
1322	847.33	22361.11	211.18	22361.11	1379.17
1342	868.87	24479.17	4768.75	24479.17	1579.86
1362	892.10	15666.67	2659.03	15666.67	1463.89
1382	909.20	5747.22	3965.28	5768.06	1402.78
1402	918.38	-1927.78	-7756.94	11270.83	1459.03
1460	930.48	-1396.53	-4703.47	6522.22	1359.72
1442	949.48	1390.97	4424.31	4451.39	227.99
1462	990.98	-137.36	-491.53	671.18	109.17
1482	1050.98	233.40	763.89	733.33	-29.88
1502	1110.98	-161.32	-534.31	733.33	41.81
1522	1170.98	211.25	705.56	708.33	-30.12
1542	1230.98	-144.65	-501.04	687.85	43.26
1562	1292.98	160.14	615.76	618.96	-40.85

Note 1: Meridonal, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)

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Table D.4. Sub-Model, Waste Contact Pressure, Gravity Plus Seismic, Horizontal and Vertical Excitation

Tank AY, 460 Inch Waste Level
 SpG = 1.83
 Sub Model
 Horizontal and Vertical Input

Waste Height Ratio		Max Pressure AP Tank, 460 in Waste Level, SpG = 1.83 Time History (PSI)	Min Pressure AP Tank, 460 in Waste Level, SpG = 1.83 Time History (PSI)				
	Waste Height			Hydrostatic (psi)	Hydro- dynamic (psi)	Theoretical Min (SRSS)	Theoretical Max (SRSS)
0.99	454.35	8.931	-7.708	0.37	1.65	0.00	2.02
0.96	443.05	11.771	-10.604	1.12	1.69	0.00	2.81
0.94	431.7625	15.521	-10.847	1.87	1.77	0.10	3.64
0.90	414.125	9.882	-4.788	3.03	1.95	1.08	4.98
0.85	390.125	8.174	0.200	4.62	2.25	2.37	6.86
0.80	366.125	9.833	1.484	6.20	2.56	3.64	8.76
0.74	342	12.236	2.042	7.80	2.87	4.93	10.67
0.69	318.325	14.771	2.693	9.36	3.16	6.20	12.52
0.64	295.225	17.410	3.688	10.89	3.42	7.46	14.31
0.59	272.125	19.118	4.612	12.41	3.67	8.75	16.08
0.54	248.975	21.472	5.807	13.94	3.89	10.05	17.84
0.49	225.825	23.438	6.951	15.47	4.10	11.37	19.57
0.44	202.725	24.910	8.250	17.00	4.28	12.71	21.28
0.39	179.625	26.979	9.674	18.53	4.45	14.08	22.98
0.34	156.475	28.549	11.424	20.06	4.60	15.46	24.65
0.29	134.075	29.396	12.750	21.54	4.72	16.82	26.25
0.24	112.475	31.590	13.931	22.96	4.82	18.14	27.78
0.20	90.875	32.028	15.785	24.39	4.90	19.49	29.29
0.15	69.275	34.354	16.910	25.82	4.97	20.85	30.78
0.10	47.738	34.785	19.007	27.24	5.01	22.23	32.25
0.05	24.500	37.458	18.868	28.78	5.05	23.73	33.82
0.02	7.755	42.681	25.306	29.88	5.06	24.82	34.94
0.00	1.755	37.979	25.389	30.28	5.06	25.22	35.34

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Table D.5. Sub-Model, Primary Tank Stresses, Shell Top, Gravity Plus Seismic Load, Horizontal Excitation

**AP Primary Tank Sub Model, Best Estimate Soil, Horizontal
Seismic, Best Estimate Tank Sub Model Concrete, 460 in. Waste
Level at 1.83 SpG**

M&D Starting M&D Element No.	Path (in.)	Shell Top Surface (inside - waste side)			
		AP-460-Sub-Horiz Seismic Hoop Stress (lbs/in^2) Top	AP-460-Sub-Horiz Seismic Meridional Stress (lbs/in^2) Top	AP-460-Sub-Horiz Seismic Stress Intensity (lbs/in^2) Top	AP-460-Sub-Horiz Seismic In-Plane Shear Stress (lbs/in^2) Top
762	67.33	158.89	-407.57	679.03	4.77
782	105.04	17.44	704.86	711.11	8.25
802	136.24	129.17	-383.54	635.00	9.18
822	181.83	-239.17	437.57	742.36	18.60
842	225.10	196.60	-509.79	845.14	58.50
862	273.66	-384.86	632.50	1143.06	179.31
882	323.27	660.28	-419.38	1403.47	523.96
902	369.20	-379.31	1373.61	3440.28	1379.17
922	419.20	2379.17	493.54	6040.28	2776.39
942	444.31	-2761.81	-6286.11	7861.11	2275.69
962	458.66	-4386.81	6838.19	12048.61	2180.56
982	473.08	-5584.03	7770.83	14506.94	2167.36
1002	484.80	-3424.31	574.10	5395.83	2213.19
1022	502.48	3536.81	-713.19	5273.61	2200.69
1042	526.48	7979.17	1040.28	7979.17	2071.53
1062	550.48	9979.17	1213.89	9986.11	1887.50
1082	574.60	12138.89	1497.22	12138.89	1673.61
1102	598.28	14513.89	1184.03	14520.83	1440.28
1122	621.38	16611.11	1561.11	16611.11	1201.39
1142	644.48	18652.78	1422.92	18652.78	932.64
1162	667.63	19930.56	1013.19	19930.56	639.10
1182	690.78	20083.33	1897.92	20083.33	287.64
1202	713.88	21013.89	1522.22	21013.89	155.49
1222	736.98	22458.33	858.33	22458.33	418.40
1242	760.13	22013.89	387.64	22020.83	731.94
1262	782.53	19986.11	2227.08	19986.11	756.94
1282	804.13	19222.22	1279.86	19222.22	961.81
1302	825.73	20055.56	878.47	20055.56	1166.67
1322	847.33	21736.11	1295.83	21736.11	1377.78
1342	868.87	21069.44	-2079.17	24611.11	1607.64
1362	892.10	13451.39	-1385.42	14916.67	1538.89
1382	909.20	3997.22	-922.92	6783.33	1484.72
1402	918.38	4131.25	11493.06	11500.00	1496.53
1460	930.48	2144.44	6756.25	6777.78	720.83
1442	949.48	-818.75	-3109.72	3440.97	604.44
1462	990.98	268.06	846.53	847.22	-37.59
1482	1050.98	-176.53	-618.47	650.28	47.80
1502	1110.98	196.53	647.15	650.28	-33.24
1522	1170.98	-155.21	-572.64	630.21	37.10
1542	1230.98	177.22	603.61	606.74	-35.14
1562	1292.98	-98.40	-500.21	549.58	51.98

Note 1: Meridonal, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)

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Table D.6. Sub-Model, Primary Tank Stresses, Shell Middle, Gravity Plus Seismic Load, Horizontal Excitation

**AP Primary Tank Sub Model, Best Estimate Soil, Horizontal
Seismic, Best Estimate Tank Sub Model Concrete, 460 in. Waste
Level at 1.83 SpG**

M&D Starting M&D Element No.	Path (in.)	Shell Mid-Plane			
		AP-460-Sub-Horiz Seismic Hoop Stress (lbs/in^2) Mid	AP-460-Sub-Horiz Seismic Meridional Stress (lbs/in^2) Mid	AP-460-Sub-Horiz Seismic Stress Intensity (lbs/in^2) Mid	AP-460-Sub-Horiz Seismic In-Plane Shear Stress (lbs/in^2) Mid
762	67.33	306.94	44.99	307.50	5.96
782	105.04	-141.67	103.33	277.71	8.06
802	136.24	302.92	128.06	305.42	9.19
822	181.83	-321.53	134.10	496.32	18.56
842	225.10	411.18	202.22	415.00	58.28
862	273.66	-475.14	322.01	882.64	179.24
882	323.27	929.86	531.88	1175.00	524.10
902	369.20	-535.28	879.86	3271.53	1378.47
922	419.20	2720.83	1211.11	5918.75	2777.78
942	444.31	-530.56	1090.28	5025.00	2283.33
962	458.66	-5656.94	1063.89	8319.44	2194.44
982	473.08	-7125.00	988.19	9840.28	2161.81
1002	484.80	-3047.92	955.56	5886.11	2186.11
1022	502.48	4067.36	1029.86	4757.64	2176.39
1042	526.48	8013.89	1136.11	8013.89	2060.42
1062	550.48	9986.11	1234.72	9993.06	1881.25
1082	574.60	12090.28	1322.92	12097.22	1666.67
1102	598.28	14590.28	1406.94	14590.28	1433.33
1122	621.38	16645.83	1475.69	16645.83	1195.83
1142	644.48	18750.00	1525.00	18750.00	928.47
1162	667.63	20173.61	1556.94	20173.61	638.75
1182	690.78	20000.00	1378.47	20000.00	288.68
1202	713.88	21020.83	1372.92	21020.83	149.93
1222	736.98	22618.06	1350.00	22618.06	417.50
1242	760.13	22305.56	1311.11	22305.56	724.31
1262	782.53	19604.17	918.06	19604.17	747.92
1282	804.13	19111.11	866.67	19111.11	960.42
1302	825.73	20041.67	806.25	20041.67	1167.36
1322	847.33	21576.39	737.50	21576.39	1379.86
1342	868.87	22333.33	652.57	22333.33	1593.75
1362	892.10	14013.89	475.56	14020.83	1501.39
1382	909.20	4393.75	444.44	4913.89	1443.75
1402	918.38	902.78	547.15	3017.36	1477.78
1460	930.48	375.56	618.54	2382.64	1038.89
1442	949.48	189.65	329.03	965.28	417.29
1462	990.98	63.21	140.76	204.79	72.43
1482	1050.98	3.37	6.15	35.10	12.76
1502	1110.98	0.88	2.30	35.10	2.12
1522	1170.98	0.35	2.35	39.43	0.20
1542	1230.98	0.24	2.11	50.93	0.32
1562	1292.98	0.07	1.65	84.86	0.27

Note 1: Meridonal, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)

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Table D.7. Sub-Model, Primary Tank Stresses, Shell Bottom, Gravity Plus Seismic Load, Horizontal Excitation

**AP Primary Tank Sub Model, Best Estimate Soil, Horizontal
Seismic, Best Estimate Tank Sub Model Concrete, 460 in. Waste
Level at 1.83 SpG**

M&D Starting M&D Element No.	Path (in.)	Shell Bottom Surface (outside - away from waste)			
		AP-460-Sub-Horiz Seismic Hoop Stress (lbs/in ²) Bot	AP-460-Sub-Horiz Seismic Meridional Stress (lbs/in ²) Bot	AP-460-Sub-Horiz Seismic Stress Intensity (lbs/in ²) Bot	AP-460-Sub-Horiz Seismic In-Plane Shear Stress (lbs/in ²) Bot
762	67.33	456.11	602.08	602.15	7.58
782	105.04	-285.35	-407.64	547.71	7.91
802	136.24	483.82	705.56	706.25	9.26
822	181.83	-403.96	-193.54	550.76	18.52
842	225.10	632.08	927.78	929.86	58.07
862	273.66	-565.49	80.97	859.03	179.10
882	323.27	1200.00	1407.64	1658.33	524.24
902	369.20	-690.28	517.99	3134.03	1377.78
922	419.20	3063.19	2502.78	5910.42	2779.17
942	444.31	1963.89	9708.33	9715.28	2290.28
962	458.66	-6905.56	-3611.11	8736.11	2207.64
982	473.08	-8673.61	-4475.00	10861.11	2156.25
1002	484.80	-2664.58	2836.81	6459.72	2158.33
1022	502.48	4597.92	2795.83	4989.58	2151.39
1042	526.48	8048.61	1245.83	8048.61	2049.31
1062	550.48	10000.00	1256.25	10000.00	1874.31
1082	574.60	12041.67	1229.17	12048.61	1660.42
1102	598.28	14701.39	1637.50	14708.33	1426.39
1122	621.38	16680.56	1390.97	16680.56	1190.28
1142	644.48	18847.22	1641.67	18847.22	923.61
1162	667.63	20409.72	2111.11	20409.72	638.33
1182	690.78	19923.61	897.22	19923.61	289.72
1202	713.88	21062.50	1250.00	21062.50	147.22
1222	736.98	22777.78	1842.36	22777.78	416.60
1242	760.13	22597.22	2234.72	22597.22	717.36
1262	782.53	19222.22	-573.68	19618.06	738.89
1282	804.13	19000.00	473.26	19000.00	959.03
1302	825.73	20027.78	742.36	20034.72	1168.06
1322	847.33	21416.67	203.40	21416.67	1381.25
1342	868.87	23597.22	4843.06	23597.22	1580.56
1362	892.10	14583.33	2403.47	14583.33	1463.89
1382	909.20	5115.28	3990.97	5611.11	1403.47
1402	918.38	-2222.92	-9006.94	10479.17	1459.03
1460	930.48	-1565.28	-5239.58	5862.50	1356.25
1442	949.48	1240.28	3961.11	3965.28	230.21
1462	990.98	-155.83	-540.28	611.04	109.17
1482	1050.98	208.75	678.61	653.26	-33.12
1502	1110.98	-180.28	-592.92	653.26	37.47
1522	1170.98	187.36	623.26	626.18	-33.87
1542	1230.98	-163.13	-555.97	610.49	38.66
1562	1292.98	143.96	542.78	546.39	-47.18

Note 1: Meridonal, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)

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Table D.8. Sub-Model, Waste Contact Pressure, Gravity Plus Seismic, Horizontal Excitation

Tank AY, 460 Inch Waste Level
 SpG = 1.83
 Best Estimate Soil
 Best Estimate Concrete

Waste Height Ratio	Waste Height	Max Pressure AP Tank, 460 in Waste Level, SpG = 1.83 Time History (PSI)	Min Pressure AP Tank, 460 in Waste Level, SpG = 1.83 Time History (PSI)	Hydrostatic (psi)	Hydrodynamic (psi)	Theoretical Min (SRSS)	Theoretical Max (SRSS)
0.99	454.35	8.847	-7.722	0.37	1.65	0.00	2.02
0.96	443.05	11.313	-10.486	1.12	1.68	0.00	2.80
0.94	431.7625	15.090	-10.299	1.87	1.75	0.12	3.61
0.90	414.125	10.326	-4.045	3.03	1.90	1.13	4.93
0.85	390.125	8.035	1.046	4.62	2.14	2.48	6.76
0.80	366.125	9.757	2.586	6.20	2.39	3.81	8.59
0.74	342	12.174	3.535	7.80	2.63	5.16	10.43
0.69	318.325	14.188	4.442	9.36	2.85	6.51	12.21
0.64	295.225	16.479	5.202	10.89	3.05	7.84	13.94
0.59	272.125	18.174	6.298	12.41	3.23	9.19	15.64
0.54	248.975	20.417	7.486	13.94	3.38	10.56	17.33
0.49	225.825	22.444	8.743	15.47	3.52	11.95	19.00
0.44	202.725	23.472	10.507	17.00	3.65	13.35	20.65
0.39	179.625	25.208	11.882	18.53	3.76	14.77	22.28
0.34	156.475	27.014	13.313	20.06	3.85	16.21	23.91
0.29	134.075	28.174	15.014	21.54	3.93	17.61	25.46
0.24	112.475	29.889	16.049	22.96	3.99	18.97	26.95
0.20	90.875	30.764	17.785	24.39	4.04	20.35	28.43
0.15	69.275	32.896	18.854	25.82	4.08	21.74	29.89
0.10	47.738	33.333	21.014	27.24	4.11	23.13	31.35
0.05	24.500	36.389	20.757	28.78	4.12	24.65	32.90
0.02	7.755	41.014	29.222	29.88	4.13	25.75	34.01
0.00	1.755	36.958	29.472	30.28	4.13	26.15	34.41

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Table D.9. Sub-Model, Primary Tank Stresses, Shell Top, Gravity Plus Seismic Load, Vertical Excitation

**AP Primary Tank Sub Model, Best Estimate Soil, Vertical
Seismic, Best Estimate Tank Sub Model Concrete, 460 in. Waste
Level at 1.83 SpG**

M&D Starting M&D Element No.	Path (in.)	Shell Top Surface (inside - waste side)			
		AP-460-Sub-Vert Seismic Hoop Stress (lbs/in ²) Top	AP-460-Sub-Vert Seismic Meridional Stress (lbs/in ²) Top	AP-460-Sub-Vert Seismic Stress Intensity (lbs/in ²) Top	AP-460-Sub-Vert Seismic In-Plane Shear Stress (lbs/in ²) Top
762	67.33	168.75	-342.15	676.53	0.71
782	105.04	1.10	698.61	700.00	0.23
802	136.24	123.40	-322.99	607.01	0.21
822	181.83	-202.43	439.17	743.06	0.17
842	225.10	145.42	-431.25	793.75	0.26
862	273.66	-329.17	627.78	1122.22	0.43
882	323.27	428.40	-370.69	989.58	1.05
902	369.20	-355.76	1543.06	2078.47	2.57
922	419.20	1410.42	-89.51	1575.00	8.15
942	444.31	-2302.08	-5234.03	7840.28	8.32
962	458.66	-3687.50	6544.44	12020.83	8.83
982	473.08	-4757.64	7215.28	14131.94	12.32
1002	484.80	-2971.53	-451.11	4197.22	12.44
1022	502.48	2567.36	-646.74	3440.97	12.85
1042	526.48	6236.81	755.56	6236.81	12.85
1062	550.48	8083.33	654.72	8083.33	9.90
1082	574.60	10034.72	867.36	10034.72	16.76
1102	598.28	12166.67	525.35	12166.67	13.84
1122	621.38	14138.89	772.92	14138.89	13.56
1142	644.48	16118.06	625.07	16118.06	13.40
1162	667.63	17506.94	210.69	17506.94	12.72
1182	690.78	17979.17	1061.81	17979.17	9.98
1202	713.88	19180.56	731.94	19180.56	11.65
1222	736.98	20805.56	147.36	20805.56	10.57
1242	760.13	20652.78	-201.53	21000.00	9.51
1262	782.53	19006.94	1657.64	19006.94	8.85
1282	804.13	18493.06	800.69	18493.06	7.72
1302	825.73	19479.17	444.58	19479.17	11.76
1322	847.33	21270.83	927.08	21270.83	9.82
1342	868.87	20944.44	-2313.19	24388.89	7.99
1362	892.10	13881.94	-1487.50	15881.94	9.10
1382	909.20	4162.50	-2091.67	6894.44	7.42
1402	918.38	4571.53	11979.17	11993.06	7.23
1460	930.48	2336.81	7493.06	7548.61	-297.78
1442	949.48	-811.11	-2747.22	3827.08	219.72
1462	990.98	301.25	959.03	963.89	-40.04
1482	1050.98	-160.63	-548.19	735.42	42.97
1502	1110.98	221.11	731.94	735.42	-30.06
1522	1170.98	-141.11	-508.75	710.42	41.44
1542	1230.98	199.24	686.39	689.65	-30.97
1562	1292.98	-89.72	-444.10	620.42	58.71

Note 1: Meridional, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)

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Table D.10. Sub-Model, Primary Tank Stresses, Shell Middle, Gravity Plus Seismic Load, Vertical Excitation

**AP Primary Tank Sub Model, Best Estimate Soil, Vertical
Seismic, Best Estimate Tank Sub Model Concrete, 460 in. Waste
Level at 1.83 SpG**

M&D Starting M&D Element No.	Path (in.)	Shell Mid-Plane			
		AP-460-Sub-Vert Seismic Hoop Stress (lbs/in ²) Mid	AP-460-Sub-Vert Seismic Meridional Stress (lbs/in ²) Mid	AP-460-Sub-Vert Seismic Stress Intensity (lbs/in ²) Mid	AP-460-Sub-Vert Seismic In-Plane Shear Stress (lbs/in ²) Mid
762	67.33	312.78	39.80	313.26	0.40
782	105.04	-120.00	93.61	275.63	0.17
802	136.24	300.14	109.58	302.29	0.16
822	181.83	-270.83	95.00	502.43	0.17
842	225.10	384.93	147.01	390.97	0.25
862	273.66	-404.10	258.75	865.97	0.41
882	323.27	738.89	467.57	745.14	1.03
902	369.20	-484.79	912.50	1641.67	2.60
922	419.20	1835.42	1255.56	1839.58	8.20
942	444.31	-451.94	1099.31	1788.89	8.48
962	458.66	-4718.75	991.67	8041.67	8.95
982	473.08	-6031.25	802.08	9673.61	11.58
1002	484.80	-2668.75	732.64	4481.94	11.53
1022	502.48	3038.89	718.75	3039.58	11.47
1042	526.48	6231.25	711.81	6231.25	11.59
1062	550.48	8097.22	704.17	8097.22	8.77
1082	574.60	9986.11	696.53	9986.11	14.81
1102	598.28	12222.22	689.03	12222.22	12.33
1122	621.38	14111.11	681.11	14111.11	11.69
1142	644.48	16138.89	673.89	16138.89	11.84
1162	667.63	17652.78	666.11	17652.78	11.44
1182	690.78	17833.33	576.46	17833.33	8.78
1202	713.88	19131.94	568.75	19131.94	9.56
1222	736.98	20937.50	561.04	20937.50	8.65
1242	760.13	20923.61	553.61	20923.61	7.99
1262	782.53	18631.94	397.08	18631.94	6.46
1282	804.13	18368.06	389.93	18368.06	6.09
1302	825.73	19465.28	382.78	19465.28	9.10
1322	847.33	21104.17	375.76	21104.17	8.13
1342	868.87	22083.33	368.82	22090.28	6.60
1362	892.10	14569.44	305.90	14576.39	6.87
1382	909.20	4953.47	311.32	5063.19	5.87
1402	918.38	914.58	472.08	1013.89	6.89
1460	930.48	199.24	518.96	802.08	-20.92
1442	949.48	125.14	320.49	351.39	-17.01
1462	990.98	55.91	156.74	160.49	-8.33
1482	1050.98	1.29	2.20	39.40	0.23
1502	1110.98	0.11	0.21	39.40	0.04
1522	1170.98	0.07	0.06	44.22	0.01
1542	1230.98	0.04	0.03	56.96	0.00
1562	1292.98	0.02	0.02	94.44	0.00

Note 1: Meridional, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)

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Table D.11. Sub-Model, Primary Tank Stresses, Shell Bottom, Gravity Plus Seismic Load, Vertical Excitation

**AP Primary Tank Sub Model, Best Estimate Soil, Vertical
Seismic, Best Estimate Tank Sub Model Concrete, 460 in. Waste
Level at 1.83 SpG**

M&D Starting M&D Element No.	Path (in.)	Shell Bottom Surface (outside - away from waste)			
		AP-460-Sub-Vert Seismic Hoop Stress (lbs/in^2) Bot	AP-460-Sub-Vert Seismic Meridional Stress (lbs/in^2) Bot	AP-460-Sub-Vert Seismic Stress Intensity (lbs/in^2) Bot	AP-460-Sub-Vert Seismic In-Plane Shear Stress (lbs/in^2) Bot
762	67.33	459.31	588.19	588.26	0.57
782	105.04	-239.72	-342.71	512.22	0.29
802	136.24	477.01	702.08	702.78	0.16
822	181.83	-339.24	-166.67	509.31	0.20
842	225.10	624.44	940.28	941.67	0.26
862	273.66	-479.10	-74.10	722.22	0.40
882	323.27	1049.31	1489.58	1493.75	1.00
902	369.20	-614.03	281.18	1207.64	2.62
922	419.20	2261.11	2645.83	2649.31	8.26
942	444.31	2096.53	10027.78	10034.72	8.63
962	458.66	-5751.39	-2992.36	8625.00	9.08
982	473.08	-7305.56	-3677.78	10805.56	10.84
1002	484.80	-2359.72	2282.64	5568.75	10.89
1022	502.48	3511.11	2358.33	3511.11	10.16
1042	526.48	6225.69	675.90	6225.69	10.59
1062	550.48	8111.11	763.19	8111.11	7.76
1082	574.60	9951.39	536.18	9951.39	12.86
1102	598.28	12270.83	855.56	12270.83	10.81
1122	621.38	14083.33	594.79	14083.33	9.83
1142	644.48	16152.78	731.25	16152.78	10.34
1162	667.63	17798.61	1155.56	17798.61	10.17
1182	690.78	17694.44	112.71	17694.44	7.57
1202	713.88	19083.33	407.29	19083.33	7.47
1222	736.98	21069.44	1002.08	21069.44	6.74
1242	760.13	21194.44	1450.69	21194.44	7.15
1262	782.53	18256.94	-546.81	19118.06	4.41
1282	804.13	18250.00	10.06	18270.83	4.57
1302	825.73	19444.44	324.17	19444.44	6.68
1322	847.33	20937.50	-136.04	21111.11	6.79
1342	868.87	23229.17	4181.25	23229.17	5.83
1362	892.10	15263.89	2604.17	15263.89	5.44
1382	909.20	5744.44	3346.53	5758.33	5.45
1402	918.38	-1943.75	-7798.61	11048.61	6.55
1460	930.48	-1403.47	-4665.97	6513.19	364.03
1442	949.48	1379.86	4419.44	4440.28	-179.31
1462	990.98	-140.69	-483.47	672.15	41.66
1482	1050.98	232.78	765.28	735.42	-31.04
1502	1110.98	-159.10	-526.53	735.42	41.78
1522	1170.98	210.90	706.94	710.42	-29.82
1542	1230.98	-143.26	-493.89	689.58	43.05
1562	1292.98	160.49	617.22	620.42	-42.18

Note 1: Meridonal, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)

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Table D.12. Sub-Model, Waste Contact Pressure, Gravity Plus Seismic, Vertical Excitation

Tank AY, 460 Inch Waste Level
 SpG = 1.83
 Sub-Model Vertical

Waste Height Ratio		Max Pressure AP Tank, 460 in Waste Level, SpG = 1.83 Time History (PSI)	Min Pressure AP Tank, 460 in Waste Level, SpG = 1.83 Time History (PSI)				
	Waste Height			Hydrostatic (psi)	Hydrodynami c (psi)	Theoretical Min (SRSS)	Theoretical Max (SRSS)
0.99	454.35	0.805	0.191	0.37	0.06	0.32	0.43
0.96	443.05	1.632	-0.566	1.12	0.17	0.95	1.29
0.94	431.7625	4.026	0.599	1.87	0.28	1.58	2.15
0.90	414.125	4.615	1.868	3.03	0.46	2.58	3.49
0.85	390.125	6.233	3.053	4.62	0.69	3.93	5.31
0.80	366.125	7.944	4.492	6.20	0.92	5.28	7.12
0.74	342	10.014	5.637	7.80	1.14	6.65	8.94
0.69	318.325	11.979	6.735	9.36	1.36	8.00	10.72
0.64	295.225	13.938	7.944	10.89	1.56	9.33	12.44
0.59	272.125	15.750	9.181	12.41	1.75	10.67	14.16
0.54	248.975	17.771	10.424	13.94	1.93	12.02	15.87
0.49	225.825	19.701	11.688	15.47	2.09	13.38	17.57
0.44	202.725	21.417	12.938	17.00	2.25	14.75	19.25
0.39	179.625	23.264	14.292	18.53	2.39	16.14	20.91
0.34	156.475	25.153	15.639	20.06	2.51	17.54	22.57
0.29	134.075	26.861	17.056	21.54	2.62	18.92	24.15
0.24	112.475	28.458	18.361	22.96	2.71	20.26	25.67
0.20	90.875	30.083	19.750	24.39	2.78	21.61	27.17
0.15	69.275	31.736	21.007	25.82	2.84	22.98	28.65
0.10	47.738	33.424	22.438	27.24	2.88	24.36	30.12
0.05	24.500	34.701	23.799	28.78	2.91	25.87	31.68
0.02	7.755	36.896	25.417	29.88	2.92	26.96	32.80
0.00	1.755	36.243	25.313	30.28	2.92	27.36	33.20

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Sub-Model File Listing, Horizontal and Vertical Excitation

Volume in drive C is 600GB 2xRAID0 (new)
Volume Serial Number is 8A0A-E4BA

Directory of C:\Users\Bruce\2008-000 PNNL\2008-005 AP-460\AP-460-Sub-Model-Both

01/02/2007	11:23 AM	<DIR>	.
01/02/2007	11:23 AM	<DIR>	..
08/21/2006	06:49 AM		101 All-Forces.txt
11/10/2006	03:07 PM		768 AP-460-Slosh-Flex-Dytran.log
11/25/2006	01:37 AM		3,753,733 AP-460-Solve-Sub-HV.out
12/17/2006	12:14 PM		460,800 AP-460-Sub-Model Both Total Reaction.xls
12/21/2006	03:50 PM		934,400 AP-460-Sub-Model Both Waste-TH-MAX.xls
12/17/2006	12:25 PM		9,311,232 AP-460-Sub-Model-Both Pri Tank Stress Seismic.xls
11/20/2006	08:59 AM		76,382 AP-460-Sub-Model-H.log
12/16/2006	07:24 AM		2,998 AP-460-Sub-Model-HV.BCS
12/16/2006	11:16 PM		43,581,440 AP-460-Sub-Model-HV.db
12/17/2006	01:15 PM		723,715 AP-460-Sub-Model-HV.err
12/17/2006	01:33 PM		1,606 AP-460-Sub-Model-HV.log
12/16/2006	07:25 AM		190,159 AP-460-Sub-Model-HV.mntr
12/16/2006	07:24 AM		67 AP-460-Sub-Model-HV.PVTS
11/25/2006	01:33 AM		97 AP-460-Sub-Model-HV.stat
11/17/2006	11:04 AM		6,046 Bolts-Friction.txt
06/09/2005	01:59 PM		262 Boundary.txt
11/19/2006	09:14 AM		227 Contact-AP.txt
08/21/2006	07:59 AM		586 Contact-Footing.txt
08/25/2006	01:28 PM		704 Contact-Insul.txt
08/25/2006	01:27 PM		704 Contact-J-Bolts.txt
08/25/2006	01:28 PM		708 Contact-Primary.txt
08/21/2006	07:59 AM		742 Contact-Soil.txt
08/21/2006	12:44 PM		632 Contact-Waste-AP.txt
01/03/2006	11:17 AM		1,616 Disp-J-Bolts.txt
11/10/2006	02:08 PM		8,620 Far-Soil.txt
11/24/2006	12:40 AM		2,002 file.bat
11/24/2006	12:40 AM		68 file.err
11/24/2006	12:40 AM		6,050 file.log
12/20/2005	04:49 PM		39,925 file.txt
10/13/2005	06:54 AM		562 Fix-Soil.txt
08/21/2006	08:00 AM		894 Force-c.txt
08/21/2006	08:00 AM		661 Force-j_bolt.txt
10/17/2006	01:37 PM		1,668 Insulate.txt
07/20/2006	06:36 AM		4,030 interface-gap1.txt
11/13/2006	01:45 PM		2,445 interfacer1.txt
08/23/2006	07:47 AM		1,971 Liner.txt
05/02/2005	02:19 PM		667 live_load.txt
07/21/2006	10:03 AM		6,214 Near-Soil-1.txt
04/20/2005	01:14 PM		508 outer-spar.txt
11/10/2006	04:08 PM		125 Post-Tank.txt
11/10/2006	04:05 PM		6,154 Primary-Props-AP.txt
09/27/2005	03:52 PM		1,538 Primary.txt
11/24/2006	12:41 AM		408,638 QA.out
10/31/2005	10:31 AM		1,108 RS_FREQ.txt
11/25/2006	05:12 PM		2,782,383 Run-Tank-Out.out
11/22/2006	06:44 AM		1,919 Run-Tank.txt
12/17/2006	01:01 PM		0 scratch.hlp
02/11/2005	01:22 PM		1,053 Slave.txt
11/11/2005	10:36 AM		4,989 Soil-Prop-Mean-Geo.txt
11/13/2006	01:57 PM		2,028 Solve-Slosh-flex.txt
12/13/2006	06:48 AM		2,184 Solve-Sub-HV.txt
08/25/2006	08:47 AM		1,918 Solve-TH-BES.txt
09/13/2006	06:12 AM		347 spectra-all.txt
09/13/2006	06:07 AM		3,690 spectra-conc-0.txt
09/13/2006	06:08 AM		3,723 spectra-conc-135.txt
09/13/2006	06:09 AM		3,723 spectra-conc-180.txt
09/13/2006	06:08 AM		3,769 spectra-conc-45.txt
09/13/2006	06:08 AM		3,649 spectra-conc-90.txt
09/13/2006	06:09 AM		1,590 spectra-conc.txt
08/28/2006	09:38 AM		2,076 spectra-concrete.txt
10/03/2006	02:02 PM		3,624 spectra-primary-0.txt

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10/03/2006	02:04	PM	3,777	spectra-primary-135.txt
09/13/2006	06:15	AM	3,777	spectra-primary-180.txt
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10/03/2006	02:03	PM	3,703	spectra-primary-90.txt
09/13/2006	06:15	AM	3,801	spectra-soil.txt
06/20/2005	09:04	AM	647	spectra-wall.txt
06/20/2005	08:52	AM	679	spectra-waste.txt
12/17/2006	12:22	PM	279,040	str-comp_0-90b.xls
12/17/2006	12:22	PM	284,160	str-comp_0-90m.xls
12/17/2006	12:22	PM	279,040	str-comp_0-90t.xls
12/17/2006	12:23	PM	279,040	str-comp_99-180b.xls
12/17/2006	12:23	PM	284,160	str-comp_99-180m.xls
12/17/2006	12:23	PM	279,040	str-comp_99-180t.xls
09/05/2006	02:00	PM	2,588	strain-backed.txt
08/21/2006	08:01	AM	566	strain-compb-p.txt
08/16/2006	01:59	PM	621	strain-compb-primary.txt
08/21/2006	08:01	AM	693	strain-compb.txt
08/21/2006	08:02	AM	566	strain-compm-p.txt
08/16/2006	02:00	PM	621	strain-compm-primary.txt
08/21/2006	08:01	AM	705	strain-compm.txt
08/21/2006	08:02	AM	578	strain-compt-p.txt
08/16/2006	02:00	PM	621	strain-compt-primary.txt
08/21/2006	08:02	AM	720	strain-compt.txt
08/21/2006	08:02	AM	730	Strain-Liner-floor.txt
01/05/2006	03:14	PM	550	Strain-Liner-p.txt
08/21/2006	08:02	AM	962	Strain-Liner-wall.txt
08/16/2006	03:01	PM	545	Strain-Liner.txt
08/16/2006	02:01	PM	292	Strain-Primary.txt
08/16/2006	02:19	PM	273	Strain.txt
08/21/2006	08:02	AM	554	stress-compb-p.txt
08/21/2006	08:02	AM	598	stress-compb.txt
08/21/2006	08:03	AM	554	stress-compm-p.txt
08/21/2006	08:03	AM	608	stress-compm.txt
08/21/2006	08:03	AM	554	stress-compt-p.txt
08/24/2006	03:19	PM	598	stress-compt.txt
08/17/2006	11:19	AM	207	Stress-Primary-M.txt
08/24/2006	12:05	PM	224	Stress-Primary.txt
12/16/2006	09:38	PM	13,519	Stress-pt_108max-b.OUT
12/16/2006	05:30	PM	13,519	Stress-pt_108max-m.OUT
12/16/2006	01:22	PM	13,519	Stress-pt_108max-t.OUT
12/16/2006	09:38	PM	6,143,768	Stress-pt_108th-b.OUT
12/16/2006	05:30	PM	6,143,768	Stress-pt_108th-m.OUT
12/16/2006	01:22	PM	6,115,040	Stress-pt_108th-t.OUT
12/16/2006	09:50	PM	13,519	Stress-pt_117max-b.OUT
12/16/2006	05:42	PM	13,519	Stress-pt_117max-m.OUT
12/16/2006	01:34	PM	13,519	Stress-pt_117max-t.OUT
12/16/2006	09:50	PM	6,143,768	Stress-pt_117th-b.OUT
12/16/2006	05:42	PM	6,143,768	Stress-pt_117th-m.OUT
12/16/2006	01:34	PM	6,115,040	Stress-pt_117th-t.OUT
12/16/2006	10:02	PM	13,519	Stress-pt_126max-b.OUT
12/16/2006	05:55	PM	13,519	Stress-pt_126max-m.OUT
12/16/2006	01:47	PM	13,519	Stress-pt_126max-t.OUT
12/16/2006	10:02	PM	6,143,768	Stress-pt_126th-b.OUT
12/16/2006	05:55	PM	6,143,768	Stress-pt_126th-m.OUT
12/16/2006	01:47	PM	6,115,040	Stress-pt_126th-t.OUT
12/16/2006	10:15	PM	13,519	Stress-pt_135max-b.OUT
12/16/2006	06:07	PM	13,519	Stress-pt_135max-m.OUT
12/16/2006	01:59	PM	13,519	Stress-pt_135max-t.OUT
12/16/2006	10:15	PM	6,143,768	Stress-pt_135th-b.OUT
12/16/2006	06:07	PM	6,143,768	Stress-pt_135th-m.OUT
12/16/2006	01:59	PM	6,115,040	Stress-pt_135th-t.OUT
12/16/2006	10:27	PM	13,519	Stress-pt_144max-b.OUT
12/16/2006	06:19	PM	13,519	Stress-pt_144max-m.OUT
12/16/2006	02:12	PM	13,519	Stress-pt_144max-t.OUT
12/16/2006	10:27	PM	6,143,768	Stress-pt_144th-b.OUT
12/16/2006	06:19	PM	6,143,768	Stress-pt_144th-m.OUT
12/16/2006	02:12	PM	6,115,040	Stress-pt_144th-t.OUT
12/16/2006	10:39	PM	13,519	Stress-pt_153max-b.OUT
12/16/2006	06:32	PM	13,519	Stress-pt_153max-m.OUT
12/16/2006	02:24	PM	13,519	Stress-pt_153max-t.OUT
12/16/2006	10:39	PM	6,143,768	Stress-pt_153th-b.OUT

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12/16/2006	06:32 PM	6,143,768	Stress-pt_153th-m.OUT
12/16/2006	02:24 PM	6,115,040	Stress-pt_153th-t.OUT
12/16/2006	10:52 PM	13,519	Stress-pt_162max-b.OUT
12/16/2006	06:44 PM	13,519	Stress-pt_162max-m.OUT
12/16/2006	02:37 PM	13,519	Stress-pt_162max-t.OUT
12/16/2006	10:52 PM	6,143,768	Stress-pt_162th-b.OUT
12/16/2006	06:44 PM	6,143,768	Stress-pt_162th-m.OUT
12/16/2006	02:37 PM	6,115,040	Stress-pt_162th-t.OUT
12/16/2006	11:04 PM	13,521	Stress-pt_171max-b.OUT
12/16/2006	06:57 PM	13,521	Stress-pt_171max-m.OUT
12/16/2006	02:49 PM	13,521	Stress-pt_171max-t.OUT
12/16/2006	11:04 PM	6,143,768	Stress-pt_171th-b.OUT
12/16/2006	06:57 PM	6,143,768	Stress-pt_171th-m.OUT
12/16/2006	02:49 PM	6,115,040	Stress-pt_171th-t.OUT
12/16/2006	11:16 PM	13,521	Stress-pt_180max-b.OUT
12/16/2006	07:09 PM	13,521	Stress-pt_180max-m.OUT
12/16/2006	03:01 PM	13,521	Stress-pt_180max-t.OUT
12/16/2006	11:16 PM	6,143,768	Stress-pt_180th-b.OUT
12/16/2006	07:09 PM	6,143,768	Stress-pt_180th-m.OUT
12/16/2006	03:01 PM	6,115,040	Stress-pt_180th-t.OUT
12/16/2006	07:34 PM	13,519	Stress-pt_18max-b.OUT
12/16/2006	03:26 PM	13,519	Stress-pt_18max-m.OUT
12/16/2006	11:18 AM	13,519	Stress-pt_18max-t.OUT
12/16/2006	07:34 PM	6,143,768	Stress-pt_18th-b.OUT
12/16/2006	03:26 PM	6,143,768	Stress-pt_18th-m.OUT
12/16/2006	11:18 AM	6,115,040	Stress-pt_18th-t.OUT
12/16/2006	07:46 PM	13,519	Stress-pt_27max-b.OUT
12/16/2006	03:38 PM	13,519	Stress-pt_27max-m.OUT
12/16/2006	11:30 AM	13,519	Stress-pt_27max-t.OUT
12/16/2006	07:46 PM	6,143,768	Stress-pt_27th-b.OUT
12/16/2006	03:38 PM	6,143,768	Stress-pt_27th-m.OUT
12/16/2006	11:30 AM	6,115,040	Stress-pt_27th-t.OUT
12/16/2006	07:58 PM	13,519	Stress-pt_36max-b.OUT
12/16/2006	03:50 PM	13,519	Stress-pt_36max-m.OUT
12/16/2006	11:42 AM	13,519	Stress-pt_36max-t.OUT
12/16/2006	07:58 PM	6,143,768	Stress-pt_36th-b.OUT
12/16/2006	03:50 PM	6,143,768	Stress-pt_36th-m.OUT
12/16/2006	11:42 AM	6,115,040	Stress-pt_36th-t.OUT
12/16/2006	08:10 PM	13,519	Stress-pt_45max-b.OUT
12/16/2006	04:02 PM	13,519	Stress-pt_45max-m.OUT
12/16/2006	11:55 AM	13,519	Stress-pt_45max-t.OUT
12/16/2006	08:10 PM	6,143,768	Stress-pt_45th-b.OUT
12/16/2006	04:03 PM	6,143,768	Stress-pt_45th-m.OUT
12/16/2006	11:55 AM	6,115,040	Stress-pt_45th-t.OUT
12/16/2006	08:22 PM	13,519	Stress-pt_54max-b.OUT
12/16/2006	04:15 PM	13,519	Stress-pt_54max-m.OUT
12/16/2006	12:07 PM	13,519	Stress-pt_54max-t.OUT
12/16/2006	08:22 PM	6,143,768	Stress-pt_54th-b.OUT
12/16/2006	04:15 PM	6,143,768	Stress-pt_54th-m.OUT
12/16/2006	12:07 PM	6,115,040	Stress-pt_54th-t.OUT
12/16/2006	08:36 PM	13,519	Stress-pt_63max-b.OUT
12/16/2006	04:28 PM	13,519	Stress-pt_63max-m.OUT
12/16/2006	12:20 PM	13,519	Stress-pt_63max-t.OUT
12/16/2006	08:36 PM	6,143,768	Stress-pt_63th-b.OUT
12/16/2006	04:28 PM	6,143,768	Stress-pt_63th-m.OUT
12/16/2006	12:20 PM	6,115,040	Stress-pt_63th-t.OUT
12/16/2006	08:48 PM	13,519	Stress-pt_72max-b.OUT
12/16/2006	04:40 PM	13,519	Stress-pt_72max-m.OUT
12/16/2006	12:32 PM	13,519	Stress-pt_72max-t.OUT
12/16/2006	08:48 PM	6,143,768	Stress-pt_72th-b.OUT
12/16/2006	04:40 PM	6,143,768	Stress-pt_72th-m.OUT
12/16/2006	12:32 PM	6,115,040	Stress-pt_72th-t.OUT
12/16/2006	09:00 PM	13,519	Stress-pt_81max-b.OUT
12/16/2006	04:52 PM	13,519	Stress-pt_81max-m.OUT
12/16/2006	12:45 PM	13,519	Stress-pt_81max-t.OUT
12/16/2006	09:00 PM	6,143,768	Stress-pt_81th-b.OUT
12/16/2006	04:53 PM	6,143,768	Stress-pt_81th-m.OUT
12/16/2006	12:45 PM	6,115,040	Stress-pt_81th-t.OUT
12/16/2006	09:13 PM	13,519	Stress-pt_90max-b.OUT
12/16/2006	05:05 PM	13,519	Stress-pt_90max-m.OUT
12/16/2006	12:57 PM	13,519	Stress-pt_90max-t.OUT

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12/16/2006	09:13 PM	6,143,768	Stress-pt_90th-b.OUT
12/16/2006	05:05 PM	6,143,768	Stress-pt_90th-m.OUT
12/16/2006	12:57 PM	6,115,040	Stress-pt_90th-t.OUT
12/16/2006	09:25 PM	13,519	Stress-pt_99max-b.OUT
12/16/2006	05:18 PM	13,519	Stress-pt_99max-m.OUT
12/16/2006	01:10 PM	13,519	Stress-pt_99max-t.OUT
12/16/2006	09:25 PM	6,143,768	Stress-pt_99th-b.OUT
12/16/2006	05:18 PM	6,143,768	Stress-pt_99th-m.OUT
12/16/2006	01:10 PM	6,115,040	Stress-pt_99th-t.OUT
12/16/2006	07:21 PM	13,519	Stress-pt_9max-b.OUT
12/16/2006	03:14 PM	13,519	Stress-pt_9max-m.OUT
12/16/2006	11:05 AM	13,519	Stress-pt_9max-t.OUT
12/16/2006	07:21 PM	6,143,896	Stress-pt_9th-b.OUT
12/16/2006	03:14 PM	6,143,896	Stress-pt_9th-m.OUT
12/16/2006	11:05 AM	6,115,168	Stress-pt_9th-t.OUT
01/02/2007	11:24 AM	0	Sub-Model-Both-Files.txt
08/02/2006	06:15 AM	4,008	Tank-Coordinates-AP.txt
05/25/2005	03:32 PM	2,512	Tank-Mesh1.txt
12/15/2006	07:28 AM	25	tank-out.out
10/17/2006	12:18 PM	5,554	Tank-Props-Rigid.txt
12/15/2006	07:29 AM	7,787	Tank-th.out
11/10/2006	02:17 PM	22,588	TH-Sub-Modal-Column.txt
11/10/2006	02:19 PM	19,879	TH-Sub-Model-h.txt
11/22/2006	08:27 AM	19,879	TH-Sub-Model-v.txt
12/19/2006	03:21 PM	10,996,224	Waste Pressure 0 deg.xls
12/19/2006	03:23 PM	11,942,400	Waste Pressure 45 deg.xls
12/19/2006	03:14 PM	11,920,384	Waste Pressure 90 deg.xls
12/16/2006	09:24 AM	10,180	Waste-Cont_108max.OUT
12/16/2006	09:25 AM	4,643,118	Waste-Cont_108th.OUT
12/16/2006	09:34 AM	10,180	Waste-Cont_117max.OUT
12/16/2006	09:34 AM	4,643,118	Waste-Cont_117th.OUT
12/16/2006	09:44 AM	10,180	Waste-Cont_126max.OUT
12/16/2006	09:44 AM	4,643,118	Waste-Cont_126th.OUT
12/16/2006	09:54 AM	10,180	Waste-Cont_135max.OUT
12/16/2006	09:54 AM	4,643,118	Waste-Cont_135th.OUT
12/16/2006	10:05 AM	10,180	Waste-Cont_144max.OUT
12/16/2006	10:05 AM	4,643,118	Waste-Cont_144th.OUT
12/16/2006	10:14 AM	10,180	Waste-Cont_153max.OUT
12/16/2006	10:14 AM	4,643,118	Waste-Cont_153th.OUT
12/16/2006	10:23 AM	10,180	Waste-Cont_162max.OUT
12/16/2006	10:23 AM	4,643,118	Waste-Cont_162th.OUT
12/16/2006	10:34 AM	10,180	Waste-Cont_171max.OUT
12/16/2006	10:34 AM	4,643,118	Waste-Cont_171th.OUT
12/16/2006	10:44 AM	10,180	Waste-Cont_180max.OUT
12/16/2006	10:44 AM	4,643,118	Waste-Cont_180th.OUT
12/16/2006	07:45 AM	10,180	Waste-Cont_18max.OUT
12/16/2006	07:45 AM	4,643,118	Waste-Cont_18th.OUT
12/16/2006	07:56 AM	10,180	Waste-Cont_27max.OUT
12/16/2006	07:56 AM	4,643,118	Waste-Cont_27th.OUT
12/16/2006	08:06 AM	10,180	Waste-Cont_36max.OUT
12/16/2006	08:06 AM	4,643,118	Waste-Cont_36th.OUT
12/16/2006	08:16 AM	10,180	Waste-Cont_45max.OUT
12/16/2006	08:16 AM	4,643,118	Waste-Cont_45th.OUT
12/16/2006	08:26 AM	10,180	Waste-Cont_54max.OUT
12/16/2006	08:26 AM	4,643,118	Waste-Cont_54th.OUT
12/16/2006	08:35 AM	10,180	Waste-Cont_63max.OUT
12/16/2006	08:35 AM	4,643,118	Waste-Cont_63th.OUT
12/16/2006	08:44 AM	10,180	Waste-Cont_72max.OUT
12/16/2006	08:44 AM	4,643,118	Waste-Cont_72th.OUT
12/16/2006	08:54 AM	10,180	Waste-Cont_81max.OUT
12/16/2006	08:54 AM	4,643,118	Waste-Cont_81th.OUT
12/16/2006	09:04 AM	10,180	Waste-Cont_90max.OUT
12/16/2006	09:04 AM	4,643,118	Waste-Cont_90th.OUT
12/16/2006	09:14 AM	10,180	Waste-Cont_99max.OUT
12/16/2006	09:14 AM	4,643,118	Waste-Cont_99th.OUT
12/16/2006	07:34 AM	10,180	Waste-Cont_9max.OUT
12/16/2006	07:34 AM	4,643,246	Waste-Cont_9th.OUT
12/16/2006	10:53 AM	45,117	Waste-Reaction-460-SD3.out
09/25/2006	10:41 AM	340	Waste-Reaction.txt
11/14/2006	07:33 AM	10,553	Waste-solid-AP-S.txt
12/17/2006	01:06 PM	683	Waste-Surface-AP.txt

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12/17/2006 01:07 PM      1,027 Waste-Surf_0max.OUT
12/17/2006 01:07 PM    572,693 Waste-Surf_0th.OUT
12/17/2006 01:12 PM      1,027 Waste-Surf_108max.OUT
12/17/2006 01:12 PM    572,693 Waste-Surf_108th.OUT
12/17/2006 01:12 PM      1,027 Waste-Surf_117max.OUT
12/17/2006 01:12 PM    572,693 Waste-Surf_117th.OUT
12/17/2006 01:13 PM      1,027 Waste-Surf_126max.OUT
12/17/2006 01:13 PM    572,693 Waste-Surf_126th.OUT
12/17/2006 01:13 PM      1,027 Waste-Surf_135max.OUT
12/17/2006 01:13 PM    572,693 Waste-Surf_135th.OUT
12/17/2006 01:14 PM      1,027 Waste-Surf_144max.OUT
12/17/2006 01:14 PM    572,693 Waste-Surf_144th.OUT
12/17/2006 01:14 PM      1,027 Waste-Surf_153max.OUT
12/17/2006 01:14 PM    572,693 Waste-Surf_153th.OUT
12/17/2006 01:14 PM      1,027 Waste-Surf_162max.OUT
12/17/2006 01:14 PM    572,693 Waste-Surf_162th.OUT
12/17/2006 01:15 PM      1,027 Waste-Surf_171max.OUT
12/17/2006 01:15 PM    572,693 Waste-Surf_171th.OUT
12/17/2006 01:15 PM      1,027 Waste-Surf_180max.OUT
12/17/2006 01:15 PM    572,693 Waste-Surf_180th.OUT
12/17/2006 01:15 PM      1,027 Waste-Surf_189max.OUT
12/17/2006 01:15 PM    572,693 Waste-Surf_189th.OUT
12/17/2006 01:08 PM      1,027 Waste-Surf_18max.OUT
12/17/2006 01:08 PM    572,693 Waste-Surf_18th.OUT
12/17/2006 01:08 PM      1,027 Waste-Surf_27max.OUT
12/17/2006 01:08 PM    572,693 Waste-Surf_27th.OUT
12/17/2006 01:09 PM      1,027 Waste-Surf_36max.OUT
12/17/2006 01:09 PM    572,693 Waste-Surf_36th.OUT
12/17/2006 01:09 PM      1,027 Waste-Surf_45max.OUT
12/17/2006 01:09 PM    572,693 Waste-Surf_45th.OUT
12/17/2006 01:09 PM      1,027 Waste-Surf_54max.OUT
12/17/2006 01:09 PM    572,693 Waste-Surf_54th.OUT
12/17/2006 01:10 PM      1,027 Waste-Surf_63max.OUT
12/17/2006 01:10 PM    572,693 Waste-Surf_63th.OUT
12/17/2006 01:10 PM      1,027 Waste-Surf_72max.OUT
12/17/2006 01:10 PM    572,693 Waste-Surf_72th.OUT
12/17/2006 01:11 PM      1,027 Waste-Surf_81max.OUT
12/17/2006 01:11 PM    572,693 Waste-Surf_81th.OUT
12/17/2006 01:11 PM      1,027 Waste-Surf_90max.OUT
12/17/2006 01:11 PM    572,693 Waste-Surf_90th.OUT
12/17/2006 01:11 PM      1,027 Waste-Surf_99max.OUT
12/17/2006 01:11 PM    572,693 Waste-Surf_99th.OUT
12/17/2006 01:07 PM      1,027 Waste-Surf_9max.OUT
12/17/2006 01:07 PM    572,693 Waste-Surf_9th.OUT
12/17/2006 12:17 PM    229,888 waste_0-90.xls
12/17/2006 12:17 PM    229,888 waste_99-180.xls
      320 File(s)      574,095,026 bytes
      2 Dir(s)  160,857,333,760 bytes free

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Sub-Model File Listing, Horizontal Excitation

Volume in drive C is 600GB 2xRAID0 (new)
Volume Serial Number is 8A0A-E4BA

Directory of C:\Users\Bruce\2008-000 PNNL\2008-005 AP-460\AP-460-Sub-Model-Horiz

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01/02/2007 11:47 AM  <DIR>      .
01/02/2007 11:47 AM  <DIR>      ..
11/19/2006 09:41 AM              3 Accel-PT-0.out
08/21/2006 06:49 AM            101 All-Forces.txt
11/10/2006 03:07 PM            768 AP-460-Slosh-Flex-Dytran.log
11/18/2006 09:46 AM    4,452,897 AP-460-Solve-Sub-Horiz.out
12/17/2006 12:14 PM    753,664 AP-460-Sub-Model-H Total Reaction.xls
12/21/2006 03:25 PM    958,464 AP-460-Sub-Model-H Waste-TH-MAX.xls
11/18/2006 09:46 AM      2,998 AP-460-Sub-Model-H.BCS
11/18/2006 12:48 PM  43,581,440 AP-460-Sub-Model-H.db
12/18/2006 01:09 PM      602 AP-460-Sub-Model-H.err
12/18/2006 01:47 PM    1,942 AP-460-Sub-Model-H.log
11/18/2006 09:46 AM   190,159 AP-460-Sub-Model-H.mntr
11/18/2006 09:46 AM      67 AP-460-Sub-Model-H.PVTS

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11/16/2006	01:10 PM	0	AP-460-Sub-Model-H.sda
11/27/2006	03:08 PM	9,269,760	AP-460-Sub-Model-Horiz Pri Tank Stress Seismic.xls
11/17/2006	11:04 AM	6,046	Bolts-Friction.txt
06/09/2005	01:59 PM	262	Boundary.txt
11/19/2006	09:14 AM	227	Contact-AP.txt
08/21/2006	07:59 AM	586	Contact-Footing.txt
08/25/2006	01:28 PM	704	Contact-Insul.txt
08/25/2006	01:27 PM	704	Contact-J-Bolts.txt
08/25/2006	01:28 PM	708	Contact-Primary.txt
08/21/2006	07:59 AM	742	Contact-Soil.txt
08/21/2006	12:44 PM	632	Contact-Waste-AP.txt
01/03/2006	11:17 AM	1,616	Disp-J-Bolts.txt
11/19/2006	09:41 AM	535,476	Disp-PT-0.out
11/10/2006	02:08 PM	8,620	Far-Soil.txt
11/17/2006	10:53 AM	287	FILE.err
11/17/2006	10:53 AM	5,822	file.log
12/20/2005	04:49 PM	39,925	file.txt
10/13/2005	06:54 AM	562	Fix-Soil.txt
08/21/2006	08:00 AM	894	Force-c.txt
08/21/2006	08:00 AM	661	Force-j_bolt.txt
01/02/2007	11:07 AM	<DIR>	Freq Test
10/17/2006	01:37 PM	1,668	Insulate.txt
07/20/2006	06:36 AM	4,030	interface-gap1.txt
11/13/2006	01:45 PM	2,445	interfacel.txt
08/23/2006	07:47 AM	1,971	Liner.txt
05/02/2005	02:19 PM	667	live_load.txt
07/21/2006	10:03 AM	6,214	Near-Soil-1.txt
04/20/2005	01:14 PM	508	outer-spar.txt
11/10/2006	04:08 PM	125	Post-Tank.txt
11/10/2006	04:05 PM	6,154	Primary-Props-AP.txt
09/27/2005	03:52 PM	1,538	Primary.txt
11/17/2006	11:14 AM	902,478	QA.out
11/19/2006	09:41 AM	47,121	RS-PT-0.out
10/31/2005	10:31 AM	1,108	RS_FREQ.txt
11/14/2006	07:38 AM	1,894	Run-Tank.txt
12/17/2006	01:33 PM	0	scratch.hlp
02/11/2005	01:22 PM	1,053	Slave.txt
11/11/2005	10:36 AM	4,989	Soil-Prop-Mean-Geo.txt
11/13/2006	01:57 PM	2,028	Solve-Slosh-flex.txt
11/17/2006	11:14 AM	2,177	Solve-Sub-Horiz.txt
08/25/2006	08:47 AM	1,918	Solve-TH-BES.txt
09/13/2006	06:12 AM	347	spectra-all.txt
09/13/2006	06:07 AM	3,690	spectra-conc-0.txt
09/13/2006	06:08 AM	3,723	spectra-conc-135.txt
09/13/2006	06:09 AM	3,723	spectra-conc-180.txt
09/13/2006	06:08 AM	3,769	spectra-conc-45.txt
09/13/2006	06:08 AM	3,649	spectra-conc-90.txt
09/13/2006	06:09 AM	1,590	spectra-conc.txt
08/28/2006	09:38 AM	2,076	spectra-concrete.txt
10/03/2006	02:02 PM	3,624	spectra-primary-0.txt
10/03/2006	02:04 PM	3,777	spectra-primary-135.txt
09/13/2006	06:15 AM	3,777	spectra-primary-180.txt
10/03/2006	02:03 PM	3,703	spectra-primary-45.txt
10/03/2006	02:03 PM	3,703	spectra-primary-90.txt
09/13/2006	06:15 AM	3,801	spectra-soil.txt
06/20/2005	09:04 AM	647	spectra-wall.txt
06/20/2005	08:52 AM	679	spectra-waste.txt
11/27/2006	09:23 AM	279,040	str-comp_0-90b.xls
11/27/2006	09:23 AM	284,672	str-comp_0-90m.xls
11/27/2006	09:23 AM	279,040	str-comp_0-90t.xls
11/27/2006	09:24 AM	279,552	str-comp_99-180b.xls
11/27/2006	09:24 AM	284,160	str-comp_99-180m.xls
11/27/2006	09:24 AM	279,040	str-comp_99-180t.xls
09/05/2006	02:00 PM	2,588	strain-backed.txt
08/21/2006	08:01 AM	566	strain-compb-p.txt
08/16/2006	01:59 PM	621	strain-compb-primary.txt
08/21/2006	08:01 AM	693	strain-compb.txt
08/21/2006	08:02 AM	566	strain-compm-p.txt
08/16/2006	02:00 PM	621	strain-compm-primary.txt
08/21/2006	08:01 AM	705	strain-compm.txt
08/21/2006	08:02 AM	578	strain-compt-p.txt

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08/16/2006	02:00	PM	621	strain-compt-primary.txt
08/21/2006	08:02	AM	720	strain-compt.txt
08/21/2006	08:02	AM	730	Strain-Liner-floor.txt
01/05/2006	03:14	PM	550	Strain-Liner-p.txt
08/21/2006	08:02	AM	962	Strain-Liner-wall.txt
08/16/2006	03:01	PM	545	Strain-Liner.txt
08/16/2006	02:01	PM	292	Strain-Primary.txt
08/16/2006	02:19	PM	273	Strain.txt
08/21/2006	08:02	AM	554	stress-compb-p.txt
08/21/2006	08:02	AM	598	stress-compb.txt
08/21/2006	08:03	AM	554	stress-compm-p.txt
08/21/2006	08:03	AM	608	stress-compm.txt
08/21/2006	08:03	AM	554	stress-compt-p.txt
08/24/2006	03:19	PM	598	stress-compt.txt
08/17/2006	11:19	AM	207	Stress-Primary-M.txt
08/24/2006	12:05	PM	224	Stress-Primary.txt
11/19/2006	07:15	PM	13, 519	Stress-pt_108max-b.OUT
11/19/2006	04:00	PM	13, 519	Stress-pt_108max-m.OUT
11/19/2006	12:45	PM	13, 519	Stress-pt_108max-t.OUT
11/19/2006	07:15	PM	6, 143, 768	Stress-pt_108th-b.OUT
11/19/2006	04:00	PM	6, 143, 768	Stress-pt_108th-m.OUT
11/19/2006	12:45	PM	6, 115, 040	Stress-pt_108th-t.OUT
11/19/2006	07:24	PM	13, 519	Stress-pt_117max-b.OUT
11/19/2006	04:10	PM	13, 519	Stress-pt_117max-m.OUT
11/19/2006	12:55	PM	13, 519	Stress-pt_117max-t.OUT
11/19/2006	07:24	PM	6, 143, 768	Stress-pt_117th-b.OUT
11/19/2006	04:10	PM	6, 143, 768	Stress-pt_117th-m.OUT
11/19/2006	12:55	PM	6, 115, 040	Stress-pt_117th-t.OUT
11/19/2006	07:34	PM	13, 519	Stress-pt_126max-b.OUT
11/19/2006	04:19	PM	13, 519	Stress-pt_126max-m.OUT
11/19/2006	01:04	PM	13, 519	Stress-pt_126max-t.OUT
11/19/2006	07:34	PM	6, 143, 768	Stress-pt_126th-b.OUT
11/19/2006	04:19	PM	6, 143, 768	Stress-pt_126th-m.OUT
11/19/2006	01:04	PM	6, 115, 040	Stress-pt_126th-t.OUT
11/19/2006	07:44	PM	13, 519	Stress-pt_135max-b.OUT
11/19/2006	04:29	PM	13, 519	Stress-pt_135max-m.OUT
11/19/2006	01:14	PM	13, 519	Stress-pt_135max-t.OUT
11/19/2006	07:44	PM	6, 143, 768	Stress-pt_135th-b.OUT
11/19/2006	04:29	PM	6, 143, 768	Stress-pt_135th-m.OUT
11/19/2006	01:14	PM	6, 115, 040	Stress-pt_135th-t.OUT
11/19/2006	07:53	PM	13, 519	Stress-pt_144max-b.OUT
11/19/2006	04:39	PM	13, 519	Stress-pt_144max-m.OUT
11/19/2006	01:24	PM	13, 519	Stress-pt_144max-t.OUT
11/19/2006	07:53	PM	6, 143, 768	Stress-pt_144th-b.OUT
11/19/2006	04:39	PM	6, 143, 768	Stress-pt_144th-m.OUT
11/19/2006	01:24	PM	6, 115, 040	Stress-pt_144th-t.OUT
11/19/2006	08:03	PM	13, 519	Stress-pt_153max-b.OUT
11/19/2006	04:49	PM	13, 519	Stress-pt_153max-m.OUT
11/19/2006	01:34	PM	13, 519	Stress-pt_153max-t.OUT
11/19/2006	08:03	PM	6, 143, 768	Stress-pt_153th-b.OUT
11/19/2006	04:49	PM	6, 143, 768	Stress-pt_153th-m.OUT
11/19/2006	01:34	PM	6, 115, 040	Stress-pt_153th-t.OUT
11/19/2006	08:13	PM	13, 519	Stress-pt_162max-b.OUT
11/19/2006	04:58	PM	13, 519	Stress-pt_162max-m.OUT
11/19/2006	01:44	PM	13, 519	Stress-pt_162max-t.OUT
11/19/2006	08:13	PM	6, 143, 768	Stress-pt_162th-b.OUT
11/19/2006	04:59	PM	6, 143, 768	Stress-pt_162th-m.OUT
11/19/2006	01:44	PM	6, 115, 040	Stress-pt_162th-t.OUT
11/19/2006	08:22	PM	13, 521	Stress-pt_171max-b.OUT
11/19/2006	05:08	PM	13, 521	Stress-pt_171max-m.OUT
11/19/2006	01:53	PM	13, 521	Stress-pt_171max-t.OUT
11/19/2006	08:22	PM	6, 143, 768	Stress-pt_171th-b.OUT
11/19/2006	05:08	PM	6, 143, 768	Stress-pt_171th-m.OUT
11/19/2006	01:53	PM	6, 115, 040	Stress-pt_171th-t.OUT
11/19/2006	08:32	PM	13, 521	Stress-pt_180max-b.OUT
11/19/2006	05:17	PM	13, 521	Stress-pt_180max-m.OUT
11/19/2006	02:03	PM	13, 521	Stress-pt_180max-t.OUT
11/19/2006	08:32	PM	6, 143, 768	Stress-pt_180th-b.OUT
11/19/2006	05:17	PM	6, 143, 768	Stress-pt_180th-m.OUT
11/19/2006	02:03	PM	6, 115, 040	Stress-pt_180th-t.OUT
11/19/2006	05:37	PM	13, 519	Stress-pt_18max-b.OUT

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11/19/2006	02:22 PM	13,519	Stress-pt_18max-m.OUT
11/19/2006	11:05 AM	13,519	Stress-pt_18max-t.OUT
11/19/2006	05:37 PM	6,143,768	Stress-pt_18th-b.OUT
11/19/2006	02:22 PM	6,143,768	Stress-pt_18th-m.OUT
11/19/2006	11:05 AM	6,115,040	Stress-pt_18th-t.OUT
11/19/2006	05:46 PM	13,519	Stress-pt_27max-b.OUT
11/19/2006	02:32 PM	13,519	Stress-pt_27max-m.OUT
11/19/2006	11:15 AM	13,519	Stress-pt_27max-t.OUT
11/19/2006	05:46 PM	6,143,768	Stress-pt_27th-b.OUT
11/19/2006	02:32 PM	6,143,768	Stress-pt_27th-m.OUT
11/19/2006	11:15 AM	6,115,040	Stress-pt_27th-t.OUT
11/19/2006	05:56 PM	13,519	Stress-pt_36max-b.OUT
11/19/2006	02:41 PM	13,519	Stress-pt_36max-m.OUT
11/19/2006	11:25 AM	13,519	Stress-pt_36max-t.OUT
11/19/2006	05:56 PM	6,143,768	Stress-pt_36th-b.OUT
11/19/2006	02:41 PM	6,143,768	Stress-pt_36th-m.OUT
11/19/2006	11:25 AM	6,115,040	Stress-pt_36th-t.OUT
11/19/2006	06:06 PM	13,519	Stress-pt_45max-b.OUT
11/19/2006	02:51 PM	13,519	Stress-pt_45max-m.OUT
11/19/2006	11:36 AM	13,519	Stress-pt_45max-t.OUT
11/19/2006	06:06 PM	6,143,768	Stress-pt_45th-b.OUT
11/19/2006	02:51 PM	6,143,768	Stress-pt_45th-m.OUT
11/19/2006	11:36 AM	6,115,040	Stress-pt_45th-t.OUT
11/19/2006	06:15 PM	13,519	Stress-pt_54max-b.OUT
11/19/2006	03:01 PM	13,519	Stress-pt_54max-m.OUT
11/19/2006	11:45 AM	13,519	Stress-pt_54max-t.OUT
11/19/2006	06:15 PM	6,143,768	Stress-pt_54th-b.OUT
11/19/2006	03:01 PM	6,143,768	Stress-pt_54th-m.OUT
11/19/2006	11:45 AM	6,115,040	Stress-pt_54th-t.OUT
11/19/2006	06:25 PM	13,519	Stress-pt_63max-b.OUT
11/19/2006	03:11 PM	13,519	Stress-pt_63max-m.OUT
11/19/2006	11:56 AM	13,519	Stress-pt_63max-t.OUT
11/19/2006	06:25 PM	6,143,768	Stress-pt_63th-b.OUT
11/19/2006	03:11 PM	6,143,768	Stress-pt_63th-m.OUT
11/19/2006	11:56 AM	6,115,040	Stress-pt_63th-t.OUT
11/19/2006	06:35 PM	13,519	Stress-pt_72max-b.OUT
11/19/2006	03:20 PM	13,519	Stress-pt_72max-m.OUT
11/19/2006	12:05 PM	13,519	Stress-pt_72max-t.OUT
11/19/2006	06:35 PM	6,143,768	Stress-pt_72th-b.OUT
11/19/2006	03:20 PM	6,143,768	Stress-pt_72th-m.OUT
11/19/2006	12:05 PM	6,115,040	Stress-pt_72th-t.OUT
11/19/2006	06:45 PM	13,519	Stress-pt_81max-b.OUT
11/19/2006	03:30 PM	13,519	Stress-pt_81max-m.OUT
11/19/2006	12:15 PM	13,519	Stress-pt_81max-t.OUT
11/19/2006	06:45 PM	6,143,768	Stress-pt_81th-b.OUT
11/19/2006	03:30 PM	6,143,768	Stress-pt_81th-m.OUT
11/19/2006	12:15 PM	6,115,040	Stress-pt_81th-t.OUT
11/19/2006	06:55 PM	13,519	Stress-pt_90max-b.OUT
11/19/2006	03:40 PM	13,519	Stress-pt_90max-m.OUT
11/19/2006	12:25 PM	13,519	Stress-pt_90max-t.OUT
11/19/2006	06:55 PM	6,143,768	Stress-pt_90th-b.OUT
11/19/2006	03:40 PM	6,143,768	Stress-pt_90th-m.OUT
11/19/2006	12:25 PM	6,115,040	Stress-pt_90th-t.OUT
11/19/2006	07:05 PM	13,519	Stress-pt_99max-b.OUT
11/19/2006	03:50 PM	13,519	Stress-pt_99max-m.OUT
11/19/2006	12:35 PM	13,519	Stress-pt_99max-t.OUT
11/19/2006	07:05 PM	6,143,768	Stress-pt_99th-b.OUT
11/19/2006	03:50 PM	6,143,768	Stress-pt_99th-m.OUT
11/19/2006	12:35 PM	6,115,040	Stress-pt_99th-t.OUT
11/19/2006	05:27 PM	13,519	Stress-pt_9max-b.OUT
11/19/2006	02:13 PM	13,519	Stress-pt_9max-m.OUT
11/19/2006	10:55 AM	13,519	Stress-pt_9max-t.OUT
11/19/2006	05:27 PM	6,143,896	Stress-pt_9th-b.OUT
11/19/2006	02:13 PM	6,143,896	Stress-pt_9th-m.OUT
11/19/2006	10:55 AM	6,115,168	Stress-pt_9th-t.OUT
01/02/2007	11:47 AM	0	Sub-Model-Horiz-files.txt
08/02/2006	06:15 AM	4,008	Tank-Coordinates-AP.txt
05/25/2005	03:32 PM	2,512	Tank-Mesh1.txt
11/17/2006	11:13 AM	25	tank-out.out
10/17/2006	12:18 PM	5,554	Tank-Props-Rigid.txt
11/17/2006	11:14 AM	7,943	Tank-th.out

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11/10/2006 02:17 PM	22,588	TH-Sub-Modal-Column.txt
11/10/2006 02:19 PM	19,879	TH-Sub-Model-h.txt
11/27/2006 10:40 AM	6,813,184	Time History - Bot.xls
11/27/2006 09:58 AM	6,813,184	Time History - Mid.xls
11/27/2006 10:40 AM	6,813,184	Time History - Top.xls
11/19/2006 09:41 AM	535,476	Vel-PT-0.out
12/19/2006 02:55 PM	11,706,368	Waste Pressure 0 deg.xls
12/19/2006 03:11 PM	11,939,328	Waste Pressure 45 deg.xls
12/19/2006 03:10 PM	10,744,320	Waste Pressure 90 deg.xls
11/18/2006 11:36 AM	10,180	Waste-Cont_108max.OUT
11/18/2006 11:36 AM	4,643,118	Waste-Cont_108th.OUT
11/18/2006 11:45 AM	10,180	Waste-Cont_117max.OUT
11/18/2006 11:45 AM	4,643,118	Waste-Cont_117th.OUT
11/18/2006 11:53 AM	10,180	Waste-Cont_126max.OUT
11/18/2006 11:53 AM	4,643,118	Waste-Cont_126th.OUT
11/18/2006 12:02 PM	10,180	Waste-Cont_135max.OUT
11/18/2006 12:02 PM	4,643,118	Waste-Cont_135th.OUT
11/18/2006 12:12 PM	10,180	Waste-Cont_144max.OUT
11/18/2006 12:12 PM	4,643,118	Waste-Cont_144th.OUT
11/18/2006 12:20 PM	10,180	Waste-Cont_153max.OUT
11/18/2006 12:20 PM	4,643,118	Waste-Cont_153th.OUT
11/18/2006 12:29 PM	10,180	Waste-Cont_162max.OUT
11/18/2006 12:29 PM	4,643,118	Waste-Cont_162th.OUT
11/18/2006 12:38 PM	10,180	Waste-Cont_171max.OUT
11/18/2006 12:38 PM	4,643,118	Waste-Cont_171th.OUT
11/18/2006 12:48 PM	10,180	Waste-Cont_180max.OUT
11/18/2006 12:48 PM	4,643,118	Waste-Cont_180th.OUT
11/18/2006 10:05 AM	10,180	Waste-Cont_18max.OUT
11/18/2006 10:05 AM	4,643,118	Waste-Cont_18th.OUT
11/18/2006 10:15 AM	10,180	Waste-Cont_27max.OUT
11/18/2006 10:15 AM	4,643,118	Waste-Cont_27th.OUT
11/18/2006 10:24 AM	10,180	Waste-Cont_36max.OUT
11/18/2006 10:24 AM	4,643,118	Waste-Cont_36th.OUT
11/18/2006 10:33 AM	10,180	Waste-Cont_45max.OUT
11/18/2006 10:33 AM	4,643,118	Waste-Cont_45th.OUT
11/18/2006 10:42 AM	10,180	Waste-Cont_54max.OUT
11/18/2006 10:42 AM	4,643,118	Waste-Cont_54th.OUT
11/18/2006 10:50 AM	10,180	Waste-Cont_63max.OUT
11/18/2006 10:50 AM	4,643,118	Waste-Cont_63th.OUT
11/18/2006 10:59 AM	10,180	Waste-Cont_72max.OUT
11/18/2006 10:59 AM	4,643,118	Waste-Cont_72th.OUT
11/18/2006 11:08 AM	10,180	Waste-Cont_81max.OUT
11/18/2006 11:08 AM	4,643,118	Waste-Cont_81th.OUT
11/18/2006 11:17 AM	10,180	Waste-Cont_90max.OUT
11/18/2006 11:17 AM	4,643,118	Waste-Cont_90th.OUT
11/18/2006 11:26 AM	10,180	Waste-Cont_99max.OUT
11/18/2006 11:26 AM	4,643,118	Waste-Cont_99th.OUT
11/18/2006 09:55 AM	10,180	Waste-Cont_9max.OUT
11/18/2006 09:55 AM	4,643,246	Waste-Cont_9th.OUT
11/19/2006 09:24 AM	45,117	Waste-Reaction-460-SD3.out
09/25/2006 10:41 AM	340	Waste-Reaction.txt
11/14/2006 07:33 AM	10,553	Waste-solid-AP-S.txt
12/17/2006 01:06 PM	683	Waste-Surface-AP.txt
12/17/2006 01:35 PM	946	Waste-Surf_0max.OUT
12/17/2006 01:35 PM	509,333	Waste-Surf_0th.OUT
12/17/2006 01:40 PM	946	Waste-Surf_108max.OUT
12/17/2006 01:40 PM	509,205	Waste-Surf_108th.OUT
12/17/2006 01:41 PM	946	Waste-Surf_117max.OUT
12/17/2006 01:41 PM	509,205	Waste-Surf_117th.OUT
12/17/2006 01:41 PM	946	Waste-Surf_126max.OUT
12/17/2006 01:41 PM	509,205	Waste-Surf_126th.OUT
12/17/2006 01:41 PM	946	Waste-Surf_135max.OUT
12/17/2006 01:41 PM	509,205	Waste-Surf_135th.OUT
12/17/2006 01:42 PM	946	Waste-Surf_144max.OUT
12/17/2006 01:42 PM	509,205	Waste-Surf_144th.OUT
12/17/2006 01:42 PM	946	Waste-Surf_153max.OUT
12/17/2006 01:42 PM	509,205	Waste-Surf_153th.OUT
12/17/2006 01:43 PM	946	Waste-Surf_162max.OUT
12/17/2006 01:43 PM	509,205	Waste-Surf_162th.OUT
12/17/2006 01:43 PM	946	Waste-Surf_171max.OUT
12/17/2006 01:43 PM	509,205	Waste-Surf_171th.OUT

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12/17/2006	01:43	PM	946	Waste-Surf_180max.OUT
12/17/2006	01:43	PM	509,205	Waste-Surf_180th.OUT
12/17/2006	01:43	PM	946	Waste-Surf_189max.OUT
12/17/2006	01:43	PM	509,205	Waste-Surf_189th.OUT
12/17/2006	01:36	PM	946	Waste-Surf_18max.OUT
12/17/2006	01:36	PM	509,205	Waste-Surf_18th.OUT
12/17/2006	01:37	PM	946	Waste-Surf_27max.OUT
12/17/2006	01:37	PM	509,205	Waste-Surf_27th.OUT
12/17/2006	01:37	PM	946	Waste-Surf_36max.OUT
12/17/2006	01:37	PM	509,205	Waste-Surf_36th.OUT
12/17/2006	01:37	PM	946	Waste-Surf_45max.OUT
12/17/2006	01:37	PM	509,205	Waste-Surf_45th.OUT
12/17/2006	01:38	PM	946	Waste-Surf_54max.OUT
12/17/2006	01:38	PM	509,205	Waste-Surf_54th.OUT
12/17/2006	01:38	PM	946	Waste-Surf_63max.OUT
12/17/2006	01:38	PM	509,205	Waste-Surf_63th.OUT
12/17/2006	01:39	PM	946	Waste-Surf_72max.OUT
12/17/2006	01:39	PM	509,205	Waste-Surf_72th.OUT
12/17/2006	01:39	PM	946	Waste-Surf_81max.OUT
12/17/2006	01:39	PM	509,205	Waste-Surf_81th.OUT
12/17/2006	01:39	PM	946	Waste-Surf_90max.OUT
12/17/2006	01:39	PM	509,205	Waste-Surf_90th.OUT
12/17/2006	01:40	PM	946	Waste-Surf_99max.OUT
12/17/2006	01:40	PM	509,205	Waste-Surf_99th.OUT
12/17/2006	01:36	PM	946	Waste-Surf_9max.OUT
12/17/2006	01:36	PM	509,205	Waste-Surf_9th.OUT
11/27/2006	09:21	AM	229,888	waste_0-90.xls
11/27/2006	09:21	AM	229,888	waste_99-180.xls
			323	File(s)
			591,651,351	bytes

Directory of C:\Users\Bruce\2008-000 PNNL\2008-005 AP-460\AP-460-Sub-Model-Horiz\Freq Test

01/02/2007	11:07	AM	<DIR>	.
01/02/2007	11:07	AM	<DIR>	..
08/21/2006	06:49	AM	101	All-Forces.txt
11/10/2006	03:07	PM	768	AP-460-Slosh-Flex-Dytran.log
12/19/2006	10:41	AM	309,512	AP-460-Slosh-Flex-V.out
12/19/2006	10:41	AM	2,998	AP-460-Sub-Model-H.BCS
12/19/2006	10:41	AM	43,646,976	AP-460-Sub-Model-H.db
12/19/2006	10:41	AM	53,084,160	AP-460-Sub-Model-H.dbb
12/19/2006	10:41	AM	11,730,944	AP-460-Sub-Model-H.emat
12/19/2006	12:49	PM	200,318	AP-460-Sub-Model-H.err
12/19/2006	10:41	AM	50,462,720	AP-460-Sub-Model-H.esav
12/19/2006	10:41	AM	12,845,056	AP-460-Sub-Model-H.full
12/19/2006	10:40	AM	15,299,480	AP-460-Sub-Model-H.ldhi
12/19/2006	01:02	PM	96,922	AP-460-Sub-Model-H.log
12/19/2006	10:41	AM	10,943	AP-460-Sub-Model-H.mntr
12/19/2006	10:40	AM	50,462,720	AP-460-Sub-Model-H.osav
12/19/2006	10:41	AM	67	AP-460-Sub-Model-H.PVTS
12/19/2006	10:41	AM	50,987,008	AP-460-Sub-Model-H.r001
12/19/2006	09:41	AM	43,646,976	AP-460-Sub-Model-H.rdb
11/19/2006	09:52	AM	0	AP-460-Sub-Model-H.sda
12/19/2006	12:48	PM	140,667	AP-460-Sub-Model-H000.jpg
12/19/2006	12:50	PM	37,344	AP-460-Sub-Model-H001.jpg
12/19/2006	12:51	PM	36,448	AP-460-Sub-Model-H002.jpg
12/19/2006	12:53	PM	51,532	AP-460-Sub-Model-H003.jpg
12/19/2006	12:54	PM	51,017	AP-460-Sub-Model-H004.jpg
12/19/2006	01:00	PM	33,346	AP-460-Sub-Model-H005.jpg
12/19/2006	01:02	PM	120,459	AP-460-Sub-Model-H006.jpg
11/17/2006	11:04	AM	6,046	Bolts-Friction.txt
06/09/2005	01:59	PM	262	Boundary.txt
11/19/2006	09:14	AM	227	Contact-AP.txt
08/21/2006	07:59	AM	586	Contact-Footing.txt
08/25/2006	01:28	PM	704	Contact-Insul.txt
08/25/2006	01:27	PM	704	Contact-J-Bolts.txt
08/25/2006	01:28	PM	708	Contact-Primary.txt
08/21/2006	07:59	AM	742	Contact-Soil.txt
08/21/2006	12:44	PM	632	Contact-Waste-AP.txt
01/03/2006	11:17	AM	1,616	Disp-J-Bolts.txt
11/10/2006	02:08	PM	8,620	Far-Soil.txt
11/17/2006	10:53	AM	5,822	file.log

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12/20/2005	04:49 PM	39,925	file.txt
10/13/2005	06:54 AM	562	Fix-Soil.txt
08/21/2006	08:00 AM	894	Force-c.txt
08/21/2006	08:00 AM	661	Force-j_bolt.txt
10/17/2006	01:37 PM	1,668	Insulate.txt
07/20/2006	06:36 AM	4,030	interface-gap1.txt
11/13/2006	01:45 PM	2,445	interface1.txt
08/23/2006	07:47 AM	1,971	Liner.txt
05/02/2005	02:19 PM	667	live_load.txt
07/21/2006	10:03 AM	6,214	Near-Soil-1.txt
04/20/2005	01:14 PM	508	outer-spar.txt
11/10/2006	04:08 PM	125	Post-Tank.txt
11/10/2006	04:05 PM	6,154	Primary-Props-AP.txt
09/27/2005	03:52 PM	1,538	Primary.txt
12/19/2006	09:41 AM	1,353,717	QA.out
10/31/2005	10:31 AM	1,108	RS_FREQ.txt
11/19/2006	09:49 AM	1,893	Run-Tank.txt
12/19/2006	09:40 AM	0	scratch.hlp
02/11/2005	01:22 PM	1,053	Slave.txt
11/11/2005	10:36 AM	4,989	Soil-Prop-Mean-Geo.txt
11/13/2006	01:57 PM	2,028	Solve-Slosh-flex.txt
11/17/2006	11:14 AM	2,177	Solve-Sub-Horiz.txt
08/25/2006	08:47 AM	1,918	Solve-TH-BES.txt
09/13/2006	06:12 AM	347	spectra-all.txt
09/13/2006	06:07 AM	3,690	spectra-conc-0.txt
09/13/2006	06:08 AM	3,723	spectra-conc-135.txt
09/13/2006	06:09 AM	3,723	spectra-conc-180.txt
09/13/2006	06:08 AM	3,769	spectra-conc-45.txt
09/13/2006	06:08 AM	3,649	spectra-conc-90.txt
09/13/2006	06:09 AM	1,590	spectra-conc.txt
08/28/2006	09:38 AM	2,076	spectra-concrete.txt
10/03/2006	02:02 PM	3,624	spectra-primary-0.txt
10/03/2006	02:04 PM	3,777	spectra-primary-135.txt
09/13/2006	06:15 AM	3,777	spectra-primary-180.txt
10/03/2006	02:03 PM	3,703	spectra-primary-45.txt
10/03/2006	02:03 PM	3,703	spectra-primary-90.txt
09/13/2006	06:15 AM	3,801	spectra-soil.txt
06/20/2005	09:04 AM	647	spectra-wall.txt
06/20/2005	08:52 AM	679	spectra-waste.txt
09/05/2006	02:00 PM	2,588	strain-backed.txt
08/21/2006	08:01 AM	566	strain-compb-p.txt
08/16/2006	01:59 PM	621	strain-compb-primary.txt
08/21/2006	08:01 AM	693	strain-compb.txt
08/21/2006	08:02 AM	566	strain-compm-p.txt
08/16/2006	02:00 PM	621	strain-compm-primary.txt
08/21/2006	08:01 AM	705	strain-compm.txt
08/21/2006	08:02 AM	578	strain-compt-p.txt
08/16/2006	02:00 PM	621	strain-compt-primary.txt
08/21/2006	08:02 AM	720	strain-compt.txt
08/21/2006	08:02 AM	730	Strain-Liner-floor.txt
01/05/2006	03:14 PM	550	Strain-Liner-p.txt
08/21/2006	08:02 AM	962	Strain-Liner-wall.txt
08/16/2006	03:01 PM	545	Strain-Liner.txt
08/16/2006	02:01 PM	292	Strain-Primary.txt
08/16/2006	02:19 PM	273	Strain.txt
08/21/2006	08:02 AM	554	stress-compb-p.txt
08/21/2006	08:02 AM	598	stress-compb.txt
08/21/2006	08:03 AM	554	stress-compm-p.txt
08/21/2006	08:03 AM	608	stress-compm.txt
08/21/2006	08:03 AM	554	stress-compt-p.txt
08/24/2006	03:19 PM	598	stress-compt.txt
08/17/2006	11:19 AM	207	Stress-Primary-M.txt
08/24/2006	12:05 PM	224	Stress-Primary.txt
08/02/2006	06:15 AM	4,008	Tank-Coordinates-AP.txt
05/25/2005	03:32 PM	2,512	Tank-Mesh1.txt
12/19/2006	09:40 AM	25	tank-out.out
10/17/2006	12:18 PM	5,554	Tank-Props-Rigid.txt
12/19/2006	09:41 AM	6,711	Tank-th.out
11/10/2006	02:17 PM	22,588	TH-Sub-Modal-Column.txt
11/10/2006	02:19 PM	19,879	TH-Sub-Model-h.txt
12/19/2006	12:34 PM	45,117	Waste-Reaction-460-SD3.out

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```
12/19/2006 12:33 PM          339 Waste-Reaction.txt
11/14/2006 07:33 AM        10,553 Waste-solid-AP-S.txt
08/21/2006 08:03 AM          776 Waste-Surface-AP.txt
          111 File(s)      334,901,264 bytes
```

```
Total Files Listed:
      434 File(s)      926,552,615 bytes
       5 Dir(s)  160,844,402,688 bytes free
```

Sub-Model File Listing, Vertical Excitation

Volume in drive C is 600GB 2xRAID0 (new)
Volume Serial Number is 8A0A-E4BA

Directory of C:\Users\Bruce\2008-000 PNNL\2008-005 AP-460\AP-460-Sub-Model-Vert

```
01/02/2007 11:56 AM  <DIR>          .
01/02/2007 11:56 AM  <DIR>          ..
08/21/2006 06:49 AM              101 All-Forces.txt
11/10/2006 03:07 PM              768 AP-460-Slosh-Flex-Dytran.log
11/23/2006 09:35 AM      3,753,412 AP-460-Solve-Sub-Vert.out
11/20/2006 08:59 AM      76,382 AP-460-Sub-Model-H.log
12/14/2006 02:38 PM      2,998 AP-460-Sub-Model-V.BCS
12/18/2006 11:39 AM    43,581,440 AP-460-Sub-Model-V.db
12/17/2006 01:55 PM      701,396 AP-460-Sub-Model-V.err
12/18/2006 11:39 AM      1,016 AP-460-Sub-Model-V.log
12/14/2006 02:38 PM     190,159 AP-460-Sub-Model-V.mntr
12/14/2006 02:38 PM        67 AP-460-Sub-Model-V.PVTS
12/13/2006 06:51 AM         0 AP-460-Sub-Model-V.sda
11/23/2006 09:30 AM        97 AP-460-Sub-Model-V.stat
12/21/2006 03:29 PM    8,952,320 AP-460-Sub-Model-Vert Pri Tank Stress Seismic.xls
12/17/2006 12:15 PM    377,856 AP-460-Sub-Model-Vert Total Reaction.xls
12/21/2006 03:28 PM    937,472 AP-460-Sub-Model-Vert Waste-TH-MAX.xls
11/17/2006 11:04 AM      6,046 Bolts-Friction.txt
06/09/2005 01:59 PM      262 Boundary.txt
11/19/2006 09:14 AM      227 Contact-AP.txt
08/21/2006 07:59 AM      586 Contact-Footing.txt
08/25/2006 01:28 PM      704 Contact-Insul.txt
08/25/2006 01:27 PM      704 Contact-J-Bolts.txt
08/25/2006 01:28 PM      708 Contact-Primary.txt
08/21/2006 07:59 AM      742 Contact-Soil.txt
08/21/2006 12:44 PM      632 Contact-Waste-AP.txt
01/03/2006 11:17 AM      1,616 Disp-J-Bolts.txt
11/10/2006 02:08 PM      8,620 Far-Soil.txt
11/22/2006 08:32 AM      2,002 file.bat
11/22/2006 08:32 AM        68 file.err
11/22/2006 08:32 AM     6,050 file.log
12/20/2005 04:49 PM    39,925 file.txt
10/13/2005 06:54 AM      562 Fix-Soil.txt
08/21/2006 08:00 AM      894 Force-c.txt
08/21/2006 08:00 AM      661 Force-j_bolt.txt
12/20/2006 07:36 AM  <DIR>          Freq Test
10/17/2006 01:37 PM      1,668 Insulate.txt
07/20/2006 06:36 AM      4,030 interface-gap1.txt
11/13/2006 01:45 PM      2,445 interfacel.txt
08/23/2006 07:47 AM      1,971 Liner.txt
05/02/2005 02:19 PM      667 live_load.txt
07/21/2006 10:03 AM      6,214 Near-Soil-1.txt
04/20/2005 01:14 PM      508 outer-spar.txt
11/10/2006 04:08 PM      125 Post-Tank.txt
11/10/2006 04:05 PM      6,154 Primary-Props-AP.txt
09/27/2005 03:52 PM      1,538 Primary.txt
11/22/2006 08:32 AM    408,638 QA.out
10/31/2005 10:31 AM      1,108 RS_FREQ.txt
11/24/2006 12:40 AM    2,782,379 Run-Tank-Out.out
11/22/2006 06:42 AM      1,920 Run-Tank.txt
12/17/2006 01:46 PM         0 scratch.hlp
02/11/2005 01:22 PM      1,053 Slave.txt
11/11/2005 10:36 AM      4,989 Soil-Prop-Mean-Geo.txt
```

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11/13/2006	01:57 PM	2,028	Solve-Slosh-flex.txt
12/13/2006	06:48 AM	2,168	Solve-Sub-Vert.txt
08/25/2006	08:47 AM	1,918	Solve-TH-BES.txt
09/13/2006	06:12 AM	347	spectra-all.txt
09/13/2006	06:07 AM	3,690	spectra-conc-0.txt
09/13/2006	06:08 AM	3,723	spectra-conc-135.txt
09/13/2006	06:09 AM	3,723	spectra-conc-180.txt
09/13/2006	06:08 AM	3,769	spectra-conc-45.txt
09/13/2006	06:08 AM	3,649	spectra-conc-90.txt
09/13/2006	06:09 AM	1,590	spectra-conc.txt
08/28/2006	09:38 AM	2,076	spectra-concrete.txt
10/03/2006	02:02 PM	3,624	spectra-primary-0.txt
10/03/2006	02:04 PM	3,777	spectra-primary-135.txt
09/13/2006	06:15 AM	3,777	spectra-primary-180.txt
10/03/2006	02:03 PM	3,703	spectra-primary-45.txt
10/03/2006	02:03 PM	3,703	spectra-primary-90.txt
09/13/2006	06:15 AM	3,801	spectra-soil.txt
06/20/2005	09:04 AM	647	spectra-wall.txt
06/20/2005	08:52 AM	679	spectra-waste.txt
12/15/2006	07:10 AM	286,720	str-comp_0-90b.xls
12/15/2006	07:11 AM	291,840	str-comp_0-90m.xls
12/15/2006	07:11 AM	292,864	str-comp_0-90t.xls
12/15/2006	07:11 AM	293,376	str-comp_99-180b.xls
12/15/2006	07:11 AM	298,496	str-comp_99-180m.xls
12/15/2006	07:12 AM	292,864	str-comp_99-180t.xls
09/05/2006	02:00 PM	2,588	strain-backed.txt
08/21/2006	08:01 AM	566	strain-compb-p.txt
08/16/2006	01:59 PM	621	strain-compb-primary.txt
08/21/2006	08:01 AM	693	strain-compb.txt
08/21/2006	08:02 AM	566	strain-compm-p.txt
08/16/2006	02:00 PM	621	strain-compm-primary.txt
08/21/2006	08:01 AM	705	strain-compm.txt
08/21/2006	08:02 AM	578	strain-compt-p.txt
08/16/2006	02:00 PM	621	strain-compt-primary.txt
08/21/2006	08:02 AM	720	strain-compt.txt
08/21/2006	08:02 AM	730	Strain-Liner-floor.txt
01/05/2006	03:14 PM	550	Strain-Liner-p.txt
08/21/2006	08:02 AM	962	Strain-Liner-wall.txt
08/16/2006	03:01 PM	545	Strain-Liner.txt
08/16/2006	02:01 PM	292	Strain-Primary.txt
08/16/2006	02:19 PM	273	Strain.txt
08/21/2006	08:02 AM	554	stress-compb-p.txt
08/21/2006	08:02 AM	598	stress-compb.txt
08/21/2006	08:03 AM	554	stress-compm-p.txt
08/21/2006	08:03 AM	608	stress-compm.txt
08/21/2006	08:03 AM	554	stress-compt-p.txt
08/24/2006	03:19 PM	598	stress-compt.txt
08/17/2006	11:19 AM	207	Stress-Primary-M.txt
08/24/2006	12:05 PM	224	Stress-Primary.txt
12/15/2006	03:27 AM	13,519	Stress-pt_108max-b.OUT
12/14/2006	11:43 PM	13,519	Stress-pt_108max-m.OUT
12/14/2006	07:58 PM	13,519	Stress-pt_108max-t.OUT
12/15/2006	03:27 AM	6,143,768	Stress-pt_108th-b.OUT
12/14/2006	11:43 PM	6,143,768	Stress-pt_108th-m.OUT
12/14/2006	07:58 PM	6,115,040	Stress-pt_108th-t.OUT
12/15/2006	03:38 AM	13,519	Stress-pt_117max-b.OUT
12/14/2006	11:54 PM	13,519	Stress-pt_117max-m.OUT
12/14/2006	08:09 PM	13,519	Stress-pt_117max-t.OUT
12/15/2006	03:38 AM	6,143,768	Stress-pt_117th-b.OUT
12/14/2006	11:54 PM	6,143,768	Stress-pt_117th-m.OUT
12/14/2006	08:09 PM	6,115,040	Stress-pt_117th-t.OUT
12/15/2006	03:49 AM	13,519	Stress-pt_126max-b.OUT
12/15/2006	12:05 AM	13,519	Stress-pt_126max-m.OUT
12/14/2006	08:21 PM	13,519	Stress-pt_126max-t.OUT
12/15/2006	03:49 AM	6,143,768	Stress-pt_126th-b.OUT
12/15/2006	12:05 AM	6,143,768	Stress-pt_126th-m.OUT
12/14/2006	08:21 PM	6,115,040	Stress-pt_126th-t.OUT
12/15/2006	04:00 AM	13,519	Stress-pt_135max-b.OUT
12/15/2006	12:16 AM	13,519	Stress-pt_135max-m.OUT
12/14/2006	08:32 PM	13,519	Stress-pt_135max-t.OUT
12/15/2006	04:01 AM	6,143,768	Stress-pt_135th-b.OUT

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12/15/2006	12:16 AM	6,143,768	Stress-pt_135th-m.OUT
12/14/2006	08:32 PM	6,115,040	Stress-pt_135th-t.OUT
12/15/2006	04:12 AM	13,519	Stress-pt_144max-b.OUT
12/15/2006	12:28 AM	13,519	Stress-pt_144max-m.OUT
12/14/2006	08:43 PM	13,519	Stress-pt_144max-t.OUT
12/15/2006	04:12 AM	6,143,768	Stress-pt_144th-b.OUT
12/15/2006	12:28 AM	6,143,768	Stress-pt_144th-m.OUT
12/14/2006	08:43 PM	6,115,040	Stress-pt_144th-t.OUT
12/15/2006	04:23 AM	13,519	Stress-pt_153max-b.OUT
12/15/2006	12:39 AM	13,519	Stress-pt_153max-m.OUT
12/14/2006	08:54 PM	13,519	Stress-pt_153max-t.OUT
12/15/2006	04:23 AM	6,143,768	Stress-pt_153th-b.OUT
12/15/2006	12:39 AM	6,143,768	Stress-pt_153th-m.OUT
12/14/2006	08:54 PM	6,115,040	Stress-pt_153th-t.OUT
12/15/2006	04:34 AM	13,519	Stress-pt_162max-b.OUT
12/15/2006	12:50 AM	13,519	Stress-pt_162max-m.OUT
12/14/2006	09:06 PM	13,519	Stress-pt_162max-t.OUT
12/15/2006	04:34 AM	6,143,768	Stress-pt_162th-b.OUT
12/15/2006	12:50 AM	6,143,768	Stress-pt_162th-m.OUT
12/14/2006	09:06 PM	6,115,040	Stress-pt_162th-t.OUT
12/15/2006	04:45 AM	13,521	Stress-pt_171max-b.OUT
12/15/2006	01:01 AM	13,521	Stress-pt_171max-m.OUT
12/14/2006	09:17 PM	13,521	Stress-pt_171max-t.OUT
12/15/2006	04:45 AM	6,143,768	Stress-pt_171th-b.OUT
12/15/2006	01:01 AM	6,143,768	Stress-pt_171th-m.OUT
12/14/2006	09:17 PM	6,115,040	Stress-pt_171th-t.OUT
12/15/2006	04:56 AM	13,521	Stress-pt_180max-b.OUT
12/15/2006	01:12 AM	13,521	Stress-pt_180max-m.OUT
12/14/2006	09:28 PM	13,521	Stress-pt_180max-t.OUT
12/15/2006	04:56 AM	6,143,768	Stress-pt_180th-b.OUT
12/15/2006	01:12 AM	6,143,768	Stress-pt_180th-m.OUT
12/14/2006	09:28 PM	6,115,040	Stress-pt_180th-t.OUT
12/15/2006	01:35 AM	13,519	Stress-pt_18max-b.OUT
12/14/2006	09:51 PM	13,519	Stress-pt_18max-m.OUT
12/14/2006	06:06 PM	13,519	Stress-pt_18max-t.OUT
12/15/2006	01:35 AM	6,143,768	Stress-pt_18th-b.OUT
12/14/2006	09:51 PM	6,143,768	Stress-pt_18th-m.OUT
12/14/2006	06:06 PM	6,115,040	Stress-pt_18th-t.OUT
12/15/2006	01:45 AM	13,519	Stress-pt_27max-b.OUT
12/14/2006	10:02 PM	13,519	Stress-pt_27max-m.OUT
12/14/2006	06:17 PM	13,519	Stress-pt_27max-t.OUT
12/15/2006	01:45 AM	6,143,768	Stress-pt_27th-b.OUT
12/14/2006	10:02 PM	6,143,768	Stress-pt_27th-m.OUT
12/14/2006	06:17 PM	6,115,040	Stress-pt_27th-t.OUT
12/15/2006	01:56 AM	13,519	Stress-pt_36max-b.OUT
12/14/2006	10:13 PM	13,519	Stress-pt_36max-m.OUT
12/14/2006	06:28 PM	13,519	Stress-pt_36max-t.OUT
12/15/2006	01:56 AM	6,143,768	Stress-pt_36th-b.OUT
12/14/2006	10:13 PM	6,143,768	Stress-pt_36th-m.OUT
12/14/2006	06:28 PM	6,115,040	Stress-pt_36th-t.OUT
12/15/2006	02:08 AM	13,519	Stress-pt_45max-b.OUT
12/14/2006	10:24 PM	13,519	Stress-pt_45max-m.OUT
12/14/2006	06:40 PM	13,519	Stress-pt_45max-t.OUT
12/15/2006	02:08 AM	6,143,768	Stress-pt_45th-b.OUT
12/14/2006	10:24 PM	6,143,768	Stress-pt_45th-m.OUT
12/14/2006	06:40 PM	6,115,040	Stress-pt_45th-t.OUT
12/15/2006	02:19 AM	13,519	Stress-pt_54max-b.OUT
12/14/2006	10:35 PM	13,519	Stress-pt_54max-m.OUT
12/14/2006	06:50 PM	13,519	Stress-pt_54max-t.OUT
12/15/2006	02:19 AM	6,143,768	Stress-pt_54th-b.OUT
12/14/2006	10:35 PM	6,143,768	Stress-pt_54th-m.OUT
12/14/2006	06:50 PM	6,115,040	Stress-pt_54th-t.OUT
12/15/2006	02:31 AM	13,519	Stress-pt_63max-b.OUT
12/14/2006	10:47 PM	13,519	Stress-pt_63max-m.OUT
12/14/2006	07:02 PM	13,519	Stress-pt_63max-t.OUT
12/15/2006	02:31 AM	6,143,768	Stress-pt_63th-b.OUT
12/14/2006	10:47 PM	6,143,768	Stress-pt_63th-m.OUT
12/14/2006	07:02 PM	6,115,040	Stress-pt_63th-t.OUT
12/15/2006	02:41 AM	13,519	Stress-pt_72max-b.OUT
12/14/2006	10:58 PM	13,519	Stress-pt_72max-m.OUT
12/14/2006	07:13 PM	13,519	Stress-pt_72max-t.OUT

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12/15/2006	02:41 AM	6,143,768	Stress-pt_72th-b.OUT
12/14/2006	10:58 PM	6,143,768	Stress-pt_72th-m.OUT
12/14/2006	07:13 PM	6,115,040	Stress-pt_72th-t.OUT
12/15/2006	02:53 AM	13,519	Stress-pt_81max-b.OUT
12/14/2006	11:09 PM	13,519	Stress-pt_81max-m.OUT
12/14/2006	07:24 PM	13,519	Stress-pt_81max-t.OUT
12/15/2006	02:53 AM	6,143,768	Stress-pt_81th-b.OUT
12/14/2006	11:09 PM	6,143,768	Stress-pt_81th-m.OUT
12/14/2006	07:24 PM	6,115,040	Stress-pt_81th-t.OUT
12/15/2006	03:04 AM	13,519	Stress-pt_90max-b.OUT
12/14/2006	11:20 PM	13,519	Stress-pt_90max-m.OUT
12/14/2006	07:36 PM	13,519	Stress-pt_90max-t.OUT
12/15/2006	03:04 AM	6,143,768	Stress-pt_90th-b.OUT
12/14/2006	11:20 PM	6,143,768	Stress-pt_90th-m.OUT
12/14/2006	07:36 PM	6,115,040	Stress-pt_90th-t.OUT
12/15/2006	03:16 AM	13,519	Stress-pt_99max-b.OUT
12/14/2006	11:32 PM	13,519	Stress-pt_99max-m.OUT
12/14/2006	07:47 PM	13,519	Stress-pt_99max-t.OUT
12/15/2006	03:16 AM	6,143,768	Stress-pt_99th-b.OUT
12/14/2006	11:32 PM	6,143,768	Stress-pt_99th-m.OUT
12/14/2006	07:47 PM	6,115,040	Stress-pt_99th-t.OUT
12/15/2006	01:23 AM	13,519	Stress-pt_9max-b.OUT
12/14/2006	09:39 PM	13,519	Stress-pt_9max-m.OUT
12/14/2006	05:55 PM	13,519	Stress-pt_9max-t.OUT
12/15/2006	01:24 AM	6,143,896	Stress-pt_9th-b.OUT
12/14/2006	09:39 PM	6,143,896	Stress-pt_9th-m.OUT
12/14/2006	05:55 PM	6,115,168	Stress-pt_9th-t.OUT
01/02/2007	11:57 AM	0	Sub-Model-Vert-Files.txt
08/02/2006	06:15 AM	4,008	Tank-Coordinates-AP.txt
05/25/2005	03:32 PM	2,512	Tank-Mesh1.txt
11/22/2006	08:32 AM	25	tank-out.out
10/17/2006	12:18 PM	5,554	Tank-Props-Rigid.txt
11/22/2006	08:32 AM	7,639	Tank-th.out
11/10/2006	02:17 PM	22,588	TH-Sub-Modal-Column.txt
11/10/2006	02:19 PM	19,879	TH-Sub-Model-h.txt
11/22/2006	08:27 AM	19,879	TH-Sub-Model-v.txt
12/19/2006	03:13 PM	11,696,640	Waste Pressure 0 deg.xls
12/19/2006	03:13 PM	11,919,872	Waste Pressure 45 deg.xls
12/19/2006	03:14 PM	11,920,384	Waste Pressure 90 deg.xls
12/14/2006	04:26 PM	10,180	Waste-Cont_108max.OUT
12/14/2006	04:26 PM	4,643,118	Waste-Cont_108th.OUT
12/14/2006	04:35 PM	10,180	Waste-Cont_117max.OUT
12/14/2006	04:35 PM	4,643,118	Waste-Cont_117th.OUT
12/14/2006	04:44 PM	10,180	Waste-Cont_126max.OUT
12/14/2006	04:44 PM	4,643,118	Waste-Cont_126th.OUT
12/14/2006	04:53 PM	10,180	Waste-Cont_135max.OUT
12/14/2006	04:53 PM	4,643,118	Waste-Cont_135th.OUT
12/14/2006	05:02 PM	10,180	Waste-Cont_144max.OUT
12/14/2006	05:02 PM	4,643,118	Waste-Cont_144th.OUT
12/14/2006	05:10 PM	10,180	Waste-Cont_153max.OUT
12/14/2006	05:10 PM	4,643,118	Waste-Cont_153th.OUT
12/14/2006	05:19 PM	10,180	Waste-Cont_162max.OUT
12/14/2006	05:19 PM	4,643,118	Waste-Cont_162th.OUT
12/14/2006	05:28 PM	10,180	Waste-Cont_171max.OUT
12/14/2006	05:28 PM	4,643,118	Waste-Cont_171th.OUT
12/14/2006	05:37 PM	10,180	Waste-Cont_180max.OUT
12/14/2006	05:37 PM	4,643,118	Waste-Cont_180th.OUT
12/14/2006	02:57 PM	10,180	Waste-Cont_18max.OUT
12/14/2006	02:57 PM	4,643,118	Waste-Cont_18th.OUT
12/14/2006	03:06 PM	10,180	Waste-Cont_27max.OUT
12/14/2006	03:06 PM	4,643,118	Waste-Cont_27th.OUT
12/14/2006	03:16 PM	10,180	Waste-Cont_36max.OUT
12/14/2006	03:16 PM	4,643,118	Waste-Cont_36th.OUT
12/14/2006	03:25 PM	10,180	Waste-Cont_45max.OUT
12/14/2006	03:25 PM	4,643,118	Waste-Cont_45th.OUT
12/14/2006	03:34 PM	10,180	Waste-Cont_54max.OUT
12/14/2006	03:34 PM	4,643,118	Waste-Cont_54th.OUT
12/14/2006	03:42 PM	10,180	Waste-Cont_63max.OUT
12/14/2006	03:42 PM	4,643,118	Waste-Cont_63th.OUT
12/14/2006	03:51 PM	10,180	Waste-Cont_72max.OUT
12/14/2006	03:51 PM	4,643,118	Waste-Cont_72th.OUT

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12/14/2006 03:59 PM      10,180 Waste-Cont_81max.OUT
12/14/2006 03:59 PM    4,643,118 Waste-Cont_81th.OUT
12/14/2006 04:08 PM      10,180 Waste-Cont_90max.OUT
12/14/2006 04:08 PM    4,643,118 Waste-Cont_90th.OUT
12/14/2006 04:17 PM      10,180 Waste-Cont_99max.OUT
12/14/2006 04:17 PM    4,643,118 Waste-Cont_99th.OUT
12/14/2006 02:47 PM      10,180 Waste-Cont_9max.OUT
12/14/2006 02:47 PM    4,643,246 Waste-Cont_9th.OUT
12/14/2006 05:43 PM      45,117 Waste-Reaction-460-SD3.out
09/25/2006 10:41 AM      340 Waste-Reaction.txt
11/14/2006 07:33 AM      10,553 Waste-solid-AP-S.txt
12/17/2006 01:06 PM      683 Waste-Surface-AP.txt
12/17/2006 01:47 PM      1,027 Waste-Surf_0max.OUT
12/17/2006 01:47 PM    572,821 Waste-Surf_0th.OUT
12/17/2006 01:52 PM      1,027 Waste-Surf_108max.OUT
12/17/2006 01:52 PM    572,693 Waste-Surf_108th.OUT
12/17/2006 01:53 PM      1,027 Waste-Surf_117max.OUT
12/17/2006 01:53 PM    572,693 Waste-Surf_117th.OUT
12/17/2006 01:53 PM      1,027 Waste-Surf_126max.OUT
12/17/2006 01:53 PM    572,693 Waste-Surf_126th.OUT
12/17/2006 01:53 PM      1,027 Waste-Surf_135max.OUT
12/17/2006 01:53 PM    572,693 Waste-Surf_135th.OUT
12/17/2006 01:54 PM      1,027 Waste-Surf_144max.OUT
12/17/2006 01:54 PM    572,693 Waste-Surf_144th.OUT
12/17/2006 01:54 PM      1,027 Waste-Surf_153max.OUT
12/17/2006 01:54 PM    572,693 Waste-Surf_153th.OUT
12/17/2006 01:55 PM      1,027 Waste-Surf_162max.OUT
12/17/2006 01:55 PM    572,693 Waste-Surf_162th.OUT
12/17/2006 01:55 PM      1,027 Waste-Surf_171max.OUT
12/17/2006 01:55 PM    572,693 Waste-Surf_171th.OUT
12/17/2006 01:55 PM      1,027 Waste-Surf_180max.OUT
12/17/2006 01:55 PM    572,693 Waste-Surf_180th.OUT
12/17/2006 01:55 PM      1,027 Waste-Surf_189max.OUT
12/17/2006 01:55 PM    572,693 Waste-Surf_189th.OUT
12/17/2006 01:48 PM      1,027 Waste-Surf_18max.OUT
12/17/2006 01:48 PM    572,693 Waste-Surf_18th.OUT
12/17/2006 01:48 PM      1,027 Waste-Surf_27max.OUT
12/17/2006 01:48 PM    572,693 Waste-Surf_27th.OUT
12/17/2006 01:49 PM      1,027 Waste-Surf_36max.OUT
12/17/2006 01:49 PM    572,693 Waste-Surf_36th.OUT
12/17/2006 01:49 PM      1,027 Waste-Surf_45max.OUT
12/17/2006 01:49 PM    572,693 Waste-Surf_45th.OUT
12/17/2006 01:50 PM      1,027 Waste-Surf_54max.OUT
12/17/2006 01:50 PM    572,693 Waste-Surf_54th.OUT
12/17/2006 01:50 PM      1,027 Waste-Surf_63max.OUT
12/17/2006 01:50 PM    572,693 Waste-Surf_63th.OUT
12/17/2006 01:50 PM      1,027 Waste-Surf_72max.OUT
12/17/2006 01:50 PM    572,693 Waste-Surf_72th.OUT
12/17/2006 01:51 PM      1,027 Waste-Surf_81max.OUT
12/17/2006 01:51 PM    572,693 Waste-Surf_81th.OUT
12/17/2006 01:51 PM      1,027 Waste-Surf_90max.OUT
12/17/2006 01:51 PM    572,693 Waste-Surf_90th.OUT
12/17/2006 01:52 PM      1,027 Waste-Surf_99max.OUT
12/17/2006 01:52 PM    572,693 Waste-Surf_99th.OUT
12/17/2006 01:48 PM      1,027 Waste-Surf_9max.OUT
12/17/2006 01:48 PM    572,693 Waste-Surf_9th.OUT
12/15/2006 07:15 AM      229,888 waste_0-90.xls
12/15/2006 07:15 AM      229,888 waste_99-180.xls
321 File(s)      574,382,541 bytes

```

Directory of C:\Users\Bruce\2008-000 PNNL\2008-005 AP-460\AP-460-Sub-Model-Vert\Freq Test

```

12/20/2006 07:36 AM    <DIR>      .
12/20/2006 07:36 AM    <DIR>      ..
08/21/2006 06:49 AM      101 All-Forces.txt
11/10/2006 03:07 PM      768 AP-460-Slosh-Flex-Dytran.log
12/19/2006 02:09 PM    323,726 AP-460-Slosh-Flex-V.out
12/19/2006 01:07 PM      136 AP-460-Sub-Model-H.err
12/19/2006 01:07 PM      77,418 AP-460-Sub-Model-H.log
12/19/2006 02:09 PM      2,998 AP-460-Sub-Model-V.BCS
12/19/2006 02:09 PM    43,646,976 AP-460-Sub-Model-V.db

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12/19/2006	02:09	PM	53,084,160	AP-460-Sub-Model-V.dbb
12/19/2006	02:09	PM	11,730,944	AP-460-Sub-Model-V.emat
12/20/2006	07:36	AM	48,725	AP-460-Sub-Model-V.err
12/19/2006	02:09	PM	50,462,720	AP-460-Sub-Model-V.esav
12/19/2006	02:09	PM	12,845,056	AP-460-Sub-Model-V.full
12/19/2006	02:08	PM	15,299,480	AP-460-Sub-Model-V.ldhi
12/20/2006	07:36	AM	2,948	AP-460-Sub-Model-V.log
12/19/2006	02:09	PM	10,943	AP-460-Sub-Model-V.mntr
12/19/2006	02:08	PM	50,462,720	AP-460-Sub-Model-V.osav
12/19/2006	02:09	PM	67	AP-460-Sub-Model-V.PVTS
12/19/2006	02:09	PM	50,987,008	AP-460-Sub-Model-V.r001
12/19/2006	01:08	PM	43,646,976	AP-460-Sub-Model-V.rdb
12/19/2006	02:09	PM	610,467,840	AP-460-Sub-Model-V.rst
11/17/2006	11:04	AM	6,046	Bolts-Friction.txt
06/09/2005	01:59	PM	262	Boundary.txt
11/19/2006	09:14	AM	227	Contact-AP.txt
08/21/2006	07:59	AM	586	Contact-Footing.txt
08/25/2006	01:28	PM	704	Contact-Insul.txt
08/25/2006	01:27	PM	704	Contact-J-Bolts.txt
08/25/2006	01:28	PM	708	Contact-Primary.txt
08/21/2006	07:59	AM	742	Contact-Soil.txt
08/21/2006	12:44	PM	632	Contact-Waste-AP.txt
01/03/2006	11:17	AM	1,616	Disp-J-Bolts.txt
11/10/2006	02:08	PM	8,620	Far-Soil.txt
11/17/2006	10:53	AM	5,822	file.log
12/20/2005	04:49	PM	39,925	file.txt
10/13/2005	06:54	AM	562	Fix-Soil.txt
08/21/2006	08:00	AM	894	Force-c.txt
08/21/2006	08:00	AM	661	Force-j_bolt.txt
10/17/2006	01:37	PM	1,668	Insulate.txt
07/20/2006	06:36	AM	4,030	interface-gap1.txt
11/13/2006	01:45	PM	2,445	interfacel.txt
08/23/2006	07:47	AM	1,971	Liner.txt
05/02/2005	02:19	PM	667	live_load.txt
07/21/2006	10:03	AM	6,214	Near-Soil-1.txt
04/20/2005	01:14	PM	508	outer-spar.txt
11/10/2006	04:08	PM	125	Post-Tank.txt
11/10/2006	04:05	PM	6,154	Primary-Props-AP.txt
09/27/2005	03:52	PM	1,538	Primary.txt
12/19/2006	01:08	PM	451,239	QA.out
10/31/2005	10:31	AM	1,108	RS_FREQ.txt
12/19/2006	09:50	AM	1,893	Run-Tank.txt
12/19/2006	01:07	PM	0	scratch.hlp
02/11/2005	01:22	PM	1,053	Slave.txt
11/11/2005	10:36	AM	4,989	Soil-Prop-Mean-Geo.txt
12/19/2006	09:50	AM	2,028	Solve-Slosh-vert.txt
11/17/2006	11:14	AM	2,177	Solve-Sub-Horiz.txt
08/25/2006	08:47	AM	1,918	Solve-TH-BES.txt
09/13/2006	06:12	AM	347	spectra-all.txt
09/13/2006	06:07	AM	3,690	spectra-conc-0.txt
09/13/2006	06:08	AM	3,723	spectra-conc-135.txt
09/13/2006	06:09	AM	3,723	spectra-conc-180.txt
09/13/2006	06:08	AM	3,769	spectra-conc-45.txt
09/13/2006	06:08	AM	3,649	spectra-conc-90.txt
09/13/2006	06:09	AM	1,590	spectra-conc.txt
08/28/2006	09:38	AM	2,076	spectra-concrete.txt
10/03/2006	02:02	PM	3,624	spectra-primary-0.txt
10/03/2006	02:04	PM	3,777	spectra-primary-135.txt
09/13/2006	06:15	AM	3,777	spectra-primary-180.txt
10/03/2006	02:03	PM	3,703	spectra-primary-45.txt
10/03/2006	02:03	PM	3,703	spectra-primary-90.txt
09/13/2006	06:15	AM	3,801	spectra-soil.txt
06/20/2005	09:04	AM	647	spectra-wall.txt
06/20/2005	08:52	AM	679	spectra-waste.txt
09/05/2006	02:00	PM	2,588	strain-backed.txt
08/21/2006	08:01	AM	566	strain-compb-p.txt
08/16/2006	01:59	PM	621	strain-compb-primary.txt
08/21/2006	08:01	AM	693	strain-compb.txt
08/21/2006	08:02	AM	566	strain-compm-p.txt
08/16/2006	02:00	PM	621	strain-compm-primary.txt
08/21/2006	08:01	AM	705	strain-compm.txt

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08/21/2006	08:02 AM	578	strain-compt-p.txt
08/16/2006	02:00 PM	621	strain-compt-primary.txt
08/21/2006	08:02 AM	720	strain-compt.txt
08/21/2006	08:02 AM	730	Strain-Liner-floor.txt
01/05/2006	03:14 PM	550	Strain-Liner-p.txt
08/21/2006	08:02 AM	962	Strain-Liner-wall.txt
08/16/2006	03:01 PM	545	Strain-Liner.txt
08/16/2006	02:01 PM	292	Strain-Primary.txt
08/16/2006	02:19 PM	273	Strain.txt
08/21/2006	08:02 AM	554	stress-compb-p.txt
08/21/2006	08:02 AM	598	stress-compb.txt
08/21/2006	08:03 AM	554	stress-compm-p.txt
08/21/2006	08:03 AM	608	stress-compm.txt
08/21/2006	08:03 AM	554	stress-compt-p.txt
08/24/2006	03:19 PM	598	stress-compt.txt
08/17/2006	11:19 AM	207	Stress-Primary-M.txt
08/24/2006	12:05 PM	224	Stress-Primary.txt
08/02/2006	06:15 AM	4,008	Tank-Coordinates-AP.txt
05/25/2005	03:32 PM	2,512	Tank-Mesh1.txt
12/19/2006	01:07 PM	25	tank-out.out
10/17/2006	12:18 PM	5,554	Tank-Props-Rigid.txt
12/19/2006	01:08 PM	6,409	Tank-th.out
11/10/2006	02:17 PM	22,588	TH-Sub-Modal-Column.txt
11/10/2006	02:19 PM	19,879	TH-Sub-Model-h.txt
12/19/2006	02:09 PM	45,117	Waste-Reaction-460-SD3.out
12/19/2006	01:45 PM	339	Waste-Reaction.txt
11/14/2006	07:33 AM	10,553	Waste-solid-AP-S.txt
08/21/2006	08:03 AM	776	Waste-Surface-AP.txt
	106 File(s)	943,841,712 bytes	

Total Files Listed:

427 File(s)	1,518,224,253 bytes
5 Dir(s)	160,786,079,744 bytes free

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Appendix E

Common ANSYS[®] Files Listing

Intentionally left blank

Appendix E

Common ANSYS® Files Listing

All-Forces.txt

```
/input,force-c.txt  
/input,stress-Primary.txt  
/input,Force-J_bolt.txt  
/input,strain-liner.txt
```

Bolts-Friction.txt

```
pi=acos(-1)                                ! Define PI  
  
!ET,4,BEAM44                                ! Rigid Links  
!KEYOPT,4,8,111  
et,4,BEAM4  
keyopt,4,6,1  
  
et,31,combin14,,1  
et,32,combin14,,2  
et,33,combin14,,3  
  
et,34,targe170  
et,35,conta173  
!keyopt,35,2,3  
keyopt,35,5,3  
keyopt,35,9,1  
keyopt,35,11,1  
!keyopt,35,12,4  
r,701,0,0,0.025  
r,702,0,0,0.025  
r,703,0,0,0.025  
r,704,0,0,0.025  
r,705,0,0,0.025  
r,706,0,0,0.025  
r,707,0,0,0.025  
r,708,0,0,0.025  
r,709,0,0,0.025  
r,710,0,0,0.025  
r,711,0,0,0.025  
  
!BX=33333/20  
!BY=33333/20  
!BZ=22777/10  
  
BX=780  
BY=780  
BZ=780 ! Set-up isotropic bolt response 65,000 lbf/in  
  
mp,mu,700,0.01  
  
/COM - Create Rigid Links for J-Bolts  
nj_bolt=11  
  
mp,ex,401,4176000
```

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mp,nuxy,401,0.30
mp,dens,401,0
r,401,1,10,10,2.5,2.5
rmore,,1e-3
r,402,1,10,10,2.5,2.5
rmore,,1e-3
r,403,1,10,10,2.5,2.5
rmore,,1e-3
r,404,1,10,10,2.5,2.5
rmore,,1e-3
r,405,1,10,10,2.5,2.5
rmore,,1e-3
r,406,1,10,10,2.5,2.5
rmore,,1e-3
r,407,1,10,10,2.5,2.5
rmore,,1e-3
r,408,1,10,10,2.5,2.5
rmore,,1e-3
r,409,1,10,10,2.5,2.5
rmore,,1e-3
r,410,1,10,10,2.5,2.5
rmore,,1e-3
r,411,1,10,10,2.5,2.5
rmore,,1e-3

r,421,1/2,10,10,2.5,2.5
rmore,,1e-3
r,422,1/2,10,10,2.5,2.5
rmore,,1e-3
r,423,1/2,10,10,2.5,2.5
rmore,,1e-3
r,424,1/2,10,10,2.5,2.5
rmore,,1e-3
r,425,1/2,10,10,2.5,2.5
rmore,,1e-3
r,426,1/2,10,10,2.5,2.5
rmore,,1e-3
r,427,1/2,10,10,2.5,2.5
rmore,,1e-3
r,428,1/2,10,10,2.5,2.5
rmore,,1e-3
r,429,1/2,10,10,2.5,2.5
rmore,,1e-3
r,430,1/2,10,10,2.5,2.5
rmore,,1e-3
r,431,1/2,10,10,2.5,2.5
rmore,,1e-3

r,501,1.364*BX
r,502,0.550*BX
r,503,0.887*BX
r,504,1.027*BX
r,505,1.971*BX
r,506,2.407*BX
r,507,3.301*BX
r,508,4.039*BX
r,509,4.369*BX
r,510,5.362*BX
r,511,3.596*BX

r,521,1.364*BY
r,522,0.550*BY
r,523,0.887*BY
r,524,1.027*BY
r,525,1.971*BY

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r,526,2.407*BY
r,527,3.301*BY
r,528,4.039*BY
r,529,4.369*BY
r,530,5.362*BY
r,531,3.596*BY

r,541,1.364*BZ
r,542,0.550*BZ
r,543,0.887*BZ
r,544,1.027*BZ
r,545,1.971*BZ
r,546,2.407*BZ
r,547,3.301*BZ
r,548,4.039*BZ
r,549,4.369*BZ
r,550,5.362*BZ
r,551,3.596*BZ

R,601,1.364*BX/2
R,602,0.550*BX/2
R,603,0.887*BX/2
R,604,1.027*BX/2
R,605,1.971*BX/2
R,606,2.407*BX/2
R,607,3.301*BX/2
R,608,4.039*BX/2
R,609,4.369*BX/2
R,610,5.362*BX/2
R,611,3.596*BX/2

R,621,1.364*BY/2
R,622,0.550*BY/2
R,623,0.887*BY/2
R,624,1.027*BY/2
R,625,1.971*BY/2
R,626,2.407*BY/2
R,627,3.301*BY/2
R,628,4.039*BY/2
R,629,4.369*BY/2
R,630,5.362*BY/2
R,631,3.596*BY/2

R,641,1.364*BZ/2
R,642,0.550*BZ/2
R,643,0.887*BZ/2
R,644,1.027*BZ/2
R,645,1.971*BZ/2
R,646,2.407*BZ/2
R,647,3.301*BZ/2
R,648,4.039*BZ/2
R,649,4.369*BZ/2
R,650,5.362*BZ/2
R,651,3.596*BZ/2

cmisel,s,primary-tank
nsle
nsel,r,loc,z,ptz(1),ptz(11)
cm,bolt-primary-n,node
nsel,none
n,,0,0,ptz(1)
*do,i,2,nj_bolt
*do,j,0,180/arcsz
angley=-j*arcsz
n,,ptx(i),angley,ptz(i)

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```

*enddo
*enddo
cm,bolt-node,node

/COM - Create link at top center of tanks
type,4
mat,401
real,401

nsel,s,loc,x,0                ! Select nodes on model origin
nsel,r,loc,z,ptz(1),ctz(1)    ! Reselect nodes on concrete and primary tanks
!nsel,u,node,,1
cmsel,u,bolt-primary-n
eintf,10                      ! Place link at dome center

csys,1
/COM - Create links for J-Bolts
*do,i,2,nj_bolt               ! Cycle by radius
REAL,400+i
*do,j,1,180/arcsize-1         ! Cycle by model slice
anglej=-j*arcsize             ! Define angle for node selection
nsel,s,loc,x,ctx(i),ptx(i)    ! Select nodes at radius
nsel,r,loc,z,ctz(i),ptz(i)
nsel,r,loc,y,anglej           ! Reselect nodes at angle "anglej"
cmsel,u,bolt-primary-n
cmsel,u,waste-n
eintf,10                      ! Create rigid link
*enddo
real,420+i
nsel,s,loc,x,ctx(i),ptx(i)    ! Select nodes at radius
nsel,r,loc,z,ctz(i),ptz(i)
nsel,r,loc,y,0                ! Reselect nodes at angle 0
cmsel,u,bolt-primary-n
cmsel,u,waste-n
eintf,10                      ! Create rigid link
nsel,s,loc,x,ctx(i),ptx(i)    ! Select nodes at radius
nsel,r,loc,z,ctz(i),ptz(i)
nsel,r,loc,y,180              ! Reselect nodes at angle 180
cmsel,u,bolt-primary-n
cmsel,u,waste-n
eintf,10                      ! Create rigid link

*enddo

esel,s,type,,4
cm,j_bolts,elem              ! Create component for J-Bolt rigid links
allsel

/COM - Create link at top center of tanks
nsel,R,loc,x,0                ! Select nodes on model origin
nsel,r,loc,z,ptz(1),ptz(1)    ! Reselect nodes on concrete and primary tanks
TYPE,31
REAL,501
eintf                          ! Place link at dome center
TYPE,32
REAL,521
eintf                          ! Place link at dome center
TYPE,33
REAL,541
eintf                          ! Place link at dome center

csys,1

```

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```

/COM - Create links for J-Bolts
*do,j,0,2
type,31+j
*do,i,2,nj_bolt                ! Cycle by radius
REAL,500+20*j+i
*do,k,1,180/arcsize-1          ! Cycle by model slice
angley=-k*arcsize              ! Define angle for node selection
nsel,s,loc,x,ptx(i),ptx(i)     ! Select nodes at radius
nsel,r,loc,z,ptz(i),ptz(i)     ! Select nodes at radius
nsel,r,loc,y,angley            ! Reselect nodes at angle "angley"
cmsel,u,waste-n
eintf                          ! Create rigid link
*enddo
real,600+j*20+i
nsel,s,loc,x,ptx(i),ptx(i)     ! Select nodes at radius
nsel,r,loc,z,ptz(i),ptz(i)     ! Select nodes at radius
nsel,r,loc,y,0                 ! Reselect nodes at angle 0
cmsel,u,waste-n
eintf                          ! Create rigid link
nsel,s,loc,x,ptx(i),ptx(i)     ! Select nodes at radius
nsel,r,loc,z,ptz(i),ptz(i)     ! Select nodes at radius
nsel,r,loc,y,180               ! Reselect nodes at angle 180
cmsel,u,waste-n
eintf                          ! Create rigid link

*enddo
*enddo

esel,s,type,,31,33
cm,bolt-springs,elem

*do,i,1,10
cmsel,s,conc-tank
nsle
nsel,r,loc,x,ctx(i),ctx(i+1)
nsel,r,loc,z,ctz(i),ctz(i+1)
esln,r
real,700+i
type,34
esurf,,bottom
cmsel,s,primary-tank
nsle
nsel,r,loc,x,ptx(i),ptx(i+1)
nsel,r,loc,z,ptz(i),ptz(i+1)
esln,r
type,35
real,700+i
mat,700
esurf,,bottom
*enddo
esel,s,type,,35
cm,bolt-friction,elem

!*do,i,3,nj_bolt
!cmsel,s,primary-tank
!cmsel,a,conc-tank
!nsle
!nsel,r,loc,z,ptz(i),ctz(i)
!nsel,r,loc,x,ptx(i),ctx(i)
!type,35
!mat,700
!real,700
!eintf,1,high
!*enddo

```

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```
*get,KMAXjb,KP,0,num,max      ! Get maximum keypoint number
*get,LMAXjb,LINE,0,num,max    ! Get maximum line number
*get,AMAXjb,AREA,0,num,max    ! Get maximum area number
*get,VMAXjb,volu,0,num,max    ! Get maximum volume number
```

Boundary.txt

```
/COM - Fix symmetry face
allsel
csys,0
nsel,s,loc,y,0
d,all,uy
csys,1

cmsel,s,conc-tank
cmsel,a,primary-tank
cmsel,a,liner
nsle
csys,0
nsel,r,loc,y,0
d,all,rotx
d,all,rotz
csys,1

allsel

!esel,s,type,,24
!nsle
!cmsel,u,conc-slab
!ddelete,all,uy
!allsel
```

Contact-AP.txt

```
/input,waste-reaction,txt
/input,contact-waste-ap,txt
/input,contact-insul,txt
/input,contact-primary,txt
/input,contact-j-bolts,txt
/input,contact-soil,txt
/input,waste-surface-ap,txt
/input,contact-footing,txt
```

Contact-Footing.txt

```
/post26
numvar,200
*do,z,2,200
VARDEL,z
*enddo

*do,i,1,21
angley=-arcsin((i-1)/21)
esel,s,type,,24
nsle
nsel,r,loc,y,angley
esln,r,1
*get,emax,elem,,num,max
esol,(2+i),(emax),,smisc,1,pr%(emax)%
esol,(32+i),(emax),,cont,slide,sl%(emax)%
esol,(62+i),(emax),,cont,gap,gp%(emax)%
esol,(92+i),(emax),,cont,stat,st%(emax)%
esol,(122+i),(emax),,smisc,2,fsy%(emax)%
esol,(152+i),(emax),,smisc,3,fsz%(emax)%
*enddo
LINES,2150
extrem
/OUT,Footing-Cont_max,OUT
```

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```
extrem,3,200
/OUT

/OUT, Footing-Cont_th, OUT
*do, k, 1, 20
PRVAR, 2+k, 32+k, 62+k, 92+k, 122+k, 152+k
*enddo
/OUT
```

Contact-Insul.txt

```
/post26
numvar,200
*do, z, 2, 200
VARDEL, z
*enddo

*do, i, 1, 20
*do, j, 1, 8
angley=-arcsize*(i-1)
esel, s, type, , 68
nsle
nsel, r, loc, y, angley, angley-arcsize
nsel, r, loc, x, ctx(j+24), ctx(j+25)
nsel, r, loc, z, ctz(j+24), ctz(j+25)
esln, r, 1
*get, emax, elem, , num, max
esol, (2+j), (emax), , cont, pres, pr%(emax)%
esol, (32+j), (emax), , cont, slide, sl%(emax)%
esol, (62+j), (emax), , cont, gap, gap%(emax)%
esol, (92+j), (emax), , cont, stat, st%(emax)%
esol, (122+j), (emax), , cont, sf, sf%(emax)%
esol, (152+j), (emax), , cont, pene, pn%(emax)%
*enddo

LINES, 2150
extrem
/OUT, Insul-Cont_%(9*i)%max, OUT
extrem, 3, 200
/OUT

/OUT, Insul-Cont_%(9*i)%th, OUT
*do, k, 1, 20
PRVAR, 2+k, 32+k, 62+k, 92+k, 122+k, 152+k
*enddo
/OUT

*enddo
```

Contact-J-Bolts.txt

```
/post26
numvar,200
*do, z, 2, 200
VARDEL, z
*enddo

*do, i, 1, 20
*do, j, 1, 9
angley=-arcsize*(i-1)
esel, s, type, , 35
nsle
nsel, r, loc, y, angley, angley-arcsize
nsel, r, loc, x, ptx(j+1), ptx(j+2)
nsel, r, loc, z, ptz(j+1), ptz(j+2)
esln, r, 1
*get, emax, elem, , num, max
```

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```
esol, (2+j), (emax), , cont, pres, pr% (emax) %  
esol, (32+j), (emax), , cont, slide, sl% (emax) %  
esol, (62+j), (emax), , cont, gap, gap% (emax) %  
esol, (92+j), (emax), , cont, stat, stat% (emax) %  
esol, (122+j), (emax), , cont, sfric, sf% (emax) %  
esol, (152+j), (emax), , cont, pene, pn% (emax) %  
*enddo
```

```
LINES, 2150  
extrem  
/OUT, J-Bolt-Cont_%(9*i) %max, OUT  
extrem, 3, 200  
/OUT
```

```
/OUT, J-Bolt-Cont_%(9*i) %th, OUT  
*do, k, 1, 21  
PRVAR, 2+k, 32+k, 62+k, 92+k, 122+k, 152+k  
*enddo  
/OUT  
  
*enddo
```

Contact-Primary.txt

```
/post26  
numvar, 200  
*do, z, 2, 200  
VARDEL, z  
*enddo
```

```
*do, i, 1, 20  
*do, j, 1, 8  
angley = -arcsize * (i-1)  
esel, s, type, , 66  
nsle  
nsel, r, loc, y, angley, angley-arcsize  
nsel, r, loc, x, ptx(j+34), ptx(j+35)  
nsel, r, loc, z, ptz(j+34), ptz(j+35)  
esln, r, 1  
*get, emax, elem, , num, max  
esol, (2+j), (emax), , cont, pres, pr% (emax) %  
esol, (32+j), (emax), , cont, slide, sl% (emax) %  
esol, (62+j), (emax), , cont, gap, gap% (emax) %  
esol, (92+j), (emax), , cont, stat, st% (emax) %  
esol, (122+j), (emax), , cont, sfric, sf% (emax) %  
esol, (152+j), (emax), , cont, pene, pn% (emax) %  
*enddo
```

```
LINES, 2150  
extrem  
/OUT, Primary-Cont_%(9*i) %max, OUT  
extrem, 3, 200  
/OUT
```

```
/OUT, Primary-Cont_%(9*i) %th, OUT  
*do, k, 1, 20  
PRVAR, 2+k, 32+k, 62+k, 92+k, 122+k, 152+k  
*enddo  
/OUT  
  
*enddo
```

Contact-Soil.txt

```
/post26  
numvar, 200  
*do, z, 2, 200  
VARDEL, z
```

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```
*enddo

*do,i,1,20
*do,j,1,20
angley=-arcsize*(i-1)
esel,s,type,,61,63,2
nsle
nsel,r,loc,y,angley,angley-arcsize
nsel,r,loc,x,ctx(j+1),ctx(j+2)
nsel,r,loc,z,ctz(j+1),ctz(j+2)
esln,r,1
*get,emax,elem,,num,max
*get,nmax,node,,num,max
esol,(2+j),(emax),,cont,pres,pr%(emax)%
esol,(32+j),(emax),,cont,slide,pr%(emax)%
esol,(62+j),(emax),,cont,gap,pr%(emax)%
esol,(92+j),(emax),,cont,stat,pr%(emax)%
esol,(122+j),(emax),nmax,smisc,8,taur%(emax)%
esol,(152+j),(emax),nmax,smisc,12,taus%(emax)%
*enddo

LINES,2150
extrem
/OUT,Soil-Contact_%(9*i)%max,OUT
extrem,3,200
/OUT

/OUT,Soil-Contact_%(9*i)%th,OUT
*do,k,1,21
PRVAR,2+k,32+k,62+k,92+k,122+k,152+k
*enddo
/OUT

*enddo
```

Contact-Waste-AP.txt

```
/post26
numvar,200
*do,z,2,200
VARDEL,z
*enddo

*do,i,1,20
*do,j,1,31
angley=-arcsize*(i-1)
cmsel,s,waste-surf
nsle
nsel,r,loc,y,angley,angley-arcsize
nsel,r,loc,x,ptx(j+wastet-1),ptx(j+wastet)
nsel,r,loc,z,ptz(j+wastet-1),ptz(j+wastet)
esln,r,1
*get,emax,elem,,num,max
esol,(2+j),(emax),,Cont,pres,pr%(emax)%
esol,(42+j),(emax),,Cont,slide,sl%(emax)%
esol,(82+j),(emax),,Cont,gap,gp%(emax)%
esol,(122+j),(emax),,Cont,stat,st%(emax)%
*enddo

LINES,2050
extrem
/OUT,Waste-Cont_%(9*i)%max,OUT
extrem,3,200
/OUT

/OUT,Waste-Cont_%(9*i)%th,OUT
*do,k,1,31
PRVAR,2+k,42+k,82+k,122+k
```

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```
*enddo
/OUT

*enddo
```

Far-Soil.txt

```
et,9,solid45          ! Use Element type SOLID45 for Far Soil
et,10,mass21
r,1001,mass,mass,mass
type,9

asel,none             ! unselect all reas
vsel,none             ! unselect all volumes
lsel,none
nsel,none
ksel,none
esel,none

/COM - Generate Keypoints at full model radius
*do,i,1,tanksoil
k,kmaxns+i,soil_radius,0,soilz(i)
*enddo

*do,i,1,9
k,kmaxns+tanksoil+i,soilx(i),0,soilz(i)
*enddo

/COM - Generate areas outside excavated soil
*do,i,1,tanksoil-1
kp1=cp(soilx(i),0,soilz(i))
kp2=cp(soil_radius,0,soilz(i))
kp3=cp(soil_radius,0,soilz(i+1))
kp4=cp(soilx(i+1),0,soilz(i+1))
a,kp1,kp2,kp3,kp4
*enddo
ksel,a,kp,,1,ct_kps,ct_kps-1
vrotat,all,,,,,1,ct_kps,180,2
cm,far-soil-volu,volu
*do,i,1,tanksoil-1
cmsel,s,far-soil-volu
vsel,r,loc,z,soilz(i),soilz(i+1)
vatt,900+i,,9          ! Assign attributes
aslv
lsla
lsel,r,loc,x,soilx(i)
lesize,all,,arcsiz     ! Match excavated soil meshing
lsla
lsel,r,loc,x,soilx(i+1)
lesize,all,,arcsiz     ! Match excavated soil meshing
lsla
lsel,r,loc,x,soil_radius
lsel,r,loc,z,soilz(i)
lesize,all,,arcsiz     ! Match excavated soil meshing
lsla
lsel,r,loc,x,soil_radius
lsel,r,loc,z,soilz(i+1)
lesize,all,,arcsiz     ! Match excavated soil meshing
*enddo

/COM - Mesh soil outside excavated soil
cmsel,s,far-soil-volu
esize,30
vmesh,all
csys,1
esel,s,type,,9
nsle
!nrotat,all            ! Rotate all nodes to cylindrical coordinates
cm,far-soil-top,elem
```


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```

/COM - Connect new soil elements to excavated soil at interface
!*do,i,1,tanksoil
!nsel,s,loc,x,soilx(i)
!nsel,r,loc,z,soilz(i)
!cmsel,u,excav-wall
!nummrg,node
!*enddo

*get,KMAXtemp,KP,0,num,max
*get,LMAXtemp,LINE,0,num,max
*get,AMAXtemp,AREA,0,num,max
*get,VMAXtemp,VOLU,0,num,max

ksel,u,kp,,all
asel,u,area,,all
vsel,u,volu,,all

/COM - Generate Keypoint below tank for five layers
*do,i,0,deepsoil-tanksoil-5
k,kmaxtemp+5*i+1,0,0,soilz(i+tanksoil) ! Keypoint on centerline
k,kmaxtemp+5*i+2,ctx(ct_kps-1-i),0,soilz(i+tanksoil) ! Keypoint to flare central area under tank
k,kmaxtemp+5*i+3,ctx(bm_kp+1),0,soilz(i+tanksoil) ! Keypoint under edge of tank
k,kmaxtemp+5*i+4,soilx(tanksoil),0,soilz(i+tanksoil) ! Keypoint under edge of excavated soil
k,kmaxtemp+5*i+5,soil_radius,0,soilz(i+tanksoil) ! Keypoint at edge of model
*enddo

/COM - Generate Keypoint below tank to full depth
*do,i,5,deepsoil-tanksoil
k,kmaxtemp+5*i+1,0,0,soilz(i+tanksoil) ! Keypoint on centerline
k,kmaxtemp+5*i+2,ctx(ct_kps-5),0,soilz(i+tanksoil) ! Keypoint for central soil area
k,kmaxtemp+5*i+3,ctx(bm_kp+1),0,soilz(i+tanksoil) ! Keypoint under edge of tank
k,kmaxtemp+5*i+4,soilx(tanksoil),0,soilz(i+tanksoil) ! Keypoint under edge of excavated soil
k,kmaxtemp+5*i+5,soil_radius,0,soilz(i+tanksoil) ! Keypoint at edge of model
*enddo

*do,i,0,3 ! Area pattern for 1st 4 layers under tank
a,kmaxtemp+5*i+1,kmaxtemp+5*i+2,kmaxtemp+5*(i+1)+2,kmaxtemp+5*(i+1)+1
a,kmaxtemp+5*i+2,kmaxtemp+5*i+3,kmaxtemp+5*(i+1)+3,kmaxtemp+5*(i+1)+2
a,kmaxtemp+5*i+3,kmaxtemp+5*i+4,kmaxtemp+5*(i+1)+4,kmaxtemp+5*(i+1)+3
a,kmaxtemp+5*i+4,kmaxtemp+5*i+5,kmaxtemp+5*(i+1)+5,kmaxtemp+5*(i+1)+4
*enddo

! Area pattern for transition layer
a,kmaxtemp+5*4+1,kmaxtemp+5*4+2,kmaxtemp+5*(4+1)+2,kmaxtemp+5*(4+1)+1
a,kmaxtemp+5*4+2,kmaxtemp+5*4+3,kmaxtemp+5*4+4,kmaxtemp+5*(4+1)+4,kmaxtemp+5*(4+1)+2
a,kmaxtemp+5*4+4,kmaxtemp+5*4+5,kmaxtemp+5*(4+1)+5,kmaxtemp+5*(4+1)+4

*do,i,5,10 ! Area pattern to bottom of model
a,kmaxtemp+5*i+1,kmaxtemp+5*i+2,kmaxtemp+5*(i+1)+2,kmaxtemp+5*(i+1)+1
a,kmaxtemp+5*i+2,kmaxtemp+5*i+4,kmaxtemp+5*(i+1)+4,kmaxtemp+5*(i+1)+2
a,kmaxtemp+5*i+4,kmaxtemp+5*i+5,kmaxtemp+5*(i+1)+5,kmaxtemp+5*(i+1)+4
*enddo

/COM - divide line interfacing with bottom of tank to match tank meshing
lsla
lsel,r,loc,z,soilz(tanksoil)
lsel,r,loc,x,ctx(ct_kps-1),ctx(bm_kp+1)
ratio=(ctx(ct_kps-1)-ctx(ct_kps-2))/(ctx(ct_kps-1)-ctx(bm_kp+1))
ldiv,all,ratio
*get,LMAXtemp,LINE,0,num,max
*do,i,1,8
lsla
lsel,r,loc,z,soilz(tanksoil)
lsel,r,loc,x,ctx(ct_kps-1-i),ctx(bm_kp+1)
ratio=(ctx(ct_kps-1-i)-ctx(ct_kps-2-i))/(ctx(ct_kps-1-i)-ctx(bm_kp+1))
ldiv,all,ratio
*enddo

/COM - Move Keypoints to match tank bottom vertical locations

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```

!lsla
!*do,i,0,ct_kps-bm_kp-1
!kact=kp(ctx(ct_kps-i),0,soilz(tanksoil))
!kmodif,kact,ctx(ct_kps-i),0,ctz(ct_kps-i)
!*enddo

ksel,a,kp,,1,ct_kps,ct_kps-1      ! Select Keypoints for rotation axis
vrotat,all,,,,,1,ct_kps,180,2      ! Develop volumes
cm,deep-soil-volu,volu
*do,i,tanksoil,deepsoil-1          ! Assign attributes
vsel,s,loc,z,soilz(i),soilz(i+1)
vatt,900+i,,9
*enddo

/COM - Control meshing to match model slices
cmsel,s,deep-soil-volu
aslv
!lsla
!sel,r,loc,x,soil_radius
!lesize,all,,arcsz
!lsla
!sel,r,loc,x,soilx(tanksoil)
!lesize,all,,arcsz
!lsla
!sel,r,loc,x,ctx(bm_kp+1)
!lesize,all,,arcsz

vsel,u,loc,x,0,soilx(tanksoil)
vmesh,all                          ! Mesh outside volumes
vsel,s,loc,x,ctx(ct_kps-5),soilx(tanksoil)
vsel,r,loc,z,soilz(tanksoil+5),soilz(deepsoil)
esize,22
vmesh,all                          ! Mesh under excavated soil and tank except for central
area

cmsel,s,deep-soil-volu
vsel,r,loc,x,0,ctx(ct_kps-3)        ! Select volumes under center of tank
aslv
asel,r,loc,z,soilz(tanksoil)        ! Select soil area at bottom of tank
!lsla
!sel,r,loc,x,ctx(ct_kps-1)          ! Select Lines on outside of center area
!lesize,all,,arcsz                  ! Control mesh for slices
!lsla
!sel,u,loc,x,ctx(ct_kps-1)
!lesize,all,,midsz                  ! control mesh on inside of area
aslv
!lsla
cmsel,s,deep-soil-volu
vsel,r,loc,x,0,ctx(ct_kps-3)
aslv
!lsla
!sel,r,loc,z,soilz(tanksoil),soilz(tanksoil+1)
!sel,u,loc,z,soilz(tanksoil)
!sel,u,loc,z,soilz(tanksoil+1)
!lesize,all,,4                      ! Control meshing under tank
cmsel,s,deep-soil-volu
vsel,r,loc,x,0,ctx(ct_kps-3)
aslv
!lsla
!sel,r,loc,z,soilz(tanksoil+1),soilz(tanksoil+2)
!sel,u,loc,z,soilz(tanksoil+1)
!sel,u,loc,z,soilz(tanksoil+2)
!lesize,all,,2                      ! Control meshing under tank
cmsel,s,deep-soil-volu
vsel,r,loc,x,0,ctx(ct_kps-3)
aslv
asel,r,loc,z,soilz(tanksoil)
type,1
amesh,all                          ! mesh area at tank/soil interface
vsweep,all                          ! Sweep mesh to bottom of model

```

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```

aclear,all                                ! Clear Pattern

cmsel,s,deep-soil-volu
aslv
lsla
lsel,r,loc,z,soilz(tanksoil+1)
lsel,r,loc,x,ctx(ct_kps-2),ctx(bm_kp+1)
lsel,u,loc,x,ctx(ct_kps-2)
lsel,u,loc,x,ctx(bm_kp+1)
lesize,all,,,8                            ! Control meshing under tank

lsla
lsel,r,loc,z,soilz(tanksoil+2)
lsel,r,loc,x,ctx(ct_kps-3),ctx(bm_kp+1)
lsel,u,loc,x,ctx(ct_kps-3)
lsel,u,loc,x,ctx(bm_kp+1)
lesize,all,,,6                            ! Control meshing under tank

lsla
lsel,r,loc,z,soilz(tanksoil+3)
lsel,r,loc,x,ctx(ct_kps-4),ctx(bm_kp+1)
lsel,u,loc,x,ctx(ct_kps-4)
lsel,u,loc,x,ctx(bm_kp+1)
lesize,all,,,4                            ! Control meshing under tank

lsla
lsel,r,loc,z,soilz(tanksoil+4)
lsel,r,loc,x,ctx(ct_kps-5),ctx(bm_kp+1)
lsel,u,loc,x,ctx(ct_kps-5)
lsel,u,loc,x,ctx(bm_kp+1)
lesize,all,,,2                            ! Control meshing under tank

*do,i,0,2
lsla
lsel,r,loc,z,soilz(tanksoil+i)
lsel,r,loc,x,ctx(bm_kp+1),soilx(tanksoil)
lsel,u,loc,x,ctx(bm_kp+1)
lsel,u,loc,x,soilx(tanksoil)
lesize,all,,,4-i                          ! Control meshing under tank
*enddo

cmsel,s,deep-soil-volu
aslv
lsla
lsel,r,loc,x,ctx(bm_kp+1)
lsel,r,loc,z,soilz(tanksoil),soilz(tanksoil+1)
lsel,u,loc,z,soilz(tanksoil)
lsel,u,loc,z,soilz(tanksoil+1)
ldiv,all,2                                ! Control meshing under tank

cmsel,s,deep-soil-volu
aslv
lsla
lsel,r,loc,z,soilz(tanksoil)
lsel,r,loc,x,ctx(ct_kps-2),ctx(bm_kp+1)
lesize,all,,arcsz                          ! Control meshing for slices

*do,i,0,4
vsel,s,loc,z,soilz(tanksoil+i),soilz(tanksoil+1+i)
vsel,r,loc,x,ctx(ct_kps-1-i),soilx(tanksoil)
aslv
asel,r,loc,y,0
type,1
amesh,all                                ! Mesh area for sweep pattern
vsweep,all                                ! Mesh volumes
aclear,all                                ! Clear pattern
*enddo

esel,s,type,,9
nsle
nummrg,node                                ! Merge bottom soil to rest of model

```

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```

esel,s,type,,9
nsle
nsel,s,loc,x,soilx(1)
nsel,r,loc,z,soilz(1)
cm,far-soil-face-node,node
*do,i,2,9
esel,s,type,,9
nsle
nsel,r,loc,x,soilx(i)
nsel,r,loc,z,soilz(i)
cmisel,a,far-soil-face-node
cm,far-soil-face-node,node
*enddo

esel,s,type,,9
nsle
nsel,r,loc,z,soilz(9)
nsel,r,loc,x,41,68
cm,far-soil-bot-node,node

!nsel,s,loc,x,68,320
!nummrg,node

!esel,s,type,,8,9
!nsle
!nsel,r,loc,z,soilz(9)
!nsel,r,loc,x,41,67
!cpint,uz

type,10
real,1001

csys,0
nsel,s,loc,z,soilz(deepsoil)
csys,1
nsel,r,loc,x,320
csys,0
nsel,r,loc,x,0
*get, master_node, node, , num, max
d, master_node, all
allsel

e, master_node                                ! Large mass for excitation

csys,1
nsel,s,loc,z,soilz(9),soilz(10)
nsel,r,loc,x,0,soilx(9)
esln,,1
esel,r,type,,9
cm,bottom-soil,elem

```

Fix-Soil.txt

```

!esel,s,type,,8,9
!nsle
!nsel,r,loc,z,soilz(9)
!nsel,r,loc,x,ctx(21)+1,68
!nummrg,node

et,90,target170
et,91,contal73
keyopt,91,9,1
mp,mu,90,0.3
mp,mu,91,0.7
mp,mu,92,0.7
r,90,,,0.1
r,91,,,0.1

```

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```

esel,s,type,,9
cmisel,s,far-soil-face-node
esln,r
type,90
real,90
mat,90
esurf
esel,s,type,,8
cmisel,s,near-soil-face-node
esln,r
type,91
esurf

esel,s,type,,9
cmisel,s,far-soil-bot-node
esln,r
type,90
real,91
mat,91
esurf
esel,s,type,,8
cmisel,s,near-soil-bot-node
esln,r
type,91
esurf

esel,s,type,,91
cm,far-soil-contact,elem

```

Force-c.txt

```

/post26
numvar,200

*do,z,2,199
VARDEL,z
*enddo

*do,i,1,20
*do,j,1,30
esol,(10+j),(36+i+20*j),,smisc,1,s1%(36+i+20*j)%
esol,(40+j),(36+i+20*j),,smisc,2,s2%(36+i+20*j)%
esol,(70+j),(36+i+20*j),,smisc,3,s3%(36+i+20*j)%
esol,(100+j),(36+i+20*j),,smisc,4,s4%(36+i+20*j)%
esol,(130+j),(36+i+20*j),,smisc,5,s5%(36+i+20*j)%
esol,(160+j),(36+i+20*j),,smisc,6,s6%(36+i+20*j)%
*enddo

LINES,2150
extrem
/OUT,Force-c_%(9*i)%max,OUT
extrem,11,198
/OUT

/OUT,Force-c_%(9*i)%th,OUT
*do,k,1,30
PRVAR,10+I,40+I,70+I,100+I,130+I,160+I
*enddo
/OUT

*enddo

*do,z,2,199
VARDEL,z
*enddo

*do,i,1,20
*do,j,1,30

```

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```
esol, (10+j), (36+i+20*j), , smisc, 7, s1% (36+i+20*j) %
esol, (40+j), (36+i+20*j), , smisc, 8, s2% (36+i+20*j) %
*enddo
```

```
LINES, 2150
extrem
/OUT, Force-c_% (9*i) %amax, OUT
extrem, 5, 80
/OUT
```

```
/OUT, Force-c_% (9*i) %ath, OUT
*do, k, 1, 30
PRVAR, 10+I, 40+I, 70+I
*enddo
/OUT
```

```
*enddo
```

Force-j_bolt.txt

```
/post26
LINES, 2150
```

```
*do, z, 2, 199
VARDEL, z
*enddo
```

```
! select j-bolts based on radius
nj_bolt=11
```

```
csys, 1
*do, i, 2, nj_bolt           ! radius selection
*do, j, 1, 21                ! angle selection
```

```
angley=-j*arcsize+arcsize
```

```
cmsel, s, j_bolts
nsle
nsel, r, loc, x, ctx(i), ptx(i)
nsel, r, loc, y, angley           ! select lines 1-21 (line 1&21 on symetry plane)
```

```
esln, s, 1
*get, emax, elem, , num, max
esol, (10+j), emax, , smisc, 7, fx% (emax) %
esol, (40+j), emax, , smisc, 8, fy% (emax) %
esol, (70+j), emax, , smisc, 9, fz% (emax) %
*enddo
```

```
LINES, 2150
extrem
/OUT, Force-jb_r%i%_max, OUT
extrem, 11, 180
/OUT
```

```
/OUT, Force-jb_r%i%-th, OUT
*do, k, 1, 21
PRVAR, 10+k, 40+k, 70+k
*enddo
/OUT
```

```
*enddo
```

Insulate.txt

```
et, 2, solid45           ! SOLID45 elements for insulating concrete
```

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```

mp,ex,50,23760
mp,dens,50,0.05/g
mp,prxy,50,0.15
mp,damp,50,0.07/DF

/COM - Key Points for Insulating Concrete
*do,i,0,tw,1
k,kmaxpt+1+i,ptx(pt_kps-i),0,ptz(pt_kps-i)      ! Match Keypoint to Primary Tank
k,kmaxpt+2+tw+i,ctx(ct_kps-i),0,ctz(ct_kps-i)    ! Match Keypoint to Concrete Tank
*enddo

/COM - Areas for Insulating Concrete
*do,i,1,tw,1
a,kmaxpt+i,kmaxpt+tw+1+i,kmaxpt+tw+2+i,kmaxpt+1+i
*enddo

/COM - Assign Material Properties
*do,i,1,tw,1
asel,s,area,,amaxpt+i
aatt,50,i,2
*enddo

asel,s,area,,amaxpt+1,amaxpt+tw
vrotat,all,,,,,1,ct_kps,180,2

type,2
/COM - Elements in insulating concrete
*do,i,2,tw,1
vsel,s,volu,,i
vsel,a,volu,,tw+i
aslv
lsla
lsl,r,loc,x,ctx(ct_kps-i),ctx(ct_kps-i-1)
lesize,all,,arcsz
vmesh,all
*enddo

/COM - Mesh center volume to match primary tank
vsel,s,volu,,1,tw+1,tw
aslv
asel,r,loc,z,ptz(pt_kps)
cm,a2,area
cmsel,a,a1
mshcopy,2,a1,a2
type,2
vsweep,all,,all

allsel
esel,s,type,,2
mpchg,50,all
cm,insul-conc,elem
cmsel,a,primary-tank
nsle
nsel,r,loc,z,ptz(pt_kps)
cm,primary-int,node
allsel
cmsel,s,conc-tank
esel,a,type,,2
nsle
nsel,r,loc,z,ctz(ct_kps)
nsel,r,loc,x,ctx(ct_kps-tw),ctx(ct_kps)

cm,insul-vol,volu
cm,insul-int,node

cmsel,s,a2
aclear,all
allsel
*get,KMAXic,KP,0,num,max      ! Get maximum Keypoint Number
*get,LMAXic,LINE,0,num,max    ! Get maximum Line Number

```


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```
*get,AMAXic,AREA,0,num,max      ! Get maximum Area Number
*get,VMAXic,VOLU,0,num,max      ! Get maximum Volume Number
```

```
cmsel,s,insul-conc
nsle
nsel,r,loc,z,ptz(pt_kps)
nsel,r,loc,x,ptx(pt_kps-tw)
csys,1
!nrotat,all
allsel
```

interface-gap1.txt

```
/COM, Create components for wall and dome of concrete tank and excavated soil for interface
coupling
csys,1
cmsel,s,conc-dome_wall-n
nsel,r,loc,x,ctx(12),ctx(14)+.1
esln,s,1
cmsel,u,liner
cm,conc-wall-e,elem
cm,conc-wall-n,node

cmsel,s,conc-dome_wall-e
cmsel,s,conc-dome_wall-n
cmsel,u,conc-wall-e
nsle,s,1
nsel,u,loc,z,ctz(13),ctz(14)
esln,r,1
cm,conc-dome-e,elem
cm,conc-dome-n,node

cmsel,s,excav-soil
nsle,s,1
nsel,r,loc,x,ctx(12),ctx(14)
nsel,r,loc,z,ctz(12),ctz(22)
esln,s
cm,excav-wall-e,elem
cm,excav-wall-n,node

cmsel,s,excav-soil
nsle,s,1
CM,EXCAV-SOIL-N,NODE
!nsel,r,loc,x,0,ctx(14)
!nsel,u,loc,z,0,soilz(3)
!nsel,u,loc,z,ctz(14),ctz(22)
!cm,ntemp,node
!nsel,r,loc,z,-11,-13.4
!nsel,u,loc,x,0,28
!cm,ntempl,node
!cmsel,s,ntemp
!cmsel,u,ntempl
CMSEL,S,EXCAV-SOIL-N
NSEL,R,LOC,X,CTX(1),CTX(2)
NSEL,R,LOC,Z,CTZ(1),CTZ(2)
cm,excav-dome-n,node
*DO,I,3,12
CMSEL,S,EXCAV-SOIL-N
NSEL,R,LOC,X,CTX(I)
NSEL,R,LOC,Z,CTZ(I)
CMSEL,A,EXCAV-DOME-N
cm,excav-dome-n,node
*ENDDO
esln,
cm,excav-dome-e,elem
```

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```

/COM, Create wall soil to concrete tank interface elements
cmsel,s,conc-wall-n
cmsel,a,excav-wall-n
cm,conc-excav-wall-int,node

cmsel,s,conc-dome-n
cmsel,a,excav-dome-n
cm,conc-excav-dome-int,node

/COM, Define contact properteis
et,61,contal73                ! Contact Surface - Concrete Tank
keyopt,61,5,3                ! Type of constriant - Shell/Solid contact normal direction
et,60,targe170                ! Contact Element - Excavated Soil
!keyopt,60,8,2                ! Asymmetric contact selection (all contact elements on one
surface and all target elements on the other surface)
keyopt,61,12,4                ! Behavior of contact surface (no seperation, sliding
permitted)
!keyopt,61,2,3

et,63,contal73
keyopt,63,5,3
et,62,targe170
!keyopt,62,8,2
!keyopt,63,12,4
!keyopt,63,2,3

mp,mu,60,0.2                  ! Coefficient of Friction between excavated soil and
concrete tank wall
MP,damp,60,0.07/DF
r,60,,,0.05

mp,mu,62,0.2                  ! Coefficient of Friction between excavated soil and
concrete tank dome
MP,damp,62,0.07/DF
r,62,,,0.05

r,61,,,0.05
r,63,,,0.025
mp,mu,64,0.6                  ! Coefficient of Friction between excavated soil and
concrete tank dome
MP,damp,64,0.07/DF

! add wall interface elements
! concrete tank surface target
cmsel,s,conc-wall-e
nsle,s,1
type,60
real,60
mat,60
esurf
esel,s,type,,60
nsle
nsel,r,loc,z,ctz(12),ctz(14)
esln,r,1
emodif,all,real,61
esel,s,type,,61
cmsel,u,conc-wall-e
cm,conc-target,elem

type,61
cmsel,s,excav-wall-e
cmsel,a,excav-wall-n
esurf
esel,s,type,,61
nsle
nsel,r,loc,z,ctz(12),ctz(14)
esln,r,1
emodif,all,real,61
esel,s,type,,61

```

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```
cmsel,u,excav-wall-e
cmsel,u,excav-wall-n
cm,excav-contact,elem

cmsel,s,conc-target
cmsel,a,excav-contact
cm,conc-excav-wall-gap,elem

! add dome interface elements
! concrete tank surface target
cmsel,s,conc-dome-e
nsle,s,1
type,62
real,62
mat,62
esurf
esel,s,type,,62
nsle
nsel,r,loc,z,ctz(12),ctz(14)
esln,r,1
emodif,all,real,62
esel,s,type,,62
cmsel,u,conc-dome-e
cm,conc-dome-target,elem

type,63
cmsel,s,excav-dome-e
esel,u,type,,1
cmsel,s,excav-dome-n
esurf
cmsel,u,excav-dome-e
cm,excav-dome-contact,elem

cmsel,s,conc-dome-target
cmsel,a,excav-dome-contact
cm,conc-excav-dome-gap,elem
allsel

/COM, Create concrete slab to soil interface elements
! spring constants
! slab
r,307,1e8
r,308,1e8
r,309,1e8
esel,none

esel,s,type,,9
nsle
nsel,r,loc,z,ctz(23)
nsel,r,loc,x,0,ctx(23)
cm,soil-slab,node
allsel
esel,none
cmsel,s,conc-slab
cmsel,a,soil-slab
type,21
real,307
eintf

type,22
real,308
eintf

type,23
real,309
eintf
cm,conc-soil-slab-spr,elem
esel,none
allsel

/COM - Create contact on top of footing slab
```

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```

cmsel,s,conc-tank
nsle
nsel,r,loc,x,ctx(23)
esln,r
nsle
type,60
real,63
mat,64
esurf,top

cmsel,s,excav-soil
nsle
nsel,r,loc,z,soilz(9)
nsel,r,loc,x,ctx(22),ctx(23)
esln,r
type,61
esurf
esel,s,real,,63
esel,r,type,,61
cm,soil-contact-foot-elem,elem

```

interface1.txt

```

et,21,combin14,,1
et,22,combin14,,2
et,23,combin14,,3

r,201,1e8
r,202,1e8
r,203,1e8

et,24,contal78
keyopt,24,2,1

R,204,,,,,,,,
RMORE,,1,,,,,

mp,mu,64,0.20                                ! Coefficient of Friction between concrete tank wall and
concrete tank slab
mp,damp,64,0.07/DF

/COM, Define contact properteis
et,65,targel70                                ! Target Surface
keyopt,65,5,3                                ! Type of constriant - Shell/Solid contact normal direction
et,66,contal73                                ! Contact Element
keyopt,66,9,1

r,65,,0.02

et,67,targel70                                ! Target Surface - Concrete Tank
keyopt,67,5,3                                ! Type of constriant - Shell/Solid contact normal direction
et,68,contal73                                ! Contact Element - Secondary Line
keyopt,68,9,1
r,67,,0.01

mp,mu,65,0.40                                ! Coefficient of Friction between primary tank and
insulating concrete (PNNL values)
MP,damp,65,0.3/DF

mp,mu,67,0.40                                ! Coefficient of Friction between secondary liner and
concrete tank basemat (PNNL values)
MP,damp,67,0.3/DF

esel,none
/COM - Create Interface Elements at Bottom of Concrete Wall
cmsel,s,wall-int
type,24

```

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```
real,204
mat,64
eintf,,,high
cm,wall-int-gap,elem

esel,none
/COM - Create Interface Elements between primary tank and insulating concrete
cmsel,s,primary-tank
csys,1
nsle
nsel,r,loc,z,ptz(40)
!nsel,r,loc,x,ptx(41),ptx(39)
cm,primary-int-n,node
esln,r,1
cm,primary-int-e,elem

cmsel,s,insul-conc
nsle
nsel,r,loc,z,ptz(40)
!nsel,r,loc,x,ptx(31),ptx(39)
cm,insul-int-n,node

cmsel,s,primary-int-e
cmsel,s,primary-int-n
type,66
real,65
mat,65
esurf,,bottom
cmsel,u,primary-int-e
cm,pri-target,elem

cmsel,s,insul-conc
cmsel,s,insul-int-n
type,65
real,65
esurf
cmsel,u,insul-conc
cm,insul-contact,elem

cmsel,s,pri-target
cmsel,a,insul-contact
cm,primary-int-gap,elem
esel,none

!nsel,s,loc,z,ptz(34)
!nsel,r,loc,x,ptx(39)-.1,ptx(40)
!cpint,uz

/COM - Create Interface Elements between concrete tank and insulating concrete
cmsel,s,conc-tank
cmsel,a,liner
cmsel,a,insul-int
esln,r,1
cm,etemp,elem

cmsel,s,etemp
esel,u,real,,51
cm,conc-temp,elem

cmsel,s,etemp
esel,r,real,,51
cm,liner-temp,elem

cmsel,s,conc-temp
nsle
type,67
real,67
mat,67
esurf,,top
cmsel,u,conc-temp
cm,conc-target,elem
```

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```

cmsel,s,liner-temp
nsle
type,68
real,67
esurf,,bottom
cmsel,u,liner-temp
cm,liner-contact,elem

cmsel,s,conc-target
cmsel,a,liner-contact
cm,conc-liner-gap,elem

```

Liner.txt

```

ksel,u,kp,,all           ! Clear active Keypoints
asel,u,area,,all        ! Clear active Areas
vsel,u,volu,,all        ! Clear active Volumes
ksel,s,kp,,1,ct_kps,ct_kps-1 ! Activate Keypoints for axis of rotation
esel,u,elem,,all
lsl,u,line,,all

et,21,combin14,,1
et,22,combin14,,2
et,23,combin14,,3

r,201,1e8
r,202,1e8
r,203,1e8

r,51,0.375/12
r,52,0.5/12
r,53,0.5625/12

cmsel,s,insul-vol
aslv
asel,r,loc,z,ctz(ct_kps)
cm,liner-a,area
aatt,101,51,1
asel,r,loc,x,ptx(pt_kps-tw),ptx(pt_kps-tw+1)
aatt,101,52,1
cmsel,s,liner-a

asel,none
k,kmaxic+1,ctx(bm_kp+3),0,ctz(bm_kp+3)
k,kmaxic+2,ctx(bm_kp)-1,0,ctz(bm_kp)
k,kmaxic+3,ctx(bm_kp)-0.2929,0,ctz(bm_kp)+0.2929
k,kmaxic+4,ctx(bm_kp),0,ctz(bm_kp)+1
k,kmaxic+5,ctx(bm_kp-1),0,ctz(bm_kp-1)
k,kmaxic+6,ctx(bm_kp-2),0,ctz(bm_kp-2)

l,kmaxic+1,kmaxic+2
l,kmaxic+2,kmaxic+3
l,kmaxic+3,kmaxic+4
l,kmaxic+4,kmaxic+5
l,kmaxic+5,kmaxic+6

arotat,all,,,,,1,ct_kps,180,2
aatt,101,52,1
cm,liner-lines,line
cmsel,a,liner-a
cm,liner-a,area
asel,r,loc,x,ctx(bm_kp)-2,ctx(bm_kp)
asel,r,loc,z,ctz(bm_kp-1),ctz(bm_kp)
aatt,101,53,1
cmsel,s,liner-a

```

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```

lsel,r,loc,x,ctx(bm_kp)
lesize,all,,arcsz
cmsgel,s,liner-lines
lsel,r,loc,x,ctx(bm_kp+3)
lesize,all,,arcsz
cmsgel,s,liner-lines
lsel,r,loc,x,ctx(bm_kp)-1
lesize,all,,arcsz
cmsgel,s,liner-lines
lsel,r,loc,x,ctx(bm_kp)-0.2929
lesize,all,,arcsz

amesh,all
nsle
nummrg,node

cm,liner,elem
nsle
nsel,r,loc,x,ctx(bm_kp+3),ctx(bm_kp)-1
cpint,uz,3.5
cmsgel,s,liner
nsle
nsel,r,loc,z,ctz(bm_kp-1),ctz(bm_kp)+1
cpintf,ux,3
cpintf,uy,3

allsel
nsel,s,loc,x,ctx(bm_kp)
nsel,r,loc,z,ctz(bm_kp-2),ctz(bm_kp)+1
cm,liner-wall,node

esel,none

/COM - Merge liner and concrete wall
nummrg,node

allsel
*get,KMAX1,KP,0,num,max           ! Get maximum Keypoint Number
*get,LMAX1,LINE,0,num,max         ! Get maximum Line Number
*get,AMAX1,AREA,0,num,max         ! Get maximum Area Number
*get,VMAX1,VOLU,0,num,max         ! Get maximum Volume Number

```

live_load.txt

```

! select nodes to apply concentrated live load over - 10 ft radius
allsel
nsel,s,loc,z,0
nsel,r,loc,x,0,11
cm,n-live,node
*get,nodes,node,,count           ! count the number of nodes selected
*get,nstart,node,,num,min        ! get min node number

live_load=200000                 ! live load 100 tons (lbs)
live_mass=live_load/(2*g*1000*nodes) ! convert live load to slugs/node selected

R,1002,live_mass,live_mass,live_mass
type,10
real,1002

cmsgel,s,n-live
cm,nlive,node                    ! temporary counter for nodes

*do,i,1,nodes
cmsgel,s,nlive
*get,cnode,node,,num,min
e,cnode

```


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```
nsel,u,node,,cnode
cm,nlive,node
*enddo

esel,s,real,,1002
cm,live-load,elem
allsel
```

outer-spar.txt

```
! deifne element type, material and real constants
et,30,link8                ! rigid link to be place between coupling and boundry
conditions

mp,ex,300,10e9             ! high modulus to create a rigid link
mp,dens,300,0              ! massless rigid link
r,300,1                    ! cross-sectional area of rigid link

! select elements and define rigid links
nsle
nsel,s,loc,x,soil_radius
nsel,u,loc,y,-10,-170
cm,ntemp,node

type,30
mat,300
real,300

*do,i,1,20
cmsel,s,ntemp
nsel,r,loc,z,soilz(i)
eintf,51
*enddo

allsel
```

Post-Tank.txt

```
/input,spectra-all.txt
/input,contact-ap.txt
/input,force-c.txt
/input,stress-Primary.txt
/input,Force-J_bolt.txt
```

Primary-Props-AP.txt

```
/COM - Material Definitions
/COM - Material 101, Tank Steel
mp,ex,101,4176200
mp,nuxy,101,0.30
mp,dens,101,490/(1000*g)
mp,damp,101,0.001

/COM - Material 102, Tank Steel
mp,ex,102,4176200
mp,nuxy,102,0.30
mp,dens,102,490/(1000*g)
mp,damp,102,0.001

/COM - Material 103, Tank Steel
mp,ex,103,4176200
mp,nuxy,103,0.30
mp,dens,103,490/(1000*g)
mp,damp,103,0.001
```

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```
/COM - Material 104, Tank Steel
mp,ex,104,4176200
mp,nuxy,104,0.30
mp,dens,104,490/(1000*g)
mp,damp,104,0.001
```

```
/COM - Material 105, Tank Steel
mp,ex,105,4176200
mp,nuxy,105,0.30
mp,dens,105,490/(1000*g)
mp,damp,105,0.001
```

```
/COM - Material 106, Tank Steel
mp,ex,106,4176200
mp,nuxy,106,0.30
mp,dens,106,490/(1000*g)
mp,damp,106,0.001
```

```
/COM - Material 107, Tank Steel
mp,ex,107,4176200
mp,nuxy,107,0.30
mp,dens,107,490/(1000*g)
mp,damp,107,0.001
```

```
/COM - Material 108, Tank Steel
mp,ex,108,4176200
mp,nuxy,108,0.30
mp,dens,108,490/(1000*g)
mp,damp,108,0.001
```

```
/COM - Material 109, Tank Steel
mp,ex,109,4176200
mp,nuxy,109,0.30
mp,dens,109,490/(1000*g)
mp,damp,109,0.001
```

```
/COM - Material,110, Tank Steel
mp,ex,110,4176200
mp,nuxy,110,0.30
mp,dens,110,490/(1000*g)
mp,damp,110,0.001
```

```
/COM - Material,111, Tank Steel
mp,ex,111,4176200
mp,nuxy,111,0.30
mp,dens,111,490/(1000*g)
mp,damp,111,0.001
```

```
/COM - Material,112, Tank Steel
mp,ex,112,4176200
mp,nuxy,112,0.30
mp,dens,112,490/(1000*g)
mp,damp,112,0.001
```

```
/COM - Material,113, Tank Steel
mp,ex,113,4176200
mp,nuxy,113,0.30
mp,dens,113,490/(1000*g)
mp,damp,113,0.001
```

```
/COM - Material,114, Tank Steel
mp,ex,114,4176200
mp,nuxy,114,0.30
mp,dens,114,490/(1000*g)
mp,damp,114,0.001
```

```
/COM - Material,115, Tank Steel
mp,ex,115,4176200
mp,nuxy,115,0.30
mp,dens,115,490/(1000*g)
```

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mp,damp,115,0.001

/COM - Material,116, Tank Steel
mp,ex,116,4176200
mp,nuxy,116,0.30
mp,dens,116,490/(1000*g)
mp,damp,116,0.001

/COM - Material,117, Tank Steel
mp,ex,117,4176200
mp,nuxy,117,0.30
mp,dens,117,490/(1000*g)
mp,damp,117,0.001

/COM - Material,118, Tank Steel
mp,ex,118,4176200
mp,nuxy,118,0.30
mp,dens,118,490/(1000*g)
mp,damp,118,0.001

/COM - Material,119, Tank Steel
mp,ex,119,4176200
mp,nuxy,119,0.30
mp,dens,119,490/(1000*g)
mp,damp,119,0.001

/COM - Material,120, Tank Steel
mp,ex,120,4176200
mp,nuxy,120,0.30
mp,dens,120,490/(1000*g)
mp,damp,120,0.001

/COM - Material,121, Tank Steel
mp,ex,121,4176200
mp,nuxy,121,0.30
mp,dens,121,490/(1000*g)
mp,damp,121,0.001

/COM - Material,122, Tank Steel
mp,ex,122,4176200
mp,nuxy,122,0.30
mp,dens,122,490/(1000*g)
mp,damp,122,0.03/df

/COM - Material,123, Tank Steel
mp,ex,123,4176200
mp,nuxy,123,0.30
mp,dens,123,490/(1000*g)
mp,damp,123,0.001

/COM - Material,124, Tank Steel
mp,ex,124,4176200
mp,nuxy,124,0.30
mp,dens,124,490/(1000*g)
mp,damp,124,0.001

/COM - Material,125, Tank Steel
mp,ex,125,4176200
mp,nuxy,125,0.30
mp,dens,125,490/(1000*g)
mp,damp,125,0.001

/COM - Material,126, Tank Steel
mp,ex,126,4176200
mp,nuxy,126,0.30
mp,dens,126,490/(1000*g)
mp,damp,126,0.001

/COM - Material,127, Tank Steel
mp,ex,127,4176200
mp,nuxy,127,0.30

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```
mp,dens,127,490/(1000*g)
mp,damp,127,0.001

/COM - Material,128, Tank Steel
mp,ex,128,4176200
mp,nuxy,128,0.30
mp,dens,128,490/(1000*g)
mp,damp,128,0.001

/COM - Material,129, Tank Steel
mp,ex,129,4176200
mp,nuxy,129,0.30
mp,dens,129,490/(1000*g)
mp,damp,129,0.001

/COM - Material,130, Tank Steel
mp,ex,130,4176200
mp,nuxy,130,0.30
mp,dens,130,490/(1000*g)
mp,damp,130,0.001

/COM - Material,131, Tank Steel
mp,ex,131,4176200
mp,nuxy,131,0.30
mp,dens,131,490/(1000*g)
mp,damp,131,0.001

/COM - Material,132, Tank Steel
mp,ex,132,4176200
mp,nuxy,132,0.30
mp,dens,132,490/(1000*g)
mp,damp,132,0.001

/COM - Material,133, Tank Steel
mp,ex,133,4176200
mp,nuxy,133,0.30
mp,dens,133,490/(1000*g)
mp,damp,133,0.001

/COM - Material,134, Tank Steel
mp,ex,134,4176200
mp,nuxy,134,0.30
mp,dens,134,490/(1000*g)
mp,damp,134,0.001

/COM - Material,135, Tank Steel
mp,ex,135,4176200
mp,nuxy,135,0.30
mp,dens,135,490/(1000*g)
mp,damp,135,0.001

/COM - Material,136, Tank Steel
mp,ex,136,4176200
mp,nuxy,136,0.30
mp,dens,136,490/(1000*g)
mp,damp,136,0.001

/COM - Material,137, Tank Steel
mp,ex,137,4176200
mp,nuxy,137,0.30
mp,dens,137,490/(1000*g)
mp,damp,137,0.001

/COM - Material,138, Tank Steel
mp,ex,138,4176200
mp,nuxy,138,0.30
mp,dens,138,490/(1000*g)
mp,damp,138,0.001

/COM - Material,139, Tank Steel
mp,ex,139,4176200
```

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```
mp,nuxy,139,0.30
mp,dens,139,490/(1000*g)
mp,damp,139,0.001

/COM - Material,140, Tank Steel
mp,ex,140,4176200
mp,nuxy,140,0.30
mp,dens,140,490/(1000*g)
mp,damp,140,0.001

/COM - Material,141, Tank Steel
mp,ex,141,4176200
mp,nuxy,141,0.30
mp,dens,141,490/(1000*g)
mp,damp,141,0.001

/COM - Material,142, Tank Steel
mp,ex,142,4176200
mp,nuxy,142,0.30
mp,dens,142,490/(1000*g)
mp,damp,142,0.001

/COM - Material,143, Tank Steel
mp,ex,143,4176200
mp,nuxy,143,0.30
mp,dens,143,490/(1000*g)
mp,damp,143,0.001

r,101,(0.5-0.06)/12
r,102,(0.5-0.06)/12
r,103,(0.375-0.06)/12
r,104,(0.375-0.06)/12
r,105,(0.375-0.06)/12
r,106,(0.375-0.06)/12
r,107,(0.375-0.06)/12
r,108,(0.375-0.06)/12
r,109,(0.375-0.06)/12
r,110,(0.375-0.06)/12
r,111,(0.5-0.06)/12
r,112,(0.5-0.06)/12
r,113,(0.5-0.06)/12
r,114,(0.5-0.06)/12
r,115,(0.5-0.06)/12
r,116,(0.5-0.06)/12
r,117,(0.5-0.06)/12
r,118,(0.5-0.06)/12
r,119,(0.5-0.06)/12
r,120,(0.5-0.06)/12
r,121,(0.5-0.06)/12
r,122,(0.5-0.06)/12
r,123,(0.5625-0.06)/12
r,124,(0.5625-0.06)/12
r,125,(0.5625-0.06)/12
r,126,(0.5625-0.06)/12
r,127,(0.75-0.06)/12
r,128,(0.75-0.06)/12
r,129,(0.75-0.06)/12
r,130,(0.75-0.06)/12
r,131,(0.75-0.06)/12
r,132,(0.875-0.06)/12
r,133,(0.9375-0.06)/12
r,134,(0.9375-0.06)/12
r,135,(0.875-0.06)/12
r,136,(0.875-0.06)/12
r,137,(0.5-0.06)/12
r,138,(0.5-0.06)/12
r,139,(0.5-0.06)/12
r,140,(0.5-0.06)/12
r,141,(0.5-0.06)/12
r,142,(0.5-0.06)/12
r,143,(1-0.06)/12
```

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Primary.txt

```
/COM - Create KeyPoints for primarytank
*do,i,1,pt_kps,1
k,kmaxct+i,ptx(i),0,ptz(i)
*enddo

/COM - Create lines for primary tank
*do,i,1,pt_kps-1,1
l,kmaxct+i,kmaxct+i+1
*enddo

/COM - Create Areas for primary tank
lsel,s,line,,LMAXct+1,LMAXct+pt_kps-1
arotat,all,,,,,1,ct_kps,180,2

/COM - Assign Material and Real Properties to primary tank areas
csys,1
*do,i,1,pt_kps-1,1
asel,s,area,,AMAXct+i
asel,a,area,,AMAXct+pt_kps-1+i
aatt,100+i,100+i,1
*enddo
allsel

/COM - Elements at tank Top center
asel,s,loc,x,ptx(1),ptx(2)
asel,r,loc,z,ptz(1),ptz(2)
lsla
lsel,r,loc,x,ptx(2)
lesize,all,,arcsiz
lsla
lsel,u,loc,x,ptx(2)
lesize,all,,midsiz
amesh,all

/COM - Elements in primary tank
*do,i,2,pt_kps-2,1
asel,s,area,,AMAXct+i
asel,a,area,,AMAXct+pt_kps-1+i
lsla
lsel,s,loc,x,ptx(i),ptx(i+1)
lsel,r,loc,z,ptz(i),ptz(i+1)
lesize,all,,arcsiz
amesh,all
*enddo

/COM - Elements at tank floor center
asel,s,loc,x,ptx(pt_kps-1),ptx(pt_kps)
asel,r,loc,z,ptz(pt_kps)
cm,al,area
lsla
lsel,r,loc,x,ptx(pt_kps-1)
lesize,all,,arcsiz
lsla
lsel,u,loc,x,ptx(pt_kps-1)
lesize,all,,midsiz
amesh,all
asel,r,loc,y,0,-90
cm,ala,area
cmsel,s,al
cmsel,u,ala
cm,alb,area
allsel
cmsel,u,conc-tank
*get,emax,elem,,num,maxd
enorm,emax
cm,primary-tank,elem
```

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```
allsel
*get,KMAXpt,KP,0,num,max      ! Get maximum Keypoint number
*get,LMAXpt,LINE,0,num,max    ! Get maximum Line Number
*get,AMAXpt,AREA,0,num,max    ! Get maximum Area Number
```

RS_FREQ.txt

```
data,2,1,152,1,frequency
(f7.3)
0.100
0.105
0.111
0.118
0.125
0.128
0.132
0.135
0.139
0.143
0.147
0.152
0.156
0.161
0.167
0.172
0.179
0.185
0.192
0.196
0.200
0.204
0.208
0.213
0.217
0.222
0.227
0.233
0.238
0.244
0.250
0.256
0.263
0.270
0.278
0.286
0.294
0.303
0.313
0.323
0.333
0.345
0.357
0.370
0.385
0.400
0.417
0.426
0.435
0.444
0.455
0.465
0.476
0.488
0.500
0.513
0.526
0.541
```


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0.556
0.571
0.588
0.606
0.625
0.645
0.667
0.690
0.714
0.741
0.769
0.800
0.833
0.870
0.909
0.952
1.000
1.020
1.042
1.064
1.087
1.111
1.136
1.163
1.190
1.220
1.250
1.282
1.316
1.351
1.389
1.429
1.471
1.515
1.563
1.613
1.667
1.724
1.754
1.786
1.818
1.852
1.887
1.923
1.961
2.000
2.041
2.083
2.128
2.174
2.222
2.273
2.326
2.381
2.439
2.500
2.564
2.632
2.703
2.778
2.857
2.941
3.030
3.125
3.226
3.333
3.448
3.571
3.704
3.846
4.000

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4.167
4.348
4.545
4.762
5.000
5.263
5.556
5.882
6.250
6.667
7.143
7.692
8.333
9.091
10.000
11.111
12.500
14.286
16.667
20.000
25.000
33.333
100.000

Slave.txt

/COM - Develop Slave Boundary Conditions
/COM - 20 Layer Model

```
csys,1                                ! Set Cylindrical Coordinates
*get,cpmax,cp,0,num,max               ! Counter for Couple Set Numbers
nsel,s,loc,x,soil_radius              ! Select soil exterior surface nodes
csys,0                                ! Set Cartesian Coordinates
nrotat,all                            ! Rotate into Global Cartesian Coordinates
nsel,s,loc,z,soilz(deepsoil)         ! Select all Base nodes
nrotat,all                            ! Rotate into Global Cartesian Coordinates

csys,1                                ! Set Cylindrical Coordinates
*do,i,1,deepsoil-1,1                 ! Cycle through each soil layer
nsel,s,loc,x,soil_radius              ! Select all exterior nodes
nsel,r,loc,z,soilz(i)                ! Select nodes by layer
cp,3*i-2+cpmax,ux,all                ! Couple in X
cp,3*i+cpmax,uz,all                  ! Couple in Z
nsel,u,loc,y,0                        ! Unselect nodes on Symmetry Plane
nsel,u,loc,y,180
cp,3*i-1+cpmax,uy,all                 ! Couple in Y
*enddo

nsel,s,loc,z,soilz(deepsoil)         ! Select base nodes
nsel,u,loc,z,320-.1,320+.1
cp,deepsoil*10+1+cpmax,ux,all        ! Couple in X
cp,deepsoil*10+2+cpmax,uy,all        ! Couple in Y
cp,deepsoil*10+3+cpmax,uz,all        ! Couple in Z

allsel
```

spectra-all.txt

```
/input,spectra-conc,txt
/input,spectra-conc-0,txt
/input,spectra-conc-45,txt
/input,spectra-conc-90,txt
/input,spectra-conc-135,txt
/input,spectra-conc-180,txt
/input,spectra-primary-0,txt
/input,spectra-primary-45,txt
/input,spectra-primary-90,txt
/input,spectra-primary-135,txt
```

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```
/input,spectra-primary-180,txt

```

spectra-conc-0.txt

```
fini

/POST26
numvar,200
*do,z,2,200
VARDEL,z
*enddo

cmsel,s,conc-tank
nsle
csys,1
nsel,r,loc,x,ctx(11)
nsel,r,loc,y,0
nsel,r,loc,z,ctz(11)
*get,ct_0_H,node,,num,max

cmsel,s,conc-tank
nsle
nsel,r,loc,x,ctx(14)
nsel,r,loc,y,0
nsel,r,loc,z,ctz(14)
*get,ct_0_382,node,,num,max

cmsel,s,conc-tank
nsle
nsel,r,loc,x,ctx(17)
nsel,r,loc,y,0
nsel,r,loc,z,ctz(17)
*get,ct_0_236,node,,num,max

cmsel,s,conc-tank
nsle
nsel,r,loc,x,ctx(19)
nsel,r,loc,y,0
nsel,r,loc,z,ctz(19)
*get,ct_0_145,node,,num,max

cmsel,s,conc-tank
nsle
nsel,r,loc,x,ctx(22)
nsel,r,loc,y,0
nsel,r,loc,z,ctz(22)
*get,ct_0_0,node,,num,max

nsol,3,ct_0_H,u,x,N_$(ct_0_H)%X
nsol,4,ct_0_382,u,x,N_$(ct_0_382)%X
nsol,5,ct_0_236,u,x,N_$(ct_0_236)%X
nsol,6,ct_0_145,u,x,N_$(ct_0_145)%X
nsol,7,ct_0_0,u,x,N_$(ct_0_0)%X

nsol,13,ct_0_H,u,y,N_$(ct_0_H)%y
nsol,14,ct_0_382,u,y,N_$(ct_0_382)%y
nsol,15,ct_0_236,u,y,N_$(ct_0_236)%y
nsol,16,ct_0_145,u,y,N_$(ct_0_145)%y
nsol,17,ct_0_0,u,y,N_$(ct_0_0)%y

nsol,23,ct_0_H,u,z,N_$(ct_0_H)%z
nsol,24,ct_0_382,u,z,N_$(ct_0_382)%z
nsol,25,ct_0_236,u,z,N_$(ct_0_236)%z
nsol,26,ct_0_145,u,z,N_$(ct_0_145)%z
nsol,27,ct_0_0,u,z,N_$(ct_0_0)%z


```

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```
resp,31,2,3,3,0.033,0.01,100,120.48
resp,32,2,4,3,0.033,0.01,100,120.48
resp,33,2,5,3,0.033,0.01,100,120.48
resp,34,2,6,3,0.033,0.01,100,120.48
resp,35,2,7,3,0.033,0.01,100,120.48
resp,41,2,13,3,0.033,0.01,100,120.48
resp,42,2,14,3,0.033,0.01,100,120.48
resp,43,2,15,3,0.033,0.01,100,120.48
resp,44,2,16,3,0.033,0.01,100,120.48
resp,45,2,17,3,0.033,0.01,100,120.48
resp,51,2,23,3,0.033,0.01,100,120.48
resp,52,2,24,3,0.033,0.01,100,120.48
resp,53,2,25,3,0.033,0.01,100,120.48
resp,54,2,26,3,0.033,0.01,100,120.48
resp,55,2,27,3,0.033,0.01,100,120.48
```

```
prod,61,31,,,rs_$(ct_0_H)%-X,,,1/g
prod,62,32,,,rs_$(ct_0_382)%-X,,,1/g
prod,63,33,,,rs_$(ct_0_236)%-X,,,1/g
prod,64,34,,,rs_$(ct_0_145)%-X,,,1/g
prod,65,35,,,rs_$(ct_0_0)%-X,,,1/g
prod,71,41,,,rs_$(ct_0_H)%-Y,,,1/g
prod,72,42,,,rs_$(ct_0_382)%-Y,,,1/g
prod,73,43,,,rs_$(ct_0_236)%-Y,,,1/g
prod,74,44,,,rs_$(ct_0_145)%-Y,,,1/g
prod,75,45,,,rs_$(ct_0_0)%-Y,,,1/g
prod,81,51,,,rs_$(ct_0_H)%-Z,,,1/g
prod,82,52,,,rs_$(ct_0_382)%-Z,,,1/g
prod,83,53,,,rs_$(ct_0_236)%-Z,,,1/g
prod,84,54,,,rs_$(ct_0_145)%-Z,,,1/g
prod,85,55,,,rs_$(ct_0_0)%-Z,,,1/g
```

```
lines,200
/out,RS-ct-0,out
prvar,2,61,62,63,64,65
prvar,2,71,72,73,74,75
prvar,2,81,82,83,84,85
/out
```

```
deriv,91,3,1,,vx3
deriv,92,4,1,,vx4
deriv,93,5,1,,vx5
deriv,94,6,1,,vx6
deriv,95,7,1,,vx7
```

```
deriv,101,13,1,,vy13
deriv,102,14,1,,vy14
deriv,103,15,1,,vy15
deriv,104,16,1,,vy16
deriv,105,17,1,,vy17
```

```
deriv,111,23,1,,vz23
deriv,112,24,1,,vz24
deriv,113,25,1,,vz25
deriv,114,26,1,,vz26
deriv,115,27,1,,vz27
```

```
deriv,121,91,1,,a_$(ct_0_H)%-x,,,1/g
deriv,122,92,1,,a_$(ct_0_382)%-x,,,1/g
deriv,123,93,1,,a_$(ct_0_236)%-x,,,1/g
deriv,124,94,1,,a_$(ct_0_145)%-x,,,1/g
deriv,125,95,1,,a_$(ct_0_0)%-x,,,1/g
```

```
deriv,131,101,1,,a_$(ct_0_H)%-y,,,1/g
deriv,132,102,1,,a_$(ct_0_382)%-y,,,1/g
deriv,133,103,1,,a_$(ct_0_236)%-y,,,1/g
deriv,134,104,1,,a_$(ct_0_145)%-y,,,1/g
deriv,135,105,1,,a_$(ct_0_0)%-y,,,1/g
```

```
deriv,141,111,1,,a_$(ct_0_H)%-z,,,1/g
```

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```
deriv,142,112,1,,a_$(ct_0_382)%-z,,,1/g
deriv,143,113,1,,a_$(ct_0_236)%-z,,,1/g
deriv,144,114,1,,a_$(ct_0_145)%-z,,,1/g
deriv,145,115,1,,a_$(ct_0_0)%-z,,,1/g
```

```
lines,2150
/out,Disp-ct-0,out
prvar,3,4,5,6,7
prvar,13,14,15,16,17
prvar,23,24,25,26,27
/out
```

```
/out,Vel-ct-0,out
prvar,91,92,93,94,95
prvar,101,102,103,104,105
prvar,111,112,113,114,115
/out
```

```
/out,Accel-ct-0,out
prvar,121,122,123,124,125
prvar,131,132,133,134,135
prvar,141,142,143,144,145
/out
```

spectra-conc-135.txt

fini

```
/POST26
numvar,200
*do,z,2,200
VARDEL,z
*enddo
```

```
csys,1
cmsel,s,conc-tank
nsle
nsel,r,loc,x,ctx(11)
nsel,r,loc,y,-135
nsel,r,loc,z,ctx(11)
*get,ct_135_H,node,,num,max
```

```
cmsel,s,conc-tank
nsle
nsel,r,loc,x,ctx(14)
nsel,r,loc,y,-135
nsel,r,loc,z,ctx(14)
*get,ct_135_382,node,,num,max
```

```
cmsel,s,conc-tank
nsle
nsel,r,loc,x,ctx(17)
nsel,r,loc,y,-135
nsel,r,loc,z,ctx(17)
*get,ct_135_236,node,,num,max
```

```
cmsel,s,conc-tank
nsle
nsel,r,loc,x,ctx(19)
nsel,r,loc,y,-135
nsel,r,loc,z,ctx(19)
*get,ct_135_145,node,,num,max
```

```
cmsel,s,conc-tank
nsle
nsel,r,loc,x,ctx(22)
nsel,r,loc,y,-135
nsel,r,loc,z,ctx(22)
*get,ct_135_0,node,,num,max
```

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```
nsol,3,ct_135_H,u,x,N_$(ct_135_H)$X
nsol,4,ct_135_382,u,x,N_$(ct_135_382)$X
nsol,5,ct_135_236,u,x,N_$(ct_135_236)$X
nsol,6,ct_135_145,u,x,N_$(ct_135_145)$X
nsol,7,ct_135_0,u,x,N_$(ct_135_0)$X
```

```
nsol,13,ct_135_H,u,y,N_$(ct_135_H)$y
nsol,14,ct_135_382,u,y,N_$(ct_135_382)$y
nsol,15,ct_135_236,u,y,N_$(ct_135_236)$y
nsol,16,ct_135_145,u,y,N_$(ct_135_145)$y
nsol,17,ct_135_0,u,y,N_$(ct_135_0)$y
```

```
nsol,23,ct_135_H,u,z,N_$(ct_135_H)$z
nsol,24,ct_135_382,u,z,N_$(ct_135_382)$z
nsol,25,ct_135_236,u,z,N_$(ct_135_236)$z
nsol,26,ct_135_145,u,z,N_$(ct_135_145)$z
nsol,27,ct_135_0,u,z,N_$(ct_135_0)$z
```

```
/input,rs_freq,txt
```

```
resp,31,2,3,3,0.033,0.01,100,120.48
resp,32,2,4,3,0.033,0.01,100,120.48
resp,33,2,5,3,0.033,0.01,100,120.48
resp,34,2,6,3,0.033,0.01,100,120.48
resp,35,2,7,3,0.033,0.01,100,120.48
resp,41,2,13,3,0.033,0.01,100,120.48
resp,42,2,14,3,0.033,0.01,100,120.48
resp,43,2,15,3,0.033,0.01,100,120.48
resp,44,2,16,3,0.033,0.01,100,120.48
resp,45,2,17,3,0.033,0.01,100,120.48
resp,51,2,23,3,0.033,0.01,100,120.48
resp,52,2,24,3,0.033,0.01,100,120.48
resp,53,2,25,3,0.033,0.01,100,120.48
resp,54,2,26,3,0.033,0.01,100,120.48
resp,55,2,27,3,0.033,0.01,100,120.48
```

```
prod,61,31,, ,rs_ct_135_H-X,, ,1/g
prod,62,32,, ,rs_ct_135_382-X,, ,1/g
prod,63,33,, ,rs_ct_135_236-X,, ,1/g
prod,64,34,, ,rs_ct_135_145-X,, ,1/g
prod,65,35,, ,rs_ct_135_0-X,, ,1/g
prod,71,41,, ,rs_ct_135_H-y,, ,1/g
prod,72,42,, ,rs_ct_135_382-y,, ,1/g
prod,73,43,, ,rs_ct_135_236-y,, ,1/g
prod,74,44,, ,rs_ct_135_145-y,, ,1/g
prod,75,45,, ,rs_ct_135_0-y,, ,1/g
prod,81,51,, ,rs_ct_135_H-z,, ,1/g
prod,82,52,, ,rs_ct_135_382-z,, ,1/g
prod,83,53,, ,rs_ct_135_236-z,, ,1/g
prod,84,54,, ,rs_ct_135_145-z,, ,1/g
prod,85,55,, ,rs_ct_135_0-z,, ,1/g
```

```
lines,200
/out,RS-ct-135,out
prvar,2,61,62,63,64,65
prvar,2,71,72,73,74,75
prvar,2,81,82,83,84,85
/out
```

```
deriv,91,3,1,,vx3
deriv,92,4,1,,vx4
deriv,93,5,1,,vx5
deriv,94,6,1,,vx6
deriv,95,7,1,,vx7
```

```
deriv,101,13,1,,vy13
deriv,102,14,1,,vy14
deriv,103,15,1,,vy15
deriv,104,16,1,,vy16
```

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```

deriv,105,71,1,,vy17

deriv,111,23,1,,vz23
deriv,112,24,1,,vz24
deriv,113,25,1,,vz25
deriv,114,26,1,,vz26
deriv,115,27,1,,vz27

deriv,121,91,1,,a_ct_135_H-x,,,1/g
deriv,122,92,1,,a_ct_135_382-x,,,1/g
deriv,123,93,1,,a_ct_135_236-x,,,1/g
deriv,124,94,1,,a_ct_135_145-x,,,1/g
deriv,125,95,1,,a_ct_135_0-x,,,1/g

deriv,131,101,1,,a_ct_135_H-y,,,1/g
deriv,132,102,1,,a_ct_135_382-y,,,1/g
deriv,133,103,1,,a_ct_135_236-y,,,1/g
deriv,134,104,1,,a_ct_135_145-y,,,1/g
deriv,135,105,1,,a_ct_135_0-y,,,1/g

deriv,141,111,1,,a_ct_135_H-z,,,1/g
deriv,142,112,1,,a_ct_135_382-z,,,1/g
deriv,143,113,1,,a_ct_135_236-z,,,1/g
deriv,144,114,1,,a_ct_135_145-z,,,1/g
deriv,145,115,1,,a_ct_135_0-z,,,1/g

lines,2150
/out,Disp-ct-135,out
prvar,3,4,5,6,7
prvar,13,14,15,16,17
prvar,23,24,25,26,27
/out

/out,Vel-ct-135,out
prvar,91,92,93,94,95
prvar,101,102,103,104,105
prvar,111,112,113,114,115
/out

/out,Accel-ct-135,out
prvar,121,122,123,124,125
prvar,131,132,133,134,135
prvar,141,142,143,144,145
/out

```

spectra-conc-180.txt

```

fini

/POST26
numvar,200
*do,z,2,200
VARDEL,z
*enddo

csys,1
cmsel,s,conc-tank
nsle
nsel,r,loc,x,ctx(11)
nsel,r,loc,y,-180
nsel,r,loc,z,ctz(11)
*get,ct_180_H,node,,num,max

cmsel,s,conc-tank
nsle
nsel,r,loc,x,ctx(14)
nsel,r,loc,y,-180
nsel,r,loc,z,ctz(14)
*get,ct_180_382,node,,num,max

```


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```

cmsel,s,conc-tank
nsle
nsel,r,loc,x,ctx(17)
nsel,r,loc,y,-180
nsel,r,loc,z,ctz(17)
*get,ct_180_236,node,,num,max

cmsel,s,conc-tank
nsle
nsel,r,loc,x,ctx(19)
nsel,r,loc,y,-180
nsel,r,loc,z,ctz(19)
*get,ct_180_145,node,,num,max

cmsel,s,conc-tank
nsle
nsel,r,loc,x,ctx(22)
nsel,r,loc,y,-180
nsel,r,loc,z,ctz(22)
*get,ct_180_0,node,,num,max

nsol,3,ct_180_H,u,x,N_$(ct_180_H)%X
nsol,4,ct_180_382,u,x,N_$(ct_180_382)%X
nsol,5,ct_180_236,u,x,N_$(ct_180_236)%X
nsol,6,ct_180_145,u,x,N_$(ct_180_145)%X
nsol,7,ct_180_0,u,x,N_$(ct_180_0)%X

nsol,13,ct_180_H,u,y,N_$(ct_180_H)%y
nsol,14,ct_180_382,u,y,N_$(ct_180_382)%y
nsol,15,ct_180_236,u,y,N_$(ct_180_236)%y
nsol,16,ct_180_145,u,y,N_$(ct_180_145)%y
nsol,17,ct_180_0,u,y,N_$(ct_180_0)%y

nsol,23,ct_180_H,u,z,N_$(ct_180_H)%z
nsol,24,ct_180_382,u,z,N_$(ct_180_382)%z
nsol,25,ct_180_236,u,z,N_$(ct_180_236)%z
nsol,26,ct_180_145,u,z,N_$(ct_180_145)%z
nsol,27,ct_180_0,u,z,N_$(ct_180_0)%z

/input,rs_freq,txt

resp,31,2,3,3,0.033,0.01,100,120.48
resp,32,2,4,3,0.033,0.01,100,120.48
resp,33,2,5,3,0.033,0.01,100,120.48
resp,34,2,6,3,0.033,0.01,100,120.48
resp,35,2,7,3,0.033,0.01,100,120.48
resp,41,2,13,3,0.033,0.01,100,120.48
resp,42,2,14,3,0.033,0.01,100,120.48
resp,43,2,15,3,0.033,0.01,100,120.48
resp,44,2,16,3,0.033,0.01,100,120.48
resp,45,2,17,3,0.033,0.01,100,120.48
resp,51,2,23,3,0.033,0.01,100,120.48
resp,52,2,24,3,0.033,0.01,100,120.48
resp,53,2,25,3,0.033,0.01,100,120.48
resp,54,2,26,3,0.033,0.01,100,120.48
resp,55,2,27,3,0.033,0.01,100,120.48

prod,61,31,,,rs_ct_180_H-X,,,1/g
prod,62,32,,,rs_ct_180_382-X,,,1/g
prod,63,33,,,rs_ct_180_236-X,,,1/g
prod,64,34,,,rs_ct_180_145-X,,,1/g
prod,65,35,,,rs_ct_180_0-X,,,1/g
prod,71,41,,,rs_ct_180_H-y,,,1/g
prod,72,42,,,rs_ct_180_382-y,,,1/g
prod,73,43,,,rs_ct_180_236-y,,,1/g
prod,74,44,,,rs_ct_180_145-y,,,1/g
prod,75,45,,,rs_ct_180_0-y,,,1/g
prod,81,51,,,rs_ct_180_H-z,,,1/g
prod,82,52,,,rs_ct_180_382-z,,,1/g
prod,83,53,,,rs_ct_180_236-z,,,1/g

```

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```

prod,84,54,,,rs_ct_180_145-z,,,1/g
prod,85,55,,,rs_ct_180_0-z,,,1/g

lines,200
/out,RS-ct-180,out
prvar,2,61,62,63,64,65
prvar,2,71,72,73,74,75
prvar,2,81,82,83,84,85
/out

deriv,91,3,1,,vx3
deriv,92,4,1,,vx4
deriv,93,5,1,,vx5
deriv,94,6,1,,vx6
deriv,95,7,1,,vx7

deriv,101,13,1,,vy13
deriv,102,14,1,,vy14
deriv,103,15,1,,vy15
deriv,104,16,1,,vy16
deriv,105,71,1,,vy17

deriv,111,23,1,,vz23
deriv,112,24,1,,vz24
deriv,113,25,1,,vz25
deriv,114,26,1,,vz26
deriv,115,27,1,,vz27

deriv,121,91,1,,a_ct_180_H-x,,,1/g
deriv,122,92,1,,a_ct_180_382-x,,,1/g
deriv,123,93,1,,a_ct_180_236-x,,,1/g
deriv,124,94,1,,a_ct_180_145-x,,,1/g
deriv,125,95,1,,a_ct_180_0-x,,,1/g

deriv,131,101,1,,a_ct_180_H-y,,,1/g
deriv,132,102,1,,a_ct_180_382-y,,,1/g
deriv,133,103,1,,a_ct_180_236-y,,,1/g
deriv,134,104,1,,a_ct_180_145-y,,,1/g
deriv,135,105,1,,a_ct_180_0-y,,,1/g

deriv,141,111,1,,a_ct_180_H-z,,,1/g
deriv,142,112,1,,a_ct_180_382-z,,,1/g
deriv,143,113,1,,a_ct_180_236-z,,,1/g
deriv,144,114,1,,a_ct_180_145-z,,,1/g
deriv,145,115,1,,a_ct_180_0-z,,,1/g

lines,2150
/out,Disp-ct-180,out
prvar,3,4,5,6,7
prvar,13,14,15,16,17
prvar,23,24,25,26,27
/out

/out,Vel-ct-180,out
prvar,91,92,93,94,95
prvar,101,102,103,104,105
prvar,111,112,113,114,115
/out

/out,Accel-ct-180,out
prvar,121,122,123,124,125
prvar,131,132,133,134,135
prvar,141,142,143,144,145
/out

```

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spectra-conc-45.txt

```
fini

/POST26
numvar,200
*do,z,2,200
VARDEL,z
*enddo

csys,1
cmisel,s,conc-tank
nsle
nsel,r,loc,x,ctx(11)
nsel,r,loc,y,-45
nsel,r,loc,z,ctz(11)
*get,ct_45_H,node,,num,max

cmisel,s,conc-tank
nsle
nsel,r,loc,x,ctx(14)
nsel,r,loc,y,-45
nsel,r,loc,z,ctz(14)
*get,ct_45_382,node,,num,max

cmisel,s,conc-tank
nsle
nsel,r,loc,x,ctx(17)
nsel,r,loc,y,-45
nsel,r,loc,z,ctz(17)
*get,ct_45_236,node,,num,max

cmisel,s,conc-tank
nsle
nsel,r,loc,x,ctx(19)
nsel,r,loc,y,-45
nsel,r,loc,z,ctz(19)
*get,ct_45_145,node,,num,max

cmisel,s,conc-tank
nsle
nsel,r,loc,x,ctx(22)
nsel,r,loc,y,-45
nsel,r,loc,z,ctz(22)
*get,ct_45_0,node,,num,max

nsol,3,ct_45_H,u,x,N_$(ct_45_H)$X
nsol,4,ct_45_382,u,x,N_$(ct_45_382)$X
nsol,5,ct_45_236,u,x,N_$(ct_45_236)$X
nsol,6,ct_45_145,u,x,N_$(ct_45_145)$X
nsol,7,ct_45_0,u,x,N_$(ct_45_0)$X

nsol,13,ct_45_H,u,y,N_$(ct_45_H)$y
nsol,14,ct_45_382,u,y,N_$(ct_45_382)$y
nsol,15,ct_45_236,u,y,N_$(ct_45_236)$y
nsol,16,ct_45_145,u,y,N_$(ct_45_145)$y
nsol,17,ct_45_0,u,y,N_$(ct_45_0)$y

nsol,23,ct_45_H,u,z,N_$(ct_45_H)$z
nsol,24,ct_45_382,u,z,N_$(ct_45_382)$z
nsol,25,ct_45_236,u,z,N_$(ct_45_236)$z
nsol,26,ct_45_145,u,z,N_$(ct_45_145)$z
nsol,27,ct_45_0,u,z,N_$(ct_45_0)$z

/input,rs_freq,txt

resp,31,2,3,3,0.033,0.01,100,120.48
resp,32,2,4,3,0.033,0.01,100,120.48
resp,33,2,5,3,0.033,0.01,100,120.48
resp,34,2,6,3,0.033,0.01,100,120.48
```

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```
resp,35,2,7,3,0.033,0.01,100,120.48
resp,41,2,13,3,0.033,0.01,100,120.48
resp,42,2,14,3,0.033,0.01,100,120.48
resp,43,2,15,3,0.033,0.01,100,120.48
resp,44,2,16,3,0.033,0.01,100,120.48
resp,45,2,17,3,0.033,0.01,100,120.48
resp,51,2,23,3,0.033,0.01,100,120.48
resp,52,2,24,3,0.033,0.01,100,120.48
resp,53,2,25,3,0.033,0.01,100,120.48
resp,54,2,26,3,0.033,0.01,100,120.48
resp,55,2,27,3,0.033,0.01,100,120.48
```

```
prod,61,31,,,rs_(ct_45_H)%-X,,,1/g
prod,62,32,,,rs_(ct_45_382)%-X,,,1/g
prod,63,33,,,rs_(ct_45_236)%-X,,,1/g
prod,64,34,,,rs_(ct_45_145)%-X,,,1/g
prod,65,35,,,rs_(ct_45_0)%-X,,,1/g
prod,71,41,,,rs_(ct_45_H)%-y,,,1/g
prod,72,42,,,rs_(ct_45_382)%-y,,,1/g
prod,73,43,,,rs_(ct_45_236)%-y,,,1/g
prod,74,44,,,rs_(ct_45_145)%-y,,,1/g
prod,75,45,,,rs_(ct_45_0)%-y,,,1/g
prod,81,51,,,rs_(ct_45_H)%-z,,,1/g
prod,82,52,,,rs_(ct_45_382)%-z,,,1/g
prod,83,53,,,rs_(ct_45_236)%-z,,,1/g
prod,84,54,,,rs_(ct_45_145)%-z,,,1/g
prod,85,55,,,rs_(ct_45_0)%-z,,,1/g
```

```
lines,200
/out,RS-ct-45,out
prvar,2,61,62,63,64,65
prvar,2,71,72,73,74,75
prvar,2,81,82,83,84,85
/out
```

```
deriv,91,3,1,,vx3
deriv,92,4,1,,vx4
deriv,93,5,1,,vx5
deriv,94,6,1,,vx6
deriv,95,7,1,,vx7
```

```
deriv,101,13,1,,vy13
deriv,102,14,1,,vy14
deriv,103,15,1,,vy15
deriv,104,16,1,,vy16
deriv,105,17,1,,vy17
```

```
deriv,111,23,1,,vz23
deriv,112,24,1,,vz24
deriv,113,25,1,,vz25
deriv,114,26,1,,vz26
deriv,115,27,1,,vz27
```

```
deriv,121,91,1,,a_(ct_45_H)%-x,,,1/g
deriv,122,92,1,,a_(ct_45_382)%-x,,,1/g
deriv,123,93,1,,a_(ct_45_236)%-x,,,1/g
deriv,124,94,1,,a_(ct_45_145)%-x,,,1/g
deriv,125,95,1,,a_(ct_45_0)%-x,,,1/g
```

```
deriv,131,101,1,,a_(ct_45_H)%-y,,,1/g
deriv,132,102,1,,a_(ct_45_382)%-y,,,1/g
deriv,133,103,1,,a_(ct_45_236)%-y,,,1/g
deriv,134,104,1,,a_(ct_45_145)%-y,,,1/g
deriv,135,105,1,,a_(ct_45_0)%-y,,,1/g
```

```
deriv,141,111,1,,a_(ct_45_H)%-z,,,1/g
deriv,142,112,1,,a_(ct_45_382)%-z,,,1/g
deriv,143,113,1,,a_(ct_45_236)%-z,,,1/g
deriv,144,114,1,,a_(ct_45_145)%-z,,,1/g
deriv,145,115,1,,a_(ct_45_0)%-z,,,1/g
```

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```
lines,2150
/out,Disp-ct-45,out
prvar,3,4,5,6,7
prvar,13,14,15,16,17
prvar,23,24,25,26,27
/out

/out,Vel-ct-45,out
prvar,91,92,93,94,95
prvar,101,102,103,104,105
prvar,111,112,113,114,115
/out

/out,Accel-ct-45,out
prvar,121,122,123,124,125
prvar,131,132,133,134,135
prvar,141,142,143,144,145
/out
```

spectra-conc-90.txt

```
fini

/POST26
numvar,200
*do,z,2,200
VARDEL,z
*enddo

csys,1
cmsel,s,conc-tank
nsle
nsel,r,loc,x,ctx(11)
nsel,r,loc,y,-90
nsel,r,loc,z,ctx(11)
*get,ct_90_H,node,,num,max

cmsel,s,conc-tank
nsle
nsel,r,loc,x,ctx(14)
nsel,r,loc,y,-90
nsel,r,loc,z,ctx(14)
*get,ct_90_382,node,,num,max

cmsel,s,conc-tank
nsle
nsel,r,loc,x,ctx(17)
nsel,r,loc,y,-90
nsel,r,loc,z,ctx(17)
*get,ct_90_236,node,,num,max

cmsel,s,conc-tank
nsle
nsel,r,loc,x,ctx(19)
nsel,r,loc,y,-90
nsel,r,loc,z,ctx(19)
*get,ct_90_145,node,,num,max

cmsel,s,conc-tank
nsle
nsel,r,loc,x,ctx(22)
nsel,r,loc,y,-90
nsel,r,loc,z,ctx(22)
*get,ct_90_0,node,,num,max

nsol,3,ct_90_H,u,x,N_$(ct_90_H)%X
nsol,4,ct_90_382,u,x,N_$(ct_90_382)%X
nsol,5,ct_90_236,u,x,N_$(ct_90_236)%X
```

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```
nsol,6,ct_90_145,u,x,N_$(ct_90_145)%X
nsol,7,ct_90_0,u,x,N_$(ct_90_0)%X
```

```
nsol,13,ct_90_H,u,y,N_$(ct_90_H)%y
nsol,14,ct_90_382,u,y,N_$(ct_90_382)%y
nsol,15,ct_90_236,u,y,N_$(ct_90_236)%y
nsol,16,ct_90_145,u,y,N_$(ct_90_145)%y
nsol,17,ct_90_0,u,y,N_$(ct_90_0)%y
```

```
nsol,23,ct_90_H,u,z,N_$(ct_90_H)%z
nsol,24,ct_90_382,u,z,N_$(ct_90_382)%z
nsol,25,ct_90_236,u,z,N_$(ct_90_236)%z
nsol,26,ct_90_145,u,z,N_$(ct_90_145)%z
nsol,27,ct_90_0,u,z,N_$(ct_90_0)%z
```

```
/input,rs_freq,txt
```

```
resp,31,2,3,3,0.033,0.01,100,120.48
resp,32,2,4,3,0.033,0.01,100,120.48
resp,33,2,5,3,0.033,0.01,100,120.48
resp,34,2,6,3,0.033,0.01,100,120.48
resp,35,2,7,3,0.033,0.01,100,120.48
resp,41,2,13,3,0.033,0.01,100,120.48
resp,42,2,14,3,0.033,0.01,100,120.48
resp,43,2,15,3,0.033,0.01,100,120.48
resp,44,2,16,3,0.033,0.01,100,120.48
resp,45,2,17,3,0.033,0.01,100,120.48
resp,51,2,23,3,0.033,0.01,100,120.48
resp,52,2,24,3,0.033,0.01,100,120.48
resp,53,2,25,3,0.033,0.01,100,120.48
resp,54,2,26,3,0.033,0.01,100,120.48
resp,55,2,27,3,0.033,0.01,100,120.48
```

```
prod,61,31,,,rs_ct_90_H-X,,,1/g
prod,62,32,,,rs_ct_90_382-X,,,1/g
prod,63,33,,,rs_ct_90_236-X,,,1/g
prod,64,34,,,rs_ct_90_145-X,,,1/g
prod,65,35,,,rs_ct_90_0-X,,,1/g
prod,71,41,,,rs_ct_90_H-y,,,1/g
prod,72,42,,,rs_ct_90_382-y,,,1/g
prod,73,43,,,rs_ct_90_236-y,,,1/g
prod,74,44,,,rs_ct_90_145-y,,,1/g
prod,75,45,,,rs_ct_90_0-y,,,1/g
prod,81,51,,,rs_ct_90_H-z,,,1/g
prod,82,52,,,rs_ct_90_382-z,,,1/g
prod,83,53,,,rs_ct_90_236-z,,,1/g
prod,84,54,,,rs_ct_90_145-z,,,1/g
prod,85,55,,,rs_ct_90_0-z,,,1/g
```

```
lines,200
/out,RS-ct-90,out
prvar,2,61,62,63,64,65
prvar,2,71,72,73,74,75
prvar,2,81,82,83,84,85
/out
```

```
deriv,91,3,1,,vx3
deriv,92,4,1,,vx4
deriv,93,5,1,,vx5
deriv,94,6,1,,vx6
deriv,95,7,1,,vx7
```

```
deriv,101,13,1,,vy13
deriv,102,14,1,,vy14
deriv,103,15,1,,vy15
deriv,104,16,1,,vy16
deriv,105,71,1,,vy17
```

```
deriv,111,23,1,,vz23
deriv,112,24,1,,vz24
```

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```

deriv,113,25,1,,vz25
deriv,114,26,1,,vz26
deriv,115,27,1,,vz27

deriv,121,91,1,,a_ct_90_H-x,,,1/g
deriv,122,92,1,,a_ct_90_382-x,,,1/g
deriv,123,93,1,,a_ct_90_236-x,,,1/g
deriv,124,94,1,,a_ct_90_145-x,,,1/g
deriv,125,95,1,,a_ct_90_0-x,,,1/g

deriv,131,101,1,,a_ct_90_H-y,,,1/g
deriv,132,102,1,,a_ct_90_382-y,,,1/g
deriv,133,103,1,,a_ct_90_236-y,,,1/g
deriv,134,104,1,,a_ct_90_145-y,,,1/g
deriv,135,105,1,,a_ct_90_0-y,,,1/g

deriv,141,111,1,,a_ct_90_H-z,,,1/g
deriv,142,112,1,,a_ct_90_382-z,,,1/g
deriv,143,113,1,,a_ct_90_236-z,,,1/g
deriv,144,114,1,,a_ct_90_145-z,,,1/g
deriv,145,115,1,,a_ct_90_0-z,,,1/g

lines,2150
/out,Disp-ct-90,out
prvar,3,4,5,6,7
prvar,13,14,15,16,17
prvar,23,24,25,26,27
/out

/out,Vel-ct-90,out
prvar,91,92,93,94,95
prvar,101,102,103,104,105
prvar,111,112,113,114,115
/out

/out,Accel-ct-90,out
prvar,121,122,123,124,125
prvar,131,132,133,134,135
prvar,141,142,143,144,145
/out

```

spectra-conc.txt

```

fini

/POST26
numvar,200
*do,z,2,200
VARDEL,z
*enddo

cmsel,s,conc-tank
nsle
csys,1
nsel,r,loc,x,ctx(1)
nsel,r,loc,z,ctx(1)
*get,ct_Top,node,,num,max

cmsel,s,conc-tank
nsle
nsel,r,loc,x,ctx(34)
nsel,r,loc,z,ctx(34)
*get,ct_Bottom,node,,num,max

nsol,3,ct_Top,u,x,N_$(ct_Top)%X
nsol,4,ct_Bottom,u,x,N_$(ct_Bottom)%X

nsol,13,ct_Top,u,y,N_$(ct_Top)%y
nsol,14,ct_Bottom,u,y,N_$(ct_Bottom)%y

```


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```

nsol,23,ct_Top,u,z,N_%(ct_Top)%z
nsol,24,ct_Bottom,u,z,N_%(ct_Bottom)%z

/input,rs_freq,txt

resp,31,2,3,3,0.033,0.01,100,120.48
resp,32,2,4,3,0.033,0.01,100,120.48
resp,41,2,13,3,0.033,0.01,100,120.48
resp,42,2,14,3,0.033,0.01,100,120.48
resp,51,2,23,3,0.033,0.01,100,120.48
resp,52,2,24,3,0.033,0.01,100,120.48

prod,61,31,,,rs_ct_Top-X,,,1/g
prod,62,32,,,rs_ct_Bottom-X,,,1/g
prod,71,41,,,rs_ct_Top-Y,,,1/g
prod,72,42,,,rs_ct_Bottom-Y,,,1/g
prod,81,51,,,rs_ct_Top-Z,,,1/g
prod,82,52,,,rs_ct_Bottom-Z,,,1/g

lines,200
/out,RS-ct,out
prvar,2,61,62
prvar,2,71,72
prvar,2,81,82
/out

deriv,91,3,1,,vx3
deriv,92,4,1,,vx4

deriv,101,13,1,,vy13
deriv,102,14,1,,vy14

deriv,111,23,1,,vz23
deriv,112,24,1,,vz24

deriv,121,91,1,,a_ct_Top-x,,,1/g
deriv,122,92,1,,a_ct_Bottom-x,,,1/g

deriv,131,101,1,,a_ct_Top-y,,,1/g
deriv,132,102,1,,a_ct_Bottom-y,,,1/g

deriv,141,111,1,,a_ct_Top-z,,,1/g
deriv,142,112,1,,a_ct_Bottom-z,,,1/g

lines,2150
/out,Disp-ct,out
prvar,3,4
prvar,13,14
prvar,23,24
/out

/out,Vel-ct,out
prvar,91,92
prvar,101,102
prvar,111,112
/out

/out,Accel-ct,out
prvar,121,122
prvar,131,132
prvar,141,142
/out

```

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spectra-concrete.txt

```
fini

/POST26
numvar,200
*do,z,2,200
VARDEL,z
*enddo

csys,1
cmsel,s,conc-tank
nsle
nsel,r,loc,x,ctx(1)
nsel,r,loc,z,ctz(1)
*get,c_top,node,,num,max

cmsel,s,conc-tank
nsle
nsel,r,loc,x,ctx(14)
nsel,r,loc,y,0
nsel,r,loc,z,ctz(14)
*get,c_bot,node,,num,max

cmsel,s,conc-tank
nsle
nsel,r,loc,x,ctx(16)
nsel,r,loc,y,0
nsel,r,loc,z,ctz(16)
*get,c_h0,node,,num,max

cmsel,s,conc-tank
nsle
nsel,r,loc,x,ctx(18)
nsel,r,loc,y,0
nsel,r,loc,z,ctz(18)
*get,c_h90,node,,num,max

cmsel,s,conc-tank
nsle
nsel,r,loc,x,ctx(20)
nsel,r,loc,y,0
nsel,r,loc,z,ctz(20)
*get,c_h180,node,,num,max

nsol,3,c_top,u,x,N_$(c_top)%X
nsol,4,c_bot,u,x,N_$(c_bot)%X
nsol,5,c_h0,u,x,N_$(c_h0)%X
nsol,6,c_h90,u,x,N_$(c_h90)%X
nsol,7,c_h180,u,x,N_$(c_h180)%X

nsol,13,c_top,u,y,N_$(c_top)%y
nsol,14,c_bot,u,y,N_$(c_bot)%y
nsol,15,c_h0,u,y,N_$(c_h0)%y
nsol,16,c_h90,u,y,N_$(c_h90)%y
nsol,17,c_h180,u,y,N_$(c_h180)%y

nsol,23,c_top,u,z,N_$(c_top)%z
nsol,24,c_bot,u,z,N_$(c_bot)%z
nsol,25,c_h0,u,z,N_$(c_h0)%z
nsol,26,c_h90,u,z,N_$(c_h90)%z
nsol,27,c_h180,u,z,N_$(c_h180)%z

/input,rs_freq.txt

resp,31,2,3,3,0.033,0.01,100,105
resp,32,2,4,3,0.033,0.01,100,105
resp,33,2,5,3,0.033,0.01,100,105
resp,34,2,6,3,0.033,0.01,100,105
resp,35,2,7,3,0.033,0.01,100,105
```

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```
resp,41,2,13,3,0.033,0.01,100,105
resp,42,2,14,3,0.033,0.01,100,105
resp,43,2,15,3,0.033,0.01,100,105
resp,44,2,16,3,0.033,0.01,100,105
resp,45,2,17,3,0.033,0.01,100,105
resp,51,2,23,3,0.033,0.01,100,105
resp,52,2,24,3,0.033,0.01,100,105
resp,53,2,25,3,0.033,0.01,100,105
resp,54,2,26,3,0.033,0.01,100,105
resp,55,2,27,3,0.033,0.01,100,105
```

```
prod,61,31,,,,,1/g
prod,62,32,,,,,1/g
prod,63,33,,,,,1/g
prod,64,34,,,,,1/g
prod,65,35,,,,,1/g
prod,71,41,,,,,1/g
prod,72,42,,,,,1/g
prod,73,43,,,,,1/g
prod,74,44,,,,,1/g
prod,75,45,,,,,1/g
prod,81,51,,,,,1/g
prod,82,52,,,,,1/g
prod,83,53,,,,,1/g
prod,84,54,,,,,1/g
prod,85,55,,,,,1/g
```

```
lines,200
/out,RS-OUT-Concrete,txt
prvar,2,61,62,63,64,65
prvar,2,71,72,73,74,75
prvar,2,81,82,83,84,85
/out
```

spectra-primary-0.txt

```
fini

/POST26
numvar,120
*do,z,2,120
VARDEL,z
*enddo

csys,1
cmsel,s,primary-tank
nsle
nsel,r,loc,x,ptx(12)
nsel,r,loc,y,0
nsel,r,loc,z,ptz(12)
*get,pt_0_460,node,,num,max

cmsel,s,primary-tank
nsle
nsel,r,loc,x,ptx(18)
nsel,r,loc,y,0
nsel,r,loc,z,ptz(18)
*get,pt_0_354,node,,num,max

cmsel,s,primary-tank
nsle
nsel,r,loc,x,ptx(22)
nsel,r,loc,y,0
nsel,r,loc,z,ptz(22)
*get,pt_0_260,node,,num,max

cmsel,s,primary-tank
nsle
```

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```

nsel,r,loc,x,ptx(28)
nsel,r,loc,y,0
nsel,r,loc,z,ptz(28)
*get,pt_0_123,node,,num,max

cmsel,s,primary-tank
nsle
nsel,r,loc,x,ptx(33)
nsel,r,loc,y,0
nsel,r,loc,z,ptz(33)
*get,pt_0_12,node,,num,max

nsol,3,pt_0_460,u,x,N_$(pt_0_460)%X
nsol,4,pt_0_354,u,x,N_$(pt_0_354)%X
nsol,5,pt_0_260,u,x,N_$(pt_0_260)%X
nsol,6,pt_0_123,u,x,N_$(pt_0_123)%X
nsol,7,pt_0_12,u,x,N_$(pt_0_12)%X

nsol,13,pt_0_460,u,y,N_$(pt_0_460)%y
nsol,14,pt_0_354,u,y,N_$(pt_0_354)%y
nsol,15,pt_0_260,u,y,N_$(pt_0_260)%y
nsol,16,pt_0_123,u,y,N_$(pt_0_123)%y
nsol,17,pt_0_12,u,y,N_$(pt_0_12)%y

nsol,23,pt_0_460,u,z,N_$(pt_0_460)%z
nsol,24,pt_0_354,u,z,N_$(pt_0_354)%z
nsol,25,pt_0_260,u,z,N_$(pt_0_260)%z
nsol,26,pt_0_123,u,z,N_$(pt_0_123)%z
nsol,27,pt_0_12,u,z,N_$(pt_0_12)%z

/input,rs_freq,txt

resp,31,2,3,3,0.033,0.01,100,112.48
resp,32,2,4,3,0.033,0.01,100,112.48
resp,33,2,5,3,0.033,0.01,100,112.48
resp,34,2,6,3,0.033,0.01,100,112.48
resp,35,2,7,3,0.033,0.01,100,112.48
resp,41,2,13,3,0.033,0.01,100,112.48
resp,42,2,14,3,0.033,0.01,100,112.48
resp,43,2,15,3,0.033,0.01,100,112.48
resp,44,2,16,3,0.033,0.01,100,112.48
resp,45,2,17,3,0.033,0.01,100,112.48
resp,51,2,23,3,0.033,0.01,100,112.48
resp,52,2,24,3,0.033,0.01,100,112.48
resp,53,2,25,3,0.033,0.01,100,112.48
resp,54,2,26,3,0.033,0.01,100,112.48
resp,55,2,27,3,0.033,0.01,100,112.48

prod,61,31,,,rs_pt_0_460-X,,,1/g
prod,62,32,,,rs_pt_0_354-X,,,1/g
prod,63,33,,,rs_pt_0_260-X,,,1/g
prod,64,34,,,rs_pt_0_123-X,,,1/g
prod,65,35,,,rs_pt_0_12-X,,,1/g
prod,71,41,,,rs_pt_0_460-y,,,1/g
prod,72,42,,,rs_pt_0_354-y,,,1/g
prod,73,43,,,rs_pt_0_260-y,,,1/g
prod,74,44,,,rs_pt_0_123-y,,,1/g
prod,75,45,,,rs_pt_0_12-y,,,1/g
prod,81,51,,,rs_pt_0_460-z,,,1/g
prod,82,52,,,rs_pt_0_354-z,,,1/g
prod,83,53,,,rs_pt_0_260-z,,,1/g
prod,84,54,,,rs_pt_0_123-z,,,1/g
prod,85,55,,,rs_pt_0_12-z,,,1/g

lines,200
/out,RS-PT-0,out
prvar,2,61,62,63,64,65
prvar,2,71,72,73,74,75
prvar,2,81,82,83,84,85
/out

```

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```

deriv,91,3,1,,vx3
deriv,92,4,1,,vx4
deriv,93,5,1,,vx5
deriv,94,6,1,,vx6
deriv,95,7,1,,vx7

deriv,101,13,1,,vy13
deriv,102,14,1,,vy14
deriv,103,15,1,,vy15
deriv,104,16,1,,vy16
deriv,105,17,1,,vy17

deriv,111,23,1,,vz23
deriv,112,24,1,,vz24
deriv,113,25,1,,vz25
deriv,114,26,1,,vz26
deriv,115,27,1,,vz27

deriv,121,91,1,,a_pt_0_460-x,,1/g
deriv,122,92,1,,a_pt_0_354-x,,1/g
deriv,123,93,1,,a_pt_0_260-x,,1/g
deriv,124,94,1,,a_pt_0_123-x,,1/g
deriv,125,95,1,,a_pt_0_12-x,,1/g

deriv,131,101,1,,a_pt_0_460-y,,1/g
deriv,132,102,1,,a_pt_0_354-y,,1/g
deriv,133,103,1,,a_pt_0_260-y,,1/g
deriv,134,104,1,,a_pt_0_123-y,,1/g
deriv,135,105,1,,a_pt_0_12-y,,1/g

deriv,141,111,1,,a_pt_0_460-z,,1/g
deriv,142,112,1,,a_pt_0_354-z,,1/g
deriv,143,113,1,,a_pt_0_260-z,,1/g
deriv,144,114,1,,a_pt_0_123-z,,1/g
deriv,145,115,1,,a_pt_0_12-z,,1/g

lines,2250
/out,Disp-PT-0,out
prvar,3,4,5,6,7
prvar,13,14,15,16,17
prvar,23,24,25,26,27
/out

/out,Vel-PT-0,out
prvar,91,92,93,94,95
prvar,101,102,103,104,105
prvar,111,112,113,114,115
/out

/out,Accel-PT-0,out
prvar,121,122,123,124,125
prvar,131,132,133,134,135
prvar,141,142,143,144,145
/out

```

spectra-primary-135.txt

```

fini

/POST26
numvar,120
*do,z,2,120
VARDEL,z
*enddo

csys,1
cmsel,s,primary-tank
nsle

```

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```

nsel,r,loc,x,ptx(12)
nsel,r,loc,y,-135
nsel,r,loc,z,ptz(12)
*get,pt_135_460,node,,num,max

cmisel,s,primary-tank
nsle
nsel,r,loc,x,ptx(18)
nsel,r,loc,y,-135
nsel,r,loc,z,ptz(18)
*get,pt_135_354,node,,num,max

cmisel,s,primary-tank
nsle
nsel,r,loc,x,ptx(22)
nsel,r,loc,y,-135
nsel,r,loc,z,ptz(22)
*get,pt_135_260,node,,num,max

cmisel,s,primary-tank
nsle
nsel,r,loc,x,ptx(28)
nsel,r,loc,y,-135
nsel,r,loc,z,ptz(28)
*get,pt_135_123,node,,num,max

cmisel,s,primary-tank
nsle
nsel,r,loc,x,ptx(33)
nsel,r,loc,y,-135
nsel,r,loc,z,ptz(33)
*get,pt_135_12,node,,num,max

nsol,3,pt_135_460,u,x,N_$(pt_135_460)%X
nsol,4,pt_135_354,u,x,N_$(pt_135_354)%X
nsol,5,pt_135_260,u,x,N_$(pt_135_260)%X
nsol,6,pt_135_123,u,x,N_$(pt_135_123)%X
nsol,7,pt_135_12,u,x,N_$(pt_135_12)%X

nsol,13,pt_135_460,u,y,N_$(pt_135_460)%y
nsol,14,pt_135_354,u,y,N_$(pt_135_354)%y
nsol,15,pt_135_260,u,y,N_$(pt_135_260)%y
nsol,16,pt_135_123,u,y,N_$(pt_135_123)%y
nsol,17,pt_135_12,u,y,N_$(pt_135_12)%y

nsol,23,pt_135_460,u,z,N_$(pt_135_460)%z
nsol,24,pt_135_354,u,z,N_$(pt_135_354)%z
nsol,25,pt_135_260,u,z,N_$(pt_135_260)%z
nsol,26,pt_135_123,u,z,N_$(pt_135_123)%z
nsol,27,pt_135_12,u,z,N_$(pt_135_12)%z

/input,rs_freq,txt

resp,31,2,3,3,0.033,0.01,100,112.48
resp,32,2,4,3,0.033,0.01,100,112.48
resp,33,2,5,3,0.033,0.01,100,112.48
resp,34,2,6,3,0.033,0.01,100,112.48
resp,35,2,7,3,0.033,0.01,100,112.48
resp,41,2,13,3,0.033,0.01,100,112.48
resp,42,2,14,3,0.033,0.01,100,112.48
resp,43,2,15,3,0.033,0.01,100,112.48
resp,44,2,16,3,0.033,0.01,100,112.48
resp,45,2,17,3,0.033,0.01,100,112.48
resp,51,2,23,3,0.033,0.01,100,112.48
resp,52,2,24,3,0.033,0.01,100,112.48
resp,53,2,25,3,0.033,0.01,100,112.48
resp,54,2,26,3,0.033,0.01,100,112.48
resp,55,2,27,3,0.033,0.01,100,112.48

prod,61,31,,,rs_pt_135_460-X,,,1/g
prod,62,32,,,rs_pt_135_354-X,,,1/g

```

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```

prod,63,33,,,rs_pt_135_260-X,,,1/g
prod,64,34,,,rs_pt_135_123-X,,,1/g
prod,65,35,,,rs_pt_135_12-X,,,1/g
prod,71,41,,,rs_pt_135_460-y,,,1/g
prod,72,42,,,rs_pt_135_354-y,,,1/g
prod,73,43,,,rs_pt_135_260-y,,,1/g
prod,74,44,,,rs_pt_135_123-y,,,1/g
prod,75,45,,,rs_pt_135_12-y,,,1/g
prod,81,51,,,rs_pt_135_460-z,,,1/g
prod,82,52,,,rs_pt_135_354-z,,,1/g
prod,83,53,,,rs_pt_135_260-z,,,1/g
prod,84,54,,,rs_pt_135_123-z,,,1/g
prod,85,55,,,rs_pt_135_12-z,,,1/g

lines,200
/out,RS-PT-135,out
prvar,2,61,62,63,64,65
prvar,2,71,72,73,74,75
prvar,2,81,82,83,84,85
/out

deriv,91,3,1,,vx3
deriv,92,4,1,,vx4
deriv,93,5,1,,vx5
deriv,94,6,1,,vx6
deriv,95,7,1,,vx7

deriv,101,13,1,,vy13
deriv,102,14,1,,vy14
deriv,103,15,1,,vy15
deriv,104,16,1,,vy16
deriv,105,71,1,,vy17

deriv,111,23,1,,vz23
deriv,112,24,1,,vz24
deriv,113,25,1,,vz25
deriv,114,26,1,,vz26
deriv,115,27,1,,vz27

deriv,121,91,1,,a_pt_135_460-x,,,1/g
deriv,122,92,1,,a_pt_135_354-x,,,1/g
deriv,123,93,1,,a_pt_135_260-x,,,1/g
deriv,124,94,1,,a_pt_135_123-x,,,1/g
deriv,125,95,1,,a_pt_135_12-x,,,1/g

deriv,131,101,1,,a_pt_135_460-y,,,1/g
deriv,132,102,1,,a_pt_135_354-y,,,1/g
deriv,133,103,1,,a_pt_135_260-y,,,1/g
deriv,134,104,1,,a_pt_135_123-y,,,1/g
deriv,135,105,1,,a_pt_135_12-y,,,1/g

deriv,141,111,1,,a_pt_135_460-z,,,1/g
deriv,142,112,1,,a_pt_135_354-z,,,1/g
deriv,143,113,1,,a_pt_135_260-z,,,1/g
deriv,144,114,1,,a_pt_135_123-z,,,1/g
deriv,145,115,1,,a_pt_135_12-z,,,1/g

lines,2250
/out,Disp-PT-135,out
prvar,3,4,5,6,7
prvar,13,14,15,16,17
prvar,23,24,25,26,27
/out

/out,Vel-PT-135,out
prvar,91,92,93,94,95
prvar,101,102,103,104,105
prvar,111,112,113,114,115
/out

```


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```
/out,Accel-PT-135,out  
prvar,121,122,123,124,125  
prvar,131,132,133,134,135  
prvar,141,142,143,144,145  
/out
```

spectra-primary-180.txt

```
fini  
  
/POST26  
numvar,120  
*do,z,2,120  
VARDEL,z  
*enddo  
  
csys,1  
cmsel,s,primary-tank  
nsle  
nsel,r,loc,x,ptx(12)  
nsel,r,loc,y,-180  
nsel,r,loc,z,ptz(12)  
*get,pt_180_460,node,,num,max  
  
cmsel,s,primary-tank  
nsle  
nsel,r,loc,x,ptx(18)  
nsel,r,loc,y,-180  
nsel,r,loc,z,ptz(18)  
*get,pt_180_354,node,,num,max  
  
cmsel,s,primary-tank  
nsle  
nsel,r,loc,x,ptx(22)  
nsel,r,loc,y,-180  
nsel,r,loc,z,ptz(22)  
*get,pt_180_260,node,,num,max  
  
cmsel,s,primary-tank  
nsle  
nsel,r,loc,x,ptx(28)  
nsel,r,loc,y,-180  
nsel,r,loc,z,ptz(28)  
*get,pt_180_123,node,,num,max  
  
cmsel,s,primary-tank  
nsle  
nsel,r,loc,x,ptx(33)  
nsel,r,loc,y,-180  
nsel,r,loc,z,ptz(33)  
*get,pt_180_12,node,,num,max  
  
nsol,3,pt_180_460,u,x,N_$(pt_180_460)%X  
nsol,4,pt_180_354,u,x,N_$(pt_180_354)%X  
nsol,5,pt_180_260,u,x,N_$(pt_180_260)%X  
nsol,6,pt_180_123,u,x,N_$(pt_180_123)%X  
nsol,7,pt_180_12,u,x,N_$(pt_180_12)%X  
  
nsol,13,pt_180_460,u,y,N_$(pt_180_460)%y  
nsol,14,pt_180_354,u,y,N_$(pt_180_354)%y  
nsol,15,pt_180_260,u,y,N_$(pt_180_260)%y  
nsol,16,pt_180_123,u,y,N_$(pt_180_123)%y  
nsol,17,pt_180_12,u,y,N_$(pt_180_12)%y  
  
nsol,23,pt_180_460,u,z,N_$(pt_180_460)%z  
nsol,24,pt_180_354,u,z,N_$(pt_180_354)%z  
nsol,25,pt_180_260,u,z,N_$(pt_180_260)%z  
nsol,26,pt_180_123,u,z,N_$(pt_180_123)%z  
nsol,27,pt_180_12,u,z,N_$(pt_180_12)%z
```

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```

/input,rs_freq,txt

resp,31,2,3,3,0.033,0.01,100,112.48
resp,32,2,4,3,0.033,0.01,100,112.48
resp,33,2,5,3,0.033,0.01,100,112.48
resp,34,2,6,3,0.033,0.01,100,112.48
resp,35,2,7,3,0.033,0.01,100,112.48
resp,41,2,13,3,0.033,0.01,100,112.48
resp,42,2,14,3,0.033,0.01,100,112.48
resp,43,2,15,3,0.033,0.01,100,112.48
resp,44,2,16,3,0.033,0.01,100,112.48
resp,45,2,17,3,0.033,0.01,100,112.48
resp,51,2,23,3,0.033,0.01,100,112.48
resp,52,2,24,3,0.033,0.01,100,112.48
resp,53,2,25,3,0.033,0.01,100,112.48
resp,54,2,26,3,0.033,0.01,100,112.48
resp,55,2,27,3,0.033,0.01,100,112.48

prod,61,31,,,rs_pt_180_460-X,,,1/g
prod,62,32,,,rs_pt_180_354-X,,,1/g
prod,63,33,,,rs_pt_180_260-X,,,1/g
prod,64,34,,,rs_pt_180_123-X,,,1/g
prod,65,35,,,rs_pt_180_12-X,,,1/g
prod,71,41,,,rs_pt_180_460-y,,,1/g
prod,72,42,,,rs_pt_180_354-y,,,1/g
prod,73,43,,,rs_pt_180_260-y,,,1/g
prod,74,44,,,rs_pt_180_123-y,,,1/g
prod,75,45,,,rs_pt_180_12-y,,,1/g
prod,81,51,,,rs_pt_180_460-z,,,1/g
prod,82,52,,,rs_pt_180_354-z,,,1/g
prod,83,53,,,rs_pt_180_260-z,,,1/g
prod,84,54,,,rs_pt_180_123-z,,,1/g
prod,85,55,,,rs_pt_180_12-z,,,1/g

lines,200
/out,RS-PT-180,out
prvar,2,61,62,63,64,65
prvar,2,71,72,73,74,75
prvar,2,81,82,83,84,85
/out

deriv,91,3,1,,vx3
deriv,92,4,1,,vx4
deriv,93,5,1,,vx5
deriv,94,6,1,,vx6
deriv,95,7,1,,vx7

deriv,101,13,1,,vy13
deriv,102,14,1,,vy14
deriv,103,15,1,,vy15
deriv,104,16,1,,vy16
deriv,105,71,1,,vy17

deriv,111,23,1,,vz23
deriv,112,24,1,,vz24
deriv,113,25,1,,vz25
deriv,114,26,1,,vz26
deriv,115,27,1,,vz27

deriv,121,91,1,,a_pt_180_460-x,,,1/g
deriv,122,92,1,,a_pt_180_354-x,,,1/g
deriv,123,93,1,,a_pt_180_260-x,,,1/g
deriv,124,94,1,,a_pt_180_123-x,,,1/g
deriv,125,95,1,,a_pt_180_12-x,,,1/g

deriv,131,101,1,,a_pt_180_460-y,,,1/g
deriv,132,102,1,,a_pt_180_354-y,,,1/g
deriv,133,103,1,,a_pt_180_260-y,,,1/g
deriv,134,104,1,,a_pt_180_123-y,,,1/g

```

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```
deriv,135,105,1,,a_pt_180_12-y,,,1/g

deriv,141,111,1,,a_pt_180_460-z,,,1/g
deriv,142,112,1,,a_pt_180_354-z,,,1/g
deriv,143,113,1,,a_pt_180_260-z,,,1/g
deriv,144,114,1,,a_pt_180_123-z,,,1/g
deriv,145,115,1,,a_pt_180_12-z,,,1/g
```

```
lines,2250
/out,Disp-PT-180,out
prvar,3,4,5,6,7
prvar,13,14,15,16,17
prvar,23,24,25,26,27
/out
```

```
/out,Vel-PT-180,out
prvar,91,92,93,94,95
prvar,101,102,103,104,105
prvar,111,112,113,114,115
/out
```

```
/out,Accel-PT-180,out
prvar,121,122,123,124,125
prvar,131,132,133,134,135
prvar,141,142,143,144,145
/out
```

spectra-primary-45.txt

```
fini

/POST26
numvar,120
*do,z,2,120
VARDEL,z
*enddo

csys,1
cmsel,s,primary-tank
nsle
nsel,r,loc,x,ptx(12)
nsel,r,loc,y,-45
nsel,r,loc,z,ptz(12)
*get,pt_45_460,node,,num,max

cmsel,s,primary-tank
nsle
nsel,r,loc,x,ptx(18)
nsel,r,loc,y,-45
nsel,r,loc,z,ptz(18)
*get,pt_45_354,node,,num,max

cmsel,s,primary-tank
nsle
nsel,r,loc,x,ptx(22)
nsel,r,loc,y,-45
nsel,r,loc,z,ptz(22)
*get,pt_45_260,node,,num,max

cmsel,s,primary-tank
nsle
nsel,r,loc,x,ptx(28)
nsel,r,loc,y,-45
nsel,r,loc,z,ptz(28)
*get,pt_45_123,node,,num,max

cmsel,s,primary-tank
nsle
nsel,r,loc,x,ptx(33)
```

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```

nsel,r,loc,y,-45
nsel,r,loc,z,ptz(33)
*get,pt_45_12,node,,num,max

nsol,3,pt_45_460,u,x,N_$(pt_45_460)%X
nsol,4,pt_45_354,u,x,N_$(pt_45_354)%X
nsol,5,pt_45_260,u,x,N_$(pt_45_260)%X
nsol,6,pt_45_123,u,x,N_$(pt_45_123)%X
nsol,7,pt_45_12,u,x,N_$(pt_45_12)%X

nsol,13,pt_45_460,u,y,N_$(pt_45_460)%y
nsol,14,pt_45_354,u,y,N_$(pt_45_354)%y
nsol,15,pt_45_260,u,y,N_$(pt_45_260)%y
nsol,16,pt_45_123,u,y,N_$(pt_45_123)%y
nsol,17,pt_45_12,u,y,N_$(pt_45_12)%y

nsol,23,pt_45_460,u,z,N_$(pt_45_460)%z
nsol,24,pt_45_354,u,z,N_$(pt_45_354)%z
nsol,25,pt_45_260,u,z,N_$(pt_45_260)%z
nsol,26,pt_45_123,u,z,N_$(pt_45_123)%z
nsol,27,pt_45_12,u,z,N_$(pt_45_12)%z

/input,rs_freq,txt

resp,31,2,3,3,0.033,0.01,100,112.48
resp,32,2,4,3,0.033,0.01,100,112.48
resp,33,2,5,3,0.033,0.01,100,112.48
resp,34,2,6,3,0.033,0.01,100,112.48
resp,35,2,7,3,0.033,0.01,100,112.48
resp,41,2,13,3,0.033,0.01,100,112.48
resp,42,2,14,3,0.033,0.01,100,112.48
resp,43,2,15,3,0.033,0.01,100,112.48
resp,44,2,16,3,0.033,0.01,100,112.48
resp,45,2,17,3,0.033,0.01,100,112.48
resp,51,2,23,3,0.033,0.01,100,112.48
resp,52,2,24,3,0.033,0.01,100,112.48
resp,53,2,25,3,0.033,0.01,100,112.48
resp,54,2,26,3,0.033,0.01,100,112.48
resp,55,2,27,3,0.033,0.01,100,112.48

prod,61,31,,,rs_pt_45_460-X,,,1/g
prod,62,32,,,rs_pt_45_354-X,,,1/g
prod,63,33,,,rs_pt_45_260-X,,,1/g
prod,64,34,,,rs_pt_45_123-X,,,1/g
prod,65,35,,,rs_pt_45_12-X,,,1/g
prod,71,41,,,rs_pt_45_460-y,,,1/g
prod,72,42,,,rs_pt_45_354-y,,,1/g
prod,73,43,,,rs_pt_45_260-y,,,1/g
prod,74,44,,,rs_pt_45_123-y,,,1/g
prod,75,45,,,rs_pt_45_12-y,,,1/g
prod,81,51,,,rs_pt_45_460-z,,,1/g
prod,82,52,,,rs_pt_45_354-z,,,1/g
prod,83,53,,,rs_pt_45_260-z,,,1/g
prod,84,54,,,rs_pt_45_123-z,,,1/g
prod,85,55,,,rs_pt_45_12-z,,,1/g

lines,200
/out,RS-PT-45,out
prvar,2,61,62,63,64,65
prvar,2,71,72,73,74,75
prvar,2,81,82,83,84,85
/out

deriv,91,3,1,,vx3
deriv,92,4,1,,vx4
deriv,93,5,1,,vx5
deriv,94,6,1,,vx6
deriv,95,7,1,,vx7

deriv,101,13,1,,vy13

```

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```

deriv,102,14,1,,vy14
deriv,103,15,1,,vy15
deriv,104,16,1,,vy16
deriv,105,71,1,,vy17

deriv,111,23,1,,vz23
deriv,112,24,1,,vz24
deriv,113,25,1,,vz25
deriv,114,26,1,,vz26
deriv,115,27,1,,vz27

deriv,121,91,1,,a_pt_45_460-x,,,1/g
deriv,122,92,1,,a_pt_45_354-x,,,1/g
deriv,123,93,1,,a_pt_45_260-x,,,1/g
deriv,124,94,1,,a_pt_45_123-x,,,1/g
deriv,125,95,1,,a_pt_45_12-x,,,1/g

deriv,131,101,1,,a_pt_45_460-y,,,1/g
deriv,132,102,1,,a_pt_45_354-y,,,1/g
deriv,133,103,1,,a_pt_45_260-y,,,1/g
deriv,134,104,1,,a_pt_45_123-y,,,1/g
deriv,135,105,1,,a_pt_45_12-y,,,1/g

deriv,141,111,1,,a_pt_45_460-z,,,1/g
deriv,142,112,1,,a_pt_45_354-z,,,1/g
deriv,143,113,1,,a_pt_45_260-z,,,1/g
deriv,144,114,1,,a_pt_45_123-z,,,1/g
deriv,145,115,1,,a_pt_45_12-z,,,1/g

lines,2150
/out,Disp-PT-45,out
prvar,3,4,5,6,7
prvar,13,14,15,16,17
prvar,23,24,25,26,27
/out

/out,Vel-PT-45,out
prvar,91,92,93,94,95
prvar,101,102,103,104,105
prvar,111,112,113,114,115
/out

/out,Accel-PT-45,out
prvar,121,122,123,124,125
prvar,131,132,133,134,135
prvar,141,142,143,144,145
/out

```

spectra-primary-90.txt

```

fini

/POST26
numvar,120
*do,z,2,120
VARDEL,z
*enddo

csys,1
cmsel,s,primary-tank
nsle
nsel,r,loc,x,ptx(12)
nsel,r,loc,y,-90
nsel,r,loc,z,ptz(12)
*get,pt_90_460,node,,num,max

cmsel,s,primary-tank
nsle
nsel,r,loc,x,ptx(18)

```

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```

nsel,r,loc,y,-90
nsel,r,loc,z,ptz(18)
*get,pt_90_354,node,,num,max

cmsel,s,primary-tank
nsle
nsel,r,loc,x,ptx(22)
nsel,r,loc,y,-90
nsel,r,loc,z,ptz(22)
*get,pt_90_260,node,,num,max

cmsel,s,primary-tank
nsle
nsel,r,loc,x,ptx(28)
nsel,r,loc,y,-90
nsel,r,loc,z,ptz(28)
*get,pt_90_123,node,,num,max

cmsel,s,primary-tank
nsle
nsel,r,loc,x,ptx(33)
nsel,r,loc,y,-90
nsel,r,loc,z,ptz(33)
*get,pt_90_12,node,,num,max

nsol,3,pt_90_460,u,x,N_$(pt_90_460)%X
nsol,4,pt_90_354,u,x,N_$(pt_90_354)%X
nsol,5,pt_90_260,u,x,N_$(pt_90_260)%X
nsol,6,pt_90_123,u,x,N_$(pt_90_123)%X
nsol,7,pt_90_12,u,x,N_$(pt_90_12)%X

nsol,13,pt_90_460,u,y,N_$(pt_90_460)%y
nsol,14,pt_90_354,u,y,N_$(pt_90_354)%y
nsol,15,pt_90_260,u,y,N_$(pt_90_260)%y
nsol,16,pt_90_123,u,y,N_$(pt_90_123)%y
nsol,17,pt_90_12,u,y,N_$(pt_90_12)%y

nsol,23,pt_90_460,u,z,N_$(pt_90_460)%z
nsol,24,pt_90_354,u,z,N_$(pt_90_354)%z
nsol,25,pt_90_260,u,z,N_$(pt_90_260)%z
nsol,26,pt_90_123,u,z,N_$(pt_90_123)%z
nsol,27,pt_90_12,u,z,N_$(pt_90_12)%z

/input,rs_freq,txt

resp,31,2,3,3,0.033,0.01,100,112.48
resp,32,2,4,3,0.033,0.01,100,112.48
resp,33,2,5,3,0.033,0.01,100,112.48
resp,34,2,6,3,0.033,0.01,100,112.48
resp,35,2,7,3,0.033,0.01,100,112.48
resp,41,2,13,3,0.033,0.01,100,112.48
resp,42,2,14,3,0.033,0.01,100,112.48
resp,43,2,15,3,0.033,0.01,100,112.48
resp,44,2,16,3,0.033,0.01,100,112.48
resp,45,2,17,3,0.033,0.01,100,112.48
resp,51,2,23,3,0.033,0.01,100,112.48
resp,52,2,24,3,0.033,0.01,100,112.48
resp,53,2,25,3,0.033,0.01,100,112.48
resp,54,2,26,3,0.033,0.01,100,112.48
resp,55,2,27,3,0.033,0.01,100,112.48

prod,61,31,,,rs_pt_90_460-X,,,1/g
prod,62,32,,,rs_pt_90_354-X,,,1/g
prod,63,33,,,rs_pt_90_260-X,,,1/g
prod,64,34,,,rs_pt_90_123-X,,,1/g
prod,65,35,,,rs_pt_90_12-X,,,1/g
prod,71,41,,,rs_pt_90_460-y,,,1/g
prod,72,42,,,rs_pt_90_354-y,,,1/g
prod,73,43,,,rs_pt_90_260-y,,,1/g
prod,74,44,,,rs_pt_90_123-y,,,1/g
prod,75,45,,,rs_pt_90_12-y,,,1/g

```

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```

prod,81,51,,,rs_pt_90_460-z,,,1/g
prod,82,52,,,rs_pt_90_354-z,,,1/g
prod,83,53,,,rs_pt_90_260-z,,,1/g
prod,84,54,,,rs_pt_90_123-z,,,1/g
prod,85,55,,,rs_pt_90_12-z,,,1/g

lines,200
/out,RS-PT-90,out
prvar,2,61,62,63,64,65
prvar,2,71,72,73,74,75
prvar,2,81,82,83,84,85
/out

deriv,91,3,1,,vx3
deriv,92,4,1,,vx4
deriv,93,5,1,,vx5
deriv,94,6,1,,vx6
deriv,95,7,1,,vx7

deriv,101,13,1,,vy13
deriv,102,14,1,,vy14
deriv,103,15,1,,vy15
deriv,104,16,1,,vy16
deriv,105,71,1,,vy17

deriv,111,23,1,,vz23
deriv,112,24,1,,vz24
deriv,113,25,1,,vz25
deriv,114,26,1,,vz26
deriv,115,27,1,,vz27

deriv,121,91,1,,a_pt_90_460-x,,,1/g
deriv,122,92,1,,a_pt_90_354-x,,,1/g
deriv,123,93,1,,a_pt_90_260-x,,,1/g
deriv,124,94,1,,a_pt_90_123-x,,,1/g
deriv,125,95,1,,a_pt_90_12-x,,,1/g

deriv,131,101,1,,a_pt_90_460-y,,,1/g
deriv,132,102,1,,a_pt_90_354-y,,,1/g
deriv,133,103,1,,a_pt_90_260-y,,,1/g
deriv,134,104,1,,a_pt_90_123-y,,,1/g
deriv,135,105,1,,a_pt_90_12-y,,,1/g

deriv,141,111,1,,a_pt_90_460-z,,,1/g
deriv,142,112,1,,a_pt_90_354-z,,,1/g
deriv,143,113,1,,a_pt_90_260-z,,,1/g
deriv,144,114,1,,a_pt_90_123-z,,,1/g
deriv,145,115,1,,a_pt_90_12-z,,,1/g

lines,2250
/out,Disp-PT-90,out
prvar,3,4,5,6,7
prvar,13,14,15,16,17
prvar,23,24,25,26,27
/out

/out,Vel-PT-90,out
prvar,91,92,93,94,95
prvar,101,102,103,104,105
prvar,111,112,113,114,115
/out

/out,Accel-PT-90,out
prvar,121,122,123,124,125
prvar,131,132,133,134,135
prvar,141,142,143,144,145
/out

```

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spectra-soil.txt

```
fini

/POST26
numvar,200
*do,z,2,200
VARDEL,z
*enddo

esel,s,type,,9
nsle
csys,1
nsel,r,loc,x,soil_radius
nsel,r,loc,y,0
nsel,r,loc,z,soilz(1)
*get,Soil_Surf,node,,num,max

nsle
nsel,r,loc,x,Soil_radius
nsel,r,loc,y,0
nsel,r,loc,z,soilz(3)
*get,Soil_Tank_top,node,,num,max

nsle
nsel,r,loc,x,Soil_radius
nsel,r,loc,y,0
nsel,r,loc,z,soilz(6)
*get,Soil_Tank_mid,node,,num,max

nsle
nsel,r,loc,x,soil_radius
nsel,r,loc,y,0
nsel,r,loc,z,soilz(9)
*get,Soil_Tank_bot,node,,num,max

nsle
nsel,r,loc,x,Soil_radius
nsel,r,loc,y,0
nsel,r,loc,z,soilz(20)
*get,Soil_Bottom,node,,num,max

nsol,3,Soil_Surf,u,x,N_$(Soil_Surf)%X
nsol,4,Soil_Tank_top,u,x,N_$(Soil_Tank_top)%X
nsol,5,Soil_Tank_mid,u,x,N_$(Soil_Tank_mid)%X
nsol,6,Soil_Tank_bot,u,x,N_$(Soil_Tank_bot)%X
nsol,7,Soil_Bottom,u,x,N_$(Soil_Bottom)%X

nsol,13,Soil_Surf,u,y,N_$(Soil_Surf)%y
nsol,14,Soil_Tank_top,u,y,N_$(Soil_Tank_top)%y
nsol,15,Soil_Tank_mid,u,y,N_$(Soil_Tank_mid)%y
nsol,16,Soil_Tank_bot,u,y,N_$(Soil_Tank_bot)%y
nsol,17,Soil_Bottom,u,y,N_$(Soil_Bottom)%y

nsol,23,Soil_Surf,u,z,N_$(Soil_Surf)%z
nsol,24,Soil_Tank_top,u,z,N_$(Soil_Tank_top)%z
nsol,25,Soil_Tank_mid,u,z,N_$(Soil_Tank_mid)%z
nsol,26,Soil_Tank_bot,u,z,N_$(Soil_Tank_bot)%z
nsol,27,Soil_Bottom,u,z,N_$(Soil_Bottom)%z

/input,rs_freq,txt

resp,31,2,3,3,0.05,0.01,100,120.48
resp,32,2,4,3,0.05,0.01,100,120.48
resp,33,2,5,3,0.05,0.01,100,120.48
resp,34,2,6,3,0.05,0.01,100,120.48
resp,35,2,7,3,0.05,0.01,100,120.48
resp,41,2,13,3,0.05,0.01,100,120.48
resp,42,2,14,3,0.05,0.01,100,120.48
resp,43,2,15,3,0.05,0.01,100,120.48
```


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```
resp,44,2,16,3,0.05,0.01,100,120.48
resp,45,2,17,3,0.05,0.01,100,120.48
resp,51,2,23,3,0.05,0.01,100,120.48
resp,52,2,24,3,0.05,0.01,100,120.48
resp,53,2,25,3,0.05,0.01,100,120.48
resp,54,2,26,3,0.05,0.01,100,120.48
resp,55,2,27,3,0.05,0.01,100,120.48

prod,61,31,,,rs_Soil_Surf-X,,,1/g
prod,62,32,,,rs_Soil_Tank_top-X,,,1/g
prod,63,33,,,rs_Soil_Tank_mid-X,,,1/g
prod,64,34,,,rs_Soil_Tank_bot-X,,,1/g
prod,65,35,,,rs_Soil_Bottom-X,,,1/g
prod,71,41,,,rs_Soil_Surf-y,,,1/g
prod,72,42,,,rs_Soil_Tank_top-y,,,1/g
prod,73,43,,,rs_Soil_Tank_mid-y,,,1/g
prod,74,44,,,rs_Soil_Tank_bot-y,,,1/g
prod,75,45,,,rs_Soil_Bottom-y,,,1/g
prod,81,51,,,rs_Soil_Surf-z,,,1/g
prod,82,52,,,rs_Soil_Tank_top-z,,,1/g
prod,83,53,,,rs_Soil_Tank_mid-z,,,1/g
prod,84,54,,,rs_Soil_Tank_bot-z,,,1/g
prod,85,55,,,rs_Soil_Bottom-z,,,1/g

lines,200
/out,RS-Soil,out
prvar,2,61,62,63,64,65
prvar,2,71,72,73,74,75
prvar,2,81,82,83,84,85
/out

deriv,91,3,1,,vx3
deriv,92,4,1,,vx4
deriv,93,5,1,,vx5
deriv,94,6,1,,vx6
deriv,95,7,1,,vx7

deriv,101,13,1,,vy13
deriv,102,14,1,,vy14
deriv,103,15,1,,vy15
deriv,104,16,1,,vy16
deriv,105,71,1,,vy17

deriv,111,23,1,,vz23
deriv,112,24,1,,vz24
deriv,113,25,1,,vz25
deriv,114,26,1,,vz26
deriv,115,27,1,,vz27

deriv,121,91,1,,a_Soil_Surf-x,,,1/g
deriv,122,92,1,,a_Soil_Tank_top-x,,,1/g
deriv,123,93,1,,a_Soil_Tank_mid-x,,,1/g
deriv,124,94,1,,a_Soil_Tank_bot-x,,,1/g
deriv,125,95,1,,a_Soil_Bottom-x,,,1/g

deriv,131,101,1,,a_Soil_Surf-y,,,1/g
deriv,132,102,1,,a_Soil_Tank_top-y,,,1/g
deriv,133,103,1,,a_Soil_Tank_mid-y,,,1/g
deriv,134,104,1,,a_Soil_Tank_bot-y,,,1/g
deriv,135,105,1,,a_Soil_Bottom-y,,,1/g

deriv,141,111,1,,a_Soil_Surf-z,,,1/g
deriv,142,112,1,,a_Soil_Tank_top-z,,,1/g
deriv,143,113,1,,a_Soil_Tank_mid-z,,,1/g
deriv,144,114,1,,a_Soil_Tank_bot-z,,,1/g
deriv,145,115,1,,a_Soil_Bottom-z,,,1/g

lines,2150
/out,Disp-Soil,out
prvar,3,4,5,6,7
```

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```
prvar,13,14,15,16,17
prvar,23,24,25,26,27
/out

/out,Vel-Soil,out
prvar,91,92,93,94,95
prvar,101,102,103,104,105
prvar,111,112,113,114,115
/out

/out,Accel-Soil,out
prvar,121,122,123,124,125
prvar,131,132,133,134,135
prvar,141,142,143,144,145
/out
```

strain-backed-principle-bot.txt

```
/post26
numvar,200
*do,z,2,200
VARDEL,z
*enddo

csys,1
*do,i,1,20
angley=-arcsize*(i-1)
*do,j,2,10
cmsel,s,strain-1
!shell,bot
nsle
nsel,r,loc,y,angley,angley-arcsize
nsel,r,loc,x,ptx(j),ptx(j+1)
nsel,r,loc,z,ptz(j)+.1,ptz(j+1)-.1
esln,r,1
*get,emax,elem,,num,max
esol,(1+j),(emax),,epel,1,epel1%(emax)%-b
esol,(44+j),(emax),,epel,2,epel2%(emax)%-b
esol,(87+j),(emax),,epel,int,epelint%(emax)%-b
esol,(130+j),(emax),,epel,3,epel3%(emax)%-b
*enddo

*do,j,11,20
cmsel,s,strain-2
nsle
shell,bot
nsel,r,loc,y,angley,angley-arcsize
nsel,r,loc,x,ctx(j),ctx(j+1)
nsel,r,loc,z,ctz(j)+.1,ctz(j+1)-.1
esln,r,1
*get,emax,elem,,num,max
esol,(1+j),(emax),,epel,1,epel1%(emax)%-b
esol,(44+j),(emax),,epel,2,epel2%(emax)%-b
esol,(87+j),(emax),,epel,int,epelint%(emax)%-b
esol,(130+j),(emax),,epel,3,epel3%(emax)%-b
*enddo

*do,j,21,23
cmsel,s,strain-3
shell,bot
nsle
nsel,r,loc,y,angley,angley-arcsize
nsel,r,loc,x,linx(j-19),linx(j+1-19)
nsel,r,loc,z,linz(j-19)+.1,linz(j+1-19)-.1
esln,r,1
*get,emax,elem,,num,max
esol,(1+j),(emax),,epel,1,epel1%(emax)%-b
esol,(44+j),(emax),,epel,2,epel2%(emax)%-b
```

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```

esol, (87+j), (emax),, epel, int, epelint%(emax) %-b
esol, (130+j), (emax),, epel, 3, epel3%(emax) %-b
*enddo

!*do, j, 24, 32
!cmsel, s, strain-4
!shell, top
!nsle
!nsel, r, loc, y, angley, angley-arcsize
!nsel, r, loc, x, ctx(j), ctx(j+1)
!nsel, r, loc, z, ctz(j)+.1, ctz(j+1)-.1
!esln, r, 1
!*get, emax, elem,, num, max
!esol, (1+j), (emax),, epel, 1, epel1%(emax) %-b
!esol, (44+j), (emax),, epel, 2, epel2%(emax) %-b
!esol, (87+j), (emax),, epel, int, epelint%(emax) %-b
!esol, (130+j), (emax),, epel, 3, epel3%(emax) %-b
!*enddo

LINES, 2050
extrem
/OUT, Strain-Backed-Princ_%(9*i) %-bot-max, OUT
extrem, 2, 200
/OUT

/OUT, Strain-Backed-Princ_%(9*i) %-bot-th, OUT
*do, k, 2, 32
PRVAR, 1+k, 44+k, 87+k, 130+k
*enddo
/OUT

*enddo

```

strain-backed-principle-mid.txt

```

/post26
numvar, 200
*do, z, 2, 200
VARDEL, z
*enddo

csys, 1
*do, i, 1, 20
angley=-arcsize*(i-1)
*do, j, 2, 10
cmsel, s, strain-1
!shell, mid
!nsle
!nsel, r, loc, y, angley, angley-arcsize
!nsel, r, loc, x, ptx(j), ptx(j+1)
!nsel, r, loc, z, ptz(j)+.1, ptz(j+1)-.1
!esln, r, 1
!*get, emax, elem,, num, max
esol, (1+j), (emax),, epel, 1, epel1%(emax) %-m
esol, (44+j), (emax),, epel, 2, epel2%(emax) %-m
esol, (87+j), (emax),, epel, int, epelint%(emax) %-m
esol, (130+j), (emax),, epel, 3, epel3%(emax) %-m
*enddo

!*do, j, 11, 20
!cmsel, s, strain-2
!nsle
!shell, bot
!nsel, r, loc, y, angley, angley-arcsize
!nsel, r, loc, x, ctx(j), ctx(j+1)
!nsel, r, loc, z, ctz(j)+.1, ctz(j+1)-.1
!esln, r, 1
!*get, emax, elem,, num, max
!esol, (1+j), (emax),, epel, 1, epel1%(emax) %-m

```

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```

!esol, (44+j), (emax), , epel, 2, epel2% (emax) % -m
!esol, (87+j), (emax), , epel, int, epelint% (emax) % -m
!esol, (130+j), (emax), , epel, 3, epel3% (emax) % -m
!*enddo

*do, j, 21, 23
cmsel, s, strain-3
!shell, mid
nsle
nsel, r, loc, y, angley, angley-arcsz
nsel, r, loc, x, linx (j-19), linx (j+1-19)
nsel, r, loc, z, linz (j-19) +.1, linz (j+1-19) -.1
esln, r, 1
*get, emax, elem, , num, max
esol, (1+j), (emax), , epel, 1, epel1% (emax) % -m
esol, (44+j), (emax), , epel, 2, epel2% (emax) % -m
esol, (87+j), (emax), , epel, int, epelint% (emax) % -m
esol, (130+j), (emax), , epel, 3, epel3% (emax) % -m
*enddo

!*do, j, 24, 32
!cmsel, s, strain-4
!shell, top
!nsle
!nsel, r, loc, y, angley, angley-arcsz
!nsel, r, loc, x, ctx (j), ctx (j+1)
!nsel, r, loc, z, ctz (j) +.1, ctz (j+1) -.1
!esln, r, 1
!*get, emax, elem, , num, max
!esol, (1+j), (emax), , epel, 1, epel1% (emax) % -m
!esol, (44+j), (emax), , epel, 2, epel2% (emax) % -m
!esol, (87+j), (emax), , epel, int, epelint% (emax) % -m
!esol, (130+j), (emax), , epel, 3, epel3% (emax) % -m
!*enddo

LINEs, 2050
extrem
/OUT, Strain-Backed-Princ_ % (9*i) % max, OUT
extrem, 2, 200
/OUT

/OUT, Strain-Backed-Princ_ % (9*i) % th, OUT
*do, k, 2, 32
PRVAR, 1+k, 44+k, 87+k, 130+k
*enddo
/OUT

*enddo

```

strain-backed-principle-top.txt

```

/post26
numvar, 200
*do, z, 2, 200
VARDEL, z
*enddo

csys, 1
*do, i, 1, 20
angley = -arcsz * (i-1)
*do, j, 2, 10
cmsel, s, strain-1
!shell, top
nsle
nsel, r, loc, y, angley, angley-arcsz
nsel, r, loc, x, ptx (j), ptx (j+1)
nsel, r, loc, z, ptz (j) +.1, ptz (j+1) -.1
esln, r, 1

```

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```

*get,emax,elem,,num,max
esol,(1+j),(emax),,epel,1,epel1%(emax)%-t
esol,(44+j),(emax),,epel,2,epel2%(emax)%-t
esol,(87+j),(emax),,epel,int,epelint%(emax)%-t
esol,(130+j),(emax),,epel,3,epel3%(emax)%-t
*enddo

!*do,j,11,20
!cmsel,s,strain-2
!nsle
!shell,bot
!nsel,r,loc,y,angle,angley,angley-arcsz
!nsel,r,loc,x,ctx(j),ctx(j+1)
!nsel,r,loc,z,ctz(j)+.1,ctz(j+1)-.1
!esln,r,1
!*get,emax,elem,,num,max
!esol,(1+j),(emax),,epel,1,epel1%(emax)%-t
!esol,(44+j),(emax),,epel,2,epel2%(emax)%-t
!esol,(87+j),(emax),,epel,int,epelint%(emax)%-t
!esol,(130+j),(emax),,epel,3,epel3%(emax)%-t
!*enddo

*do,j,21,23
cmsel,s,strain-3
!shell,top
nsle
nsel,r,loc,y,angle,angley,angley-arcsz
nsel,r,loc,x,linx(j-19),linx(j+1-19)
nsel,r,loc,z,linz(j-19)+.1,linz(j+1-19)-.1
esln,r,1
*get,emax,elem,,num,max
esol,(1+j),(emax),,epel,1,epel1%(emax)%-t
esol,(44+j),(emax),,epel,2,epel2%(emax)%-t
esol,(87+j),(emax),,epel,int,epelint%(emax)%-t
esol,(130+j),(emax),,epel,3,epel3%(emax)%-t
*enddo

*do,j,24,32
cmsel,s,strain-4
!shell,top
nsle
nsel,r,loc,y,angle,angley,angley-arcsz
nsel,r,loc,x,ctx(j),ctx(j+1)
nsel,r,loc,z,ctz(j)+.1,ctz(j+1)-.1
esln,r,1
*get,emax,elem,,num,max
esol,(1+j),(emax),,epel,1,epel1%(emax)%-t
esol,(44+j),(emax),,epel,2,epel2%(emax)%-t
esol,(87+j),(emax),,epel,int,epelint%(emax)%-t
esol,(130+j),(emax),,epel,3,epel3%(emax)%-t
*enddo

LINES,2050
extrem
/OUT,Strain-Backed-Princ_%(9*i)%-Top-max,OUT
extrem,2,200
/OUT

/OUT,Strain-Backed-Princ_%(9*i)%-Top-th,OUT
*do,k,2,32
PRVAR,1+k,44+k,87+k,130+k
*enddo
/OUT

*enddo

```

strain-backed-principle.txt

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```

! Primary Tank in dome
cmsel,s,primary-tank
nsle
nsel,r,loc,x,ptx(2),ptx(11)
nsel,r,loc,z,ptz(2),ptz(11)
esln,r,1
cm,strain-1,elem

cmsel,s,conc-tank
nsle
nsel,r,loc,x,ctx(11),ctx(21)
nsel,r,loc,z,ctx(11),ctx(21)
esln,r,1
cm,strain-2,elem

*dim,linx,,20
*dim,linz,,20

linx(1)=ctx(20),ctx(21),ctx(22),ctx(22)-0.2929,ctx(22)-1,ctx(25),ctx(26),ctx(27),ctx(28),ctx(29)
linx(11)=ctx(30),ctx(31),ctx(32),ctx(33),ctx(34)

linz(1)=ctx(20),ctx(21),-56.643,-57.350,ctx(24),ctx(25),ctx(26),ctx(27),ctx(28),ctx(29)
linz(11)=ctx(30),ctx(31),ctx(32),ctx(33),ctx(34)

cmsel,s,liner
nsle
nsel,r,loc,x,linx(2),linx(5)
nsel,r,loc,z,linz(2),linz(5)
esln,r,1
cm,strain-3,elem

cmsel,s,conc-tank
nsle
nsel,r,loc,x,ctx(24),ctx(33)
nsel,r,loc,z,ctx(24),ctx(33)
esln,r,1
cm,strain-4,elem

/post26
shell,bot
/input,strain-backed-Principle-Bot,txt
shell,mid
/input,strain-backed-Principle-Mid,txt
shell,top
/input,strain-backed-Principle-Top,txt

```

stress-compb.txt

```

/post26

*do,z,2,200
VARDEL,z
*enddo
csys,1
*do,i,1,20
angley=-arcsize*(i-1)
*do,j,2,42
cmsel,s,primary-tank
nsle
nsel,r,loc,y,angley,angley-arcsize
nsel,r,loc,x,ptx(j),ptx(j+1)
nsel,r,loc,z,ptz(j)+.1,ptz(j+1)-.1
esln,r,1
*get,emax,elem,,num,max
esol,(1+j),(emax),,s,x,sx%(emax)%-b
esol,(44+j),(emax),,s,y,sy%(emax)%-b
esol,(87+j),(emax),,s,int,sint%(emax)%-b
esol,(130+j),(emax),,s,xy,sxy%(emax)%-b
*enddo

```

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```

LINES,2150
extrem
/OUT,Stress-pt_$(9*i)%max-b,OUT
extrem,2,200
/OUT

/OUT,Stress-pt_$(9*i)%th-b,OUT
*do,k,2,42
PRVAR,1+k,44+k,87+k,130+k
*enddo
/OUT

*enddo

```

stress-compm.txt

```

/post26
numvar,200
*do,z,2,200
VARDEL,z
*enddo
csys,1
*do,i,1,20
angley=-arcsize*(i-1)
*do,j,2,42
cmsel,s,primary-tank
nsle
nsel,r,loc,y,angley,angley-arcsize
nsel,r,loc,x,ptx(j),ptx(j+1)
nsel,r,loc,z,ptz(j)+.1,ptz(j+1)-.1
esln,r,1
*get,emax,elem,,num,max
esol,(1+j),(emax),,s,x,sx$(emax)%-m
esol,(44+j),(emax),,s,y,sy$(emax)%-m
esol,(87+j),(emax),,s,int,sint$(emax)%-m
esol,(130+j),(emax),,s,xy,sxy$(emax)%-m
*enddo

LINES,2150
extrem
/OUT,Stress-pt_$(9*i)%max-m,OUT
extrem,2,200
/OUT

/OUT,Stress-pt_$(9*i)%th-m,OUT
*do,k,2,42
PRVAR,1+k,44+k,87+k,130+k
*enddo
/OUT

*enddo

```

stress-compt.txt

```

/post26

*do,z,2,200
VARDEL,z
*enddo
csys,1
*do,i,1,20
angley=-arcsize*(i-1)
*do,j,2,42
cmsel,s,primary-tank
nsle
nsel,r,loc,y,angley,angley-arcsize
nsel,r,loc,x,ptx(j),ptx(j+1)

```

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```

nsel,r,loc,z,ptz(j)+.1,ptz(j+1)-.1
esln,r,1
*get,emax,elem,,num,max
esol,(1+j),(emax),,s,x,sx%(emax)%-t
esol,(43+j),(emax),,s,y,sy%(emax)%-t
esol,(87+j),(emax),,s,int,sint%(emax)%-t
esol,(130+j),(emax),,s,xy,sxy%(emax)%-t
*enddo

```

```

LINES,2150
extrem
/OUT,Stress-pt_%(9*i)%max-t,OUT
extrem,2,200
/OUT

```

```

/OUT,Stress-pt_%(9*i)%th-t,OUT
*do,k,2,42
PRVAR,1+k,44+k,87+k,130+k
*enddo
/OUT

```

```

*enddo

```

Stress-Primary.txt

```

! extract primary tank stress components at the top, middel and bottom surface of the shell
/post26
numvar,200
shell,top
/input,stress-compt,txt

shell,mid
/input,stress-compm,txt

shell,bot
/input,stress-compb,txt

```

Tank-Coordinates-AP.txt

/COM - Definition of KeyPoints for Primary tank

```

ct_kps=34          ! Total number of Concrete tank Coordinate pairs
pt_kps=44          ! Total number of Primary Tank Coordinate pairs
bm_kp=22           ! Coordinate pair at bottom on concrete tank wall
tw=9               ! Rings in common for insulating concrete
arcsz=9            ! Control for meshing, section angle
Midsize=5          ! Control for meshing, center areas
z_off=57.31        ! Vertical offset for tank (bottom of primary tank is Z=0 for coordinates)
C_Floor=-4

```

```

*dim,ctx,,ct_kps   ! Concrete Tank Keypoint X Coordinates
*dim,ctz,,ct_kps   ! Concrete Tank Keypoint Z Coordinates
*dim,ptx,,pt_kps   ! Primary Tank Keypoint X Coordinates
*dim,ptz,,pt_kps   ! Primary Tank Keypoint Z Coordinates

```

/COM - Define Horizontal Keypoint Locations

```

ctx(1)=0
ctx(2)=45/12
ctx(3)=90.4/12
ctx(4)=120.72/12
ctx(5)=152.9/12
ctx(6)=211.4/12
ctx(7)=239.1/12
ctx(8)=306.63/12
ctx(9)=335.6/12
ctx(10)=393.7/12
ctx(11)=428.7/12
ctx(12)=469.9/12

```


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```
ctx(13)=486.9/12
ctx(14)=489/12
ctx(15)=489/12
ctx(16)=489/12
ctx(17)=489/12
ctx(18)=489/12
ctx(19)=489/12
ctx(20)=489/12
ctx(21)=489/12
ctx(22)=489/12
ctx(23)=531/12
ctx(24)=489/12
ctx(25)=438/12
ctx(26)=423/12
ctx(27)=400/12
ctx(28)=340/12
ctx(29)=280/12
ctx(30)=220/12
ctx(31)=160/12
ctx(32)=100/12
ctx(33)=36/12
ctx(34)=0
```

/COM - Define Vertical Keypoint Locations

```
ctz(1)=576.8/12-z_off
ctz(2)=576/12-z_off
ctz(3)=573.8/12-z_off
ctz(4)=571.21/12-z_off
ctz(5)=567.7/12-z_off
ctz(6)=558.7/12-z_off
ctz(7)=553.2/12-z_off
ctz(8)=535.68/12-z_off
ctz(9)=526.2/12-z_off
ctz(10)=502.5/12-z_off
ctz(11)=484.2/12-z_off
ctz(12)=455.4/12-z_off
ctz(13)=415.1/12-z_off
ctz(14)=382.1/12-z_off
ctz(15)=335/12-z_off
ctz(16)=281/12-z_off
ctz(17)=236.5/12-z_off
ctz(18)=186.8/12-z_off
ctz(19)=145.5/12-z_off
ctz(20)=70/12-z_off
ctz(21)=(c_Floor+24)/12-z_off
ctz(22)=C_Floor/12-z_off
ctz(23)=C_Floor/12-z_off
ctz(24)=C_Floor/12-z_off
ctz(25)=C_Floor/12-z_off
ctz(26)=C_Floor/12-z_off
ctz(27)=C_Floor/12-z_off
ctz(28)=C_Floor/12-z_off
ctz(29)=C_Floor/12-z_off
ctz(30)=C_Floor/12-z_off
ctz(31)=C_Floor/12-z_off
ctz(32)=C_Floor/12-z_off
ctz(33)=C_Floor/12-z_off
ctz(34)=C_Floor/12-z_off
```

```
ptx(1)=0
ptx(2)=44.73689/12
ptx(3)=89.86533/12
ptx(4)=119.99721/12
ptx(5)=151.96854/12
ptx(6)=210.05344/12
ptx(7)=237.53366/12
ptx(8)=304.42488/12
ptx(9)=333.05132/12
ptx(10)=390.22141/12
ptx(11)=422.26434/12
```

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ptx(12)=432/12
ptx(13)=444.36/12
ptx(14)=448.66/12
ptx(15)=450/12
ptx(16)=450/12
ptx(17)=450/12
ptx(18)=450/12
ptx(19)=450/12
ptx(20)=450/12
ptx(21)=450/12
ptx(22)=450/12
ptx(23)=450/12
ptx(24)=450/12
ptx(25)=450/12
ptx(26)=450/12
ptx(27)=450/12
ptx(28)=450/12
ptx(29)=450/12
ptx(30)=450/12
ptx(31)=450/12
ptx(32)=450/12
ptx(33)=450/12
ptx(34)=446.49/12
ptx(35)=438/12
ptx(36)=423/12
ptx(37)=400/12
ptx(38)=340/12
ptx(39)=280/12
ptx(40)=220/12
ptx(41)=160/12
ptx(42)=100/12
ptx(43)=36/12
ptx(44)=0

ptz(1)=569.30000/12-z_off
ptz(2)=568.50462/12-z_off
ptz(3)=566.31908/12-z_off
ptz(4)=563.74491/12-z_off
ptz(5)=560.25807/12-z_off
ptz(6)=551.32187/12-z_off
ptz(7)=545.86539/12-z_off
ptz(8)=528.51150/12-z_off
ptz(9)=519.14633/12-z_off
ptz(10)=495.85550/12-z_off
ptz(11)=474.92388/12-z_off
ptz(12)=468/12-z_off
ptz(13)=456.7/12-z_off
ptz(14)=445.4/12-z_off
ptz(15)=432.3125/12-z_off
ptz(16)=410.125/12-z_off
ptz(17)=386.125/12-z_off
ptz(18)=362.125/12-z_off
ptz(19)=337.875/12-z_off
ptz(20)=314.775/12-z_off
ptz(21)=291.675/12-z_off
ptz(22)=268.575/12-z_off
ptz(23)=245.375/12-z_off
ptz(24)=222.275/12-z_off
ptz(25)=199.175/12-z_off
ptz(26)=176.075/12-z_off
ptz(27)=152.875/12-z_off
ptz(28)=131.275/12-z_off
ptz(29)=109.675/12-z_off
ptz(30)=88.075/12-z_off
ptz(31)=66.475/12-z_off
ptz(32)=45/12-z_off
ptz(33)=20/12-z_off
ptz(34)=11.51/12-z_off
ptz(35)=8/12-z_off
ptz(36)=8/12-z_off
ptz(37)=8/12-z_off

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```
ptz(38)=8/12-z_off
ptz(39)=8/12-z_off
ptz(40)=8/12-z_off
ptz(41)=8/12-z_off
ptz(42)=8/12-z_off
ptz(43)=8/12-z_off
ptz(44)=8/12-z_off
```

Tank-Mesh1.txt

```
et,1,shell143          ! SHELL143 Elements for Concrete Tank
keyopt,1,3,2
keyopt,1,5,1

csys,1                 ! Cylindrical Coordinates
/COM - Create KeyPoints for concrete tank
*do,i,1,ct_kps,1
k,i,ctx(i),0,ctz(i)
*enddo

/COM - Create lines from top of tank to bottom of wall
*do,i,1,bm_kp-1,1
l,i,i+1
*enddo

/COM - Create lines from edge of foundation to center
/COM - Wall and Foundation do not have common lines
*do,i,bm_kp+1,ct_kps-1,1
l,i,i+1
*enddo

/COM - Create Areas for tank dome and walls
lsl,s,line,,1,bm_kp-1
arotat,all,,,,,1,ct_kps,180,2

/COM - Create areas for tank foundation/floor
lsl,s,line,,bm_kp,ct_kps-2
arotat,all,,,,,1,ct_kps,180,2

/COM - Assign Material and Real Properties to areas
csys,1
*do,i,1,bm_kp-1,1
asel,s,loc,x,ctx(i),ctx(i+1)
asel,r,loc,z,ctz(i),ctz(i+1)
aatt,i,i,1
*enddo

asel,s,area,,1,2*(bm_kp-1)
CM,ctank-u,area

*do,i,bm_kp,ct_kps-2,1
asel,s,area,,bm_kp-1+i
asel,a,area,,ct_kps-2+i
aatt,i,i,1
*enddo

/COM - Create Elements
/COM - Elements at dome apex
esize,7                ! Define element maximum size
asel,s,loc,x,ctx(1),ctx(2) ! Select area at top
asel,r,loc,z,ctz(1),ctz(2)
lsla                    ! Select lines from areas
lsel,r,loc,x,ctx(2)      ! Select line at a radius of CTX(2)
lesize,all,,arcsizes    ! Divide line to match tank slices
lsla
lsel,u,loc,x,ctx(2)      ! Select only interior lines
lesize,all,,midsizes    ! Define element resolution
amesh,all               ! Mesh area
```

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```
/COM - Elements in dome and wall
*do,i,2,bm_kp-1,1
asel,s,loc,x,ctx(i),ctx(i+1)
asel,r,loc,z,ctz(i),ctz(i+1)
lsla
lsel,s,loc,x,ctx(i),ctx(i+1)
lsel,r,loc,z,ctz(i),ctz(i+1)
lesize,all,,arcsize
amesh,all
*enddo
cm,conc-dome_wall-n,node
cm,conc-dome_wall-e,elem

esel,none
nsel,none
*do,i,bm_kp+1,ct_kps-2,1
asel,s,area,,bm_kp-2+i
asel,a,area,,ct_kps-3+i
lsla
lsel,s,loc,x,ctx(i),ctx(i+1)
lsel,r,loc,z,ctz(i),ctz(i+1)
lesize,all,,arcsize
amesh,all
*enddo

/COM - Elements at floor center
asel,s,loc,x,ctx(ct_kps-1),ctx(ct_kps)
lsla
lsel,r,loc,x,ctx(ct_kps-1)
lesize,all,,arcsize
lsla
lsel,u,loc,x,ctx(ct_kps-1)
lesize,all,,midsize
amesh,all
cm,conc-slab,node
cm,conc-floor-e,elem
allsel
cm,conc-tank,elem
cm,conc-tank-a,area

/COM - Create Component for Concrete Wall/Floor Interface nodes
nsel,s,loc,z,ctz(bm_kp)
nsel,r,loc,x,ctx(bm_kp)
cm,Wall-int,node

allsel
*get,KMAXct,KP,0,num,max      ! Get Maximum Keypoint Number
*get,LMAXct,LINE,0,num,max    ! Get Maximum Line Number
*get,AMAXct,AREA,0,num,max    ! Get Maximum Area Number
```

Waste-Reaction.txt

```
/post1
*dim,REACTX,,2149
*dim,REACTZ,,2149

cmsel,s,waste
cmsel,a,waste-surf
nsle
*do,i,1,2149
set,i
fsum,,cont
*get,REACTX(i),FSUM,0,ITEM,FX
*get,reactz(i),FSUM,0,ITEM,FZ
*enddo
/out,Waste-Reaction-460-SD3,out
```

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```
*vwrite
('Total Waste Forces')
*vwrite
('      Fx      FZ')
*vwrite, reactx(1), reactz(1)
(f10.1, f10.1)
/out
```

Waste-solid-AP-S.txt

```
et,3,solid45      ! Solid45 Elements
Wastet=12         ! Primary tank coordinate for top of waste (460 in for AP Tanks)
Wasteb=35         ! Primary tank coordinate for bottom of waste

mp,ex,201,2.592                ! Bulk Modulus = 300,000 psi
mp,ey,201,2.592
mp,ez,201,2.592
mp,prxy,201,0.49999
mp,pryz,201,0.49999
mp,prxz,201,0.49999
mp,gxy,201,0.464
mp,gyz,201,0.464
mp,gxz,201,0.464
mp,dens,201,1.83*62.4/(1000*g)  ! Waste Density
mp,damp,201,0.001

ksel,u,kp,,all                ! Clear active Keypoints
asel,u,area,,all              ! Clear active Areas
vsel,u,volu,,all              ! Clear active Volumes
ksel,s,kp,,1,ct_kps,ct_kps-1  ! Activate Keypoints for center of rotation

/COM - Create KeyPoints for waste in tank
*do,i,0,Wasteb-Wastet,1        ! Cycle on vertical Keypoints
*do,j,0,tw-1                   ! Cycle on horizontal Keypoints
k,kmaxl+i*(tw+1)+j+1,ptx(pt_kps-j),0,ptz(i+Wastet)
*enddo
k,kmaxl+i*(tw+1)+j+2,ptx(i+Wastet),0,ptz(i+Wastet)    !
*enddo

/COM - Create Areas for waste in tank
*do,i,0,Wasteb-Wastet-1,1
*do,j,0,tw-1
a,kmaxl+i*(tw+1)+j+1,kmaxl+i*(tw+1)+j+2,kmaxl+(i+1)*(tw+1)+j+2,kmaxl+(i+1)*(tw+1)+j+1
*enddo
*enddo

/COM - Create Volumes for Waste
vrotat,all,,,,,1,ct_kps,180,2

/COM - Assign attributes
vatt,201,,3

wastevols=(tw)*(wasteb-wastet)
/COM - Elements in waste
*do,i,0,Wasteb-Wastet-1,1
*do,j,1,tw-1,1
vsel,s,volu,,vmaxl+i*tw+j+1
vsel,a,volu,,vmaxl+wastevols+i*tw+j+1
aslv
lsla
lsel,r,loc,x,ptx(pt_kps-j),ptx(i+Wastet)
lesize,all,,arcsiz
vmesh,all
*enddo
*enddo
```

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```
allsel
/COM - Mesh center column to match primary tank center
asel,s,loc,x,ptx(pt_kps-1),ptx(pt_kps)
asel,r,loc,z,ptz(wastet)
asel,r,loc,y,0,-90
cm,a3a,area
cmsel,s,a3a
cmsel,a,ala
mshcopy,2,ala,a3a,,,ptz(wastet)-ptz(wasteb)
allsel
asel,s,loc,x,ptx(pt_kps-1),ptx(pt_kps)
asel,r,loc,z,ptz(wastet)
cmsel,u,a3a
cm,a3b,area
cmsel,a,alb
mshcopy,2,alb,a3b,,,ptz(wastet)-ptz(wasteb)
vsel,s,volu,,vmax1+1,vmax1+2*waste vols+1,tw
vsweep,all,,all
cmsel,u,alb
cmsel,a,a3a
aclear,all
```

```
esel,s,type,,3
cm,waste,elem
nsle
cm,waste-n,node
```

```
/COM - Couple waste to primary tank
csys,1
allsel
```

```
et,44,target170
et,45,contal73
et,46,contal73
r,800,,,400/1.5
r,801,,,400/1.5
r,802,,,400/1.5
r,803,,,400/1.5
r,804,,,380/1.5
r,805,,,360/1.5
r,806,,,340/1.5
r,807,,,320/1.5
r,808,,,300/1.5
r,809,,,280/1.5
```

```
r,810,,,400/1.5
r,811,,,400/1.5
r,812,,,400/1.5
r,813,,,400/1.5
r,814,,,380/1.5
r,815,,,360/1.5
r,816,,,340/1.5
r,817,,,320/1.5
r,818,,,300/1.5
r,819,,,280/1.5
```

```
r,820,,,400/1.5
r,821,,,400/1.5
r,822,,,400/1.5
r,823,,,400/1.5
r,824,,,380/1.5
r,825,,,360/1.5
r,826,,,340/1.5
r,827,,,320/1.5
r,828,,,300/1.5
r,829,,,280/1.5
```

```
r,830,,,400/1.5
```

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```
r,831,,,400/1.5
r,832,,,400/1.5
r,833,,,400/1.5
r,834,,,380/1.5
r,835,,,360/1.5
r,836,,,340/1.5
r,837,,,320/1.5
r,838,,,300/1.5
r,839,,,280/1.5
```

```
keyopt,45,12,4
keyopt,46,12,4
```

```
! - Third Facet of Haunch
cmsel,s,primary-tank
nsle
nsel,r,loc,z,ptz(8),ptz(16)
nsel,r,loc,x,ptx(8),ptx(16)
esln,r,1
type,44
real,809
esurf
real,819
esurf
real,829
esurf
real,839
esurf
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(12),ptz(13)
nsel,r,loc,x,ptx(12),ptx(13)
nsel,r,loc,y,0,-45
esln,r
real,809
type,46
esurf
```

```
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(12),ptz(13)
nsel,r,loc,x,ptx(12),ptx(13)
nsel,r,loc,y,-45,-90
esln,r
real,819
type,46
esurf
```

```
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(12),ptz(13)
nsel,r,loc,x,ptx(12),ptx(13)
nsel,r,loc,y,-90,-135
esln,r
real,829
type,46
esurf
```

```
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(12),ptz(13)
nsel,r,loc,x,ptx(12),ptx(13)
nsel,r,loc,y,-135,-180
esln,r
real,839
type,46
esurf
```

```
! - Second Facet of Haunch
cmsel,s,primary-tank
```

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```

nsle
nsel, r, loc, z, ptz(9), ptz(17)
nsel, r, loc, x, ptx(9), ptx(17)
esln, r, 1
type, 44
real, 808
esurf
real, 818
esurf
real, 828
esurf
real, 838
esurf
cmsel, s, waste
nsle
nsel, r, loc, z, ptz(13), ptz(14)
nsel, r, loc, x, ptx(13), ptx(14)
nsel, r, loc, y, 0, -45
esln, r
real, 808
type, 46
esurf

cmsel, s, waste
nsle
nsel, r, loc, z, ptz(13), ptz(14)
nsel, r, loc, x, ptx(13), ptx(14)
nsel, r, loc, y, -45, -90
esln, r
real, 818
type, 46
esurf

cmsel, s, waste
nsle
nsel, r, loc, z, ptz(13), ptz(14)
nsel, r, loc, x, ptx(13), ptx(14)
nsel, r, loc, y, -90, -135
esln, r
real, 828
type, 46
esurf

cmsel, s, waste
nsle
nsel, r, loc, z, ptz(13), ptz(14)
nsel, r, loc, x, ptx(13), ptx(14)
nsel, r, loc, y, -135, -180
esln, r
real, 838
type, 46
esurf

! - First Facet of Haunch
cmsel, s, primary-tank
nsle
nsel, r, loc, z, ptz(10), ptz(18)
nsel, r, loc, x, ptx(10), ptx(18)
esln, r, 1
type, 44
real, 807
esurf
real, 817
esurf
real, 827
esurf
real, 837
esurf
cmsel, s, waste
nsle
nsel, r, loc, z, ptz(14), ptz(15)

```


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```
nsel,r,loc,x,ptx(14),ptx(15)
nsel,r,loc,y,0,-45
esln,r
real,807
type,46
esurf
```

```
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(14),ptz(15)
nsel,r,loc,x,ptx(14),ptx(15)
nsel,r,loc,y,-45,-90
esln,r
real,817
type,46
esurf
```

```
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(14),ptz(15)
nsel,r,loc,x,ptx(14),ptx(15)
nsel,r,loc,y,-90,-135
esln,r
real,827
type,46
esurf
```

```
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(14),ptz(15)
nsel,r,loc,x,ptx(14),ptx(15)
nsel,r,loc,y,-135,-180
esln,r
real,837
type,46
esurf
```

```
! - First Layer below Haunch
cmsel,s,primary-tank
nsle
nsel,r,loc,z,ptz(11),ptz(19)
nsel,r,loc,x,ptx(11),ptx(19)
esln,r,1
type,44
real,806
esurf
real,816
esurf
real,826
esurf
real,836
esurf
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(15),ptz(16)
nsel,r,loc,x,ptx(15),ptx(16)
nsel,r,loc,y,0,-45
esln,r
real,806
type,46
esurf
```

```
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(15),ptz(16)
nsel,r,loc,x,ptx(15),ptx(16)
nsel,r,loc,y,-45,-90
esln,r
real,816
type,46
esurf
```

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```
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(15),ptz(16)
nsel,r,loc,x,ptx(15),ptx(16)
nsel,r,loc,y,-90,-135
esln,r
real,826
type,46
esurf
```

```
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(15),ptz(16)
nsel,r,loc,x,ptx(15),ptx(16)
nsel,r,loc,y,-135,-180
esln,r
real,836
type,46
esurf
```

```
! - First Facet of Haunch
cmsel,s,primary-tank
nsle
nsel,r,loc,z,ptz(12),ptz(20)
nsel,r,loc,x,ptx(12),ptx(20)
esln,r,1
type,44
real,805
esurf
real,815
esurf
real,825
esurf
real,835
esurf
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(16),ptz(17)
nsel,r,loc,x,ptx(16),ptx(17)
nsel,r,loc,y,0,-45
esln,r
real,805
type,46
esurf
```

```
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(16),ptz(17)
nsel,r,loc,x,ptx(16),ptx(17)
nsel,r,loc,y,-45,-90
esln,r
real,815
type,46
esurf
```

```
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(16),ptz(17)
nsel,r,loc,x,ptx(16),ptx(17)
nsel,r,loc,y,-90,-135
esln,r
real,825
type,46
esurf
```

```
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(16),ptz(17)
nsel,r,loc,x,ptx(16),ptx(17)
nsel,r,loc,y,-135,-180
```

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```
esln,r
real,835
type,46
esurf

! - First Facet of Haunch
cmsel,s,primary-tank
nsle
nsel,r,loc,z,ptz(13),ptz(21)
nsel,r,loc,x,ptx(13),ptx(21)
esln,r,1
type,44
real,804
esurf
real,814
esurf
real,824
esurf
real,834
esurf
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(17),ptz(18)
nsel,r,loc,x,ptx(17),ptx(18)
nsel,r,loc,y,0,-45
esln,r
real,804
type,46
esurf

cmsel,s,waste
nsle
nsel,r,loc,z,ptz(17),ptz(18)
nsel,r,loc,x,ptx(17),ptx(18)
nsel,r,loc,y,-45,-90
esln,r
real,814
type,46
esurf

cmsel,s,waste
nsle
nsel,r,loc,z,ptz(17),ptz(18)
nsel,r,loc,x,ptx(17),ptx(18)
nsel,r,loc,y,-90,-135
esln,r
real,824
type,46
esurf

cmsel,s,waste
nsle
nsel,r,loc,z,ptz(17),ptz(18)
nsel,r,loc,x,ptx(17),ptx(18)
nsel,r,loc,y,-135,-180
esln,r
real,834
type,46
esurf

cmsel,s,primary-tank
nsle
nsel,r,loc,z,ptz(15),ptz(33)
esln,r,1
nsle
type,44
real,803
esurf
real,813
esurf
real,823
```

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```
esurf
real,833
esurf
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(18),ptz(34)
nsel,r,loc,x,ptx(18)
nsel,r,loc,y,0,-45
esln,r
real,803
type,45
esurf
```

```
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(18),ptz(34)
nsel,r,loc,x,ptx(18)
nsel,r,loc,y,-45,-90
esln,r
real,813
type,45
esurf
```

```
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(18),ptz(34)
nsel,r,loc,x,ptx(18)
nsel,r,loc,y,-90,-135
esln,r
real,823
type,45
esurf
```

```
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(18),ptz(34)
nsel,r,loc,x,ptx(18)
nsel,r,loc,y,-135,-180
esln,r
real,833
type,45
esurf
```

```
! - Second Facet of Knuckle
cmsel,s,primary-tank
nsle
nsel,r,loc,z,ptz(32),ptz(36)
nsel,r,loc,x,ptx(32),ptx(36)
esln,r,1
type,44
real,802
esurf
real,812
esurf
real,822
esurf
real,832
esurf
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(33),ptz(34)
nsel,r,loc,x,ptx(33),ptx(34)
nsel,r,loc,y,0,-45
esln,r
real,802
type,46
esurf
```

```
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(33),ptz(34)
```

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```
nsel,r,loc,x,ptx(33),ptx(34)
nsel,r,loc,y,-45,-90
esln,r
real,812
type,46
esurf
```

```
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(33),ptz(34)
nsel,r,loc,x,ptx(33),ptx(34)
nsel,r,loc,y,-90,-135
esln,r
real,822
type,46
esurf
```

```
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(33),ptz(34)
nsel,r,loc,x,ptx(33),ptx(34)
nsel,r,loc,y,-135,-180
esln,r
real,832
type,46
esurf
```

```
! - First Facet of Knuckle
cmsel,s,primary-tank
nsle
nsel,r,loc,z,ptz(32),ptz(37)
nsel,r,loc,x,ptx(32),ptx(37)
esln,r,1
type,44
real,801
esurf
real,811
esurf
real,821
esurf
real,831
esurf
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(34),ptz(35)
nsel,r,loc,x,ptx(34),ptx(35)
nsel,r,loc,y,0,-45
esln,r
real,801
type,46
esurf
```

```
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(34),ptz(35)
nsel,r,loc,x,ptx(34),ptx(35)
nsel,r,loc,y,-45,-90
esln,r
real,811
type,46
esurf
```

```
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(34),ptz(35)
nsel,r,loc,x,ptx(34),ptx(35)
nsel,r,loc,y,-90,-135
esln,r
real,821
type,46
esurf
```

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```

cmsel,s,waste
nsle
nsel,r,loc,z,ptz(34),ptz(35)
nsel,r,loc,x,ptx(34),ptx(35)
nsel,r,loc,y,-135,-180
esln,r
real,831
type,46
esurf

! - Bottom of Waste
cmsel,s,primary-tank
nsle
nsel,r,loc,z,ptz(33),ptz(36)
esln,r,1
type,44
real,800
esurf
cmsel,s,waste
nsle
nsel,r,loc,z,ptz(36)
esln,r
type,45
esurf

esel,s,type,,45,46
cm,waste-surf,elem

!cmsel,s,waste-n
!nsel,r,loc,z,ptz(wastet+2),ptz(wastet)
!nsel,r,loc,x,ptx(36),ptx(21)
!esln,r,1
!emodif,mat,,202

!cmsel,s,waste
!nsle
!nsel,r,loc,z,ptz(wastet)

allsel
*get,KMAXw,KP,0,num,max      ! Get maximum Keypoint number
*get,LMAXw,LINE,0,num,max    ! Get maximum Line number
*get,AMAXw,AREA,0,num,max    ! Get maximum Area number
*get,VMAXw,VOLU,0,num,max    ! Get maximum Volume number

```

Waste-Surface-AP.txt

```

/post26
numvar,200
*do,z,2,200
VARDEL,z
*enddo

cmsel,s,waste
nsle
nsel,r,loc,x,ptx(pt_kps)
nsel,r,loc,z,ptz(wasteb)
*get,nmax,node,,num,max
nsol,(2),(nmax),u,z,uz%(nmax)%

*do,i,0,21
*do,j,0,9
angley=-arcsin(uz%(i))

```

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```
cmsel,s,waste
nsle
nsel,r,loc,y,angley
nsel,r,loc,x,ptx(pt_kps-j)
nsel,r,loc,z,ptz(wastet)
*get,nmax,node,,num,max
nsol,(2+j),(nmax),u,z,uz%(nmax)%
add,(2+j),(2+J),2,,uz%(nmax)%,,1,-1
*enddo

cmsel,s,waste
nsle
nsel,r,loc,y,angley
nsel,r,loc,x,ptx(wastet)
nsel,r,loc,z,ptz(wastet)
*get,nmax,node,,num,max
nsol,(3+j),(nmax),u,z,uz%(nmax)%
add,(3+j),(3+J),2,,uz%(nmax)%,,1,-1

LINEs,2150
extrem
/OUT,Waste-Surf_%(9*i)%max,OUT
extrem,3,200
/OUT

/OUT,Waste-Surf_%(9*i)%th,OUT
*do,k,2,11
PRVAR,2+k
*enddo
/OUT

*enddo
```

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Appendix F

Lower Bound Soil, Best Estimate Concrete

Results Load Case Specific Input Files File Listing

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Appendix F

Lower Bound Soil, Best Estimate Concrete

Results Load Case Specific Input Files File Listing

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Table F.1. LBS-BEC Concrete Forces and Moment, Gravity Load Only

AP Primary Tank, Lower Bound Soil (Geomatrix), Gravity Only, Best Estimate Concrete, 460 in. Waste Level at 1.83 SpG

ANSYS MAXIMUMS BY PATH

PNNL Section No.	Path (in.)	Gravity Hoop Force (kip/ft) AP LBS-BEC	Gravity Meridonal Force (kip/ft) AP-LBS-BEC	Gravity In- Plane Shear Force (kip/ft) AP-LBS-BEC	Gravity Hoop Moment (ft*kip/ft) AP- LBS-BEC	Gravity Meridonal Moment (ft*kip/ft) AP-LBS-BEC	Gravity Through-Wall Shear Force (kip/ft) AP-LBS- BEC
2	67.734	-72.190	-76.220	-0.160	-6.222	-3.128	1.712
3	105.676	-67.460	-74.910	-0.257	-4.144	-0.764	1.013
4	137.076	-63.000	-73.590	-0.320	-2.707	1.656	1.139
6	182.856	-58.820	-71.570	-0.239	-1.631	2.216	-0.527
8	226.570	-55.770	-70.340	-0.061	-1.573	-1.478	-1.101
9	275.574	-53.430	-69.430	-0.261	-1.939	-2.809	-1.097
11	325.697	-45.010	-68.610	-0.268	-2.843	-7.213	-1.192
13	372.312	-35.110	-67.460	-0.169	-6.118	-9.082	-0.772
17	423.434	-10.880	-65.800	0.065	-3.728	-7.689	2.217
20	468.315	42.570	-63.200	0.019	-12.950	14.350	10.470
22	515.319	24.640	-65.570	-0.015	5.384	35.730	-2.411
24	553.722	4.816	-64.080	-0.012	2.814	15.480	-7.823
26	593.805	-13.870	-66.160	-0.007	0.025	0.136	-2.836
30	644.355	-30.340	-68.310	-0.004	-0.577	-3.205	0.709
33	693.605	-37.280	-69.900	0.003	-0.176	-0.978	0.523
35	740.705	-42.540	-71.450	0.003	0.043	0.239	-0.034
38	786.205	-37.090	-72.970	0.003	-0.244	-1.357	-0.466
41	844.605	-35.910	-75.000	0.004	-0.184	-1.020	-0.224
43	901.355	-16.710	-31.660	0.010	-0.131	-0.720	1.196
46	932.355	-27.450	-74.280	0.058	-0.700	-3.476	-2.551
48	1007.355	-3.424	-11.680	0.674	-5.823	28.450	-16.400
51	1053.855	-4.459	-13.040	0.711	-1.921	26.630	15.710
53	1086.855	-1.691	-7.447	0.472	1.868	3.811	-1.096
55	1105.855	-1.448	-5.416	0.334	3.753	4.877	1.687
57	1147.355	-0.396	-3.032	0.220	0.487	1.631	-1.588
58	1207.355	0.239	-0.143	0.036	-0.021	-0.149	0.327
59	1267.355	0.313	0.230	0.014	0.033	0.163	-0.259
60	1327.355	0.486	0.075	0.040	-0.039	-0.244	0.211
61	1387.355	0.484	0.674	-0.022	0.033	0.068	-0.121
62	1449.355	2.307	2.417	-0.027	0.088	0.085	0.281

Note: Meridonal/Hoop Forces and Meridonal/Hoop Moments are Reversed in Highlighted Sections.

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Table F.2. LBS-BEC Concrete Forces and Moments, Gravity Plus Seismic Load

AP- Primary Tank, Lower Bound Soil (Geomatrix), Best Estimate Concrete,

ANSYS MAXIMUMS BY PATH

PNNL Section No.	Path (in.)	Seismic Hoop Force (kip/ft) AP-LBS-BEC	Seismic Meridonal Force (kip/ft) AP-LBS-BEC	Seismic -In- Plane Shear Force (kip/ft) AP-LBS-BEC	Seismic Hoop Moment (ft*kip/ft) AP- LBS-BEC	Seismic Meridonal Moment (ft*kip/ft) AP-LBS-BEC	Seismic Through-Wall Shear Force (kip/ft) AP-LBS- BEC
2	67.734	-98.830	-103.500	4.949	-14.140	-12.350	3.582
3	105.676	-94.430	-101.500	7.021	-10.770	-9.063	2.352
4	137.076	-88.460	-99.280	8.423	-8.239	7.385	2.735
6	182.856	-81.550	-95.050	9.777	-4.853	6.732	2.625
8	226.570	-77.210	-91.170	11.130	-3.541	-6.991	2.015
9	275.574	-77.340	-87.730	13.380	-3.232	-6.305	1.709
11	325.697	-69.820	-85.120	15.590	-4.145	-10.110	1.855
13	372.312	-68.710	-82.440	18.180	-8.406	-12.050	1.514
17	423.434	-24.530	-79.710	20.680	-4.879	-11.790	3.520
20	468.315	115.700	-75.760	24.360	-18.220	21.460	12.540
22	515.319	49.410	-77.010	27.690	7.540	46.460	3.792
24	553.722	16.710	-75.860	27.090	3.738	20.310	10.040
26	593.805	-23.100	-79.150	27.870	0.149	0.739	3.633
30	644.355	-38.380	-81.020	29.010	-0.728	-3.947	0.873
33	693.605	-45.790	-82.550	30.560	-0.254	-1.280	0.623
35	740.705	-51.440	-84.580	32.210	0.082	0.391	0.094
38	786.205	-44.090	-86.540	33.700	-0.317	-1.714	0.559
41	844.605	-42.540	-89.120	36.260	-0.321	-1.709	0.414
43	901.355	-19.560	-37.710	17.950	-0.206	-1.146	2.047
46	932.355	-57.260	-89.170	39.730	-0.872	-4.364	3.257
48	1007.355	-21.090	-16.390	12.130	-7.356	34.450	19.860
51	1053.855	-60.570	-18.680	17.580	-3.392	33.120	18.730
53	1086.855	-16.970	-13.830	11.320	2.330	5.081	2.040
55	1105.855	-46.410	-11.590	10.520	4.925	6.378	2.403
57	1147.355	-9.667	-8.374	6.165	0.642	2.128	2.060
58	1207.355	3.810	-3.875	3.206	-0.028	-0.193	0.420
59	1267.355	2.999	3.141	2.193	0.045	0.215	0.330
60	1327.355	3.613	-2.481	1.831	-0.055	-0.299	0.285
61	1387.355	2.108	2.712	1.363	0.044	0.099	0.202
62	1449.355	6.171	5.432	1.477	0.190	0.220	0.424

Note: Meridonal/Hoop Forces and Meridonal/Hoop Moments are Reversed in Highlighted Sections.

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Table F.3. LBS-BEC Concrete Forces and Moments, Seismic Only

**AP- Primary Tank, Lower Bound Soil (Geomatrix), Best Estimate Concrete,
460 in. Waste Level at 1.83 SpG**

ANSYS MAXIMUMS BY PATH

PNNL Section No.	Path (in.)	Seismic Only Hoop Force (kip/ft) AP-LBS- BEC	Seismic Only Meridional Force (kip/ft) AP-LBS-BEC	Seismic Only - In-Plane Shear Force (kip/ft) AP-LBS-BEC	Seismic Only Hoop Moment (ft*kip/ft) AP- LBS-BEC	Seismic Only Meridional Moment (ft*kip/ft) AP-LBS- BEC	Seismic Only Through-Wall Shear Force (kip/ft) AP-LBS- BEC
2	67.734	28.410	27.280	5.026	8.007	9.328	1.895
3	105.676	28.760	26.590	7.202	6.934	8.591	1.441
4	137.076	25.730	25.690	8.584	5.602	6.011	1.837
6	182.856	25.140	23.480	9.875	3.348	5.084	2.117
8	226.570	25.340	20.830	11.102	2.079	5.515	0.917
9	275.574	25.430	18.300	13.323	1.444	3.511	0.810
11	325.697	25.100	16.510	15.527	1.309	3.293	0.723
13	372.312	34.915	14.980	18.140	2.300	3.340	0.774
17	423.434	14.181	13.910	20.664	1.185	4.269	1.344
20	468.315	73.130	12.560	24.358	5.370	7.110	2.100
22	515.319	24.770	11.450	27.695	2.157	10.730	1.381
24	553.722	11.912	11.790	27.094	0.926	4.840	2.217
26	593.805	9.230	12.990	27.873	0.156	0.741	0.799
30	644.355	8.040	12.710	29.012	0.151	0.742	0.184
33	693.605	8.510	12.650	30.562	0.078	0.303	0.101
35	740.705	8.900	13.130	32.212	0.053	0.152	0.061
38	786.205	7.070	15.260	33.702	0.076	0.394	0.097
41	844.605	6.870	18.140	36.263	0.137	0.690	0.191
43	901.355	3.230	8.220	17.952	0.094	0.530	0.855
46	932.355	29.860	18.820	39.720	0.260	1.167	1.021
48	1007.355	17.689	5.082	11.488	1.743	7.860	4.540
51	1053.855	56.204	6.798	18.290	1.738	7.890	4.170
53	1086.855	15.311	6.952	11.777	0.469	1.289	0.945
55	1105.855	45.073	6.723	10.840	1.228	1.508	0.722
57	1147.355	9.299	5.777	6.374	0.161	0.498	0.473
58	1207.355	3.671	3.735	3.235	0.008	0.044	0.094
59	1267.355	2.687	3.026	2.186	0.015	0.052	0.072
60	1327.355	3.128	2.536	1.796	0.019	0.056	0.076
61	1387.355	1.625	2.252	1.378	0.011	0.031	0.062
62	1449.355	3.973	3.214	1.463	0.101	0.151	0.149

Note: Meridional/Hoop Forces and Meridional/Hoop Moments are Reversed in Highlighted Sections

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Table F.4. LBS-BEC Primary Tank Stresses, Shell Top, Gravity Load Only

**AP Primary Tank, Lower Bound Soil, Gravity Only, Best
Estimate Tank Concrete, 460 in. Waste Level at 1.83 SpG**

M&D Starting Element No.	Path (in.)	Shell Top Surface (inside - waste side)			
		AP-460-LBS-BEC Gravity Hoop Stress (lbs/in ²) Top	AP-460-LBS-BEC Gravity Meridional Stress (lbs/in ²) Top	AP-460-LBS-BEC Gravity Stress Intensity (lbs/in ²) Top	AP-460-LBS-BEC Gravity In-Plane Shear Stress (lbs/in ²) Top
762	67.33	-1781.94	-1527.78	1781.94	6.02
782	105.04	-1776.39	-2723.61	2724.31	12.41
802	136.24	-1736.81	-1931.94	1932.64	14.94
822	181.83	-1300.69	-2182.64	2182.64	11.91
842	225.10	-1373.61	-1329.86	1373.61	2.92
862	273.66	-797.22	-1549.31	1549.31	11.38
882	323.27	-680.90	-796.53	797.92	10.77
902	369.20	150.07	-794.44	944.44	7.01
922	419.20	934.72	-220.07	1155.56	-3.17
942	444.31	745.14	-2059.72	2804.86	-1.32
962	458.66	683.40	1363.89	1363.89	-0.90
982	473.08	608.68	1151.39	1151.39	-0.88
1002	484.80	1454.86	-383.82	1838.89	-0.88
1022	502.48	3062.50	-12.06	3079.86	-0.85
1042	526.48	4693.75	112.57	4693.75	-0.76
1062	550.48	6315.28	-36.29	6352.78	-0.54
1082	574.60	7881.94	192.99	7881.94	-0.38
1102	598.28	9569.44	-83.82	9652.78	-0.25
1122	621.38	11125.00	115.49	11125.00	-0.19
1142	644.48	12694.44	-12.06	12708.33	-0.17
1162	667.63	13791.67	-360.76	14152.78	-0.22
1182	690.78	14201.39	409.86	14201.39	-0.22
1202	713.88	15201.39	146.88	15201.39	-0.21
1222	736.98	16562.50	-348.06	16909.72	-0.24
1242	760.13	16506.94	-729.17	17236.11	-0.28
1262	782.53	15270.83	1013.89	15270.83	-0.24
1282	804.13	14930.56	327.99	14930.56	0.30
1302	825.73	15770.83	-31.66	15805.56	0.38
1322	847.33	17138.89	348.54	17138.89	-0.35
1342	868.87	17541.67	-1929.17	19472.22	-0.73
1362	892.10	13256.94	-3013.19	16277.78	1.10
1382	909.20	3752.08	-9562.50	13326.39	1.33
1402	918.38	3770.83	5961.81	6009.03	-1.79
1460	930.48	3492.36	9909.72	9958.33	-508.47
1442	949.48	192.85	-497.22	695.83	54.65
1462	990.98	605.28	937.50	939.58	-26.92
1482	1050.98	422.78	487.78	583.26	-6.02
1502	1110.98	419.65	582.36	583.26	-13.95
1522	1170.98	297.64	233.75	298.06	6.37
1542	1230.98	351.53	416.60	417.01	-6.35
1562	1292.98	286.39	306.60	307.01	-2.99

Note 1: Meridional, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)

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Table F.5. LBS-BEC Primary Tank Stresses, Shell Middle, Gravity Load Only

**AP Primary Tank, Lower Bound Soil, Gravity Only, Best
Estimate Tank Concrete, 460 in. Waste Level at 1.83 SpG**

M&D Starting Element No.	Path (in.)	Shell Mid-Plane			
		AP-460-LBS-BEC Gravity Hoop Stress (lbs/in ²) Mid	AP-460-LBS-BEC Gravity Meridional Stress (lbs/in ²) Mid	AP-460-LBS-BEC Gravity Stress Intensity (lbs/in ²) Mid	AP-460-LBS-BEC Gravity In-Plane Shear Stress (lbs/in ²) Mid
762	67.33	-1885.42	-1821.53	1885.42	5.55
782	105.04	-1700.69	-2415.28	2415.28	11.76
802	136.24	-1842.36	-2250.69	2251.39	13.85
822	181.83	-1247.22	-1988.19	1988.19	10.88
842	225.10	-1495.83	-1725.69	1725.69	2.48
862	273.66	-764.58	-1418.75	1418.75	10.67
882	323.27	-765.28	-1068.75	1070.14	10.36
902	369.20	161.94	-729.17	891.67	6.85
922	419.20	906.25	-298.26	1204.86	-3.20
942	444.31	1394.44	65.06	1409.72	-1.35
962	458.66	314.31	86.88	314.93	-0.96
982	473.08	281.88	80.69	283.68	-0.90
1002	484.80	1590.28	76.60	1592.36	-0.86
1022	502.48	3087.50	72.43	3088.89	-0.78
1042	526.48	4679.17	65.99	4679.86	-0.69
1062	550.48	6343.75	59.24	6344.44	-0.50
1082	574.60	7840.28	52.47	7840.28	-0.36
1102	598.28	9611.11	45.78	9611.11	-0.24
1122	621.38	11097.22	39.27	11097.22	-0.19
1142	644.48	12701.39	32.75	12708.33	-0.16
1162	667.63	13909.72	26.19	13909.72	-0.20
1182	690.78	14083.33	16.78	14083.33	-0.19
1202	713.88	15159.72	10.22	15159.72	-0.19
1222	736.98	16666.67	3.67	16680.56	-0.23
1242	760.13	16722.22	-3.90	16729.17	-0.28
1262	782.53	14965.28	-8.31	14979.17	-0.21
1282	804.13	14826.39	-14.41	14840.28	-0.29
1302	825.73	15770.83	-20.58	15791.67	0.36
1322	847.33	17027.78	-26.76	17048.61	-0.36
1342	868.87	18111.11	-32.76	18159.72	-0.58
1362	892.10	14152.78	-33.93	14201.39	0.87
1382	909.20	6488.89	-44.09	6660.42	1.05
1402	918.38	1690.28	122.43	2010.42	-1.12
1460	930.48	448.82	384.86	570.21	5.61
1442	949.48	464.79	431.46	465.56	2.98
1462	990.98	543.26	755.56	756.94	-17.38
1482	1050.98	454.17	597.50	459.58	-12.31
1502	1110.98	381.39	459.10	459.58	-7.23
1522	1170.98	331.25	349.24	349.38	-2.64
1542	1230.98	317.71	324.38	324.58	-1.79
1562	1292.98	296.60	358.19	358.82	-6.17

Note 1: Meridional, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)

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Table F.6. LBS-BEC Primary Tank Stresses, Shell Bottom, Gravity Load Only

**AP Primary Tank, Lower Bound Soil, Gravity Only, Best
Estimate Tank Concrete, 460 in. Waste Level at 1.83 SpG**

M&D Starting Element No.	Path (in.)	Shell Bottom Surface (outside - away from waste)			
		AP-460-LBS-BEC Gravity Hoop Stress (lbs/in ²) Bot	AP-460-LBS-BEC Gravity Meridional Stress (lbs/in ²) Bot	AP-460-LBS-BEC Gravity Stress Intensity (lbs/in ²) Bot	AP-460-LBS-BEC Gravity In-Plane Shear Stress (lbs/in ²) Bot
762	67.33	-1996.53	-2115.28	2115.28	5.93
782	105.04	-1624.31	-2106.25	2106.94	-11.19
802	136.24	-1947.22	-2569.44	2570.14	13.06
822	181.83	-1193.75	-1793.75	1793.75	-10.11
842	225.10	-1618.75	-2122.22	2122.22	2.20
862	273.66	-731.94	-1288.19	1288.19	9.97
882	323.27	-850.00	-1340.97	1342.36	9.95
902	369.20	173.82	-664.38	838.19	6.69
922	419.20	878.47	-376.46	1254.86	-3.23
942	444.31	2043.06	2188.19	2188.89	-1.37
962	458.66	-62.10	-1190.28	1190.97	-1.02
982	473.08	-49.34	-989.58	990.28	-0.93
1002	484.80	1726.39	536.18	1726.39	-0.84
1022	502.48	3112.50	156.60	3113.19	-0.71
1042	526.48	4665.97	19.58	4668.06	-0.62
1062	550.48	6372.22	154.03	6372.92	-0.47
1082	574.60	7798.61	-89.03	7888.89	-0.34
1102	598.28	9645.83	174.44	9645.83	-0.23
1122	621.38	11076.39	-38.00	11118.06	-0.19
1142	644.48	12715.28	76.46	12715.28	-0.16
1162	667.63	14027.78	412.15	14027.78	-0.19
1182	690.78	13965.28	-377.36	14340.28	-0.17
1202	713.88	15118.06	-127.36	15243.06	-0.19
1222	736.98	16777.78	354.72	16777.78	-0.22
1242	760.13	16937.50	722.92	16937.50	-0.27
1262	782.53	14659.72	-1029.86	15687.50	-0.22
1282	804.13	14722.22	-356.32	15076.39	-0.28
1302	825.73	15777.78	-8.72	15784.72	0.35
1322	847.33	16909.72	-401.25	17312.50	-0.37
1342	868.87	18680.56	1867.36	18680.56	-0.43
1362	892.10	15048.61	2948.61	15048.61	0.63
1382	909.20	9229.17	9479.17	9486.11	0.76
1402	918.38	-393.13	-5716.67	5766.67	-0.50
1460	930.48	-2600.69	-9138.89	9187.50	518.47
1442	949.48	737.50	1358.33	1362.50	-49.54
1462	990.98	481.39	574.65	575.28	-7.85
1482	1050.98	485.83	708.33	343.40	-18.61
1502	1110.98	343.33	337.36	343.40	1.64
1522	1170.98	365.14	466.53	467.08	-9.22
1542	1230.98	284.58	234.31	284.93	5.36
1562	1292.98	308.13	412.15	412.85	-9.89

Note 1: Meridional, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)

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Table F.7. LBS-BEC Primary Tank Stresses, Shell Top, Gravity Plus Seismic Load

**AP Primary Tank, Lower Bound Soil, Horizontal and Vertical
Seismic, Best Estimate Tank Concrete, 460 in. Waste Level at
1.83 SpG**

M&D Starting M&D Element No.	Path (in.)	Shell Top Surface (inside - waste side)			
		AP-460-LBS-BEC Seismic Hoop Stress (lbs/in ²) Top	AP-460-LBS-BEC Seismic Meridional Stress (lbs/in ²) Top	AP-460-LBS-BEC Seismic Stress Intensity (lbs/in ²) Top	AP-460-LBS-BEC Seismic In-Plane Shear Stress (lbs/in ²) Top
762	67.33	-2589.58	-2490.97	2590.28	-217.99
782	105.04	-2638.19	-4195.83	4197.22	-398.89
802	136.24	-2787.50	-2940.28	2940.28	-440.56
822	181.83	-1931.94	-3304.86	3305.56	-458.40
842	225.10	-2497.22	-2348.61	2498.61	528.96
862	273.66	-1672.92	-2555.56	2555.56	-741.67
882	323.27	-2430.56	-1672.92	2702.78	1228.47
902	369.20	2236.81	-2111.81	3995.83	1826.39
922	419.20	4151.39	-1132.64	6142.36	2977.08
942	444.31	5570.14	-5634.03	6727.08	2870.83
962	458.66	6760.42	6794.44	11680.56	2870.14
982	473.08	6797.22	6912.50	12368.06	3075.69
1002	484.80	5085.42	-2000.00	6875.00	3179.17
1022	502.48	5620.14	831.25	7180.56	3113.89
1042	526.48	9631.94	1054.17	9638.89	2927.78
1062	550.48	12083.33	-1122.92	12083.33	2690.28
1082	574.60	14458.33	1574.31	14465.28	2397.92
1102	598.28	17083.33	-1417.36	17083.33	2067.36
1122	621.38	19479.17	1633.33	19479.17	1693.06
1142	644.48	21784.72	1498.61	21784.72	-1311.11
1162	667.63	23083.33	-1811.81	23083.33	1018.06
1182	690.78	23201.39	2072.92	23201.39	1000.00
1202	713.88	24291.67	1713.19	24291.67	1215.28
1222	736.98	25881.94	-1696.53	25881.94	1472.92
1242	760.13	25256.94	-953.47	25375.00	1765.97
1262	782.53	22868.06	2377.08	22868.06	1541.67
1282	804.13	21902.78	1436.81	21902.78	1755.56
1302	825.73	22756.94	950.69	22756.94	1997.22
1322	847.33	24437.50	1340.97	24444.44	2259.03
1342	868.87	24465.28	-2303.47	27347.22	2551.39
1362	892.10	17284.72	-3600.00	22770.83	2466.67
1382	909.20	5804.86	-11416.67	20895.83	2491.67
1402	918.38	5911.11	10611.11	10638.89	2483.33
1460	930.48	6288.19	17541.67	17625.00	-2960.42
1442	949.48	4259.72	-1142.36	4614.58	-2118.75
1462	990.98	3768.75	1581.25	6131.94	-3061.11
1482	1050.98	2843.06	881.94	2379.86	-1863.19
1502	1110.98	2218.06	812.50	2379.86	-1189.58
1522	1170.98	1658.33	553.96	1660.42	-768.06
1542	1230.98	1253.47	629.93	1254.86	-491.11
1562	1292.98	809.03	544.17	809.03	-252.43

Note 1: Meridional, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)

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Table F.8. LBS-BEC Primary Tank Stresses, Shell Middle, Gravity Plus Seismic Load

**AP Primary Tank, Lower Bound Soil, Horizontal and Vertical
Seismic, Best Estimate Tank Concrete, 460 in. Waste Level at
1.83 SpG**

M&D Starting M&D Element No.	Path (in.)	Shell Mid-Plane			
		AP-460-LBS-BEC Seismic Hoop Stress (lbs/in ²) Mid	AP-460-LBS-BEC Seismic Meridional Stress (lbs/in ²) Mid	AP-460-LBS-BEC Seismic Stress Intensity (lbs/in ²) Mid	AP-460-LBS-BEC Seismic In-Plane Shear Stress (lbs/in ²) Mid
762	67.33	-2887.50	-2473.61	2888.19	-218.47
782	105.04	-2431.25	-3298.61	3300.00	-393.82
802	136.24	-3097.22	-3110.42	3163.89	-436.18
822	181.83	-1827.08	-2778.47	2778.47	-454.44
842	225.10	-2872.92	-2459.03	2876.39	-527.78
862	273.66	-1611.81	-2142.36	2142.36	-740.97
882	323.27	-2690.28	-1870.83	2695.14	1229.86
902	369.20	2203.47	-1663.89	3947.22	1825.69
922	419.20	4165.28	-1413.19	6178.47	2979.17
942	444.31	5346.53	1000.00	6381.25	2913.89
962	458.66	7277.78	988.19	7902.78	2899.31
982	473.08	7986.11	922.92	8784.72	3024.31
1002	484.80	5050.00	865.28	6704.17	3117.36
1022	502.48	6075.69	938.89	7076.39	3088.19
1042	526.48	9645.83	1052.08	9645.83	2921.53
1062	550.48	12118.06	1186.81	12125.00	2684.72
1082	574.60	14395.83	1338.89	14402.78	2390.97
1102	598.28	17166.67	1475.69	17173.61	2059.03
1122	621.38	19472.22	1590.28	19472.22	1686.11
1142	644.48	21840.28	1682.64	21840.28	-1306.94
1162	667.63	23284.72	1753.47	23284.72	1018.06
1182	690.78	23034.72	1572.92	23034.72	996.53
1202	713.88	24250.00	1586.81	24256.94	1213.89
1222	736.98	26069.44	1576.39	26069.44	1470.83
1242	760.13	25611.11	1536.11	25611.11	1747.22
1262	782.53	22479.17	1078.47	22479.17	1515.28
1282	804.13	21798.61	1015.97	21798.61	1740.97
1302	825.73	22798.61	934.03	22798.61	1998.61
1322	847.33	24305.56	834.72	24305.56	2263.89
1342	868.87	25444.44	-706.25	25451.39	2546.53
1362	892.10	18756.94	-514.72	18868.06	2402.08
1382	909.20	8715.28	-494.38	9145.83	2320.83
1402	918.38	5263.89	517.71	5650.00	2313.19
1460	930.48	4431.94	846.53	4701.39	-2305.56
1442	949.48	4218.06	861.81	4424.31	-2190.97
1462	990.98	3722.22	1319.44	6122.22	-3052.78
1482	1050.98	2847.22	902.08	2374.31	-1870.14
1502	1110.98	2193.06	654.10	2374.31	-1184.03
1522	1170.98	1670.14	519.72	1672.22	-775.69
1542	1230.98	1235.42	487.29	1236.81	-485.83
1562	1292.98	806.94	533.26	806.94	-255.56

Note 1: Meridional, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)

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Table F.9. LBS-BEC Primary Tank Stresses, Shell Bottom, Gravity Plus Seismic Load

**AP Primary Tank, Lower Bound Soil, Horizontal and Vertical
Seismic, Best Estimate Tank Concrete, 460 in. Waste Level at
1.83 SpG**

M&D Starting M&D Element No.	Path (in.)	Shell Bottom Surface (outside - away from waste)			
		AP-460-LBS-BEC Seismic Hoop Stress (lbs/in ²) Bot	AP-460-LBS-BEC Seismic Meridional Stress (lbs/in ²) Bot	AP-460-LBS-BEC Seismic Stress Intensity (lbs/in ²) Bot	AP-460-LBS-BEC Seismic In-Plane Shear Stress (lbs/in ²) Bot
762	67.33	-3185.42	-3328.47	3328.47	-219.58
782	105.04	-2347.92	-3218.06	3218.75	-388.68
802	136.24	-3406.94	-4052.78	4054.86	-431.81
822	181.83	-1738.89	-2603.47	2604.17	-450.49
842	225.10	-3248.61	-3630.56	3634.03	-526.94
862	273.66	-1551.39	-1970.14	1986.11	-740.28
882	323.27	-2950.00	-2849.31	2955.56	1230.56
902	369.20	2170.14	-1271.53	3902.08	1825.00
922	419.20	4179.86	-2270.14	6228.47	2981.94
942	444.31	5568.06	7631.94	7631.94	2956.94
962	458.66	-8375.00	-4968.75	8375.00	2928.47
982	473.08	-9388.89	-5129.17	9395.83	2972.92
1002	484.80	5075.00	2765.28	6566.67	3055.56
1022	502.48	6531.25	2556.94	7020.83	3062.50
1042	526.48	9652.78	1090.97	9659.72	2915.28
1062	550.48	12159.72	1359.03	12159.72	2679.86
1082	574.60	14333.33	-1239.58	14333.33	2384.03
1102	598.28	17256.94	1661.81	17256.94	2050.69
1122	621.38	19465.28	1546.53	19472.22	1679.17
1142	644.48	21902.78	1865.97	21902.78	-1302.78
1162	667.63	23493.06	2309.03	23493.06	1018.06
1182	690.78	22861.11	-1718.06	22861.11	993.06
1202	713.88	24215.28	-1627.08	24215.28	1212.50
1222	736.98	26256.94	2054.17	26256.94	1468.75
1242	760.13	25993.06	2539.58	25993.06	1740.97
1262	782.53	22090.28	-1786.11	22819.44	1488.19
1282	804.13	21694.44	-1235.42	21701.39	1738.89
1302	825.73	22840.28	-944.44	22840.28	2000.69
1322	847.33	24166.67	-1052.08	24291.67	2268.06
1342	868.87	26423.61	4566.67	26423.61	2542.36
1362	892.10	20444.44	5553.47	20451.39	2336.81
1382	909.20	13333.33	17229.17	17229.17	2152.08
1402	918.38	-5414.58	-9993.06	10069.44	2151.39
1460	930.48	-8708.33	-16791.67	16875.00	2659.72
1442	949.48	4232.64	2478.47	5154.17	-2262.50
1462	990.98	3676.39	1100.69	6115.28	-3044.44
1482	1050.98	2856.94	1075.69	2377.78	-1877.08
1502	1110.98	2170.14	697.22	2377.78	-1178.47
1522	1170.98	1681.94	672.99	1684.03	-783.33
1542	1230.98	1218.06	523.68	1219.44	-480.56
1562	1292.98	806.25	621.81	807.64	-258.75

Note 1: Meridional, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)

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Table F.10. LBS-BEC Primary Tank Stresses, Shell Top, Seismic Load Only

**AP Primary Tank, Lower Bound Soil, Horizontal and Vertical
Seismic, Best Estimate Tank Concrete, 460 in. Waste Level at
1.83 SpG**

M&D Starting M&D Element No.	Path (in.)	Shell Top Surface (inside - waste side)			
		AP-460-LBS-BEC Seismic Only Hoop Stress (lbs/in ²) Top	AP-460-LBS-BEC Seismic Only Meridional Stress (lbs/in ²) Top	AP-460-LBS-BEC Seismic Only Stress Intensity (lbs/in ²) Top	AP-460-LBS-BEC Seismic Only In-Plane Shear Stress (lbs/in ²) Top
762	67.33	822.22	963.19	822.92	218.67
782	105.04	879.17	1472.22	1472.92	402.58
802	136.24	1068.06	1034.03	1007.64	444.39
822	181.83	739.51	1122.92	1123.61	460.70
842	225.10	1267.85	1072.78	1125.00	528.06
862	273.66	889.65	1054.10	1048.26	739.03
882	323.27	1779.86	963.68	1904.86	1225.99
902	369.20	2087.01	1317.36	3061.11	1824.80
922	419.20	3272.92	945.42	4988.19	2976.42
942	444.31	4825.69	3574.31	3925.00	2870.66
962	458.66	6077.43	5431.94	10317.36	2869.99
982	473.08	6515.97	5938.19	11217.36	3075.57
1002	484.80	3756.25	1617.57	5038.89	3179.05
1022	502.48	2558.33	842.42	4100.69	3113.78
1042	526.48	4938.89	950.35	4945.14	2927.70
1062	550.48	5768.06	1087.33	5730.56	2690.21
1082	574.60	6576.39	1381.39	6583.33	2398.00
1102	598.28	7513.89	1383.61	7430.56	2067.38
1122	621.38	8354.17	1518.13	8354.17	1693.05
1142	644.48	9097.22	1509.73	9076.39	1311.14
1162	667.63	9291.67	1556.88	8930.56	1018.10
1182	690.78	9000.00	1663.26	9000.00	999.97
1202	713.88	9113.89	1566.53	9090.28	1215.33
1222	736.98	9409.72	1445.83	8972.22	1472.92
1242	760.13	8833.33	1270.35	8138.89	1765.86
1262	782.53	7597.22	1440.14	7597.22	1541.59
1282	804.13	6979.17	1109.03	6979.17	1755.64
1302	825.73	6986.11	982.41	6958.33	1997.43
1322	847.33	7298.61	992.57	7305.56	2259.05
1342	868.87	6923.61	1425.76	7875.00	2550.94
1362	892.10	4027.78	3195.00	6701.39	2466.68
1382	909.20	2110.42	8826.39	7847.92	2491.65
1402	918.38	2142.36	4652.78	4632.64	2483.31
1422	930.48	2853.82	7645.83	7680.56	2452.57
1442	949.48	4068.61	826.53	3922.08	2173.02
1462	990.98	3247.36	857.64	5193.06	3034.79
1482	1050.98	2441.04	396.46	1798.06	1858.05
1502	1110.98	1849.51	394.24	1798.06	1176.75
1522	1170.98	1360.69	322.71	1362.36	773.14
1542	1230.98	902.57	397.88	842.50	485.97
1562	1292.98	522.64	261.99	505.49	251.26

Note 1: Meridonal, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)

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Table F.11. LBS-BEC Primary Tank Stresses, Shell Middle, Seismic Load Only

**AP Primary Tank, Lower Bound Soil, Horizontal and Vertical
Seismic, Best Estimate Tank Concrete, 460 in. Waste Level at
1.83 SpG**

M&D Starting M&D Element No.	Path (in.)	Shell Mid-Plane			
		AP-460-LBS-BEC Seismic Only Hoop Stress (lbs/in ²) Mid	AP-460-LBS-BEC Seismic Only Meridional Stress (lbs/in ²) Mid	AP-460-LBS-BEC Seismic Only Stress Intensity (lbs/in ²) Mid	AP-460-LBS-BEC Seismic Only In-Plane Shear Stress (lbs/in ²) Mid
762	67.33	1009.72	652.08	1010.42	219.52
782	105.04	795.14	883.33	884.72	397.11
802	136.24	1270.83	859.72	934.03	439.95
822	181.83	662.71	790.28	790.28	456.57
842	225.10	1562.86	733.33	1150.69	527.06
862	273.66	847.92	723.61	723.61	738.44
882	323.27	1925.69	802.08	1625.00	1227.48
902	369.20	2041.81	934.72	3065.28	1824.12
922	419.20	3361.81	1114.93	4974.31	2978.50
942	444.31	3952.78	979.13	4976.39	2913.69
962	458.66	7061.11	933.75	7588.40	2899.13
982	473.08	7932.15	870.76	8501.04	3024.17
1002	484.80	3460.42	818.75	5113.19	3117.24
1022	502.48	2988.89	891.04	3988.19	3088.09
1042	526.48	4966.67	997.01	4965.97	2921.44
1062	550.48	5774.31	1127.72	5780.56	2684.65
1082	574.60	6555.56	1286.65	6562.50	2391.04
1102	598.28	7555.56	1430.15	7562.50	2059.05
1122	621.38	8375.00	1551.24	8375.00	1686.11
1142	644.48	9138.89	1650.13	9131.94	1306.96
1162	667.63	9375.00	1727.52	9375.00	1018.09
1182	690.78	8951.39	1556.32	8951.39	996.52
1202	713.88	9090.28	1576.75	9097.22	1213.93
1222	736.98	9465.28	1572.93	9388.89	1470.83
1242	760.13	8923.61	1539.23	8881.94	1747.14
1262	782.53	7513.89	1086.20	7506.94	1515.23
1282	804.13	6972.22	1029.85	6958.33	1741.04
1302	825.73	7027.78	954.05	7006.94	1998.75
1322	847.33	7277.78	860.89	7256.94	2263.88
1342	868.87	7333.33	735.28	7291.67	2546.21
1362	892.10	4750.00	520.01	4784.72	2402.10
1382	909.20	2586.81	480.90	2668.75	2320.86
1402	918.38	3575.00	395.49	3640.28	2313.23
1422	930.48	4052.43	461.67	4131.32	2310.35
1442	949.48	3855.28	501.53	3960.83	2193.64
1462	990.98	3234.93	716.50	5365.28	3035.92
1482	1050.98	2446.74	423.40	1914.72	1858.76
1502	1110.98	1835.76	304.93	1914.72	1177.85
1522	1170.98	1338.96	302.61	1325.21	774.26
1542	1230.98	917.71	286.72	914.93	485.29
1562	1292.98	510.35	263.13	451.32	250.70

Note 1: Meridional, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)

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Table F.12. LBS-BEC Primary Tank Stresses, Shell Bottom, Seismic Load Only

**AP Primary Tank, Lower Bound Soil, Horizontal and Vertical
Seismic, Best Estimate Tank Concrete, 460 in. Waste Level at
1.83 SpG**

M&D Starting M&D Element No.	Path (in.)	Shell Bottom Surface (outside - away from waste)			
		AP-460-LBS-BEC Seismic Only Hoop Stress (lbs/in ²) Bot	AP-460-LBS-BEC Seismic Only Meridional Stress (lbs/in ²) Bot	AP-460-LBS-BEC Seismic Only Stress Intensity (lbs/in ²) Bot	AP-460-LBS-BEC Seismic Only In-Plane Shear Stress (lbs/in ²) Bot
762	67.33	1197.92	1213.89	1213.19	221.30
782	105.04	776.39	1118.75	1116.67	391.57
802	136.24	1476.04	1483.33	1485.42	435.51
822	181.83	585.21	884.03	810.42	452.44
842	225.10	1857.15	1572.29	1511.81	526.39
862	273.66	819.44	784.17	704.86	737.84
882	323.27	2201.39	1622.85	1613.19	1228.27
902	369.20	1996.67	783.06	3069.44	1823.43
922	419.20	3472.22	1893.68	4976.39	2981.27
942	444.31	3525.00	5444.44	5443.75	2956.72
962	458.66	8317.75	3779.17	7184.72	2928.27
982	473.08	9341.40	4222.22	8406.25	2972.76
1002	484.80	3350.00	2230.49	4841.67	3055.43
1022	502.48	3419.44	2544.58	3908.33	3062.39
1042	526.48	4987.50	1084.67	4991.67	2915.18
1062	550.48	5787.50	1247.36	5787.50	2679.78
1082	574.60	6534.72	1224.86	6444.44	2384.08
1102	598.28	7611.11	1519.79	7611.11	2050.72
1122	621.38	8388.89	1583.63	8361.11	1679.18
1142	644.48	9187.50	1789.86	9187.50	1302.78
1162	667.63	9465.28	1897.15	9465.28	1018.09
1182	690.78	8895.83	1456.04	8520.83	993.06
1202	713.88	9097.22	1586.25	8972.22	1212.53
1222	736.98	9520.83	1699.72	9486.11	1468.75
1242	760.13	9055.56	1838.89	9055.56	1740.92
1262	782.53	7430.56	852.99	7131.94	1488.17
1282	804.13	6972.22	962.92	6625.00	1739.00
1302	825.73	7062.50	936.06	7055.56	2000.84
1322	847.33	7256.94	729.86	6979.17	2268.18
1342	868.87	7743.06	2747.92	7743.06	2542.49
1362	892.10	5541.67	2696.25	5534.72	2336.83
1382	909.20	4164.58	7976.39	7750.00	2152.15
1402	918.38	5023.40	4653.47	4306.25	2151.49
1422	930.48	6111.81	7659.72	7694.44	2214.10
1442	949.48	3665.97	1407.90	3795.14	2213.51
1462	990.98	3222.43	673.33	5540.00	3037.05
1482	1050.98	2451.74	528.61	2036.74	1859.49
1502	1110.98	1826.81	362.57	2036.74	1178.94
1522	1170.98	1340.83	386.60	1220.90	775.38
1542	1230.98	933.47	292.15	934.51	484.61
1562	1292.98	523.33	400.88	398.68	250.22

Note 1: Meridonal, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)

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Table F.13. LBS-BEC Anchor Bolt Forces, Gravity Load Only

AP Primary Tank, Lower Bound Soil, Gravity Only, Best Estimate Concrete, 460 in. Waste Level at 1.83 SpG											
ANSYS MAXIMUMS BY RADIUS											
M&D J-Bolt Radius No.	Mean J-Bolt Radius	Radius of J-Bolts Included		Average Bolts per Element	Min Axial Force (kip) LBS-BEC Gravity Only	Max Axial Force (kip) LBS-BEC Gravity Only	Shear Force1 (kip) LBS- BEC Gravity	Maximum Shear Force1 Model Angle	Shear Force2 (kip) LBS- BEC Gravity Only	Maximum Shear Force2 Model Angle	Total Shear (kip) LBS- BEC Gravity
		min	max								
Radius 2	44.72	22.36	67.29	0.55	-0.005	-0.004	0.001	45	0.007	90	0.007
Radius 3	89.87	67.29	104.93	0.89	-0.005	-0.004	0.002	27	0.100	180	0.100
Radius 4	120.00	104.93	135.98	1.03	-0.001	0.000	0.003	153	0.165	180	0.165
Radius 5	151.97	135.98	181.01	1.97	-0.002	-0.001	0.007	153	0.265	90	0.265
Radius 6	210.05	181.01	223.79	2.41	-0.005	-0.005	0.012	153	0.447	81	0.447
Radius 7	237.53	223.79	270.98	3.30	0.011	0.012	0.011	153	0.529	135	0.529
Radius 8	304.43	270.98	318.74	4.04	-0.012	-0.012	0.004	153	0.672	135	0.672
Radius 9	333.05	318.74	361.64	4.37	0.030	0.030	0.001	153	0.690	45	0.690
Radius 10	390.22	361.64	406.24	5.36	-0.076	-0.074	0.000	144	0.759	45	0.759
Radius 11	422.26	406.24	431.63	3.60	0.547	0.549	0.001	117	1.050	171	1.050

M&D J-Bolt Radius No.	Mean J-Bolt Radius	Radius of J-Bolts Included		Average Bolts per Element	Bolt Angle (Rad)	Shear Stiffness (kip/ft)	Axial Stiffness (kip/ft)	Shear Displacement LBS-BEC- Gravity Only	Axial Min Displacement LBS-BEC- Gravity Only	Axial Max Displacement LBS-BEC- Gravity Only
		min	max							
Radius 2	44.72	22.36	67.29	0.55	0.0351	780	780	0.00010	-0.00007	-0.00005
Radius 3	89.87	67.29	104.93	0.89	0.0715	780	780	0.00154	-0.00008	-0.00007
Radius 4	120.00	104.93	135.98	1.03	0.0968	780	780	0.00254	-0.00001	0.00000
Radius 5	151.97	135.98	181.01	1.97	0.1252	780	780	0.00408	-0.00003	-0.00002
Radius 6	210.05	181.01	223.79	2.41	0.1825	780	780	0.00688	-0.00008	-0.00007
Radius 7	237.53	223.79	270.98	3.30	0.2136	780	780	0.00814	0.00018	0.00019
Radius 8	304.43	270.98	318.74	4.04	0.3076	780	780	0.01034	-0.00019	-0.00018
Radius 9	333.05	318.74	361.64	4.37	0.3613	780	780	0.01062	0.00046	0.00047
Radius 10	390.22	361.64	406.24	5.36	0.5235	780	780	0.01167	-0.00117	-0.00115
Radius 11	460.26	406.24	431.63	3.60	0.6938	780	780	0.01616	0.00842	0.00845

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Table F.14. LBS-BEC Anchor Bolt Forces, Gravity Plus Seismic Loads

AP Primary Tank, Lower Bound Soil, Gravity Only, Best Estimate Concrete, 460 in. Waste Level at 1.83 SpG											
ANSYS MAXIMUMS BY RADIUS											
M&D J-Bolt Radius No.	Mean J-Bolt Radius	Radius of J-Bolts Included		Average Bolts per Element	Min Axial Force (kip) LBS-BEC	Max Axial Force (kip) LBS-BEC	Shear Force1 (kip) LBS-BEC	Maximum Shear Force1 Model Angle	Shear Force2 (kip) LBS-BEC	Maximum Shear Force2 Model Angle	Total Shear (kip) LBS- BEC
		min	max								
Radius 2	44.72	22.36	67.29	0.55	-0.074	0.050	0.627	90	0.604	0	0.642
Radius 3	89.87	67.29	104.93	0.89	-0.058	0.017	0.690	90	0.720	180	0.735
Radius 4	120.00	104.93	135.98	1.03	-0.044	0.061	0.781	90	0.820	180	0.854
Radius 5	151.97	135.98	181.01	1.97	-0.021	0.246	0.914	90	0.958	180	1.017
Radius 6	210.05	181.01	223.79	2.41	-0.048	0.078	1.233	90	1.165	0	1.366
Radius 7	237.53	223.79	270.98	3.30	-0.073	0.306	1.483	90	1.269	0	1.606
Radius 8	304.43	270.98	318.74	4.04	-0.163	0.399	2.204	90	1.556	0	2.332
Radius 9	333.05	318.74	361.64	4.37	-0.118	0.531	2.635	90	1.678	180	2.757
Radius 10	390.22	361.64	406.24	5.36	-0.509	0.739	3.760	90	1.965	0	3.864
Radius 11	422.26	406.24	431.63	3.60	-0.474	1.864	4.750	90	2.627	180	4.915

M&D J-Bolt Radius No.	Mean J-Bolt Radius	Radius of J-Bolts Included		Average Bolts per Element	Bolt Angle (Rad)	Shear Stiffness (kip/ft)	Axial Stiffness (kip/ft)	Shear Disp LBS-BEC- Seismic	Axial Min Disp LBS-BEC- Seismic	Axial Max Disp LBS-BEC- Seismic
		min	max							
Radius 2	44.72	22.36	67.29	0.55	0.0351	780	780	0.00987	-0.00115	0.00077
Radius 3	89.87	67.29	104.93	0.89	0.0715	780	780	0.01130	-0.00090	0.00026
Radius 4	120.00	104.93	135.98	1.03	0.0968	780	780	0.01314	-0.00068	0.00094
Radius 5	151.97	135.98	181.01	1.97	0.1252	780	780	0.01564	-0.00033	0.00378
Radius 6	210.05	181.01	223.79	2.41	0.1825	780	780	0.02101	-0.00074	0.00120
Radius 7	237.53	223.79	270.98	3.30	0.2136	780	780	0.02471	-0.00113	0.00471
Radius 8	304.43	270.98	318.74	4.04	0.3076	780	780	0.03588	-0.00251	0.00613
Radius 9	333.05	318.74	361.64	4.37	0.3613	780	780	0.04241	-0.00181	0.00817
Radius 10	390.22	361.64	406.24	5.36	0.5235	780	780	0.05945	-0.00783	0.01137
Radius 11	460.26	406.24	431.63	3.60	0.6938	780	780	0.07562	-0.00730	0.02868

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Table F.15. LBS-BEC Anchor Bolt Forces, Seismic Load Only

AP Primary Tank, Lower Bound Soil, Seismic Only, Best Estimate Concrete, 460 in. Waste Level at 1.83 SpG											
ANSYS MAXIMUMS BY RADIUS											
M&D J-Bolt Radius No.	Mean J-Bolt Radius	Radius of J-Bolts Included		Average Bolts per Element	Min Axial Force (kip) LBS-BEC- Seismic Only	Max Axial Force (kip) LBS-BEC- Seismic Only	Shear Force1 (kip) LBS-BEC- Seismic Only	Maximum Shear Force1 Model Angle	Shear Force2 (kip) LBS- BEC-Seismic Only	Maximum Shear Force2 Model Angle	Total Shear (kip) LBS- BEC- Seismic Only
		min	max								
Radius 2	44.72	22.36	67.29	0.55	-0.070	0.053	0.626	108	0.598	0	0.866
Radius 3	89.87	67.29	104.93	0.89	-0.053	0.022	0.688	108	0.620	0	0.926
Radius 4	120.00	104.93	135.98	1.03	-0.044	0.062	0.778	108	0.655	0	1.017
Radius 5	151.97	135.98	181.01	1.97	-0.019	0.247	0.907	108	0.692	0	1.141
Radius 6	210.05	181.01	223.79	2.41	-0.043	0.082	1.221	108	0.717	144	1.416
Radius 7	237.53	223.79	270.98	3.30	-0.085	0.294	1.472	90	0.739	135	1.647
Radius 8	304.43	270.98	318.74	4.04	-0.151	0.411	2.200	117	0.883	117	2.371
Radius 9	333.05	318.74	361.64	4.37	-0.147	0.501	2.633	117	0.987	117	2.812
Radius 10	390.22	361.64	406.24	5.36	-0.433	0.813	3.760	108	1.207	0	3.948
Radius 11	460.26	406.24	431.63	3.60	-1.021	1.315	4.750	108	1.577	0	5.005

M&D J-Bolt Radius No.	Mean J-Bolt Radius	Radius of J-Bolts Included		Average Bolts per Element	Bolt Angle (Rad)	Shear Stiffness (kip/ft)	Axial Stiffness (kip/ft)	Shear Disp LBS-BEC- Seismic Only	Axial Min Disp LBS-BEC- Seismic Only	Axial Max Disp LBS-BEC- Seismic Only
		min	max							
Radius 2	44.72	22.36	67.29	0.55	0.0351	780	780	0.01332	-0.00107	0.00082
Radius 3	89.87	67.29	104.93	0.89	0.0715	780	780	0.01425	-0.00082	0.00033
Radius 4	120.00	104.93	135.98	1.03	0.0968	780	780	0.01564	-0.00067	0.00095
Radius 5	151.97	135.98	181.01	1.97	0.1252	780	780	0.01756	-0.00030	0.00380
Radius 6	210.05	181.01	223.79	2.41	0.1825	780	780	0.02179	-0.00066	0.00127
Radius 7	237.53	223.79	270.98	3.30	0.2136	780	780	0.02534	-0.00130	0.00452
Radius 8	304.43	270.98	318.74	4.04	0.3076	780	780	0.03647	-0.00232	0.00632
Radius 9	333.05	318.74	361.64	4.37	0.3613	780	780	0.04327	-0.00227	0.00770
Radius 10	390.22	361.64	406.24	5.36	0.5235	780	780	0.06075	-0.00666	0.01251
Radius 11	460.26	406.24	431.63	3.60	0.6938	780	780	0.07699	-0.01571	0.02023

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Table F.16. LBS-BEC Concrete Backed Steel Strain, Shell Top, Gravity Load Only

**AP Backed Steel, Lower Bound Soil, Gravity Only, Best Estimate Tank Concrete, 460 In Waste
Level at 1.83SpG**

M&D Starting M&D Element No.	Path (in)	Shell Top Surface (inside - towards waste) Gravity					
		AP-460-LBS-BEC EPEL P1 Strain (in/in) Gravity Top Min	AP-460-LBS-BEC EPEL P1 Strain (in/in) Gravity Top Max	AP-460-LBS-BEC EPEL P2 (in/in) Gravity Top Min	AP-460-LBS-BEC EPEL P2 Strain (in/in) Gravity Top Max	AP-460-LBS-BEC EPEL P3 Strain (in/in) Gravity Top Min	AP-460-LBS-BEC EPEL P3 Strain (in/in) Gravity Top Max
762	67.33	3.42E-05	3.42E-05	-3.40E-05	-3.40E-05	-4.51E-05	-4.51E-05
782	105.04	4.63E-05	4.64E-05	-3.25E-05	-3.25E-05	-7.43E-05	-7.42E-05
802	136.24	3.78E-05	3.78E-05	-3.93E-05	-3.93E-05	-4.74E-05	-4.74E-05
822	181.71	3.59E-05	3.60E-05	-2.21E-05	-2.20E-05	-6.04E-05	-6.03E-05
842	225.10	2.79E-05	2.80E-05	-3.07E-05	-3.06E-05	-3.33E-05	-3.33E-05
862	273.66	2.43E-05	2.43E-05	-1.14E-05	-1.14E-05	-4.42E-05	-4.41E-05
882	323.27	1.53E-05	1.53E-05	-1.52E-05	-1.52E-05	-1.98E-05	-1.98E-05
902	369.20	1.34E-05	1.34E-05	6.67E-06	6.67E-06	-2.85E-05	-2.84E-05
922	419.20	3.45E-05	3.45E-05	-7.31E-06	-7.30E-06	-1.71E-05	-1.71E-05
237	463.02						
257	510.03						
277	544.44						
297	580.53						
317	631.08						
337	680.34						
357	727.44						
377	772.93						
397	831.34						
417	894.09						
2132	925.08	3.46E-05	3.47E-05	-3.25E-05	-3.25E-05	-4.24E-05	-4.24E-05
2122	935.67	7.56E-05	7.57E-05	-2.12E-05	-2.12E-05	-3.10E-05	-3.10E-05
2112	944.86	9.60E-05	9.61E-05	-7.77E-06	-7.76E-06	-2.13E-04	-2.13E-04
477	968.95						
497	1002.45						
517	1042.45						
537	1108.60						
557	1178.35						
577	1227.20						
597	1271.50						
617	1313.65						
637	1360.60						

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Table F.17. LBS-BEC Concrete Backed Steel Strain, Shell Middle, Gravity Load Only

**AP Backed Steel, Lower Bound Soil, Gravity Only, Best Estimate Tank Concrete, 460 In Waste
Level at 1.83SpG**

M&D Starting M&D Element No.	Path (in)	Shell Mid-Plane					
		AP-460-LBS-BEC EPEL P1 Strain (in/in) Gravity Mid Min	AP-460-LBS-BEC EPEL P1 Strain (in/in) Gravity Mid Max	AP-460-LBS-BEC EPEL P2 (in/in) Gravity Mid Min	AP-460-LBS-BEC EPEL P2 Strain (in/in) Gravity Mid Max	AP-460-LBS-BEC EPEL P3 Strain (in/in) Gravity Mid Min	AP-460-LBS-BEC EPEL P3 Strain (in/in) Gravity Mid Max
762	67.33	3.82E-05	3.83E-05	-4.29E-05	-4.29E-05	-4.59E-05	-4.59E-05
782	105.04	4.24E-05	4.24E-05	-3.30E-05	-3.30E-05	-6.47E-05	-6.47E-05
802	136.24	4.22E-05	4.22E-05	-3.97E-05	-3.97E-05	-5.73E-05	-5.72E-05
822	181.71	3.34E-05	3.34E-05	-2.23E-05	-2.23E-05	-5.42E-05	-5.42E-05
842	225.10	3.33E-05	3.33E-05	-3.33E-05	-3.33E-05	-4.28E-05	-4.28E-05
862	273.66	2.26E-05	2.26E-05	-1.16E-05	-1.16E-05	-4.01E-05	-4.00E-05
882	323.27	1.90E-05	1.90E-05	-1.53E-05	-1.53E-05	-2.83E-05	-2.83E-05
902	369.20	1.31E-05	1.31E-05	5.88E-06	5.88E-06	-2.64E-05	-2.64E-05
922	419.20	3.43E-05	3.43E-05	-6.23E-06	-6.22E-06	-1.95E-05	-1.95E-05
237	463.02	5.70E-05	5.71E-05	3.65E-06	3.66E-06	-7.06E-05	-7.05E-05
257	510.03	8.29E-05	8.30E-05	5.61E-05	5.62E-05	-3.38E-04	-3.38E-04
277	544.44	1.16E-04	1.16E-04	7.40E-05	7.42E-05	-5.94E-04	-5.94E-04
297	580.53	8.16E-05	8.16E-05	-1.08E-05	-1.07E-05	-3.58E-04	-3.58E-04
317	631.08	9.16E-05	9.17E-05	-1.17E-04	-1.17E-04	-3.00E-04	-3.00E-04
337	680.34	1.18E-04	1.18E-04	-1.60E-04	-1.60E-04	-3.77E-04	-3.76E-04
357	727.44	1.21E-04	1.21E-04	-1.73E-04	-1.73E-04	-3.79E-04	-3.79E-04
377	772.93	1.38E-04	1.38E-04	-1.82E-04	-1.81E-04	-4.46E-04	-4.46E-04
397	831.34	1.28E-04	1.28E-04	-1.52E-04	-1.52E-04	-4.32E-04	-4.31E-04
417	894.09	5.96E-05	5.97E-05	-8.25E-05	-8.24E-05	-1.86E-04	-1.86E-04
2132	925.08	2.92E-05	2.92E-05	-1.67E-05	-1.67E-05	-4.25E-05	-4.24E-05
2122	935.67	3.02E-05	3.02E-05	-2.90E-05	-2.90E-05	-3.07E-05	-3.07E-05
2112	944.86	2.20E-05	2.20E-05	-7.73E-06	-7.73E-06	-3.54E-05	-3.54E-05
477	968.95	2.44E-05	2.45E-05	8.71E-06	8.72E-06	-1.09E-04	-1.09E-04
497	1002.45	2.04E-05	2.04E-05	1.43E-05	1.43E-05	-8.17E-06	-8.16E-06
517	1042.45	1.39E-05	1.40E-05	1.32E-05	1.32E-05	-6.15E-06	-6.14E-06
537	1108.60	3.74E-05	3.74E-05	7.10E-06	7.12E-06	-1.14E-05	-1.14E-05
557	1178.35	4.77E-06	4.77E-06	3.89E-06	3.90E-06	-2.31E-05	-2.30E-05
577	1227.20	2.80E-05	2.80E-05	3.92E-06	3.93E-06	-7.30E-06	-7.29E-06
597	1271.50	5.03E-06	5.04E-06	4.31E-06	4.31E-06	-2.38E-05	-2.38E-05
617	1313.65	1.75E-05	1.75E-05	7.74E-06	7.75E-06	-5.57E-06	-5.56E-06
637	1360.60	5.09E-06	5.09E-06	4.74E-06	4.75E-06	-2.02E-06	-2.01E-06

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Table F.18. LBS-BEC Concrete Backed Steel Strain, Shell Bottom, Gravity Load Only

AP Backed Steel, Lower Bound Soil, Gravity Only, Best Estimate Tank Concrete, 460 In Waste Level at 1.83SpG

M&D Starting M&D Element No.	Path (in)	Shell Bottom Surface (outside - away from waste) Gravity					
		AP-460-LBS-BEC EPEL P1 Strain (in/in) Gravity Bot Min	AP-460-LBS-BEC EPEL P1 Strain (in/in) Gravity Bot Max	AP-460-LBS-BEC EPEL P2 (in/in) Gravity Bot Min	AP-460-LBS-BEC EPEL P2 Strain (in/in) Gravity Bot Max	AP-460-LBS-BEC EPEL P3 Strain (in/in) Gravity Bot Min	AP-460-LBS-BEC EPEL P3 Strain (in/in) Gravity Bot Max
762	67.33	4.24E-05	4.24E-05	-4.66E-05	-4.65E-05	-5.17E-05	-5.16E-05
782	105.04	3.84E-05	3.84E-05	-3.35E-05	-3.35E-05	-5.50E-05	-5.50E-05
802	136.24	4.66E-05	4.66E-05	-4.01E-05	-4.01E-05	-6.71E-05	-6.70E-05
822	181.71	3.09E-05	3.09E-05	-2.26E-05	-2.26E-05	-4.80E-05	-4.80E-05
842	225.10	3.87E-05	3.87E-05	-3.33E-05	-3.33E-05	-5.49E-05	-5.48E-05
862	273.66	2.09E-05	2.09E-05	-1.19E-05	-1.19E-05	-3.59E-05	-3.59E-05
882	323.27	2.27E-05	2.27E-05	-1.54E-05	-1.54E-05	-3.68E-05	-3.68E-05
902	369.20	1.28E-05	1.29E-05	5.10E-06	5.10E-06	-2.43E-05	-2.43E-05
922	419.20	3.41E-05	3.42E-05	-5.13E-06	-5.13E-06	-2.19E-05	-2.18E-05
237	463.02						
257	510.03						
277	544.44						
297	580.53						
317	631.08						
337	680.34						
357	727.44						
377	772.93						
397	831.34						
417	894.09						
2132	925.08	2.79E-05	2.80E-05	-4.82E-06	-4.82E-06	-4.25E-05	-4.24E-05
2122	935.67	6.42E-05	6.43E-05	-3.03E-05	-3.03E-05	-1.16E-04	-1.16E-04
2112	944.86	1.56E-04	1.56E-04	-7.70E-06	-7.70E-06	-6.33E-05	-6.32E-05
477	968.95						
497	1002.45						
517	1042.45						
537	1108.60						
557	1178.35						
577	1227.20						
597	1271.50						
617	1313.65						
637	1360.60						

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Table F.19. LBS-BEC Concrete Backed Steel Strain, Shell Top, Gravity Plus Seismic Load

**AP Backed Steel, Lower Bound Soil, Seismic Only, Best Estimate Tank Concrete, 460 In Waste
Level at 1.83SpG**

M&D Starting M&D Element No.	Path (in)	Shell Top Surface (inside - towards waste) Seismic					
		AP-460-LBS-BEC EPEL P1 Strain (in/in)	AP-460-LBS-BEC EPEL P1 Strain (in/in)	AP-460-LBS-BEC EPEL P2 Strain (in/in)	AP-460-LBS-BEC EPEL P2 Strain (in/in)	AP-460-LBS-BEC EPEL P3 Strain (in/in)	AP-460-LBS-BEC EPEL P3 Strain (in/in)
		Seismic Top Min	Seismic Top Max	Seismic Top Min	Seismic Top Max	Seismic Top Min	Seismic Top Max
762	67.33	2.28E-05	4.61E-05	-4.91E-05	-5.64E-06	-5.89E-05	-2.77E-05
782	105.04	3.37E-05	7.07E-05	-4.27E-05	-1.31E-05	-9.45E-05	-3.49E-05
802	136.24	2.59E-05	5.13E-05	-4.99E-05	-3.86E-07	-7.37E-05	-3.07E-05
822	181.71	2.70E-05	5.42E-05	-3.06E-05	-3.90E-06	-8.10E-05	-3.13E-05
842	225.10	2.12E-05	3.83E-05	-3.64E-05	2.04E-05	-6.13E-05	-2.42E-05
862	273.66	1.94E-05	3.89E-05	-1.93E-05	1.89E-05	-6.95E-05	-1.43E-05
882	323.27	1.28E-05	5.44E-05	-1.87E-05	2.36E-05	-7.22E-05	-1.16E-05
902	369.20	6.02E-06	8.86E-05	-9.00E-07	2.08E-05	-7.17E-05	-1.50E-06
922	419.20	1.74E-05	1.52E-04	-1.13E-05	1.78E-05	-7.55E-05	-4.46E-07
237	463.02						
257	510.03						
277	544.44						
297	580.53						
317	631.08						
337	680.34						
357	727.44						
377	772.93						
397	831.34						
417	894.09						
2132	925.08	2.90E-05	4.70E-05	-3.72E-05	2.01E-05	-5.92E-05	-3.31E-05
2122	935.67	6.48E-05	1.18E-04	-2.40E-05	1.11E-05	-4.83E-05	-1.97E-05
2112	944.86	7.25E-05	1.60E-04	-1.34E-05	4.54E-05	-2.52E-04	-5.00E-05
477	968.95						
497	1002.45						
517	1042.45						
537	1108.60						
557	1178.35						
577	1227.20						
597	1271.50						
617	1313.65						
637	1360.60						

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Table F.20. LBS-BEC Concrete Backed Steel Strain, Shell Middle, Gravity Plus Seismic Load

AP Backed Steel, Lower Bound Soil, Seismic Only, Best Estimate Tank Concrete, 460 In Waste
Level at 1.83SpG

M&D Starting M&D Element No.	Path (in)	Shell Mid-Plane					
		AP-460-LBS-BEC		AP-460-LBS-BEC		AP-460-LBS-BEC	
		EPEL P1 Strain (in/in) Seismic Mid Min	EPEL P1 Strain (in/in) Seismic Mid Max	EPEL P2 Strain (in/in) Seismic Mid Min	EPEL P2 Strain (in/in) Seismic Mid Max	EPEL P3 Strain (in/in) Seismic Mid Min	EPEL P3 Strain (in/in) Seismic Mid Max
762	67.33	2.70E-05	5.52E-05	-5.60E-05	-1.89E-05	-6.11E-05	-3.01E-05
782	105.04	2.90E-05	5.89E-05	-4.37E-05	-1.30E-05	-8.58E-05	-4.30E-05
802	136.24	3.07E-05	6.42E-05	-5.06E-05	-9.42E-07	-7.96E-05	-3.77E-05
822	161.71	2.46E-05	4.70E-05	-3.06E-05	-4.11E-06	-7.54E-05	-3.18E-05
842	225.10	2.60E-05	5.46E-05	-4.37E-05	1.77E-05	-6.76E-05	-2.70E-05
862	273.66	1.81E-05	3.42E-05	-1.94E-05	1.92E-05	-6.42E-05	-2.09E-05
882	323.27	1.51E-05	5.42E-05	-2.42E-05	2.33E-05	-7.27E-05	-1.35E-05
902	369.20	5.79E-06	8.91E-05	-1.03E-06	1.92E-05	-6.39E-05	-1.87E-06
922	419.20	1.70E-05	1.51E-04	-1.19E-05	2.38E-05	-7.11E-05	-2.13E-06
237	463.02	3.09E-05	1.07E-04	1.40E-06	9.62E-06	-8.48E-05	-5.07E-05
257	510.03	5.33E-05	1.38E-04	4.97E-05	6.74E-05	-3.93E-04	-2.76E-04
277	544.44	1.04E-04	1.37E-04	4.12E-05	1.32E-04	-6.94E-04	-4.85E-04
297	580.53	7.35E-05	9.62E-05	-3.62E-05	7.01E-05	-4.24E-04	-2.96E-04
317	631.08	8.18E-05	1.08E-04	-1.37E-04	3.83E-05	-3.52E-04	-2.53E-04
337	680.34	1.05E-04	1.37E-04	-1.81E-04	1.13E-06	-4.43E-04	-3.13E-04
357	727.44	1.08E-04	1.40E-04	-1.93E-04	-1.68E-05	-4.45E-04	-3.07E-04
377	772.93	1.21E-04	1.61E-04	-2.01E-04	3.29E-05	-5.34E-04	-3.38E-04
397	831.34	1.11E-04	1.50E-04	-1.68E-04	4.88E-05	-5.15E-04	-3.11E-04
417	894.09	5.17E-05	6.98E-05	-9.10E-05	4.32E-05	-2.23E-04	-1.15E-04
2132	925.08	2.43E-05	3.63E-05	-2.02E-05	1.83E-05	-5.58E-05	-2.28E-05
2122	935.67	2.47E-05	3.73E-05	-3.21E-05	1.41E-05	-6.30E-05	-2.42E-05
2112	944.86	1.75E-05	4.52E-05	-1.23E-05	2.53E-05	-6.15E-05	-2.01E-05
477	968.95	2.01E-05	6.69E-05	-3.01E-07	2.42E-05	-1.29E-04	-7.87E-05
497	1002.45	1.39E-05	7.12E-05	-5.04E-06	3.52E-05	-3.57E-05	-3.55E-06
517	1042.45	1.18E-05	6.50E-05	-2.38E-06	2.40E-05	-9.20E-06	-1.58E-06
537	1108.60	3.11E-05	7.61E-05	-6.99E-06	4.40E-05	-2.58E-05	-5.62E-06
557	1178.35	4.04E-06	4.32E-05	-3.10E-06	1.06E-05	-5.45E-05	-3.61E-06
577	1227.20	1.76E-05	6.83E-05	-6.63E-06	3.61E-05	-2.38E-05	-2.39E-06
597	1271.50	4.40E-06	3.18E-05	-4.37E-06	7.93E-06	-3.93E-05	-6.00E-06
617	1313.65	2.46E-06	4.36E-05	-4.13E-06	2.54E-05	-1.32E-05	-8.19E-07
637	1360.60	1.59E-06	1.20E-05	-5.59E-07	8.53E-06	-3.67E-06	-3.00E-07

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Table F.21. LBS-BEC Concrete Backed Steel Strain, Shell Bottom, Gravity Plus Seismic Load

**AP Backed Steel, Lower Bound Soil, Seismic Only, Best Estimate Tank Concrete, 460 In Waste
Level at 1.83SpG**

M&D Starting M&D Element No.	Path (in)	Shell Bottom Surface (outside - away from waste) Seismic					
		AP-460-LBS-BEC EPEL P1 Strain (in/in)	AP-460-LBS-BEC EPEL P1 Strain (in/in)	AP-460-LBS-BEC EPEL P2 (in/in)	AP-460-LBS-BEC EPEL P2 Strain (in/in)	AP-460-LBS-BEC EPEL P3 Strain (in/in)	AP-460-LBS-BEC EPEL P3 Strain (in/in)
		Seismic Bot Min	Seismic Bot Max	Seismic Bot Min	Seismic Bot Max	Seismic Bot Min	Seismic Bot Max
762	67.33	3.10E-05	6.74E-05	-5.95E-05	-1.96E-05	-6.68E-05	-2.42E-05
782	105.04	2.43E-05	5.56E-05	-4.45E-05	-1.29E-05	-7.87E-05	-2.40E-05
802	136.24	3.53E-05	7.72E-05	-5.09E-05	-1.50E-06	-8.77E-05	-3.43E-05
822	181.71	2.14E-05	4.12E-05	-3.08E-05	-4.32E-06	-7.06E-05	-2.70E-05
842	225.10	3.02E-05	7.11E-05	-4.93E-05	1.38E-05	-7.90E-05	-2.05E-05
862	273.66	1.66E-05	2.99E-05	-1.94E-05	1.99E-05	-6.15E-05	-1.97E-05
882	323.27	1.68E-05	5.53E-05	-2.71E-05	2.58E-05	-7.57E-05	-3.65E-06
902	369.20	5.53E-06	8.96E-05	-1.14E-06	1.81E-05	-6.05E-05	-6.78E-06
922	419.20	1.64E-05	1.51E-04	-1.27E-05	3.03E-05	-7.82E-05	-1.85E-06
237	463.02						
257	510.03						
277	544.44						
297	580.53						
317	631.08						
337	660.34						
357	727.44						
377	772.93						
397	831.34						
417	894.09						
2132	925.08	2.46E-05	3.43E-05	-8.41E-06	1.60E-05	-5.31E-05	-1.68E-05
2122	935.67	5.31E-05	9.24E-05	-3.64E-05	9.63E-06	-1.39E-04	-4.79E-05
2112	944.86	1.18E-04	2.73E-04	-1.82E-05	4.49E-05	-7.44E-05	-2.64E-05
477	968.95						
497	1002.45						
517	1042.45						
537	1108.60						
557	1178.35						
577	1227.20						
597	1271.50						
617	1313.65						
637	1360.60						

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Table F.22. LBS-BEC Concrete Backed Steel Strain, Shell Top, Seismic Load Only

**AP Backed Steel, Lower Bound Soil, Seismic Only, Best Estimate Tank Concrete, 460 In
Waste Level at 1.83SpG**

M&D Starting M&D Element No.	Path (in)	Shell Top Surface (inside - towards waste) Seismic					
		AP-460-LBS-BEC EPEL P1 Strain (in/in)	AP-460-LBS-BEC EPEL P1 Strain (in/in)	AP-460-LBS-BEC EPEL P2 (in/in)	AP-460-LBS-BEC EPEL P2 Strain (in/in)	AP-460-LBS-BEC EPEL P3 Strain (in/in) Seismic Only	AP-460-LBS-BEC EPEL P3 Strain (in/in)
		Seismic Only Top Min	Seismic Only Top Max	Seismic Only Top Min	Seismic Only Top Max	Top Min	Seismic Only Top Max
762	67.33	-1.14E-05	1.19E-05	-1.51E-05	2.83E-05	-1.37E-05	1.74E-05
782	105.04	-1.27E-05	2.43E-05	-1.03E-05	1.94E-05	-2.02E-05	3.93E-05
802	136.24	-1.18E-05	1.35E-05	-1.06E-05	3.89E-05	-2.63E-05	1.66E-05
822	181.71	-8.90E-06	1.82E-05	-8.51E-06	1.81E-05	-2.07E-05	2.90E-05
842	225.10	-6.77E-06	1.04E-05	-5.68E-06	5.11E-05	-2.80E-05	9.04E-06
862	273.66	-4.85E-06	1.46E-05	-7.94E-06	3.03E-05	-2.53E-05	2.99E-05
882	323.27	-2.47E-06	3.91E-05	-3.54E-06	3.88E-05	-5.24E-05	8.21E-06
902	369.20	-7.34E-06	7.52E-05	-7.57E-06	1.41E-05	-4.32E-05	2.69E-05
922	419.20	-1.71E-05	1.18E-04	-3.99E-06	2.51E-05	-5.84E-05	1.66E-05
237	463.02						
257	510.03						
277	544.44						
297	580.53						
317	631.08						
337	680.34						
357	727.44						
377	772.93						
397	831.34						
417	894.09						
2062	925.08	-5.68E-06	1.24E-05	-4.68E-06	5.26E-05	-1.68E-05	9.37E-06
2052	935.67	-1.08E-05	4.21E-05	-2.83E-06	3.23E-05	-1.73E-05	1.13E-05
2042	944.86	-2.35E-05	6.37E-05	-5.64E-06	5.32E-05	-3.87E-05	1.63E-04
477	968.95						
497	1002.45						
517	1042.45						
537	1108.60						
557	1178.35						
577	1227.20						
597	1271.50						
617	1313.65						
637	1360.60						

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Table F.23. LBS-BEC Concrete Backed Steel Strain, Shell Middle, Seismic Load Only

**AP Backed Steel, Lower Bound Soil, Seismic Only, Best Estimate Tank Concrete, 460 In
Waste Level at 1.83SpG**

M&D Starting M&D Element No.	Path (in)	Shell Mid-Plane					
		AP-460-LBS- BEC EPEL P1 Strain (in/in)	AP-460-LBS-BEC EPEL P1 Strain (in/in)	AP-460-LBS-BEC EPEL P2 (in/in)	AP-460-LBS-BEC EPEL P2 Strain (in/in)	AP-460-LBS-BEC EPEL P3 Strain (in/in)	AP-460-LBS-BEC EPEL P3 Strain (in/in)
		Seismic Only Mid Min	Seismic Only Mid Max	Seismic Only Mid Min	Seismic Only Mid Max	Seismic Only Mid Min	Seismic Only Mid Max
762	67.33	-1.12E-05	1.69E-05	-1.31E-05	2.40E-05	-1.52E-05	1.57E-05
782	105.04	-1.34E-05	1.65E-05	-1.07E-05	2.00E-05	-2.10E-05	2.17E-05
802	136.24	-1.15E-05	2.20E-05	-1.09E-05	3.87E-05	-2.24E-05	1.95E-05
822	181.71	-8.82E-06	1.36E-05	-8.28E-06	1.82E-05	-2.12E-05	2.24E-05
842	225.10	-7.35E-06	2.12E-05	-1.04E-05	5.10E-05	-2.48E-05	1.58E-05
862	273.66	-4.47E-06	1.16E-05	-7.80E-06	3.09E-05	-2.41E-05	1.91E-05
882	323.27	-3.86E-06	3.52E-05	-8.91E-06	3.86E-05	-4.44E-05	1.48E-05
902	369.20	-7.31E-06	7.59E-05	-6.91E-06	1.33E-05	-3.75E-05	2.45E-05
922	419.20	-1.73E-05	1.17E-04	-5.70E-06	3.00E-05	-5.16E-05	1.73E-05
237	463.02	-2.61E-05	4.97E-05	-2.25E-06	5.96E-06	-1.42E-05	1.98E-05
257	510.03	-2.95E-05	5.53E-05	-6.41E-06	1.12E-05	-5.49E-05	6.24E-05
277	544.44	-1.23E-05	2.11E-05	-3.28E-05	5.80E-05	-9.93E-05	1.09E-04
297	580.53	-8.07E-06	1.46E-05	-2.54E-05	8.08E-05	-6.58E-05	6.19E-05
317	631.08	-9.80E-06	1.59E-05	-2.02E-05	1.55E-04	-5.15E-05	4.67E-05
337	680.34	-1.27E-05	1.89E-05	-2.07E-05	1.61E-04	-6.59E-05	6.37E-05
357	727.44	-1.36E-05	1.87E-05	-1.95E-05	1.56E-04	-6.56E-05	7.13E-05
377	772.93	-1.67E-05	2.29E-05	-1.93E-05	2.14E-04	-8.73E-05	1.08E-04
397	831.34	-1.69E-05	2.16E-05	-1.61E-05	2.01E-04	-8.27E-05	1.21E-04
417	894.09	-7.86E-06	1.02E-05	-8.54E-06	1.26E-04	-3.67E-05	7.15E-05
2062	925.08	-4.95E-06	7.07E-06	-3.54E-06	3.50E-05	-1.33E-05	1.97E-05
2052	935.67	-5.49E-06	7.15E-06	-3.09E-06	4.31E-05	-3.22E-05	6.52E-06
2042	944.86	-4.48E-06	2.31E-05	-4.55E-06	3.30E-05	-2.62E-05	1.52E-05
477	968.95	-4.30E-06	4.24E-05	-9.01E-06	1.55E-05	-2.00E-05	3.05E-05
497	1002.45	-6.48E-06	5.07E-05	-1.93E-05	2.10E-05	-2.75E-05	4.61E-06
517	1042.45	-2.09E-06	5.10E-05	-1.56E-05	1.08E-05	-3.05E-06	4.56E-06
537	1108.60	-6.31E-06	3.87E-05	-1.41E-05	3.68E-05	-1.44E-05	5.76E-06
557	1178.35	-7.31E-07	3.84E-05	-6.98E-06	6.67E-06	-3.15E-05	1.94E-05
577	1227.20	-1.04E-05	4.03E-05	-1.06E-05	3.22E-05	-1.65E-05	4.90E-06
597	1271.50	-6.29E-07	2.68E-05	-8.68E-06	3.62E-06	-1.55E-05	1.78E-05
617	1313.65	-1.50E-05	2.61E-05	-1.19E-05	1.76E-05	-7.60E-06	4.74E-06
637	1360.60	-3.50E-06	6.88E-06	-5.30E-06	3.79E-06	-1.65E-06	1.71E-06

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Table F.24. LBS-BEC Concrete Backed Steel Strain, Shell Bottom, Seismic Load Only

**AP Backed Steel, Lower Bound Soil, Seismic Only, Best Estimate Tank Concrete, 460 In Waste
Level at 1.83SpG**

M&D Starting M&D Element No.	Path (in)	Shell Bottom Surface (outside - away from waste) Seismic					
		AP-460-LBS-BEC EPEL P1 Strain (in/in)	AP-460-LBS-BEC EPEL P1 Strain (in/in)	AP-460-LBS-BEC EPEL P2 (in/in)	AP-460-LBS-BEC EPEL P2 Strain (in/in)	AP-460-LBS-BEC EPEL P3 Strain (in/in)	AP-460-LBS-BEC EPEL P3 Strain (in/in)
		Seismic Only Bot Min	Seismic Only Bot Max	Seismic Only Bot Min	Seismic Only Bot Max	Seismic Only Bot Min	Seismic Only Bot Max
762	67.33	-1.14E-05	2.49E-05	-1.30E-05	2.69E-05	-1.51E-05	2.74E-05
782	105.04	-1.41E-05	1.72E-05	-1.10E-05	2.07E-05	-2.36E-05	3.10E-05
802	136.24	-1.12E-05	3.06E-05	-1.08E-05	3.86E-05	-2.07E-05	3.27E-05
822	181.71	-9.46E-06	1.03E-05	-8.18E-06	1.83E-05	-2.25E-05	2.10E-05
842	225.10	-8.46E-06	3.24E-05	-1.60E-05	4.71E-05	-2.41E-05	3.43E-05
862	273.66	-4.28E-06	8.97E-06	-7.51E-06	3.17E-05	-2.56E-05	1.62E-05
882	323.27	-5.87E-06	3.27E-05	-1.16E-05	4.12E-05	-3.89E-05	3.31E-05
902	369.20	-7.31E-06	7.67E-05	-6.24E-06	1.30E-05	-3.62E-05	1.75E-05
922	419.20	-1.77E-05	1.17E-04	-7.55E-06	3.54E-05	-5.63E-05	2.00E-05
237	463.02						
257	510.03						
277	544.44						
297	580.53						
317	631.08						
337	680.34						
357	727.44						
377	772.93						
397	831.34						
417	894.09						
2062	925.08	-3.35E-06	6.36E-06	-3.59E-06	2.08E-05	-1.06E-05	2.56E-05
2052	935.67	-1.12E-05	2.82E-05	-6.12E-06	3.99E-05	-2.32E-05	6.81E-05
2042	944.86	-3.80E-05	1.17E-04	-1.05E-05	5.26E-05	-1.11E-05	3.68E-05
477	968.95						
497	1002.45						
517	1042.45						
537	1108.60						
557	1178.35						
577	1227.20						
597	1271.50						
617	1313.65						
637	1360.60						

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Table F.25. LBS-BEC Concrete Wall/Footing Contact Forces, Gravity Only

Tank AY, 460 Inch Waste Level
 SpG = 1.83
 Lower Bound Soi
 Best Estimate Concrete

Angle	Vertical Min AP- LBS-BEC Gravity	Vertical Max AP- LBS-BEC Gravity	Shear Y Min AP- LBS-BEC Gravity	Shear Y Max AP- LBS-BEC Gravity	Shear X Min AP- LBS-BEC Gravity	Shear X Max AP- LBS-BEC Gravity	Shear Y Min AP- LBS-BEC Gravity	Shear X Max AP- LBS-BEC Gravity	Shear Y Min AP- LBS-BEC Gravity	Shear X Max AP- LBS-BEC Gravity	Vertical Force Max AP-LBS- BEC Gravity	Vertical Force Min AP-LBS- BEC Gravity
0	-239.10	-238.90	0.00	0.00	-4.32	-4.31	0.00	1.35	1.35	1.35	-74.72	-74.66
9	-478.40	-477.80	-1.59	-1.58	-8.78	-8.76	0.25	1.37	1.39	1.39	-74.75	-74.66
18	-478.30	-477.80	-2.28	-2.28	-8.09	-8.08	0.36	1.26	1.31	1.31	-74.73	-74.66
27	-478.30	-477.70	-3.43	-3.43	-7.63	-7.61	0.54	1.19	1.31	1.31	-74.73	-74.64
36	-478.30	-477.80	-5.30	-5.29	-7.19	-7.18	0.83	1.12	1.40	1.40	-74.73	-74.66
45	-478.20	-477.60	-6.13	-6.12	-6.11	-6.10	0.96	0.95	1.35	1.35	-74.72	-74.63
54	-478.20	-477.60	-7.19	-7.18	-5.28	-5.27	1.12	0.83	1.39	1.39	-74.72	-74.63
63	-478.20	-477.60	-7.65	-7.64	-3.93	-3.93	1.20	0.61	1.34	1.34	-74.72	-74.63
72	-478.30	-477.70	-8.52	-8.51	-2.70	-2.70	1.33	0.42	1.40	1.40	-74.73	-74.64
81	-478.10	-477.60	-8.26	-8.25	-1.43	-1.42	1.29	0.22	1.31	1.31	-74.70	-74.63
90	-478.20	-477.60	-8.87	-8.86	0.04	0.04	1.39	0.01	1.39	1.39	-74.72	-74.63
99	-478.20	-477.70	-8.73	-8.72	1.44	1.44	1.36	0.23	1.38	1.38	-74.72	-74.64
108	-478.20	-477.60	-8.02	-8.01	2.43	2.43	1.25	0.38	1.31	1.31	-74.72	-74.63
117	-478.30	-477.70	-7.93	-7.92	4.07	4.07	1.24	0.64	1.39	1.39	-74.73	-74.64
126	-478.20	-477.70	-6.95	-6.94	5.11	5.12	1.09	0.80	1.35	1.35	-74.72	-74.64
135	-478.20	-477.60	-6.18	-6.17	6.31	6.31	0.97	0.99	1.38	1.38	-74.72	-74.63
144	-478.10	-477.60	-5.13	-5.12	7.11	7.12	0.80	1.11	1.37	1.37	-74.70	-74.63
153	-478.20	-477.60	-4.01	-4.00	7.81	7.82	0.63	1.22	1.37	1.37	-74.72	-74.63
162	-478.20	-477.70	-2.67	-2.66	8.29	8.31	0.42	1.30	1.36	1.36	-74.72	-74.64
171	-478.20	-477.70	-1.33	-1.32	8.66	8.68	0.21	1.36	1.37	1.37	-74.72	-74.64
180	-239.10	-238.90	0.00	0.00	4.39	4.39	0.00	1.37	1.37	1.37	-74.72	-74.66

Table F.26. LBS-BEC Concrete Wall/Footing Contact Forces, Gravity Plus Seismic

Tank AY, 460 Inch Waste Level
 SpG = 1.83
 Lower Bound Soi
 Best Estimate Concrete

Angle	Vertical Min AP- LBS-BEC Seismic	Vertical Max AP- LBS-BEC Seismic	Shear Y Min AP- LBS-BEC Seismic	Shear Y Max AP- LBS-BEC Seismic	Shear X Min AP- LBS-BEC Seismic	Shear X Max AP- LBS-BEC Seismic	Shear Y Min AP- LBS-BEC Seismic	Shear X Max AP- LBS-BEC Seismic	Shear Y Min AP- LBS-BEC Seismic	Shear X Max AP- LBS-BEC Seismic	Vertical Force Max AP-LBS- BEC Seismic	Vertical Force Min AP-LBS- BEC Seismic
0	-288.20	-178.10	0.00	0.00	-11.14	3.35	0.00	3.48	3.48	3.48	-90.06	-55.66
9	-575.80	-357.20	-37.54	31.55	-27.58	12.08	5.87	4.31	7.28	7.28	-89.97	-55.81
18	-573.50	-359.70	-70.60	60.67	-42.10	29.07	11.03	6.58	12.84	12.84	-89.61	-56.20
27	-569.70	-363.80	-97.45	83.30	-65.49	55.16	15.23	10.23	18.35	18.35	-89.02	-56.84
36	-565.60	-369.40	-115.90	97.00	-95.37	87.95	18.11	14.90	23.45	23.45	-88.38	-57.72
45	-565.70	-375.80	-122.60	101.80	-128.00	125.00	19.16	20.00	27.69	27.69	-88.39	-58.72
54	-566.10	-382.90	-118.20	95.58	-160.90	162.10	18.47	25.33	31.35	31.35	-88.45	-59.83
63	-566.50	-390.10	-102.30	79.59	-189.80	196.40	15.98	30.69	34.60	34.60	-88.52	-60.95
72	-567.00	-397.10	-77.36	54.57	-212.30	224.20	12.09	35.03	37.06	37.06	-88.59	-62.05
81	-567.20	-402.90	-44.57	24.57	-226.00	242.60	6.96	37.91	38.54	38.54	-88.63	-62.95
90	-567.60	-402.80	-10.98	-7.05	-229.60	250.00	1.72	39.06	39.10	39.10	-88.69	-62.94
99	-568.10	-402.50	-42.65	28.14	-222.70	245.80	6.66	38.41	38.98	38.98	-88.77	-62.89
108	-568.40	-401.50	-71.95	61.89	-206.10	230.20	11.24	35.97	37.68	37.68	-88.81	-62.73
117	-568.90	-400.20	-95.63	88.24	-180.50	205.70	14.94	32.14	35.44	35.44	-88.89	-62.53
126	-569.20	-398.30	-109.80	106.10	-149.30	173.70	17.16	27.14	32.11	32.11	-88.94	-62.23
135	-569.50	-396.10	-114.20	112.50	-114.90	138.20	17.84	21.59	28.01	28.01	-88.98	-61.89
144	-569.70	-393.70	-107.90	107.60	-80.92	102.70	16.86	16.05	23.28	23.28	-89.02	-61.52
153	-569.90	-391.60	-81.48	91.67	-50.30	70.57	14.32	11.03	18.08	18.08	-89.05	-61.19
162	-570.10	-390.10	-66.29	66.72	-26.06	45.05	10.43	7.04	12.58	12.58	-89.08	-60.95
171	-570.20	-388.90	-34.81	35.14	-10.36	28.76	5.49	4.49	7.10	7.10	-89.09	-60.77
180	-285.10	-194.20	0.00	0.00	-2.51	11.68	0.00	3.65	3.65	3.65	-89.09	-60.69

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Table F.27. LBS-BEC Concrete Wall/Footing Contact Forces, Seismic Only

Tank AY, 460 Inch Waste Level
SpG = 1.83
Lower Bound Soil
Best Estimate Concrete

Angle	Vertical Min AP- LBS-BEC Seismic Only	Vertical Max AP- LBS-BEC Seismic Only	Shear Y Min AP- LBS-BEC Seismic Only	Shear Y Max AP- LBS-BEC Seismic Only	Shear X Min AP- LBS-BEC Seismic Only	Shear X Max AP- LBS-BEC Seismic Only	Shear Y Min AP- LBS-BEC Seismic Only	Shear Y Max AP- LBS-BEC Seismic Only	Shear Max AP- LBS-BEC Seismic Only	Vertical Force Max AP-LBS- BEC Seismic Only	Vertical Force Min AP-LBS- BEC Seismic Only
0	-49.10	60.80	0.00	0.00	-6.82	7.66	0.00	2.39	2.39	-15.34	19.00
9	-97.40	120.60	-35.95	33.13	-18.81	20.84	5.62	3.26	6.49	-15.22	18.84
18	-95.20	118.10	-68.32	62.95	-34.01	37.15	10.68	5.80	12.15	-14.88	18.45
27	-91.40	113.90	-94.02	86.73	-57.86	62.77	14.69	9.81	17.66	-14.28	17.80
36	-87.30	108.40	-110.60	102.29	-88.18	95.13	17.28	14.86	22.79	-13.64	16.94
45	-87.50	101.80	-116.47	107.92	-121.89	131.10	18.20	20.48	27.40	-13.67	15.91
54	-87.90	94.70	-111.01	102.76	-155.62	167.37	17.35	26.15	31.38	-13.73	14.80
63	-88.30	87.50	-94.65	87.23	-185.87	200.33	14.79	31.30	34.62	-13.80	13.67
72	-88.70	80.60	-68.84	63.08	-209.60	226.90	10.76	35.45	37.05	-13.86	12.59
81	-89.10	74.70	-36.31	32.82	-224.58	244.02	5.67	38.13	38.55	-13.92	11.67
90	-89.40	74.80	-2.11	1.81	-229.64	249.96	0.33	39.06	39.06	-13.97	11.69
99	-89.90	75.20	-33.92	36.86	-224.14	244.36	5.76	38.18	38.61	-14.05	11.75
108	-90.20	76.10	-63.93	69.90	-208.53	227.77	10.92	35.59	37.23	-14.09	11.89
117	-90.60	77.50	-87.70	96.16	-184.57	201.63	15.03	31.50	34.90	-14.16	12.11
126	-91.00	79.40	-102.85	113.04	-154.41	168.58	17.66	26.34	31.71	-14.22	12.41
135	-91.30	81.50	-108.02	118.67	-121.21	131.89	18.54	20.61	27.72	-14.27	12.73
144	-91.60	83.90	-102.77	112.72	-88.03	95.58	17.61	14.93	23.09	-14.31	13.11
153	-91.70	86.00	-87.47	95.67	-58.11	62.75	14.95	9.80	17.88	-14.33	13.44
162	-91.90	87.60	-63.62	69.38	-34.35	36.74	10.84	5.74	12.27	-14.36	13.69
171	-92.00	88.80	-33.49	36.46	-19.02	20.08	5.70	3.14	6.50	-14.38	13.88
180	-46.00	44.70	0.00	0.00	-6.90	7.29	0.00	2.28	2.28	-14.38	13.97

Table F.28. LBS-BEC Soil/Concrete Tank Contact Forces, Gravity Only

Tank AP, 460 Inch Waste Level
SpG = 1.83
Lower Bound Soil
Best Estimate Concrete

	Angle (rad)	Path	Max Pressure Soil (LBS) AP Gravity (PSI)	Min Pressure Soil (LBS) AP Gravity (PSI)	Max Meridional Friction Soil (LBS) AP Gravity (PSI)	Max Tangential Friction Soil (LBS) AP Gravity (PSI)	Max Contact Displacement Soil (LBS) AP Gravity (PSI)	0.24g Dome Vertical	0.19g Haunch Vertical	Active Pressure Phi = 49 deg
568	-0.035089	67.727	11.67	11.53	1.51	0.03	0.02	14.48	13.89	7.11
565.8	-0.07135	105.668	10.10	9.90	1.91	0.06	0.02	12.53	12.02	7.26
563.21	-0.096521	137.069	8.85	7.73	1.83	0.09	0.03	10.97	10.53	7.42
559.7	-0.124516	182.849	7.56	6.49	1.76	0.06	0.03	9.37	8.99	7.65
550.7	-0.180521	226.563	10.22	7.01	2.05	0.08	0.03	12.67	12.16	8.22
545.2	-0.210395	275.566	10.38	9.84	2.11	0.06	0.03	12.87	12.35	8.55
527.68	-0.298426	325.690	10.16	9.72	2.09	0.02	0.04	12.60	12.09	9.56
518.2	-0.34673	372.305	12.84	12.73	2.52	0.03	0.04	15.92	15.28	10.04
494.5	-0.482293	423.427	20.64	20.58	2.64	0.07	0.04	25.59	24.56	10.97
476.2	-0.606571	468.308	33.99	33.94	3.33	0.13	0.04	42.14	40.44	11.27
447.4	-0.656685	515.312	33.02	32.97	6.65	0.22	0.08	40.95	39.29	12.51
407.1	-0.710341	549.725	24.42	24.38	5.03	0.09	0.10	30.29	29.06	14.18
382.1	-1.570796	585.819	14.29	14.27	3.48	0.05	0.11	17.72	17.01	2.85
335	-1.570796	636.369	6.71	6.71	1.60	0.01	0.11	8.33	7.99	3.32
281	-1.570796	685.619	5.33	5.32	1.16	0.01	0.12	6.60	6.34	3.86
236.5	-1.570796	732.719	6.11	6.10	1.23	0.01	0.12	7.58	7.27	4.30
186.8	-1.570796	778.219	6.07	6.06	1.22	0.01	0.11	7.53	7.22	4.80
145.5	-1.570796	821.369	7.60	7.58	1.70	0.01	0.10	9.42	9.04	5.21
70	-1.570796	874.169	10.10	10.08	2.13	0.03	0.08	12.53	12.02	5.96
24	-1.570796	930.544	11.90	11.81	2.47	0.05	0.06	14.76	14.16	6.42

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Table F.29. LBS-BEC Soil/Concrete Tank Contact Forces, Gravity Plus Seismic

Tank AP, 460 Inch Waste Level
 SpG = 1.83
 Lower Bound Soil
 Best Estimate Concrete

	Angle (rad)	Path	Max Pressure Soil (LBS) AP Seismic (PSI)	Min Pressure Soil (LBS) AP Seismic (PSI)	Max Meridional Friction Soil (LBS) AP Seismic (PSI)	Max Tangential Friction Soil (LBS) AP Seismic (PSI)	Max Contact Displacement Soil (LBS) AP Seismic (inch)	Vertical Pressure	Active Pressure Phi = 33 deg	Active Pressure Phi = 49 deg
568	-0.035089	67.727	19.68	3.13	9.48	4.45	0.08	7.12	7.11	7.11
565.8	-0.07135	105.668	17.76	3.00	7.32	3.37	0.06	7.27	7.26	7.26
563.21	-0.096521	137.069	13.73	1.77	6.40	2.64	0.05	7.46	7.43	7.42
559.7	-0.124516	182.849	10.70	3.63	4.17	3.36	0.04	7.71	7.65	7.65
550.7	-0.180521	226.563	14.90	4.14	4.73	4.34	0.05	8.35	8.23	8.22
545.2	-0.210395	275.566	13.59	6.43	5.44	4.44	0.05	8.74	8.57	8.55
527.68	-0.298426	325.690	12.41	6.83	5.42	4.14	0.05	9.99	9.59	9.56
518.2	-0.34673	372.305	15.56	10.06	5.52	3.95	0.05	10.66	10.09	10.04
494.5	-0.482293	423.427	25.44	16.64	5.51	3.87	0.05	12.35	11.07	10.97
476.2	-0.606571	468.308	42.53	26.42	5.80	4.01	0.05	13.65	11.45	11.27
447.4	-0.656685	515.312	40.03	27.19	11.78	4.14	0.10	15.70	12.75	12.51
407.1	-0.710341	549.725	30.04	20.35	12.51	3.11	0.13	18.57	14.53	14.18
382.1	-1.570796	585.819	17.26	11.94	10.56	2.36	0.15	20.35	6.00	2.85
335	-1.570796	636.369	8.03	5.59	5.30	2.48	0.16	23.70	6.99	3.32
281	-1.570796	685.619	6.43	4.34	4.06	2.56	0.17	27.55	8.13	3.86
236.5	-1.570796	732.719	7.17	5.01	4.15	2.48	0.17	30.71	9.06	4.30
186.8	-1.570796	778.219	6.91	4.98	4.04	2.70	0.16	34.25	10.10	4.80
145.5	-1.570796	821.369	8.85	6.08	5.86	3.26	0.14	37.19	10.97	5.21
70	-1.570796	874.169	13.75	6.49	6.89	3.33	0.11	42.57	12.56	5.96
24	-1.570796	930.544	19.95	3.60	6.55	3.01	0.07	45.84	13.52	6.42

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Table F.30. LBS-BEC Soil/Concrete Tank Contact Forces, Seismic Only

Tank AP, 460 Inch Waste Level
 SpG = 1.83
 Lower Bound Soil
 Best Estimate Concrete

	Angle (rad)	Path	Max Pressure Soil (LBS) AP Seismic Only (PSI)	Min Pressure Soil (LBS) AP Seismic Only (PSI)	Max Meridional Friction (LBS) AP Seismic Only (PSI)	Max Tangential Friction (LBS) AP Seismic Only (PSI)	Max Contact Displacement (LBS) AP Seismic Only (inch)
568	-0.035089	67.727	8.01	-8.55	7.97	4.42	0.07
565.8	-0.07135	105.668	7.66	-7.10	5.41	3.31	0.03
563.21	-0.096521	137.069	4.88	-7.08	4.57	2.55	0.02
559.7	-0.124516	182.849	3.15	-3.92	2.40	3.30	0.01
550.7	-0.180521	226.563	4.68	-6.07	2.68	4.26	0.02
545.2	-0.210395	275.566	3.21	-3.96	3.34	4.38	0.02
527.68	-0.298426	325.690	2.25	-3.33	3.33	4.12	0.02
518.2	-0.34673	372.305	2.72	-2.78	3.00	3.91	0.01
494.5	-0.482293	423.427	4.81	-4.00	2.87	3.81	0.01
476.2	-0.606571	468.308	8.54	-7.56	2.46	3.88	0.01
447.4	-0.656685	515.312	7.01	-5.83	5.12	3.92	0.02
407.1	-0.710341	549.725	5.62	-4.07	7.48	3.02	0.03
382.1	-1.570796	585.819	2.97	-2.35	7.08	2.32	0.04
335	-1.570796	636.369	1.32	-1.13	3.69	2.47	0.05
281	-1.570796	685.619	1.10	-0.99	2.90	2.56	0.06
236.5	-1.570796	732.719	1.06	-1.10	2.92	2.47	0.06
186.8	-1.570796	778.219	0.84	-1.09	2.82	2.70	0.05
145.5	-1.570796	821.369	1.25	-1.52	4.15	3.25	0.04
70	-1.570796	874.169	3.65	-3.62	4.76	3.30	0.03
24	-1.570796	930.544	8.05	-8.31	4.08	2.96	0.02

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Table F.31. LBS-BEC Primary Tank/Concrete Dome Contact Data, Gravity Only

Tank AP, 460 Inch Waste Level
SpG = 1.83
Lower Bound Soil
Best Estimate Concrete

Radius	Max Pressure Primary Tank/Concrete Tank Dome AP Gravity (PSI)	Min Pressure Primary Tank/Concrete Tank Dome AP Gravity (PSI)	Max Gap Lateral Displacement Primary Tank /Concrete Tank Dome Gravity (in)	Max Gap Displacement Primary Tank/Concrete Tank Dome AP Gravity (Inches)
67.727	0.981	0.937	0.002978	0.000000
105.668	0.983	0.967	0.003391	0.000000
137.069	0.270	0.250	0.002503	-0.000012
182.849	0.701	0.691	0.003308	-0.000028
226.563	0.907	0.856	0.004315	-0.000102
275.566	0.343	0.324	0.005107	-0.000104
325.690	0.952	0.928	0.006469	-0.000285
372.305	0.000	0.000	0.000188	-0.000054
423.427	0.000	0.000	0.000000	-1.058760

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Table F.32. LBS-BEC Primary Tank/Concrete Dome Contact Data, Gravity Plus Seismic

Tank AP, 460 Inch Waste Level
 SpG = 1.83
 Lower Bound Soil
 Best Estimate Concrete

Radius	Max Pressure Primary Tank/Concrete Tank Dome AP Seismic (PSI)	Min Pressure Primary Tank/Concrete Tank Dome AP Seismic (PSI)	Max Gap Lateral Displacement Primary Tank /Concrete Tank Dome Seismic (in)	Max Gap Displacement Primary Tank/Concrete Tank Dome AP Seismic (Inches)
67.727	8.306	0.110	0.011134	-0.000231
105.668	9.500	0.000	0.018240	-0.000209
137.069	5.744	0.000	0.047772	-0.000946
182.849	2.745	0.000	0.046452	-0.000915
226.563	6.760	0.000	0.030888	-0.001931
275.566	4.763	0.000	0.036312	-0.004744
325.690	7.521	0.000	0.034296	-0.003840
372.305	31.979	0.000	0.074472	-0.007304
423.427	13.097	0.000	0.001961	-1.074120

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Table F.33. LBS-BEC Primary Tank/Concrete Dome Contact Data, Seismic Only

Tank AP, 460 Inch Waste Level
SpG = 1.83
Lower Bound Soil
Best Estimate Concrete

Radius	Max Pressure Primary Tank/Concrete Tank Dome AP Seismic Only (PSI)	Min Pressure Primary Tank/Concrete Tank Dome AP Seismic Only (PSI)	Max Gap Lateral Displacement Primary Tank /Concrete Tank Dome Seismic Only (in)	Max Gap Displacement Primary Tank/Concrete Tank Dome AP Seismic Only (Inches)
67.727	7.324	-0.827	0.008155	-0.000231
105.668	8.517	-0.967	0.014849	-0.000209
137.069	5.474	-0.250	0.045269	-0.000934
182.849	2.044	-0.691	0.043144	-0.000886
226.563	5.853	-0.856	0.026573	-0.001829
275.566	4.420	-0.324	0.031205	-0.004640
325.690	6.569	-0.928	0.027827	-0.003555
372.305	31.979	0.000	0.074284	-0.007251
423.427	13.097	0.000	0.001961	-0.015360

Table F.34. LBS-BEC Primary Tank/Insulating Concrete Contact Forces, Gravity Only

Tank AP, 460 Inch Waste Level
SpG = 1.83
Lower Bound Soil
Best Estimate Concrete

Radius	Max Pressure Primary Tank/Insulating Concrete AP Gravity (PSI)	Min Pressure Primary Tank/Insulating Concrete AP Gravity (PSI)	Max Lateral Displacement Primary Tank / Insulating Concrete AP Gravity (Inches)	Min Lateral Displacement Primary Tank / Insulating Concrete AP Gravity (Inches)
424.00	75.486	75.347	0.011330	0.011302
384.00	13.069	13.049	0.000375	0.000368
317.85	33.403	33.368	0.002321	0.002309
248.10	29.701	29.674	0.002796	0.002785
199.25	30.764	30.736	0.002148	0.002140
154.95	30.479	30.444	0.001122	0.001116
112.80	30.479	30.438	0.000217	0.000208
65.85	30.896	30.799	0.000469	0.000452

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Table F.35. LBS-BEC Primary Tank/ Insulating Concrete Contact Data, Gravity Plus Seismic

Tank AP, 460 Inch Waste Level
SpG = 1.83
Lower Bound Soil
Best Estimate Concrete

Radius	Max Pressure Primary Tank/Insulating Concrete AP Seismic (PSI)	Min Pressure Primary Tank/Insulating Concrete AP Seismic (PSI)	Max Lateral Displacement Primary Tank/Insulating Concrete AP Seismic (Inches)	Min Lateral Displacement Primary Tank/Insulating Concrete AP Seismic (Inches)
424.00	110.764	26.257	0.055104	0.006257
384.00	25.903	3.496	0.200160	0.000102
317.85	43.215	24.319	0.032280	0.000832
248.10	37.646	22.299	0.016752	0.000552
199.25	38.375	24.549	0.009676	0.000295
154.95	36.111	25.063	0.006120	0.000376
112.80	35.181	25.014	0.004398	0.000069
65.85	35.819	25.451	0.003653	0.000314

Table F.36. LBS-BEC Primary Tank/Insulating Concrete Contact Forces, Seismic Only

Tank AP, 460 Inch Waste Level
SpG = 1.83
Lower Bound Soil
Best Estimate Concrete

Radius	Max Pressure Primary Tank/Insulating Concrete AP Seismic Only (PSI)	Min Pressure Primary Tank/Insulating Concrete AP Seismic Only (PSI)	Max Lateral Displacement Primary Tank/Insulating Concrete AP Seismic Only (Inches)	Min Lateral Displacement Primary Tank/Insulating Concrete AP Seismic Only (Inches)
424.00	35.278	-49.090	0.044	-0.005
384.00	12.833	-9.553	0.200	0.000
317.85	9.813	-9.049	0.030	-0.001
248.10	7.944	-7.375	0.014	-0.002
199.25	7.611	-6.188	0.008	-0.002
154.95	5.632	-5.382	0.005	-0.001
112.80	4.701	-5.424	0.004	0.000
65.85	4.924	-5.347	0.003	0.000

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Table F.37. LBS-BEC Insulating Concrete/Concrete Backed Steel Contact Data, Gravity Only

Tank AP, 460 Inch Waste Level
SpG = 1.83
Lower Bound Soil
Best Estimate Concrete

Radius	Max Pressure Insulating Concrete/Secondary Liner AP Gravity (PSI)	Min Pressure Insulating Concrete/Secondary Liner AP Gravity (PSI)	Max Lateral Displacement Insulating Concrete/Secondary Liner AP Gravity (Inches)	Min Lateral Displacement Insulating Concrete/Secondary Liner AP Gravity (Inches)
424.00	96.944	96.597	0.005172	0.005129
384.00	34.653	34.563	0.004285	0.004247
317.85	27.389	27.354	0.003188	0.003155
248.10	31.625	31.597	0.002322	0.002297
199.25	30.882	30.840	0.001525	0.001510
154.95	30.486	30.438	0.001106	0.001097
112.80	31.313	31.222	0.000803	0.000800
65.85	30.424	30.188	0.000313	0.000307

Table F.38. LBS-BEC Insulating Concrete/Concrete Backed Steel Contact Data, Gravity Plus Seismic

Tank AP, 460 Inch Waste Level
SpG = 1.83
Lower Bound Soil
Best Estimate Concrete

Radius	Max Pressure Insulating Concrete/Secondary Liner AP Seismic (PSI)	Min Pressure Insulating Concrete/Secondary Liner AP Seismic (PSI)	Max Lateral Displacement Insulating Concrete/Secondary Liner AP Seismic (Inches)	Min Lateral Displacement Insulating Concrete/Secondary Liner AP Seismic (Inches)
424.00	113.194	80.278	0.021720	0.000214
384.00	43.944	25.917	0.020244	0.000346
317.85	36.146	18.813	0.017892	0.000140
248.10	39.986	24.208	0.015684	0.000072
199.25	38.438	24.618	0.013416	0.000090
154.95	36.194	25.181	0.011056	0.000060
112.80	35.944	25.806	0.009767	0.000050
65.85	35.417	25.542	0.008903	0.000099

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Table F.39. LBS-BEC Insulating Concrete/Concrete Backed Steel Contact Data, Seismic Only

Tank AP, 460 Inch Waste Level
SpG = 1.83
Lower Bound Soil
Best Estimate Concrete

Radius	Max Pressure Insulating Concrete/Secondary Liner AP Seismic Only (PSI)	Min Pressure Insulating Concrete/Secondary Liner AP Seismic Only (PSI)	Max Lateral Displacement Insulating Concrete/Secondary Liner AP Seismic Only (Inches)	Min Lateral Displacement Insulating Concrete/Secondary Liner AP Seismic Only (Inches)
424.00	16.250	-16.319	0.017	-0.005
384.00	9.292	-8.646	0.016	-0.004
317.85	8.757	-8.542	0.015	-0.003
248.10	8.361	-7.389	0.013	-0.002
199.25	7.556	-6.222	0.012	-0.001
154.95	5.708	-5.257	0.010	-0.001
112.80	4.632	-5.417	0.009	-0.001
65.85	4.993	-4.646	0.009	0.000

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Table F.40. LBS-BEC Waste Contact Pressure, Gravity Plus Seismic

Tank AP, 460 Inch Waste Level
 SpG = 1.83
 Lower Bound Soil
 Best Estimate Concrete

Waste Height Ratio		Max Pressure AP Tank, 460 in Waste Level, SpG = 1.83 Time History (PSI)	Min Pressure AP Tank, 460 in Waste Level, SpG = 1.83 Time History (PSI)				
	Waste Height			Hydrostatic (psi)	Hydrodynamic (psi)	Theoretical Min (SRSS)	Theoretical Max (SRSS)
0.99	454.35	11.153	-10.382	0.37	1.79	0.00	2.16
0.96	443.05	15.646	-13.264	1.12	2.03	0.00	3.15
0.94	431.7625	16.660	-13.042	1.87	2.35	0.00	4.21
0.90	414.125	14.694	-8.833	3.03	2.91	0.13	5.94
0.85	390.125	10.396	-1.240	4.62	3.69	0.93	8.30
0.80	366.125	12.222	0.239	6.20	4.44	1.77	10.64
0.74	342	14.486	1.451	7.80	5.15	2.65	12.94
0.69	318.325	16.799	2.137	9.36	5.80	3.57	15.16
0.64	295.225	19.319	3.182	10.89	6.38	4.50	17.27
0.59	272.125	21.528	3.831	12.41	6.93	5.49	19.34
0.54	248.975	23.458	4.776	13.94	7.43	6.52	21.37
0.49	225.825	25.646	5.795	15.47	7.89	7.59	23.36
0.44	202.725	28.215	6.840	17.00	8.30	8.70	25.30
0.39	179.625	30.361	7.819	18.53	8.67	9.85	27.20
0.34	156.475	31.104	9.500	20.06	9.00	11.06	29.05
0.29	134.075	32.458	10.944	21.54	9.28	12.26	30.81
0.24	112.475	34.750	12.153	22.96	9.50	13.46	32.46
0.20	90.875	34.965	13.736	24.39	9.69	14.70	34.08
0.15	69.275	38.563	15.389	25.82	9.84	15.98	35.66
0.10	47.738	38.250	17.097	27.24	9.95	17.29	37.19
0.05	24.500	43.639	15.104	28.78	10.02	18.76	38.79
0.02	7.755	45.778	24.743	29.88	10.04	19.84	39.92
0.00	1.755	42.493	24.465	30.28	10.04	20.23	40.32

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Table F.41. LBS-BEC Waste Contact Pressure, Theoretical Pressures

Tank Radius, Hr	450 HI/Hr			1.022222222		Waste Dens		1.71E-04														
Waste Depth, HI	460 Conv 1st			Conv 2nd		Conv 3rd		Impul H		Pressure												
Centroid	Conv 1st		Conv 2nd		Conv 3rd		Conv 1st		Conv 2nd		Conv 3rd		Impul H		Impul V							
	Lamda		1.841		5.331		8.536		Sa=		0.064		0.108		0.163							
													0.32		0.29							
Height	nu	con0(n)		con1(n)		con2(n)		ci(n)		24.7296		41.7312		62.9832		123.65		112.06		SRSS		
	454.35	0.99	0.82		0.07		0.03		0.09		1.56		0.22		0.12		0.84		0.14		1.79	
	443.05	0.96	0.78		0.06		0.02		0.14		1.49		0.19		0.10		1.30		0.41		2.03	
	431.7625	0.94	0.75		0.05		0.02		0.18		1.43		0.17		0.08		1.73		0.68		2.35	
	414.125	0.90	0.70		0.04		0.01		0.24		1.33		0.14		0.06		2.33		1.10		2.91	
	390.125	0.85	0.64		0.03		0.01		0.32		1.22		0.10		0.04		3.05		1.67		3.69	
	366.125	0.80	0.59		0.02		0.00		0.39		1.11		0.08		0.02		3.68		2.22		4.44	
	342	0.74	0.54		0.02		0.00		0.44		1.02		0.06		0.01		4.22		2.77		5.15	
	318.325	0.69	0.49		0.01		0.00		0.49		0.94		0.04		0.01		4.68		3.28		5.80	
	295.225	0.64	0.45		0.01		0.00		0.53		0.86		0.03		0.01		5.08		3.76		6.38	
	272.125	0.59	0.42		0.01		0.00		0.57		0.80		0.03		0.00		5.43		4.22		6.93	
	248.975	0.54	0.39		0.01		0.00		0.60		0.74		0.02		0.00		5.74		4.65		7.43	
	225.825	0.49	0.36		0.00		0.00		0.63		0.69		0.01		0.00		6.01		5.06		7.89	
	202.725	0.44	0.34		0.00		0.00		0.66		0.65		0.01		0.00		6.25		5.43		8.30	
	179.625	0.39	0.32		0.00		0.00		0.68		0.61		0.01		0.00		6.45		5.77		8.67	
	156.475	0.34	0.30		0.00		0.00		0.70		0.57		0.01		0.00		6.62		6.07		9.00	
	134.075	0.29	0.29		0.00		0.00		0.71		0.55		0.01		0.00		6.76		6.33		9.28	
	112.475	0.24	0.28		0.00		0.00		0.72		0.53		0.00		0.00		6.88		6.54		9.50	
	90.875	0.20	0.27		0.00		0.00		0.73		0.51		0.00		0.00		6.97		6.71		9.69	
	69.275	0.15	0.26		0.00		0.00		0.74		0.49		0.00		0.00		7.04		6.86		9.84	
	47.7375	0.10	0.25		0.00		0.00		0.75		0.48		0.00		0.00		7.09		6.96		9.95	
	24.5	0.05	0.25		0.00		0.00		0.75		0.48		0.00		0.00		7.13		7.03		10.02	
	7.755	0.02	0.25		0.00		0.00		0.75		0.47		0.00		0.00		7.14		7.05		10.04	
	1.755	0.00	0.25		0.00		0.00		0.75		0.47		0.00		0.00		7.14		7.05		10.04	

Table F.42. LBS-BEC Waste Surface Displacement, Gravity Plus Seismic

Tank AP, 460 Inch Waste Level
SpG = 1.83
Lower Bound Soil
Best Estimate Concrete

Waste Radius	Max Vertical Displacement AP-460-BES-BEC Time History (in)	Min Vertical Displacement AP-460-BES-BEC Time History (in)
95.7	7.30	-13.81
129.9	8.22	-12.68
180	8.92	-14.41
218.5	7.96	-15.54
277.7	8.88	-15.61
358	9.27	-15.74
410	7.69	-14.93
450	5.10	-11.27

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Near-Soil-1.txt

```

et,8,solid45                                ! Use Element SOLID45 for Near Soil Elements
/input,soil-prop-LB-geo,txt                  ! Read Soil Properties

ksel,u,kp,,1,kmaxjb                         ! Unselect existing Keypoints
asel,u,area,,1,amaxjb                      ! Unselect existing Area
lsel,u,line,,1,lmaxjb                      ! Unselect existing Lines
vsel,u,volu,,1,vmaxw                       ! Unselect existing Volumes

/COM - Create Keypoints to match concrete tank profile
*do,i,1,bm_kp
k,kmaxjb+i,ctx(i),0,ctz(i)
*enddo

/COM - Create Keypoints above top of tank
k,kmaxjb+bm_kp+1,0,0,0                     ! Keypoint at origin (surface)
k,kmaxjb+bm_kp+2,0,0,soilz(2)             ! Keypoint at to divide soil above tank
*get,KMAXtemp1,KP,0,num,max                ! Get maximum keypoint number for counter

/COM - Create Keypoints at outside of excavated soil
*do,i,1,tanksoil
k,kmaxtemp1+i,soilx(i),0,soilz(i)
*enddo
*get,KMAXtemp2,KP,0,num,max                ! Get maximum keypoint number for counter

/COM - Create additional keypoint in soil above tank
k,kmaxtemp2+1,ctx(2),0,soilz(1)
k,kmaxtemp2+2,ctx(9),0,soilz(1)
k,kmaxtemp2+3,ctx(12),0,soilz(1)
k,kmaxtemp2+4,ctx(2),0,soilz(2)
k,kmaxtemp2+5,ctx(9),0,soilz(2)
k,kmaxtemp2+6,ctx(12),0,soilz(2)
k,kmaxtemp2+7,ctx(12),0,soilz(3)
k,kmaxtemp2+8,ctx(bm_kp+1),0,ctz(bm_kp+1)

a,kmaxtemp2+1,kmaxtemp2+2,kmaxtemp2+5,kmaxtemp2+4
a,kmaxtemp2+2,kmaxtemp2+3,kmaxtemp2+6,kmaxtemp2+5
a,kmaxtemp2+3,kmaxtemp1+1,kmaxtemp1+2,kmaxtemp2+6
a,kmaxtemp2+4,kmaxtemp2+5,kmaxjb+9,kmaxjb+8,kmaxjb+7,kmaxjb+6,kmaxjb+5,kmaxjb+4,kmaxjb+3,kmaxjb+2
!a,740,741,712,711,710,709,708,707,706,705
a,kmaxtemp2+5,kmaxtemp2+6,kmaxtemp2+7,kmaxjb+12,kmaxjb+11,kmaxjb+10,kmaxjb+9
a,kmaxtemp2+6,kmaxtemp1+2,kmaxtemp1+3,kmaxtemp2+7
a,kmaxtemp2+7,kmaxtemp1+3,kmaxtemp1+4,kmaxjb+12
a,kmaxjb+12,kmaxtemp1+4,kmaxtemp1+5,kmaxjb+14,kmaxjb+13
a,kmaxjb+14,kmaxtemp1+5,kmaxtemp1+6,kmaxjb+16,kmaxjb+15
a,kmaxjb+16,kmaxtemp1+6,kmaxtemp1+7,kmaxjb+18,kmaxjb+17
a,kmaxjb+18,kmaxtemp1+7,kmaxtemp1+8,kmaxjb+20,kmaxjb+19
a,kmaxjb+20,kmaxtemp1+8,kmaxtemp1+9,kmaxtemp2+8,kmaxjb+22,kmaxjb+21

cm,top-soil-area,area
ls1a
cm,top-soil,line
type,1
real,1

/COM - Define line divisions to control meshing
lsel,s,loc,z,soilz(1),soilz(2)
lsel,r,loc,x,ctx(3),ctx(8)
lesize,all,,,14                           ! soil above tank top, match tank meshing
lsel,s,loc,z,soilz(1),soilz(2)
lsel,r,loc,x,ctx(10),ctx(11)
lesize,all,,,3                             ! soil above tank top, match tank meshing
cmsel,s,top-soil                          ! Reselect lines in near soil
lsel,r,loc,x,ctx(2)
lesize,all,,,2                             ! Control vertical element size, above tank
cmsel,s,top-soil
lsel,s,loc,x,ctx(9)
lesize,all,,,2                             ! Control vertical element size, above tank

```

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```

cmsel,s,top-soil
lsel,r,loc,x,ctx(12)
lesize,all,,,2                                ! Control vertical element size, above tank
cmsel,s,top-soil
lsel,r,loc,z,ctz(2),ctz(12)
lsel,r,loc,x,ctx(2),ctx(12)
lesize,all,,,1                                ! Control vertical element size, outside excavation mesh
lsel,s,line,,lmaxjb+8,lmaxjb+10,2
lsel,a,line,,lmaxjb+26,lmaxjb+28,2
lsel,a,line,,lmaxjb+30,lmaxjb+38,4
lesize,all,,,9
lsel,s,line,,lmaxjb+42,lmaxjb+42,4
lesize,all,,,7                                ! Control horizontal meshing in soil
lsel,s,line,,lmaxjb+9
lsel,a,line,,lmaxjb+25,lmaxjb+27,2
lsel,a,line,,lmaxjb+29,lmaxjb+45,4
lesize,all,,,1                                ! Control horizontal meshing in soil
lsel,s,line,,lmaxjb+6
lsel,a,line,,lmaxjb+20,lmaxjb+21
lsel,a,line,,lmaxjb+32,lmaxjb+44,4
lsel,a,line,,lmaxjb+31,lmaxjb+43,4
lsel,a,line,,lmaxjb+47,lmaxjb+49
lesize,all,,,1                                ! Control meshing to match tank
lsel,s,line,,lmaxjb+46
lesize,all,,,4                                ! Control mesh size at bottom of excavated soil

cmsel,s,top-soil-area

amesh,all                                      ! Mesh area to develop pattern for volume meshing

type,8
ksel,a,kp,,1                                  ! Select Keypoint for rotation axis
ksel,a,kp,,ct_kps                             ! Select Keypoint for rotation axis
vrotat,all,,,,,1,ct_kps,180,2                ! Generate Volumes for excavated soil
lsla
lsel,r,loc,x,ctx(2)
lesize,all,,arcsiz
lsla
lsel,r,loc,x,ctx(9)
lesize,all,,arcsiz                             ! Define meshing for slices
lsla
lsel,r,loc,x,ctx(12)
lesize,all,,arcsiz                             ! Define meshing for slices
vsweep,all                                    ! Sweep pattern into volume
aclear,all                                    ! Delete elements used for sweep
cm,top-soil-vol,volu

*get,VMAXtemp,VOLU,0,num,max
/COM - Generate element above top center of tank
asel,u,area,,all
vsel,u,volu,,all
a,kmaxjb+bm_kp+1,kmaxtemp2+1,kmaxtemp2+4,kmaxjb+bm_kp+2
a,kmaxjb+bm_kp+2,kmaxtemp2+4,kmaxjb+2,kmaxjb+1
vrotat,all,,,,,1,ct_kps,180,2
vsel,s,volu,,vmaxtemp+1,vmaxtemp+3,2
vatt,801,,8                                  ! Assign material properties
vsel,s,volu,,vmaxtemp+2,vmaxtemp+4,2
vatt,802,,8                                  ! Assign material properties
vsel,s,volu,,vmaxtemp+1,vmaxtemp+4
allsel
asel,s,loc,z,ctz(1),ctz(2)
type,1
asel,r,loc,x,0,4
asel,r,loc,z,ctz(1),ctz(2)
cmsel,u,conc-tank-a
*get,atemp,area,,num,max
*get,atempl,area,,num,min
asel,a,area,,1,22,21
mshcopy,2,1,atempl                            ! copy mesh top match top of concrete tank
mshcopy,2,22,atemp                            ! copy mesh top match top of concrete tank
asel,u,area,,1,22,21

```

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```

vsel,s,volu,,vmaxtemp+1,vmaxtemp+4
vsweep,all ! Generate elements by sweeping area
aclear,atemp
aclear,atempl

/COM - Assign soil properties by layer
*do,i,1,tanksoil-1
cmsel,s,top-soil-vol
vsel,r,loc,z,soilz(i),soilz(i+1)
eslv
emodif,all,mat,800+i
esys,0
*enddo

cmsel,s,top-soil-vol
vsel,a,loc,z,soilz(1),ctz(2)
eslv
cm,excav-soil,elem
nsle
nummrg,node

/COM - Define component for excavated soil - tank walls only
cmsel,s,excav-soil
nsle,s,1
nsel,r,loc,z,soilz(5),soilz(9)
esln,r,1
cm,excav-wall,elem

/COM - Define component for excavated soil - tank dome only
cmsel,s,excav-soil
cmsel,u,excav-wall
cm,excav-dome,elem

csys,1
cmsel,s,excav-wall
nsle
nsel,r,loc,x,ctx(14)
cm,excav-wall-n,node

esel,s,type,,8
nsle
nsel,s,loc,x,soilx(1)
nsel,r,loc,z,soilz(1)
cm,near-soil-face-node,node
*do,i,2,9
esel,s,type,,8
nsle
nsel,r,loc,x,soilx(i)
nsel,r,loc,z,soilz(i)
cmsel,a,near-soil-face-node
cm,near-soil-face-node,node
*enddo

esel,s,type,,8
nsle
nsel,r,loc,z,soilz(9)
nsel,r,loc,x,41,68
cm,near-soil-bot-node,node

allsel
*get,KMAXns,KP,0,num,max ! Get maximum Keypoint number
*get,LMAXns,LINE,0,num,max ! Get maximum line number
*get,AMAXns,AREA,0,num,max ! Get maximum Area number
*get,VMAXns,volu,0,num,max ! Get maximum Volume number

```

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Run-Tank.txt

```
!/batch
! PNNL DST Seismic Analysis, Gravity Inputs, Lower Bound Soil, Best Est Concrete Properties, AP
Primary Tank Geometry, Dome Friction=0.0
!
fini
/clear
/filename,AP-460-LBS-BEC-Seismic,1
/config,nres,3000          ! Increase allowable number of results to 3000
/config,nproc,2            ! Activate 2 processors for solution
/config,fsplit,1024        ! Split binary file at 4.2GB
/prep7
g=32.2                    ! Gravity (ft/sec)

DF=40                     ! Factor for beta (stiffness) damping
ALPHA=0.4                 ! Alpha damping

/out,tank-out,out
/sys,"X:\07.00 - Quality Assurance\ANSYS QA\usrcfg.bat" > QA.out
/out,QA,out,,append
/input,tank-coordinates-AP,txt ! Run file defining tank coordinates (concrete and primary)
/input,tank-props-bee-250,txt ! Run file defining fully cracked concrete properties (PNNL
Concrete Properties)
/input,tank-mesh1,txt        ! Develop concrete tank
/input,primary-props-AP,txt  ! Run file defining AP Primary tank properties
/input,primary,txt          ! Develop Primary tank
/input,insulate,txt         ! Develop insulating concrete model
/input,liner,txt            ! Develop Liner model
/input,waste-solid-AP-s,txt  ! Develop waste model
/input,bolts-friction,txt    ! Develop J-Bolt model
/input,near-soil-1,txt       ! Develop excavated soil model
/input,far-soil,txt         ! Develop Far-Field soil model
/input,interfacel,txt       ! Develop Soil and Concrete Interfaces
/input,interface-gap1,txt    ! Develop Primary Tank Interfaces
/input,slave,txt            ! Develop slaved boundary conditions
/input,boundary,txt         ! Place base and symmetry boundary conditions
/input,outer-spar,txt       ! Connect soil model to symmetry plane
/input,live_load,txt        ! Apply live load over a 10ft radius over dome center
/input,fix-soil,txt
/out
ALLSEL

/out,Tank-th,out

save

/input,solve-TH-LBS,txt      ! Run solution Phase

/input,post-tank,txt

/out
/exit
```

Soil-Prop-LB-Geo.txt

```
Tanksoil=9
deepsoil=20
soil_radius=320
mass=1e8

*dim,soilx,,30
*dim,soilz,,30

soilz(1)=0
soilz(2)=-5
soilz(3)=ctz(9)
```

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```
soilz(4)=ctz(12)
soilz(5)=ctz(14)
soilz(6)=ctz(16)
soilz(7)=ctz(18)
soilz(8)=ctz(20)
soilz(9)=ctz(23)
soilz(10)=-73.5
soilz(11)=-90.5
soilz(12)=-106.5
soilz(13)=-123.5
soilz(14)=-139.5
soilz(15)=-156
soilz(16)=-178
soilz(17)=-200
soilz(18)=-222
soilz(19)=-244
soilz(20)=-266
```

```
soilx(9)=68
soilx(8)=soilx(9)-(soilz(9)-soilz(8))/1.5
soilx(7)=soilx(9)-(soilz(9)-soilz(7))/1.5
soilx(6)=soilx(9)-(soilz(9)-soilz(6))/1.5
soilx(5)=soilx(9)-(soilz(9)-soilz(5))/1.5
soilx(4)=soilx(9)-(soilz(9)-soilz(4))/1.5
soilx(3)=soilx(9)-(soilz(9)-soilz(3))/1.5
soilx(2)=soilx(9)-(soilz(9)-soilz(2))/1.5
soilx(1)=soilx(9)-(soilz(9)-soilz(1))/1.5
```

/COM Excavated Soil Properties

/COM - Material Definitions

/COM - Material 801, Soil (Top Layer)

```
mp,ex,801,6470
mp,nuxy,801,0.27
mp,dens,801,125/(1000*g)
mp,damp,801,0.023/df
```

/COM - Material 802, Soil

```
mp,ex,802,5402
mp,nuxy,802,0.27
mp,dens,802,125/(1000*g)
mp,damp,802,0.044/df
```

/COM - Material 803, Soil

```
mp,ex,803,4527
mp,nuxy,803,0.27
mp,dens,803,125/(1000*g)
mp,damp,803,0.066/df
```

/COM - Material 804, Soil

```
mp,ex,804,4854
mp,nuxy,804,0.27
mp,dens,804,125/(1000*g)
mp,damp,804,0.053/df
```

/COM - Material 805, Soil

```
mp,ex,805,4514
mp,nuxy,805,0.27
mp,dens,805,125/(1000*g)
mp,damp,805,0.061/df
```

/COM - Material 806, Soil

```
mp,ex,806,4291
mp,nuxy,806,0.27
mp,dens,806,125/(1000*g)
mp,damp,806,0.067/df
```

/COM - Material 807, Soil

```
mp,ex,807,4136
mp,nuxy,807,0.27
```

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```
mp,dens,807,125/(1000*g)
mp,damp,807,0.070/df

/COM - Material 808, Soil
mp,ex,808,4612
mp,nuxy,808,0.27
mp,dens,808,125/(1000*g)
mp,damp,808,0.056/df

/COM - Material 810, Soil
mp,ex,810,250
mp,nuxy,810,0.27
mp,dens,810,125/(1000*g)
mp,damp,810,0.056/df

/COM - Lower Bound Soil Properties Geomatrix Soil Data
/COM - 19 Layer Mode
/COM - Material Definitions

/COM - Material 901, Soil (Top Layer)
mp,ex,901,10870
mp,nuxy,901,0.24
mp,dens,901,110/(1000*g)
mp,damp,901,0.018/df

/COM - Material 902, Soil
mp,ex,902,9930
mp,nuxy,902,0.24
mp,dens,902,110/(1000*g)
mp,damp,902,0.030/df

/COM - Material 903, Soil
mp,ex,903,8904
mp,nuxy,903,0.24
mp,dens,903,110/(1000*g)
mp,damp,903,0.043/df

/COM - Material 904, Soil
mp,ex,904,9274
mp,nuxy,904,0.24
mp,dens,904,110/(1000*g)
mp,damp,904,0.034/df

/COM - Material 905, Soil
mp,ex,905,8452
mp,nuxy,905,0.19
mp,dens,905,110/(1000*g)
mp,damp,905,0.040/df

/COM - Material 906, Soil
mp,ex,906,9530
mp,nuxy,906,0.19
mp,dens,906,110/(1000*g)
mp,damp,906,0.042/df

/COM - Material 907, Soil
mp,ex,907,10856
mp,nuxy,907,0.19
mp,dens,907,110/(1000*g)
mp,damp,907,0.042/df

/COM - Material 908, Soil
mp,ex,908,13399
mp,nuxy,908,0.19
mp,dens,908,110/(1000*g)
mp,damp,908,0.030/df

/COM - Material 909, Soil
mp,ex,909,15068
```


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```
mp,nuxy,909,0.19
mp,dens,909,110/(1000*g)
mp,damp,909,0.030/df

/COM - Material 910, Soil
mp,ex,910,14438
mp,nuxy,910,0.19
mp,dens,910,110/(1000*g)
mp,damp,910,0.035/df

/COM - Material 911, Soil
mp,ex,911,13879
mp,nuxy,911,0.19
mp,dens,911,110/(1000*g)
mp,damp,911,0.039/df

/COM - Material 912, Soil
mp,ex,912,13408
mp,nuxy,912,0.19
mp,dens,912,110/(1000*g)
mp,damp,912,0.043/df

/COM - Material 913, Soil
mp,ex,913,16152
mp,nuxy,913,0.19
mp,dens,913,110/(1000*g)
mp,damp,913,0.032/df

/COM - Material 914, Soil
mp,ex,914,16097
mp,nuxy,914,0.19
mp,dens,914,110/(1000*g)
mp,damp,914,0.032/df

/COM - Material 915, Soil
mp,ex,915,22066
mp,nuxy,915,0.28
mp,dens,915,120/(1000*g)
mp,damp,915,0.028/df

/COM - Material 916, Soil
mp,ex,916,24180
mp,nuxy,916,0.28
mp,dens,916,120/(1000*g)
mp,damp,916,0.028/df

/COM - Material 917, Soil
mp,ex,917,23846
mp,nuxy,917,0.28
mp,dens,917,120/(1000*g)
mp,damp,917,0.029/df

/COM - Material 918, Soil
mp,ex,918,23861
mp,nuxy,918,0.28
mp,dens,918,120/(1000*g)
mp,damp,918,0.029/df

/COM - Material 919, Soil
mp,ex,919,27106
mp,nuxy,919,0.28
mp,dens,919,120/(1000*g)
mp,damp,919,0.026/df
```

Solve-Gravity-LBS.txt

```
/prep7
massm_z=148414.59
d,master_node,all
```

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```

allsel

cmsel,s,excav-soil
nsle
csys,0
nsel,r,loc,x,-ctx(6)-1,ctx(6)+1
nsel,r,loc,y,0,-ctx(6)-1
esln,r,1
mpchg,810,all

cmsel,s,excav-soil
nsle
csys,1
nsel,r,loc,x,ctx(11)-1,ctx(13)+1
nsel,r,loc,z,soilz(1),soilz(3)-1
esln,r,1
mpchg,810,all

*do,i,801,808
esel,s,mat,,i
mpchg,i+10,all
*enddo
allsel

/out,AP-460-BEC-LBS-Gravity,out
/solu
antype,trans
TRNOPT,FULL
lumpm,OFF
!nlgeom,on
NROPT,auto
NTIM=10 !NUMBER OF TIME STEPS
DT=0.01
TIM=1e-06
autots,on
KBC,on
TIMINT,ON,STRU
solcontrol,ON,off,,
ncnv,0,200
LNSRCH,OFF
PRED,on,,on

/COM - Time File

/COM - Dimension Horizontal Input
*DIM,A_1_x,,2148
*DIM,A_1_z,,2148

*VREAD,A_1_x(1),th-266-LB-geo,txt
(8(F9.6))
*VREAD,A_1_z(1),th-266-LB-geo-v,txt
(8(F9.6))

/Title,Load Case: AP-460-LBS-BEC, Full Non-linear, Dome Contact Friction = 0.0, Gravity
OUTPR,all,NONE,
OUTRES, ALL,NONE,
OUTRES,RSOL,last
OUTRES,NSOL,last
OUTRES,ESOL,last,conc-tank
OUTRES,esol,last,Primary-tank
OUTRES,ESOL,last,J_bolts
OUTRES,Epel,last,liner
outres,esol,last,wall-int-gap
outres,esol,last,conc-excav-wall-gap
outres,esol,last,conc-excav-dome-gap
!outres, strs,last,excav-soil
!outres, strs,last,bottom-soil
outres,esol,last,bolt-friction
outres,esol,last,waste-surf
outres, strs,last,insul-conc
outres,esol,last,primary-int-gap

```

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```

outres,esol,last,conc-liner-gap
outres,esol,last,far-soil-contact
!outres,esol,last,soil-contact-foot-elem

alphad,alpha
NSUBST,20,200,5,ON
TIME,100
TIMINT,off
acel,0,0,g
SOLVE
SAVE
TIMINT,on
ITIM=1
DS=TIM
NSUBST,1,20,1,ON

!ddelete,master_node,ux
!ddelete,master_node,uz

esel,s,type,,61,63,2
mpchg,64,all

esel,s,type,,91,93,2
mpchg,92,all

allsel

*DO,ITIM,1,NTIM,1

TIM=DT*ITIM

TIME,TIM+100

!F,master_node,FX,A_1_X(itim)*mass*g
!F,master_node,Fz,(A_1_Z(itim)+1)*(mass+massm_z)*g

SOLVE
SAVE
*ENDDO
FINISH
/out

```

Solve-TH-LBS

```

/prep7
massm_z=148414.59
d,master_node,all
allsel

cmsel,s,excav-soil
nsle
csys,0
nsel,r,loc,x,-ctx(6)-1,ctx(6)+1
nsel,r,loc,y,0,-ctx(6)-1
esln,r,1
mpchg,810,all

cmsel,s,excav-soil
nsle
csys,1
nsel,r,loc,x,ctx(11)-1,ctx(13)+1
nsel,r,loc,z,soilz(1),soilz(3)-1
esln,r,1
mpchg,810,all

*do,i,801,808
esel,s,mat,,i
mpchg,i+10,all
*enddo

```

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```

allsel

/out,AP-460-BEC-LBS-Seismic,out
/solu
antype,trans
TRNOPT,FULL
lumpm,OFF
!nlgeom,on
NROPT,auto
NTIM=2148      !NUMBER OF TIME STEPS
DT=0.01
TIM=1e-06
autots,on
KBC,on
TIMINT,ON,STRU
solcontrol,ON,off,,
ncnv,0,200
LNSRCH,OFF
PRED,on,,on

/COM - Time File

/COM - Dimension Horizontal Input
*DIM,A_1_x,,2148
*DIM,A_1_z,,2148

*VREAD,A_1_x(1),th-266-LB-geo,txt
(8(F9.6))
*VREAD,A_1_z(1),th-266-LB-geo-v,txt
(8(F9.6))

/Title,Load Case: AP-460-LBS-BEC, Full Non-linear, Dome Contact Friction = 0.0
OUTPR,all,NONE,
OUTRES, ALL,NONE,
OUTRES,RSOL,last
OUTRES,NSOL,last
OUTRES,ESOL,last,conc-tank
OUTRES,esol,last,Primary-tank
OUTRES,ESOL,last,J_bolts
OUTRES,Epel,last,liner
outres,esol,last,wall-int-gap
outres,esol,last,conc-excav-wall-gap
outres,esol,last,conc-excav-dome-gap
!outres, strs,last,excav-soil
!outres, strs,last,bottom-soil
outres,esol,last,bolt-friction
outres,esol,last,waste-surf
outres, strs,last,insul-conc
outres,esol,last,primary-int-gap
outres,esol,last,conc-liner-gap
outres,esol,last,far-soil-contact
!outres, esol,last,soil-contact-foot-elem

alphad,alpha
NSUBST,20,200,5,ON
TIME,100
TIMINT,off
acel,0,0,g
SOLVE
SAVE
TIMINT,on
ITIM=1
DS=TIM
NSUBST,1,20,1,ON

ddele, master_node,ux
ddele, master_node,uz

esel,s,type,,61,63,2
mpchg,64,all

```

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```
esel,s,type,,91,93,2
mpchg,92,all

allsel

*DO,ITIM,1,NTIM,1

TIM=DT*ITIM

TIME,TIM+100

F,master_node,FX,1.175*A_1_X(itim)*mass*g
F,master_node,Fz,(1.12*A_1_Z(itim)+1)*(mass+massm_z)*g

SOLVE
SAVE
*ENDDO
FINISH
/out
```

Tank-Props-BEC-250

```
/COM - Tank Concrete Properties

/COM - Material Definitions
! EX - Youngs Modulus, (k/ft2)
! NUXY - Poisons ratio
! DENS - Density (1000*slugs/ft3)
! DAMP - Beta (Stiffness) Damping

/COM - Material 1, Tank Concrete
mp,ex,1,626754
mp,nuxy,1,0.18
mp,dens,1,148/(1000*g)
mp,damp,1,0.07/df

/COM - Material 2, Tank Concrete
mp,ex,2,620114
mp,nuxy,2,0.18
mp,dens,2,149/(1000*g)
mp,damp,2,0.07/df

/COM - Material 3, Tank Concrete
mp,ex,3,616594
mp,nuxy,3,0.18
mp,dens,3,149/(1000*g)
mp,damp,3,0.07/df

/COM - Material 4, Tank Concrete
mp,ex,4,610922
mp,nuxy,4,0.18
mp,dens,4,149/(1000*g)
mp,damp,4,0.07/df

/COM - Material 5, Tank Concrete
mp,ex,5,612305
mp,nuxy,5,0.18
mp,dens,5,148/(1000*g)
mp,damp,5,0.07/df

/COM - Material 6, Tank Concrete
mp,ex,6,607093
mp,nuxy,6,0.18
mp,dens,6,148/(1000*g)
mp,damp,6,0.07/df

/COM - Material 7, Tank Concrete
mp,ex,7,639237
mp,nuxy,7,0.18
```

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mp,dens,7,146/(1000*g)
mp,damp,7,0.07/df

/COM - Material 8, Tank Concrete
mp,ex,8,634338
mp,nuxy,8,0.18
mp,dens,8,147/(1000*g)
mp,damp,8,0.07/df

/COM - Material 9, Tank Concrete
mp,ex,9,628756
mp,nuxy,9,0.18
mp,dens,9,147/(1000*g)
mp,damp,9,0.07/df

/COM - Material,10, Tank Concrete
mp,ex,10,193677
mp,nuxy,10,0.18
mp,dens,10,165/(1000*g)
mp,damp,10,0.07/df

/COM - Material,11, Tank Concrete
mp,ex,11,575959
mp,nuxy,11,0.18
mp,dens,11,144/(1000*g)
mp,damp,11,0.07/df

/COM - Material,12, Tank Concrete
mp,ex,12,202953
mp,nuxy,12,0.18
mp,dens,12,159/(1000*g)
mp,damp,12,0.07/df

/COM - Material,13, Tank Concrete
mp,ex,13,157426
mp,nuxy,13,0.18
mp,dens,13,176/(1000*g)
mp,damp,13,0.07/df

/COM - Material,14, Tank Concrete
mp,ex,14,153784
mp,nuxy,14,0.18
mp,dens,14,193/(1000*g)
mp,damp,14,0.07/df

/COM - Material,15, Tank Concrete
mp,ex,15,136651
mp,nuxy,15,0.18
mp,dens,15,200/(1000*g)
mp,damp,15,0.07/df

/COM - Material,16, Tank Concrete
mp,ex,16,136651
mp,nuxy,16,0.18
mp,dens,16,200/(1000*g)
mp,damp,16,0.07/df

/COM - Material,17, Tank Concrete
mp,ex,17,138084
mp,nuxy,17,0.18
mp,dens,17,181/(1000*g)
mp,damp,17,0.07/df

/COM - Material,18, Tank Concrete
mp,ex,18,123378
mp,nuxy,18,0.18
mp,dens,18,209/(1000*g)
mp,damp,18,0.07/df

/COM - Material,19, Tank Concrete
mp,ex,19,124633

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```
mp,nuxy,19,0.18
mp,dens,19,190/(1000*g)
mp,damp,19,0.07/df

/COM - Material,20, Tank Concrete
mp,ex,20,124388
mp,nuxy,20,0.18
mp,dens,20,210/(1000*g)
mp,damp,20,0.07/df

/COM - Material,21, Tank Concrete
mp,ex,21,548683
mp,nuxy,21,0.18
mp,dens,21,166/(1000*g)
mp,damp,21,0.07/df

/COM - Material,22, Tank Concrete
mp,ex,22,154870
mp,nuxy,22,0.18
mp,dens,22,184/(1000*g)
mp,damp,22,0.07/df

/COM - Material,23, Tank Concrete
mp,ex,23,514287
mp,nuxy,23,0.18
mp,dens,23,172/(1000*g)
mp,damp,23,0.060/df

/COM - Material,24, Tank Concrete
mp,ex,24,164113
mp,nuxy,24,0.18
mp,dens,24,288/(1000*g)
mp,damp,24,0.07/df

/COM - Material,25, Tank Concrete
mp,ex,25,522946
mp,nuxy,25,0.18
mp,dens,25,201/(1000*g)
mp,damp,25,0.07/df

/COM - Material,26, Tank Concrete
mp,ex,26,194254
mp,nuxy,26,0.18
mp,dens,26,322/(1000*g)
mp,damp,26,0.07/df

/COM - Material,27, Tank Concrete
mp,ex,27,199783
mp,nuxy,27,0.18
mp,dens,27,281/(1000*g)
mp,damp,27,0.07/df

/COM - Material,28, Tank Concrete
mp,ex,28,162553
mp,nuxy,28,0.18
mp,dens,28,299/(1000*g)
mp,damp,28,0.07/df

/COM - Material,29, Tank Concrete
mp,ex,29,200531
mp,nuxy,29,0.18
mp,dens,29,3894/(1000*g)
mp,damp,29,0.07/df

/COM - Material,30, Tank Concrete
mp,ex,30,167538
mp,nuxy,30,0.18
mp,dens,30,411/(1000*g)
mp,damp,30,0.07/df

/COM - Material,31, Tank Concrete
```

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```

mp,ex,31,731952
mp,nuxy,31,0.18
mp,dens,31,150/(1000*g)
mp,damp,31,0.07/df

/COM - Material,32, Tank Concrete
mp,ex,32,731952
mp,nuxy,32,0.18
mp,dens,32,150/(1000*g)
mp,damp,32,0.07/df

!/COM - Material,33, Tank Concrete
!mp,ex,33,731952
!mp,nuxy,33,0.18
!mp,dens,33,150/(1000*g)
!mp,damp,33,0.07/df

!/COM - Material,34, Tank Concrete
!mp,ex,34,731952
!mp,nuxy,34,0.18
!mp,dens,34,150/(1000*g)
!mp,damp,34,0.07/df

!/COM - Material,35, Tank Concrete
!mp,ex,35,731952
!mp,nuxy,35,0.18
!mp,dens,35,150/(1000*g)
!mp,damp,35,0.07/df

!/COM - Material,36, Tank Concrete
!mp,ex,36,731952
!mp,nuxy,36,0.18
!mp,dens,36,150/(1000*g)
!mp,damp,36,0.07/df

!/COM - Material,37, Tank Concrete
!mp,ex,37,731952
!mp,nuxy,37,0.18
!mp,dens,37,150/(1000*g)
!mp,damp,37,0.07/df

/COM - Concrete Real Values, t in ft
r,1,1.26 ! 15 in
r,2,1.26 ! 15 in
r,3,1.26 ! 15 in
r,4,1.26 ! 15 in
r,5,1.27 ! 15 in
r,6,1.26 ! 15 in
r,7,1.28 ! 15 in
r,8,1.28 ! 15 in
r,9,1.73 ! 15 in
r,10,1.73,1.73,2.23,2.23 ! 15 in to
r,11,2.23,2.22,3.15,3.15 !
r,12,3.15,3.15,1.50,1.50 !
r,13,1.50,1.50,1.28,1.28 !
r,14,1.17 ! 18 in
r,15,1.13 ! 18 in
r,16,1.13 ! 18 in
r,17,1.24 ! 18 in
r,18,1.07 ! 18 in
r,19,1.18 ! 18 in
r,20,1.07 ! 18 in
r,21,1.07 ! 18 in
r,22,1.97 ! 18 in
r,23,1.97,1.67,1.67,1.97 ! 18 in
r,24,1.67 !
r,25,1.68,1.43,1.43,1.68 !
r,26,1.43,0.51,0.51,1.43 ! 8 in
r,27,0.51,0.41,0.41,0.51 ! 8 in
r,28,0.41,0.55,0.55,0.41 ! 8 in
r,29,0.55 ! 8 in

```


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```
r,30,0.55,0.40,0.40,0.55      ! 8 in
r,31,0.40,1.02,1.02,0.40      ! 8 in to
r,32,1.02                      !
!r,34,1
!r,35,1
!r,36,1
!r,37,1
!r,39,1
```

```
/COM - Material,50, Insulating Concrete
mp,ex,50,23760
mp,nuxy,50,0.15
mp,dens,50,50/(1000*g)
mp,damp,50,0.07/df
```

TH-266-LB-Geo-V.txt

```
-0.000173-0.000255 0.000174 0.000257-0.000174-0.000258 0.000176 0.000261    1
-0.000176-0.000262 0.000178 0.000264-0.000178-0.000265 0.000180 0.000268    2
-0.000180-0.000269 0.000182 0.000272-0.000182-0.000273 0.000184 0.000277    3
.....
-0.000163-0.000237 0.000164 0.000238-0.000164-0.000239 0.000165 0.000241   510
-0.000166-0.000242 0.000167 0.000244-0.000167-0.000245 0.000169 0.000247   511
-0.000169-0.000248 0.000171 0.000250-0.000171-0.000251 0.000172 0.000254   512
```

TH-266-LB-Geo.txt

```
-0.000061 0.000024 0.000058-0.000026-0.000058 0.000024 0.000054-0.000026    1
-0.000054 0.000024 0.000050-0.000026-0.000051 0.000024 0.000045-0.000027    2
-0.000046 0.000023 0.000040-0.000027-0.000041 0.000023 0.000034-0.000028    3
.....
-0.000073 0.000023 0.000072-0.000024-0.000072 0.000023 0.000070-0.000024   510
-0.000070 0.000023 0.000068-0.000024-0.000068 0.000023 0.000066-0.000025   511
-0.000066 0.000024 0.000063-0.000025-0.000064 0.000024 0.000061-0.000025   512
```

LBS-BEC Seismic File Listing

```
Volume in drive C is 600GB 2xRAID0
Volume Serial Number is 8A0A-E4BA
```

Directory of C:\Users\FGA\2008-005 AP-460\AP-460-LBS-BEC-Seismic 780 Secant

```
11/28/2007 02:18 PM <DIR> .
11/28/2007 02:18 PM <DIR> ..
08/21/2006 06:49 AM      101 All-Forces.txt
09/19/2007 08:35 AM    4,715,923 AP-460-BEC-LBS-Seismic.out
11/28/2007 01:50 PM    747,520 AP-460-LBS-BEC J Bolt ForcesTH 780 Secant.xls
11/23/2007 11:14 AM    791,040 AP-460-LBS-BEC J-Bolt-Contact-Seismic.xls
09/19/2007 08:35 AM      2,998 AP-460-LBS-BEC-Seismic.BCS
09/19/2007 08:37 AM    43,843,584 AP-460-LBS-BEC-Seismic.db
09/19/2007 08:35 AM    63,897,600 AP-460-LBS-BEC-Seismic.dbb
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11/21/2007 11:44 AM     237,696 AP-460-LBS-BEC-Seismic.err
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11/21/2007 01:30 PM      3,008 AP-460-LBS-BEC-Seismic.log
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09/19/2007 08:35 AM      1,699 AP-460-LBS-BEC-Seismic.PVTS
09/19/2007 08:35 AM   112,656,384 AP-460-LBS-BEC-Seismic.r001
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09/19/2007	08:35 AM	1,388,445,696	AP-460-LBS-BEC-Seismic.rst09
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09/08/2006	02:54 PM	277	Boundary.txt
08/25/2006	08:48 AM	220	Contact-AP.txt
08/21/2006	07:59 AM	586	Contact-Footing.txt
08/25/2006	01:28 PM	704	Contact-Insul.txt
08/25/2006	01:27 PM	704	Contact-J-Bolts.txt
08/25/2006	01:28 PM	708	Contact-Primary.txt
08/21/2006	07:59 AM	742	Contact-Soil.txt
08/21/2006	12:44 PM	632	Contact-Waste-AP.txt
11/28/2007	02:18 PM	0	dir_listing.txt
01/03/2006	11:17 AM	1,616	Disp-J-Bolts.txt
05/08/2006	01:31 PM	8,616	Far-Soil.txt
01/09/2007	06:41 AM	50,448	file-list.txt
10/13/2005	06:54 AM	562	Fix-Soil.txt
08/21/2006	08:00 AM	894	Force-c.txt
11/19/2007	02:53 PM	135,680	force-jb.xls
09/19/2007	12:02 PM	2,666,244	Force-jb_r10-th.OUT
09/19/2007	12:02 PM	5,239	Force-jb_r10_max.OUT
09/19/2007	12:03 PM	2,666,244	Force-jb_r11-th.OUT
09/19/2007	12:03 PM	5,239	Force-jb_r11_max.OUT
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09/19/2007	11:56 AM	2,666,244	Force-jb_r3-th.OUT
09/19/2007	11:55 AM	5,239	Force-jb_r3_max.OUT
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11/23/2007	11:13 AM	<DIR>	Gravity
09/01/2005	10:27 AM	1,664	Insulate.txt
07/20/2006	06:36 AM	4,030	interface-gap1.txt
08/23/2006	07:55 AM	2,411	interface1.txt
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11/23/2007	11:14 AM	116,224	J-Bolt-Contact_99-180.xls
11/21/2007	12:01 PM	4,519	J-Bolt-Cont_108max.OUT
11/21/2007	12:01 PM	1,685,484	J-Bolt-Cont_108th.OUT
11/21/2007	12:03 PM	4,519	J-Bolt-Cont_117max.OUT
11/21/2007	12:03 PM	1,685,484	J-Bolt-Cont_117th.OUT
11/21/2007	12:04 PM	4,519	J-Bolt-Cont_126max.OUT
11/21/2007	12:04 PM	1,685,484	J-Bolt-Cont_126th.OUT
11/21/2007	12:06 PM	4,519	J-Bolt-Cont_135max.OUT
11/21/2007	12:06 PM	1,685,484	J-Bolt-Cont_135th.OUT
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11/21/2007	12:06 PM	1,685,484	J-Bolt-Cont_144th.OUT
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11/21/2007	12:06 PM	1,685,484	J-Bolt-Cont_153th.OUT

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11/21/2007	12:09 PM	4, 519	J-Bolt-Cont_171max.OUT
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11/21/2007	11:54 AM	4, 519	J-Bolt-Cont_45max.OUT
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11/21/2007	12:00 PM	1, 685, 484	J-Bolt-Cont_99th.OUT
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12/22/2006	08:33 AM	52, 949	LBS-BEC-Seismic-File-List.txt
08/23/2006	07:47 AM	1, 971	Liner.txt
05/02/2005	02:19 PM	667	live_load.txt
09/01/2006	06:03 AM	6, 212	Near-Soil-1.txt
04/20/2005	01:14 PM	508	outer-spar.txt
09/17/2007	04:05 PM	162	Post-Tank.txt
10/12/2006	02:28 PM	6, 028	Primary-Props-AP.txt
09/27/2005	03:52 PM	1, 538	Primary.txt
09/17/2007	04:06 PM	448, 180	QA.out
10/31/2005	10:31 AM	1, 108	RS_FREQ.txt
09/01/2006	06:03 AM	1, 819	Run-Tank.txt
11/21/2007	11:44 AM	0	scratch.hlp
02/11/2005	01:22 PM	1, 053	Slave.txt
09/20/2005	02:46 PM	4, 106	Soil-Prop-LB-Geo.txt
09/11/2006	09:46 AM	1, 925	Solve-TH-LBS.txt
09/13/2006	06:12 AM	347	spectra-all.txt
09/13/2006	06:07 AM	3, 690	spectra-conc-0.txt
09/13/2006	06:08 AM	3, 723	spectra-conc-135.txt
09/13/2006	06:09 AM	3, 723	spectra-conc-180.txt
09/13/2006	06:08 AM	3, 769	spectra-conc-45.txt
09/13/2006	06:08 AM	3, 649	spectra-conc-90.txt
09/13/2006	06:09 AM	1, 590	spectra-conc.txt
08/28/2006	09:38 AM	2, 076	spectra-concrete.txt
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09/13/2006	06:15 AM	3, 777	spectra-primary-180.txt
09/13/2006	06:13 AM	3, 688	spectra-primary-45.txt
09/13/2006	06:14 AM	3, 688	spectra-primary-90.txt
09/13/2006	06:15 AM	3, 801	spectra-soil.txt
06/20/2005	09:04 AM	647	spectra-wall.txt
06/20/2005	08:52 AM	679	spectra-waste.txt
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01/03/2007	03:40 PM	1, 828	strain-backed-principle-mid.txt
01/03/2007	03:41 PM	1, 825	strain-backed-principle-top.txt
01/03/2007	04:02 PM	966	strain-backed-principle.txt
08/21/2006	08:02 AM	598	stress-compb.txt
08/21/2006	08:03 AM	608	stress-compm.txt

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08/24/2006	03:19 PM	598 stress-compt.txt
08/24/2006	12:05 PM	224 Stress-Primary.txt
10/12/2006	02:29 PM	4,009 Tank-Coordinates-AP.txt
05/25/2005	03:32 PM	2,512 Tank-Mesh1.txt
09/17/2007	04:05 PM	102 tank-out.out
08/25/2006	07:52 AM	5,450 Tank-Props-BEC-250.txt
09/17/2007	04:06 PM	6,495 Tank-th.out
05/16/2005	03:41 PM	41,470 TH-266-LB-Geo-V.txt
05/16/2005	08:44 AM	41,472 TH-266-LB-Geo.txt
08/25/2006	08:47 AM	340 Waste-Reaction.txt
10/12/2006	02:27 PM	10,266 Waste-solid-AP-S.txt
08/21/2006	08:03 AM	776 Waste-Surface-AP.txt
158 File(s)		36,687,730,876 bytes
3 Dir(s)		111,055,118,336 bytes free

Appendix G

Best Estimate Soil, Best Estimate Concrete

Results Load Case Specific Input Files File Listing

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Appendix G

Best Estimate Soil, Best Estimate Concrete

Results Load Case Specific Input Files File Listing

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Table G.1. BES-BEC Concrete Forces and Moment, Gravity Load Only

AP Primary Tank, Best Estimate Soil (Geomatrix), Gravity Only, Best Estimate Concrete, 460 in. Waste Level at 1.83 SpG

ANSYS MAXIMUMS BY PATH

PNNL Section No.	Path (in.)	Gravity Hoop Force (kip/ft) AP-BES-BEC	Gravity Meridonal Force (kip/ft) AP-BES-BEC	Gravity -In- Plane Shear Force (kip/ft) AP-BES-BEC	Gravity Hoop Moment (ft*kip/ft) AP- BES-BEC	Gravity Meridonal Moment (ft*kip/ft) AP-BES-BEC	Gravity Through-Wall Shear Force (kip/ft) AP-BES- BEC
2	67.734	-71.110	-75.640	-0.115	-7.359	-4.269	1.725
3	105.676	-65.280	-73.940	-0.172	-5.205	-1.763	1.115
4	137.076	-59.520	-72.100	-0.224	-3.637	0.778	1.262
6	182.856	-52.840	-69.090	-0.184	-2.253	1.984	0.273
8	226.570	-47.630	-66.820	-0.049	-1.825	-0.616	-0.795
9	275.574	-42.980	-64.660	-0.178	-1.864	-1.317	-0.734
11	325.697	-34.650	-62.850	0.141	-2.292	-4.489	-0.803
13	372.312	-24.800	-61.000	-0.056	-4.864	-5.474	-0.438
17	423.434	-8.647	-59.050	-0.024	-2.396	-3.279	2.161
20	468.315	31.900	-56.900	-0.055	-8.195	15.940	8.741
22	515.319	15.520	-58.080	-0.044	4.760	30.140	-3.421
24	553.722	-0.166	-56.480	-0.026	2.016	11.050	-6.813
26	593.805	-14.320	-58.640	-0.014	-0.170	-0.937	-1.767
30	644.355	-24.810	-60.520	-0.008	-0.405	-2.248	0.770
33	693.605	-28.700	-61.900	0.004	-0.065	-0.362	0.261
35	740.705	-32.290	-63.310	0.003	0.045	0.247	-0.041
38	786.205	-28.640	-64.690	0.003	-0.161	-0.893	-0.290
41	844.605	-28.470	-66.490	-0.004	-0.114	-0.629	-0.222
43	901.355	-14.020	-28.120	0.004	-0.187	-1.035	0.678
46	932.355	-23.880	-66.640	0.039	-0.678	-3.632	-1.768
48	1007.355	-2.856	-10.330	0.617	-4.280	21.190	-12.210
51	1053.855	-3.510	-12.650	0.753	-0.938	17.440	12.750
53	1086.855	-1.228	-6.325	0.425	1.922	6.127	-3.114
55	1105.855	-0.545	-4.383	0.329	2.571	4.504	0.226
57	1147.355	-0.136	-2.277	0.184	0.305	1.091	-1.199
58	1207.355	0.292	0.039	0.030	-0.019	-0.127	0.285
59	1267.355	0.328	0.294	0.011	0.026	0.131	-0.233
60	1327.355	0.480	0.107	0.038	-0.033	-0.194	0.208
61	1387.355	0.468	0.635	-0.021	0.024	0.059	-0.146
62	1449.355	2.289	2.414	-0.032	0.034	-0.044	0.279

Note: Meridonal/Hoop Forces and Meridonal/Hoop Moments are Reversed in Highlighted Sections.

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Table G.2. BES-BEC Concrete Forces and Moments, Gravity Plus Seismic Load

**AP- Primary Tank, Best Estimate Soil (Geomatrix), Best Estimate Concrete,
460 in. Waste Level at 1.83 SpG**

ANSYS MAXIMUMS BY PATH

PNNL Section No.	Path (in.)	Seismic Hoop Force (kip/ft) AP-BES-BEC	Seismic Meridional Force (kip/ft) AP-BES-BEC	Seismic -In- Plane Shear Force (kip/ft) AP-BES-BEC	Seismic Hoop Moment (ft*kip/ft) AP- BES-BEC	Seismic Meridional Moment (ft*kip/ft) AP-BES-BEC	Seismic Through-Wall Shear Force (kip/ft) AP-BES- BEC
2	67.734	-96.440	-103.800	5.353	-15.350	-14.470	3.477
3	105.676	-88.430	-101.100	7.498	-12.520	-10.690	2.686
4	137.076	-81.280	-97.610	8.596	-9.537	7.415	3.311
6	182.856	-73.450	-91.730	9.255	-5.238	5.605	2.666
8	226.570	-66.750	-86.140	9.807	-3.423	-7.668	1.606
9	275.574	-64.820	-80.840	11.780	-3.009	-5.030	1.250
11	325.697	-56.930	-76.780	13.720	-3.158	-6.846	1.503
13	372.312	-54.220	-73.110	15.940	-6.309	-7.928	1.026
17	423.434	-19.820	-70.070	18.480	-3.318	-7.832	2.956
20	468.315	68.280	-66.760	21.530	-11.860	20.960	10.290
22	515.319	27.650	-66.500	22.230	6.166	36.750	4.649
24	553.722	-6.263	-65.470	20.600	2.479	13.540	8.250
26	593.805	-19.360	-68.740	20.190	-0.251	-1.344	2.151
30	644.355	-29.250	-70.050	20.030	-0.478	-2.618	0.898
33	693.605	-33.400	-70.790	20.250	-0.106	-0.535	0.310
35	740.705	-37.390	-72.550	21.040	0.070	0.368	0.099
38	786.205	-33.060	-74.480	21.730	-0.203	-1.100	0.365
41	844.605	-33.070	-76.790	23.470	-0.200	-1.063	0.385
43	901.355	-15.980	-32.500	11.900	-0.287	-1.585	1.237
46	932.355	-40.250	-76.550	28.440	-0.781	-4.292	2.501
48	1007.355	-12.370	-14.460	8.134	-4.936	24.690	14.220
51	1053.855	-35.450	-17.660	13.060	-1.602	20.540	14.760
53	1086.855	-10.000	-11.080	8.448	2.280	7.062	3.796
55	1105.855	-26.420	-9.378	7.597	3.577	5.514	0.832
57	1147.355	-5.582	-6.731	4.422	0.435	1.458	1.559
58	1207.355	2.624	-2.730	1.997	-0.024	-0.160	0.361
59	1267.355	2.340	2.360	1.257	0.038	0.165	0.297
60	1327.355	3.044	2.318	1.060	-0.043	-0.230	0.289
61	1387.355	1.962	2.510	0.875	0.031	0.081	0.242
62	1449.355	6.335	5.830	1.007	0.104	-0.200	0.408

Note: Meridional/Hoop Forces and Meridional/Hoop Moments are Reversed in Highlighted Sections.

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Table G.3. BES-BEC Concrete Forces and Moments, Seismic Only

**AP- Primary Tank, Best Estimate Soil (Geomatrix), Best Estimate Concrete,
460 in. Waste Level at 1.83 SpG**

ANSYS MAXIMUMS BY PATH

PNNL Section No.	Path (in.)	Seismic Only Hoop Force (kip/ft) AP-BES- BEC	Seismic Only Meridional Force (kip/ft) AP-BES-BEC	Seismic Only - In-Plane Shear Force (kip/ft) AP-BES-BEC	Seismic Only Hoop Moment (ft*kip/ft) AP- BES-BEC	Seismic Only Meridional Moment (ft*kip/ft) AP-BES- BEC	Seismic Only Through-Wall Shear Force (kip/ft) AP-BES BEC
2	67.734	28.810	28.160	5.365	9.065	10.250	2.132
3	105.676	26.430	27.160	7.538	7.611	9.112	1.623
4	137.076	21.960	25.510	8.651	5.900	6.716	2.083
6	182.856	21.650	22.640	9.292	3.215	4.025	2.489
8	226.570	20.710	19.320	9.799	1.812	7.157	0.906
9	275.574	21.860	16.180	11.746	1.416	3.930	0.805
11	325.697	22.450	13.930	13.690	1.138	2.360	0.737
13	372.312	29.740	12.110	15.931	1.990	2.713	0.719
17	423.434	11.282	11.020	18.487	1.005	4.676	0.983
20	468.315	41.840	9.860	21.545	4.720	6.110	1.582
22	515.319	12.220	8.450	22.241	1.639	7.290	1.502
24	553.722	6.097	9.000	20.607	0.478	2.510	1.608
26	593.805	5.040	10.110	20.194	0.081	0.408	0.388
30	644.355	4.750	9.530	20.032	0.073	0.372	0.132
33	693.605	5.190	9.110	20.250	0.040	0.175	0.058
35	740.705	5.810	10.040	21.040	0.028	0.120	0.058
38	786.205	4.960	11.370	21.730	0.042	0.207	0.078
41	844.605	5.570	13.690	23.470	0.092	0.468	0.163
43	901.355	2.220	6.420	11.901	0.102	0.557	0.617
46	932.355	18.039	15.610	28.432	0.161	0.848	0.735
48	1007.355	9.539	4.496	7.551	1.107	5.600	3.231
51	1053.855	32.038	5.710	12.672	0.877	5.260	3.087
53	1086.855	8.802	4.756	8.043	0.449	1.190	0.688
55	1105.855	25.990	4.995	7.421	1.010	1.244	0.614
57	1147.355	5.478	4.454	4.300	0.130	0.367	0.361
58	1207.355	2.431	2.744	2.017	0.005	0.034	0.077
59	1267.355	2.012	2.087	1.254	0.012	0.034	0.065
60	1327.355	2.564	2.234	1.066	0.012	0.036	0.083
61	1387.355	1.495	2.144	0.862	0.007	0.023	0.098
62	1449.355	4.050	3.459	0.992	0.070	0.163	0.135

Note: Meridional/Hoop Forces and Meridional/Hoop Moments are Reversed in Highlighted Sections.

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Table G.4. BES-BEC Primary Tank Stresses, Shell Top, Gravity Load Only

M&D Starting Element No.	Path (in.)	Shell Top Surface (inside - waste side)			
		AP-460-BES-BEC Gravity Hoop Stress (lbs/in ²) Top	AP-460-BES-BEC Gravity Meridional Stress (lbs/in ²) Top	AP-460-BES-BEC Gravity Stress Intensity (lbs/in ²) Top	AP-460-BES-BEC Gravity In-Plane Shear Stress (lbs/in ²) Top
762	67.33	-1272.22	-1369.44	1369.44	-3.76
782	105.04	-1247.22	-1814.58	1814.58	7.28
802	136.24	-1081.94	-1628.47	1629.17	8.82
822	181.83	-781.94	-1445.83	1445.83	7.51
842	225.10	-592.08	-1179.17	1179.17	2.95
862	273.66	-288.19	-925.69	925.69	7.91
882	323.27	99.31	-737.50	837.50	-6.02
902	369.20	456.94	-280.97	738.19	3.06
922	419.20	1305.56	-253.54	1559.72	0.33
942	444.31	407.64	-1658.33	2065.97	0.68
962	458.66	-119.79	1870.14	1988.89	-0.65
982	473.08	-214.51	1607.64	1821.53	-0.59
1002	484.80	920.83	-461.81	1383.33	-0.89
1022	502.48	2954.17	-101.18	3055.56	-0.94
1042	526.48	4704.86	180.28	4705.56	-0.75
1062	550.48	6313.19	26.81	6315.28	-0.50
1082	574.60	7881.94	252.29	7881.94	-0.34
1102	598.28	9569.44	-23.74	9590.28	0.21
1122	621.38	11118.06	175.49	11118.06	-0.16
1142	644.48	12687.50	49.22	12687.50	-0.16
1162	667.63	13791.67	-300.42	14090.28	-0.22
1182	690.78	14194.44	461.94	14194.44	-0.22
1202	713.88	15201.39	199.44	15201.39	-0.21
1222	736.98	16562.50	-295.42	16854.17	-0.25
1242	760.13	16506.94	-675.49	17180.56	0.32
1262	782.53	15270.83	1050.69	15270.83	-0.26
1282	804.13	14923.61	365.00	14923.61	0.36
1302	825.73	15770.83	14.14	15770.83	0.44
1322	847.33	17152.78	395.28	17152.78	-0.37
1342	868.87	17493.06	-2025.00	19520.83	-0.74
1362	892.10	13062.50	-2853.47	15916.67	1.15
1382	909.20	3731.94	-8770.83	12513.89	1.25
1402	918.38	3771.53	6309.03	6349.31	-1.44
1460	930.48	3376.39	9611.11	9659.72	-493.96
1442	949.48	136.11	-624.03	767.36	60.24
1462	990.98	582.08	900.69	902.78	-25.90
1482	1050.98	397.50	422.85	585.14	-3.02
1502	1110.98	419.72	584.24	585.14	-14.28
1522	1170.98	295.56	225.42	296.11	7.03
1542	1230.98	355.49	440.21	440.69	-8.19
1562	1292.98	275.90	279.17	279.72	-1.98
Note 1: Meridional, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)					

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Table G.5. BES-BEC Primary Tank Stresses, Shell Middle, Gravity Load Only

AP Primary Tank, Best Estimate Soil, Gravity Only, Best Estimate Tank Concrete, 460 in. Waste Level at 1.83 SpG					
M&D Starting Element No.	Path (in.)	Shell Mid-Plane			
		AP-460-BES-BEC Gravity Hoop Stress (lbs/in ²) Mid	AP-460-BES-BEC Gravity Meridional Stress (lbs/in ²) Mid	AP-460-BES-BEC Gravity Stress Intensity (lbs/in ²) Mid	AP-460-BES-BEC Gravity In-Plane Shear Stress (lbs/in ²) Mid
762	67.33	-1313.19	-1400.00	1400.00	3.26
782	105.04	-1265.28	-1811.11	1811.11	6.90
802	136.24	-1102.78	-1652.78	1652.78	8.15
822	181.83	-784.03	-1423.61	1423.61	6.71
842	225.10	-602.99	-1197.22	1197.92	2.62
862	273.66	-299.24	-940.97	940.97	7.23
882	323.27	121.60	-653.33	775.69	5.79
902	369.20	424.10	-371.60	795.83	2.98
922	419.20	1371.53	-29.13	1402.08	0.38
942	444.31	984.03	172.99	990.97	-0.51
962	458.66	-609.31	174.79	784.72	-0.51
982	473.08	-659.93	148.19	810.42	-0.50
1002	484.80	1097.22	137.36	1098.61	-0.78
1022	502.48	3023.61	132.57	3024.31	-0.83
1042	526.48	4688.89	126.04	4688.89	-0.68
1062	550.48	6340.97	119.38	6340.97	-0.47
1082	574.60	7840.28	112.64	7840.28	-0.32
1102	598.28	9604.17	105.90	9604.17	0.21
1122	621.38	11097.22	99.38	11097.22	-0.16
1142	644.48	12701.39	92.78	12701.39	-0.14
1162	667.63	13909.72	86.25	13909.72	-0.19
1182	690.78	14076.39	69.35	14076.39	-0.19
1202	713.88	15159.72	62.78	15159.72	-0.20
1222	736.98	16666.67	56.18	16666.67	-0.24
1242	760.13	16722.22	49.59	16722.22	-0.29
1262	782.53	14965.28	30.62	14965.28	-0.24
1282	804.13	14819.44	24.51	14826.39	0.34
1302	825.73	15770.83	18.46	15770.83	0.42
1322	847.33	17041.67	12.38	17041.67	-0.38
1342	868.87	18104.17	6.32	18131.94	-0.59
1362	892.10	13916.67	-1.40	13937.50	0.88
1382	909.20	6245.14	-10.08	6400.00	0.97
1402	918.38	1611.81	151.18	1899.31	-0.94
1460	930.48	441.67	394.31	576.25	4.22
1442	949.48	453.47	429.03	454.38	2.22
1462	990.98	522.78	718.75	720.14	-16.15
1482	1050.98	437.64	558.40	445.14	-10.64
1502	1110.98	376.88	444.65	445.14	-6.64
1522	1170.98	333.96	354.72	354.93	-3.07
1542	1230.98	318.68	330.07	330.28	-2.39
1562	1292.98	293.40	353.47	354.24	-6.27
Note 1: Meridional, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)					

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Table G.6. BES-BEC Primary Tank Stresses, Shell Bottom, Gravity Load Only

AP Primary Tank, Best Estimate Soil, Gravity Only, Best Estimate Tank Concrete, 460 in. Waste Level at 1.83 SpG					
M&D Starting Element No.	Path (in.)	Shell Bottom Surface (outside - away from waste)			
		AP-460-BES-BEC Gravity Hoop Stress (lbs/in ²) Bot	AP-460-BES-BEC Gravity Meridional Stress (lbs/in ²) Bot	AP-460-BES-BEC Gravity Stress Intensity (lbs/in ²) Bot	AP-460-BES-BEC Gravity In-Plane Shear Stress (lbs/in ²) Bot
762	67.33	-1359.72	-1431.94	1431.94	3.56
782	105.04	-1283.33	-1807.64	1807.64	-6.60
802	136.24	-1124.31	-1677.08	1677.08	7.62
822	181.83	-786.81	-1400.69	1400.69	-6.08
842	225.10	-613.89	-1215.97	1215.97	2.29
862	273.66	-310.35	-956.94	956.94	6.55
882	323.27	143.96	-568.96	713.19	5.57
902	369.20	391.25	-462.15	853.47	2.91
922	419.20	1436.81	196.39	1436.81	0.43
942	444.31	1559.72	2004.17	2005.56	-0.34
962	458.66	-1098.61	-1520.83	1520.83	-0.37
982	473.08	-1105.56	-1311.11	1311.81	-0.42
1002	484.80	1273.61	735.42	1273.61	-0.67
1022	502.48	3093.75	366.11	3093.75	-0.71
1042	526.48	4672.92	72.15	4673.61	-0.61
1062	550.48	6368.75	212.15	6369.44	-0.45
1082	574.60	7798.61	-28.39	7826.39	-0.31
1102	598.28	9645.83	234.44	9645.83	0.21
1122	621.38	11076.39	23.42	11076.39	-0.15
1142	644.48	12715.28	136.60	12715.28	-0.13
1162	667.63	14020.83	471.81	14020.83	-0.16
1182	690.78	13958.33	-324.31	14284.72	-0.17
1202	713.88	15118.06	-74.93	15194.44	-0.21
1222	736.98	16770.83	407.15	16770.83	-0.24
1242	760.13	16937.50	775.00	16937.50	-0.28
1262	782.53	14659.72	-990.28	15645.83	-0.23
1282	804.13	14722.22	-316.88	15034.72	0.33
1302	825.73	15770.83	23.08	15777.78	0.40
1322	847.33	16923.61	-371.32	17298.61	-0.38
1342	868.87	18715.28	2039.58	18715.28	0.47
1362	892.10	14770.83	2853.47	14770.83	0.63
1382	909.20	8756.94	8756.94	8763.89	0.70
1402	918.38	-551.04	-6007.64	6049.31	-0.53
1460	930.48	-2497.92	-8819.44	8868.06	501.32
1442	949.48	771.53	1480.56	1485.42	-56.49
1462	990.98	463.89	538.13	538.61	-6.46
1482	1050.98	478.19	695.83	334.65	-18.30
1502	1110.98	334.44	307.08	334.65	3.46
1522	1170.98	372.85	486.11	486.74	-10.38
1542	1230.98	282.57	222.50	283.06	6.41
1562	1292.98	312.08	430.49	431.32	-11.42
Note 1: Meridional, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)					

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Table G.7. BES-BEC Primary Tank Stresses, Shell Top, Gravity Plus Seismic Load

AP Primary Tank, Best Estimate Soil, Horizontal and Vertical Seismic, Best Estimate Tank Concrete, 460 in. Waste Level at 1.83 SpG					
M&D Starting M&D Element No.	Path (in.)	Shell Top Surface (inside - waste side)			
		AP-460-BES-BEC Seismic Hoop Stress (lbs/in ²) Top	AP-460-BES-BEC Seismic Meridional Stress (lbs/in ²) Top	AP-460-BES-BEC Seismic Stress Intensity (lbs/in ²) Top	AP-460-BES-BEC Seismic In-Plane Shear Stress (lbs/in ²) Top
762	67.33	-1979.86	-2286.11	2287.50	-276.60
782	105.04	-2059.72	-2946.53	2946.53	-499.58
802	136.24	-2120.83	-2656.25	2657.64	-549.72
822	181.83	-1608.33	-2292.36	2292.36	-617.15
842	225.10	-1761.81	-2152.78	2747.22	-745.14
862	273.66	-1178.47	-1757.64	2112.50	-914.58
882	323.27	1866.67	-1627.78	3393.75	-1321.53
902	369.20	2257.64	-1345.83	3791.67	-1785.42
922	419.20	3761.11	-1186.11	5418.06	-2539.58
942	444.31	5225.69	-4339.58	5232.64	-2271.53
962	458.66	6493.06	6580.56	12451.39	-2289.58
982	473.08	6569.44	7180.56	13631.94	-2521.53
1002	484.80	4723.61	-1836.11	5711.11	-2677.78
1022	502.48	5224.31	-819.44	6156.25	-2623.61
1042	526.48	8944.44	1163.89	8944.44	-2407.64
1062	550.48	11375.00	-1191.67	11381.94	-2152.08
1082	574.60	13798.61	1548.61	13798.61	-1859.72
1102	598.28	16368.06	-1318.06	16368.06	-1518.75
1122	621.38	18750.00	1605.56	18750.00	-1142.36
1142	644.48	21104.17	1454.86	21104.17	-909.03
1162	667.63	22680.56	-1637.50	22680.56	-853.47
1182	690.78	23083.33	1930.56	23083.33	702.78
1202	713.88	24236.11	1502.08	24236.11	896.53
1222	736.98	25840.28	-1423.61	25840.28	1195.83
1242	760.13	25326.39	-862.50	25770.83	1583.33
1262	782.53	23055.56	2210.42	23055.56	1463.89
1282	804.13	22118.06	1170.14	22118.06	1752.08
1302	825.73	22965.28	664.93	22965.28	2045.14
1322	847.33	24611.11	1084.72	24611.11	2352.08
1342	868.87	24763.89	-2556.25	27513.89	2691.67
1362	892.10	17465.28	-3325.00	22333.33	2596.53
1382	909.20	5411.11	-10069.44	17222.22	2559.03
1402	918.38	5891.67	10694.44	10736.11	2522.92
1460	930.48	6323.61	15131.94	15208.33	-2936.11
1442	949.48	4151.39	-1133.33	4781.94	-2173.61
1462	990.98	3684.72	1426.39	6450.69	-3222.92
1482	1050.98	2707.64	713.19	2450.69	-2015.28
1502	1110.98	2077.08	844.44	2450.69	-1225.00
1522	1170.98	1522.22	401.74	1523.61	-743.06
1542	1230.98	1140.28	632.64	1140.97	-455.35
1562	1292.98	757.64	474.58	757.64	-226.11
Note 1: Meridional, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)					

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Table G.8. BES-BEC Primary Tank Stresses, Shell Middle, Gravity Plus Seismic Load

AP Primary Tank, Best Estimate Soil, Horizontal and Vertical Seismic, Best Estimate Tank Concrete, 460 in. Waste Level at 1.83 SpG					
M&D Starting M&D Element No.	Path (in.)	Shell Mid-Plane			
		AP-460-BES-BEC Seismic Hoop Stress (lbs/in ²) Mid	AP-460-BES-BEC Seismic Meridional Stress (lbs/in ²) Mid	AP-460-BES-BEC Seismic Stress Intensity (lbs/in ²) Mid	AP-460-BES-BEC Seismic In-Plane Shear Stress (lbs/in ²) Mid
762	67.33	-2085.42	-2069.44	2095.14	-271.04
782	105.04	-2028.47	-2654.86	2655.56	-490.49
802	136.24	-2281.94	-2408.33	2409.03	-540.90
822	181.83	-1550.69	-2100.69	2100.69	-612.15
842	225.10	-1982.64	-1824.31	2285.42	-740.97
862	273.66	-1143.75	-1552.08	2127.08	-913.19
882	323.27	2056.25	-1418.75	2931.94	-1320.14
902	369.20	2238.89	-1328.47	3804.17	-1784.03
922	419.20	3894.44	-1259.72	5403.47	-2540.97
942	444.31	4600.69	1131.25	5440.97	-2315.28
962	458.66	-7618.06	1075.00	8708.33	-2336.11
982	473.08	-8333.33	980.56	9326.39	-2479.86
1002	484.80	4602.78	933.33	5551.39	-2607.64
1022	502.48	5626.39	1018.75	5854.17	-2589.58
1042	526.48	8916.67	1140.97	8916.67	-2402.08
1062	550.48	11402.78	1248.61	11402.78	-2147.22
1082	574.60	13715.28	1354.17	13715.28	-1852.08
1102	598.28	16402.78	1440.28	16402.78	-1512.50
1122	621.38	18680.56	1508.33	18680.56	-1138.19
1142	644.48	21076.39	1552.78	21076.39	-890.97
1162	667.63	22798.61	1571.53	22798.61	-840.97
1182	690.78	22833.33	1372.92	22833.33	700.00
1202	713.88	24097.22	1341.67	24097.22	895.83
1222	736.98	25895.83	1286.11	25895.83	1195.14
1242	760.13	25562.50	-1216.67	25562.50	1574.31
1262	782.53	22493.06	-835.42	22493.06	1452.78
1282	804.13	21854.17	-767.36	21861.11	1751.39
1302	825.73	22895.83	-684.86	22895.83	2047.92
1322	847.33	24381.94	-590.63	24388.89	2356.94
1342	868.87	25611.11	-482.15	25618.06	2679.86
1362	892.10	18909.72	351.81	18944.44	2519.44
1382	909.20	8048.61	348.96	8534.72	2404.17
1402	918.38	5303.47	417.01	5787.50	2390.97
1460	930.48	4448.61	774.31	4832.64	-2371.53
1442	949.48	4219.44	786.81	4605.56	-2246.53
1462	990.98	3648.61	1203.47	6438.19	-3213.89
1482	1050.98	2721.53	870.14	2451.39	-2023.61
1502	1110.98	2056.25	676.25	2451.39	-1218.06
1522	1170.98	1531.94	545.14	1533.33	-750.00
1542	1230.98	1127.08	493.89	1128.47	-449.58
1562	1292.98	751.39	500.14	751.39	-230.83
Note 1: Meridional, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)					

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Table G.9. BES-BEC Primary Tank Stresses, Shell Bottom, Gravity Plus Seismic Load

AP Primary Tank, Best Estimate Soil, Horizontal and Vertical Seismic, Best Estimate Tank Concrete, 460 in. Waste Level at 1.83 SpG					
M&D Starting M&D Element No.	Path (in.)	Shell Bottom Surface (outside - away from waste)			
		AP-460-BES-BEC Seismic Hoop Stress (lbs/in ²) Bot	AP-460-BES-BEC Seismic Meridional Stress (lbs/in ²) Bot	AP-460-BES-BEC Seismic Stress Intensity (lbs/in ²) Bot	AP-460-BES-BEC Seismic In-Plane Shear Stress (lbs/in ²) Bot
762	67.33	-2242.36	-2348.61	2348.61	-265.49
782	105.04	-2067.36	-2923.61	2927.08	-481.32
802	136.24	-2443.06	-2779.17	2779.86	-532.01
822	181.83	-1493.06	-2168.75	2169.44	-607.15
842	225.10	-2203.47	-2487.50	2488.89	-739.58
862	273.66	-1109.03	-1672.92	2154.86	-911.81
882	323.27	2245.83	-1950.00	2878.47	-1318.06
902	369.20	2220.83	-1359.03	3818.75	-1782.64
922	419.20	4028.47	2017.36	5388.89	-2542.36
942	444.31	4000.00	6545.83	7229.17	-2359.03
962	458.66	-9145.83	-4723.61	9145.83	-2383.33
982	473.08	-10229.17	-5237.50	10236.11	-2438.89
1002	484.80	4482.64	2787.50	5598.61	-2537.50
1022	502.48	6027.78	2822.92	6029.86	-2555.56
1042	526.48	8895.83	1125.69	8895.83	-2396.53
1062	550.48	11423.61	1369.44	11423.61	-2142.36
1082	574.60	13631.94	-1311.11	13631.94	-1845.14
1102	598.28	16430.56	1656.94	16430.56	-1506.25
1122	621.38	18611.11	-1496.53	18611.11	-1133.33
1142	644.48	21048.61	1650.69	21048.61	-872.22
1162	667.63	22916.67	2145.14	22916.67	-829.17
1182	690.78	22638.89	-1495.14	22638.89	697.92
1202	713.88	24055.56	-1422.92	24055.56	895.83
1222	736.98	26090.28	1824.31	26097.22	1195.14
1242	760.13	25958.33	2193.75	25958.33	1565.28
1262	782.53	22131.94	-1551.39	23076.39	1440.97
1282	804.13	21777.78	-1006.94	21819.44	1750.69
1302	825.73	22937.50	-660.56	22944.44	2050.69
1322	847.33	24180.56	-817.36	24500.00	2362.50
1342	868.87	26451.39	3852.08	26451.39	2668.75
1362	892.10	20361.11	4879.86	20361.11	2443.06
1382	909.20	11388.89	13993.06	14000.00	2249.31
1402	918.38	-5659.03	-10000.00	10076.39	2264.58
1460	930.48	-7770.83	-14055.56	14138.89	2375.00
1442	949.48	4288.19	2384.72	5330.56	-2318.75
1462	990.98	3612.50	979.86	6427.78	-3204.86
1482	1050.98	2735.42	1036.11	2455.56	-2031.94
1502	1110.98	2034.72	520.28	2455.56	-1211.11
1522	1170.98	1547.92	706.25	1549.31	-756.94
1542	1230.98	1114.58	398.82	1115.97	-443.82
1562	1292.98	748.61	599.93	750.69	-235.63
Note 1: Meridional, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)					

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Table G.10. BES-BEC Primary Tank Stresses, Shell Top, Seismic Load Only

AP Primary Tank, Best Estimate Soil, Horizontal and Vertical Seismic, Best Estimate Tank Concrete, 460 in. Waste Level at 1.83 SpG					
M&D Starting M&D Element No.	Path (in.)	Shell Top Surface (inside - waste side)			
		AP-460-BES-BEC Seismic Only Hoop Stress (lbs/in ²) Top	AP-460-BES-BEC Seismic Only Meridional Stress (lbs/in ²) Top	AP-460-BES-BEC Seismic Only Stress Intensity (lbs/in ²) Top	AP-460-BES-BEC Seismic Only In-Plane Shear Stress (lbs/in ²) Top
762	67.33	769.58	918.06	919.44	276.51
782	105.04	903.33	1283.82	1274.38	501.68
802	136.24	1107.65	1029.17	1031.94	549.07
822	181.83	842.66	981.67	980.14	618.25
842	225.10	1335.28	974.31	1568.06	746.01
862	273.66	1023.68	985.58	1193.75	912.99
882	323.27	1767.36	890.28	2556.25	1322.78
902	369.20	1893.47	1288.19	3059.72	1784.81
922	419.20	2477.78	932.78	3861.81	2539.52
942	444.31	4818.06	2999.31	3166.67	2271.28
962	458.66	6610.69	4711.81	10464.58	2289.47
982	473.08	6781.67	6039.58	11813.19	2521.58
1002	484.80	3806.25	1375.35	4330.56	2677.91
1022	502.48	2480.56	749.93	3100.69	2623.75
1042	526.48	5180.97	1092.99	4239.58	2407.74
1062	550.48	6196.81	1218.35	5066.67	2152.16
1082	574.60	7243.19	1430.56	6039.58	1859.68
1102	598.28	8335.42	1295.53	7031.94	1518.78
1122	621.38	9247.92	1511.53	7931.94	1142.36
1142	644.48	9952.78	1464.37	8545.83	909.01
1162	667.63	10189.58	1338.13	8903.47	853.44
1182	690.78	9801.39	1613.61	8888.89	702.82
1202	713.88	9752.78	1397.22	9041.67	896.61
1222	736.98	9873.61	1128.75	8986.11	1195.80
1242	760.13	9236.11	938.89	8590.28	1583.42
1262	782.53	7930.56	1348.40	7784.72	1463.96
1282	804.13	7194.44	942.08	7194.44	1752.16
1302	825.73	7194.44	723.12	7194.44	2045.25
1322	847.33	7458.33	853.75	7458.33	2352.08
1342	868.87	7270.83	1231.94	7993.06	2691.21
1362	892.10	4402.78	2378.47	6416.67	2596.55
1382	909.20	1997.22	6050.69	5125.00	2559.04
1402	918.38	2340.97	5061.11	4389.58	2522.93
1422	930.48	2948.61	5965.97	5562.50	2442.92
1442	949.48	4016.67	616.48	4016.67	2233.34
1462	990.98	3102.99	916.10	5548.61	3197.68
1482	1050.98	2310.42	442.28	1867.36	2013.24
1502	1110.98	1690.56	315.07	1867.36	1212.04
1522	1170.98	1235.97	247.71	1227.50	748.61
1542	1230.98	806.25	206.67	705.90	448.70
1562	1292.98	481.74	251.02	481.39	226.24
Note 1: Meridional, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)					

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Table G.11. BES-BEC Primary Tank Stresses, Shell Middle, Seismic Load Only

AP Primary Tank, Best Estimate Soil, Horizontal and Vertical Seismic, Best Estimate Tank Concrete, 460 in. Waste Level at 1.83 SpG					
M&D Starting M&D Element No.	Path (in.)	Shell Mid-Plane			
		AP-460-BES-BEC Seismic Only Hoop Stress (lbs/in ²) Mid	AP-460-BES-BEC Seismic Only Meridional Stress (lbs/in ²) Mid	AP-460-BES-BEC Seismic Only Stress Intensity (lbs/in ²) Mid	AP-460-BES-BEC Seismic Only In-Plane Shear Stress (lbs/in ²) Mid
762	67.33	887.92	669.44	700.00	271.49
782	105.04	807.99	898.61	897.22	492.31
802	136.24	1242.29	846.53	845.14	540.51
822	181.83	787.73	765.49	764.17	613.13
842	225.10	1560.76	688.96	1087.50	741.71
862	273.66	944.65	705.14	1200.69	911.66
882	323.27	1934.65	820.35	2158.33	1321.34
902	369.20	1881.46	983.82	3014.58	1783.42
922	419.20	2522.92	1230.81	4004.86	2540.92
942	444.31	3616.67	1033.13	4450.69	2315.09
962	458.66	7525.14	973.82	7925.00	2336.03
982	473.08	8331.25	908.33	8518.06	2479.90
1002	484.80	3509.03	878.82	4453.47	2607.75
1022	502.48	2957.85	979.58	2830.56	2589.71
1042	526.48	5196.25	1121.74	4227.78	2402.19
1062	550.48	6214.86	1246.39	5061.81	2147.31
1082	574.60	7233.61	1357.64	5964.58	1852.05
1102	598.28	8390.97	1448.19	7042.36	1512.54
1122	621.38	9259.72	1515.35	7865.97	1138.20
1142	644.48	9991.67	1562.92	8540.28	890.96
1162	667.63	10289.58	1586.88	8888.89	840.94
1182	690.78	9751.39	1392.94	8756.94	699.96
1202	713.88	9761.81	1373.17	8937.50	895.91
1222	736.98	9947.92	1331.82	9229.17	1195.10
1242	760.13	9361.11	1266.19	8840.28	1574.40
1262	782.53	7798.61	866.01	7527.78	1452.86
1282	804.13	7152.78	791.78	7034.72	1751.49
1302	825.73	7125.00	703.13	7125.00	2048.05
1322	847.33	7340.28	602.68	7347.22	2356.91
1342	868.87	7506.94	487.85	7486.11	2679.53
1362	892.10	4993.06	352.83	5006.94	2519.47
1382	909.20	1809.72	358.08	2135.42	2404.21
1402	918.38	3725.00	308.19	3888.89	2391.02
1422	930.48	4008.61	494.79	4256.67	2375.10
1442	949.48	3776.04	546.94	4152.78	2248.48
1462	990.98	3125.90	841.04	5718.06	3198.32
1482	1050.98	2294.86	490.08	2006.25	2014.01
1502	1110.98	1699.38	274.86	2006.25	1212.65
1522	1170.98	1224.51	215.76	1181.25	748.34
1542	1230.98	815.83	219.31	801.39	448.67
1562	1292.98	457.99	223.54	400.90	226.10
Note 1: Meridional, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)					

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Table G.12. BES-BEC Primary Tank Stresses, Shell Bottom, Seismic Load Only

AP Primary Tank, Best Estimate Soil, Horizontal and Vertical Seismic, Best Estimate Tank Concrete, 460 in. Waste Level at 1.83 SpG					
M&D Starting M&D Element No.	Path (in.)	Shell Bottom Surface (outside - away from waste)			
		AP-460-BES-BEC Seismic Only Hoop Stress (lbs/in ²) Bot	AP-460-BES-BEC Seismic Only Meridional Stress (lbs/in ²) Bot	AP-460-BES-BEC Seismic Only Stress Intensity (lbs/in ²) Bot	AP-460-BES-BEC Seismic Only In-Plane Shear Stress (lbs/in ²) Bot
762	67.33	1024.10	1046.53	1044.31	266.48
782	105.04	796.53	1118.75	1122.22	482.87
802	136.24	1376.94	1276.74	1222.50	532.01
822	181.83	732.80	768.06	768.75	608.02
842	225.10	1785.56	1401.39	1272.92	738.98
862	273.66	865.63	715.97	1215.97	910.32
882	323.27	2101.88	1448.82	2170.14	1319.20
902	369.20	1869.44	896.88	2974.31	1782.02
922	419.20	2591.67	1821.67	3954.86	2542.31
942	444.31	2541.67	4972.92	5225.00	2358.90
962	458.66	8443.75	3204.17	7625.69	2383.29
982	473.08	9880.56	4238.89	8925.00	2438.92
1002	484.80	3213.19	2052.78	4328.47	2537.59
1022	502.48	3435.83	2653.06	2936.81	2555.68
1042	526.48	5212.22	1152.64	4222.22	2396.64
1062	550.48	6232.92	1273.61	5121.53	2142.46
1082	574.60	7224.03	1283.99	5917.36	1845.12
1102	598.28	8453.47	1600.76	7080.56	1506.30
1122	621.38	9279.17	1519.74	7792.36	1133.35
1142	644.48	10030.56	1661.46	8541.67	872.22
1162	667.63	10388.89	1846.39	9013.89	829.14
1182	690.78	9700.69	1171.88	8551.39	697.90
1202	713.88	9764.58	1349.03	8868.06	895.83
1222	736.98	10021.53	1534.58	9326.39	1195.10
1242	760.13	9486.11	1595.14	9020.83	1565.38
1262	782.53	7659.72	621.81	7430.56	1441.07
1282	804.13	7131.94	690.76	6784.72	1750.81
1302	825.73	7166.67	682.98	7173.61	2050.84
1322	847.33	7256.94	481.67	7201.39	2362.63
1342	868.87	7736.11	2177.64	7736.11	2668.87
1362	892.10	5590.28	2292.01	5590.28	2443.09
1382	909.20	2868.75	5440.97	5243.06	2249.38
1402	918.38	5263.26	4604.86	4029.17	2264.68
1422	930.48	5396.53	5638.89	5277.78	2320.00
1442	949.48	3572.22	1366.94	3850.69	2262.88
1462	990.98	3148.89	790.56	5889.17	3198.96
1482	1050.98	2281.67	551.04	2123.82	2014.78
1502	1110.98	1708.89	251.76	2123.82	1213.26
1522	1170.98	1213.06	224.44	1067.43	748.06
1542	1230.98	832.01	244.28	832.92	448.63
1562	1292.98	437.29	213.19	324.24	226.03
Note 1: Meridional, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)					

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Table G.13. BES-BEC Anchor Bolt Forces, Gravity Load Only

AP Primary Tank, Best Estimate Soil, Gravity Only, Best Estimate Tank Concrete, 460 in. Waste Level at 1.83 SpG											
ANSYS MAXIMUMS BY RADIUS											
M&D J-Bolt Radius No.	Mean J-Bolt Radius	Radius of J-Bolts Included		Average Bolts per Element	Min Axial Force (kip) BES-BEC Gravity Only	Max Axial Force (kip) BES-BEC Gravity Only	Shear Force1 (kip) BES- BEC Gravity	Maximum Shear Force1 Model Angle	Shear Force2 (kip) BES- BEC Gravity Only	Maximum Shear Force2 Model Angle	Total Shear (kip) BES BEC Gravity
		min	max								
Radius 2	44.72	22.36	67.29	0.55	-0.005	-0.004	0.001	45	0.021	90	0.021
Radius 3	89.87	67.29	104.93	0.89	-0.004	-0.004	0.001	36	0.068	0	0.068
Radius 4	120.00	104.93	135.98	1.03	-0.001	-0.001	0.002	27	0.125	180	0.125
Radius 5	151.97	135.98	181.01	1.97	-0.001	-0.001	0.005	153	0.218	90	0.218
Radius 6	210.05	181.01	223.79	2.41	-0.006	-0.006	0.009	144	0.401	81	0.401
Radius 7	237.53	223.79	270.98	3.30	0.016	0.016	0.008	144	0.492	45	0.492
Radius 8	304.43	270.98	318.74	4.04	-0.026	-0.025	0.002	153	0.656	45	0.656
Radius 9	333.05	318.74	361.64	4.37	0.088	0.089	0.001	144	0.714	45	0.714
Radius 10	390.22	361.64	406.24	5.36	0.051	0.052	0.001	117	0.810	0	0.810
Radius 11	422.26	406.24	431.63	3.60	0.671	0.674	0.001	54	1.191	0	1.191

M&D J-Bolt Radius No.	Mean J-Bolt Radius	Radius of J-Bolts Included		Average Bolts per Element	Bolt Angle (Rad)	Shear Stiffness (kip/ft)	Axial Stiffness (kip/ft)	Shear Displacement BES-BEC- Gravity Only	Axial Min Displacement BES-BEC- Gravity Only	Axial Max Displacement BES-BEC- Gravity Only
		min	max							
Radius 2	44.72	22.36	67.29	0.55	0.0351	780	780	0.00033	-0.00008	-0.00006
Radius 3	89.87	67.29	104.93	0.89	0.0715	780	780	0.00104	-0.00007	-0.00006
Radius 4	120.00	104.93	135.98	1.03	0.0968	780	780	0.00192	-0.00002	-0.00001
Radius 5	151.97	135.98	181.01	1.97	0.1252	780	780	0.00335	-0.00002	-0.00002
Radius 6	210.05	181.01	223.79	2.41	0.1825	780	780	0.00617	-0.00010	-0.00009
Radius 7	237.53	223.79	270.98	3.30	0.2136	780	780	0.00757	0.00025	0.00025
Radius 8	304.43	270.98	318.74	4.04	0.3076	780	780	0.01009	-0.00039	-0.00038
Radius 9	333.05	318.74	361.64	4.37	0.3613	780	780	0.01098	0.00135	0.00138
Radius 10	390.22	361.64	406.24	5.36	0.5235	780	780	0.01246	0.00078	0.00080
Radius 11	460.26	406.24	431.63	3.60	0.6938	780	780	0.01833	0.01032	0.01037

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Table G.14. BES-BEC Anchor Bolt Forces, Gravity Plus Seismic Loads

AP Primary Tank, Best Estimate Soil, Horizontal and Vertical Seismic Input, Best Estimate Tank Concrete, 460 in. Waste Level at 1.83 SpG											
ANSYS MAXIMUMS BY RADIUS											
M&D J-Bolt Radius No.	Mean J-Bolt Radius	Radius of J-Bolts Included		Average Bolts per Element	Min Axial Force (kip) BES-BEC	Max Axial Force (kip) BES-BEC	Shear Force1 (kip) BES-BEC	Maximum Shear Force1 Model Angle	Shear Force2 (kip) BES-BEC	Maximum Shear Force2 Model Angle	Total Shear (kip) BES- BEC
		min	max								
Radius 2	44.72	22.36	67.29	0.55	-0.071	0.008	0.618	90	0.663	0	0.663
Radius 3	89.87	67.29	104.93	0.89	-0.045	0.007	0.691	90	0.621	180	0.729
Radius 4	120.00	104.93	135.98	1.03	-0.035	0.015	0.783	90	0.685	180	0.834
Radius 5	151.97	135.98	181.01	1.97	-0.107	0.048	0.909	90	0.802	180	0.975
Radius 6	210.05	181.01	223.79	2.41	-0.073	0.118	1.194	90	1.073	180	1.293
Radius 7	237.53	223.79	270.98	3.30	-0.065	0.425	1.423	90	1.239	180	1.542
Radius 8	304.43	270.98	318.74	4.04	-0.150	0.331	2.083	90	1.573	180	2.217
Radius 9	333.05	318.74	361.64	4.37	-0.163	0.577	2.479	90	1.708	180	2.617
Radius 10	390.22	361.64	406.24	5.36	-0.232	0.582	3.497	90	2.010	180	3.623
Radius 11	422.26	406.24	431.63	3.60	-0.234	1.595	4.458	90	2.665	180	4.676

M&D J-Bolt Radius No.	Mean J-Bolt Radius	Radius of J-Bolts Included		Average Bolts per Element	Bolt Angle (Rad)	Shear Stiffness (kip/ft)	Axial Stiffness (kip/ft)	Shear Disp BES-BEC- Seismic	Axial Min Disp BES-BEC- Seismic	Axial Max Disp BES-BEC- Seismic
		min	max							
Radius 2	44.72	22.36	67.29	0.55	0.0351	780	780	0.01019	-0.00109	0.00013
Radius 3	89.87	67.29	104.93	0.89	0.0715	780	780	0.01122	-0.00069	0.00011
Radius 4	120.00	104.93	135.98	1.03	0.0968	780	780	0.01283	-0.00053	0.00024
Radius 5	151.97	135.98	181.01	1.97	0.1252	780	780	0.01500	-0.00165	0.00074
Radius 6	210.05	181.01	223.79	2.41	0.1825	780	780	0.01989	-0.00113	0.00182
Radius 7	237.53	223.79	270.98	3.30	0.2136	780	780	0.02373	-0.00100	0.00653
Radius 8	304.43	270.98	318.74	4.04	0.3076	780	780	0.03410	-0.00231	0.00509
Radius 9	333.05	318.74	361.64	4.37	0.3613	780	780	0.04026	-0.00251	0.00887
Radius 10	390.22	361.64	406.24	5.36	0.5235	780	780	0.05574	-0.00357	0.00895
Radius 11	460.26	406.24	431.63	3.60	0.6938	780	780	0.07195	-0.00360	0.02453

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Table G.15. BES-BEC Anchor Bolt Forces, Seismic Load Only

AP Primary Tank, Best Estimate Soil, Horizontal and Vertical Seismic Input, Best Estimate Tank Concrete, 460 in. Waste Level at 1.83 SpG Seismic Only											
ANSYS MAXIMUMS BY RADIUS											
M&D J-Bolt Radius No.	Mean J-Bolt Radius	Radius of J-Bolts Included		Average Bolts per Element	Min Axial Force (kip) BES-BEC- Seismic Only	Max Axial Force (kip) BES-BEC- Seismic Only	Shear Force1 (kip) BES-BEC- Seismic Only	Maximum Shear Force1 Model Angle	Shear Force2 (kip) BES- BEC-Seismic Only	Maximum Shear Force2 Model Angle	Total Shear (kip) BES- BEC- Seismic Only
		min	max								
Radius 2	44.72	22.36	67.29	0.55	-0.066	0.012	0.617	108	0.641	0	0.890
Radius 3	89.87	67.29	104.93	0.89	-0.040	0.011	0.690	108	0.553	0	0.884
Radius 4	120.00	104.93	135.98	1.03	-0.034	0.016	0.781	108	0.560	0	0.961
Radius 5	151.97	135.98	181.01	1.97	-0.106	0.049	0.904	108	0.584	0	1.076
Radius 6	210.05	181.01	223.79	2.41	-0.067	0.124	1.186	108	0.672	144	1.363
Radius 7	237.53	223.79	270.98	3.30	-0.081	0.408	1.415	90	0.747	135	1.600
Radius 8	304.43	270.98	318.74	4.04	-0.125	0.356	2.081	117	0.917	117	2.274
Radius 9	333.05	318.74	361.64	4.37	-0.251	0.487	2.478	117	0.994	117	2.670
Radius 10	390.22	361.64	406.24	5.36	-0.283	0.529	3.496	108	1.200	0	3.696
Radius 11	460.26	406.24	431.63	3.60	-0.905	0.921	4.458	108	1.474	0	4.695

M&D J-Bolt Radius No.	Mean J-Bolt Radius	Radius of J-Bolts Included		Average Bolts per Element	Bolt Angle (Rad)	Shear Stiffness (kip/ft)	Axial Stiffness (kip/ft)	Shear Disp BES-BEC- Seismic Only	Axial Min Disp BES-BEC- Seismic Only	Axial Max Disp BES-BEC- Seismic Only
		min	max							
Radius 2	44.72	22.36	67.29	0.55	0.0351	780	780	0.01369	-0.00101	0.00019
Radius 3	89.87	67.29	104.93	0.89	0.0715	780	780	0.01360	-0.00062	0.00017
Radius 4	120.00	104.93	135.98	1.03	0.0968	780	780	0.01478	-0.00052	0.00025
Radius 5	151.97	135.98	181.01	1.97	0.1252	780	780	0.01655	-0.00163	0.00076
Radius 6	210.05	181.01	223.79	2.41	0.1825	780	780	0.02097	-0.00103	0.00191
Radius 7	237.53	223.79	270.98	3.30	0.2136	780	780	0.02462	-0.00124	0.00628
Radius 8	304.43	270.98	318.74	4.04	0.3076	780	780	0.03498	-0.00192	0.00548
Radius 9	333.05	318.74	361.64	4.37	0.3613	780	780	0.04108	-0.00386	0.00750
Radius 10	390.22	361.64	406.24	5.36	0.5235	780	780	0.05687	-0.00435	0.00814
Radius 11	460.26	406.24	431.63	3.60	0.6938	780	780	0.07223	-0.01393	0.01417

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Table G.16. BES-BEC Concrete Backed Steel Strain, Shell Top, Gravity Load Only

**AP Backed Steel, Best Estimate Soil, Gravity Only, Best Estimate Tank Concrete, 460 In Waste
Level at 1.83SpG**

M&D Starting M&D Element No.	Path (in)	Shell Top Surface (inside - towards waste) Gravity					
		AP-460-BES-BEC EPEL P1 Strain (in/in) Gravity Top Min		AP-460-BES-BEC EPEL P1 Strain (in/in) Gravity Top Max		AP-460-BES-BEC EPEL P2 Strain (in/in) Gravity Top Min	
		AP-460-BES-BEC EPEL P2 Strain (in/in) Gravity Top Max		AP-460-BES-BEC EPEL P3 Strain (in/in) Gravity Top Min		AP-460-BES-BEC EPEL P3 Strain (in/in) Gravity Top Max	
762	67.33	3.36E-05	3.37E-05	-3.81E-05	-3.81E-05	-3.99E-05	-3.99E-05
782	105.04	4.21E-05	4.21E-05	-3.12E-05	-3.12E-05	-6.62E-05	-6.61E-05
802	136.24	3.62E-05	3.62E-05	-3.18E-05	-3.18E-05	-5.17E-05	-5.17E-05
822	181.71	3.22E-05	3.23E-05	-1.89E-05	-1.88E-05	-5.55E-05	-5.54E-05
842	225.10	2.56E-05	2.56E-05	-2.06E-05	-2.06E-05	-3.82E-05	-3.82E-05
862	273.66	2.01E-05	2.01E-05	-6.25E-06	-6.25E-06	-4.00E-05	-3.99E-05
882	323.27	1.22E-05	1.22E-05	-7.65E-07	-7.54E-07	-2.72E-05	-2.72E-05
902	369.20	1.45E-05	1.45E-05	3.10E-06	3.10E-06	-2.14E-05	-2.14E-05
922	419.20	4.13E-05	4.13E-05	-8.89E-06	-8.88E-06	-2.03E-05	-2.03E-05
237	463.02						
257	510.03						
277	544.44						
297	580.53						
317	631.08						
337	680.34						
357	727.44						
377	772.93						
397	831.34						
417	894.09						
2132	925.08	2.84E-05	2.84E-05	-2.59E-05	-2.59E-05	-3.60E-05	-3.60E-05
2122	935.67	7.02E-05	7.02E-05	-1.99E-05	-1.99E-05	-2.67E-05	-2.67E-05
2112	944.86	7.35E-05	7.36E-05	-5.93E-06	-5.93E-06	-1.63E-04	-1.63E-04
477	968.95						
497	1002.45						
517	1042.45						
537	1108.60						
557	1178.35						
577	1227.20						
597	1271.50						
617	1313.65						
637	1360.60						

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Table G.17. BES-BEC Concrete Backed Steel Strain, Shell Middle, Gravity Load Only

**AP Backed Steel, Best Estimate Soil, Gravity Only, Best Estimate Tank Concrete, 460 In Waste
Level at 1.83SpG**

M&D Starting M&D Element No.	Path (in)	Shell Mid-Plane					
		AP-460-BES-BEC EPEL P1 Strain (in/in) Gravity Mid Min	AP-460-BES-BEC EPEL P1 Strain (in/in) Gravity Mid Max	AP-460-BES-BEC EPEL P2 Strain (in/in) Gravity Mid Min	AP-460-BES-BEC EPEL P2 Strain (in/in) Gravity Mid Max	AP-460-BES-BEC EPEL P3 Strain (in/in) Gravity Mid Min	AP-460-BES-BEC EPEL P3 Strain (in/in) Gravity Mid Max
762	67.33	3.58E-05	3.59E-05	-4.10E-05	-4.10E-05	-4.23E-05	-4.23E-05
782	105.04	4.05E-05	4.05E-05	-3.19E-05	-3.18E-05	-6.20E-05	-6.19E-05
802	136.24	3.84E-05	3.84E-05	-3.24E-05	-3.23E-05	-5.64E-05	-5.64E-05
822	181.71	3.10E-05	3.11E-05	-1.92E-05	-1.92E-05	-5.24E-05	-5.23E-05
842	225.10	2.80E-05	2.81E-05	-2.07E-05	-2.07E-05	-4.37E-05	-4.36E-05
862	273.66	1.95E-05	1.95E-05	-6.50E-06	-6.49E-06	-3.85E-05	-3.84E-05
882	323.27	1.30E-05	1.30E-05	-8.69E-07	-8.58E-07	-2.90E-05	-2.89E-05
902	369.20	1.43E-05	1.43E-05	3.61E-06	3.61E-06	-2.24E-05	-2.23E-05
922	419.20	4.12E-05	4.12E-05	-1.04E-05	-1.03E-05	-1.67E-05	-1.67E-05
237	463.02	4.30E-05	4.31E-05	5.58E-06	5.58E-06	-6.61E-05	-6.60E-05
257	510.03	5.86E-05	5.87E-05	5.08E-05	5.08E-05	-2.89E-04	-2.89E-04
277	544.44	9.53E-05	9.53E-05	4.55E-05	4.56E-05	-4.71E-04	-4.70E-04
297	580.53	6.77E-05	6.77E-05	-2.07E-05	-2.07E-05	-2.86E-04	-2.86E-04
317	631.08	8.31E-05	8.32E-05	-9.00E-05	-9.00E-05	-2.88E-04	-2.88E-04
337	680.34	1.03E-04	1.03E-04	-1.14E-04	-1.14E-04	-3.55E-04	-3.55E-04
357	727.44	1.02E-04	1.02E-04	-1.22E-04	-1.22E-04	-3.42E-04	-3.42E-04
377	772.93	1.19E-04	1.19E-04	-1.29E-04	-1.29E-04	-4.14E-04	-4.14E-04
397	831.34	1.12E-04	1.12E-04	-1.12E-04	-1.12E-04	-3.96E-04	-3.96E-04
417	894.09	4.79E-05	4.80E-05	-6.72E-05	-6.72E-05	-1.50E-04	-1.50E-04
2132	925.08	2.35E-05	2.35E-05	-1.16E-05	-1.16E-05	-3.60E-05	-3.60E-05
2122	935.67	2.38E-05	2.39E-05	-2.10E-05	-2.10E-05	-2.64E-05	-2.64E-05
2112	944.86	1.64E-05	1.64E-05	-5.73E-06	-5.73E-06	-2.66E-05	-2.66E-05
477	968.95	1.76E-05	1.76E-05	7.07E-06	7.08E-06	-7.69E-05	-7.69E-05
497	1002.45	5.64E-05	5.65E-05	1.03E-05	1.03E-05	-1.66E-05	-1.66E-05
517	1042.45	1.40E-05	1.40E-05	8.75E-06	8.77E-06	-4.96E-06	-4.96E-06
537	1108.60	2.42E-05	2.42E-05	5.07E-06	5.08E-06	-7.85E-06	-7.84E-06
557	1178.35	3.77E-06	3.78E-06	3.74E-06	3.74E-06	-1.83E-05	-1.83E-05
577	1227.20	2.37E-05	2.37E-05	3.79E-06	3.80E-06	-6.31E-06	-6.30E-06
597	1271.50	4.61E-06	4.62E-06	3.33E-06	3.33E-06	-1.87E-05	-1.87E-05
617	1313.65	1.59E-05	1.59E-05	6.58E-06	6.59E-06	-5.03E-06	-5.02E-06
637	1360.60	4.24E-06	4.24E-06	3.26E-06	3.27E-06	-1.52E-06	-1.52E-06

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Table G.18. BES-BEC Concrete Backed Steel Strain, Shell Bottom, Gravity Load Only

AP Backed Steel, Best Estimate Soil, Gravity Only, Best Estimate Tank Concrete, 460 In Waste Level at 1.83SpG

M&D Starting M&D Element No.	Path (in)	Shell Bottom Surface (outside - away from waste) Gravity					
		AP-460-BES-BEC EPEL P1 Strain (in/in) Gravity Bot Min	AP-460-BES-BEC EPEL P1 Strain (in/in) Gravity Bot Max	AP-460-BES-BEC EPEL P2 Strain (in/in) Gravity Bot Min	AP-460-BES-BEC EPEL P2 Strain (in/in) Gravity Bot Max	AP-460-BES-BEC EPEL P3 Strain (in/in) Gravity Bot Min	AP-460-BES-BEC EPEL P3 Strain (in/in) Gravity Bot Max
762	67.33	3.81E-05	3.82E-05	-4.20E-05	-4.20E-05	-4.64E-05	-4.63E-05
782	105.04	3.90E-05	3.90E-05	-3.25E-05	-3.24E-05	-5.77E-05	-5.77E-05
802	136.24	4.06E-05	4.07E-05	-3.29E-05	-3.28E-05	-6.10E-05	-6.10E-05
822	181.71	2.98E-05	2.99E-05	-1.95E-05	-1.95E-05	-4.92E-05	-4.91E-05
842	225.10	3.05E-05	3.05E-05	-2.08E-05	-2.08E-05	-4.90E-05	-4.90E-05
862	273.66	1.89E-05	1.90E-05	-6.74E-06	-6.74E-06	-3.69E-05	-3.69E-05
882	323.27	1.37E-05	1.38E-05	-9.72E-07	-9.62E-07	-3.07E-05	-3.07E-05
902	369.20	1.40E-05	1.41E-05	4.12E-06	4.13E-06	-2.33E-05	-2.33E-05
922	419.20	4.11E-05	4.11E-05	-1.17E-05	-1.16E-05	-1.33E-05	-1.33E-05
237	463.02						
257	510.03						
277	544.44						
297	580.53						
317	631.08						
337	680.34						
357	727.44						
377	772.93						
397	831.34						
417	894.09						
2132	925.08	2.34E-05	2.34E-05	-1.89E-06	-1.89E-06	-3.60E-05	-3.60E-05
2122	935.67	5.46E-05	5.46E-05	-2.61E-05	-2.61E-05	-9.89E-05	-9.88E-05
2112	944.86	1.20E-04	1.20E-04	-5.54E-06	-5.54E-06	-4.89E-05	-4.89E-05
477	968.95						
497	1002.45						
517	1042.45						
537	1108.60						
557	1178.35						
577	1227.20						
597	1271.50						
617	1313.65						
637	1360.60						

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Table G.19. BES-BEC Concrete Backed Steel Strain, Shell Top, Gravity Plus Seismic Load

**AP Backed Steel, Best Estimate Soil, Seismic Only, Best Estimate Tank Concrete, 460 In Waste
Level at 1.83SpG**

M&D Starting M&D Element No.	Path (in)	Shell Top Surface (inside - towards waste) Seismic					
		AP-460-BES-BEC EPEL P1 Strain (in/in) Seismic Top Min	AP-460-BES-BEC EPEL P1 Strain (in/in) Seismic Top Max	AP-460-BES-BEC EPEL P2 (in/in) Seismic Top Min	AP-460-BES-BEC EPEL P2 Strain (in/in) Seismic Top Max	AP-460-BES-BEC EPEL P3 Strain (in/in) Seismic Top Min	AP-460-BES-BEC EPEL P3 Strain (in/in) Seismic Top Max
762	67.33	2.37E-05	4.65E-05	-5.00E-05	-1.42E-05	-5.76E-05	-2.65E-05
782	105.04	3.16E-05	5.71E-05	-3.97E-05	-1.16E-05	-8.53E-05	-3.43E-05
802	136.24	2.67E-05	4.97E-05	-4.15E-05	-2.67E-06	-7.72E-05	-3.12E-05
822	181.71	2.56E-05	4.39E-05	-2.74E-05	-1.04E-06	-7.52E-05	-3.18E-05
842	225.10	2.05E-05	3.39E-05	-3.08E-05	1.95E-05	-6.46E-05	-2.27E-05
862	273.66	1.67E-05	3.21E-05	-1.50E-05	1.68E-05	-5.78E-05	-1.46E-05
882	323.27	1.03E-05	4.60E-05	-1.26E-05	1.61E-05	-5.70E-05	-1.25E-05
902	369.20	4.61E-06	7.34E-05	4.30E-07	1.35E-05	-5.01E-05	-1.05E-06
922	419.20	2.68E-05	1.32E-04	-1.26E-05	7.35E-06	-5.54E-05	-1.16E-06
237	463.02						
257	510.03						
277	544.44						
297	580.53						
317	631.08						
337	680.34						
357	727.44						
377	772.93						
397	831.34						
417	894.09						
2132	925.08	2.51E-05	3.78E-05	-2.99E-05	1.03E-05	-4.95E-05	-2.79E-05
2122	935.67	5.90E-05	1.06E-04	-2.28E-05	5.30E-07	-3.75E-05	-1.90E-05
2112	944.86	6.05E-05	1.26E-04	-9.28E-06	2.69E-05	-1.98E-04	-3.32E-05
477	968.95						
497	1002.45						
517	1042.45						
537	1108.60						
557	1178.35						
577	1227.20						
597	1271.50						
617	1313.65						
637	1360.60						

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Table G.20. BES-BEC Concrete Backed Steel Strain, Shell Middle, Gravity Plus Seismic Load

AP Backed Steel, Best Estimate Soil, Seismic Only, Best Estimate Tank Concrete, 460 In Waste Level at 1.83SpG							
M&D Starting M&D Element No.	Path (in)	Shell Mid-Plane					
		AP-460-BES-BEC EPEL P1 Strain (in/in) Seismic Mid Min	AP-460-BES-BEC EPEL P1 Strain (in/in) Seismic Mid Max	AP-460-BES-BEC EPEL P2 Strain (in/in) Seismic Mid Min	AP-460-BES-BEC EPEL P2 Strain (in/in) Seismic Mid Max	AP-460-BES-BEC EPEL P3 Strain (in/in) Seismic Mid Min	AP-460-BES-BEC EPEL P3 Strain (in/in) Seismic Mid Max
762	67.33	2.62E-05	4.94E-05	-5.20E-05	-1.91E-05	-5.86E-05	-2.94E-05
782	105.04	2.95E-05	5.63E-05	-4.06E-05	-1.17E-05	-8.41E-05	-4.12E-05
802	136.24	2.94E-05	5.24E-05	-4.26E-05	-2.82E-06	-7.84E-05	-3.64E-05
822	181.71	2.42E-05	4.16E-05	-2.76E-05	-1.43E-06	-7.29E-05	-3.06E-05
842	225.10	2.32E-05	4.41E-05	-3.41E-05	1.73E-05	-6.37E-05	-2.37E-05
862	273.66	1.66E-05	2.75E-05	-1.51E-05	1.74E-05	-5.74E-05	-1.84E-05
882	323.27	8.94E-06	4.59E-05	-1.29E-05	1.79E-05	-5.21E-05	-1.18E-05
902	369.20	4.75E-06	7.36E-05	1.66E-06	1.26E-05	-4.83E-05	-1.47E-06
922	419.20	2.69E-05	1.31E-04	-1.60E-05	1.48E-05	-5.03E-05	-1.53E-06
237	463.02	2.56E-05	6.90E-05	4.25E-06	8.71E-06	-7.68E-05	-4.87E-05
257	510.03	4.64E-05	8.64E-05	3.96E-05	5.86E-05	-3.23E-04	-2.34E-04
277	544.44	8.49E-05	1.10E-04	2.57E-05	7.37E-05	-5.25E-04	-3.97E-04
297	580.53	6.15E-05	7.89E-05	-3.55E-05	4.04E-05	-3.29E-04	-2.48E-04
317	631.08	7.42E-05	9.58E-05	-1.03E-04	7.00E-06	-3.33E-04	-2.45E-04
337	680.34	9.15E-05	1.17E-04	-1.27E-04	-2.04E-05	-4.05E-04	-3.01E-04
357	727.44	9.03E-05	1.16E-04	-1.36E-04	-3.21E-05	-3.87E-04	-2.87E-04
377	772.93	1.04E-04	1.36E-04	-1.43E-04	-1.06E-05	-4.69E-04	-3.33E-04
397	831.34	9.70E-05	1.27E-04	-1.24E-04	-5.43E-07	-4.48E-04	-3.02E-04
417	894.09	4.16E-05	5.83E-05	-7.40E-05	1.75E-05	-1.74E-04	-1.07E-04
2132	925.08	2.03E-05	2.97E-05	-1.55E-05	1.35E-05	-4.57E-05	-2.28E-05
2122	935.67	2.06E-05	3.04E-05	-2.53E-05	1.18E-05	-4.80E-05	-2.14E-05
2112	944.86	1.38E-05	2.75E-05	-8.58E-06	2.02E-05	-4.91E-05	-1.44E-05
477	968.95	1.52E-05	4.10E-05	-9.57E-07	1.82E-05	-8.74E-05	-5.82E-05
497	1002.45	4.73E-05	7.53E-05	-5.91E-06	4.15E-05	-1.96E-05	-1.11E-05
517	1042.45	1.19E-05	3.91E-05	-2.27E-06	1.84E-05	-7.40E-06	-1.77E-06
537	1108.60	1.85E-05	4.88E-05	-4.62E-06	3.13E-05	-1.93E-05	-4.15E-06
557	1178.35	3.48E-06	2.73E-05	-1.97E-06	7.18E-06	-3.72E-05	-2.74E-06
577	1227.20	1.42E-05	4.92E-05	-4.52E-06	2.59E-05	-1.24E-05	-2.31E-06
597	1271.50	3.55E-06	2.51E-05	-4.04E-06	5.75E-06	-2.90E-05	-6.14E-06
617	1313.65	4.07E-06	4.12E-05	-2.43E-06	2.14E-05	-1.10E-05	-1.21E-06
637	1360.60	6.81E-07	1.16E-05	-1.33E-07	7.33E-06	-3.33E-06	-3.34E-07

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Table G.21. BES-BEC Concrete Backed Steel Strain, Shell Bottom, Gravity Plus Seismic Load

**AP Backed Steel, Best Estimate Soil, Seismic Only, Best Estimate Tank Concrete, 460 In Waste
Level at 1.83SpG**

M&D Starting M&D Element No.	Path (in)	Shell Bottom Surface (outside - away from waste) Seismic					
		AP-460-BES-BEC EPEL P1 Strain (in/in)	AP-460-BES-BEC EPEL P1 Strain (in/in)	AP-460-BES-BEC EPEL P2 (in/in)	AP-460-BES-BEC EPEL P2 Strain (in/in)	AP-460-BES-BEC EPEL P3 Strain (in/in)	AP-460-BES-BEC EPEL P3 Strain (in/in)
		Seismic Bot Min	Seismic Bot Max	Seismic Bot Min	Seismic Bot Max	Seismic Bot Min	Seismic Bot Max
762	67.33	2.82E-05	5.41E-05	-5.40E-05	-2.01E-05	-6.05E-05	-2.43E-05
782	105.04	2.66E-05	5.54E-05	-4.16E-05	-1.19E-05	-8.29E-05	-3.24E-05
802	136.24	3.20E-05	6.06E-05	-4.29E-05	-2.97E-06	-8.06E-05	-3.49E-05
822	181.71	2.27E-05	4.05E-05	-2.78E-05	-1.82E-06	-7.03E-05	-2.78E-05
842	225.10	2.38E-05	5.65E-05	-3.47E-05	1.49E-05	-6.68E-05	-2.16E-05
862	273.66	1.59E-05	2.62E-05	-1.52E-05	1.80E-05	-5.63E-05	-1.72E-05
882	323.27	7.95E-06	4.58E-05	-1.31E-05	1.93E-05	-5.70E-05	-2.69E-06
902	369.20	5.13E-06	7.37E-05	1.78E-06	1.31E-05	-4.77E-05	-4.69E-06
922	419.20	2.71E-05	1.31E-04	-1.94E-05	3.38E-05	-5.13E-05	-2.29E-06
237	463.02						
257	510.03						
277	544.44						
297	580.53						
317	631.08						
337	680.34						
357	727.44						
377	772.93						
397	831.34						
417	894.09						
2132	925.08	2.05E-05	2.91E-05	-4.99E-06	1.35E-05	-4.41E-05	-1.61E-05
2122	935.67	4.71E-05	7.77E-05	-2.96E-05	-3.28E-06	-1.19E-04	-4.22E-05
2112	944.86	9.89E-05	2.12E-04	-1.31E-05	2.72E-05	-5.87E-05	-1.85E-05
477	968.95						
497	1002.45						
517	1042.45						
537	1108.60						
557	1178.35						
577	1227.20						
597	1271.50						
617	1313.65						
637	1360.60						

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Table G.22. BES-BEC Concrete Backed Steel Strain, Shell Top, Seismic Load Only

**AP Backed Steel, Best Estimate Soil, Seismic Only, Best Estimate Tank Concrete, 460 In
Waste Level at 1.83SpG**

M&D Starting M&D Element No.	Path (in)	Shell Top Surface (inside - towards waste) Seismic					
		AP-460-BES-BEC EPEL P1 Strain (in/in)	AP-460-BES-BEC EPEL P1 Strain (in/in)	AP-460-BES-BEC EPEL P2 (in/in)	AP-460-BES-BEC EPEL P2 Strain (in/in)	AP-460-BES-BEC EPEL P3 Strain (in/in) Seismic Only	AP-460-BES-BEC EPEL P3 Strain (in/in)
		Seismic Only Top Min	Seismic Only Top Max	Seismic Only Top Min	Seismic Only Top Max	Top Min	Seismic Only Top Max
762	67.33	-9.92E-06	1.28E-05	-1.19E-05	2.39E-05	-1.77E-05	1.34E-05
782	105.04	-1.05E-05	1.50E-05	-8.51E-06	1.96E-05	-1.92E-05	3.18E-05
802	136.24	-9.45E-06	1.35E-05	-9.68E-06	2.91E-05	-2.55E-05	2.05E-05
822	181.71	-6.68E-06	1.17E-05	-8.55E-06	1.78E-05	-1.97E-05	2.37E-05
842	225.10	-5.01E-06	8.30E-06	-1.02E-05	4.01E-05	-2.64E-05	1.55E-05
862	273.66	-3.34E-06	1.21E-05	-8.78E-06	2.31E-05	-1.78E-05	2.53E-05
882	323.27	-1.85E-06	3.38E-05	-1.19E-05	1.68E-05	-2.98E-05	1.47E-05
902	369.20	-9.87E-06	5.89E-05	-2.67E-06	1.03E-05	-2.87E-05	2.03E-05
922	419.20	-1.45E-05	9.06E-05	-3.73E-06	1.62E-05	-3.51E-05	1.91E-05
237	463.02						
257	510.03						
277	544.44						
297	580.53						
317	631.08						
337	680.34						
357	727.44						
377	772.93						
397	831.34						
417	894.09						
2062	925.08	-3.31E-06	9.35E-06	-4.02E-06	3.62E-05	-1.34E-05	8.11E-06
2052	935.67	-1.13E-05	3.55E-05	-2.87E-06	2.04E-05	-1.08E-05	7.71E-06
2042	944.66	-1.31E-05	5.21E-05	-3.35E-06	3.28E-05	-3.44E-05	1.30E-04
477	968.95						
497	1002.45						
517	1042.45						
537	1108.60						
557	1178.35						
577	1227.20						
597	1271.50						
617	1313.65						
637	1360.60						

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Table G.23. BES-BEC Concrete Backed Steel Strain, Shell Middle, Seismic Load Only

**AP Backed Steel, Best Estimate Soil, Seismic Only, Best Estimate Tank Concrete, 460 In
Waste Level at 1.83SpG**

M&D Starting M&D Element No.	Path (in)	Shell Mid-Plane					
		AP-460-BES- BEC EPEL P1 Strain (in/in) Seismic Only Mid Min	AP-460-BES-BEC EPEL P1 Strain (in/in) Seismic Only Mid Max	AP-460-BES-BEC EPEL P2 (in/in) Seismic Only Mid Min	AP-460-BES-BEC EPEL P2 Strain (in/in) Seismic Only Mid Max	AP-460-BES-BEC EPEL P3 Strain (in/in) Seismic Only Mid Min	AP-460-BES-BEC EPEL P3 Strain (in/in) Seismic Only Mid Max
762	67.33	-9.67E-06	1.36E-05	-1.10E-05	2.19E-05	-1.63E-05	1.29E-05
782	105.04	-1.10E-05	1.57E-05	-8.76E-06	2.01E-05	-2.21E-05	2.07E-05
802	136.24	-9.01E-06	1.39E-05	-1.02E-05	2.95E-05	-2.20E-05	2.00E-05
822	181.71	-6.85E-06	1.06E-05	-8.40E-06	1.77E-05	-2.06E-05	2.18E-05
842	225.10	-4.85E-06	1.61E-05	-1.34E-05	3.80E-05	-2.01E-05	1.99E-05
862	273.66	-2.95E-06	7.98E-06	-8.62E-06	2.39E-05	-1.90E-05	2.01E-05
882	323.27	-4.02E-06	3.29E-05	-1.20E-05	1.87E-05	-2.32E-05	1.71E-05
902	369.20	-9.50E-06	5.93E-05	-1.95E-06	9.00E-06	-2.60E-05	2.09E-05
922	419.20	-1.43E-05	9.02E-05	-5.64E-06	2.52E-05	-3.35E-05	1.52E-05
237	463.02	-1.74E-05	2.59E-05	-1.33E-06	3.14E-06	-1.07E-05	1.74E-05
257	510.03	-1.22E-05	2.77E-05	-1.12E-05	7.82E-06	-3.38E-05	5.52E-05
277	544.44	-1.03E-05	1.47E-05	-1.98E-05	2.81E-05	-5.42E-05	7.34E-05
297	580.53	-6.16E-06	1.12E-05	-1.48E-05	6.10E-05	-4.33E-05	3.76E-05
317	631.08	-8.90E-06	1.26E-05	-1.32E-05	9.70E-05	-4.46E-05	4.28E-05
337	680.34	-1.14E-05	1.35E-05	-1.35E-05	9.32E-05	-5.00E-05	5.38E-05
357	727.44	-1.16E-05	1.37E-05	-1.36E-05	8.99E-05	-4.46E-05	5.53E-05
377	772.93	-1.47E-05	1.66E-05	-1.41E-05	1.18E-04	-5.53E-05	8.08E-05
397	831.34	-1.45E-05	1.54E-05	-1.19E-05	1.12E-04	-5.14E-05	9.42E-05
417	894.09	-6.37E-06	1.03E-05	-6.74E-06	8.47E-05	-2.38E-05	4.35E-05
2062	925.08	-3.20E-06	6.19E-06	-3.89E-06	2.50E-05	-9.65E-06	1.32E-05
2052	935.67	-3.27E-06	6.59E-06	-4.31E-06	3.28E-05	-2.16E-05	5.03E-06
2042	944.86	-2.58E-06	1.11E-05	-2.85E-06	2.59E-05	-2.25E-05	1.22E-05
477	968.95	-2.36E-06	2.34E-05	-8.03E-06	1.11E-05	-1.05E-05	1.87E-05
497	1002.45	-9.10E-06	1.88E-05	-1.62E-05	3.12E-05	-3.02E-06	5.48E-06
517	1042.45	-2.07E-06	2.51E-05	-1.10E-05	9.62E-06	-2.44E-06	3.19E-06
537	1108.60	-5.73E-06	2.46E-05	-9.69E-06	2.62E-05	-1.15E-05	3.69E-06
557	1178.35	-2.96E-07	2.35E-05	-5.71E-06	3.43E-06	-1.89E-05	1.56E-05
577	1227.20	-9.52E-06	2.55E-05	-8.31E-06	2.21E-05	-6.05E-06	3.99E-06
597	1271.50	-1.06E-06	2.05E-05	-7.37E-06	2.43E-06	-1.03E-05	1.26E-05
617	1313.65	-1.18E-05	2.53E-05	-9.01E-06	1.48E-05	-6.01E-06	3.81E-06
637	1360.60	-3.56E-06	7.31E-06	-3.40E-06	4.07E-06	-1.81E-06	1.19E-06

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Table G.24. BES-BEC Concrete Backed Steel Strain, Shell Bottom, Seismic Load Only

**AP Backed Steel, Best Estimate Soil, Seismic Only, Best Estimate Tank Concrete, 460 In Waste
Level at 1.83SpG**

M&D Starting M&D Element No.	Path (in)	Shell Bottom Surface (outside - away from waste) Seismic					
		AP-460-BES-BEC EPEL P1 Strain (in/in) Seismic Only Bot Min	AP-460-BES-BEC EPEL P1 Strain (in/in) Seismic Only Bot Max	AP-460-BES-BEC EPEL P2 (in/in) Seismic Only Bot Min	AP-460-BES-BEC EPEL P2 Strain (in/in) Seismic Only Bot Max	AP-460-BES-BEC EPEL P3 Strain (in/in) Seismic Only Bot Min	AP-460-BES-BEC EPEL P3 Strain (in/in) Seismic Only Bot Max
762	67.33	-9.96E-06	1.59E-05	-1.19E-05	2.19E-05	-1.42E-05	2.21E-05
782	105.04	-1.23E-05	1.64E-05	-9.10E-06	2.06E-05	-2.52E-05	2.53E-05
802	136.24	-8.68E-06	1.99E-05	-9.99E-06	2.99E-05	-1.96E-05	2.61E-05
822	181.71	-7.11E-06	1.07E-05	-8.22E-06	1.77E-05	-2.12E-05	2.14E-05
842	225.10	-6.67E-06	2.60E-05	-1.39E-05	3.57E-05	-1.78E-05	2.73E-05
862	273.66	-3.01E-06	7.24E-06	-8.41E-06	2.47E-05	-1.94E-05	1.97E-05
882	323.27	-5.79E-06	3.21E-05	-1.21E-05	2.03E-05	-2.63E-05	2.80E-05
902	369.20	-8.89E-06	5.97E-05	-2.35E-06	8.94E-06	-2.44E-05	1.86E-05
922	419.20	-1.40E-05	8.99E-05	-7.71E-06	4.54E-05	-3.80E-05	1.10E-05
237	463.02						
257	510.03						
277	544.44						
297	580.53						
317	631.08						
337	680.34						
357	727.44						
377	772.93						
397	831.34						
417	894.09						
2062	925.08	-2.83E-06	5.72E-06	-3.09E-06	1.54E-05	-8.07E-06	1.99E-05
2052	935.67	-7.48E-06	2.31E-05	-3.46E-06	2.28E-05	-2.05E-05	5.66E-05
2042	944.86	-2.10E-05	9.19E-05	-7.55E-06	3.27E-05	-9.80E-06	3.04E-05
477	968.95						
497	1002.45						
517	1042.45						
537	1108.60						
557	1178.35						
577	1227.20						
597	1271.50						
617	1313.65						
637	1360.60						

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Table G.25. BES-BEC Concrete Wall/Footing Contact Forces, Gravity Only

Tank AY, 460 Inch Waste Level
 SpG = 1.83
 Best Estimate Soil
 Best Estimate Concrete

Angle	Vertical Min AP- BES-BEC Gravity	Vertical Max AP- BES-BEC Gravity	Shear Y Min AP- BES-BEC Gravity	Shear Y Max AP- BES-BEC Gravity	Shear X Min AP- BES-BEC Gravity	Shear X Max AP- BES-BEC Gravity	Shear Y Max AP- BES-BEC Gravity	Shear X Max AP- BES-BEC Gravity	Shear Max AP- BES-BEC Gravity	Vertical Force Max AP-BES- BEC Gravity	Vertical Force Min AP-BES- BEC Gravity
0	-214.80	-214.60	0.00	0.00	-1.16	-1.16	0.00	0.36	0.36	-67.13	-67.06
9	-429.60	-429.20	-0.44	-0.43	-2.34	-2.33	0.07	0.37	0.37	-67.13	-67.06
18	-429.60	-429.20	-0.48	-0.48	-2.19	-2.19	0.07	0.34	0.35	-67.13	-67.06
27	-429.60	-429.20	-0.75	-0.74	-2.09	-2.08	0.12	0.33	0.35	-67.13	-67.06
36	-429.60	-429.20	-1.45	-1.45	-1.91	-1.90	0.23	0.30	0.37	-67.13	-67.06
45	-429.60	-429.20	-1.64	-1.64	-1.64	-1.64	0.26	0.26	0.36	-67.13	-67.06
54	-429.50	-429.10	-1.93	-1.92	-1.46	-1.46	0.30	0.23	0.38	-67.11	-67.05
63	-429.50	-429.10	-2.03	-2.02	-1.08	-1.08	0.32	0.17	0.36	-67.11	-67.05
72	-429.60	-429.20	-2.29	-2.29	-0.72	-0.72	0.36	0.11	0.38	-67.13	-67.06
81	-429.50	-429.10	-2.17	-2.16	-0.44	-0.44	0.34	0.07	0.35	-67.11	-67.05
90	-429.50	-429.10	-2.39	-2.39	0.04	0.04	0.37	0.01	0.37	-67.11	-67.05
99	-429.60	-429.10	-2.34	-2.33	0.42	0.42	0.37	0.07	0.37	-67.13	-67.05
108	-429.50	-429.10	-2.14	-2.13	0.57	0.58	0.33	0.09	0.35	-67.11	-67.05
117	-429.60	-429.20	-2.10	-2.10	1.14	1.14	0.33	0.18	0.37	-67.13	-67.06
126	-429.60	-429.20	-1.82	-1.82	1.41	1.42	0.28	0.22	0.36	-67.13	-67.06
135	-429.60	-429.20	-1.62	-1.61	1.74	1.75	0.25	0.27	0.37	-67.13	-67.06
144	-429.50	-429.10	-1.35	-1.35	1.95	1.95	0.21	0.30	0.37	-67.11	-67.05
153	-429.60	-429.20	-1.06	-1.06	2.10	2.11	0.17	0.33	0.37	-67.13	-67.06
162	-429.60	-429.20	-0.68	-0.68	2.22	2.23	0.11	0.35	0.36	-67.13	-67.06
171	-429.60	-429.20	-0.32	-0.32	2.33	2.34	0.05	0.37	0.37	-67.13	-67.06
180	-214.80	-214.60	0.00	0.00	1.18	1.18	0.00	0.37	0.37	-67.13	-67.06

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Table G.26. BES-BEC Concrete Wall/Footing Contact Forces, Gravity Plus Seismic

Tank AY, 460 Inch Waste Level												
SpG = 1.83												
Best Estimate Soil												
Best Estimate Concrete												
	Vertical	Vertical	Shear Y	Shear Y	Shear X	Shear X	Shear Y	Shear X	Shear			
	Min AP-	Max AP-	Min AP-	Max AP-	Min AP-	Max AP-	Max AP-	Max AP-	Max AP-	Vertical Force	Vertical Force	
	BES-BEC	BES-BEC	BES-BEC	BES-BEC	BES-BEC	BES-BEC	BES-BEC	BES-BEC	BES-BEC	Max AP-BES-	Min AP-BES-	
Angle	Seismic	Seismic	Seismic	Seismic	Seismic	Seismic	Seismic	Seismic	Seismic	BEC Seismic	BEC Seismic	
0	-244.40	-164.40	0.00	0.00	-6.50	5.80	0.00	2.03	2.03	-76.38	-51.38	
9	-488.80	-329.60	-25.61	23.57	-16.79	15.49	4.00	2.62	4.78	-76.38	-51.50	
18	-488.60	-331.90	-48.32	45.24	-27.71	27.18	7.55	4.33	8.70	-76.34	-51.86	
27	-488.20	-335.60	-66.59	62.29	-44.87	45.22	10.40	7.07	12.58	-76.28	-52.44	
36	-487.70	-340.70	-78.90	72.74	-66.53	68.06	12.33	10.63	16.28	-76.20	-53.23	
45	-487.00	-346.60	-83.23	76.43	-90.52	93.61	13.00	14.63	19.57	-76.09	-54.16	
54	-486.20	-353.10	-79.77	72.33	-114.60	119.40	12.46	18.66	22.44	-75.97	-55.17	
63	-485.40	-357.20	-68.48	61.10	-136.10	143.30	10.70	22.39	24.82	-75.84	-55.81	
72	-484.50	-359.80	-50.62	43.44	-153.10	162.60	7.91	25.41	26.61	-75.70	-56.22	
81	-483.50	-361.60	-27.53	21.66	-163.80	175.30	4.30	27.39	27.73	-75.55	-56.50	
90	-482.50	-362.80	-3.27	-1.25	-166.70	180.30	0.51	28.17	28.18	-75.39	-56.69	
99	-481.60	-363.10	-26.79	24.34	-161.70	176.80	4.19	27.63	27.94	-75.25	-56.73	
108	-483.40	-362.70	-47.87	47.96	-149.50	164.90	7.49	25.77	26.83	-75.53	-56.67	
117	-485.20	-362.00	-64.34	66.27	-130.80	146.20	10.35	22.84	25.08	-75.81	-56.56	
126	-486.70	-360.80	-74.32	77.74	-108.40	122.30	12.15	19.11	22.64	-76.05	-56.38	
135	-487.90	-359.30	-77.31	81.09	-84.14	96.11	12.67	15.02	19.65	-76.23	-56.14	
144	-489.20	-358.00	-72.96	76.45	-60.40	70.34	11.95	10.99	16.23	-76.44	-55.94	
153	-490.60	-357.10	-61.73	64.46	-39.34	47.51	10.07	7.42	12.51	-76.66	-55.80	
162	-492.10	-356.80	-44.60	46.51	-23.11	29.80	7.27	4.66	8.63	-76.89	-55.75	
171	-493.20	-356.70	-23.36	24.35	-12.65	18.59	3.80	2.90	4.79	-77.06	-55.73	
180	-246.80	-178.40	0.00	0.00	-4.55	7.40	0.00	2.31	2.31	-77.13	-55.75	

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Table G.27. BES-BEC Concrete Wall/Footing Contact Forces, Seismic Only

Tank AY, 460 Inch Waste Level
 SpG = 1.83
 Best Estimate Soil
 Best Estimate Concrete

Angle	Vertical Min AP- BES-BEC Seismic Only	Vertical Max AP- BES-BEC Seismic Only	Shear Y Min AP- BES-BEC Seismic Only	Shear Y Max AP- BES-BEC Seismic Only	Shear X Min AP- BES-BEC Seismic Only	Shear X Max AP- BES-BEC Seismic Only	Shear Y Max AP- BES-BEC Seismic Only	Shear X Max AP- BES-BEC Seismic Only	Shear Max AP- BES-BEC Seismic Only	Vertical Force Max AP- BES- BEC Seismic Only	Vertical Force Min AP- BES- BEC Seismic Only
0	-29.60	50.20	0.00	0.00	-5.34	6.96	0.00	2.17	2.17	-9.25	15.69
9	-59.20	99.60	-25.17	24.00	-14.45	17.82	3.93	2.79	4.82	-9.25	15.56
18	-59.00	97.30	-47.84	45.72	-25.52	29.37	7.48	4.59	8.77	-9.22	15.20
27	-58.60	93.60	-65.84	63.03	-42.78	47.30	10.29	7.39	12.67	-9.16	14.63
36	-58.10	88.50	-77.45	74.19	-64.62	69.96	12.10	10.93	16.31	-9.08	13.83
45	-57.40	82.60	-81.59	78.07	-88.88	95.25	12.75	14.88	19.60	-8.97	12.91
54	-56.70	76.00	-77.85	74.25	-113.14	120.86	12.16	18.88	22.46	-8.86	11.88
63	-55.90	71.90	-66.46	63.12	-135.02	144.38	10.38	22.56	24.83	-8.73	11.23
72	-54.90	69.40	-48.33	45.73	-152.38	163.32	7.55	25.52	26.61	-8.58	10.84
81	-54.00	67.50	-25.37	23.82	-163.36	175.74	3.96	27.46	27.74	-8.44	10.55
90	-53.00	66.30	-0.88	1.14	-166.74	180.26	0.18	28.17	28.17	-8.28	10.36
99	-52.00	66.00	-24.45	26.67	-162.12	176.38	4.17	27.56	27.87	-8.13	10.31
108	-53.90	66.40	-45.73	50.09	-150.07	164.32	7.83	25.68	26.84	-8.42	10.38
117	-55.60	67.20	-62.24	68.37	-131.94	145.06	10.68	22.67	25.06	-8.69	10.50
126	-57.10	68.40	-72.50	79.56	-109.81	120.88	12.43	18.89	22.61	-8.92	10.69
135	-58.30	69.90	-75.70	82.70	-85.88	94.36	12.92	14.74	19.61	-9.11	10.92
144	-59.70	71.10	-71.61	77.80	-62.35	68.39	12.16	10.69	16.18	-9.33	11.11
153	-61.00	72.10	-60.67	65.52	-41.44	45.40	10.24	7.09	12.46	-9.53	11.27
162	-62.50	72.40	-43.92	47.19	-25.33	27.58	7.37	4.31	8.54	-9.77	11.31
171	-63.60	72.50	-23.04	24.67	-14.98	16.25	3.85	2.54	4.62	-9.94	11.33
180	-32.00	36.20	0.00	0.00	-5.73	6.22	0.00	1.94	1.94	-10.00	11.31

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Table G.28. BES-BEC Soil/Concrete Tank Contact Forces, Gravity Only

Tank AP, 460 Inch Waste Level
 SpG = 1.83
 Best Estimate Soil
 Best Estimate Concrete

1.22 1.17

	Angle (rad)	Path	Max Pressure Soil (BES) AP Gravity (PSI)	Min Pressure Soil (BES) AP Gravity (PSI)	Max Meridional Friction Soil (BES) AP Gravity (PSI)	Max Tangential Friction Soil (BES) AP Gravity (PSI)	Max Contact Displacement Soil (BES) AP Gravity (PSI)	Vertical Pressure	Active Pressure Phi = 33 deg	Active Pressure Phi = 49 deg	0.22g Dome Vertical	0.17g Haunch Vertical
568	-0.035089	67.727	11.63	11.48	1.60	0.04	0.01	7.12	7.11	7.11	14.19	13.61
565.8	-0.07135	105.668	10.01	9.83	1.98	0.07	0.02	7.27	7.26	7.26	12.22	11.72
563.21	-0.096521	137.069	8.80	7.76	1.82	0.11	0.02	7.46	7.43	7.42	10.73	10.29
559.7	-0.124516	182.849	7.22	6.28	1.60	0.17	0.02	7.71	7.65	7.65	8.80	8.44
550.7	-0.180521	226.563	9.13	6.44	1.81	0.28	0.02	8.35	8.23	8.22	11.13	10.68
545.2	-0.210395	275.566	9.17	8.77	1.85	0.14	0.02	8.74	8.57	8.55	11.18	10.73
527.68	-0.298428	325.690	8.64	8.24	1.77	0.03	0.02	9.99	9.59	9.56	10.54	10.11
518.2	-0.34673	372.305	10.81	10.72	2.04	0.03	0.02	10.66	10.09	10.04	13.19	12.65
494.5	-0.482293	423.427	17.48	17.40	2.06	0.06	0.02	12.35	11.07	10.97	21.32	20.45
476.2	-0.606571	468.308	27.65	27.60	2.21	0.11	0.02	13.65	11.45	11.27	33.73	32.35
447.4	-0.656685	515.312	31.96	31.86	4.44	0.21	0.03	15.70	12.75	12.51	38.99	37.39
407.1	-0.710341	549.725	25.83	25.77	5.35	0.16	0.04	18.57	14.53	14.18	31.51	30.22
382.1	-1.570796	585.819	12.88	12.86	3.35	0.07	0.04	20.35	6.00	2.85	15.72	15.07
335	-1.570796	636.369	4.50	4.50	1.10	0.01	0.05	23.70	6.99	3.32	5.49	5.27
281	-1.570796	685.619	3.96	3.96	0.93	0.00	0.05	27.55	8.13	3.86	4.83	4.64
236.5	-1.570796	732.719	4.95	4.94	1.01	0.00	0.06	30.71	9.06	4.30	6.03	5.79
186.8	-1.570796	778.219	4.66	4.65	0.95	0.00	0.06	34.25	10.10	4.80	5.68	5.45
145.5	-1.570796	821.369	5.71	5.71	1.28	0.01	0.06	37.19	10.97	5.21	6.97	6.68
70	-1.570796	874.169	8.43	8.42	1.87	0.02	0.05	42.57	12.56	5.96	10.29	9.86
24	-1.570796	930.544	12.40	12.35	2.76	0.06	0.04	45.84	13.52	6.42	15.12	14.50

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Table G.29. BES-BEC Soil/Concrete Tank Contact Forces, Gravity Plus Seismic

Tank AP, 460 Inch Waste Level
 SpG = 1.83
 Best Estimate Soil
 Best Estimate Concrete

	Angle (rad)	Path	Max Pressure Soil (BES) AP Seismic (PSI)	Min Pressure Soil (BES) AP Seismic (PSI)	Max Meridional Friction Soil (BES) AP Seismic (PSI)	Max Tangential Friction Soil (BES) AP Seismic (PSI)	Max Contact Displacement Soil (BES) AP Seismic (inch)	Vertical Pressure	Active Pressure Phi = 33 deg	Active Pressure Phi = 49 deg
568	-0.035089	67.727	19.56	2.90	7.42	5.24	0.03	7.12	7.11	7.11
565.8	-0.07135	105.668	16.92	3.56	6.97	3.94	0.03	7.27	7.26	7.26
563.21	-0.096521	137.069	13.97	2.25	5.64	3.20	0.03	7.46	7.43	7.42
559.7	-0.124516	182.849	10.26	3.75	4.55	3.54	0.03	7.71	7.65	7.65
550.7	-0.180521	226.563	14.65	3.75	3.97	4.55	0.03	8.35	8.23	8.22
545.2	-0.210395	275.566	11.66	5.97	4.65	4.41	0.03	8.74	8.57	8.55
527.68	-0.298426	325.690	10.22	6.15	4.23	3.76	0.03	9.99	9.59	9.56
518.2	-0.34673	372.305	12.73	8.69	3.81	3.45	0.02	10.66	10.09	10.04
494.5	-0.482293	423.427	20.78	14.57	3.96	2.86	0.02	12.35	11.07	10.97
476.2	-0.606571	468.308	34.52	21.40	4.71	2.88	0.02	13.65	11.45	11.27
447.4	-0.656685	515.312	37.42	27.36	9.98	2.80	0.04	15.70	12.75	12.51
407.1	-0.710341	549.725	30.17	21.50	12.74	2.23	0.06	18.57	14.53	14.18
382.1	-1.570796	585.819	14.94	10.65	8.51	1.54	0.06	20.35	6.00	2.85
335	-1.570796	636.369	5.22	3.96	3.65	1.39	0.08	23.70	6.99	3.32
281	-1.570796	685.619	4.60	3.34	3.13	1.56	0.09	27.53	8.13	3.86
236.5	-1.570796	732.719	5.58	4.37	3.25	1.54	0.09	30.71	9.06	4.30
186.8	-1.570796	778.219	5.18	4.04	2.99	2.02	0.09	34.25	10.10	4.80
145.5	-1.570796	821.369	6.51	4.98	4.40	2.92	0.08	37.19	10.97	5.21
70	-1.570796	874.169	11.69	4.74	7.17	3.15	0.07	42.57	12.56	5.96
24	-1.570796	930.544	20.17	3.45	6.35	3.00	0.05	45.84	13.52	6.42

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Table G.30. BES-BEC Soil/Concrete Tank Contact Forces, Seismic Only

Tank AP, 460 Inch Waste Level
 SpG = 1.83
 Best Estimate Soil
 Best Estimate Concrete

			Max Pressure Soil (BES) AP Seismic Only (PSI)	Min Pressure Soil (BES) AP Seismic Only (PSI)	Max Meridional Friction (BES) AP Seismic Only (PSI)	Max Tangential Friction (BES) AP Seismic Only (PSI)	Max Contact Displacement (BES) AP Seismic Only (inch)
	Angle (rad)	Path					
568	-0.035089	67.727	7.92	-8.74	5.82	5.20	0.01
565.8	-0.07135	105.668	6.91	-6.45	4.99	3.88	0.01
563.21	-0.096521	137.069	5.17	-6.55	3.82	3.09	0.01
559.7	-0.124516	182.849	3.04	-3.46	2.94	3.37	0.01
550.7	-0.180521	226.563	5.53	-5.37	2.16	4.27	0.01
545.2	-0.210395	275.566	2.49	-3.20	2.80	4.27	0.01
527.68	-0.298426	325.690	1.58	-2.49	2.46	3.73	0.01
518.2	-0.34673	372.305	1.92	-2.13	1.77	3.42	0.01
494.5	-0.482293	423.427	3.30	-2.91	1.90	2.79	0.00
476.2	-0.606571	468.308	6.88	-6.25	2.51	2.77	0.01
447.4	-0.656685	515.312	5.47	-4.60	5.54	2.60	0.01
407.1	-0.710341	549.725	4.34	-4.33	7.40	2.07	0.02
382.1	-1.570796	585.819	2.06	-2.24	5.16	1.47	0.02
335	-1.570796	636.369	0.72	-0.54	2.55	1.38	0.03
281	-1.570796	685.619	0.64	-0.63	2.20	1.56	0.03
236.5	-1.570796	732.719	0.64	-0.58	2.24	1.53	0.03
186.8	-1.570796	778.219	0.52	-0.62	2.04	2.02	0.03
145.5	-1.570796	821.369	0.80	-0.73	3.12	2.91	0.03
70	-1.570796	874.169	3.26	-3.69	5.30	3.13	0.02
24	-1.570796	930.544	7.78	-8.95	3.60	2.95	0.01

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Table G.31. BES-BEC Primary Tank/Concrete Dome Contact Data, Gravity Only

Tank AP, 460 Inch Waste Level
SpG = 1.83
Best Estimate Soil
Best Estimate Concrete

Radius	Max Pressure Primary Tank/Concrete Tank Dome AP Gravity (PSI)	Min Pressure Primary Tank/Concrete Tank Dome AP Gravity (PSI)	Max Gap Lateral Displacement Primary Tank /Concrete Tank Dome Gravity (in)	Max Gap Displacement Primary Tank/Concrete Tank Dome AP Gravity (Inches)
67.727	0.959	0.916	0.003014	0.000000
105.668	0.901	0.883	0.004594	0.000000
137.069	0.263	0.245	0.002545	-0.000011
182.849	0.591	0.585	0.003366	-0.000015
226.563	0.843	0.805	0.004369	-0.000124
275.566	0.227	0.216	0.005150	-0.000025
325.690	0.659	0.648	0.006431	-0.000623
372.305	0.000	0.000	0.000000	-0.001489
423.427	0.000	0.000	0.000000	-1.060800

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Table G.32. BES-BEC Primary Tank/Concrete Dome Contact Data, Gravity Plus Seismic

Tank AP, 460 Inch Waste Level
 SpG = 1.83
 Best Estimate Soil
 Best Estimate Concrete

Radius	Max Pressure Primary Tank/Concrete Tank Dome AP Seismic (PSI)	Min Pressure Primary Tank/Concrete Tank Dome AP Seismic (PSI)	Max Gap Lateral Displacement Primary Tank /Concrete Tank Dome Seismic (in)	Max Gap Displacement Primary Tank/Concrete Tank Dome AP Seismic (Inches)
67.727	8.785	0.215	0.010040	-0.000055
105.668	5.176	0.043	0.010741	-0.000074
137.069	8.813	0.000	0.015468	-0.000195
182.849	6.749	0.000	0.022668	-0.000867
226.563	3.673	0.000	0.013956	-0.002641
275.566	5.413	0.000	0.017100	-0.003173
325.690	11.097	0.000	0.010916	-0.003451
372.305	6.685	0.000	0.052536	-0.007267
423.427	2.430	0.000	0.000000	-1.071000

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Table G.33. BES-BEC Primary Tank/Concrete Dome Contact Data, Seismic Only

Tank AP, 460 Inch Waste Level
 SpG = 1.83
 Best Estimate Soil
 Best Estimate Concrete

Radius	Max Pressure Primary Tank/Concrete Tank Dome AP Seismic Only (PSI)	Min Pressure Primary Tank/Concrete Tank Dome AP Seismic Only (PSI)	Max Gap Lateral Displacement Primary Tank /Concrete Tank Dome Seismic Only (in)	Max Gap Displacement Primary Tank/Concrete Tank Dome AP Seismic Only (Inches)
67.727	7.826	-0.701	0.007026	-0.000055
105.668	4.276	-0.840	0.006148	-0.000074
137.069	8.550	-0.245	0.012923	-0.000183
182.849	6.158	-0.585	0.019302	-0.000851
226.563	2.830	-0.805	0.009587	-0.002517
275.566	5.186	-0.216	0.011950	-0.003148
325.690	10.438	-0.648	0.004486	-0.002828
372.305	6.685	0.000	0.052536	-0.005778
423.427	2.430	0.000	0.000000	-0.010200

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Table G.34. BES-BEC Primary Tank/Insulating Concrete Contact Forces, Gravity Only

Tank AP, 460 Inch Waste Level
 SpG = 1.83
 Best Estimate Soil
 Best Estimate Concrete

Radius	Max Pressure Primary Tank/Insulating Concrete AP Gravity (PSI)	Min Pressure Primary Tank/Insulating Concrete AP Gravity (PSI)	Max Lateral Displacement Primary Tank / Insulating Concrete AP Gravity (Inches)	Min Lateral Displacement Primary Tank / Insulating Concrete AP Gravity (Inches)
424.00	72.708	72.639	0.008764	0.008744
384.00	13.465	13.451	0.000326	0.000267
317.85	33.285	33.250	0.002755	0.002741
248.10	29.729	29.701	0.002479	0.002467
199.25	30.750	30.722	0.001744	0.001735
154.95	30.479	30.451	0.000997	0.000990
112.80	30.444	30.417	0.000156	0.000150
65.85	30.979	30.917	0.000304	0.000291

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Table G.35. BES-BEC Primary Tank/Insulating Concrete Contact Data, Gravity Plus Seismic

Tank AP, 460 Inch Waste Level
 SpG = 1.83
 Best Estimate Soil
 Best Estimate Concrete

Radius	Max Pressure Primary Tank/Insulating Concrete AP Seismic (PSI)	Min Pressure Primary Tank/Insulating Concrete AP Seismic (PSI)	Max Lateral Displacement Primary Tank/Insulating Concrete AP Seismic (Inches)	Min Lateral Displacement Primary Tank/Insulating Concrete AP Seismic (Inches)
424.00	98.681	39.125	0.062712	0.004598
384.00	24.521	7.299	0.306360	0.000106
317.85	43.042	23.340	0.038640	0.000744
248.10	37.042	21.035	0.020028	0.000514
199.25	38.014	22.083	0.010837	0.000289
154.95	36.465	22.764	0.006524	0.000288
112.80	36.056	24.014	0.004350	0.000037
65.85	36.465	24.431	0.003374	0.000234

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Table G.36. BES-BEC Primary Tank/Insulating Concrete Contact Forces, Seismic Only

Tank AP, 460 Inch Waste Level
 SpG = 1.83
 Best Estimate Soil
 Best Estimate Concrete

Radius	Max Pressure Primary Tank/Insulating Concrete AP Seismic Only (PSI)	Min Pressure Primary Tank/Insulating Concrete AP Seismic Only (PSI)	Max Lateral Displacement Primary Tank/Insulating Concrete AP Seismic Only (Inches)	Min Lateral Displacement Primary Tank/Insulating Concrete AP Seismic Only (Inches)
424.00	25.972	-33.514	0.054	-0.004
384.00	11.056	-6.153	0.306	0.000
317.85	9.757	-9.910	0.036	-0.002
248.10	7.313	-8.667	0.018	-0.002
199.25	7.264	-8.639	0.009	-0.001
154.95	5.986	-7.688	0.006	-0.001
112.80	5.611	-6.403	0.004	0.000
65.85	5.486	-6.486	0.003	0.000

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Table G.37. BES-BEC Insulating Concrete/Concrete Backed Steel Contact Data, Gravity Only

Tank AP, 460 Inch Waste Level
 SpG = 1.83
 Best Estimate Soil
 Best Estimate Concrete

Radius	Max Pressure Insulating Concrete/Secondary Liner AP Gravity (PSI)	Min Pressure Insulating Concrete/Secondary Liner AP Gravity (PSI)	Max Lateral Displacement Insulating Concrete/Secondary Liner AP Gravity (Inches)	Min Lateral Displacement Insulating Concrete/Secondary Liner AP Gravity (Inches)
424.00	86.458	86.250	0.003563	0.003527
384.00	33.854	33.785	0.002846	0.002810
317.85	27.736	27.701	0.002029	0.001997
248.10	31.500	31.472	0.001470	0.001445
199.25	30.931	30.896	0.000920	0.000905
154.95	30.576	30.542	0.000659	0.000651
112.80	31.215	31.146	0.000489	0.000487
65.85	30.597	30.410	0.000165	0.000160

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Table G.38. BES-BEC Insulating Concrete/Concrete Backed Steel Contact Data, Gravity Plus Seismic

Tank AP, 460 Inch Waste Level
 SpG = 1.83
 Best Estimate Soil
 Best Estimate Concrete

Radius	Max Pressure Insulating Concrete/Seco ndary Liner AP Seismic (PSI)	Min Pressure Insulating Concrete/Seco ndary Liner AP Seismic (PSI)	Max Lateral Displacement Insulating Concrete/Secondary Liner AP Seismic (Inches)	Min Lateral Displacement Insulating Concrete/Secondary Liner AP Seismic (Inches)
424.00	99.444	71.944	0.017964	0.000158
384.00	42.083	24.590	0.016872	0.000273
317.85	35.910	17.715	0.015096	0.000084
248.10	39.340	22.556	0.014532	0.000060
199.25	38.076	22.181	0.012588	0.000027
154.95	36.625	22.806	0.010172	0.000031
112.80	36.896	24.556	0.008530	0.000037
65.85	35.951	24.250	0.007418	0.000060

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Table G.39. BES-BEC Insulating Concrete/Concrete Backed Steel Contact Data, Seismic Only

Tank AP, 460 Inch Waste Level
 SpG = 1.83
 Best Estimate Soil
 Best Estimate Concrete

Radius	Max Pressure Insulating Concrete/Secondary Liner AP Seismic Only (PSI)	Min Pressure Insulating Concrete/Secondary Liner AP Seismic Only (PSI)	Max Lateral Displacement Insulating Concrete/Secondary Liner AP Seismic Only (Inches)	Min Lateral Displacement Insulating Concrete/Secondary Liner AP Seismic Only (Inches)
424.00	12.986	-14.306	0.014	-0.003
384.00	8.229	-9.194	0.014	-0.003
317.85	8.174	-9.986	0.013	-0.002
248.10	7.840	-8.917	0.013	-0.001
199.25	7.146	-8.715	0.012	-0.001
154.95	6.049	-7.736	0.010	-0.001
112.80	5.681	-6.590	0.008	0.000
65.85	5.354	-6.160	0.007	0.000

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Table G.40. BES-BEC Waste Contact Pressure, Gravity Plus Seismic

Tank AY, 460 Inch Waste Level
 SpG = 1.83
 Best Estimate Soil
 Best Estimate Concrete

Waste Height Ratio							
	Waste Height	Max Pressure AP Tank, 460 in Waste Level, SpG = 1.83 Time History (PSI)	Min Pressure AP Tank, 460 in Waste Level, SpG = 1.83 Time History (PSI)	Hydrostatic (psi)	Hydrodynamic (psi)	Theoretical Min (SRSS)	Theoretical Max (SRSS)
0.99	454.35	9.264	-8.222	0.37	1.74	0.00	2.12
0.96	443.05	13.104	-11.611	1.12	1.92	0.00	3.04
0.94	431.7625	14.535	-10.382	1.87	2.17	0.00	4.04
0.90	414.125	12.028	-7.035	3.03	2.63	0.40	5.66
0.85	390.125	9.514	-0.906	4.62	3.30	1.32	7.91
0.80	366.125	11.271	0.116	6.20	3.94	2.26	10.15
0.74	342	13.979	0.463	7.80	4.56	3.23	12.36
0.69	318.325	16.167	1.108	9.36	5.13	4.23	14.49
0.64	295.225	18.438	1.572	10.89	5.65	5.24	16.54
0.59	272.125	20.757	2.526	12.41	6.13	6.29	18.54
0.54	248.975	22.771	3.436	13.94	6.57	7.37	20.52
0.49	225.825	25.306	4.401	15.47	6.98	8.49	22.45
0.44	202.725	26.910	5.671	17.00	7.35	9.65	24.35
0.39	179.625	28.771	7.035	18.53	7.68	10.85	26.20
0.34	156.475	31.257	8.424	20.06	7.97	12.09	28.02
0.29	134.075	32.653	9.958	21.54	8.21	13.32	29.75
0.24	112.475	33.715	11.424	22.96	8.42	14.55	31.38
0.20	90.875	34.958	12.993	24.39	8.58	15.81	32.97
0.15	69.275	37.014	14.299	25.82	8.72	17.10	34.53
0.10	47.738	37.903	16.264	27.24	8.81	18.43	36.05
0.05	24.500	41.528	16.674	28.78	8.88	19.90	37.65
0.02	7.755	46.472	24.743	29.88	8.90	20.98	38.78
0.00	1.755	40.597	25.056	30.28	8.90	21.38	39.18

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Table G.41. BES-BEC Waste Contact Pressure, Theoretical Pressures

Tank Radius, Hr	450 HI/Hr			1.022222222		Waste Dens		1.71E-04				
Waste Depth, HI	460 Conv 1st		Conv 2nd		Conv 3rd		Impul H		Pressure			
Centroid	Conv 1st		Conv 2nd		Conv 3rd		Conv 1st		Conv 2nd			
	Lamda		1.841		5.331		8.536		Sa=			
			0.064		0.108		0.163		0.28			
			0.26									
Height	nu	con0(n)	con1(n)	con2(n)	ci(n)		24.7296	41.7312	62.9832	108.19	100.46	SRSS
	454.35	0.99	0.82	0.07	0.03	0.09	1.56	0.22	0.12	0.73	0.12	1.74
	443.05	0.96	0.78	0.06	0.02	0.14	1.49	0.19	0.10	1.14	0.37	1.92
	431.7625	0.94	0.75	0.05	0.02	0.18	1.43	0.17	0.08	1.51	0.61	2.17
	414.125	0.90	0.70	0.04	0.01	0.24	1.33	0.14	0.06	2.04	0.99	2.63
	390.125	0.85	0.64	0.03	0.01	0.32	1.22	0.10	0.04	2.67	1.49	3.30
	366.125	0.80	0.59	0.02	0.00	0.39	1.11	0.08	0.02	3.22	1.99	3.94
	342	0.74	0.54	0.02	0.00	0.44	1.02	0.06	0.01	3.69	2.48	4.56
	318.325	0.69	0.49	0.01	0.00	0.49	0.94	0.04	0.01	4.10	2.94	5.13
	295.225	0.64	0.45	0.01	0.00	0.53	0.86	0.03	0.01	4.45	3.37	5.65
	272.125	0.59	0.42	0.01	0.00	0.57	0.80	0.03	0.00	4.75	3.78	6.13
	248.975	0.54	0.39	0.01	0.00	0.60	0.74	0.02	0.00	5.02	4.17	6.57
	225.825	0.49	0.36	0.00	0.00	0.63	0.69	0.01	0.00	5.26	4.53	6.98
	202.725	0.44	0.34	0.00	0.00	0.66	0.65	0.01	0.00	5.46	4.87	7.35
	179.625	0.39	0.32	0.00	0.00	0.68	0.61	0.01	0.00	5.64	5.17	7.68
	156.475	0.34	0.30	0.00	0.00	0.70	0.57	0.01	0.00	5.79	5.44	7.97
	134.075	0.29	0.29	0.00	0.00	0.71	0.55	0.01	0.00	5.92	5.67	8.21
	112.475	0.24	0.28	0.00	0.00	0.72	0.53	0.00	0.00	6.02	5.86	8.42
	90.875	0.20	0.27	0.00	0.00	0.73	0.51	0.00	0.00	6.10	6.02	8.58
	69.275	0.15	0.26	0.00	0.00	0.74	0.49	0.00	0.00	6.16	6.15	8.72
	47.7375	0.10	0.25	0.00	0.00	0.75	0.48	0.00	0.00	6.20	6.24	8.81
	24.5	0.05	0.25	0.00	0.00	0.75	0.48	0.00	0.00	6.23	6.30	8.88
	7.755	0.02	0.25	0.00	0.00	0.75	0.47	0.00	0.00	6.24	6.32	8.90
	1.755	0.00	0.25	0.00	0.00	0.75	0.47	0.00	0.00	6.25	6.32	8.90

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Table G.42. BES-BEC Waste Surface Displacement, Gravity Plus Seismic

Tank AP, 460 Inch Waste Level
SpG = 1.83
Best Estimate Soil
Best Estimate Concrete

Waste Radius	Max Vertical Displacement AP-460-BES- BEC Time History (in)	Min Vertical Displacement AP-460-BES- BEC Time History (in)
95.7	6.60	-11.66
129.9	7.52	-10.69
180	8.07	-12.12
218.5	7.39	-13.09
277.7	8.11	-13.20
358	8.58	-13.24
410	7.09	-12.43
450	5.02	-9.41

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Near-Soil-1.txt

```
et,8,solid45                      ! Use Element SOLID45 for Near Soil Elements
/input,soil-prop-Mean-geo,txt      ! Read Soil Properties

ksel,u,kp,,1,kmaxjb               ! Unselect existing Keypoints
asel,u,area,,1,amaxjb            ! Unselect existing Area
lsel,u,line,,1,lmaxjb            ! Unselect existing Lines
vsel,u,volu,,1,vmaxw             ! Unselect existing Volumes

/COM - Create Keypoints to match concrete tank profile
*do,i,1,bm_kp
k,kmaxjb+i,ctx(i),0,ctz(i)
*enddo

/COM - Create Keypoints above top of tank
k,kmaxjb+bm_kp+1,0,0,0           ! Keypoint at origin (surface)
k,kmaxjb+bm_kp+2,0,0,soilz(2)    ! Keypoint at to divide soil above tank
*get,KMAXtemp1,KP,0,num,max       ! Get maximum keypoint number for counter

/COM - Create Keypoints at outside of excavated soil
*do,i,1,tanksoil
k,kmaxtemp1+i,soilx(i),0,soilz(i)
*enddo
*get,KMAXtemp2,KP,0,num,max       ! Get maximum keypoint number for counter

/COM - Create additional keypoint in soil above tank
k,kmaxtemp2+1,ctx(2),0,soilz(1)
k,kmaxtemp2+2,ctx(9),0,soilz(1)
k,kmaxtemp2+3,ctx(12),0,soilz(1)
k,kmaxtemp2+4,ctx(2),0,soilz(2)
k,kmaxtemp2+5,ctx(9),0,soilz(2)
k,kmaxtemp2+6,ctx(12),0,soilz(2)
k,kmaxtemp2+7,ctx(12),0,soilz(3)
k,kmaxtemp2+8,ctx(bm_kp+1),0,ctz(bm_kp+1)

a,kmaxtemp2+1,kmaxtemp2+2,kmaxtemp2+5,kmaxtemp2+4
a,kmaxtemp2+2,kmaxtemp2+3,kmaxtemp2+6,kmaxtemp2+5
a,kmaxtemp2+3,kmaxtemp1+1,kmaxtemp1+2,kmaxtemp2+6
a,kmaxtemp2+4,kmaxtemp2+5,kmaxjb+9,kmaxjb+8,kmaxjb+7,kmaxjb+6,kmaxjb+5,kmaxjb+4,kmaxjb+3,kmaxjb+2
!a,740,741,712,711,710,709,708,707,706,705
a,kmaxtemp2+5,kmaxtemp2+6,kmaxtemp2+7,kmaxjb+12,kmaxjb+11,kmaxjb+10,kmaxjb+9
a,kmaxtemp2+6,kmaxtemp1+2,kmaxtemp1+3,kmaxtemp2+7
a,kmaxtemp2+7,kmaxtemp1+3,kmaxtemp1+4,kmaxjb+12
a,kmaxjb+12,kmaxtemp1+4,kmaxtemp1+5,kmaxjb+14,kmaxjb+13
a,kmaxjb+14,kmaxtemp1+5,kmaxtemp1+6,kmaxjb+16,kmaxjb+15
a,kmaxjb+16,kmaxtemp1+6,kmaxtemp1+7,kmaxjb+18,kmaxjb+17
a,kmaxjb+18,kmaxtemp1+7,kmaxtemp1+8,kmaxjb+20,kmaxjb+19
a,kmaxjb+20,kmaxtemp1+8,kmaxtemp1+9,kmaxtemp2+8,kmaxjb+22,kmaxjb+21

cm,top-soil-area,area
lsla
cm,top-soil,line
type,1
real,1

/COM - Define line divisions to control meshing
lsel,s,loc,z,soilz(1),soilz(2)
lsel,r,loc,x,ctx(3),ctx(8)
lesize,all,,,14                  ! soil above tank top, match tank meshing
lsel,s,loc,z,soilz(1),soilz(2)
lsel,r,loc,x,ctx(10),ctx(11)
lesize,all,,,3                   ! soil above tank top, match tank meshing
cmsel,s,top-soil                 ! Reselect lines in near soil
lsel,r,loc,x,ctx(2)
lesize,all,,,2                   ! Control vertical element size, above tank
cmsel,s,top-soil
lsel,s,loc,x,ctx(9)
lesize,all,,,2                   ! Control vertical element size, above tank
```

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```

cmsel,s,top-soil
lsel,r,loc,x,ctx(12)
lesize,all,,,2                                ! Control vertical element size, above tank
cmsel,s,top-soil
lsel,r,loc,z,ctz(2),ctz(12)
lsel,r,loc,x,ctx(2),ctx(12)
lesize,all,,,1                                ! Control vertical element size, outside excavation mesh
lsel,s,line,,lmaxjb+8,lmaxjb+10,2
lsel,a,line,,lmaxjb+26,lmaxjb+28,2
lsel,a,line,,lmaxjb+30,lmaxjb+38,4
lesize,all,,,9
lsel,s,line,,lmaxjb+42,lmaxjb+42,4
lesize,all,,,7                                ! Control horizontal meshing in soil
lsel,s,line,,lmaxjb+9
lsel,a,line,,lmaxjb+25,lmaxjb+27,2
lsel,a,line,,lmaxjb+29,lmaxjb+45,4
lesize,all,,,1                                ! Control horizontal meshing in soil
lsel,s,line,,lmaxjb+6
lsel,a,line,,lmaxjb+20,lmaxjb+21
lsel,a,line,,lmaxjb+32,lmaxjb+44,4
lsel,a,line,,lmaxjb+31,lmaxjb+43,4
lsel,a,line,,lmaxjb+47,lmaxjb+49
lesize,all,,,1                                ! Control meshing to match tank
lsel,s,line,,lmaxjb+46
lesize,all,,,4                                ! Control mesh size at bottom of excavated soil

cmsel,s,top-soil-area

amesh,all                                      ! Mesh area to develop pattern for volume meshing

type,8
ksel,a,kp,,1                                  ! Select Keypoint for rotation axis
ksel,a,kp,,ct_kps                             ! Select Keypoint for rotation axis
vrotat,all,,,,,1,ct_kps,180,2                ! Generate Volumes for excavated soil
lsla
lsel,r,loc,x,ctx(2)
lesize,all,,arcsiz
lsla
lsel,r,loc,x,ctx(9)
lesize,all,,arcsiz                             ! Define meshing for slices
lsla
lsel,r,loc,x,ctx(12)
lesize,all,,arcsiz                             ! Define meshing for slices
vsweep,all                                     ! Sweep pattern into volume
aclear,all                                     ! Delete elements used for sweep
cm,top-soil-vol,volu

*get,VMAXtemp,VOLU,0,num,max
/COM - Generate element above top center of tank
asel,u,area,,all
vsel,u,volu,,all
a,kmaxjb+bm_kp+1,kmaxtemp2+1,kmaxtemp2+4,kmaxjb+bm_kp+2
a,kmaxjb+bm_kp+2,kmaxtemp2+4,kmaxjb+2,kmaxjb+1
vrotat,all,,,,,1,ct_kps,180,2
vsel,s,volu,,vmaxtemp+1,vmaxtemp+3,2
vatt,801,,8                                    ! Assign material properties
vsel,s,volu,,vmaxtemp+2,vmaxtemp+4,2
vatt,802,,8                                    ! Assign material properties
vsel,s,volu,,vmaxtemp+1,vmaxtemp+4
allsel
asel,s,loc,z,ctz(1),ctz(2)
type,1
asel,r,loc,x,0,4
asel,r,loc,z,ctz(1),ctz(2)
cmsel,u,conc-tank-a
*get,atemp,area,,num,max
*get,atempl,area,,num,min
asel,a,area,,1,22,21
mshcopy,2,1,atempl                             ! copy mesh top match top of concrete tank
mshcopy,2,22,atemp                             ! copy mesh top match top of concrete tank
asel,u,area,,1,22,21

```

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```

vsel,s,volu,,vmaxtemp+1,vmaxtemp+4
vsweep,all                                ! Generate elements by sweeping area
aclear,atemp
aclear,atempl

/COM - Assign soil properties by layer
*do,i,1,tanksoil-1
cmsel,s,top-soil-vol
vsel,r,loc,z,soilz(i),soilz(i+1)
eslv
emodif,all,mat,800+i
esys,0
*enddo

cmsel,s,top-soil-vol
vsel,a,loc,z,soilz(1),ctz(2)
eslv
cm,excav-soil,elem
nsle
nummrg,node

/COM - Define component for excavated soil - tank walls only
cmsel,s,excav-soil
nsle,s,1
nsel,r,loc,z,soilz(5),soilz(9)
esln,r,1
cm,excav-wall,elem

/COM - Define component for excavated soil - tank dome only
cmsel,s,excav-soil
cmsel,u,excav-wall
cm,excav-dome,elem

csys,1
cmsel,s,excav-wall
nsle
nsel,r,loc,x,ctx(14)
cm,excav-wall-n,node

esel,s,type,,8
nsle
nsel,s,loc,x,soilx(1)
nsel,r,loc,z,soilz(1)
cm,near-soil-face-node,node
*do,i,2,9
esel,s,type,,8
nsle
nsel,r,loc,x,soilx(i)
nsel,r,loc,z,soilz(i)
cmsel,a,near-soil-face-node
cm,near-soil-face-node,node
*enddo

esel,s,type,,8
nsle
nsel,r,loc,z,soilz(9)
nsel,r,loc,x,41,68
cm,near-soil-bot-node,node

allsel
*get,KMAXns,KP,0,num,max                ! Get maximum Keypoint number
*get,LMAXns,LINE,0,num,max              ! Get maximum line number
*get,AMAXns,AREA,0,num,max             ! Get maximum Area number
*get,VMAXns,volu,0,num,max             ! Get maximum Volume number

```

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Run-Tank.txt

```
!/batch
! PNNL DST Seismic Analysis, Gravity Inputs, Best Est Soil, Best Est Concrete Properties, AP
Primary Tank Geometry, Dome Friction=0.0
!
fini
/clear
/filename,AP-460-BES-BEC-Seismic,1
/config,nres,3000          ! Increase allowable number of results to 3000
/config,nproc,2            ! Activate 2 processors for solution
/config,fsplit,1024        ! Split binary file at 4.2GB
/prep7
g=32.2                    ! Gravity (ft/sec)

DF=40                     ! Factor for beta (stiffness) damping
ALPHA=0.4                 ! Alpha damping

/out,tank-out,out
/sys,"X:\07.00 - Quality Assurance\ANSYS QA\usrcfg.bat" > QA.out
/out,QA,out,,append
/input,tank-coordinates-AP,txt ! Run file defining tank coordinates (concrete and primary)
/input,tank-props-bee-250,txt ! Run file defining fully cracked concrete properties (PNNL
Concrete Properties)
/input,tank-mesh1,txt        ! Develop concrete tank
/input,primary-props-AP,txt  ! Run file defining AP Primary tank properties
/input,primary,txt          ! Develop Primary tank
/input,insulate,txt         ! Develop insulating concrete model
/input,liner,txt            ! Develop Liner model
/input,waste-solid-AP-s,txt  ! Develop waste model
/input,bolts-friction,txt    ! Develop J-Bolt model
/input,near-soil-1,txt       ! Develop excavated soil model
/input,far-soil,txt          ! Develop Far-Field soil model
/input,interfacel,txt        ! Develop Soil and Concrete Interfaces
/input,interface-gap1,txt    ! Develop Primary Tank Interfaces
/input,slave,txt             ! Develop slaved boundary conditions
/input,boundary,txt          ! Place base and symmetry boundary conditions
/input,outer-spar,txt        ! Connect soil model to symmetry plane
/input,live_load,txt         ! Apply live load over a 10ft radius over dome center
/input,fix-soil,txt
/out
ALLSEL

/out,Tank-th,out

save

/input,solve-TH-BES,txt      ! Run solution Phase

/input,post-tank,txt

/out
/exit
```

Soil-Prop-Mean-Geo.txt

```
Tanksoil=9
deepsoil=20
soil_radius=320
mass=1e8

*dim,soilx,,30
*dim,soilz,,30

soilz(1)=0
soilz(2)=-5
soilz(3)=ctz(9)
```

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```
soilz(4)=ctz(12)
soilz(5)=ctz(14)
soilz(6)=ctz(16)
soilz(7)=ctz(18)
soilz(8)=ctz(20)
soilz(9)=ctz(23)
soilz(10)=-73.5
soilz(11)=-90.5
soilz(12)=-106.5
soilz(13)=-123.5
soilz(14)=-139.5
soilz(15)=-156
soilz(16)=-178
soilz(17)=-200
soilz(18)=-222
soilz(19)=-244
soilz(20)=-266
```

```
soilx(9)=68
soilx(8)=soilx(9)-(soilz(9)-soilz(8))/1.5
soilx(7)=soilx(9)-(soilz(9)-soilz(7))/1.5
soilx(6)=soilx(9)-(soilz(9)-soilz(6))/1.5
soilx(5)=soilx(9)-(soilz(9)-soilz(5))/1.5
soilx(4)=soilx(9)-(soilz(9)-soilz(4))/1.5
soilx(3)=soilx(9)-(soilz(9)-soilz(3))/1.5
soilx(2)=soilx(9)-(soilz(9)-soilz(2))/1.5
soilx(1)=soilx(9)-(soilz(9)-soilz(1))/1.5
```

/COM Excavated Soil Properties

```
mp,ex,801,18*144
mp,nuxy,801,0.27
mp,dens,801,125/(1000*g)
mp,damp,801,0.017/df
```

/COM - Material 802, Soil

```
mp,ex,802,22.5*144
mp,nuxy,802,0.27
mp,dens,802,125/(1000*g)
mp,damp,802,0.027/df
```

/COM - Material 803, Soil

```
mp,ex,803,29.25*144
mp,nuxy,803,0.27
mp,dens,803,125/(1000*g)
mp,damp,803,0.039/df
```

/COM - Material 804, Soil

```
mp,ex,804,36*144
mp,nuxy,804,0.27
mp,dens,804,125/(1000*g)
mp,damp,804,0.031/df
```

/COM - Material 805, Soil

```
mp,ex,805,42*144
mp,nuxy,805,0.27
mp,dens,805,125/(1000*g)
mp,damp,805,0.035/df
```

/COM - Material 806, Soil

```
mp,ex,806,48.75*144
mp,nuxy,806,0.27
mp,dens,806,125/(1000*g)
mp,damp,806,0.042/df
```

/COM - Material 807, Soil

```
mp,ex,807,55.5*144
mp,nuxy,807,0.27
mp,dens,807,125/(1000*g)
mp,damp,807,0.047/df
```


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```
/COM - Material 808, Soil
mp,ex,808,60*144
mp,nuxy,808,0.27
mp,dens,808,125/(1000*g)
mp,damp,808,0.037/df

/COM - Material 810, Soil
mp,ex,810,250
mp,nuxy,810,0.27
mp,dens,810,125/(1000*g)
mp,damp,810,0.037/df

/COM - Material Definitions
/COM - Material 811, Soil      (Top Layer)
mp,ex,811,9958
mp,nuxy,811,0.27
mp,dens,811,125/(1000*g)
mp,damp,811,0.019/df

/COM - Material 812, Soil
mp,ex,812,8797
mp,nuxy,812,0.27
mp,dens,812,125/(1000*g)
mp,damp,812,0.035/df

/COM - Material 813, Soil
mp,ex,813,7845
mp,nuxy,813,0.27
mp,dens,813,125/(1000*g)
mp,damp,813,0.048/df

/COM - Material 814, Soil
mp,ex,814,8209
mp,nuxy,814,0.27
mp,dens,814,125/(1000*g)
mp,damp,814,0.039/df

/COM - Material 815, Soil
mp,ex,815,7634
mp,nuxy,815,0.27
mp,dens,815,125/(1000*g)
mp,damp,815,0.048/df

/COM - Material 816, Soil
mp,ex,816,7188
mp,nuxy,816,0.27
mp,dens,816,125/(1000*g)
mp,damp,816,0.055/df

/COM - Material 817, Soil
mp,ex,817,6933
mp,nuxy,817,0.27
mp,dens,817,125/(1000*g)
mp,damp,817,0.059/df

/COM - Material 818, Soil
mp,ex,818,7667
mp,nuxy,818,0.27
mp,dens,818,125/(1000*g)
mp,damp,818,0.045/df

/COM - Mean Soil Properties Geomatrix Soil Data
/COM - 19 Layer Mode
/COM - Material Definitions

/COM - Material 901, Soil      (Top Layer)
mp,ex,901,16423
mp,nuxy,901,0.24
mp,dens,901,110/(1000*g)
```

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mp,damp,901,0.017/df

/COM - Material 902, Soil
mp,ex,902,15479
mp,nuxy,902,0.24
mp,dens,902,110/(1000*g)
mp,damp,902,0.025/df

/COM - Material 903, Soil
mp,ex,903,14481
mp,nuxy,903,0.24
mp,dens,903,110/(1000*g)
mp,damp,903,0.034/df

/COM - Material 904, Soil
mp,ex,904,14707
mp,nuxy,904,0.24
mp,dens,904,110/(1000*g)
mp,damp,904,0.028/df

/COM - Material 905, Soil
mp,ex,905,13625
mp,nuxy,905,0.19
mp,dens,905,110/(1000*g)
mp,damp,905,0.032/df

/COM - Material 906, Soil
mp,ex,906,15456
mp,nuxy,906,0.19
mp,dens,906,110/(1000*g)
mp,damp,906,0.033/df

/COM - Material 907, Soil
mp,ex,907,17532
mp,nuxy,907,0.19
mp,dens,907,110/(1000*g)
mp,damp,907,0.033/df

/COM - Material 908, Soil
mp,ex,908,20972
mp,nuxy,908,0.19
mp,dens,908,110/(1000*g)
mp,damp,908,0.025/df

/COM - Material 909, Soil
mp,ex,909,23447
mp,nuxy,909,0.19
mp,dens,909,110/(1000*g)
mp,damp,909,0.026/df

/COM - Material 910, Soil
mp,ex,910,23138
mp,nuxy,910,0.19
mp,dens,910,110/(1000*g)
mp,damp,910,0.027/df

/COM - Material 911, Soil
mp,ex,911,22753
mp,nuxy,911,0.19
mp,dens,911,110/(1000*g)
mp,damp,911,0.029/df

/COM - Material 912, Soil
mp,ex,912,22069
mp,nuxy,912,0.19
mp,dens,912,110/(1000*g)
mp,damp,912,0.033/df

/COM - Material 913, Soil
mp,ex,913,25780
mp,nuxy,913,0.19

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```
mp,dens,913,110/(1000*g)
mp,damp,913,0.025/df
```

```
/COM - Material 914, Soil
mp,ex,914,25333
mp,nuxy,914,0.19
mp,dens,914,110/(1000*g)
mp,damp,914,0.027/df
```

```
/COM - Material 915, Soil
mp,ex,915,35501
mp,nuxy,915,0.28
mp,dens,915,120/(1000*g)
mp,damp,915,0.022/df
```

```
/COM - Material 916, Soil
mp,ex,916,39465
mp,nuxy,916,0.28
mp,dens,916,120/(1000*g)
mp,damp,916,0.021/df
```

```
/COM - Material 917, Soil
mp,ex,917,38565
mp,nuxy,917,0.28
mp,dens,917,120/(1000*g)
mp,damp,917,0.023/df
```

```
/COM - Material 918, Soil
mp,ex,918,37715
mp,nuxy,918,0.28
mp,dens,918,120/(1000*g)
mp,damp,918,0.025/df
```

```
/COM - Material 919, Soil
mp,ex,919,41496
mp,nuxy,919,0.28
mp,dens,919,120/(1000*g)
mp,damp,919,0.024/df
```

Solve-Gravity-LBS.txt

```
/prep7
massm_z=148414.59
d,master_node,all
allsel

cmsel,s,excav-soil
nsle
csys,0
nsel,r,loc,x,-ctx(6)-1,ctx(6)+1
nsel,r,loc,y,0,-ctx(6)-1
esln,r,1
mpchg,810,all

cmsel,s,excav-soil
nsle
csys,1
nsel,r,loc,x,ctx(11)-1,ctx(13)+1
nsel,r,loc,z,soilz(1),soilz(3)-1
esln,r,1
mpchg,810,all

*do,i,801,808
esel,s,mat,,i
mpchg,i+10,all
*enddo
allsel

/out,AP-460-BEC-BES-Gravity,out
```

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```

/solu
antype,trans
TRNOPT,FULL
lumpm,OFF
!nlgeom,on
NROPT,auto
NTIM=10 !NUMBER OF TIME STEPS
DT=0.01
TIM=1e-06
autots,on
KBC,on
TIMINT,ON,STRU
solcontrol,ON,off,,
ncnv,0,200
LNSRCH,OFF
PRED,on,,on

/COM - Time File

/COM - Dimension Horizontal Input
*DIM,A_1_x,,2148
*DIM,A_1_z,,2148

*VREAD,A_1_x(1),th-266-Mean-geo,txt
(8(F9.6))
*VREAD,A_1_z(1),th-266-Mean-geo-v,txt
(8(F9.6))

/Title,Load Case: AP-460-BES-BEC, Full Non-linear, Dome Contact Friction = 0.0, Gravity
OUTPR,all,NONE,
OUTRES, ALL,NONE,
OUTRES,RSOL,last
OUTRES,NSOL,last
OUTRES,ESOL,last,conc-tank
OUTRES,esol,last,Primary-tank
OUTRES,ESOL,last,J_bolts
OUTRES,Epel,last,liner
outres,esol,last,wall-int-gap
outres,esol,last,conc-excav-wall-gap
outres,esol,last,conc-excav-dome-gap
!outres, strs,last,excav-soil
!outres, strs,last,bottom-soil
outres,esol,last,bolt-friction
outres,esol,last,waste-surf
outres, strs,last,insul-conc
outres,esol,last,primary-int-gap
outres,esol,last,conc-liner-gap
outres,esol,last,far-soil-contact
!outres,esol,last,soil-contact-foot-elem

alphad,alpha
NSUBST,20,200,5,ON
TIME,100
TIMINT,off
acel,0,0,g
SOLVE
SAVE
TIMINT,on
ITIM=1
DS=TIM
NSUBST,1,20,1,ON

!ddelete, master_node,ux
!ddelete, master_node,uz

esel,s,type,,61,63,2
mpchg,64,all

esel,s,type,,91,93,2
mpchg,92,all

```

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```
allsel

*DO, ITIM, 1, NTIM, 1

TIM=DT*ITIM

TIME, TIM+100

!F, master_node, FX, A_1_X(itim) * mass * g
!F, master_node, Fz, (A_1_Z(itim) + 1) * (mass + massm_z) * g

SOLVE
SAVE
*ENDDO
FINISH
/out
```

Solve-TH-BES

```
/prep7
massm_z=148414.59
d, master_node, all
allsel

cmsel, s, excav-soil
nsle
csys, 0
nsel, r, loc, x, -ctx(6) - 1, ctx(6) + 1
nsel, r, loc, y, 0, -ctx(6) - 1
esln, r, 1
mpchg, 810, all

cmsel, s, excav-soil
nsle
csys, 1
nsel, r, loc, x, ctx(11) - 1, ctx(13) + 1
nsel, r, loc, z, soilz(1), soilz(3) - 1
esln, r, 1
mpchg, 810, all

*do, i, 801, 808
esel, s, mat, , i
mpchg, i + 10, all
*enddo
allsel

/out, AP-460-BEC-BES-Seismic, out
/solu
antype, trans
TRNOPT, FULL
lumpm, OFF
!nlgeom, on
NROPT, auto
NTIM=2148      !NUMBER OF TIME STEPS
DT=0.01
TIM=1e-06
autots, on
KBC, on
TIMINT, ON, STRU
solcontrol, ON, off, ,
ncnv, 0, 200
LNSRCH, OFF
PRED, on, , on

/COM - Time File

/COM - Dimension Horizontal Input
*DIM, A_1_x, , 2148
*DIM, A_1_z, , 2148
```

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```

*VREAD,A_1_x(1),th-266-Mean-geo,txt
(8(F9.6))
*VREAD,A_1_Z(1),th-266-Mean-geo-v,txt
(8(F9.6))

/Title,Load Case: AP-460-BES-BEC, Full Non-linear, Dome Contact Friction = 0.0
OUTPR,all,NONE,
OUTRES, ALL,NONE,
OUTRES,RSOL,last
OUTRES,NSOL,last
OUTRES,ESOL,last,conc-tank
OUTRES,esol,last,Primary-tank
OUTRES,ESOL,last,J_bolts
OUTRES,Epel,last,liner
outres,esol,last,wall-int-gap
outres,esol,last,conc-excav-wall-gap
outres,esol,last,conc-excav-dome-gap
!outres, strs,last,excav-soil
!outres, strs,last,bottom-soil
outres,esol,last,bolt-friction
outres,esol,last,waste-surf
outres, strs,last,insul-conc
outres,esol,last,primary-int-gap
outres,esol,last,conc-liner-gap
outres,esol,last,far-soil-contact
!outres,esol,last,soil-contact-foot-elem

alphad,alpha
NSUBST,20,200,5,ON
TIME,100
TIMINT,off
acel,0,0,g
SOLVE
SAVE
TIMINT,on
ITIM=1
DS=TIM
NSUBST,1,20,1,ON

ddelete, master_node, ux
ddelete, master_node, uz

esel,s,type,,61,63,2
mpchg,64,all

esel,s,type,,91,93,2
mpchg,92,all

allsel

*DO, ITIM, 1, NTIM, 1

TIM=DT*ITIM

TIME, TIM+100

F, master_node, FX, A_1_X(itim) * mass * g
F, master_node, Fz, (A_1_Z(itim) + 1) * (mass + massm_z) * g

SOLVE
SAVE
*ENDDO
FINISH
/out

```

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Tank-Props-BEC-250

```
/COM - Tank Concrete Properties

/COM - Material Definitions
! EX - Youngs Modulus, (k/ft2)
! NUXY - Poissons ratio
! DENS - Density (1000*slugs/ft3)
! DAMP - Beta (Stiffness) Damping

/COM - Material 1, Tank Concrete
mp,ex,1,626754
mp,nuxy,1,0.18
mp,dens,1,148/(1000*g)
mp,damp,1,0.07/df

/COM - Material 2, Tank Concrete
mp,ex,2,620114
mp,nuxy,2,0.18
mp,dens,2,149/(1000*g)
mp,damp,2,0.07/df

/COM - Material 3, Tank Concrete
mp,ex,3,616594
mp,nuxy,3,0.18
mp,dens,3,149/(1000*g)
mp,damp,3,0.07/df

/COM - Material 4, Tank Concrete
mp,ex,4,610922
mp,nuxy,4,0.18
mp,dens,4,149/(1000*g)
mp,damp,4,0.07/df

/COM - Material 5, Tank Concrete
mp,ex, 5,612305
mp,nuxy, 5,0.18
mp,dens, 5,148/(1000*g)
mp,damp,5,0.07/df

/COM - Material 6, Tank Concrete
mp,ex,6,607093
mp,nuxy,6,0.18
mp,dens,6,148/(1000*g)
mp,damp,6,0.07/df

/COM - Material 7, Tank Concrete
mp,ex,7,639237
mp,nuxy,7,0.18
mp,dens,7,146/(1000*g)
mp,damp,7,0.07/df

/COM - Material 8, Tank Concrete
mp,ex,8,634338
mp,nuxy,8,0.18
mp,dens,8,147/(1000*g)
mp,damp,8,0.07/df

/COM - Material 9, Tank Concrete
mp,ex,9,628756
mp,nuxy,9,0.18
mp,dens,9,147/(1000*g)
mp,damp,9,0.07/df

/COM - Material,10, Tank Concrete
mp,ex,10,193677
mp,nuxy,10,0.18
mp,dens,10,165/(1000*g)
mp,damp,10,0.07/df
```

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/COM - Material,11, Tank Concrete
mp,ex,11,575959
mp,nuxy,11,0.18
mp,dens,11,144/(1000*g)
mp,damp,11,0.07/df

/COM - Material,12, Tank Concrete
mp,ex,12,202953
mp,nuxy,12,0.18
mp,dens,12,159/(1000*g)
mp,damp,12,0.07/df

/COM - Material,13, Tank Concrete
mp,ex,13,157426
mp,nuxy,13,0.18
mp,dens,13,176/(1000*g)
mp,damp,13,0.07/df

/COM - Material,14, Tank Concrete
mp,ex,14,153784
mp,nuxy,14,0.18
mp,dens,14,193/(1000*g)
mp,damp,14,0.07/df

/COM - Material,15, Tank Concrete
mp,ex,15,136651
mp,nuxy,15,0.18
mp,dens,15,200/(1000*g)
mp,damp,15,0.07/df

/COM - Material,16, Tank Concrete
mp,ex,16,136651
mp,nuxy,16,0.18
mp,dens,16,200/(1000*g)
mp,damp,16,0.07/df

/COM - Material,17, Tank Concrete
mp,ex,17,138084
mp,nuxy,17,0.18
mp,dens,17,181/(1000*g)
mp,damp,17,0.07/df

/COM - Material,18, Tank Concrete
mp,ex,18,123378
mp,nuxy,18,0.18
mp,dens,18,209/(1000*g)
mp,damp,18,0.07/df

/COM - Material,19, Tank Concrete
mp,ex,19,124633
mp,nuxy,19,0.18
mp,dens,19,190/(1000*g)
mp,damp,19,0.07/df

/COM - Material,20, Tank Concrete
mp,ex,20,124388
mp,nuxy,20,0.18
mp,dens,20,210/(1000*g)
mp,damp,20,0.07/df

/COM - Material,21, Tank Concrete
mp,ex,21,548683
mp,nuxy,21,0.18
mp,dens,21,166/(1000*g)
mp,damp,21,0.07/df

/COM - Material,22, Tank Concrete
mp,ex,22,154870
mp,nuxy,22,0.18
mp,dens,22,184/(1000*g)
mp,damp,22,0.07/df

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/COM - Material,23, Tank Concrete
mp,ex,23,514287
mp,nuxy,23,0.18
mp,dens,23,172/(1000*g)
mp,damp,23,0.060/df

/COM - Material,24, Tank Concrete
mp,ex,24,164113
mp,nuxy,24,0.18
mp,dens,24,288/(1000*g)
mp,damp,24,0.07/df

/COM - Material,25, Tank Concrete
mp,ex,25,522946
mp,nuxy,25,0.18
mp,dens,25,201/(1000*g)
mp,damp,25,0.07/df

/COM - Material,26, Tank Concrete
mp,ex,26,194254
mp,nuxy,26,0.18
mp,dens,26,322/(1000*g)
mp,damp,26,0.07/df

/COM - Material,27, Tank Concrete
mp,ex,27,199783
mp,nuxy,27,0.18
mp,dens,27,281/(1000*g)
mp,damp,27,0.07/df

/COM - Material,28, Tank Concrete
mp,ex,28,162553
mp,nuxy,28,0.18
mp,dens,28,299/(1000*g)
mp,damp,28,0.07/df

/COM - Material,29, Tank Concrete
mp,ex,29,200531
mp,nuxy,29,0.18
mp,dens,29,3894/(1000*g)
mp,damp,29,0.07/df

/COM - Material,30, Tank Concrete
mp,ex,30,167538
mp,nuxy,30,0.18
mp,dens,30,411/(1000*g)
mp,damp,30,0.07/df

/COM - Material,31, Tank Concrete
mp,ex,31,731952
mp,nuxy,31,0.18
mp,dens,31,150/(1000*g)
mp,damp,31,0.07/df

/COM - Material,32, Tank Concrete
mp,ex,32,731952
mp,nuxy,32,0.18
mp,dens,32,150/(1000*g)
mp,damp,32,0.07/df

!/COM - Material,33, Tank Concrete
!mp,ex,33,731952
!mp,nuxy,33,0.18
!mp,dens,33,150/(1000*g)
!mp,damp,33,0.07/df

!/COM - Material,34, Tank Concrete
!mp,ex,34,731952
!mp,nuxy,34,0.18
!mp,dens,34,150/(1000*g)

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```

!mp,damp,34,0.07/df

!/COM - Material,35, Tank Concrete
!mp,ex,35,731952
!mp,nuxy,35,0.18
!mp,dens,35,150/(1000*g)
!mp,damp,35,0.07/df

!/COM - Material,36, Tank Concrete
!mp,ex,36,731952
!mp,nuxy,36,0.18
!mp,dens,36,150/(1000*g)
!mp,damp,36,0.07/df

!/COM - Material,37, Tank Concrete
!mp,ex,37,731952
!mp,nuxy,37,0.18
!mp,dens,37,150/(1000*g)
!mp,damp,37,0.07/df

/COM - Concrete Real Values, t in ft
r,1,1.26 ! 15 in
r,2,1.26 ! 15 in
r,3,1.26 ! 15 in
r,4,1.26 ! 15 in
r,5,1.27 ! 15 in
r,6,1.26 ! 15 in
r,7,1.28 ! 15 in
r,8,1.28 ! 15 in
r,9,1.73 ! 15 in
r,10,1.73,1.73,2.23,2.23 ! 15 in to
r,11,2.23,2.22,3.15,3.15 !
r,12,3.15,3.15,1.50,1.50 !
r,13,1.50,1.50,1.28,1.28 !
r,14,1.17 ! 18 in
r,15,1.13 ! 18 in
r,16,1.13 ! 18 in
r,17,1.24 ! 18 in
r,18,1.07 ! 18 in
r,19,1.18 ! 18 in
r,20,1.07 ! 18 in
r,21,1.07 ! 18 in
r,22,1.97 ! 18 in
r,23,1.97,1.67,1.67,1.97 ! 18 in
r,24,1.67 !
r,25,1.68,1.43,1.43,1.68 !
r,26,1.43,0.51,0.51,1.43 ! 8 in
r,27,0.51,0.41,0.41,0.51 ! 8 in
r,28,0.41,0.55,0.55,0.41 ! 8 in
r,29,0.55 ! 8 in
r,30,0.55,0.40,0.40,0.55 ! 8 in
r,31,0.40,1.02,1.02,0.40 ! 8 in to
r,32,1.02 !
!r,34,1
!r,35,1
!r,36,1
!r,37,1
!r,39,1

/COM - Material,50, Insulating Concrete
mp,ex,50,23760
mp,nuxy,50,0.15
mp,dens,50,50/(1000*g)
mp,damp,50,0.07/df

```

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TH-266-Mean-Geo.txt

```
-0.000046 0.000024 0.000044-0.000025-0.000044 0.000024 0.000042-0.000025    1
-0.000042 0.000024 0.000040-0.000025-0.000040 0.000024 0.000037-0.000025    2
-0.000037 0.000024 0.000033-0.000025-0.000033 0.000023 0.000030-0.000026    3
.....
-0.000054 0.000023 0.000053-0.000023-0.000053 0.000023 0.000052-0.000023   510
-0.000052 0.000023 0.000051-0.000024-0.000051 0.000023 0.000050-0.000024   511
-0.000049 0.000023 0.000048-0.000024-0.000048 0.000023 0.000046-0.000024   512
```

TH-266-Mean-Geo-V.txt

```
-0.000029 0.000124 0.000029-0.000125-0.000029 0.000126 0.000030-0.000127    1
-0.000030 0.000128 0.000030-0.000128-0.000030 0.000130 0.000031-0.000130    2
-0.000031 0.000131 0.000032-0.000132-0.000032 0.000133 0.000033-0.000134    3
.....
-0.000026 0.000116 0.000026-0.000116-0.000026 0.000117 0.000027-0.000118   510
-0.000027 0.000118 0.000027-0.000119-0.000027 0.000120 0.000028-0.000120   511
-0.000028 0.000121 0.000028-0.000122-0.000028 0.000123 0.000029-0.000123   512
```

BES-BEC Seismic File Listing

Volume in drive C is 600GB 2xRAID0
Volume Serial Number is 8A0A-E4BA

Directory of C:\Users\FGA\2008-005 AP-460\AP-460-BES-BEC-Seismic 780 Secant

```
11/28/2007  03:32 PM  <DIR>          .
11/28/2007  03:32 PM  <DIR>          ..
09/01/2007  07:20 AM             561,576 Accel-ct-0.out
09/01/2007  07:21 AM             561,828 Accel-ct-135.out
09/01/2007  07:21 AM             561,828 Accel-ct-180.out
09/01/2007  07:20 AM             561,576 Accel-ct-45.out
09/01/2007  07:20 AM             561,828 Accel-ct-90.out
09/01/2007  07:20 AM             290,676 Accel-ct.out
09/01/2007  07:21 AM             561,828 Accel-PT-0.out
09/01/2007  07:21 AM             561,828 Accel-PT-135.out
09/01/2007  07:21 AM             561,828 Accel-PT-180.out
09/01/2007  07:21 AM             561,828 Accel-PT-45.out
09/01/2007  07:21 AM             561,828 Accel-PT-90.out
09/01/2007  07:21 AM             561,828 Accel-Soil.out
10/12/2006  02:42 PM              99 All-Forces.txt
09/01/2007  07:17 AM           4,757,137 AP-460-BEC-BES-Seismic.out
11/28/2007  03:26 PM           746,496 AP-460-BES-BEC J Bolt ForcesTH 780 Secant.xls
11/26/2007  09:37 AM           786,944 AP-460-BES-BEC J-Bolt-Contact-Seismic.xls
11/28/2007  01:39 PM           7,587,840 AP-460-BES-BEC Pri Tank Stress Seismic Only Compare.xls
11/27/2007  11:03 AM           7,571,968 AP-460-BES-BEC Pri Tank Stress Seismic Only.xls
11/27/2007  09:23 AM           7,297,024 AP-460-BES-BEC Pri Tank Stress Seismic.xls
09/01/2007  07:17 AM              2,998 AP-460-BES-BEC-Seismic.BCS
09/01/2007  07:17 AM          63,897,600 AP-460-BES-BEC-Seismic.db
09/01/2007  07:16 AM          63,897,600 AP-460-BES-BEC-Seismic.dbb
09/07/2007  07:23 AM              1,851 AP-460-BES-BEC-Seismic.DO1
09/02/2007  01:32 AM              537 AP-460-BES-BEC-Seismic.DO5
09/01/2007  07:17 AM          12,713,984 AP-460-BES-BEC-Seismic.emat
11/27/2007  08:52 AM           566,179 AP-460-BES-BEC-Seismic.err
09/01/2007  07:17 AM          111,607,808 AP-460-BES-BEC-Seismic.esav
09/01/2007  07:17 AM          30,081,024 AP-460-BES-BEC-Seismic.full
09/01/2007  07:16 AM          340,804,299 AP-460-BES-BEC-Seismic.ldhi
11/27/2007  09:15 AM           13,222 AP-460-BES-BEC-Seismic.log
09/01/2007  07:17 AM           198,991 AP-460-BES-BEC-Seismic.mntr
09/01/2007  07:16 AM          111,607,808 AP-460-BES-BEC-Seismic.osav
09/01/2007  07:17 AM           1,699 AP-460-BES-BEC-Seismic.PVTS
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09/01/2007	07:17 AM	112,656,384	AP-460-BES-BEC-Seismic.r001
08/30/2007	03:08 PM	43,974,656	AP-460-BES-BEC-Seismic.rdb
09/01/2007	07:17 AM	4,294,967,296	AP-460-BES-BEC-Seismic.rst
08/31/2007	12:04 AM	4,294,967,296	AP-460-BES-BEC-Seismic.rst02
08/31/2007	04:41 AM	4,294,967,296	AP-460-BES-BEC-Seismic.rst03
08/31/2007	09:26 AM	4,294,967,296	AP-460-BES-BEC-Seismic.rst04
08/31/2007	02:19 PM	4,294,967,296	AP-460-BES-BEC-Seismic.rst05
08/31/2007	07:19 PM	4,294,967,296	AP-460-BES-BEC-Seismic.rst06
09/01/2007	12:24 AM	4,294,967,296	AP-460-BES-BEC-Seismic.rst07
09/01/2007	05:36 AM	4,294,967,296	AP-460-BES-BEC-Seismic.rst08
09/01/2007	07:17 AM	1,388,445,696	AP-460-BES-BEC-Seismic.rst09
11/26/2007	03:52 PM	513	AP-460-LBS-BEC-Seismic.err
11/26/2007	03:52 PM	678	AP-460-LBS-BEC-Seismic.log
12/22/2006	09:40 AM	61,025	BES-BEC-Seismic-File-List.txt
08/15/2007	10:18 AM	6,120	Bolts-Friction.txt
09/08/2006	07:10 AM	277	Boundary.txt
08/25/2006	08:48 AM	220	Contact-AP.txt
08/21/2006	07:59 AM	586	Contact-Footing.txt
08/25/2006	01:28 PM	704	Contact-Insul.txt
08/25/2006	01:27 PM	704	Contact-J-Bolts.txt
08/25/2006	01:28 PM	708	Contact-Primary.txt
08/21/2006	07:59 AM	742	Contact-Soil.txt
08/21/2006	12:44 PM	632	Contact-Waste-AP.txt
11/28/2007	03:32 PM	0	dir_listing.txt
09/01/2007	07:20 AM	561,576	Disp-ct-0.out
09/01/2007	07:21 AM	561,576	Disp-ct-135.out
09/01/2007	07:21 AM	561,576	Disp-ct-180.out
09/01/2007	07:20 AM	561,576	Disp-ct-45.out
09/01/2007	07:20 AM	561,576	Disp-ct-90.out
09/01/2007	07:20 AM	290,550	Disp-ct.out
01/03/2006	11:17 AM	1,616	Disp-J-Bolts.txt
09/01/2007	07:21 AM	561,576	Disp-PT-0.out
09/01/2007	07:21 AM	561,576	Disp-PT-135.out
09/01/2007	07:21 AM	561,576	Disp-PT-180.out
09/01/2007	07:21 AM	561,576	Disp-PT-45.out
09/01/2007	07:21 AM	561,576	Disp-PT-90.out
09/01/2007	07:21 AM	561,576	Disp-Soil.out
05/08/2006	01:31 PM	8,616	Far-Soil.txt
01/09/2007	06:21 AM	50,902	File-List.txt
09/06/2007	09:16 AM	43,843,584	file.db
09/04/2007	08:26 AM	43,843,584	file.dbb
09/04/2007	08:03 AM	293	file.D01
09/06/2007	09:16 AM	211,205	file.err
09/06/2007	09:18 AM	6,999	file.log
12/20/2005	04:49 PM	39,925	file.txt
10/13/2005	06:54 AM	562	Fix-Soil.txt
09/01/2007	05:46 PM	10,342	Footing-Cont_max.OUT
09/01/2007	05:46 PM	4,346,248	Footing-Cont_th.OUT
08/21/2006	08:00 AM	894	Force-c.txt
09/01/2007	11:48 PM	4,996	Force-c_108amax.OUT
09/01/2007	11:48 PM	2,905,500	Force-c_108ath.OUT
09/01/2007	08:03 PM	14,716	Force-c_108max.OUT
09/01/2007	08:03 PM	6,519,180	Force-c_108th.OUT
09/01/2007	11:59 PM	4,996	Force-c_117amax.OUT
09/01/2007	11:59 PM	2,905,500	Force-c_117ath.OUT
09/01/2007	08:14 PM	14,716	Force-c_117max.OUT
09/01/2007	08:14 PM	6,519,180	Force-c_117th.OUT
09/02/2007	12:10 AM	4,996	Force-c_126amax.OUT
09/02/2007	12:10 AM	2,905,500	Force-c_126ath.OUT
09/01/2007	08:25 PM	14,716	Force-c_126max.OUT
09/01/2007	08:25 PM	6,519,180	Force-c_126th.OUT
09/02/2007	12:21 AM	4,996	Force-c_135amax.OUT
09/02/2007	12:21 AM	2,905,500	Force-c_135ath.OUT
09/01/2007	08:36 PM	14,716	Force-c_135max.OUT
09/01/2007	08:36 PM	6,519,180	Force-c_135th.OUT

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09/02/2007	12:32 AM	4,996	Force-c_144amax.OUT
09/02/2007	12:32 AM	2,905,500	Force-c_144ath.OUT
09/01/2007	08:48 PM	14,716	Force-c_144max.OUT
09/01/2007	08:48 PM	6,519,180	Force-c_144th.OUT
09/02/2007	12:43 AM	4,996	Force-c_153amax.OUT
09/02/2007	12:43 AM	2,905,500	Force-c_153ath.OUT
09/01/2007	09:00 PM	14,716	Force-c_153max.OUT
09/01/2007	09:00 PM	6,519,180	Force-c_153th.OUT
09/02/2007	12:54 AM	4,996	Force-c_162amax.OUT
09/02/2007	12:54 AM	2,905,500	Force-c_162ath.OUT
09/01/2007	09:10 PM	14,716	Force-c_162max.OUT
09/01/2007	09:10 PM	6,519,180	Force-c_162th.OUT
09/02/2007	01:05 AM	4,996	Force-c_171amax.OUT
09/02/2007	01:05 AM	2,905,500	Force-c_171ath.OUT
09/01/2007	09:22 PM	14,716	Force-c_171max.OUT
09/01/2007	09:22 PM	6,519,180	Force-c_171th.OUT
09/02/2007	01:17 AM	4,996	Force-c_180amax.OUT
09/02/2007	01:17 AM	2,905,500	Force-c_180ath.OUT
09/01/2007	09:34 PM	14,716	Force-c_180max.OUT
09/01/2007	09:34 PM	6,519,180	Force-c_180th.OUT
09/01/2007	09:57 PM	4,996	Force-c_18amax.OUT
09/01/2007	09:57 PM	2,905,500	Force-c_18ath.OUT
09/01/2007	06:09 PM	14,716	Force-c_18max.OUT
09/01/2007	06:09 PM	6,519,180	Force-c_18th.OUT
09/01/2007	10:08 PM	4,996	Force-c_27amax.OUT
09/01/2007	10:08 PM	2,905,500	Force-c_27ath.OUT
09/01/2007	06:20 PM	14,716	Force-c_27max.OUT
09/01/2007	06:20 PM	6,519,180	Force-c_27th.OUT
09/01/2007	10:19 PM	4,996	Force-c_36amax.OUT
09/01/2007	10:20 PM	2,905,500	Force-c_36ath.OUT
09/01/2007	06:32 PM	14,716	Force-c_36max.OUT
09/01/2007	06:32 PM	6,519,180	Force-c_36th.OUT
09/01/2007	10:31 PM	4,996	Force-c_45amax.OUT
09/01/2007	10:31 PM	2,905,500	Force-c_45ath.OUT
09/01/2007	06:43 PM	14,716	Force-c_45max.OUT
09/01/2007	06:43 PM	6,519,180	Force-c_45th.OUT
09/01/2007	10:41 PM	4,996	Force-c_54amax.OUT
09/01/2007	10:41 PM	2,905,500	Force-c_54ath.OUT
09/01/2007	06:54 PM	14,716	Force-c_54max.OUT
09/01/2007	06:54 PM	6,519,180	Force-c_54th.OUT
09/01/2007	10:52 PM	4,996	Force-c_63amax.OUT
09/01/2007	10:52 PM	2,905,500	Force-c_63ath.OUT
09/01/2007	07:06 PM	14,716	Force-c_63max.OUT
09/01/2007	07:06 PM	6,519,180	Force-c_63th.OUT
09/01/2007	11:03 PM	4,996	Force-c_72amax.OUT
09/01/2007	11:03 PM	2,905,500	Force-c_72ath.OUT
09/01/2007	07:16 PM	14,716	Force-c_72max.OUT
09/01/2007	07:16 PM	6,519,180	Force-c_72th.OUT
09/01/2007	11:14 PM	4,996	Force-c_81amax.OUT
09/01/2007	11:14 PM	2,905,500	Force-c_81ath.OUT
09/01/2007	07:28 PM	14,716	Force-c_81max.OUT
09/01/2007	07:28 PM	6,519,180	Force-c_81th.OUT
09/01/2007	11:25 PM	4,996	Force-c_90amax.OUT
09/01/2007	11:25 PM	2,905,500	Force-c_90ath.OUT
09/01/2007	07:39 PM	14,716	Force-c_90max.OUT
09/01/2007	07:39 PM	6,519,180	Force-c_90th.OUT
09/01/2007	11:36 PM	4,996	Force-c_99amax.OUT
09/01/2007	11:36 PM	2,905,500	Force-c_99ath.OUT
09/01/2007	07:51 PM	14,716	Force-c_99max.OUT
09/01/2007	07:51 PM	6,519,180	Force-c_99th.OUT
09/01/2007	09:45 PM	4,996	Force-c_9amax.OUT
09/01/2007	09:45 PM	2,905,628	Force-c_9ath.OUT
09/01/2007	05:57 PM	14,716	Force-c_9max.OUT
09/01/2007	05:57 PM	6,519,308	Force-c_9th.OUT
11/19/2007	01:45 PM	135,680	force-jb.xls

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09/07/2007	08:08 AM	2,666,244	Force-jb_r10-th.OUT
09/07/2007	08:08 AM	5,239	Force-jb_r10_max.OUT
09/07/2007	08:09 AM	2,666,244	Force-jb_r11-th.OUT
09/07/2007	08:09 AM	5,239	Force-jb_r11_max.OUT
09/07/2007	08:05 AM	2,666,372	Force-jb_r2-th.OUT
09/07/2007	08:05 AM	5,239	Force-jb_r2_max.OUT
09/07/2007	08:05 AM	2,666,244	Force-jb_r3-th.OUT
09/07/2007	08:05 AM	5,239	Force-jb_r3_max.OUT
09/07/2007	08:06 AM	2,666,244	Force-jb_r4-th.OUT
09/07/2007	08:06 AM	5,239	Force-jb_r4_max.OUT
09/07/2007	08:06 AM	2,666,244	Force-jb_r5-th.OUT
09/07/2007	08:06 AM	5,239	Force-jb_r5_max.OUT
09/07/2007	08:06 AM	2,666,244	Force-jb_r6-th.OUT
09/07/2007	08:06 AM	5,239	Force-jb_r6_max.OUT
09/07/2007	08:07 AM	2,666,244	Force-jb_r7-th.OUT
09/07/2007	08:07 AM	5,239	Force-jb_r7_max.OUT
09/07/2007	08:07 AM	2,666,244	Force-jb_r8-th.OUT
09/07/2007	08:07 AM	5,239	Force-jb_r8_max.OUT
09/07/2007	08:08 AM	2,666,244	Force-jb_r9-th.OUT
09/07/2007	08:08 AM	5,239	Force-jb_r9_max.OUT
09/07/2007	08:05 AM	833	Force-j_bolt-milon.txt
08/21/2006	08:00 AM	661	Force-j_bolt.txt
11/28/2007	02:54 PM	<DIR>	Gravity
09/01/2007	12:35 PM	4,024	Insul-Cont_108max.OUT
09/01/2007	12:35 PM	1,738,448	Insul-Cont_108th.OUT
09/01/2007	12:37 PM	4,024	Insul-Cont_117max.OUT
09/01/2007	12:37 PM	1,738,448	Insul-Cont_117th.OUT
09/01/2007	12:38 PM	4,024	Insul-Cont_126max.OUT
09/01/2007	12:38 PM	1,738,448	Insul-Cont_126th.OUT
09/01/2007	12:41 PM	4,024	Insul-Cont_135max.OUT
09/01/2007	12:41 PM	1,738,448	Insul-Cont_135th.OUT
09/01/2007	12:42 PM	4,024	Insul-Cont_144max.OUT
09/01/2007	12:42 PM	1,738,448	Insul-Cont_144th.OUT
09/01/2007	12:44 PM	4,024	Insul-Cont_153max.OUT
09/01/2007	12:44 PM	1,738,448	Insul-Cont_153th.OUT
09/01/2007	12:45 PM	4,024	Insul-Cont_162max.OUT
09/01/2007	12:45 PM	1,738,448	Insul-Cont_162th.OUT
09/01/2007	12:47 PM	4,024	Insul-Cont_171max.OUT
09/01/2007	12:47 PM	1,738,448	Insul-Cont_171th.OUT
09/01/2007	12:48 PM	4,024	Insul-Cont_180max.OUT
09/01/2007	12:48 PM	1,738,448	Insul-Cont_180th.OUT
09/01/2007	12:21 PM	4,024	Insul-Cont_18max.OUT
09/01/2007	12:21 PM	1,738,448	Insul-Cont_18th.OUT
09/01/2007	12:23 PM	4,024	Insul-Cont_27max.OUT
09/01/2007	12:23 PM	1,738,448	Insul-Cont_27th.OUT
09/01/2007	12:24 PM	4,024	Insul-Cont_36max.OUT
09/01/2007	12:24 PM	1,738,448	Insul-Cont_36th.OUT
09/01/2007	12:26 PM	4,024	Insul-Cont_45max.OUT
09/01/2007	12:26 PM	1,738,448	Insul-Cont_45th.OUT
09/01/2007	12:27 PM	4,024	Insul-Cont_54max.OUT
09/01/2007	12:27 PM	1,738,448	Insul-Cont_54th.OUT
09/01/2007	12:28 PM	4,024	Insul-Cont_63max.OUT
09/01/2007	12:28 PM	1,738,448	Insul-Cont_63th.OUT
09/01/2007	12:29 PM	4,024	Insul-Cont_72max.OUT
09/01/2007	12:29 PM	1,738,448	Insul-Cont_72th.OUT
09/01/2007	12:30 PM	4,024	Insul-Cont_81max.OUT
09/01/2007	12:30 PM	1,738,448	Insul-Cont_81th.OUT
09/01/2007	12:32 PM	4,024	Insul-Cont_90max.OUT
09/01/2007	12:32 PM	1,738,448	Insul-Cont_90th.OUT
09/01/2007	12:33 PM	4,024	Insul-Cont_99max.OUT
09/01/2007	12:33 PM	1,738,448	Insul-Cont_99th.OUT
09/01/2007	12:19 PM	4,024	Insul-Cont_9max.OUT
09/01/2007	12:19 PM	1,738,576	Insul-Cont_9th.OUT
09/01/2005	10:27 AM	1,664	Insulate.txt
07/20/2006	06:36 AM	4,030	interface-gap1.txt

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08/23/2006	07:55 AM	2,411	interfacel.txt
11/26/2007	08:39 AM	116,224	J-Bolt-Contact_0-90.xls
11/26/2007	08:45 AM	116,224	J-Bolt-Contact_99-180.xls
09/01/2007	02:03 PM	4,519	J-Bolt-Cont_108max.OUT
09/01/2007	02:03 PM	1,685,484	J-Bolt-Cont_108th.OUT
09/01/2007	02:05 PM	4,519	J-Bolt-Cont_117max.OUT
09/01/2007	02:05 PM	1,685,484	J-Bolt-Cont_117th.OUT
09/01/2007	02:07 PM	4,519	J-Bolt-Cont_126max.OUT
09/01/2007	02:07 PM	1,685,484	J-Bolt-Cont_126th.OUT
09/01/2007	02:10 PM	4,519	J-Bolt-Cont_135max.OUT
09/01/2007	02:10 PM	1,685,484	J-Bolt-Cont_135th.OUT
09/01/2007	02:11 PM	4,519	J-Bolt-Cont_144max.OUT
09/01/2007	02:11 PM	1,685,484	J-Bolt-Cont_144th.OUT
09/01/2007	02:11 PM	4,519	J-Bolt-Cont_153max.OUT
09/01/2007	02:11 PM	1,685,484	J-Bolt-Cont_153th.OUT
09/01/2007	02:11 PM	4,519	J-Bolt-Cont_162max.OUT
09/01/2007	02:11 PM	1,685,484	J-Bolt-Cont_162th.OUT
09/01/2007	02:15 PM	4,519	J-Bolt-Cont_171max.OUT
09/01/2007	02:15 PM	1,685,484	J-Bolt-Cont_171th.OUT
09/01/2007	02:17 PM	4,519	J-Bolt-Cont_180max.OUT
09/01/2007	02:17 PM	1,685,484	J-Bolt-Cont_180th.OUT
09/01/2007	01:41 PM	4,519	J-Bolt-Cont_18max.OUT
09/01/2007	01:41 PM	1,685,484	J-Bolt-Cont_18th.OUT
09/01/2007	01:43 PM	4,519	J-Bolt-Cont_27max.OUT
09/01/2007	01:43 PM	1,685,484	J-Bolt-Cont_27th.OUT
09/01/2007	01:45 PM	4,519	J-Bolt-Cont_36max.OUT
09/01/2007	01:45 PM	1,685,484	J-Bolt-Cont_36th.OUT
09/01/2007	01:48 PM	4,519	J-Bolt-Cont_45max.OUT
09/01/2007	01:48 PM	1,685,484	J-Bolt-Cont_45th.OUT
09/01/2007	01:52 PM	4,519	J-Bolt-Cont_54max.OUT
09/01/2007	01:52 PM	1,685,484	J-Bolt-Cont_54th.OUT
09/01/2007	01:54 PM	4,519	J-Bolt-Cont_63max.OUT
09/01/2007	01:54 PM	1,685,484	J-Bolt-Cont_63th.OUT
09/01/2007	01:55 PM	4,519	J-Bolt-Cont_72max.OUT
09/01/2007	01:55 PM	1,685,484	J-Bolt-Cont_72th.OUT
09/01/2007	01:58 PM	4,519	J-Bolt-Cont_81max.OUT
09/01/2007	01:58 PM	1,685,484	J-Bolt-Cont_81th.OUT
09/01/2007	02:00 PM	4,519	J-Bolt-Cont_90max.OUT
09/01/2007	02:00 PM	1,685,484	J-Bolt-Cont_90th.OUT
09/01/2007	02:01 PM	4,519	J-Bolt-Cont_99max.OUT
09/01/2007	02:01 PM	1,685,484	J-Bolt-Cont_99th.OUT
09/01/2007	01:39 PM	4,519	J-Bolt-Cont_9max.OUT
09/01/2007	01:39 PM	1,685,612	J-Bolt-Cont_9th.OUT
09/07/2007	07:23 AM	1,800	junk.out
08/23/2006	07:47 AM	1,971	Liner.txt
11/28/2007	08:46 AM	39,218	list.txt
05/02/2005	02:19 PM	667	live_load.txt
09/07/2007	07:46 AM	5,542	milon.out
07/21/2006	10:03 AM	6,214	Near-Soil-1.txt
04/20/2005	01:14 PM	508	outer-spar.txt
10/13/2006	01:29 PM	147	Post-Tank.txt
09/01/2007	01:17 PM	4,024	Primary-Cont_108max.OUT
09/01/2007	01:17 PM	1,738,448	Primary-Cont_108th.OUT
09/01/2007	01:20 PM	4,024	Primary-Cont_117max.OUT
09/01/2007	01:20 PM	1,738,448	Primary-Cont_117th.OUT
09/01/2007	01:22 PM	4,024	Primary-Cont_126max.OUT
09/01/2007	01:22 PM	1,738,448	Primary-Cont_126th.OUT
09/01/2007	01:24 PM	4,024	Primary-Cont_135max.OUT
09/01/2007	01:24 PM	1,738,448	Primary-Cont_135th.OUT
09/01/2007	01:26 PM	4,024	Primary-Cont_144max.OUT
09/01/2007	01:26 PM	1,738,448	Primary-Cont_144th.OUT
09/01/2007	01:28 PM	4,024	Primary-Cont_153max.OUT
09/01/2007	01:28 PM	1,738,448	Primary-Cont_153th.OUT
09/01/2007	01:30 PM	4,024	Primary-Cont_162max.OUT
09/01/2007	01:30 PM	1,738,448	Primary-Cont_162th.OUT

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09/01/2007	01:33	PM	4,024	Primary-Cont_171max.OUT
09/01/2007	01:33	PM	1,738,448	Primary-Cont_171th.OUT
09/01/2007	01:35	PM	4,024	Primary-Cont_180max.OUT
09/01/2007	01:35	PM	1,738,448	Primary-Cont_180th.OUT
09/01/2007	12:55	PM	4,024	Primary-Cont_18max.OUT
09/01/2007	12:55	PM	1,738,448	Primary-Cont_18th.OUT
09/01/2007	12:57	PM	4,024	Primary-Cont_27max.OUT
09/01/2007	12:57	PM	1,738,448	Primary-Cont_27th.OUT
09/01/2007	12:59	PM	4,024	Primary-Cont_36max.OUT
09/01/2007	12:59	PM	1,738,448	Primary-Cont_36th.OUT
09/01/2007	01:02	PM	4,024	Primary-Cont_45max.OUT
09/01/2007	01:02	PM	1,738,448	Primary-Cont_45th.OUT
09/01/2007	01:04	PM	4,024	Primary-Cont_54max.OUT
09/01/2007	01:04	PM	1,738,448	Primary-Cont_54th.OUT
09/01/2007	01:06	PM	4,024	Primary-Cont_63max.OUT
09/01/2007	01:06	PM	1,738,448	Primary-Cont_63th.OUT
09/01/2007	01:08	PM	4,024	Primary-Cont_72max.OUT
09/01/2007	01:08	PM	1,738,448	Primary-Cont_72th.OUT
09/01/2007	01:11	PM	4,024	Primary-Cont_81max.OUT
09/01/2007	01:11	PM	1,738,448	Primary-Cont_81th.OUT
09/01/2007	01:13	PM	4,024	Primary-Cont_90max.OUT
09/01/2007	01:13	PM	1,738,448	Primary-Cont_90th.OUT
09/01/2007	01:15	PM	4,024	Primary-Cont_99max.OUT
09/01/2007	01:15	PM	1,738,448	Primary-Cont_99th.OUT
09/01/2007	12:52	PM	4,024	Primary-Cont_9max.OUT
09/01/2007	12:52	PM	1,738,576	Primary-Cont_9th.OUT
10/12/2006	02:28	PM	6,028	Primary-Props-AP.txt
09/27/2005	03:52	PM	1,538	Primary.txt
08/30/2007	03:08	PM	450,096	QA.out
09/01/2007	07:20	AM	47,121	RS-ct-0.out
09/01/2007	07:21	AM	47,121	RS-ct-135.out
09/01/2007	07:21	AM	47,121	RS-ct-180.out
09/01/2007	07:20	AM	47,121	RS-ct-45.out
09/01/2007	07:20	AM	47,121	RS-ct-90.out
09/01/2007	07:20	AM	27,591	RS-ct.out
08/28/2006	10:32	AM	47,121	RS-OUT-Concrete.txt
08/28/2006	08:24	AM	34,101	RS-OUT-Soil.txt
09/01/2007	07:21	AM	47,121	RS-PT-0.out
09/01/2007	07:21	AM	47,121	RS-PT-135.out
09/01/2007	07:21	AM	47,121	RS-PT-180.out
09/01/2007	07:21	AM	47,121	RS-PT-45.out
09/01/2007	07:21	AM	47,121	RS-PT-90.out
09/01/2007	07:21	AM	47,121	RS-Soil.out
05/22/2006	02:21	PM	1,285	RS_FREQ-d.txt
10/31/2005	10:31	AM	1,108	RS_FREQ.txt
08/23/2006	09:01	AM	1,816	Run-Tank.txt
11/27/2007	08:52	AM	0	scratch.hlp
02/11/2005	01:22	PM	1,053	Slave.txt
09/01/2007	04:06	PM	9,896	Soil-Contact_108max.OUT
09/01/2007	04:06	PM	4,348,080	Soil-Contact_108th.OUT
09/01/2007	04:15	PM	9,896	Soil-Contact_117max.OUT
09/01/2007	04:15	PM	4,348,080	Soil-Contact_117th.OUT
09/01/2007	04:25	PM	9,896	Soil-Contact_126max.OUT
09/01/2007	04:25	PM	4,348,080	Soil-Contact_126th.OUT
09/01/2007	04:34	PM	9,896	Soil-Contact_135max.OUT
09/01/2007	04:34	PM	4,348,080	Soil-Contact_135th.OUT
09/01/2007	04:43	PM	9,896	Soil-Contact_144max.OUT
09/01/2007	04:43	PM	4,348,080	Soil-Contact_144th.OUT
09/01/2007	04:53	PM	9,896	Soil-Contact_153max.OUT
09/01/2007	04:53	PM	4,348,080	Soil-Contact_153th.OUT
09/01/2007	05:02	PM	9,896	Soil-Contact_162max.OUT
09/01/2007	05:02	PM	4,348,080	Soil-Contact_162th.OUT
09/01/2007	05:11	PM	9,896	Soil-Contact_171max.OUT
09/01/2007	05:11	PM	4,348,080	Soil-Contact_171th.OUT
09/01/2007	05:20	PM	9,896	Soil-Contact_180max.OUT

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09/01/2007	05:20 PM	4,348,080	Soil-Contact_180th.OUT
09/01/2007	02:34 PM	9,896	Soil-Contact_18max.OUT
09/01/2007	02:34 PM	4,348,080	Soil-Contact_18th.OUT
09/01/2007	02:44 PM	9,896	Soil-Contact_27max.OUT
09/01/2007	02:44 PM	4,348,080	Soil-Contact_27th.OUT
09/01/2007	02:53 PM	9,896	Soil-Contact_36max.OUT
09/01/2007	02:53 PM	4,348,080	Soil-Contact_36th.OUT
09/01/2007	03:02 PM	9,896	Soil-Contact_45max.OUT
09/01/2007	03:02 PM	4,348,080	Soil-Contact_45th.OUT
09/01/2007	03:11 PM	9,896	Soil-Contact_54max.OUT
09/01/2007	03:11 PM	4,348,080	Soil-Contact_54th.OUT
09/01/2007	03:20 PM	9,896	Soil-Contact_63max.OUT
09/01/2007	03:20 PM	4,348,080	Soil-Contact_63th.OUT
09/01/2007	03:29 PM	9,896	Soil-Contact_72max.OUT
09/01/2007	03:30 PM	4,348,080	Soil-Contact_72th.OUT
09/01/2007	03:39 PM	9,896	Soil-Contact_81max.OUT
09/01/2007	03:39 PM	4,348,080	Soil-Contact_81th.OUT
09/01/2007	03:48 PM	9,896	Soil-Contact_90max.OUT
09/01/2007	03:48 PM	4,348,080	Soil-Contact_90th.OUT
09/01/2007	03:57 PM	9,896	Soil-Contact_99max.OUT
09/01/2007	03:57 PM	4,348,080	Soil-Contact_99th.OUT
09/01/2007	02:25 PM	9,896	Soil-Contact_9max.OUT
09/01/2007	02:25 PM	4,348,208	Soil-Contact_9th.OUT
11/11/2005	10:36 AM	4,989	Soil-Prop-Mean-Geo.txt
08/25/2006	08:47 AM	1,918	Solve-TH-BES.txt
09/13/2006	06:12 AM	347	spectra-all.txt
10/30/2006	03:57 PM	3,074	spectra-base.txt
09/13/2006	06:07 AM	3,690	spectra-conc-0.txt
09/13/2006	06:08 AM	3,723	spectra-conc-135.txt
09/13/2006	06:09 AM	3,723	spectra-conc-180.txt
09/13/2006	06:08 AM	3,769	spectra-conc-45.txt
09/13/2006	06:08 AM	3,649	spectra-conc-90.txt
10/16/2006	02:18 PM	1,596	spectra-conc.txt
08/28/2006	09:38 AM	2,076	spectra-concrete.txt
10/03/2006	02:02 PM	3,624	spectra-primary-0.txt
10/03/2006	02:04 PM	3,777	spectra-primary-135.txt
09/13/2006	06:15 AM	3,777	spectra-primary-180.txt
10/03/2006	02:03 PM	3,703	spectra-primary-45.txt
10/03/2006	02:03 PM	3,703	spectra-primary-90.txt
09/13/2006	06:15 AM	3,801	spectra-soil.txt
06/20/2005	09:04 AM	647	spectra-wall.txt
06/20/2005	08:52 AM	679	spectra-waste.txt
11/27/2007	08:21 AM	276,480	str-comp_0-90b.xls
11/27/2007	08:26 AM	276,480	str-comp_0-90m.xls
11/27/2007	08:31 AM	276,992	str-comp_0-90t.xls
11/27/2007	08:24 AM	276,480	str-comp_99-180b.xls
11/27/2007	08:29 AM	276,480	str-comp_99-180m.xls
11/27/2007	09:15 AM	276,480	str-comp_99-180t.xls
01/03/2007	03:40 PM	1,823	strain-backed-principle-bot.txt
01/03/2007	03:40 PM	1,828	strain-backed-principle-mid.txt
01/03/2007	03:41 PM	1,825	strain-backed-principle-top.txt
01/03/2007	04:02 PM	966	strain-backed-principle.txt
08/21/2006	08:02 AM	598	stress-compb.txt
08/21/2006	08:03 AM	608	stress-compm.txt
11/27/2007	09:10 AM	598	stress-compt.txt
11/27/2007	09:10 AM	224	Stress-Primary.txt
11/26/2007	09:54 PM	13,519	Stress-pt_108max-b.OUT
11/26/2007	06:09 PM	13,519	Stress-pt_108max-m.OUT
09/02/2007	04:12 AM	13,519	Stress-pt_108max-t.OUT
11/26/2007	09:54 PM	6,443,068	Stress-pt_108th-b.OUT
11/26/2007	06:09 PM	6,443,068	Stress-pt_108th-m.OUT
09/02/2007	04:12 AM	6,412,940	Stress-pt_108th-t.OUT
11/26/2007	10:06 PM	13,519	Stress-pt_117max-b.OUT
11/26/2007	06:21 PM	13,519	Stress-pt_117max-m.OUT
09/02/2007	04:27 AM	13,519	Stress-pt_117max-t.OUT

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11/26/2007	10:06 PM	6,443,068	Stress-pt_117th-b.OUT
11/26/2007	06:21 PM	6,443,068	Stress-pt_117th-m.OUT
09/02/2007	04:27 AM	6,412,940	Stress-pt_117th-t.OUT
11/26/2007	10:16 PM	13,519	Stress-pt_126max-b.OUT
11/26/2007	06:31 PM	13,519	Stress-pt_126max-m.OUT
09/02/2007	04:41 AM	13,519	Stress-pt_126max-t.OUT
11/26/2007	10:16 PM	6,443,068	Stress-pt_126th-b.OUT
11/26/2007	06:31 PM	6,443,068	Stress-pt_126th-m.OUT
09/02/2007	04:41 AM	6,412,940	Stress-pt_126th-t.OUT
11/26/2007	10:27 PM	13,519	Stress-pt_135max-b.OUT
11/26/2007	06:42 PM	13,519	Stress-pt_135max-m.OUT
09/02/2007	04:55 AM	13,519	Stress-pt_135max-t.OUT
11/26/2007	10:27 PM	6,443,068	Stress-pt_135th-b.OUT
11/26/2007	06:42 PM	6,443,068	Stress-pt_135th-m.OUT
09/02/2007	04:55 AM	6,412,940	Stress-pt_135th-t.OUT
11/26/2007	10:38 PM	13,519	Stress-pt_144max-b.OUT
11/26/2007	06:53 PM	13,519	Stress-pt_144max-m.OUT
09/02/2007	05:10 AM	13,519	Stress-pt_144max-t.OUT
11/26/2007	10:38 PM	6,443,068	Stress-pt_144th-b.OUT
11/26/2007	06:53 PM	6,443,068	Stress-pt_144th-m.OUT
09/02/2007	05:10 AM	6,412,940	Stress-pt_144th-t.OUT
11/26/2007	10:50 PM	13,519	Stress-pt_153max-b.OUT
11/26/2007	07:05 PM	13,519	Stress-pt_153max-m.OUT
09/02/2007	05:24 AM	13,519	Stress-pt_153max-t.OUT
11/26/2007	10:50 PM	6,443,068	Stress-pt_153th-b.OUT
11/26/2007	07:05 PM	6,443,068	Stress-pt_153th-m.OUT
09/02/2007	05:24 AM	6,412,940	Stress-pt_153th-t.OUT
11/26/2007	11:01 PM	13,519	Stress-pt_162max-b.OUT
11/26/2007	07:16 PM	13,519	Stress-pt_162max-m.OUT
09/02/2007	05:39 AM	13,519	Stress-pt_162max-t.OUT
11/26/2007	11:01 PM	6,443,068	Stress-pt_162th-b.OUT
11/26/2007	07:16 PM	6,443,068	Stress-pt_162th-m.OUT
09/02/2007	05:39 AM	6,412,940	Stress-pt_162th-t.OUT
11/26/2007	11:12 PM	13,521	Stress-pt_171max-b.OUT
11/26/2007	07:28 PM	13,521	Stress-pt_171max-m.OUT
09/02/2007	05:53 AM	13,521	Stress-pt_171max-t.OUT
11/26/2007	11:12 PM	6,443,068	Stress-pt_171th-b.OUT
11/26/2007	07:28 PM	6,443,068	Stress-pt_171th-m.OUT
09/02/2007	05:53 AM	6,412,940	Stress-pt_171th-t.OUT
11/26/2007	11:24 PM	13,521	Stress-pt_180max-b.OUT
11/26/2007	07:39 PM	13,521	Stress-pt_180max-m.OUT
11/27/2007	09:05 AM	13,521	Stress-pt_180max-t.OUT
11/26/2007	11:24 PM	6,443,068	Stress-pt_180th-b.OUT
11/26/2007	07:39 PM	6,443,068	Stress-pt_180th-m.OUT
11/27/2007	09:05 AM	6,412,940	Stress-pt_180th-t.OUT
11/26/2007	08:02 PM	13,519	Stress-pt_18max-b.OUT
11/26/2007	04:16 PM	13,519	Stress-pt_18max-m.OUT
09/02/2007	01:46 AM	13,519	Stress-pt_18max-t.OUT
11/26/2007	08:02 PM	6,443,068	Stress-pt_18th-b.OUT
11/26/2007	04:16 PM	6,443,068	Stress-pt_18th-m.OUT
09/02/2007	01:46 AM	6,412,940	Stress-pt_18th-t.OUT
11/26/2007	08:13 PM	13,519	Stress-pt_27max-b.OUT
11/26/2007	04:28 PM	13,519	Stress-pt_27max-m.OUT
09/02/2007	02:01 AM	13,519	Stress-pt_27max-t.OUT
11/26/2007	08:13 PM	6,443,068	Stress-pt_27th-b.OUT
11/26/2007	04:28 PM	6,443,068	Stress-pt_27th-m.OUT
09/02/2007	02:01 AM	6,412,940	Stress-pt_27th-t.OUT
11/26/2007	08:25 PM	13,519	Stress-pt_36max-b.OUT
11/26/2007	04:40 PM	13,519	Stress-pt_36max-m.OUT
09/02/2007	02:15 AM	13,519	Stress-pt_36max-t.OUT
11/26/2007	08:25 PM	6,443,068	Stress-pt_36th-b.OUT
11/26/2007	04:40 PM	6,443,068	Stress-pt_36th-m.OUT
09/02/2007	02:15 AM	6,412,940	Stress-pt_36th-t.OUT
11/26/2007	08:36 PM	13,519	Stress-pt_45max-b.OUT
11/26/2007	04:51 PM	13,519	Stress-pt_45max-m.OUT

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09/02/2007	02:30 AM	13,519	Stress-pt_45max-t.OUT
11/26/2007	08:36 PM	6,443,068	Stress-pt_45th-b.OUT
11/26/2007	04:51 PM	6,443,068	Stress-pt_45th-m.OUT
09/02/2007	02:30 AM	6,412,940	Stress-pt_45th-t.OUT
11/26/2007	08:47 PM	13,519	Stress-pt_54max-b.OUT
11/26/2007	05:02 PM	13,519	Stress-pt_54max-m.OUT
09/02/2007	02:44 AM	13,519	Stress-pt_54max-t.OUT
11/26/2007	08:47 PM	6,443,068	Stress-pt_54th-b.OUT
11/26/2007	05:02 PM	6,443,068	Stress-pt_54th-m.OUT
09/02/2007	02:44 AM	6,412,940	Stress-pt_54th-t.OUT
11/26/2007	08:58 PM	13,519	Stress-pt_63max-b.OUT
11/26/2007	05:13 PM	13,519	Stress-pt_63max-m.OUT
09/02/2007	02:59 AM	13,519	Stress-pt_63max-t.OUT
11/26/2007	08:58 PM	6,443,068	Stress-pt_63th-b.OUT
11/26/2007	05:13 PM	6,443,068	Stress-pt_63th-m.OUT
09/02/2007	02:59 AM	6,412,940	Stress-pt_63th-t.OUT
11/26/2007	09:09 PM	13,519	Stress-pt_72max-b.OUT
11/26/2007	05:24 PM	13,519	Stress-pt_72max-m.OUT
09/02/2007	03:13 AM	13,519	Stress-pt_72max-t.OUT
11/26/2007	09:09 PM	6,443,068	Stress-pt_72th-b.OUT
11/26/2007	05:24 PM	6,443,068	Stress-pt_72th-m.OUT
09/02/2007	03:13 AM	6,412,940	Stress-pt_72th-t.OUT
11/26/2007	09:20 PM	13,519	Stress-pt_81max-b.OUT
11/26/2007	05:35 PM	13,519	Stress-pt_81max-m.OUT
09/02/2007	03:27 AM	13,519	Stress-pt_81max-t.OUT
11/26/2007	09:20 PM	6,443,068	Stress-pt_81th-b.OUT
11/26/2007	05:35 PM	6,443,068	Stress-pt_81th-m.OUT
09/02/2007	03:27 AM	6,412,940	Stress-pt_81th-t.OUT
11/26/2007	09:32 PM	13,519	Stress-pt_90max-b.OUT
11/26/2007	05:47 PM	13,519	Stress-pt_90max-m.OUT
09/02/2007	03:41 AM	13,519	Stress-pt_90max-t.OUT
11/26/2007	09:32 PM	6,443,068	Stress-pt_90th-b.OUT
11/26/2007	05:47 PM	6,443,068	Stress-pt_90th-m.OUT
09/02/2007	03:41 AM	6,412,940	Stress-pt_90th-t.OUT
11/26/2007	09:43 PM	13,519	Stress-pt_99max-b.OUT
11/26/2007	05:58 PM	13,519	Stress-pt_99max-m.OUT
09/02/2007	03:56 AM	13,519	Stress-pt_99max-t.OUT
11/26/2007	09:43 PM	6,443,068	Stress-pt_99th-b.OUT
11/26/2007	05:58 PM	6,443,068	Stress-pt_99th-m.OUT
09/02/2007	03:56 AM	6,412,940	Stress-pt_99th-t.OUT
11/26/2007	07:51 PM	13,519	Stress-pt_9max-b.OUT
11/26/2007	04:05 PM	13,519	Stress-pt_9max-m.OUT
09/02/2007	01:32 AM	13,519	Stress-pt_9max-t.OUT
11/26/2007	07:51 PM	6,443,196	Stress-pt_9th-b.OUT
11/26/2007	04:05 PM	6,443,196	Stress-pt_9th-m.OUT
09/02/2007	01:32 AM	6,413,068	Stress-pt_9th-t.OUT
10/12/2006	02:29 PM	4,009	Tank-Coordinates-AP.txt
05/25/2005	03:32 PM	2,512	Tank-Mesh1.txt
08/30/2007	03:07 PM	102	tank-out.out
08/25/2006	07:52 AM	5,450	Tank-Props-BEC-250.txt
07/21/2006	09:41 AM	5,591	Tank-Props-Rigid.txt
08/30/2007	03:08 PM	4,687	Tank-th.out
09/06/2007	10:14 AM	683	temp.txt
08/09/2006	07:43 AM	23,166	TH-266-Mean-Geo-V.txt
08/09/2006	07:31 AM	23,166	TH-266-Mean-Geo.txt
09/01/2007	07:20 AM	561,576	Vel-ct-0.out
09/01/2007	07:21 AM	561,576	Vel-ct-135.out
09/01/2007	07:21 AM	561,576	Vel-ct-180.out
09/01/2007	07:20 AM	561,576	Vel-ct-45.out
09/01/2007	07:20 AM	561,576	Vel-ct-90.out
09/01/2007	07:20 AM	290,550	Vel-ct.out
09/01/2007	07:21 AM	561,576	Vel-PT-0.out
09/01/2007	07:21 AM	561,576	Vel-PT-135.out
09/01/2007	07:21 AM	561,576	Vel-PT-180.out
09/01/2007	07:21 AM	561,576	Vel-PT-45.out

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09/01/2007	07:21 AM	561,576	Vel-PT-90.out
09/01/2007	07:21 AM	561,576	Vel-Soil.out
09/01/2007	10:43 AM	10,180	Waste-Cont_108max.OUT
09/01/2007	10:43 AM	4,875,649	Waste-Cont_108th.OUT
09/01/2007	10:55 AM	10,180	Waste-Cont_117max.OUT
09/01/2007	10:55 AM	4,875,649	Waste-Cont_117th.OUT
09/01/2007	11:06 AM	10,180	Waste-Cont_126max.OUT
09/01/2007	11:06 AM	4,875,649	Waste-Cont_126th.OUT
09/01/2007	11:18 AM	10,180	Waste-Cont_135max.OUT
09/01/2007	11:18 AM	4,875,649	Waste-Cont_135th.OUT
09/01/2007	11:29 AM	10,180	Waste-Cont_144max.OUT
09/01/2007	11:30 AM	4,875,649	Waste-Cont_144th.OUT
09/01/2007	11:41 AM	10,180	Waste-Cont_153max.OUT
09/01/2007	11:41 AM	4,875,649	Waste-Cont_153th.OUT
09/01/2007	11:52 AM	10,180	Waste-Cont_162max.OUT
09/01/2007	11:52 AM	4,875,649	Waste-Cont_162th.OUT
09/01/2007	12:04 PM	10,180	Waste-Cont_171max.OUT
09/01/2007	12:04 PM	4,875,649	Waste-Cont_171th.OUT
09/01/2007	12:16 PM	10,180	Waste-Cont_180max.OUT
09/01/2007	12:16 PM	4,875,649	Waste-Cont_180th.OUT
09/01/2007	08:42 AM	10,180	Waste-Cont_18max.OUT
09/01/2007	08:42 AM	4,875,649	Waste-Cont_18th.OUT
09/01/2007	09:00 AM	10,180	Waste-Cont_27max.OUT
09/01/2007	09:00 AM	4,875,649	Waste-Cont_27th.OUT
09/01/2007	09:11 AM	10,180	Waste-Cont_36max.OUT
09/01/2007	09:11 AM	4,875,649	Waste-Cont_36th.OUT
09/01/2007	09:23 AM	10,180	Waste-Cont_45max.OUT
09/01/2007	09:23 AM	4,875,649	Waste-Cont_45th.OUT
09/01/2007	09:34 AM	10,180	Waste-Cont_54max.OUT
09/01/2007	09:34 AM	4,875,649	Waste-Cont_54th.OUT
09/01/2007	09:45 AM	10,180	Waste-Cont_63max.OUT
09/01/2007	09:45 AM	4,875,649	Waste-Cont_63th.OUT
09/01/2007	09:56 AM	10,180	Waste-Cont_72max.OUT
09/01/2007	09:56 AM	4,875,649	Waste-Cont_72th.OUT
09/01/2007	10:08 AM	10,180	Waste-Cont_81max.OUT
09/01/2007	10:08 AM	4,875,649	Waste-Cont_81th.OUT
09/01/2007	10:20 AM	10,180	Waste-Cont_90max.OUT
09/01/2007	10:20 AM	4,875,649	Waste-Cont_90th.OUT
09/01/2007	10:31 AM	10,180	Waste-Cont_99max.OUT
09/01/2007	10:31 AM	4,875,649	Waste-Cont_99th.OUT
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Appendix H

Upper Bound Soil, Best Estimate Concrete

Results Load Case Specific Input Files File Listing

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Appendix H

Upper Bound Soil, Best Estimate Concrete

Results Load Case Specific Input Files File Listing

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Table H.1. UBS-BEC Concrete Forces and Moment, Gravity Load Only

AP Primary Tank, Upper Bound Soil (Geomatrix), Gravity Only, Best Estimate Concrete, 460 in. Waste Level at 1.83 SpG

ANSYS MAXIMUMS BY PATH

PNNL Section No.	Path (in.)	Gravity Hoop Force (kip/ft) AP- UBS-BEC	Gravity Meridional Force (kip/ft) AP-UBS-BEC	Gravity -In- Plane Shear Force (kip/ft) AP-UBS-BEC	Gravity Hoop Moment (ft*kip/ft) AP- UBS-BEC	Gravity Meridional Moment (ft*kip/ft) AP-UBS-BEC	Gravity Through-Wall Shear Force (kip/ft) AP-UBS- BEC
2	67.734	-69.410	-74.460	-0.072	-8.576	-5.449	1.759
3	105.676	-62.430	-72.330	-0.076	-6.342	-2.705	1.264
4	137.076	-55.370	-69.950	-0.118	-4.600	-0.353	1.449
6	182.856	-46.480	-65.970	-0.151	-2.740	2.189	0.566
8	226.570	-39.590	-62.720	-0.045	-1.858	1.464	-0.500
9	275.574	-33.840	-59.530	-0.072	-1.692	-0.047	-0.579
11	325.697	-26.210	-57.030	-0.033	-1.871	-2.710	-0.650
13	372.312	-16.800	-54.780	0.072	-3.958	-3.227	-0.209
17	423.434	-6.761	-52.680	0.104	-1.474	-0.406	2.161
20	468.315	24.610	-50.820	0.119	-4.868	16.550	7.303
22	515.319	9.539	-50.480	0.072	4.106	25.040	-4.144
24	553.722	-2.727	-47.960	0.040	1.371	7.485	-5.798
26	593.805	-12.990	-49.340	-0.022	-0.264	-1.462	-0.886
30	644.355	-19.210	-50.880	0.011	-0.250	-1.389	0.687
33	693.605	-21.350	-52.100	0.008	-0.008	-0.044	0.049
35	740.705	-23.900	-53.400	0.006	0.024	0.132	-0.021
38	786.205	-21.500	-54.650	0.005	-0.109	-0.604	-0.155
41	844.605	-21.740	-56.270	0.004	-0.048	-0.268	-0.160
43	901.355	-11.290	-23.860	0.002	-0.212	-1.174	0.202
46	932.355	-19.870	-57.220	0.029	-0.653	-3.582	-1.056
48	1007.355	-2.220	-8.751	0.547	-2.896	14.650	-8.440
51	1053.855	-2.412	-11.600	0.762	-0.224	10.270	9.595
53	1086.855	-0.718	-4.912	0.358	1.698	6.434	-4.284
55	1105.855	0.478	-3.251	0.314	1.607	3.343	-0.508
57	1147.355	0.146	-1.541	0.147	0.172	0.624	-0.750
58	1207.355	0.338	0.172	0.024	-0.012	-0.081	0.196
59	1267.355	0.341	0.345	-0.009	0.017	0.085	-0.166
60	1327.355	0.475	0.146	0.036	-0.022	-0.129	0.155
61	1387.355	0.450	0.597	-0.020	0.016	0.039	-0.119
62	1449.355	2.264	2.390	-0.036	0.025	-0.029	0.240

Note: Meridional/Hoop Forces and Meridional/Hoop Moments are Reversed in Highlighted Sections.

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Table H.2. UBS-BEC Concrete Forces and Moments, Gravity Plus Seismic Load

**AP- Primary Tank, Upper Bound Soil (Geomatrix), Best Estimate Concrete,
460 in. Waste Level at 1.83 SpG**

ANSYS MAXIMUMS BY PATH

PNNL Section No.	Path (in.)	Seismic Hoop Force (kip/ft) AP- UBS-BEC	Seismic Meridional Force (kip/ft) AP-UBS-BEC	Seismic In-Plane Shear Force (kip/ft) AP-UBS-BEC	Seismic Hoop Moment (ft*kip/ft) AP- UBS-BEC	Seismic Meridional Moment (ft*kip/ft) AP-UBS-BEC	Seismic Through-Wall Shear Force (kip/ft) AP-UBS- BEC
2	67.734	-103.900	-113.000	4.856	-19.810	-15.180	4.528
3	105.676	-92.840	-108.400	6.714	-15.150	-12.180	3.446
4	137.076	-81.560	-103.300	7.732	-11.100	-7.493	3.735
6	182.856	-67.230	-95.150	8.727	-6.310	7.211	2.769
8	226.570	-62.250	-86.830	10.470	-3.880	8.797	1.401
9	275.574	-56.500	-79.710	12.550	-3.306	3.917	1.263
11	325.697	-47.570	-74.290	14.780	-3.064	-4.724	1.311
13	372.312	-45.490	-70.310	16.800	-5.947	-5.676	0.900
17	423.434	-17.450	-67.590	19.100	-2.814	-4.724	3.235
20	468.315	63.220	-65.180	21.520	-10.030	24.920	9.534
22	515.319	19.210	-64.410	20.710	5.829	33.590	6.383
24	553.722	-8.599	-60.400	18.360	1.795	9.814	7.800
26	593.805	-18.510	-62.570	17.200	-0.383	-2.051	1.142
30	644.355	-24.670	-64.490	16.320	-0.322	-1.752	0.887
33	693.605	-26.560	-65.320	15.940	-0.045	-0.200	0.086
35	740.705	-29.160	-66.550	16.540	0.044	0.223	0.068
38	786.205	-25.710	-67.690	17.410	-0.136	-0.723	0.237
41	844.605	-26.280	-69.090	19.260	-0.127	-0.658	0.336
43	901.355	-13.420	-29.420	10.010	-0.304	-1.680	0.695
46	932.355	-31.060	-69.910	25.870	-0.827	-4.653	1.580
48	1007.355	-8.971	-15.030	6.888	-3.586	18.730	10.790
51	1053.855	-25.790	-19.290	12.370	-0.737	13.430	12.170
53	1086.855	-7.688	-11.170	7.282	2.289	8.229	5.182
55	1105.855	19.890	-9.631	6.783	2.503	4.929	0.828
57	1147.355	-4.624	-6.422	3.789	0.274	0.964	1.138
58	1207.355	2.394	2.794	1.617	-0.018	-0.121	0.292
59	1267.355	1.958	2.346	0.950	0.026	0.125	0.248
60	1327.355	2.465	2.060	0.840	-0.032	-0.170	0.244
61	1387.355	1.632	2.479	0.604	0.022	0.061	0.205
62	1449.355	5.977	5.532	0.774	0.082	-0.156	0.368

Note: Meridional/Hoop Forces and Meridional/Hoop Moments are Reversed in Highlighted Sections.

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Table H.3. UBS-BEC Concrete Forces and Moments, Seismic Only

**AP- Primary Tank, Upper Bound Soil (Geomatrix), Best Estimate Concrete,
460 in. Waste Level at 1.83 SpG**

ANSYS MAXIMUMS BY PATH

PNNL Section No.	Path (in.)	Seismic Only Hoop Force (kip/ft) AP-UBS- BEC	Seismic Only Meridonal Force (kip/ft) AP-UBS-BEC	Seismic Only - In-Plane Shear Force (kip/ft) AP-UBS-BEC	Seismic Only Hoop Moment (ft*kip/ft) AP- UBS-BEC	Seismic Only Meridonal Moment (ft*kip/ft) AP-UBS- BEC	Seismic Only Through-Wall Shear Force (kip/ft) AP-UBS BEC
2	67.734	34.600	38.540	4.833	11.325	10.425	2.780
3	105.676	30.510	36.090	6.735	8.886	9.536	2.460
4	137.076	26.330	33.350	7.776	6.528	7.482	2.596
6	182.856	22.860	29.180	8.815	3.706	5.916	2.776
8	226.570	24.180	24.130	10.491	2.109	8.946	1.086
9	275.574	25.245	20.190	12.549	1.832	3.927	1.022
11	325.697	23.465	17.260	14.785	1.485	2.367	0.729
13	372.312	28.990	15.530	16.821	2.446	2.769	0.875
17	423.434	10.780	14.930	19.127	1.395	4.407	1.112
20	468.315	39.180	14.380	21.549	5.322	8.390	2.274
22	515.319	11.178	13.970	20.727	1.732	8.590	2.240
24	553.722	5.872	12.470	18.369	0.447	2.360	2.011
26	593.805	5.530	13.250	17.205	0.118	0.589	0.280
30	644.355	5.460	13.620	16.322	0.072	0.367	0.200
33	693.605	5.210	13.230	15.943	0.037	0.156	0.042
35	740.705	5.270	13.150	16.540	0.028	0.096	0.047
38	786.205	4.660	13.040	17.410	0.027	0.138	0.081
41	844.605	5.220	12.820	19.259	0.078	0.390	0.176
43	901.355	2.493	5.940	10.010	0.122	0.676	0.494
46	932.355	11.260	14.380	25.869	0.182	1.073	0.897
48	1007.355	6.779	6.282	6.378	0.792	4.080	2.353
51	1053.855	23.498	7.690	11.631	0.566	3.590	2.578
53	1086.855	7.008	6.259	6.949	0.593	1.803	1.005
55	1105.855	20.194	6.382	6.491	0.899	1.589	0.474
57	1147.355	4.768	4.882	3.654	0.103	0.340	0.389
58	1207.355	2.314	2.809	1.603	0.006	0.040	0.097
59	1267.355	1.843	2.083	0.950	0.010	0.040	0.083
60	1327.355	2.206	2.127	0.811	0.010	0.040	0.090
61	1387.355	1.186	1.910	0.615	0.007	0.022	0.088
62	1449.355	3.718	3.144	0.766	0.057	0.134	0.134

Note: Meridonal/Hoop Forces and Meridonal/Hoop Moments are Reversed in Highlighted Sections.

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Table H.4. UBS-BEC Primary Tank Stresses, Shell Top, Gravity Load Only

AP Primary Tank, Upper Bound Soil, Gravity Only, Best Estimate
Tank Concrete, 460 in. Waste Level at 1.83 SpG

M&D Starting Element No.	Path (in.)	Shell Top Surface (inside - waste side)			
		AP-460-UBS-BEC Gravity Hoop Stress (lbs/in ²) Top	AP-460-UBS-BEC Gravity Meridional Stress (lbs/in ²) Top	AP-460-UBS-BEC Gravity Stress Intensity (lbs/in ²) Top	AP-460-UBS-BEC Gravity In-Plane Shear Stress (lbs/in ²) Top
762	67.33	-1502.08	-1661.81	1661.81	-2.88
782	105.04	-1497.92	-2139.58	2139.58	2.76
802	136.24	-1302.08	-2003.47	2003.47	3.59
822	181.83	-969.44	-1763.19	1763.19	4.02
842	225.10	-704.17	-1513.19	1513.89	1.37
862	273.66	-410.21	-1140.28	1140.28	4.02
882	323.27	38.32	-941.67	979.86	2.04
902	369.20	314.44	-302.08	615.28	-0.79
922	419.20	1289.58	-270.49	1559.72	-2.83
942	444.31	-152.15	-2658.33	2660.42	-2.49
962	458.66	-1099.31	2782.64	3881.94	1.76
982	473.08	-1508.33	2658.33	4166.67	-0.66
1002	484.80	-35.86	-534.38	535.76	-0.95
1022	502.48	2752.08	-272.15	3022.92	-1.11
1042	526.48	4727.78	298.89	4727.78	-0.77
1062	550.48	6309.72	136.32	6310.42	-0.50
1082	574.60	7881.94	356.18	7881.94	-0.33
1102	598.28	9569.44	83.54	9569.44	0.21
1122	621.38	11118.06	280.97	11118.06	-0.17
1142	644.48	12687.50	154.79	12687.50	-0.20
1162	667.63	13791.67	-194.38	13986.11	-0.26
1182	690.78	14194.44	553.26	14194.44	-0.27
1202	713.88	15194.44	291.67	15194.44	-0.27
1222	736.98	16555.56	-202.99	16763.89	-0.31
1242	760.13	16500.00	-581.53	17083.33	0.40
1262	782.53	15263.89	1115.28	15263.89	-0.33
1282	804.13	14923.61	430.28	14923.61	-0.41
1302	825.73	15770.83	93.40	15770.83	0.50
1322	847.33	17180.56	474.44	17180.56	-0.43
1342	868.87	17416.67	-2172.92	19590.28	-0.80
1362	892.10	12756.94	-2569.44	15326.39	1.22
1382	909.20	3725.00	-7534.72	11263.89	1.19
1402	918.38	3745.14	6644.44	6674.31	-1.23
1460	930.48	3176.39	8972.22	9013.89	-459.24
1442	949.48	102.92	-761.11	872.92	68.54
1462	990.98	599.03	913.19	914.58	-25.53
1482	1050.98	408.75	401.18	629.03	1.75
1502	1110.98	454.03	628.06	629.03	-15.15
1522	1170.98	321.67	240.63	322.22	8.08
1542	1230.98	391.39	498.68	499.31	-10.18
1562	1292.98	294.65	283.19	295.21	3.42

Note 1: Meridional, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)

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Table H.5. UBS-BEC Primary Tank Stresses, Shell Middle, Gravity Load Only

AP Primary Tank, Upper Bound Soil, Gravity Only, Best Estimate
Tank Concrete, 460 in. Waste Level at 1.83 SpG

M&D Starting Element No.	Path (in.)	Shell Mid-Plane			
		AP-460-UBS-BEC Gravity Hoop Stress (lbs/in ²) Mid	AP-460-UBS-BEC Gravity Meridional Stress (lbs/in ²) Mid	AP-460-UBS-BEC Gravity Stress Intensity (lbs/in ²) Mid	AP-460-UBS-BEC Gravity In-Plane Shear Stress (lbs/in ²) Mid
762	67.33	-1543.06	-1666.67	1666.67	2.08
782	105.04	-1529.86	-2172.22	2172.22	-2.60
802	136.24	-1320.14	-2002.78	2002.78	3.31
822	181.83	-977.78	-1754.86	1754.86	3.41
842	225.10	-702.78	-1486.81	1486.81	1.23
862	273.66	-425.83	-1171.53	1171.53	3.62
882	323.27	78.61	-798.61	877.78	1.90
902	369.20	271.04	-427.22	697.22	-0.79
922	419.20	1375.69	25.11	1383.33	-2.78
942	444.31	794.44	341.32	802.08	-2.15
962	458.66	-1803.47	324.03	2128.47	1.52
982	473.08	-2235.42	267.01	2505.56	-0.75
1002	484.80	202.01	244.03	247.08	-0.73
1022	502.48	2904.17	238.06	2904.86	-0.95
1042	526.48	4706.94	231.67	4707.64	-0.70
1062	550.48	6336.11	225.00	6336.81	-0.48
1082	574.60	7840.28	218.19	7840.28	-0.32
1102	598.28	9604.17	211.53	9604.17	-0.21
1122	621.38	11097.22	204.93	11097.22	-0.15
1142	644.48	12701.39	198.40	12701.39	-0.17
1162	667.63	13902.78	191.74	13902.78	-0.23
1182	690.78	14076.39	161.74	14076.39	-0.24
1202	713.88	15152.78	155.21	15152.78	-0.26
1222	736.98	16659.72	148.54	16666.67	-0.29
1242	760.13	16722.22	141.94	16722.22	0.36
1262	782.53	14958.33	97.85	14958.33	-0.31
1282	804.13	14819.44	91.67	14819.44	0.40
1302	825.73	15770.83	85.63	15770.83	0.48
1322	847.33	17062.50	79.51	17062.50	-0.43
1342	868.87	18090.28	73.47	18097.22	-0.66
1362	892.10	13541.67	55.90	13541.67	0.91
1382	909.20	5888.19	49.03	6018.06	0.92
1402	918.38	1523.61	197.85	1756.94	-0.84
1460	930.48	460.49	414.51	582.57	4.07
1442	949.48	469.03	437.71	470.14	2.78
1462	990.98	536.94	716.67	718.06	-14.92
1482	1050.98	457.85	564.38	466.94	-9.58
1502	1110.98	404.72	466.46	466.94	-6.28
1522	1170.98	366.46	389.86	390.14	-3.42
1542	1230.98	349.31	365.21	365.56	-2.89
1562	1292.98	318.61	382.57	383.47	-6.71

Note 1: Meridional, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)

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Table H.6. UBS-BEC Primary Tank Stresses, Shell Bottom, Gravity Load Only

AP Primary Tank, Upper Bound Soil, Gravity Only, Best Estimate
Tank Concrete, 460 in. Waste Level at 1.83 SpG

M&D Starting Element No.	Path (in.)	Shell Bottom Surface (outside - away from waste)			
		AP-460-UBS-BEC Gravity Hoop Stress (lbs/in ²) Bot	AP-460-UBS-BEC Gravity Meridional Stress (lbs/in ²) Bot	AP-460-UBS-BEC Gravity Stress Intensity (lbs/in ²) Bot	AP-460-UBS-BEC Gravity In-Plane Shear Stress (lbs/in ²) Bot
762	67.33	-1588.19	-1675.00	1675.00	-2.97
782	105.04	-1561.11	-2205.56	2205.56	2.79
802	136.24	-1338.89	-2002.08	2002.08	3.18
822	181.83	-986.11	-1747.22	1747.22	3.05
842	225.10	-700.69	-1461.11	1461.81	1.15
862	273.66	-442.01	-1203.47	1203.47	3.23
882	323.27	118.89	-656.60	775.00	1.76
902	369.20	227.57	-552.57	779.17	-0.79
922	419.20	1462.50	319.17	1463.19	-2.73
942	444.31	1735.42	3340.97	3343.06	-1.81
962	458.66	-2507.64	-2134.03	2507.64	1.28
982	473.08	-2962.50	-2124.31	2962.50	-0.83
1002	484.80	430.35	1021.53	1022.22	-0.51
1022	502.48	3056.94	747.92	3056.94	-0.78
1042	526.48	4687.50	164.79	4687.50	-0.66
1062	550.48	6363.89	313.82	6363.89	-0.45
1082	574.60	7798.61	80.35	7798.61	-0.30
1102	598.28	9645.83	339.65	9645.83	-0.21
1122	621.38	11069.44	129.10	11069.44	-0.15
1142	644.48	12715.28	242.15	12715.28	-0.14
1162	667.63	14020.83	576.46	14020.83	-0.20
1182	690.78	13958.33	-231.25	14187.50	-0.21
1202	713.88	15111.11	18.72	15118.06	-0.28
1222	736.98	16770.83	499.17	16770.83	-0.31
1242	760.13	16937.50	865.28	16937.50	-0.34
1262	782.53	14652.78	-920.14	15576.39	-0.30
1282	804.13	14715.28	-247.78	14965.28	0.38
1302	825.73	15770.83	78.19	15770.83	0.46
1322	847.33	16944.44	-316.04	17263.89	-0.43
1342	868.87	18763.89	2321.53	18763.89	0.54
1362	892.10	14333.33	2683.33	14333.33	0.64
1382	909.20	8055.56	7638.89	8055.56	0.65
1402	918.38	-700.69	-6249.31	6281.25	-0.56
1460	930.48	-2259.72	-8145.83	8187.50	466.46
1442	949.48	836.11	1636.11	1640.97	-63.61
1462	990.98	475.14	521.74	522.08	-4.35
1482	1050.98	507.50	729.17	356.25	-18.74
1502	1110.98	355.90	307.29	356.25	5.27
1522	1170.98	411.81	541.88	542.57	-11.86
1542	1230.98	307.92	235.00	308.54	7.65
1562	1292.98	344.51	485.35	486.39	-13.51

Note 1: Meridional, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)

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Table H.7. UBS-BEC Primary Tank Stresses, Shell Top, Gravity Plus Seismic Load

**AP Primary Tank, Upper Bound Soil, Horizontal and Vertical
Seismic, Best Estimate Tank Concrete, 460 in. Waste Level at
1.83 SpG**

M&D Starting M&D Element No.	Path (in.)	Shell Top Surface (inside - waste side)			
		AP-460-UBS-BEC Seismic Hoop Stress (lbs/in ²) Top	AP-460-UBS-BEC Seismic Meridional Stress (lbs/in ²) Top	AP-460-UBS-BEC Seismic Stress Intensity (lbs/in ²) Top	AP-460-UBS-BEC Seismic In-Plane Shear Stress (lbs/in ²) Top
762	67.33	-2245.14	-2742.36	2742.36	-201.11
782	105.04	-2256.94	-3507.64	3508.33	-348.82
802	136.24	-2132.64	-3238.89	3238.89	-386.18
822	181.83	-1668.75	-2829.86	2829.86	-418.40
842	225.10	-1895.14	-2602.08	3173.61	-559.03
862	273.66	-1345.14	-2063.19	2063.89	-770.83
882	323.27	2020.83	-1820.14	3844.44	-1286.81
902	369.20	2405.56	-1342.36	3922.22	-1927.08
922	419.20	4272.92	-1131.25	6597.22	-3168.75
942	444.31	-5152.78	-5706.94	6786.11	-3086.11
962	458.66	-7756.94	7854.17	15576.39	-3050.69
982	473.08	-8354.17	8847.22	17201.39	-3215.97
1002	484.80	-3935.42	-2038.19	6749.31	-3363.19
1022	502.48	5833.33	-976.39	7750.00	-3288.19
1042	526.48	10590.28	1439.58	10604.17	-3028.47
1062	550.48	13673.61	1465.97	13680.56	-2744.44
1082	574.60	16437.50	1953.47	16437.50	-2420.83
1102	598.28	19298.61	1600.00	19305.56	2075.00
1122	621.38	21868.06	2027.78	21875.00	1718.75
1142	644.48	24263.89	1914.58	24270.83	1396.53
1162	667.63	25701.39	-1625.00	25701.39	-1136.11
1182	690.78	25854.17	2385.42	25854.17	-977.78
1202	713.88	27097.22	1981.25	27097.22	-927.08
1222	736.98	28965.28	-1486.81	28972.22	-1095.83
1242	760.13	28437.50	-815.28	28437.50	1452.78
1262	782.53	25715.28	2821.53	25715.28	1406.94
1282	804.13	24597.22	1657.64	24597.22	1766.67
1302	825.73	25604.17	1055.56	25604.17	2127.08
1322	847.33	27638.89	1551.39	27638.89	2491.67
1342	868.87	26895.83	-2937.50	31006.94	2922.22
1362	892.10	17354.17	-3022.92	21263.89	2857.64
1382	909.20	5661.11	-8923.61	17250.00	2781.94
1402	918.38	6266.67	12805.56	12826.39	2710.42
1460	930.48	6727.78	13368.06	13437.50	-3097.92
1442	949.48	4522.92	-1597.22	5188.19	-2340.97
1462	990.98	3940.28	1666.67	7062.50	-3529.86
1482	1050.98	2915.28	765.97	2761.11	-2287.50
1502	1110.98	2204.17	938.19	2761.11	-1371.53
1522	1170.98	1642.36	474.72	1673.61	-813.19
1542	1230.98	1189.58	734.72	1190.97	-493.19
1562	1292.98	755.56	495.83	756.25	-239.65

Note 1: Meridional, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)

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Table H.8. UBS-BEC Primary Tank Stresses, Shell Middle, Gravity Plus Seismic Load

**AP Primary Tank, Upper Bound Soil, Horizontal and Vertical
Seismic, Best Estimate Tank Concrete, 460 in. Waste Level at
1.83 SpG**

M&D Starting M&D Element No.	Path (in.)	Shell Mid-Plane			
		AP-460-UBS-BEC Seismic Hoop Stress (lbs/in ²) Mid	AP-460-UBS-BEC Seismic Meridional Stress (lbs/in ²) Mid	AP-460-UBS-BEC Seismic Stress Intensity (lbs/in ²) Mid	AP-460-UBS-BEC Seismic In-Plane Shear Stress (lbs/in ²) Mid
762	67.33	-2385.42	-2530.56	2530.56	-193.61
782	105.04	-2297.22	-3287.50	3287.50	-341.94
802	136.24	-2281.25	-3027.78	3028.47	-379.58
822	181.83	-1618.06	-2666.67	2667.36	-414.72
842	225.10	-2095.83	-2272.92	2548.61	-558.40
862	273.66	-1306.94	-1866.67	2118.06	-770.14
882	323.27	2300.69	-1506.25	3187.50	-1287.50
902	369.20	2339.58	-1193.06	3946.53	-1927.78
922	419.20	4418.06	1083.33	6533.33	-3170.83
942	444.31	4818.06	1334.03	6265.97	-3115.28
962	458.66	-9659.72	1285.42	10805.56	-3078.47
982	473.08	-10673.61	1189.58	11881.94	-3170.83
1002	484.80	-3440.97	1153.47	6676.39	-3287.50
1022	502.48	6311.11	1277.08	7319.44	-3250.69
1042	526.48	10590.28	1445.83	10597.22	-3021.53
1062	550.48	13777.78	1593.06	13784.72	-2736.81
1082	574.60	16395.83	1727.78	16402.78	-2412.50
1102	598.28	19409.72	1838.19	19409.72	2067.36
1122	621.38	21888.89	1926.39	21888.89	1711.81
1142	644.48	24347.22	1988.89	24347.22	1390.97
1162	667.63	25944.44	2026.39	25944.44	-1118.06
1182	690.78	25708.33	1790.28	25708.33	-961.11
1202	713.88	27076.39	1777.78	27076.39	-911.81
1222	736.98	29194.44	1736.81	29194.44	-1091.67
1242	760.13	28854.17	1668.75	28854.17	1443.75
1262	782.53	25256.94	1161.81	25256.94	1395.14
1282	804.13	24472.22	1093.06	24472.22	1764.58
1302	825.73	25625.00	1009.03	25625.00	2128.47
1322	847.33	27479.17	905.56	27486.11	2499.31
1342	868.87	28388.89	779.86	28388.89	2905.56
1362	892.10	18548.61	556.88	18555.56	2761.11
1382	909.20	8597.22	489.72	8875.00	2622.22
1402	918.38	5717.36	637.43	6207.64	2606.25
1460	930.48	4837.50	952.78	5327.78	-2586.11
1442	949.48	4585.42	940.97	5043.75	-2431.25
1462	990.98	3925.69	1391.67	7041.67	-3518.75
1482	1050.98	2916.67	960.42	2759.03	-2297.22
1502	1110.98	2197.92	734.72	2759.03	-1363.19
1522	1170.98	1643.75	610.42	1658.33	-822.92
1542	1230.98	1186.81	562.85	1188.19	-485.14
1562	1292.98	751.39	577.78	751.39	-245.28

Note 1: Meridonal, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)

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Table H.9. UBS-BEC Primary Tank Stresses, Shell Bottom, Gravity Plus Seismic Load

**AP Primary Tank, Upper Bound Soil, Horizontal and Vertical
Seismic, Best Estimate Tank Concrete, 460 in. Waste Level at
1.83 SpG**

M&D Starting M&D Element No.	Path (in.)	Shell Bottom Surface (outside - away from waste)			
		AP-460-UBS-BEC Seismic Hoop Stress (lbs/in ²) Bot	AP-460-UBS-BEC Seismic Meridional Stress (lbs/in ²) Bot	AP-460-UBS-BEC Seismic Stress Intensity (lbs/in ²) Bot	AP-460-UBS-BEC Seismic In-Plane Shear Stress (lbs/in ²) Bot
762	67.33	-2561.11	-2770.83	2770.83	-186.94
782	105.04	-2372.22	-3586.81	3586.81	-335.07
802	136.24	-2429.86	-3338.89	3339.58	-373.06
822	181.83	-1567.36	-2730.56	2730.56	-410.97
842	225.10	-2295.83	-2763.19	2763.89	-557.78
862	273.66	-1268.75	-1897.22	2204.17	-769.44
882	323.27	2579.86	-1876.39	2833.33	-1288.19
902	369.20	2294.44	-1256.25	3975.00	-1927.78
922	419.20	4662.50	1831.94	6484.03	-3172.92
942	444.31	5178.47	8368.06	8923.61	-3144.44
962	458.66	-11604.17	-5586.81	11611.11	-3106.25
982	473.08	-13006.94	-6466.67	13013.89	-3125.69
1002	484.80	3309.72	3699.31	6729.17	-3212.50
1022	502.48	6836.11	3530.56	7083.33	-3213.19
1042	526.48	10583.33	1451.39	10590.28	-3013.89
1062	550.48	13881.94	1720.14	13881.94	-2729.86
1082	574.60	16361.11	1502.78	16361.11	-2404.86
1102	598.28	19513.89	2076.39	19513.89	2060.42
1122	621.38	21909.72	1825.00	21909.72	1704.86
1142	644.48	24423.61	2063.19	24423.61	1385.42
1162	667.63	26180.56	2627.78	26180.56	-1100.69
1182	690.78	25555.56	-1560.42	25555.56	-944.44
1202	713.88	27048.61	1575.00	27048.61	-897.22
1222	736.98	29416.67	2315.97	29416.67	-1088.89
1242	760.13	29270.83	2925.69	29270.83	1434.72
1262	782.53	24805.56	-1659.03	25305.56	1383.33
1282	804.13	24340.28	-1076.39	24340.28	1764.58
1302	825.73	25645.83	982.64	25652.78	2130.56
1322	847.33	27326.39	-925.69	27326.39	2508.33
1342	868.87	29875.00	5667.36	29875.00	2888.19
1362	892.10	19743.06	4586.11	19743.06	2664.58
1382	909.20	11729.17	12472.22	12479.17	2463.19
1402	918.38	-6575.69	-11659.72	11680.56	2501.39
1460	930.48	-7326.39	-12277.78	12354.17	2584.72
1442	949.48	4648.61	3089.58	6072.22	-2520.83
1462	990.98	3911.81	1125.69	7027.78	-3506.94
1482	1050.98	2918.06	1175.69	2762.50	-2306.94
1502	1110.98	2192.36	569.72	2762.50	-1354.86
1522	1170.98	1645.14	804.17	1665.97	-831.94
1542	1230.98	1184.03	452.64	1185.42	-477.08
1562	1292.98	748.61	705.56	750.00	-251.53

Note 1: Meridonal, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)

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Table H.10. UBS-BEC Primary Tank Stresses, Shell Top, Seismic Load Only

**AP Primary Tank, Upper Bound Soil, Horizontal and Vertical
Seismic, Best Estimate Tank Concrete, 460 in. Waste Level at
1.83 SpG**

M&D Starting M&D Element No.	Path (in.)	Shell Top Surface (inside - waste side)			
		AP-460-UBS-BEC Seismic Only Hoop Stress (lbs/in ²) Top	AP-460-UBS-BEC Seismic Only Meridional Stress (lbs/in ²) Top	AP-460-UBS-BEC Seismic Only Stress Intensity (lbs/in ²) Top	AP-460-UBS-BEC Seismic Only In-Plane Shear Stress (lbs/in ²) Top
762	67.33	768.06	1093.68	1084.72	200.17
782	105.04	762.50	1368.06	1368.75	349.46
802	136.24	834.03	1248.61	1235.42	386.72
822	181.83	700.69	1066.67	1066.67	418.78
842	225.10	1333.89	1222.99	1661.81	558.66
862	273.66	1003.33	923.61	924.31	770.36
882	323.27	1982.51	1044.17	2864.58	1286.68
902	369.20	2091.32	1041.81	3309.51	1927.42
922	419.20	2984.03	990.35	5038.89	3168.13
942	444.31	5001.94	3237.78	4125.69	3085.34
962	458.66	6659.03	5073.61	11697.22	3050.26
982	473.08	6847.92	6190.28	13038.19	3215.90
1002	484.80	3901.01	1504.86	6214.93	3363.30
1022	502.48	3291.67	715.21	4727.08	3288.34
1042	526.48	5924.31	1141.11	5877.08	3028.56
1062	550.48	7363.89	1329.86	7370.14	2744.27
1082	574.60	8555.56	1597.50	8555.56	2420.79
1102	598.28	9729.17	1516.74	9736.11	2074.96
1122	621.38	10750.00	1747.08	10756.94	1718.69
1142	644.48	11576.39	1760.07	11583.33	1396.44
1162	667.63	11909.72	1617.85	11715.28	1136.05
1182	690.78	11659.72	1832.36	11659.72	977.70
1202	713.88	11902.78	1689.79	11902.78	926.97
1222	736.98	12409.72	1360.28	12215.28	1095.58
1242	760.13	11937.50	1142.57	11354.17	1452.90
1262	782.53	10451.39	1706.25	10451.39	1407.04
1282	804.13	9680.56	1227.36	9680.56	1766.71
1302	825.73	9833.33	962.15	9833.33	2127.24
1322	847.33	10458.33	1077.08	10458.33	2491.65
1342	868.87	9479.17	1931.94	11416.67	2922.35
1362	892.10	4604.17	1607.64	5937.50	2857.70
1382	909.20	1936.81	5631.94	5993.06	2782.01
1402	918.38	2524.31	6163.89	6154.86	2710.47
1422	930.48	3552.78	4402.78	4430.56	2639.51
1442	949.48	4421.32	837.50	4318.06	2408.89
1462	990.98	3341.32	1110.35	6149.31	3505.07
1482	1050.98	2506.88	513.13	2133.68	2287.72
1502	1110.98	1750.42	448.61	2133.68	1357.86
1522	1170.98	1320.69	236.88	1355.07	819.62
1542	1230.98	798.89	300.21	698.19	484.82
1562	1292.98	474.24	213.47	461.81	240.60

Note 1: Meridional, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)

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Table H.11. UBS-BEC Primary Tank Stresses, Shell Middle, Seismic Load Only

**AP Primary Tank, Upper Bound Soil, Horizontal and Vertical
Seismic, Best Estimate Tank Concrete, 460 in. Waste Level at
1.83 SpG**

M&D Starting M&D Element No.	Path (in.)	Shell Mid-Plane			
		AP-460-UBS-BEC Seismic Only Hoop Stress (lbs/in ²) Mid	AP-460-UBS-BEC Seismic Only Meridional Stress (lbs/in ²) Mid	AP-460-UBS-BEC Seismic Only Stress Intensity (lbs/in ²) Mid	AP-460-UBS-BEC Seismic Only In-Plane Shear Stress (lbs/in ²) Mid
762	67.33	859.65	864.58	863.89	193.40
782	105.04	772.92	1115.28	1115.28	342.35
802	136.24	965.28	1025.69	1026.39	380.21
822	181.83	641.67	912.50	913.19	414.98
842	225.10	1587.50	786.81	1062.50	558.10
862	273.66	940.42	695.83	947.22	769.65
882	323.27	2222.08	708.33	2309.72	1287.39
902	369.20	2068.82	767.01	3252.08	1928.09
922	419.20	3051.39	1059.11	5151.39	3170.21
942	444.31	4026.39	992.92	5467.36	3114.62
962	458.66	7858.33	961.60	8679.17	3078.09
982	473.08	8440.97	922.85	9379.17	3170.72
1002	484.80	3634.79	909.65	6429.31	3287.56
1022	502.48	3699.31	1039.24	4415.97	3250.81
1042	526.48	5954.86	1214.44	5889.58	3021.62
1062	550.48	7441.67	1368.33	7447.92	2736.67
1082	574.60	8555.56	1509.86	8562.50	2412.47
1102	598.28	9805.56	1627.01	9805.56	2067.33
1122	621.38	10791.67	1721.74	10791.67	1711.76
1142	644.48	11645.83	1790.76	11645.83	1390.90
1162	667.63	12041.67	1834.86	12041.67	1118.00
1182	690.78	11631.94	1628.68	11631.94	961.04
1202	713.88	11923.61	1622.78	11923.61	911.70
1222	736.98	12534.72	1588.40	12527.78	1091.42
1242	760.13	12131.94	1526.94	12131.94	1443.88
1262	782.53	10298.61	1063.96	10298.61	1395.25
1282	804.13	9652.78	1001.39	9652.78	1764.60
1302	825.73	9854.17	923.54	9854.17	2128.58
1322	847.33	10416.67	826.25	10423.61	2499.26
1342	868.87	10298.61	706.94	10291.67	2905.69
1362	892.10	5006.94	501.06	5013.89	2761.18
1382	909.20	2710.42	440.75	2859.03	2622.30
1402	918.38	4195.83	439.72	4451.39	2606.33
1422	930.48	4378.68	547.01	4745.56	2589.66
1442	949.48	4117.15	611.32	4575.07	2433.77
1462	990.98	3388.96	985.14	6323.61	3504.51
1482	1050.98	2458.82	611.23	2292.15	2288.35
1502	1110.98	1793.26	349.72	2292.15	1357.86
1522	1170.98	1277.29	232.29	1268.19	821.05
1542	1230.98	837.50	197.71	826.18	483.87
1562	1292.98	454.58	195.28	372.01	240.25

Note 1: Meridonal, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)

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Table H.12. UBS-BEC Primary Tank Stresses, Shell Bottom, Seismic Load Only

**AP Primary Tank, Upper Bound Soil, Horizontal and Vertical
Seismic, Best Estimate Tank Concrete, 460 in. Waste Level at
1.83 SpG**

M&D Starting M&D Element No.	Path (in.)	Shell Bottom Surface (outside - away from waste)			
		AP-460-UBS-BEC Seismic Only Hoop Stress (lbs/in ²) Bot	AP-460-UBS-BEC Seismic Only Meridional Stress (lbs/in ²) Bot	AP-460-UBS-BEC Seismic Only Stress Intensity (lbs/in ²) Bot	AP-460-UBS-BEC Seismic Only In-Plane Shear Stress (lbs/in ²) Bot
762	67.33	976.39	1095.83	1095.83	186.63
782	105.04	817.36	1382.64	1382.64	335.23
802	136.24	1095.83	1337.50	1337.50	373.78
822	181.83	581.94	984.03	984.03	411.12
842	225.10	1842.36	1302.78	1303.47	557.54
862	273.66	877.50	760.83	1001.39	768.94
882	323.27	2460.97	1221.18	2064.58	1288.11
902	369.20	2067.08	751.25	3198.61	1928.07
922	419.20	3200.00	1633.89	5020.83	3172.08
942	444.31	3444.44	5075.69	5581.94	3143.90
962	458.66	9099.31	3502.78	9105.56	3105.91
982	473.08	10047.22	4645.83	10053.47	3125.54
1002	484.80	3723.47	2678.47	5707.64	3212.51
1022	502.48	4125.69	2782.64	4026.39	3213.29
1042	526.48	5984.72	1287.08	5902.78	3013.99
1062	550.48	7518.75	1406.81	7518.75	2729.76
1082	574.60	8562.50	1422.99	8562.50	2404.84
1102	598.28	9868.06	1737.29	9868.06	2060.40
1122	621.38	10840.28	1696.32	10840.28	1704.83
1142	644.48	11708.33	1821.46	11708.33	1385.37
1162	667.63	12159.72	2051.74	12159.72	1100.64
1182	690.78	11597.22	1425.56	11368.06	944.38
1202	713.88	11937.50	1556.47	11937.50	897.12
1222	736.98	12645.83	1817.15	12645.83	1088.76
1242	760.13	12333.33	2060.42	12333.33	1434.85
1262	782.53	10152.78	739.58	9729.17	1383.46
1282	804.13	9625.00	841.18	9375.00	1764.72
1302	825.73	9881.94	905.00	9888.89	2130.73
1322	847.33	10381.94	641.81	10062.50	2508.49
1342	868.87	11111.11	3345.83	11111.11	2888.34
1362	892.10	5416.67	1911.11	5416.67	2664.65
1382	909.20	3829.17	4840.28	4430.56	2463.28
1402	918.38	5877.08	5413.89	5402.78	2501.49
1422	930.48	5202.78	4145.83	4173.61	2539.44
1442	949.48	3813.89	1528.26	4437.50	2457.90
1462	990.98	3437.22	862.85	6505.69	3503.26
1482	1050.98	2410.83	713.57	2409.58	2288.99
1502	1110.98	1836.46	279.60	2409.58	1358.33
1522	1170.98	1233.96	319.10	1125.97	821.78
1542	1230.98	876.11	220.90	876.88	482.91
1562	1292.98	434.93	283.96	269.51	240.24

Note 1: Meridonal, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)

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Table H.13. UBS-BEC Anchor Bolt Forces, Gravity Load Only

AP Primary Tank, Upper Bound Soil, Gravity Only, Best Estimate Tank Concrete, 460 in. Waste Level at 1.83 SpG											
ANSYS MAXIMUMS BY RADIUS											
M&D J-Bolt Radius No.	Mean J-Bolt Radius	Radius of J-Bolts Included		Average Bolts per Element	Min Axial Force (kip) BES-BEC Gravity Only	Max Axial Force (kip) BES-BEC Gravity Only	Shear Force1 (kip) BES- BEC Gravity	Maximum Shear Force1 Model Angle	Shear Force2 (kip) BES- BEC Gravity Only	Maximum Shear Force2 Model Angle	Total Shear (kip) BES- BEC Gravity
		min	max								
Radius 2	44.72	22.36	67.29	0.55	-0.005	-0.004	0.001	45	0.038	90	0.038
Radius 3	89.87	67.29	104.93	0.89	-0.003	-0.003	0.002	63	0.033	27	0.033
Radius 4	120.00	104.93	135.98	1.03	-0.002	-0.001	0.002	63	0.082	180	0.082
Radius 5	151.97	135.98	181.01	1.97	-0.001	0.000	0.001	27	0.170	90	0.170
Radius 6	210.05	181.01	223.79	2.41	-0.007	-0.007	0.005	144	0.366	90	0.366
Radius 7	237.53	223.79	270.98	3.30	0.020	0.020	0.005	144	0.471	45	0.471
Radius 8	304.43	270.98	318.74	4.04	-0.031	-0.031	0.001	144	0.654	45	0.654
Radius 9	333.05	318.74	361.64	4.37	0.128	0.129	0.001	126	0.743	0	0.743
Radius 10	390.22	361.64	406.24	5.36	0.168	0.171	0.001	117	0.855	0	0.855
Radius 11	422.26	406.24	431.63	3.60	0.804	0.807	0.001	27	1.302	0	1.302

M&D J-Bolt Radius No.	Mean J-Bolt Radius	Radius of J-Bolts Included		Average Bolts per Element	Bolt Angle (Rad)	Shear Stiffness (kip/ft)	Axial Stiffness (kip/ft)	Shear Displacement BES-BEC- Gravity Only	Axial Min Displacement BES-BEC- Gravity Only	Axial Max Displacement BES-BEC- Gravity Only
		min	max							
Radius 2	44.72	22.36	67.29	0.55	0.0351	780	780	0.00058	-0.00008	-0.00007
Radius 3	89.87	67.29	104.93	0.89	0.0715	780	780	0.00051	-0.00005	-0.00005
Radius 4	120.00	104.93	135.98	1.03	0.0968	780	780	0.00125	-0.00002	-0.00002
Radius 5	151.97	135.98	181.01	1.97	0.1252	780	780	0.00261	-0.00001	-0.00001
Radius 6	210.05	181.01	223.79	2.41	0.1825	780	780	0.00563	-0.00011	-0.00011
Radius 7	237.53	223.79	270.98	3.30	0.2136	780	780	0.00725	0.00030	0.00031
Radius 8	304.43	270.98	318.74	4.04	0.3076	780	780	0.01005	-0.00048	-0.00048
Radius 9	333.05	318.74	361.64	4.37	0.3613	780	780	0.01142	0.00196	0.00198
Radius 10	390.22	361.64	406.24	5.36	0.5235	780	780	0.01315	0.00258	0.00263
Radius 11	460.26	406.24	431.63	3.60	0.6938	780	780	0.02003	0.01236	0.01241

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Table H.14. UBS-BEC Anchor Bolt Forces, Gravity Plus Seismic Loads

AP Primary Tank, Upper Bound Soil, Horizontal and Vertical Seismic Input, Best Estimate Tank Concrete, 460 in. Waste Level at 1.83 SpG											
ANSYS MAXIMUMS BY RADIUS											
M&D J-Bolt Radius No.	Mean J-Bolt Radius	Radius of J-Bolts Included		Average Bolts per Element	Min Axial Force (kip) BES-BEC	Max Axial Force (kip) BES-BEC	Shear Force1 (kip) BES-BEC	Maximum Shear Force1 Model Angle	Shear Force2 (kip) BES-BEC	Maximum Shear Force2 Model Angle	Total Shear (kip) BES- BEC
		min	max								
Radius 2	44.72	22.36	67.29	0.55	-0.138	0.124	0.730	90	0.760	180	0.763
Radius 3	89.87	67.29	104.93	0.89	-0.042	0.184	0.824	90	0.858	180	0.875
Radius 4	120.00	104.93	135.98	1.03	-0.054	0.309	0.952	90	0.907	180	1.002
Radius 5	151.97	135.98	181.01	1.97	-0.076	0.535	1.128	90	0.988	180	1.185
Radius 6	210.05	181.01	223.79	2.41	-0.070	0.218	1.529	90	1.213	180	1.611
Radius 7	237.53	223.79	270.98	3.30	-0.064	0.387	1.853	90	1.379	180	1.953
Radius 8	304.43	270.98	318.74	4.04	-0.161	0.434	2.775	90	1.774	180	2.905
Radius 9	333.05	318.74	361.64	4.37	-0.189	0.501	3.321	90	1.971	180	3.460
Radius 10	390.22	361.64	406.24	5.36	-0.266	0.986	4.719	90	2.366	180	4.840
Radius 11	422.26	406.24	431.63	3.60	-0.202	1.667	5.966	90	3.137	180	6.189

M&D J-Bolt Radius No.	Mean J-Bolt Radius	Radius of J-Bolts Included		Average Bolts per Element	Bolt Angle (Rad)	Shear Stiffness (kip/ft)	Axial Stiffness (kip/ft)	Shear Disp BES-BEC- Seismic	Axial Min Disp BES-BEC- Seismic	Axial Max Disp BES-BEC- Seismic
		min	max							
Radius 2	44.72	22.36	67.29	0.55	0.0351	780	780	0.01174	-0.00212	0.00190
Radius 3	89.87	67.29	104.93	0.89	0.0715	780	780	0.01347	-0.00065	0.00283
Radius 4	120.00	104.93	135.98	1.03	0.0968	780	780	0.01541	-0.00083	0.00475
Radius 5	151.97	135.98	181.01	1.97	0.1252	780	780	0.01823	-0.00116	0.00823
Radius 6	210.05	181.01	223.79	2.41	0.1825	780	780	0.02479	-0.00108	0.00335
Radius 7	237.53	223.79	270.98	3.30	0.2136	780	780	0.03005	-0.00098	0.00596
Radius 8	304.43	270.98	318.74	4.04	0.3076	780	780	0.04469	-0.00248	0.00668
Radius 9	333.05	318.74	361.64	4.37	0.3613	780	780	0.05322	-0.00291	0.00772
Radius 10	390.22	361.64	406.24	5.36	0.5235	780	780	0.07446	-0.00410	0.01517
Radius 11	460.26	406.24	431.63	3.60	0.6938	780	780	0.09522	-0.00311	0.02564

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Table H.15. UBS-BEC Anchor Bolt Forces, Seismic Load Only

AP Primary Tank, Upper Bound Soil, Horizontal and Vertical Seismic Input, Best Estimate Tank Concrete, 460 in. Waste Level at 1.83 SpG Seismic Only ANSYS MAXIMUMS BY RADIUS											
M&D J-Bolt Radius No.	Mean J-Bolt Radius	Radius of J-Bolts Included		Average Bolts per Element	Min Axial Force (kip) BES-BEC- Seismic Only	Max Axial Force (kip) BES-BEC- Seismic Only	Shear Force1 (kip) BES-BEC- Seismic Only	Maximum Shear Force1 Model Angle	Shear Force2 (kip) BES- BEC-Seismic Only	Maximum Shear Force2 Model Angle	Total Shear (kip) BES- BEC- Seismic Only
		min	max								
Radius 2	44.72	22.36	67.29	0.55	-0.132	0.128	0.729	108	0.722	0	1.026
Radius 3	89.87	67.29	104.93	0.89	-0.039	0.187	0.823	108	0.825	0	1.165
Radius 4	120.00	104.93	135.98	1.03	-0.053	0.310	0.950	108	0.825	0	1.259
Radius 5	151.97	135.98	181.01	1.97	-0.075	0.535	1.126	108	0.818	0	1.392
Radius 6	210.05	181.01	223.79	2.41	-0.063	0.225	1.524	108	0.847	144	1.744
Radius 7	237.53	223.79	270.98	3.30	-0.084	0.368	1.848	90	0.908	135	2.059
Radius 8	304.43	270.98	318.74	4.04	-0.130	0.465	2.774	117	1.120	117	2.991
Radius 9	333.05	318.74	361.64	4.37	-0.317	0.372	3.321	117	1.228	117	3.541
Radius 10	390.22	361.64	406.24	5.36	-0.434	0.815	4.717	108	1.511	0	4.953
Radius 11	460.26	406.24	431.63	3.60	-1.006	0.860	5.965	108	1.836	0	6.241

M&D J-Bolt Radius No.	Mean J-Bolt Radius	Radius of J-Bolts Included		Average Bolts per Element	Bolt Angle (Rad)	Shear Stiffness (kip/ft)	Axial Stiffness (kip/ft)	Shear Disp BES-BEC- Seismic Only	Axial Min Disp BES-BEC- Seismic Only	Axial Max Disp BES-BEC- Seismic Only
		min	max							
Radius 2	44.72	22.36	67.29	0.55	0.0351	780	780	0.01579	-0.00204	0.00197
Radius 3	89.87	67.29	104.93	0.89	0.0715	780	780	0.01792	-0.00059	0.00288
Radius 4	120.00	104.93	135.98	1.03	0.0968	780	780	0.01936	-0.00081	0.00477
Radius 5	151.97	135.98	181.01	1.97	0.1252	780	780	0.02141	-0.00115	0.00823
Radius 6	210.05	181.01	223.79	2.41	0.1825	780	780	0.02683	-0.00097	0.00346
Radius 7	237.53	223.79	270.98	3.30	0.2136	780	780	0.03168	-0.00129	0.00565
Radius 8	304.43	270.98	318.74	4.04	0.3076	780	780	0.04602	-0.00200	0.00716
Radius 9	333.05	318.74	361.64	4.37	0.3613	780	780	0.05447	-0.00488	0.00573
Radius 10	390.22	361.64	406.24	5.36	0.5235	780	780	0.07621	-0.00668	0.01253
Radius 11	460.26	406.24	431.63	3.60	0.6938	780	780	0.09602	-0.01547	0.01323

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Table H.16. UBS-BEC Concrete Backed Steel Strain, Shell Top, Gravity Load Only

**AP Backed Steel, Upper Bound Soil, Gravity Only, Best Estimate Tank Concrete, 460 In Waste
Level at 1.83SpG**

M&D Starting M&D Element No.	Path (in)	Shell Top Surface (inside - towards waste) Gravity					
		AP-460-UBS-BEC EPEL P1 Strain (in/in) Gravity Top Min	AP-460-UBS-BEC EPEL P1 Strain (in/in) Gravity Top Max	AP-460-UBS-BEC EPEL P2 (in/in) Gravity Top Min	AP-460-UBS-BEC EPEL P2 Strain (in/in) Gravity Top Max	AP-460-UBS-BEC EPEL P3 Strain (in/in) Gravity Top Min	AP-460-UBS-BEC EPEL P3 Strain (in/in) Gravity Top Max
762	67.33	3.27E-05	3.27E-05	-3.44E-05	-3.43E-05	-4.15E-05	-4.15E-05
782	105.04	3.76E-05	3.76E-05	-2.94E-05	-2.94E-05	-5.79E-05	-5.79E-05
802	136.24	3.41E-05	3.42E-05	-2.41E-05	-2.40E-05	-5.53E-05	-5.53E-05
822	181.71	2.82E-05	2.83E-05	-1.51E-05	-1.51E-05	-5.05E-05	-5.04E-05
842	225.10	2.29E-05	2.29E-05	-8.47E-06	-8.46E-06	-4.46E-05	-4.46E-05
862	273.66	1.60E-05	1.60E-05	-2.29E-06	-2.29E-06	-3.49E-05	-3.49E-05
882	323.27	1.10E-05	1.11E-05	9.41E-06	9.41E-06	-3.27E-05	-3.26E-05
902	369.20	1.39E-05	1.40E-05	-4.62E-08	-4.19E-08	-1.36E-05	-1.36E-05
922	419.20	4.72E-05	4.73E-05	-1.04E-05	-1.04E-05	-2.26E-05	-2.26E-05
237	463.02						
257	510.03						
277	544.44						
297	580.53						
317	631.08						
337	680.34						
357	727.44						
377	772.93						
397	831.34						
417	894.09						
2132	925.08	2.22E-05	2.22E-05	-1.96E-05	-1.96E-05	-2.93E-05	-2.92E-05
2122	935.67	6.32E-05	6.32E-05	-1.82E-05	-1.82E-05	-2.21E-05	-2.21E-05
2112	944.86	5.15E-05	5.15E-05	-4.28E-06	-4.28E-06	-1.14E-04	-1.14E-04
477	968.95						
497	1002.45						
517	1042.45						
537	1108.60						
557	1178.35						
577	1227.20						
597	1271.50						
617	1313.65						
637	1360.60						

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Table H.17. UBS-BEC Concrete Backed Steel Strain, Shell Middle, Gravity Load Only

**AP Backed Steel, Upper Bound Soil, Gravity Only, Best Estimate Tank Concrete, 460 In Waste
Level at 1.83SpG**

M&D Starting M&D Element No.	Path (in)	Shell Mid-Plane					
		AP-460-UBS-BEC EPEL P1 Strain (in/in) Gravity Mid Min	AP-460-UBS-BEC EPEL P1 Strain (in/in) Gravity Mid Max	AP-460-UBS-BEC EPEL P2 Strain (in/in) Gravity Mid Min	AP-460-UBS-BEC EPEL P2 Strain (in/in) Gravity Mid Max	AP-460-UBS-BEC EPEL P3 Strain (in/in) Gravity Mid Min	AP-460-UBS-BEC EPEL P3 Strain (in/in) Gravity Mid Max
762	67.33	3.32E-05	3.32E-05	-3.59E-05	-3.58E-05	-4.13E-05	-4.13E-05
782	105.04	3.82E-05	3.83E-05	-3.01E-05	-3.01E-05	-5.89E-05	-5.88E-05
802	136.24	3.43E-05	3.43E-05	-2.47E-05	-2.47E-05	-5.51E-05	-5.51E-05
822	181.71	2.82E-05	2.83E-05	-1.55E-05	-1.55E-05	-5.01E-05	-5.01E-05
842	225.10	2.26E-05	2.26E-05	-8.69E-06	-8.68E-06	-4.37E-05	-4.37E-05
862	273.66	1.65E-05	1.65E-05	-2.53E-06	-2.52E-06	-3.58E-05	-3.58E-05
882	323.27	1.09E-05	1.10E-05	7.55E-06	7.55E-06	-2.82E-05	-2.82E-05
902	369.20	1.37E-05	1.38E-05	1.69E-06	1.70E-06	-1.74E-05	-1.74E-05
922	419.20	4.71E-05	4.72E-05	-1.30E-05	-1.30E-05	-1.48E-05	-1.47E-05
237	463.02	3.31E-05	3.31E-05	6.58E-06	6.58E-06	-6.11E-05	-6.11E-05
257	510.03	4.47E-05	4.47E-05	4.16E-05	4.17E-05	-2.43E-04	-2.43E-04
277	544.44	7.53E-05	7.53E-05	2.70E-05	2.71E-05	-3.61E-04	-3.61E-04
297	580.53	5.36E-05	5.36E-05	-2.25E-05	-2.25E-05	-2.21E-04	-2.21E-04
317	631.08	7.16E-05	7.17E-05	-6.50E-05	-6.49E-05	-2.61E-04	-2.61E-04
337	680.34	8.52E-05	8.53E-05	-7.75E-05	-7.75E-05	-3.11E-04	-3.11E-04
357	727.44	8.20E-05	8.21E-05	-8.34E-05	-8.34E-05	-2.90E-04	-2.90E-04
377	772.93	9.83E-05	9.84E-05	-8.83E-05	-8.83E-05	-3.60E-04	-3.60E-04
397	831.34	9.35E-05	9.35E-05	-7.89E-05	-7.89E-05	-3.47E-04	-3.47E-04
417	894.09	3.70E-05	3.71E-05	-5.25E-05	-5.25E-05	-1.16E-04	-1.16E-04
2132	925.08	1.79E-05	1.79E-05	-6.80E-06	-6.79E-06	-2.93E-05	-2.92E-05
2122	935.67	1.76E-05	1.76E-05	-1.33E-05	-1.33E-05	-2.19E-05	-2.19E-05
2112	944.86	1.11E-05	1.11E-05	-3.95E-06	-3.95E-06	-1.81E-05	-1.81E-05
477	968.95	1.18E-05	1.18E-05	5.86E-06	5.86E-06	-5.07E-05	-5.06E-05
497	1002.45	6.75E-05	6.75E-05	7.48E-06	7.48E-06	-1.96E-05	-1.96E-05
517	1042.45	1.05E-05	1.06E-05	6.04E-06	6.05E-06	-3.63E-06	-3.63E-06
537	1108.60	1.28E-05	1.28E-05	4.14E-06	4.14E-06	-4.74E-06	-4.73E-06
557	1178.35	3.79E-06	3.80E-06	1.94E-06	1.94E-06	-1.05E-05	-1.05E-05
577	1227.20	1.72E-05	1.72E-05	3.72E-06	3.73E-06	-4.75E-06	-4.75E-06
597	1271.50	4.36E-06	4.36E-06	1.91E-06	1.92E-06	-1.21E-05	-1.21E-05
617	1313.65	1.25E-05	1.25E-05	5.73E-06	5.74E-06	-4.06E-06	-4.05E-06
637	1360.60	4.01E-06	4.01E-06	3.43E-06	3.43E-06	-1.51E-06	-1.51E-06

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Table H.18. UBS-BEC Concrete Backed Steel Strain, Shell Bottom, Gravity Load Only

**AP Backed Steel, Upper Bound Soil, Gravity Only, Best Estimate Tank Concrete, 460 In Waste
Level at 1.83SpG**

M&D Starting M&D Element No.	Path (In)	Shell Bottom Surface (outside - away from waste) Gravity					
		AP-460-UBS-BEC EPEL P1 Strain (in/in) Gravity Bot Min	AP-460-UBS-BEC EPEL P1 Strain (in/in) Gravity Bot Max	AP-460-UBS-BEC EPEL P2 (in/in) Gravity Bot Min	AP-460-UBS-BEC EPEL P2 Strain (in/in) Gravity Bot Max	AP-460-UBS-BEC EPEL P3 Strain (in/in) Gravity Bot Min	AP-460-UBS-BEC EPEL P3 Strain (in/in) Gravity Bot Max
762	67.33	3.37E-05	3.37E-05	-3.72E-05	-3.72E-05	-4.11E-05	-4.10E-05
782	105.04	3.89E-05	3.90E-05	-3.08E-05	-3.08E-05	-5.97E-05	-5.96E-05
802	136.24	3.45E-05	3.45E-05	-2.53E-05	-2.53E-05	-5.49E-05	-5.48E-05
822	181.71	2.82E-05	2.83E-05	-1.59E-05	-1.59E-05	-4.97E-05	-4.97E-05
842	225.10	2.24E-05	2.24E-05	-8.86E-06	-8.85E-06	-4.27E-05	-4.27E-05
862	273.66	1.70E-05	1.70E-05	-2.77E-06	-2.76E-06	-3.67E-05	-3.67E-05
882	323.27	1.09E-05	1.09E-05	5.69E-06	5.70E-06	-2.38E-05	-2.38E-05
902	369.20	1.35E-05	1.36E-05	3.44E-06	3.44E-06	-2.13E-05	-2.13E-05
922	419.20	4.71E-05	4.71E-05	-4.09E-06	-4.08E-06	-1.84E-05	-1.83E-05
237	463.02						
257	510.03						
277	544.44						
297	580.53						
317	631.08						
337	680.34						
357	727.44						
377	772.93						
397	831.34						
417	894.09						
2132	925.08	1.92E-05	1.92E-05	2.55E-07	2.57E-07	-2.93E-05	-2.92E-05
2122	935.67	4.45E-05	4.45E-05	-2.17E-05	-2.17E-05	-8.05E-05	-8.05E-05
2112	944.86	8.44E-05	8.45E-05	-3.62E-06	-3.62E-06	-3.45E-05	-3.44E-05
477	968.95						
497	1002.45						
517	1042.45						
537	1108.60						
557	1178.35						
577	1227.20						
597	1271.50						
617	1313.65						
637	1360.60						

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Table H.19. UBS-BEC Concrete Backed Steel Strain, Shell Top, Gravity Plus Seismic Load

**AP Backed Steel, Upper Bound Soil, Seismic Only, Best Estimate Tank Concrete, 460 In Waste
Level at 1.83SpG**

M&D Starting M&D Element No.	Path (in)	Shell Top Surface (inside - towards waste) Seismic					
		AP-460-UBS-BEC EPEL P1 Strain (in/in) Seismic Top Min	AP-460-UBS-BEC EPEL P1 Strain (in/in) Seismic Top Max	AP-460-UBS-BEC EPEL P2 (in/in) Seismic Top Min	AP-460-UBS-BEC EPEL P2 Strain (in/in) Seismic Top Max	AP-460-UBS-BEC EPEL P3 Strain (in/in) Seismic Top Min	AP-460-UBS-BEC EPEL P3 Strain (in/in) Seismic Top Max
762	67.33	1.98E-05	4.96E-05	-4.67E-05	-5.69E-06	-6.59E-05	-2.34E-05
782	105.04	2.33E-05	5.90E-05	-3.95E-05	-1.17E-05	-8.19E-05	-2.64E-05
802	136.24	2.26E-05	5.05E-05	-3.73E-05	5.22E-06	-8.91E-05	-2.66E-05
822	181.71	1.97E-05	4.41E-05	-2.68E-05	5.38E-06	-7.47E-05	-2.35E-05
842	225.10	1.70E-05	4.78E-05	-2.37E-05	2.49E-05	-7.60E-05	-1.97E-05
862	273.66	1.17E-05	3.36E-05	-1.33E-05	1.91E-05	-5.81E-05	-9.51E-06
882	323.27	7.55E-06	8.86E-05	-6.78E-06	1.71E-05	-7.30E-05	-1.10E-05
902	369.20	2.17E-06	9.39E-05	-3.49E-06	1.54E-05	-5.63E-05	-7.98E-07
922	419.20	2.48E-05	1.70E-04	-1.52E-05	1.11E-05	-7.03E-05	-1.51E-06
237	463.02						
257	510.03						
277	544.44						
297	580.53						
317	631.08						
337	680.34						
357	727.44						
377	772.93						
397	831.34						
417	894.09						
2132	925.08	1.90E-05	3.28E-05	-2.30E-05	6.56E-06	-4.18E-05	-2.16E-05
2122	935.67	4.94E-05	9.48E-05	-2.14E-05	-2.19E-06	-3.63E-05	-1.44E-05
2112	944.86	3.60E-05	1.02E-04	-7.88E-06	1.91E-05	-1.43E-04	-1.84E-05
477	968.95						
497	1002.45						
517	1042.45						
537	1108.60						
557	1178.35						
577	1227.20						
597	1271.50						
617	1313.65						
637	1360.60						

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Table H.20. UBS-BEC Concrete Backed Steel Strain, Shell Middle, Gravity Plus Seismic Load

**AP Backed Steel, Upper Bound Soil, Seismic Only, Best Estimate Tank Concrete, 460 In Waste
Level at 1.83SpG**

M&D Starting M&D Element No.	Path (in)	Shell Mid-Plane					
		AP-460-UBS-BEC EPEL P1 Strain (in/in) Seismic Mid Min	AP-460-UBS-BEC EPEL P1 Strain (in/in) Seismic Mid Max	AP-460-UBS-BEC EPEL P2 (in/in) Seismic Mid Min	AP-460-UBS-BEC EPEL P2 Strain (in/in) Seismic Mid Max	AP-460-UBS-BEC EPEL P3 Strain (in/in) Seismic Mid Min	AP-460-UBS-BEC EPEL P3 Strain (in/in) Seismic Mid Max
762	67.33	1.99E-05	5.00E-05	-4.93E-05	-1.32E-05	-6.21E-05	-2.33E-05
782	105.04	2.41E-05	5.76E-05	-4.03E-05	-1.21E-05	-8.74E-05	-3.12E-05
802	136.24	2.22E-05	5.33E-05	-3.80E-05	4.45E-06	-8.41E-05	-2.80E-05
822	181.71	2.01E-05	4.11E-05	-2.67E-05	4.88E-06	-7.62E-05	-2.38E-05
842	225.10	1.63E-05	4.76E-05	-2.73E-05	2.20E-05	-6.85E-05	-2.05E-05
862	273.66	1.27E-05	3.33E-05	-1.40E-05	1.92E-05	-5.92E-05	-1.40E-05
882	323.27	5.27E-06	8.85E-05	-6.84E-06	1.92E-05	-5.76E-05	-7.64E-06
902	369.20	2.52E-06	9.21E-05	-3.87E-07	1.55E-05	-5.60E-05	-8.82E-07
922	419.20	2.48E-05	1.74E-04	-2.18E-05	1.73E-05	-6.49E-05	-1.64E-06
237	463.02	1.46E-05	5.85E-05	5.26E-06	1.04E-05	-7.62E-05	-4.08E-05
257	510.03	3.93E-05	6.67E-05	2.15E-05	5.75E-05	-2.93E-04	-1.79E-04
277	544.44	6.55E-05	9.63E-05	7.42E-06	5.17E-05	-4.33E-04	-2.75E-04
297	580.53	4.77E-05	6.77E-05	-4.16E-05	2.61E-05	-2.73E-04	-1.73E-04
317	631.08	6.34E-05	8.82E-05	-8.37E-05	-5.93E-06	-3.15E-04	-2.09E-04
337	680.34	7.43E-05	1.03E-04	-9.54E-05	-2.36E-05	-3.70E-04	-2.53E-04
357	727.44	7.06E-05	9.82E-05	-9.97E-05	-3.13E-05	-3.42E-04	-2.34E-04
377	772.93	8.30E-05	1.19E-04	-1.02E-04	-1.71E-05	-4.24E-04	-2.82E-04
397	831.34	7.80E-05	1.12E-04	-9.02E-05	-8.00E-06	-4.04E-04	-2.64E-04
417	894.09	3.01E-05	4.46E-05	-5.96E-05	1.29E-05	-1.42E-04	-6.47E-05
2132	925.08	1.47E-05	2.60E-05	-1.04E-05	1.01E-05	-3.98E-05	-1.55E-05
2122	935.67	1.44E-05	3.15E-05	-1.78E-05	1.08E-05	-3.70E-05	-1.55E-05
2112	944.86	8.41E-06	3.58E-05	-6.94E-06	1.61E-05	-4.26E-05	-9.28E-06
477	968.95	9.72E-06	3.35E-05	-1.25E-06	1.32E-05	-6.15E-05	-3.42E-05
497	1002.45	5.60E-05	9.09E-05	-5.22E-06	3.41E-05	-2.46E-05	-1.27E-05
517	1042.45	8.13E-06	3.20E-05	-2.44E-06	1.68E-05	-6.55E-06	-5.41E-07
537	1108.60	7.45E-06	4.04E-05	-3.54E-06	2.41E-05	-1.65E-05	-2.27E-06
557	1178.35	2.05E-06	2.48E-05	-3.51E-06	1.15E-05	-2.77E-05	-1.55E-06
577	1227.20	8.54E-06	4.61E-05	-3.54E-06	2.24E-05	-1.04E-05	-1.41E-06
597	1271.50	2.41E-06	2.11E-05	-3.65E-06	5.29E-06	-2.13E-05	-1.32E-06
617	1313.65	1.13E-06	3.57E-05	-1.45E-06	1.81E-05	-9.55E-06	-5.16E-07
637	1360.60	7.40E-07	1.08E-05	-2.01E-07	7.59E-06	-3.21E-06	-2.97E-07

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Table H.21. UBS-BEC Concrete Backed Steel Strain, Shell Bottom, Gravity Plus Seismic Load

**AP Backed Steel, Upper Bound Soil, Seismic Only, Best Estimate Tank Concrete, 460 In Waste
Level at 1.83SpG**

M&D Starting M&D Element No.	Path (in)	Shell Bottom Surface (outside - away from waste) Seismic					
		AP-460-UBS-BEC EPEL P1 Strain (in/in) Seismic Bot Min	AP-460-UBS-BEC EPEL P1 Strain (in/in) Seismic Bot Max	AP-460-UBS-BEC EPEL P2 (in/in) Seismic Bot Min	AP-460-UBS-BEC EPEL P2 Strain (in/in) Seismic Bot Max	AP-460-UBS-BEC EPEL P3 Strain (in/in) Seismic Bot Min	AP-460-UBS-BEC EPEL P3 Strain (in/in) Seismic Bot Max
762	67.33	1.94E-05	5.52E-05	-5.18E-05	-1.38E-05	-5.91E-05	-1.92E-05
782	105.04	2.30E-05	6.08E-05	-4.16E-05	-1.24E-05	-9.33E-05	-2.15E-05
802	136.24	2.20E-05	5.92E-05	-3.85E-05	3.72E-06	-7.92E-05	-2.67E-05
822	181.71	1.96E-05	4.04E-05	-2.67E-05	4.38E-06	-7.79E-05	-2.22E-05
842	225.10	1.39E-05	4.91E-05	-2.90E-05	1.84E-05	-6.54E-05	-1.50E-05
862	273.66	1.29E-05	3.31E-05	-1.49E-05	1.96E-05	-6.19E-05	-1.61E-05
882	323.27	3.03E-06	8.85E-05	-7.27E-06	2.06E-05	-5.49E-05	-1.80E-06
902	369.20	3.65E-06	9.08E-05	7.64E-07	1.78E-05	-5.76E-05	-4.03E-06
922	419.20	2.47E-05	1.78E-04	-2.82E-05	3.43E-05	-6.13E-05	-1.62E-06
237	463.02						
257	510.03						
277	544.44						
297	580.53						
317	631.08						
337	680.34						
357	727.44						
377	772.93						
397	831.34						
417	894.09						
2132	925.08	1.65E-05	2.89E-05	-2.10E-06	9.30E-06	-3.89E-05	-1.55E-05
2122	935.67	3.73E-05	6.96E-05	-2.68E-05	2.34E-06	-1.07E-04	-2.60E-05
2112	944.86	6.11E-05	1.74E-04	-1.59E-05	1.95E-05	-4.35E-05	-1.07E-05
477	968.95						
497	1002.45						
517	1042.45						
537	1108.60						
557	1178.35						
577	1227.20						
597	1271.50						
617	1313.65						
637	1360.60						

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Table H.22. UBS-BEC Concrete Backed Steel Strain, Shell Top, Seismic Load Only

**AP Backed Steel, Upper Bound Soil, Seismic Only, Best Estimate Tank Concrete, 460 In
Waste Level at 1.83SpG**

M&D Starting M&D Element No.	Path (in)	Shell Top Surface (inside - towards waste) Seismic					
		AP-460-UBS-BEC EPEL P1 Strain (in/in)		AP-460-UBS-BEC EPEL P1 Strain (in/in)		AP-460-UBS-BEC EPEL P2 Strain (in/in)	
		Seismic Only	Top Min	Seismic Only	Top Max	Seismic Only	Top Min
762	67.33	-1.29E-05		1.68E-05		-1.24E-05	2.86E-05
782	105.04	-1.43E-05		2.14E-05		-1.01E-05	1.77E-05
802	136.24	-1.16E-05		1.63E-05		-1.33E-05	2.92E-05
822	181.71	-8.49E-06		1.59E-05		-1.17E-05	2.05E-05
842	225.10	-5.95E-06		2.49E-05		-1.53E-05	3.34E-05
862	273.66	-4.28E-06		1.76E-05		-1.10E-05	2.14E-05
882	323.27	-3.48E-06		7.75E-05		-1.62E-05	7.71E-06
902	369.20	-1.18E-05		7.99E-05		-3.45E-06	1.54E-05
922	419.20	-2.24E-05		1.23E-04		-4.72E-06	2.15E-05
237	463.02						
257	510.03						
277	544.44						
297	580.53						
317	631.08						
337	680.34						
357	727.44						
377	772.93						
397	831.34						
417	894.09						
2062	925.08	-3.24E-06		1.06E-05		-3.45E-06	2.61E-05
2052	935.67	-1.37E-05		3.16E-05		-3.22E-06	1.60E-05
2042	944.86	-1.55E-05		5.08E-05		-3.60E-06	2.33E-05
477	968.95						
497	1002.45						
517	1042.45						
537	1108.60						
557	1178.35						
577	1227.20						
597	1271.50						
617	1313.65						
637	1360.60						

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Table H.23. UBS-BEC Concrete Backed Steel Strain, Shell Middle, Seismic Load Only

**AP Backed Steel, Lower Bound Soil, Seismic Only, Best Estimate Tank Concrete, 460 In
Waste Level at 1.83SpG**

M&D Starting M&D Element No.	Path (in)	Shell Top Surface (inside - towards waste) Seismic					
		AP-460-LBS-BEC EPEL P1 Strain (in/in)	AP-460-LBS-BEC EPEL P1 Strain (in/in)	AP-460-LBS-BEC EPEL P2 (in/in)	AP-460-LBS-BEC EPEL P2 Strain (in/in)	AP-460-LBS-BEC EPEL P3 Strain (in/in) Seismic Only	AP-460-LBS-BEC EPEL P3 Strain (in/in)
		Seismic Only Top Min	Seismic Only Top Max	Seismic Only Top Min	Seismic Only Top Max	Top Min	Seismic Only Top Max
762	67.33	-1.14E-05	1.19E-05	-1.51E-05	2.83E-05	-1.37E-05	1.74E-05
782	105.04	-1.27E-05	2.43E-05	-1.03E-05	1.94E-05	-2.02E-05	3.93E-05
802	136.24	-1.18E-05	1.35E-05	-1.06E-05	3.89E-05	-2.63E-05	1.66E-05
822	181.71	-8.90E-06	1.82E-05	-8.51E-06	1.81E-05	-2.07E-05	2.90E-05
842	225.10	-6.77E-06	1.04E-05	-5.68E-06	5.11E-05	-2.80E-05	9.04E-06
862	273.66	-4.85E-06	1.46E-05	-7.94E-06	3.03E-05	-2.53E-05	2.99E-05
882	323.27	-2.47E-06	3.91E-05	-3.54E-06	3.88E-05	-5.24E-05	8.21E-06
902	369.20	-7.34E-06	7.52E-05	-7.57E-06	1.41E-05	-4.32E-05	2.69E-05
922	419.20	-1.71E-05	1.18E-04	-3.99E-06	2.51E-05	-5.84E-05	1.66E-05
237	463.02						
257	510.03						
277	544.44						
297	580.53						
317	631.08						
337	680.34						
357	727.44						
377	772.93						
397	831.34						
417	894.09						
2062	925.08	-5.68E-06	1.24E-05	-4.68E-06	5.26E-05	-1.68E-05	9.37E-06
2052	935.67	-1.08E-05	4.21E-05	-2.83E-06	3.23E-05	-1.73E-05	1.13E-05
2042	944.86	-2.35E-05	6.37E-05	-5.64E-06	5.32E-05	-3.87E-05	1.63E-04
477	968.95						
497	1002.45						
517	1042.45						
537	1108.60						
557	1178.35						
577	1227.20						
597	1271.50						
617	1313.65						
637	1360.60						

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Table H.24. UBS-BEC Concrete Backed Steel Strain, Shell Bottom, Seismic Load Only

**AP Backed Steel, Upper Bound Soil, Seismic Only, Best Estimate Tank Concrete, 460 In Waste
Level at 1.83SpG**

M&D Starting M&D Element No.	Path (in)	Shell Bottom Surface (outside - away from waste) Seismic					
		AP-460-UBS-BEC EPEL P1 Strain (in/in) Seismic Only Bot	AP-460-UBS-BEC EPEL P1 Strain (in/in) Seismic Only Bot	AP-460-UBS-BEC EPEL P2 Strain (in/in) Seismic Only Bot	AP-460-UBS-BEC EPEL P2 Strain (in/in) Seismic Only Bot	AP-460-UBS-BEC EPEL P3 Strain (in/in) Seismic Only Bot	AP-460-UBS-BEC EPEL P3 Strain (in/in) Seismic Only Bot
		Min	Max	Min	Max	Min	Max
762	67.33	-1.43E-05	2.14E-05	-1.45E-05	2.34E-05	-1.80E-05	2.18E-05
782	105.04	-1.59E-05	2.19E-05	-1.08E-05	1.84E-05	-3.37E-05	3.81E-05
802	136.24	-1.25E-05	2.47E-05	-1.32E-05	2.90E-05	-2.43E-05	2.82E-05
822	181.71	-8.60E-06	1.21E-05	-1.08E-05	2.03E-05	-2.82E-05	2.74E-05
842	225.10	-8.42E-06	2.68E-05	-2.01E-05	2.72E-05	-2.26E-05	2.78E-05
862	273.66	-4.16E-06	1.60E-05	-1.21E-05	2.23E-05	-2.52E-05	2.06E-05
882	323.27	-7.82E-06	7.76E-05	-1.30E-05	1.49E-05	-3.11E-05	2.20E-05
902	369.20	-9.88E-06	7.73E-05	-2.67E-06	1.43E-05	-3.63E-05	1.73E-05
922	419.20	-2.24E-05	1.30E-04	-2.41E-05	3.84E-05	-4.30E-05	1.67E-05
237	463.02						
257	510.03						
277	544.44						
297	580.53						
317	631.08						
337	680.34						
357	727.44						
377	772.93						
397	831.34						
417	894.09						
2062	925.08	-2.75E-06	9.61E-06	-2.35E-06	9.04E-06	-9.69E-06	1.37E-05
2052	935.67	-7.13E-06	2.51E-05	-5.16E-06	2.40E-05	-2.63E-05	5.45E-05
2042	944.86	-2.33E-05	8.94E-05	-1.23E-05	2.31E-05	-9.09E-06	2.38E-05
477	968.95						
497	1002.45						
517	1042.45						
537	1108.60						
557	1178.35						
577	1227.20						
597	1271.50						
617	1313.65						
637	1360.60						

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Table H.25. UBS-BEC Concrete Wall/Footing Contact Forces, Gravity Only

Tank AY, 460 Inch Waste Level
 SpG = 1.83

Upper Bound Soil

Best Estimate Concrete

Angle	Vertical Min AP- UBS-BEC Gravity	Vertical Max AP- UBS-BEC Gravity	Shear Y Min AP- UBS-BEC Gravity	Shear Y Max AP- UBS-BEC Gravity	Shear X Min AP- UBS-BEC Gravity	Shear X Max AP- UBS-BEC Gravity	Shear Y Min AP- UBS-BEC Gravity	Shear Y Max AP- UBS-BEC Gravity	Shear X Min AP- UBS-BEC Gravity	Shear X Max AP- UBS-BEC Gravity	Vertical Force Max AP-UBS- BEC Gravity	Vertical Force Min AP-UBS- BEC Gravity
0	-184.90	-184.70	0.00	0.00	2.01	2.01	0.00	0.63		0.63	-57.78	-57.72
9	-369.60	-369.40	0.65	0.65	4.00	4.00	0.10	0.63		0.63	-57.75	-57.72
18	-369.70	-369.40	1.39	1.39	3.72	3.72	0.22	0.58		0.62	-57.77	-57.72
27	-369.70	-369.40	2.00	2.00	3.46	3.46	0.31	0.54		0.62	-57.77	-57.72
36	-369.60	-369.40	2.37	2.37	3.26	3.26	0.37	0.51		0.63	-57.75	-57.72
45	-369.60	-369.30	2.87	2.87	2.80	2.80	0.45	0.44		0.63	-57.75	-57.70
54	-369.60	-369.30	3.29	3.29	2.29	2.29	0.51	0.36		0.63	-57.75	-57.70
63	-369.60	-369.30	3.62	3.62	1.75	1.75	0.57	0.27		0.63	-57.75	-57.70
72	-369.60	-369.30	3.85	3.85	1.20	1.20	0.60	0.19		0.63	-57.75	-57.70
81	-369.60	-369.30	3.97	3.97	0.61	0.61	0.62	0.10		0.63	-57.75	-57.70
90	-369.50	-369.30	4.02	4.02	-0.01	-0.01	0.63	0.00		0.63	-57.73	-57.70
99	-369.60	-369.30	3.97	3.98	-0.62	-0.62	0.62	0.10		0.63	-57.75	-57.70
108	-369.60	-369.30	3.82	3.82	-1.24	-1.24	0.60	0.19		0.63	-57.75	-57.70
117	-369.60	-369.30	3.62	3.62	-1.78	-1.78	0.57	0.28		0.63	-57.75	-57.70
126	-369.60	-369.30	3.31	3.31	-2.30	-2.30	0.52	0.36		0.63	-57.75	-57.70
135	-369.60	-369.30	2.92	2.92	-2.77	-2.77	0.46	0.43		0.63	-57.75	-57.70
144	-369.60	-369.30	2.42	2.42	-3.19	-3.19	0.38	0.50		0.63	-57.75	-57.70
153	-369.60	-369.40	1.87	1.87	-3.57	-3.57	0.29	0.56		0.63	-57.75	-57.72
162	-369.60	-369.40	1.31	1.31	-3.83	-3.83	0.20	0.60		0.63	-57.75	-57.72
171	-369.60	-369.40	0.69	0.69	-3.97	-3.97	0.11	0.62		0.63	-57.75	-57.72
180	-184.90	-184.70	0.00	0.00	-2.02	-2.02	0.00	0.63		0.63	-57.78	-57.72

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Table H.26. UBS-BEC Concrete Wall/Footing Contact Forces, Gravity Plus Seismic

Tank AY, 460 Inch Waste Level
SpG = 1.83
Upper Bound Soil
Best Estimate Concrete

Angle	Vertical Min AP- UBS-BEC Seismic	Vertical Max AP- UBS-BEC Seismic	Shear Y Min AP- UBS-BEC Seismic	Shear Y Max AP- UBS-BEC Seismic	Shear X Min AP- UBS-BEC Seismic	Shear X Max AP- UBS-BEC Seismic	Shear Y Min AP- UBS-BEC Seismic	Shear Y Max AP- UBS-BEC Seismic	Shear X Min AP- UBS-BEC Seismic	Shear X Max AP- UBS-BEC Seismic	Vertical Force Max AP-UBS- BEC Seismic	Vertical Force Min AP-UBS- BEC Seismic
0	-215.60	-138.50	0.00	0.00	-5.23	10.13	0.00	3.17	3.17		-67.38	-43.28
9	-431.20	-277.20	-22.41	21.83	-13.78	23.72	3.50	3.71	5.10		-67.38	-43.31
18	-431.30	-278.10	-42.46	41.88	-23.89	33.85	6.63	5.29	8.48		-67.39	-43.45
27	-431.30	-279.40	-58.29	58.22	-39.64	49.85	9.11	7.79	11.98		-67.39	-43.66
36	-431.40	-281.30	-68.40	69.21	-59.79	70.13	10.81	10.96	15.40		-67.41	-43.95
45	-431.50	-283.70	-71.50	74.04	-82.93	92.39	11.57	14.44	18.50		-67.42	-44.33
54	-431.70	-286.50	-67.47	71.79	-106.70	114.80	11.22	17.94	21.16		-67.45	-44.77
63	-431.80	-289.20	-56.75	62.36	-128.50	135.30	9.74	21.14	23.28		-67.47	-45.19
72	-432.00	-291.60	-40.22	46.53	-145.60	151.90	7.27	23.73	24.82		-67.50	-45.56
81	-437.20	-293.50	-19.30	26.11	-156.20	162.70	4.08	25.42	25.75		-68.31	-45.86
90	-442.10	-295.00	2.70	6.17	-159.40	166.10	0.96	25.95	25.97		-69.08	-46.09
99	-445.70	-296.10	-18.82	27.55	-155.30	161.50	4.30	25.23	25.60		-69.64	-46.27
108	-448.20	-296.10	-38.66	48.25	-144.40	149.30	7.54	23.33	24.52		-70.03	-46.27
117	-450.00	-293.70	-54.13	63.96	-128.20	130.70	9.99	20.42	22.74		-70.31	-45.89
126	-451.10	-291.80	-63.99	73.24	-108.40	108.10	11.44	16.94	20.44		-70.48	-45.59
135	-451.50	-290.20	-67.40	75.60	-86.81	84.04	11.81	13.56	17.99		-70.55	-45.34
144	-451.70	-288.50	-64.20	70.90	-65.50	60.80	11.08	10.23	15.08		-70.58	-45.08
153	-452.00	-287.20	-54.68	59.59	-46.44	40.20	9.31	7.26	11.80		-70.63	-44.88
162	-452.30	-286.50	-39.73	42.85	-31.34	24.05	6.70	4.90	8.29		-70.67	-44.77
171	-452.50	-286.00	-20.89	22.39	-21.59	14.18	3.50	3.37	4.86		-70.70	-44.69
180	-226.30	-143.00	0.00	0.00	-9.16	5.51	0.00	2.86	2.86		-70.72	-44.69

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Table H.27. UBS-BEC Concrete Wall/Footing Contact Forces, Seismic Only

Tank AY, 460 Inch Waste Level
 SpG = 1.83
 Upper Bound Soil
 Best Estimate Concrete

Angle	Vertical Min AP- UBS-BEC Seismic Only	Vertical Max AP- UBS-BEC Seismic Only	Shear Y Min AP- UBS-BEC Seismic Only	Shear Y Max AP- UBS-BEC Seismic Only	Shear X Min AP- UBS-BEC Seismic Only	Shear X Max AP- UBS-BEC Seismic Only	Shear Y Max AP- UBS-BEC Seismic Only	Shear X Max AP- UBS-BEC Seismic Only	Shear Max AP- UBS-BEC Seismic Only	Vertical Force Max AP-UBS- BEC Seismic Only	Vertical Force Min AP-UBS- BEC Seismic Only
0	-30.70	46.20	0.00	0.00	-7.24	8.12	0.00	2.54	2.54	-9.59	14.44
9	-61.60	92.20	-23.06	21.18	-17.78	19.72	3.60	3.08	4.74	-9.62	14.41
18	-61.60	91.30	-43.85	40.49	-27.61	30.13	6.85	4.71	8.31	-9.63	14.27
27	-61.60	90.00	-60.29	56.22	-43.10	46.39	9.42	7.25	11.89	-9.63	14.06
36	-61.80	88.10	-70.77	66.84	-63.05	66.87	11.06	10.45	15.21	-9.66	13.77
45	-61.90	85.60	-74.37	71.17	-85.73	89.59	11.62	14.00	18.19	-9.67	13.38
54	-62.10	82.80	-70.76	68.50	-108.99	112.51	11.06	17.58	20.77	-9.70	12.94
63	-62.20	80.10	-60.37	58.74	-130.25	133.55	9.43	20.87	22.90	-9.72	12.52
72	-62.40	77.70	-44.07	42.68	-146.80	150.70	6.89	23.55	24.53	-9.75	12.14
81	-67.60	75.80	-23.27	22.14	-156.81	162.09	3.64	25.33	25.59	-10.56	11.84
90	-72.60	74.30	-1.31	2.15	-159.39	166.11	0.34	25.95	25.96	-11.34	11.61
99	-76.10	73.20	-22.79	23.58	-154.68	162.12	3.68	25.33	25.60	-11.89	11.44
108	-78.60	73.20	-42.48	44.43	-143.16	150.54	6.94	23.52	24.52	-12.28	11.44
117	-80.40	75.60	-57.75	60.34	-126.42	132.48	9.43	20.70	22.75	-12.56	11.81
126	-81.50	77.50	-67.30	69.93	-106.10	110.40	10.93	17.25	20.42	-12.73	12.11
135	-81.90	79.10	-70.32	72.68	-84.04	86.81	11.36	13.56	17.69	-12.80	12.36
144	-82.10	80.80	-66.62	68.48	-62.31	63.99	10.70	10.00	14.64	-12.83	12.63
153	-82.40	82.20	-56.55	57.72	-42.87	43.77	9.02	6.84	11.32	-12.88	12.84
162	-82.70	82.90	-41.04	41.54	-27.51	27.88	6.49	4.36	7.82	-12.92	12.95
171	-82.90	83.40	-21.58	21.70	-17.62	18.15	3.39	2.84	4.42	-12.95	13.03
180	-41.40	41.70	0.00	0.00	-7.14	7.53	0.00	2.35	2.35	-12.94	13.03

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Table H.28. UBS-BEC Soil/Concrete Tank Contact Forces, Gravity Only

Tank AP, 460 Inch Waste Level
 SpG = 1.83
 Best Estimate Soil
 Best Estimate Concrete

1.22 1.17

	Angle (rad)	Path	Max Pressure Soil (BES) AP Gravity (PSI)	Min Pressure Soil (BES) AP Gravity (PSI)	Max Meridional Friction Soil (BES) AP Gravity (PSI)	Max Tangential Friction Soil (BES) AP Gravity (PSI)	Max Contact Displacement Soil (BES) AP Gravity (PSI)	Vertical Pressure	Active Pressure Phi = 33 deg	Active Pressure Phi = 49 deg	0.22g Dome Vertical	0.17g Haunch Vertical
568	-0.035089	67.727	11.63	11.48	1.60	0.04	0.01	7.12	7.11	7.11	14.19	13.61
565.8	-0.07135	105.668	10.01	9.83	1.98	0.07	0.02	7.27	7.26	7.26	12.22	11.72
563.21	-0.096521	137.069	8.90	7.76	1.82	0.11	0.02	7.46	7.43	7.42	10.73	10.29
559.7	-0.124516	182.849	7.22	6.28	1.60	0.17	0.02	7.71	7.65	7.65	8.80	8.44
550.7	-0.180521	226.563	9.13	6.44	1.81	0.28	0.02	8.35	8.23	8.22	11.13	10.68
545.2	-0.210395	275.566	9.17	8.77	1.85	0.14	0.02	8.74	8.57	8.55	11.18	10.73
527.68	-0.298426	325.690	8.64	8.24	1.77	0.03	0.02	9.99	9.59	9.56	10.54	10.11
518.2	-0.34673	372.305	10.81	10.72	2.04	0.03	0.02	10.66	10.09	10.04	13.19	12.65
494.6	-0.482293	423.427	17.48	17.40	2.06	0.06	0.02	12.35	11.07	10.97	21.32	20.45
476.2	-0.606571	466.308	27.65	27.60	2.21	0.11	0.02	13.65	11.45	11.27	33.73	32.35
447.4	-0.656685	513.312	31.96	31.86	4.44	0.21	0.03	15.70	12.75	12.51	38.99	37.39
407.1	-0.710341	549.725	25.83	25.77	5.35	0.16	0.04	18.57	14.53	14.18	31.51	30.22
382.1	-1.570796	585.819	12.88	12.86	3.35	0.07	0.04	20.35	6.00	2.85	15.72	15.07
335	-1.570796	636.369	4.50	4.50	1.10	0.01	0.05	23.70	6.99	3.32	5.49	5.27
281	-1.570796	685.619	3.96	3.96	0.93	0.00	0.05	27.55	8.13	3.86	4.83	4.64
236.5	-1.570796	732.719	4.95	4.94	1.01	0.00	0.06	30.71	9.06	4.30	6.03	5.79
186.8	-1.570796	778.219	4.66	4.65	0.95	0.00	0.06	34.25	10.10	4.80	5.68	5.45
145.5	-1.570796	821.369	5.71	5.71	1.28	0.01	0.06	37.19	10.97	5.21	6.97	6.68
70	-1.570796	874.169	8.43	8.42	1.87	0.02	0.05	42.57	12.56	5.96	10.29	9.86
24	-1.570796	930.544	12.40	12.35	2.76	0.06	0.04	45.84	13.52	6.42	15.12	14.50

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Table H.30. UBS-BEC Soil/Concrete Tank Contact Forces, Seismic Only

Tank AP, 460 Inch Waste Level
 SpG = 1.83
 Upper Bound Soil
 Best Estimate Concrete

	Angle (rad)	Path	Max Pressure Soil (UBS) AP Seismic Only (PSI)	Min Pressure Soil (UBS) AP Seismic Only (PSI)	Max Meridional Friction (UBS) AP Seismic Only (PSI)	Max Tangential Friction (UBS) AP Seismic Only (PSI)	Max Contact Displacement (UBS) AP Seismic Only (inch)
568	-0.035089	67.727	12.15	-9.70	14.93	6.20	0.52
565.8	-0.07135	105.668	7.56	-6.52	7.88	3.51	0.44
563.21	-0.096521	137.069	5.53	-7.50	6.92	2.70	0.21
559.7	-0.124516	182.849	3.51	-3.98	5.22	3.65	0.08
550.7	-0.180521	226.563	6.18	-6.07	3.99	4.74	0.01
545.2	-0.210395	275.566	2.79	-3.54	2.68	4.75	0.01
527.68	-0.298426	325.690	2.23	-2.78	2.69	4.18	0.01
518.2	-0.34673	372.305	2.42	-2.42	2.74	3.88	0.00
494.5	-0.482293	423.427	4.59	-4.05	2.70	3.32	0.00
476.2	-0.606571	468.308	6.94	-5.01	2.97	3.28	0.01
447.4	-0.656685	515.312	8.06	-5.39	6.53	4.19	0.01
407.1	-0.710341	549.725	8.58	-6.73	9.17	3.75	0.01
382.1	-1.570796	585.819	3.55	-2.74	6.20	2.73	0.02
335	-1.570796	636.369	0.82	-0.57	1.72	2.08	0.02
281	-1.570796	685.619	0.84	-0.64	1.95	1.53	0.02
236.5	-1.570796	732.719	0.80	-0.73	2.09	1.66	0.02
186.8	-1.570796	778.219	0.70	-0.52	1.79	2.11	0.02
145.5	-1.570796	821.369	0.73	-0.89	2.37	2.99	0.02
70	-1.570796	874.169	3.51	-2.95	6.04	4.54	0.02
24	-1.570796	930.544	10.40	-9.14	5.34	4.29	0.01

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Table H.31. UBS-BEC Primary Tank/Concrete Dome Contact Data, Gravity Only

Tank AP, 460 Inch Waste Level
 SpG = 1.83
 Upper Bound Soil
 Best Estimate Concrete

Radius	Max Pressure Primary Tank/Concrete Tank Dome AP Gravity (PSI)	Min Pressure Primary Tank/Concrete Tank Dome AP Gravity (PSI)	Max Gap Lateral Displacement Primary Tank /Concrete Tank Dome Gravity (in)	Max Gap Displacement Primary Tank/Concrete Tank Dome AP Gravity (Inches)
67.727	0.923	0.882	0.003043	0.000000
105.668	0.801	0.782	0.004643	0.000000
137.069	0.247	0.233	0.002581	-0.000011
182.849	0.473	0.466	0.003415	-0.000007
226.563	0.753	0.729	0.004411	-0.000143
275.566	0.211	0.201	0.010849	0.000000
325.690	0.146	0.123	0.006404	-0.000857
372.305	0.000	0.000	0.000000	-0.002717
423.427	0.000	0.000	0.000000	-1.062840

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Table H.32. UBS-BEC Primary Tank/Concrete Dome Contact Data, Gravity Plus Seismic

Tank AP, 460 Inch Waste Level
 SpG = 1.83
 Upper Bound Soil
 Best Estimate Concrete

Radius	Max Pressure Primary Tank/Concrete Tank Dome AP Seismic (PSI)	Min Pressure Primary Tank/Concrete Tank Dome AP Seismic (PSI)	Max Gap Lateral Displacement Primary Tank /Concrete Tank Dome Seismic (in)	Max Gap Displacement Primary Tank/Concrete Tank Dome AP Seismic (Inches)
67.727	16.160	0.000	0.017004	-0.000887
105.668	5.399	0.000	0.018972	-0.002879
137.069	3.411	0.000	0.048360	-0.002411
182.849	5.190	0.000	0.037272	-0.003506
226.563	6.168	0.000	0.032880	-0.002796
275.566	7.368	0.000	0.032328	-0.004583
325.690	8.833	0.000	0.046980	-0.005611
372.305	8.757	0.000	0.035256	-0.010124
423.427	3.121	0.000	0.000000	-1.073160

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Table H.33. UBS-BEC Primary Tank/Concrete Dome Contact Data, Seismic Only

Tank AP, 460 Inch Waste Level
 SpG = 1.83
 Upper Bound Soil
 Best Estimate Concrete

Radius	Max Pressure Primary Tank/Concrete Tank Dome AP Seismic Only (PSI)	Min Pressure Primary Tank/Concrete Tank Dome AP Seismic Only (PSI)	Max Gap Lateral Displacement Primary Tank /Concrete Tank Dome Seismic Only (in)	Max Gap Displacement Primary Tank/Concrete Tank Dome AP Seismic Only (Inches)
67.727	15.237	-0.882	0.013961	-0.000887
105.668	4.599	-0.782	0.014329	-0.002879
137.069	3.165	-0.233	0.045779	-0.002400
182.849	4.717	-0.466	0.033857	-0.003499
226.563	5.415	-0.729	0.028469	-0.002653
275.566	7.157	-0.201	0.021479	-0.004583
325.690	8.688	-0.123	0.040576	-0.004754
372.305	8.757	0.000	0.035256	-0.007408
423.427	3.121	0.000	0.000000	-0.010320

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Table H.34. UBS-BEC Primary Tank/Insulating Concrete Contact Forces, Gravity Only

Tank AP, 460 Inch Waste Level
 SpG = 1.83
 Upper Bound Soil
 Best Estimate Concrete

Radius	Max Pressure Primary Tank/Insulating Concrete AP Gravity (PSI)	Min Pressure Primary Tank/Insulating Concrete AP Gravity (PSI)	Max Lateral Displacement Primary Tank / Insulating Concrete AP Gravity (Inches)	Min Lateral Displacement Primary Tank / Insulating Concrete AP Gravity (Inches)
424.00	69.931	69.861	0.006617	0.006601
384.00	13.882	13.868	0.000730	0.000654
317.85	33.153	33.132	0.002825	0.002809
248.10	29.764	29.743	0.002167	0.002156
199.25	30.729	30.708	0.001478	0.001471
154.95	30.486	30.465	0.000894	0.000888
112.80	30.424	30.396	0.000110	0.000107
65.85	31.056	31.014	0.000205	0.000198

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Table H.35. UBS-BEC Primary Tank/Insulating Concrete Contact Data, Gravity Plus Seismic

Tank AP, 460 Inch Waste Level
 SpG = 1.83
 Upper Bound Soil
 Best Estimate Concrete

Radius	Max Pressure Primary Tank/Insulating Concrete AP Seismic (PSI)	Min Pressure Primary Tank/Insulating Concrete AP Seismic (PSI)	Max Lateral Displacement Primary Tank/Insulating Concrete AP Seismic (Inches)	Min Lateral Displacement Primary Tank/Insulating Concrete AP Seismic (Inches)
424.00	95.556	43.160	0.071064	0.002243
384.00	27.160	6.400	0.369000	0.000574
317.85	46.319	22.889	0.045408	0.000556
248.10	40.931	20.604	0.024048	0.000414
199.25	41.340	22.229	0.012828	0.000174
154.95	38.618	23.271	0.007506	0.000200
112.80	38.021	24.014	0.004883	0.000015
65.85	38.486	24.563	0.003655	0.000092

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Table H.36. UBS-BEC Primary Tank/Insulating Concrete Contact Forces, Seismic Only

Tank AP, 460 Inch Waste Level
 SpG = 1.83
 Upper Bound Soil
 Best Estimate Concrete

Radius	Max Pressure Insulating Concrete/Secondary Liner AP Gravity (PSI)	Min Pressure Insulating Concrete/Secondary Liner AP Gravity (PSI)	Max Lateral Displacement Insulating Concrete/Secondary Liner AP Gravity (Inches)	Min Lateral Displacement Insulating Concrete/Secondary Liner AP Gravity (Inches)
424.00	76.458	76.250	0.002165	0.002129
384.00	32.896	32.847	0.001609	0.001573
317.85	28.125	28.097	0.001042	0.001010
248.10	31.438	31.417	0.000724	0.000700
199.25	30.917	30.889	0.000378	0.000363
154.95	30.667	30.639	0.000262	0.000253
112.80	31.118	31.069	0.000212	0.000211
65.85	30.771	30.639	0.000041	0.000040

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Table H.37. UBS-BEC Insulating Concrete/Concrete Backed Steel Contact Data, Gravity Only

Tank AP, 460 Inch Waste Level
 SpG = 1.83
 Best Estimate Soil
 Best Estimate Concrete

Radius	Max Pressure Insulating Concrete/Secondary Liner AP Gravity (PSI)	Min Pressure Insulating Concrete/Secondary Liner AP Gravity (PSI)	Max Lateral Displacement Insulating Concrete/Secondary Liner AP Gravity (Inches)	Min Lateral Displacement Insulating Concrete/Secondary Liner AP Gravity (Inches)
424.00	86.458	86.250	0.003563	0.003527
384.00	33.854	33.785	0.002846	0.002810
317.85	27.736	27.701	0.002029	0.001997
248.10	31.500	31.472	0.001470	0.001445
199.25	30.931	30.896	0.000920	0.000905
154.95	30.576	30.542	0.000659	0.000651
112.80	31.215	31.146	0.000489	0.000487
65.85	30.597	30.410	0.000165	0.000160

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Table H.38. UBS-BEC Insulating Concrete/Concrete Backed Steel Contact Data, Gravity Plus Seismic

Tank AP, 460 Inch Waste Level
 SpG = 1.83
 Upper Bound Soil
 Best Estimate Concrete

Radius	Max Pressure Insulating Concrete/Secondary Liner AP Seismic (PSI)	Min Pressure Insulating Concrete/Secondary Liner AP Seismic (PSI)	Max Lateral Displacement Insulating Concrete/Secondary Liner AP Seismic (Inches)	Min Lateral Displacement Insulating Concrete/Secondary Liner AP Seismic (Inches)
424.00	91.667	58.111	0.014472	0.000072
384.00	45.764	22.153	0.013884	0.000181
317.85	40.826	18.181	0.015360	0.000021
248.10	42.938	22.174	0.015672	0.000029
199.25	41.424	22.444	0.013560	0.000036
154.95	38.924	23.410	0.010792	0.000017
112.80	38.750	24.764	0.008864	0.000011
65.85	38.194	24.222	0.007630	0.000014

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Table H.39. UBS-BEC Insulating Concrete/Concrete Backed Steel Contact Data, Seismic Only

Tank AP, 460 Inch Waste Level
 SpG = 1.83
 Upper Bound Soil
 Best Estimate Concrete

Radius	Max Pressure Insulating Concrete/Secondary Liner AP Seismic Only (PSI)	Min Pressure Insulating Concrete/Secondary Liner AP Seismic Only (PSI)	Max Lateral Displacement Insulating Concrete/Secondary Liner AP Seismic Only (Inches)	Min Lateral Displacement Insulating Concrete/Secondary Liner AP Seismic Only (Inches)
424.00	15.208	-18.139	0.012	-0.002
384.00	12.868	-10.694	0.012	-0.001
317.85	12.701	-9.917	0.014	-0.001
248.10	11.500	-9.243	0.015	-0.001
199.25	10.507	-8.444	0.013	0.000
154.95	8.257	-7.229	0.011	0.000
112.80	7.632	-6.306	0.009	0.000
65.85	7.424	-6.417	0.008	0.000

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Table H.40. UBS-BEC Waste Contact Pressure, Gravity Plus Seismic

Tank AY, 460 Inch Waste Level
 SpG = 1.83
 Upper Bound Soil
 Best Estimate Concrete

Waste Height Ratio	Waste Height	Max Pressure AP Tank, 460 in Waste Level, SpG = 1.83 Time History (PSI)	Min Pressure AP Tank, 460 in Waste Level, SpG = 1.83 Time History (PSI)	Hydrostatic (psi)	Hydrodynamic (psi)	Theoretical Min (SRSS)	Theoretical Max (SRSS)
0.99	454.35	10.694	-9.875	0.37	1.84	0.00	2.22
0.96	443.05	14.229	-13.764	1.12	2.15	0.00	3.27
0.94	431.7625	17.111	-13.556	1.87	2.53	0.00	4.40
0.90	414.125	16.431	-10.236	3.03	3.19	0.00	6.22
0.85	390.125	10.375	-2.190	4.62	4.08	0.53	8.70
0.80	366.125	14.229	-0.505	6.20	4.93	1.27	11.14
0.74	342	16.729	0.006	7.80	5.73	2.06	13.53
0.69	318.325	18.889	0.908	9.36	6.46	2.90	15.82
0.64	295.225	22.257	1.893	10.89	7.12	3.77	18.01
0.59	272.125	22.833	2.556	12.41	7.73	4.69	20.14
0.54	248.975	26.625	3.820	13.94	8.28	5.66	22.23
0.49	225.825	28.882	4.864	15.47	8.79	6.68	24.27
0.44	202.725	29.236	5.892	17.00	9.26	7.74	26.25
0.39	179.625	31.549	7.188	18.53	9.67	8.86	28.19
0.34	156.475	35.306	8.819	20.06	10.03	10.02	30.09
0.29	134.075	36.264	10.250	21.54	10.34	11.20	31.87
0.24	112.475	36.938	11.396	22.96	10.59	12.37	33.55
0.20	90.875	39.639	12.507	24.39	10.80	13.59	35.19
0.15	69.275	40.958	13.632	25.82	10.96	14.85	36.78
0.10	47.738	42.993	15.139	27.24	11.08	16.16	38.32
0.05	24.500	43.382	12.514	28.78	11.16	17.61	39.94
0.02	7.755	47.694	23.021	29.88	11.19	18.69	41.07
0.00	1.755	44.396	23.486	30.28	11.19	19.09	41.47

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Table H.41. UBS-BEC Waste Contact Pressure, Theoretical Pressures

Tank Radius, Hr	450 H/M-Hr			1.022222222		Waste Dens		1.71E-04			
Waste Depth, Hl	460			Conv 1st	Conv 2nd	Conv 3rd	Impul H	Pressure			
				Conv 1st	Conv 2nd	Conv 3rd		Conv 1st	Conv 2nd	Conv 3rd	Impul H
Centroid	Hydrodynamic			1.841	5.331	8.536	Sa=	0.064	0.108	0.163	0.36
										0.32	
Height	nu	con0(n)	con1(n)	con2(n)	ci(n)	24.7296	41.7312	62.9832	139.1	123.65	SRSS
454.35	0.987717391	0.82	0.07	0.03	0.09	1.56	0.22	0.12	0.94	0.15	1.84
443.05	0.963152174	0.78	0.06	0.02	0.14	1.49	0.19	0.10	1.46	0.45	2.15
431.7625	0.93861413	0.75	0.05	0.02	0.18	1.43	0.17	0.08	1.94	0.75	2.53
414.125	0.900271739	0.70	0.04	0.01	0.24	1.33	0.14	0.06	2.62	1.21	3.19
390.125	0.848097826	0.64	0.03	0.01	0.32	1.22	0.10	0.04	3.43	1.84	4.08
366.125	0.795923913	0.59	0.02	0.00	0.39	1.11	0.08	0.02	4.13	2.45	4.93
342	0.743478261	0.54	0.02	0.00	0.44	1.02	0.06	0.01	4.75	3.05	5.73
318.325	0.69201087	0.49	0.01	0.00	0.49	0.94	0.04	0.01	5.27	3.62	6.46
295.225	0.641793478	0.45	0.01	0.00	0.53	0.86	0.03	0.01	5.72	4.15	7.12
272.125	0.591576087	0.42	0.01	0.00	0.57	0.80	0.03	0.00	6.11	4.66	7.73
248.975	0.54125	0.39	0.01	0.00	0.60	0.74	0.02	0.00	6.46	5.13	8.28
225.825	0.490923913	0.36	0.00	0.00	0.63	0.69	0.01	0.00	6.76	5.58	8.79
202.725	0.440706522	0.34	0.00	0.00	0.66	0.65	0.01	0.00	7.03	5.99	9.26
179.625	0.39048913	0.32	0.00	0.00	0.68	0.61	0.01	0.00	7.25	6.36	9.67
156.475	0.340163043	0.30	0.00	0.00	0.70	0.57	0.01	0.00	7.45	6.70	10.03
134.075	0.291467391	0.29	0.00	0.00	0.71	0.55	0.01	0.00	7.61	6.98	10.34
112.475	0.24451087	0.28	0.00	0.00	0.72	0.53	0.00	0.00	7.74	7.21	10.59
90.875	0.197554348	0.27	0.00	0.00	0.73	0.51	0.00	0.00	7.84	7.41	10.80
69.275	0.150597826	0.26	0.00	0.00	0.74	0.49	0.00	0.00	7.92	7.56	10.96
47.7375	0.103777174	0.25	0.00	0.00	0.75	0.48	0.00	0.00	7.98	7.68	11.08
24.5	0.05326087	0.25	0.00	0.00	0.75	0.48	0.00	0.00	8.02	7.75	11.16
7.755	0.016858696	0.25	0.00	0.00	0.75	0.47	0.00	0.00	8.03	7.78	11.19
1.755	0.003815217	0.25	0.00	0.00	0.75	0.47	0.00	0.00	8.03	7.78	11.19

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Table H.42. UBS-BEC Waste Surface Displacement, Gravity Plus Seismic

Tank AP, 460 Inch Waste Level
 SpG = 1.83
 Upper Bound Soil
 Best Estimate Concrete

Waste Radius	Max Vertical Displacement AP-460-UBS-BEC Time History (in)	Min Vertical Displacement AP-460-UBS-BEC Time History (in)
95.7	8.49	-13.15
129.9	9.27	-11.94
180	9.83	-13.40
218.5	9.54	-14.71
277.7	10.19	-14.76
358	10.51	-14.93
410	9.13	-13.92
450	6.72	-10.55

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Near-Soil-1.txt

```

et,8,solid45                                ! Use Element SOLID45 for Near Soil Elements
/input,soil-prop-UB-geo,txt                 ! Read Soil Properties

ksel,u,kp,,1,kmaxjb                         ! Unselect existing Keypoints
asel,u,area,,1,amaxjb                     ! Unselect existing Area
lsel,u,line,,1,lmaxjb                     ! Unselect existing Lines
vsel,u,volu,,1,vmaxw                      ! Unselect existing Volumes

/COM - Create Keypoints to match concrete tank profile
*do,i,1,bm_kp
k,kmaxjb+i,ctx(i),0,ctz(i)
*enddo

/COM - Create Keypoints above top of tank
k,kmaxjb+bm_kp+1,0,0,0                     ! Keypoint at origin (surface)
k,kmaxjb+bm_kp+2,0,0,soilz(2)             ! Keypoint at to divide soil above tank
*get,KMAXtemp1,KP,0,num,max               ! Get maximum keypoint number for counter

/COM - Create Keypoints at outside of excavated soil
*do,i,1,tanksoil
k,kmaxtemp1+i,soilx(i),0,soilz(i)
*enddo
*get,KMAXtemp2,KP,0,num,max               ! Get maximum keypoint number for counter

/COM - Create additional keypoint in soil above tank
k,kmaxtemp2+1,ctx(2),0,soilz(1)
k,kmaxtemp2+2,ctx(9),0,soilz(1)
k,kmaxtemp2+3,ctx(12),0,soilz(1)
k,kmaxtemp2+4,ctx(2),0,soilz(2)
k,kmaxtemp2+5,ctx(9),0,soilz(2)
k,kmaxtemp2+6,ctx(12),0,soilz(2)
k,kmaxtemp2+7,ctx(12),0,soilz(3)
k,kmaxtemp2+8,ctx(bm_kp+1),0,ctz(bm_kp+1)

a,kmaxtemp2+1,kmaxtemp2+2,kmaxtemp2+5,kmaxtemp2+4
a,kmaxtemp2+2,kmaxtemp2+3,kmaxtemp2+6,kmaxtemp2+5
a,kmaxtemp2+3,kmaxtemp1+1,kmaxtemp1+2,kmaxtemp2+6
a,kmaxtemp2+4,kmaxtemp2+5,kmaxjb+9,kmaxjb+8,kmaxjb+7,kmaxjb+6,kmaxjb+5,kmaxjb+4,kmaxjb+3,kmaxjb+2
!a,740,741,712,711,710,709,708,707,706,705
a,kmaxtemp2+5,kmaxtemp2+6,kmaxtemp2+7,kmaxjb+12,kmaxjb+11,kmaxjb+10,kmaxjb+9
a,kmaxtemp2+6,kmaxtemp1+2,kmaxtemp1+3,kmaxtemp2+7
a,kmaxtemp2+7,kmaxtemp1+3,kmaxtemp1+4,kmaxjb+12
a,kmaxjb+12,kmaxtemp1+4,kmaxtemp1+5,kmaxjb+14,kmaxjb+13
a,kmaxjb+14,kmaxtemp1+5,kmaxtemp1+6,kmaxjb+16,kmaxjb+15
a,kmaxjb+16,kmaxtemp1+6,kmaxtemp1+7,kmaxjb+18,kmaxjb+17
a,kmaxjb+18,kmaxtemp1+7,kmaxtemp1+8,kmaxjb+20,kmaxjb+19
a,kmaxjb+20,kmaxtemp1+8,kmaxtemp1+9,kmaxtemp2+8,kmaxjb+22,kmaxjb+21

cm,top-soil-area,area
ls1a
cm,top-soil,line
type,1
real,1

/COM - Define line divisions to control meshing
lsel,s,loc,z,soilz(1),soilz(2)
lsel,r,loc,x,ctx(3),ctx(8)
lesize,all,,,14                          ! soil above tank top, match tank meshing
lsel,s,loc,z,soilz(1),soilz(2)
lsel,r,loc,x,ctx(10),ctx(11)
lesize,all,,,3                          ! soil above tank top, match tank meshing
cmsel,s,top-soil                         ! Reselect lines in near soil
lsel,r,loc,x,ctx(2)
lesize,all,,,2                          ! Control vertical element size, above tank
cmsel,s,top-soil
lsel,s,loc,x,ctx(9)
lesize,all,,,2                          ! Control vertical element size, above tank

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cmsel,s,top-soil
lsel,r,loc,x,ctx(12)
lesize,all,,,2                                ! Control vertical element size, above tank
cmsel,s,top-soil
lsel,r,loc,z,ctz(2),ctz(12)
lsel,r,loc,x,ctx(2),ctx(12)
lesize,all,,,1                                ! Control vertical element size, outside excavation mesh
lsel,s,line,,lmaxjb+8,lmaxjb+10,2
lsel,a,line,,lmaxjb+26,lmaxjb+28,2
lsel,a,line,,lmaxjb+30,lmaxjb+38,4
lesize,all,,,9
lsel,s,line,,lmaxjb+42,lmaxjb+42,4
lesize,all,,,7                                ! Control horizontal meshing in soil
lsel,s,line,,lmaxjb+9
lsel,a,line,,lmaxjb+25,lmaxjb+27,2
lsel,a,line,,lmaxjb+29,lmaxjb+45,4
lesize,all,,,1                                ! Control horizontal meshing in soil
lsel,s,line,,lmaxjb+6
lsel,a,line,,lmaxjb+20,lmaxjb+21
lsel,a,line,,lmaxjb+32,lmaxjb+44,4
lsel,a,line,,lmaxjb+31,lmaxjb+43,4
lsel,a,line,,lmaxjb+47,lmaxjb+49
lesize,all,,,1                                ! Control meshing to match tank
lsel,s,line,,lmaxjb+46
lesize,all,,,4                                ! Control mesh size at bottom of excavated soil

cmsel,s,top-soil-area

amesh,all                                      ! Mesh area to develop pattern for volume meshing

type,8
ksel,a,kp,,1                                  ! Select Keypoint for rotation axis
ksel,a,kp,,ct_kps                             ! Select Keypoint for rotation axis
vrotat,all,,,,,1,ct_kps,180,2                ! Generate Volumes for excavated soil
lsla
lsel,r,loc,x,ctx(2)
lesize,all,,arcsz                             ! Define meshing for slices
lsla
lsel,r,loc,x,ctx(9)
lesize,all,,arcsz                             ! Define meshing for slices
lsla
lsel,r,loc,x,ctx(12)
lesize,all,,arcsz                             ! Define meshing for slices
vsweep,all                                    ! Sweep pattern into volume
aclear,all                                    ! Delete elements used for sweep
cm,top-soil-vol,volu

*get,VMAXtemp,VOLU,0,num,max
/COM - Generate element above top center of tank
asel,u,area,,all
vsel,u,volu,,all
a,kmaxjb+bm_kp+1,kmaxtemp2+1,kmaxtemp2+4,kmaxjb+bm_kp+2
a,kmaxjb+bm_kp+2,kmaxtemp2+4,kmaxjb+2,kmaxjb+1
vrotat,all,,,,,1,ct_kps,180,2
vsel,s,volu,,vmaxtemp+1,vmaxtemp+3,2
vatt,801,,8                                  ! Assign material properties
vsel,s,volu,,vmaxtemp+2,vmaxtemp+4,2
vatt,802,,8                                  ! Assign material properties
vsel,s,volu,,vmaxtemp+1,vmaxtemp+4
allsel
asel,s,loc,z,ctz(1),ctz(2)
type,1
asel,r,loc,x,0,4
asel,r,loc,z,ctz(1),ctz(2)
cmsel,u,conc-tank-a
*get,atemp,area,,num,max
*get,atempl,area,,num,min
asel,a,area,,1,22,21
mshcopy,2,1,atempl                            ! copy mesh top match top of concrete tank
mshcopy,2,22,atemp                            ! copy mesh top match top of concrete tank
asel,u,area,,1,22,21

```

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```

vsel,s,volu,,vmaxtemp+1,vmaxtemp+4
vsweep,all                                ! Generate elements by sweeping area
aclear,atemp
aclear,atempl

/COM - Assign soil properties by layer
*do,i,1,tanksoil-1
  cmsel,s,top-soil-vol
  vsel,r,loc,z,soilz(i),soilz(i+1)
  eslv
  emodif,all,mat,800+i
  esys,0
*enddo

cmsel,s,top-soil-vol
vsel,a,loc,z,soilz(1),ctz(2)
eslv
cm,excav-soil,elem
nsle
nummrg,node

/COM - Define component for excavated soil - tank walls only
cmsel,s,excav-soil
nsle,s,1
nsel,r,loc,z,soilz(5),soilz(9)
esln,r,1
cm,excav-wall,elem

/COM - Define component for excavated soil - tank dome only
cmsel,s,excav-soil
cmsel,u,excav-wall
cm,excav-dome,elem

csys,1
cmsel,s,excav-wall
nsle
nsel,r,loc,x,ctx(14)
cm,excav-wall-n,node

esel,s,type,,8
nsle
nsel,s,loc,x,soilx(1)
nsel,r,loc,z,soilz(1)
cm,near-soil-face-node,node
*do,i,2,9
  esel,s,type,,8
  nsle
  nsel,r,loc,x,soilx(i)
  nsel,r,loc,z,soilz(i)
  cmsel,a,near-soil-face-node
  cm,near-soil-face-node,node
*enddo

esel,s,type,,8
nsle
nsel,r,loc,z,soilz(9)
nsel,r,loc,x,41,68
cm,near-soil-bot-node,node

allsel
*get,KMAXns,KP,0,num,max                ! Get maximum Keypoint number
*get,LMAXns,LINE,0,num,max              ! Get maximum line number
*get,AMAXns,AREA,0,num,max              ! Get maximum Area number
*get,VMAXns,volu,0,num,max              ! Get maximum Volume number

```


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Run-Tank.txt

```
!/batch
! PNNL DST Seismic Analysis, Gravity Inputs, Upper Bound Soil, Best Est Concrete Properties, AP
Primary Tank Geometry, Dome Friction=0.0
!
fini
/clear
/filename,AP-460-UBS-BEC-Seismic,1
/config,nres,3000          ! Increase allowable number of results to 3000
/config,nproc,2            ! Activate 2 processors for solution
/config,fsplit,1024        ! Split binary file at 4.2GB
/prep7
g=32.2                    ! Gravity (ft/sec)

DF=40                      ! Factor for beta (stiffness) damping
ALPHA=0.4                  ! Alpha damping

/out,tank-out,out
/sys,"X:\07.00 - Quality Assurance\ANSYS QA\usrcfg.bat" > QA.out
/out,QA,out,,append
/input,tank-coordinates-AP,txt ! Run file defining tank coordinates (concrete and primary)
/input,tank-props-bec-250,txt ! Run file defining fully cracked concrete properties (PNNL
Concrete Properties)
/input,tank-mesh1,txt        ! Develop concrete tank
/input,primary-props-AP,txt  ! Run file defining AP Primary tank properties
/input,primary,txt           ! Develop Primary tank
/input,insulate,txt          ! Develop insulating concrete model
/input,liner,txt             ! Develop Liner model
/input,waste-solid-AP-s,txt  ! Develop waste model
/input,bolts-friction,txt    ! Develop J-Bolt model
/input,near-soil-1,txt       ! Develop excavated soil model
/input,far-soil,txt          ! Develop Far-Field soil model
/input,interfacel,txt        ! Develop Soil and Concrete Interfaces
/input,interface-gap1,txt    ! Develop Primary Tank Interfaces
/input,slave,txt             ! Develop slaved boundary conditions
/input,boundary,txt          ! Place base and symmetry boundary conditions
/input,outer-spar,txt        ! Connect soil model to symmetry plane
/input,live_load,txt         ! Apply live load over a 10ft radius over dome center
/input,fix-soil,txt
/out
ALLSEL

/out,Tank-th,out

save

/input,solve-TH-UBS,txt      ! Run solution Phase

/input,post-tank,txt

/out
/exit
```

Soil-Prop-UB-Geo.txt

```
Tanksoil=9
deepsoil=20
soil_radius=320
mass=1e8

*dim,soilx,,30
*dim,soilz,,30

soilz(1)=0
soilz(2)=-5
soilz(3)=ctz(9)
soilz(4)=ctz(12)
```

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```
soilz(5)=ctz(14)
soilz(6)=ctz(16)
soilz(7)=ctz(18)
soilz(8)=ctz(20)
soilz(9)=ctz(23)
soilz(10)=-73.5
soilz(11)=-90.5
soilz(12)=-106.5
soilz(13)=-123.5
soilz(14)=-139.5
soilz(15)=-156
soilz(16)=-178
soilz(17)=-200
soilz(18)=-222
soilz(19)=-244
soilz(20)=-266
```

```
soilx(9)=68
soilx(8)=soilx(9)-(soilz(9)-soilz(8))/1.5
soilx(7)=soilx(9)-(soilz(9)-soilz(7))/1.5
soilx(6)=soilx(9)-(soilz(9)-soilz(6))/1.5
soilx(5)=soilx(9)-(soilz(9)-soilz(5))/1.5
soilx(4)=soilx(9)-(soilz(9)-soilz(4))/1.5
soilx(3)=soilx(9)-(soilz(9)-soilz(3))/1.5
soilx(2)=soilx(9)-(soilz(9)-soilz(2))/1.5
soilx(1)=soilx(9)-(soilz(9)-soilz(1))/1.5
```

/COM Excavated Soil Properties

```
/COM - Material 801, Soil      (Top Layer)
mp,ex,801,18*144
mp,nuxy,801,0.27
mp,dens,801,125/(1000*g)
mp,damp,801,0.017/df
```

```
/COM - Material 802, Soil
mp,ex,802,22.5*144
mp,nuxy,802,0.27
mp,dens,802,125/(1000*g)
mp,damp,802,0.027/df
```

```
/COM - Material 803, Soil
mp,ex,803,29.25*144
mp,nuxy,803,0.27
mp,dens,803,125/(1000*g)
mp,damp,803,0.039/df
```

```
/COM - Material 804, Soil
mp,ex,804,36*144
mp,nuxy,804,0.27
mp,dens,804,125/(1000*g)
mp,damp,804,0.031/df
```

```
/COM - Material 805, Soil
mp,ex,805,42*144
mp,nuxy,805,0.27
mp,dens,805,125/(1000*g)
mp,damp,805,0.035/df
```

```
/COM - Material 806, Soil
mp,ex,806,48.75*144
mp,nuxy,806,0.27
mp,dens,806,125/(1000*g)
mp,damp,806,0.042/df
```

```
/COM - Material 807, Soil
mp,ex,807,55.5*144
mp,nuxy,807,0.27
mp,dens,807,125/(1000*g)
```

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```
mp,damp,807,0.047/df

/COM - Material 808, Soil
mp,ex,808,60*144
mp,nuxy,808,0.27
mp,dens,808,125/(1000*g)
mp,damp,808,0.037/df

/COM - Material 810, Soil
mp,ex,810,250
mp,nuxy,810,0.27
mp,dens,810,125/(1000*g)
mp,damp,810,0.037/df

/COM - Material 811, Soil      (Top Layer)
mp,ex,811,15131
mp,nuxy,811,0.27
mp,dens,811,125/(1000*g)
mp,damp,811,0.017/df

/COM - Material 812, Soil
mp,ex,812,14108
mp,nuxy,812,0.27
mp,dens,812,125/(1000*g)
mp,damp,812,0.027/df

/COM - Material 813, Soil
mp,ex,813,12816
mp,nuxy,813,0.27
mp,dens,813,125/(1000*g)
mp,damp,813,0.039/df

/COM - Material 814, Soil
mp,ex,814,13186
mp,nuxy,814,0.27
mp,dens,814,125/(1000*g)
mp,damp,814,0.031/df

/COM - Material 815, Soil
mp,ex,815,12714
mp,nuxy,815,0.27
mp,dens,815,125/(1000*g)
mp,damp,815,0.035/df

/COM - Material 816, Soil
mp,ex,816,12059
mp,nuxy,816,0.27
mp,dens,816,125/(1000*g)
mp,damp,816,0.042/df

/COM - Material 817, Soil
mp,ex,817,11562
mp,nuxy,817,0.27
mp,dens,817,125/(1000*g)
mp,damp,817,0.047/df

/COM - Material 818, Soil
mp,ex,818,12357
mp,nuxy,818,0.27
mp,dens,818,125/(1000*g)
mp,damp,818,0.037/df

/COM - Upper Bound Soil Properties Geomatrix Soil Data
/COM - 19 Layer Mode
/COM - Material Definitions

/COM - Material 901, Soil      (Top Layer)
mp,ex,901,24801
mp,nuxy,901,0.24
mp,dens,901,110/(1000*g)
```

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mp,damp,901,0.016/df

/COM - Material 902, Soil
mp,ex,902,23826
mp,nuxy,902,0.24
mp,dens,902,110/(1000*g)
mp,damp,902,0.022/df

/COM - Material 903, Soil
mp,ex,903,22996
mp,nuxy,903,0.24
mp,dens,903,110/(1000*g)
mp,damp,903,0.027/df

/COM - Material 904, Soil
mp,ex,904,23271
mp,nuxy,904,0.24
mp,dens,904,110/(1000*g)
mp,damp,904,0.022/df

/COM - Material 905, Soil
mp,ex,905,21584
mp,nuxy,905,0.19
mp,dens,905,110/(1000*g)
mp,damp,905,0.026/df

/COM - Material 906, Soil
mp,ex,906,24488
mp,nuxy,906,0.19
mp,dens,906,110/(1000*g)
mp,damp,906,0.027/df

/COM - Material 907, Soil
mp,ex,907,27725
mp,nuxy,907,0.19
mp,dens,907,110/(1000*g)
mp,damp,907,0.028/df

/COM - Material 908, Soil
mp,ex,908,32629
mp,nuxy,908,0.19
mp,dens,908,110/(1000*g)
mp,damp,908,0.022/df

/COM - Material 909, Soil
mp,ex,909,36376
mp,nuxy,909,0.19
mp,dens,909,110/(1000*g)
mp,damp,909,0.022/df

/COM - Material 910, Soil
mp,ex,910,35784
mp,nuxy,910,0.19
mp,dens,910,110/(1000*g)
mp,damp,910,0.024/df

/COM - Material 911, Soil
mp,ex,911,35374
mp,nuxy,911,0.19
mp,dens,911,110/(1000*g)
mp,damp,911,0.025/df

/COM - Material 912, Soil
mp,ex,912,35096
mp,nuxy,912,0.19
mp,dens,912,110/(1000*g)
mp,damp,912,0.026/df

/COM - Material 913, Soil
mp,ex,913,40418
mp,nuxy,913,0.19

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```
mp,dens,913,110/(1000*g)
mp,damp,913,0.020/df
```

```
/COM - Material 914, Soil
mp,ex,914,40076
mp,nuxy,914,0.19
mp,dens,914,110/(1000*g)
mp,damp,914,0.021/df
```

```
/COM - Material 915, Soil
mp,ex,915,55863
mp,nuxy,915,0.28
mp,dens,915,120/(1000*g)
mp,damp,915,0.019/df
```

```
/COM - Material 916, Soil
mp,ex,916,61211
mp,nuxy,916,0.28
mp,dens,916,120/(1000*g)
mp,damp,916,0.019/df
```

```
/COM - Material 917, Soil
mp,ex,917,60604
mp,nuxy,917,0.28
mp,dens,917,120/(1000*g)
mp,damp,917,0.020/df
```

```
/COM - Material 918, Soil
mp,ex,918,60224
mp,nuxy,918,0.28
mp,dens,918,120/(1000*g)
mp,damp,918,0.020/df
```

```
/COM - Material 919, Soil
mp,ex,919,66350
mp,nuxy,919,0.28
mp,dens,919,120/(1000*g)
mp,damp,919,0.019/df
```

Solve-Gravity-UBS.txt

```
/prep7
massm_z=148414.59
d,master_node,all
allsel

cmsel,s,excav-soil
nsle
csys,0
nsel,r,loc,x,-ctx(6)-1,ctx(6)+1
nsel,r,loc,y,0,-ctx(6)-1
esln,r,1
mpchg,810,all

cmsel,s,excav-soil
nsle
csys,1
nsel,r,loc,x,ctx(11)-1,ctx(13)+1
nsel,r,loc,z,soilz(1),soilz(3)-1
esln,r,1
mpchg,810,all

*do,i,801,808
esel,s,mat,,i
mpchg,i+10,all
*enddo
allsel

/out,AP-460-BEC-UBS-Gravity,out
```

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```

/solu
antype,trans
TRNOPT,FULL
lumpm,OFF
!nlgeom,on
NROPT,auto
NTIM=10 !NUMBER OF TIME STEPS
DT=0.01
TIM=1e-06
autots,on
KBC,on
TIMINT,ON,STRU
solcontrol,ON,off,,
ncnv,0,200
LNSRCH,OFF
PRED,on,,on

/COM - Time File

/COM - Dimension Horizontal Input
*DIM,A_1_x,,2148
*DIM,A_1_z,,2148

*VREAD,A_1_x(1),th-266-UB-geo,txt
(8(F9.6))
*VREAD,A_1_z(1),th-266-UB-geo-v,txt
(8(F9.6))

/Title,Load Case: AP-460-UBS-BEC, Full Non-linear, Dome Contact Friction = 0.0, Gravity
OUTPR,all,NONE,
OUTRES, ALL,NONE,
OUTRES,RSOL,last
OUTRES,NSOL,last
OUTRES,ESOL,last,conc-tank
OUTRES,esol,last,Primary-tank
OUTRES,ESOL,last,J_bolts
OUTRES,Epel,last,liner
outres,esol,last,wall-int-gap
outres,esol,last,conc-excav-wall-gap
outres,esol,last,conc-excav-dome-gap
!outres, strs,last,excav-soil
!outres, strs,last,bottom-soil
outres,esol,last,bolt-friction
outres,esol,last,waste-surf
outres, strs,last,insul-conc
outres,esol,last,primary-int-gap
outres,esol,last,conc-liner-gap
outres,esol,last,far-soil-contact
!outres,esol,last,soil-contact-foot-elem

alphad,alpha
NSUBST,20,200,5,ON
TIME,100
TIMINT,off
acel,0,0,g
SOLVE
SAVE
TIMINT,on
ITIM=1
DS=TIM
NSUBST,1,20,1,ON

!ddelete, master_node,ux
!ddelete, master_node,uz

esel,s,type,,61,63,2
mpchg,64,all

esel,s,type,,91,93,2
mpchg,92,all

```

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```

allsel

*DO, ITIM, 1, NTIM, 1

TIM=DT*ITIM

TIME, TIM+100

!F, master_node, FX, A_1_X(itim) * mass * g
!F, master_node, Fz, (A_1_Z(itim) + 1) * (mass + massm_z) * g

SOLVE
SAVE
*ENDDO
FINISH
/out

```

Solve-TH-UBS

```

/prep7
massm_z=148414.59
d, master_node, all
allsel

cmsel, s, excav-soil
nsle
csys, 0
nsel, r, loc, x, -ctx(6) - 1, ctx(6) + 1
nsel, r, loc, y, 0, -ctx(6) - 1
esln, r, 1
mpchg, 810, all

cmsel, s, excav-soil
nsle
csys, 1
nsel, r, loc, x, ctx(11) - 1, ctx(13) + 1
nsel, r, loc, z, soilz(1), soilz(3) - 1
esln, r, 1
mpchg, 810, all

*do, i, 801, 808
esel, s, mat, , i
mpchg, i + 10, all
*enddo
allsel

/out, AP-460-BEC-UBS-Seismic, out
/solu
antype, trans
TRNOPT, FULL
lumpm, OFF
!nlgeom, on
NROPT, auto
NTIM=2148
DT=0.01
TIM=1e-06
autots, on
KBC, on
TIMINT, ON, STRU
solcontrol, ON, off, ,
ncnv, 0, 200
LNSRCH, OFF
PRED, on, , on

/COM - Time File

/COM - Dimension Horizontal Input
*DIM, A_1_x, , 2148
*DIM, A_1_z, , 2148

```

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```

*VREAD,A_1_x(1),th-266-UB-geo,txt
(8(F9.6))
*VREAD,A_1_Z(1),th-266-UB-geo-v,txt
(8(F9.6))

/Title,Load Case: AP-460-UBS-BEC, Full Non-linear, Dome Contact Friction = 0.0
OUTPR,all,NONE,
OUTRES, ALL,NONE,
OUTRES,RSOL,last
OUTRES,NSOL,last
OUTRES,ESOL,last,conc-tank
OUTRES,esol,last,Primary-tank
OUTRES,ESOL,last,J_bolts
OUTRES,Epel,last,liner
outres,esol,last,wall-int-gap
outres,esol,last,conc-excav-wall-gap
outres,esol,last,conc-excav-dome-gap
!outres, strs,last,excav-soil
!outres, strs,last,bottom-soil
outres,esol,last,bolt-friction
outres,esol,last,waste-surf
outres, strs,last,insul-conc
outres,esol,last,primary-int-gap
outres,esol,last,conc-liner-gap
outres,esol,last,far-soil-contact
!outres,esol,last,soil-contact-foot-elem

alphad,alpha
NSUBST,20,200,5,ON
TIME,100
TIMINT,off
acel,0,0,g
SOLVE
SAVE
TIMINT,on
ITIM=1
DS=TIM
NSUBST,1,20,1,ON

ddelete,master_node,ux
ddelete,master_node,uz

esel,s,type,,61,63,2
mpchg,64,all

esel,s,type,,91,93,2
mpchg,92,all

allsel

*DO,ITIM,1,NTIM,1

TIM=DT*ITIM

TIME,TIM+100

F,master_node,FX,1.12*A_1_X(itim)*mass*g
F,master_node,Fz,(1.19*A_1_Z(itim)+1)*(mass+massm_z)*g

SOLVE
SAVE
*ENDDO
FINISH
/out

```


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Tank-Props-BEC-250

```
/COM - Tank Concrete Properties

/COM - Material Definitions
! EX - Youngs Modulus, (k/ft2)
! NUXY - Poissons ratio
! DENS - Density (1000*slugs/ft3)
! DAMP - Beta (Stiffness) Damping

/COM - Material 1, Tank Concrete
mp,ex,1,626754
mp,nuxy,1,0.18
mp,dens,1,148/(1000*g)
mp,damp,1,0.07/df

/COM - Material 2, Tank Concrete
mp,ex,2,620114
mp,nuxy,2,0.18
mp,dens,2,149/(1000*g)
mp,damp,2,0.07/df

/COM - Material 3, Tank Concrete
mp,ex,3,616594
mp,nuxy,3,0.18
mp,dens,3,149/(1000*g)
mp,damp,3,0.07/df

/COM - Material 4, Tank Concrete
mp,ex,4,610922
mp,nuxy,4,0.18
mp,dens,4,149/(1000*g)
mp,damp,4,0.07/df

/COM - Material 5, Tank Concrete
mp,ex, 5,612305
mp,nuxy, 5,0.18
mp,dens, 5,148/(1000*g)
mp,damp,5,0.07/df

/COM - Material 6, Tank Concrete
mp,ex,6,607093
mp,nuxy,6,0.18
mp,dens,6,148/(1000*g)
mp,damp,6,0.07/df

/COM - Material 7, Tank Concrete
mp,ex,7,639237
mp,nuxy,7,0.18
mp,dens,7,146/(1000*g)
mp,damp,7,0.07/df

/COM - Material 8, Tank Concrete
mp,ex,8,634338
mp,nuxy,8,0.18
mp,dens,8,147/(1000*g)
mp,damp,8,0.07/df

/COM - Material 9, Tank Concrete
mp,ex,9,628756
mp,nuxy,9,0.18
mp,dens,9,147/(1000*g)
mp,damp,9,0.07/df

/COM - Material,10, Tank Concrete
mp,ex,10,193677
mp,nuxy,10,0.18
mp,dens,10,165/(1000*g)
mp,damp,10,0.07/df
```

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/COM - Material,11, Tank Concrete
mp,ex,11,575959
mp,nuxy,11,0.18
mp,dens,11,144/(1000*g)
mp,damp,11,0.07/df

/COM - Material,12, Tank Concrete
mp,ex,12,202953
mp,nuxy,12,0.18
mp,dens,12,159/(1000*g)
mp,damp,12,0.07/df

/COM - Material,13, Tank Concrete
mp,ex,13,157426
mp,nuxy,13,0.18
mp,dens,13,176/(1000*g)
mp,damp,13,0.07/df

/COM - Material,14, Tank Concrete
mp,ex,14,153784
mp,nuxy,14,0.18
mp,dens,14,193/(1000*g)
mp,damp,14,0.07/df

/COM - Material,15, Tank Concrete
mp,ex,15,136651
mp,nuxy,15,0.18
mp,dens,15,200/(1000*g)
mp,damp,15,0.07/df

/COM - Material,16, Tank Concrete
mp,ex,16,136651
mp,nuxy,16,0.18
mp,dens,16,200/(1000*g)
mp,damp,16,0.07/df

/COM - Material,17, Tank Concrete
mp,ex,17,138084
mp,nuxy,17,0.18
mp,dens,17,181/(1000*g)
mp,damp,17,0.07/df

/COM - Material,18, Tank Concrete
mp,ex,18,123378
mp,nuxy,18,0.18
mp,dens,18,209/(1000*g)
mp,damp,18,0.07/df

/COM - Material,19, Tank Concrete
mp,ex,19,124633
mp,nuxy,19,0.18
mp,dens,19,190/(1000*g)
mp,damp,19,0.07/df

/COM - Material,20, Tank Concrete
mp,ex,20,124388
mp,nuxy,20,0.18
mp,dens,20,210/(1000*g)
mp,damp,20,0.07/df

/COM - Material,21, Tank Concrete
mp,ex,21,548683
mp,nuxy,21,0.18
mp,dens,21,166/(1000*g)
mp,damp,21,0.07/df

/COM - Material,22, Tank Concrete
mp,ex,22,154870
mp,nuxy,22,0.18
mp,dens,22,184/(1000*g)
mp,damp,22,0.07/df

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```
/COM - Material,23, Tank Concrete  
mp,ex,23,514287  
mp,nuxy,23,0.18  
mp,dens,23,172/(1000*g)  
mp,damp,23,0.060/df
```

```
/COM - Material,24, Tank Concrete  
mp,ex,24,164113  
mp,nuxy,24,0.18  
mp,dens,24,288/(1000*g)  
mp,damp,24,0.07/df
```

```
/COM - Material,25, Tank Concrete  
mp,ex,25,522946  
mp,nuxy,25,0.18  
mp,dens,25,201/(1000*g)  
mp,damp,25,0.07/df
```

```
/COM - Material,26, Tank Concrete  
mp,ex,26,194254  
mp,nuxy,26,0.18  
mp,dens,26,322/(1000*g)  
mp,damp,26,0.07/df
```

```
/COM - Material,27, Tank Concrete  
mp,ex,27,199783  
mp,nuxy,27,0.18  
mp,dens,27,281/(1000*g)  
mp,damp,27,0.07/df
```

```
/COM - Material,28, Tank Concrete  
mp,ex,28,162553  
mp,nuxy,28,0.18  
mp,dens,28,299/(1000*g)  
mp,damp,28,0.07/df
```

```
/COM - Material,29, Tank Concrete  
mp,ex,29,200531  
mp,nuxy,29,0.18  
mp,dens,29,3894/(1000*g)  
mp,damp,29,0.07/df
```

```
/COM - Material,30, Tank Concrete  
mp,ex,30,167538  
mp,nuxy,30,0.18  
mp,dens,30,411/(1000*g)  
mp,damp,30,0.07/df
```

```
/COM - Material,31, Tank Concrete  
mp,ex,31,731952  
mp,nuxy,31,0.18  
mp,dens,31,150/(1000*g)  
mp,damp,31,0.07/df
```

```
/COM - Material,32, Tank Concrete  
mp,ex,32,731952  
mp,nuxy,32,0.18  
mp,dens,32,150/(1000*g)  
mp,damp,32,0.07/df
```

```
!/COM - Material,33, Tank Concrete  
!mp,ex,33,731952  
!mp,nuxy,33,0.18  
!mp,dens,33,150/(1000*g)  
!mp,damp,33,0.07/df
```

```
!/COM - Material,34, Tank Concrete  
!mp,ex,34,731952  
!mp,nuxy,34,0.18  
!mp,dens,34,150/(1000*g)
```

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```

!mp,damp,34,0.07/df

!/COM - Material,35, Tank Concrete
!mp,ex,35,731952
!mp,nuxy,35,0.18
!mp,dens,35,150/(1000*g)
!mp,damp,35,0.07/df

!/COM - Material,36, Tank Concrete
!mp,ex,36,731952
!mp,nuxy,36,0.18
!mp,dens,36,150/(1000*g)
!mp,damp,36,0.07/df

!/COM - Material,37, Tank Concrete
!mp,ex,37,731952
!mp,nuxy,37,0.18
!mp,dens,37,150/(1000*g)
!mp,damp,37,0.07/df

/COM - Concrete Real Values, t in ft
r,1,1.26 ! 15 in
r,2,1.26 ! 15 in
r,3,1.26 ! 15 in
r,4,1.26 ! 15 in
r,5,1.27 ! 15 in
r,6,1.26 ! 15 in
r,7,1.28 ! 15 in
r,8,1.28 ! 15 in
r,9,1.73 ! 15 in
r,10,1.73,1.73,2.23,2.23 ! 15 in to
r,11,2.23,2.22,3.15,3.15 !
r,12,3.15,3.15,1.50,1.50 !
r,13,1.50,1.50,1.28,1.28 !
r,14,1.17 ! 18 in
r,15,1.13 ! 18 in
r,16,1.13 ! 18 in
r,17,1.24 ! 18 in
r,18,1.07 ! 18 in
r,19,1.18 ! 18 in
r,20,1.07 ! 18 in
r,21,1.07 ! 18 in
r,22,1.97 ! 18 in
r,23,1.97,1.67,1.67,1.97 ! 18 in
r,24,1.67 !
r,25,1.68,1.43,1.43,1.68 !
r,26,1.43,0.51,0.51,1.43 ! 8 in
r,27,0.51,0.41,0.41,0.51 ! 8 in
r,28,0.41,0.55,0.55,0.41 ! 8 in
r,29,0.55 ! 8 in
r,30,0.55,0.40,0.40,0.55 ! 8 in
r,31,0.40,1.02,1.02,0.40 ! 8 in to
r,32,1.02 !
!r,34,1
!r,35,1
!r,36,1
!r,37,1
!r,39,1

/COM - Material,50, Insulating Concrete
mp,ex,50,23760
mp,nuxy,50,0.15
mp,dens,50,50/(1000*g)
mp,damp,50,0.07/df

```

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TH-266-UB-Geo-V.txt

```
-0.000079-0.000134 0.000080 0.000135-0.000080-0.000136 0.000081 0.000137    1
-0.000081-0.000138 0.000081 0.000139-0.000081-0.000140 0.000082 0.000141    2
-0.000082-0.000142 0.000083 0.000143-0.000083-0.000144 0.000084 0.000145    3
.....
-0.000075-0.000125 0.000075 0.000125-0.000076-0.000126 0.000076 0.000127   510
-0.000076-0.000127 0.000077 0.000128-0.000077-0.000129 0.000078 0.000130   511
-0.000078-0.000131 0.000078 0.000132-0.000078-0.000132 0.000079 0.000133   512
```

TH-266-UB-Geo.txt

```
-0.000021 0.000047 0.000020-0.000047-0.000020 0.000045 0.000019-0.000045    2
-0.000019 0.000043 0.000017-0.000043-0.000017 0.000041 0.000016-0.000040    3
-0.000016 0.000038 0.000014-0.000037-0.000014 0.000034 0.000012-0.000034    4
.....
-0.000028 0.000056 0.000027-0.000056-0.000027 0.000055 0.000026-0.000055   510
-0.000026 0.000054 0.000026-0.000054-0.000026 0.000054 0.000025-0.000053   511
-0.000025 0.000053 0.000024-0.000052-0.000024 0.000052 0.000023-0.000051   512
```

UBS-BEC Seismic File Listing

Volume in drive C is 600GB 2xRAID0
Volume Serial Number is 8A0A-E4BA

Directory of C:\Users\FGA\2008-005 AP-460\AP-460-UBS-BEC-Seismic780 Secant

```
11/28/2007  03:42 PM    <DIR>          .
11/28/2007  03:42 PM    <DIR>          ..
09/16/2007  12:12 PM                561,576 Accel-ct-0.out
09/16/2007  12:12 PM                561,828 Accel-ct-135.out
09/16/2007  12:12 PM                561,828 Accel-ct-180.out
09/16/2007  12:12 PM                561,576 Accel-ct-45.out
09/16/2007  12:12 PM                561,828 Accel-ct-90.out
09/16/2007  12:12 PM                290,676 Accel-ct.out
09/16/2007  12:12 PM                561,828 Accel-PT-0.out
09/16/2007  12:13 PM                561,828 Accel-PT-135.out
09/16/2007  12:13 PM                561,828 Accel-PT-180.out
09/16/2007  12:13 PM                561,828 Accel-PT-45.out
09/16/2007  12:13 PM                561,828 Accel-PT-90.out
09/16/2007  12:13 PM                561,828 Accel-SOil.out
09/11/2006   03:21 PM                   99 All-Forces.txt
09/16/2007   01:36 AM          4,705,103 AP-460-BEC-UBS-Seismic.out
11/19/2007   04:11 PM          746,496 AP-460-UBS-BEC J Bolt ForcesTH 780 Secant.xls
11/26/2007   09:49 AM          791,552 AP-460-UBS-BEC J-Bolt-Contact-Seismic.xls
09/16/2007   01:35 AM           2,998 AP-460-UBS-BEC-Seismic.BCS
09/17/2007  12:56 PM          43,909,120 AP-460-UBS-BEC-Seismic.db
09/16/2007   01:35 AM          63,897,600 AP-460-UBS-BEC-Seismic.dbb
09/16/2007   01:35 AM          12,713,984 AP-460-UBS-BEC-Seismic.emat
09/17/2007  12:56 PM           59,261 AP-460-UBS-BEC-Seismic.err
09/16/2007   01:35 AM          111,607,808 AP-460-UBS-BEC-Seismic.esav
09/16/2007   01:35 AM          30,081,024 AP-460-UBS-BEC-Seismic.full
09/16/2007   01:35 AM          340,804,299 AP-460-UBS-BEC-Seismic.ldhi
09/14/2007   08:50 AM           250 AP-460-UBS-BEC-Seismic.log
09/16/2007   01:35 AM          198,991 AP-460-UBS-BEC-Seismic.mntr
09/16/2007   01:35 AM          111,607,808 AP-460-UBS-BEC-Seismic.osav
09/16/2007   01:35 AM           1,795 AP-460-UBS-BEC-Seismic.PVTS
09/16/2007   01:35 AM          112,656,384 AP-460-UBS-BEC-Seismic.r001
09/14/2007   08:51 AM          43,974,656 AP-460-UBS-BEC-Seismic.rdb
09/16/2007   01:35 AM          4,294,967,296 AP-460-UBS-BEC-Seismic.rst
09/14/2007   06:03 PM          4,294,967,296 AP-460-UBS-BEC-Seismic.rst02
```

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09/14/2007	10:44 PM	4,294,967,296	AP-460-UBS-BEC-Seismic.rst03
09/15/2007	03:30 AM	4,294,967,296	AP-460-UBS-BEC-Seismic.rst04
09/15/2007	08:26 AM	4,294,967,296	AP-460-UBS-BEC-Seismic.rst05
09/15/2007	01:29 PM	4,294,967,296	AP-460-UBS-BEC-Seismic.rst06
09/15/2007	06:38 PM	4,294,967,296	AP-460-UBS-BEC-Seismic.rst07
09/15/2007	11:54 PM	4,294,967,296	AP-460-UBS-BEC-Seismic.rst08
09/16/2007	01:35 AM	1,388,445,696	AP-460-UBS-BEC-Seismic.rst09
08/15/2007	10:18 AM	6,120	Bolts-Friction.txt
09/08/2006	07:08 AM	277	Boundary.txt
08/25/2006	08:48 AM	220	Contact-AP.txt
08/21/2006	07:59 AM	586	Contact-Footing.txt
08/25/2006	01:28 PM	704	Contact-Insul.txt
08/25/2006	01:27 PM	704	Contact-J-Bolts.txt
08/25/2006	01:28 PM	708	Contact-Primary.txt
08/21/2006	07:59 AM	742	Contact-Soil.txt
08/21/2006	12:44 PM	632	Contact-Waste-AP.txt
11/28/2007	03:42 PM	0	dir_listing.txt
09/16/2007	12:12 PM	561,576	Disp-ct-0.out
09/16/2007	12:12 PM	561,576	Disp-ct-135.out
09/16/2007	12:12 PM	561,576	Disp-ct-180.out
09/16/2007	12:12 PM	561,576	Disp-ct-45.out
09/16/2007	12:12 PM	561,576	Disp-ct-90.out
09/16/2007	12:12 PM	290,550	Disp-ct.out
01/03/2006	11:17 AM	1,616	Disp-J-Bolts.txt
09/16/2007	12:12 PM	561,576	Disp-PT-0.out
09/16/2007	12:13 PM	561,576	Disp-PT-135.out
09/16/2007	12:13 PM	561,576	Disp-PT-180.out
09/16/2007	12:13 PM	561,576	Disp-PT-45.out
09/16/2007	12:13 PM	561,576	Disp-PT-90.out
09/16/2007	12:13 PM	561,576	Disp-Soil.out
05/08/2006	01:31 PM	8,616	Far-Soil.txt
01/09/2007	06:53 AM	52,339	File-List.txt
10/13/2005	06:54 AM	562	Fix-Soil.txt
09/16/2007	12:09 PM	10,342	Footing-Cont_max.OUT
09/16/2007	12:09 PM	4,346,248	Footing-Cont_th.OUT
08/21/2006	08:00 AM	894	Force-c.txt
09/16/2007	06:58 PM	4,996	Force-c_108amax.OUT
09/16/2007	06:58 PM	2,905,500	Force-c_108ath.OUT
09/16/2007	02:45 PM	14,716	Force-c_108max.OUT
09/16/2007	02:45 PM	6,519,180	Force-c_108th.OUT
09/16/2007	07:11 PM	4,996	Force-c_117amax.OUT
09/16/2007	07:11 PM	2,905,500	Force-c_117ath.OUT
09/16/2007	02:58 PM	14,716	Force-c_117max.OUT
09/16/2007	02:58 PM	6,519,180	Force-c_117th.OUT
09/16/2007	07:23 PM	4,996	Force-c_126amax.OUT
09/16/2007	07:23 PM	2,905,500	Force-c_126ath.OUT
09/16/2007	03:10 PM	14,716	Force-c_126max.OUT
09/16/2007	03:10 PM	6,519,180	Force-c_126th.OUT
09/16/2007	07:35 PM	4,996	Force-c_135amax.OUT
09/16/2007	07:35 PM	2,905,500	Force-c_135ath.OUT
09/16/2007	03:23 PM	14,716	Force-c_135max.OUT
09/16/2007	03:23 PM	6,519,180	Force-c_135th.OUT
09/16/2007	07:48 PM	4,996	Force-c_144amax.OUT
09/16/2007	07:48 PM	2,905,500	Force-c_144ath.OUT
09/16/2007	03:36 PM	14,716	Force-c_144max.OUT
09/16/2007	03:36 PM	6,519,180	Force-c_144th.OUT
09/16/2007	08:01 PM	4,996	Force-c_153amax.OUT
09/16/2007	08:01 PM	2,905,500	Force-c_153ath.OUT
09/16/2007	03:49 PM	14,716	Force-c_153max.OUT
09/16/2007	03:49 PM	6,519,180	Force-c_153th.OUT
09/16/2007	08:13 PM	4,996	Force-c_162amax.OUT
09/16/2007	08:13 PM	2,905,500	Force-c_162ath.OUT
09/16/2007	04:01 PM	14,716	Force-c_162max.OUT
09/16/2007	04:01 PM	6,519,180	Force-c_162th.OUT
09/16/2007	08:26 PM	4,996	Force-c_171amax.OUT

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09/16/2007	08:26 PM	2,905,500	Force-c_171ath.OUT
09/16/2007	04:15 PM	14,716	Force-c_171max.OUT
09/16/2007	04:15 PM	6,519,180	Force-c_171th.OUT
09/16/2007	08:39 PM	4,996	Force-c_180amax.OUT
09/16/2007	08:39 PM	2,905,500	Force-c_180ath.OUT
09/16/2007	04:28 PM	14,716	Force-c_180max.OUT
09/16/2007	04:28 PM	6,519,180	Force-c_180th.OUT
09/16/2007	04:54 PM	4,996	Force-c_18amax.OUT
09/16/2007	04:54 PM	2,905,500	Force-c_18ath.OUT
09/16/2007	12:39 PM	14,716	Force-c_18max.OUT
09/16/2007	12:39 PM	6,519,180	Force-c_18th.OUT
09/16/2007	05:06 PM	4,996	Force-c_27amax.OUT
09/16/2007	05:06 PM	2,905,500	Force-c_27ath.OUT
09/16/2007	12:51 PM	14,716	Force-c_27max.OUT
09/16/2007	12:51 PM	6,519,180	Force-c_27th.OUT
09/16/2007	05:19 PM	4,996	Force-c_36amax.OUT
09/16/2007	05:19 PM	2,905,500	Force-c_36ath.OUT
09/16/2007	01:04 PM	14,716	Force-c_36max.OUT
09/16/2007	01:04 PM	6,519,180	Force-c_36th.OUT
09/16/2007	05:32 PM	4,996	Force-c_45amax.OUT
09/16/2007	05:32 PM	2,905,500	Force-c_45ath.OUT
09/16/2007	01:17 PM	14,716	Force-c_45max.OUT
09/16/2007	01:17 PM	6,519,180	Force-c_45th.OUT
09/16/2007	05:44 PM	4,996	Force-c_54amax.OUT
09/16/2007	05:44 PM	2,905,500	Force-c_54ath.OUT
09/16/2007	01:29 PM	14,716	Force-c_54max.OUT
09/16/2007	01:29 PM	6,519,180	Force-c_54th.OUT
09/16/2007	05:56 PM	4,996	Force-c_63amax.OUT
09/16/2007	05:56 PM	2,905,500	Force-c_63ath.OUT
09/16/2007	01:42 PM	14,716	Force-c_63max.OUT
09/16/2007	01:42 PM	6,519,180	Force-c_63th.OUT
09/16/2007	06:08 PM	4,996	Force-c_72amax.OUT
09/16/2007	06:08 PM	2,905,500	Force-c_72ath.OUT
09/16/2007	01:53 PM	14,716	Force-c_72max.OUT
09/16/2007	01:53 PM	6,519,180	Force-c_72th.OUT
09/16/2007	06:20 PM	4,996	Force-c_81amax.OUT
09/16/2007	06:21 PM	2,905,500	Force-c_81ath.OUT
09/16/2007	02:06 PM	14,716	Force-c_81max.OUT
09/16/2007	02:06 PM	6,519,180	Force-c_81th.OUT
09/16/2007	06:33 PM	4,996	Force-c_90amax.OUT
09/16/2007	06:33 PM	2,905,500	Force-c_90ath.OUT
09/16/2007	02:19 PM	14,716	Force-c_90max.OUT
09/16/2007	02:19 PM	6,519,180	Force-c_90th.OUT
09/16/2007	06:46 PM	4,996	Force-c_99amax.OUT
09/16/2007	06:46 PM	2,905,500	Force-c_99ath.OUT
09/16/2007	02:32 PM	14,716	Force-c_99max.OUT
09/16/2007	02:32 PM	6,519,180	Force-c_99th.OUT
09/16/2007	04:41 PM	4,996	Force-c_9amax.OUT
09/16/2007	04:41 PM	2,905,628	Force-c_9ath.OUT
09/16/2007	12:26 PM	14,716	Force-c_9max.OUT
09/16/2007	12:26 PM	6,519,308	Force-c_9th.OUT
11/19/2007	03:02 PM	135,168	force-jb.xls
09/17/2007	12:55 PM	2,666,244	Force-jb_r10-th.OUT
09/17/2007	12:55 PM	5,239	Force-jb_r10_max.OUT
09/17/2007	12:56 PM	2,666,244	Force-jb_r11-th.OUT
09/17/2007	12:56 PM	5,239	Force-jb_r11_max.OUT
09/17/2007	12:47 PM	2,666,372	Force-jb_r2-th.OUT
09/17/2007	12:47 PM	5,239	Force-jb_r2_max.OUT
09/17/2007	12:47 PM	2,666,244	Force-jb_r3-th.OUT
09/17/2007	12:47 PM	5,239	Force-jb_r3_max.OUT
09/17/2007	12:48 PM	2,666,244	Force-jb_r4-th.OUT
09/17/2007	12:48 PM	5,239	Force-jb_r4_max.OUT
09/17/2007	12:50 PM	2,666,244	Force-jb_r5-th.OUT
09/17/2007	12:50 PM	5,239	Force-jb_r5_max.OUT
09/17/2007	12:51 PM	2,666,244	Force-jb_r6-th.OUT

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09/17/2007	12:51 PM	5,239	Force-jb_r6_max.OUT
09/17/2007	12:51 PM	2,666,244	Force-jb_r7-th.OUT
09/17/2007	12:51 PM	5,239	Force-jb_r7_max.OUT
09/17/2007	12:53 PM	2,666,244	Force-jb_r8-th.OUT
09/17/2007	12:53 PM	5,239	Force-jb_r8_max.OUT
09/17/2007	12:54 PM	2,666,244	Force-jb_r9-th.OUT
09/17/2007	12:54 PM	5,239	Force-jb_r9_max.OUT
08/21/2006	08:00 AM	661	Force-j_bolt.txt
11/23/2007	11:55 AM	<DIR>	Gravity
09/16/2007	06:28 AM	4,024	Insul-Cont_108max.OUT
09/16/2007	06:28 AM	1,738,448	Insul-Cont_108th.OUT
09/16/2007	06:30 AM	4,024	Insul-Cont_117max.OUT
09/16/2007	06:30 AM	1,738,448	Insul-Cont_117th.OUT
09/16/2007	06:32 AM	4,024	Insul-Cont_126max.OUT
09/16/2007	06:32 AM	1,738,448	Insul-Cont_126th.OUT
09/16/2007	06:34 AM	4,024	Insul-Cont_135max.OUT
09/16/2007	06:34 AM	1,738,448	Insul-Cont_135th.OUT
09/16/2007	06:36 AM	4,024	Insul-Cont_144max.OUT
09/16/2007	06:36 AM	1,738,448	Insul-Cont_144th.OUT
09/16/2007	06:38 AM	4,024	Insul-Cont_153max.OUT
09/16/2007	06:38 AM	1,738,448	Insul-Cont_153th.OUT
09/16/2007	06:38 AM	4,024	Insul-Cont_162max.OUT
09/16/2007	06:38 AM	1,738,448	Insul-Cont_162th.OUT
09/16/2007	06:41 AM	4,024	Insul-Cont_171max.OUT
09/16/2007	06:41 AM	1,738,448	Insul-Cont_171th.OUT
09/16/2007	06:42 AM	4,024	Insul-Cont_180max.OUT
09/16/2007	06:42 AM	1,738,448	Insul-Cont_180th.OUT
09/16/2007	06:13 AM	4,024	Insul-Cont_18max.OUT
09/16/2007	06:13 AM	1,738,448	Insul-Cont_18th.OUT
09/16/2007	06:15 AM	4,024	Insul-Cont_27max.OUT
09/16/2007	06:15 AM	1,738,448	Insul-Cont_27th.OUT
09/16/2007	06:16 AM	4,024	Insul-Cont_36max.OUT
09/16/2007	06:16 AM	1,738,448	Insul-Cont_36th.OUT
09/16/2007	06:19 AM	4,024	Insul-Cont_45max.OUT
09/16/2007	06:19 AM	1,738,448	Insul-Cont_45th.OUT
09/16/2007	06:19 AM	4,024	Insul-Cont_54max.OUT
09/16/2007	06:19 AM	1,738,448	Insul-Cont_54th.OUT
09/16/2007	06:21 AM	4,024	Insul-Cont_63max.OUT
09/16/2007	06:21 AM	1,738,448	Insul-Cont_63th.OUT
09/16/2007	06:21 AM	4,024	Insul-Cont_72max.OUT
09/16/2007	06:21 AM	1,738,448	Insul-Cont_72th.OUT
09/16/2007	06:23 AM	4,024	Insul-Cont_81max.OUT
09/16/2007	06:23 AM	1,738,448	Insul-Cont_81th.OUT
09/16/2007	06:25 AM	4,024	Insul-Cont_90max.OUT
09/16/2007	06:25 AM	1,738,448	Insul-Cont_90th.OUT
09/16/2007	06:26 AM	4,024	Insul-Cont_99max.OUT
09/16/2007	06:26 AM	1,738,448	Insul-Cont_99th.OUT
09/16/2007	06:11 AM	4,024	Insul-Cont_9max.OUT
09/16/2007	06:11 AM	1,738,576	Insul-Cont_9th.OUT
09/01/2005	10:27 AM	1,664	Insulate.txt
07/20/2006	06:36 AM	4,030	interface-gap1.txt
08/23/2006	07:55 AM	2,411	interface1.txt
11/23/2007	11:35 AM	115,200	J-Bolt-Contact_0-90.xls
11/23/2007	11:37 AM	115,712	J-Bolt-Contact_99-180.xls
09/16/2007	08:04 AM	4,519	J-Bolt-Cont_108max.OUT
09/16/2007	08:04 AM	1,685,484	J-Bolt-Cont_108th.OUT
09/16/2007	08:07 AM	4,519	J-Bolt-Cont_117max.OUT
09/16/2007	08:07 AM	1,685,484	J-Bolt-Cont_117th.OUT
09/16/2007	08:09 AM	4,519	J-Bolt-Cont_126max.OUT
09/16/2007	08:09 AM	1,685,484	J-Bolt-Cont_126th.OUT
09/16/2007	08:12 AM	4,519	J-Bolt-Cont_135max.OUT
09/16/2007	08:12 AM	1,685,484	J-Bolt-Cont_135th.OUT
09/16/2007	08:13 AM	4,519	J-Bolt-Cont_144max.OUT
09/16/2007	08:13 AM	1,685,484	J-Bolt-Cont_144th.OUT
09/16/2007	08:13 AM	4,519	J-Bolt-Cont_153max.OUT

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09/16/2007	08:13 AM	1,685,484	J-Bolt-Cont_153th.OUT
09/16/2007	08:14 AM	4,519	J-Bolt-Cont_162max.OUT
09/16/2007	08:14 AM	1,685,484	J-Bolt-Cont_162th.OUT
09/16/2007	08:17 AM	4,519	J-Bolt-Cont_171max.OUT
09/16/2007	08:17 AM	1,685,484	J-Bolt-Cont_171th.OUT
09/16/2007	08:19 AM	4,519	J-Bolt-Cont_180max.OUT
09/16/2007	08:19 AM	1,685,484	J-Bolt-Cont_180th.OUT
09/16/2007	07:41 AM	4,519	J-Bolt-Cont_18max.OUT
09/16/2007	07:41 AM	1,685,484	J-Bolt-Cont_18th.OUT
09/16/2007	07:43 AM	4,519	J-Bolt-Cont_27max.OUT
09/16/2007	07:43 AM	1,685,484	J-Bolt-Cont_27th.OUT
09/16/2007	07:45 AM	4,519	J-Bolt-Cont_36max.OUT
09/16/2007	07:45 AM	1,685,484	J-Bolt-Cont_36th.OUT
09/16/2007	07:49 AM	4,519	J-Bolt-Cont_45max.OUT
09/16/2007	07:49 AM	1,685,484	J-Bolt-Cont_45th.OUT
09/16/2007	07:52 AM	4,519	J-Bolt-Cont_54max.OUT
09/16/2007	07:52 AM	1,685,484	J-Bolt-Cont_54th.OUT
09/16/2007	07:55 AM	4,519	J-Bolt-Cont_63max.OUT
09/16/2007	07:55 AM	1,685,484	J-Bolt-Cont_63th.OUT
09/16/2007	07:56 AM	4,519	J-Bolt-Cont_72max.OUT
09/16/2007	07:56 AM	1,685,484	J-Bolt-Cont_72th.OUT
09/16/2007	07:59 AM	4,519	J-Bolt-Cont_81max.OUT
09/16/2007	07:59 AM	1,685,484	J-Bolt-Cont_81th.OUT
09/16/2007	08:01 AM	4,519	J-Bolt-Cont_90max.OUT
09/16/2007	08:01 AM	1,685,484	J-Bolt-Cont_90th.OUT
09/16/2007	08:02 AM	4,519	J-Bolt-Cont_99max.OUT
09/16/2007	08:02 AM	1,685,484	J-Bolt-Cont_99th.OUT
09/16/2007	07:38 AM	4,519	J-Bolt-Cont_9max.OUT
09/16/2007	07:38 AM	1,685,612	J-Bolt-Cont_9th.OUT
08/23/2006	07:47 AM	1,971	Liner.txt
05/02/2005	02:19 PM	667	live_load.txt
08/31/2006	03:05 PM	6,212	Near-Soil-1.txt
04/20/2005	01:14 PM	508	outer-spar.txt
10/13/2006	07:45 AM	147	Post-Tank.txt
09/16/2007	07:15 AM	4,024	Primary-Cont_108max.OUT
09/16/2007	07:15 AM	1,738,448	Primary-Cont_108th.OUT
09/16/2007	07:17 AM	4,024	Primary-Cont_117max.OUT
09/16/2007	07:17 AM	1,738,448	Primary-Cont_117th.OUT
09/16/2007	07:20 AM	4,024	Primary-Cont_126max.OUT
09/16/2007	07:20 AM	1,738,448	Primary-Cont_126th.OUT
09/16/2007	07:23 AM	4,024	Primary-Cont_135max.OUT
09/16/2007	07:23 AM	1,738,448	Primary-Cont_135th.OUT
09/16/2007	07:25 AM	4,024	Primary-Cont_144max.OUT
09/16/2007	07:25 AM	1,738,448	Primary-Cont_144th.OUT
09/16/2007	07:27 AM	4,024	Primary-Cont_153max.OUT
09/16/2007	07:27 AM	1,738,448	Primary-Cont_153th.OUT
09/16/2007	07:28 AM	4,024	Primary-Cont_162max.OUT
09/16/2007	07:28 AM	1,738,448	Primary-Cont_162th.OUT
09/16/2007	07:32 AM	4,024	Primary-Cont_171max.OUT
09/16/2007	07:32 AM	1,738,448	Primary-Cont_171th.OUT
09/16/2007	07:34 AM	4,024	Primary-Cont_180max.OUT
09/16/2007	07:34 AM	1,738,448	Primary-Cont_180th.OUT
09/16/2007	06:50 AM	4,024	Primary-Cont_18max.OUT
09/16/2007	06:50 AM	1,738,448	Primary-Cont_18th.OUT
09/16/2007	06:52 AM	4,024	Primary-Cont_27max.OUT
09/16/2007	06:52 AM	1,738,448	Primary-Cont_27th.OUT
09/16/2007	06:54 AM	4,024	Primary-Cont_36max.OUT
09/16/2007	06:54 AM	1,738,448	Primary-Cont_36th.OUT
09/16/2007	06:58 AM	4,024	Primary-Cont_45max.OUT
09/16/2007	06:58 AM	1,738,448	Primary-Cont_45th.OUT
09/16/2007	07:00 AM	4,024	Primary-Cont_54max.OUT
09/16/2007	07:00 AM	1,738,448	Primary-Cont_54th.OUT
09/16/2007	07:02 AM	4,024	Primary-Cont_63max.OUT
09/16/2007	07:02 AM	1,738,448	Primary-Cont_63th.OUT
09/16/2007	07:05 AM	4,024	Primary-Cont_72max.OUT

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09/16/2007	07:05 AM	1,738,448	Primary-Cont_72th.OUT
09/16/2007	07:07 AM	4,024	Primary-Cont_81max.OUT
09/16/2007	07:07 AM	1,738,448	Primary-Cont_81th.OUT
09/16/2007	07:10 AM	4,024	Primary-Cont_90max.OUT
09/16/2007	07:10 AM	1,738,448	Primary-Cont_90th.OUT
09/16/2007	07:12 AM	4,024	Primary-Cont_99max.OUT
09/16/2007	07:12 AM	1,738,448	Primary-Cont_99th.OUT
09/16/2007	06:46 AM	4,024	Primary-Cont_9max.OUT
09/16/2007	06:46 AM	1,738,576	Primary-Cont_9th.OUT
10/12/2006	02:28 PM	6,028	Primary-Props-AP.txt
09/27/2005	03:52 PM	1,538	Primary.txt
09/14/2007	08:51 AM	450,111	QA.out
09/16/2007	12:12 PM	47,121	RS-ct-0.out
09/16/2007	12:12 PM	47,121	RS-ct-135.out
09/16/2007	12:12 PM	47,121	RS-ct-180.out
09/16/2007	12:12 PM	47,121	RS-ct-45.out
09/16/2007	12:12 PM	47,121	RS-ct-90.out
09/16/2007	12:12 PM	27,591	RS-ct.out
09/11/2006	02:59 PM	47,121	RS-OUT-Concrete.txt
09/16/2007	12:12 PM	47,121	RS-PT-0.out
09/16/2007	12:13 PM	47,121	RS-PT-135.out
09/16/2007	12:13 PM	47,121	RS-PT-180.out
09/16/2007	12:13 PM	47,121	RS-PT-45.out
09/16/2007	12:13 PM	47,121	RS-PT-90.out
09/16/2007	12:13 PM	47,121	RS-Soil.out
10/31/2005	10:31 AM	1,108	RS_FREQ.txt
08/31/2006	02:56 PM	1,819	Run-Tank.txt
09/14/2007	08:50 AM	0	scratch.hlp
12/29/2006	11:03 AM	54,765	Seismic-File-List.txt
02/11/2005	01:22 PM	1,053	Slave.txt
09/16/2007	10:21 AM	9,896	Soil-Contact_108max.OUT
09/16/2007	10:21 AM	4,348,080	Soil-Contact_108th.OUT
09/16/2007	10:31 AM	9,896	Soil-Contact_117max.OUT
09/16/2007	10:31 AM	4,348,080	Soil-Contact_117th.OUT
09/16/2007	10:41 AM	9,896	Soil-Contact_126max.OUT
09/16/2007	10:41 AM	4,348,080	Soil-Contact_126th.OUT
09/16/2007	10:52 AM	9,896	Soil-Contact_135max.OUT
09/16/2007	10:52 AM	4,348,080	Soil-Contact_135th.OUT
09/16/2007	11:02 AM	9,896	Soil-Contact_144max.OUT
09/16/2007	11:02 AM	4,348,080	Soil-Contact_144th.OUT
09/16/2007	11:12 AM	9,896	Soil-Contact_153max.OUT
09/16/2007	11:12 AM	4,348,080	Soil-Contact_153th.OUT
09/16/2007	11:23 AM	9,896	Soil-Contact_162max.OUT
09/16/2007	11:23 AM	4,348,080	Soil-Contact_162th.OUT
09/16/2007	11:33 AM	9,896	Soil-Contact_171max.OUT
09/16/2007	11:33 AM	4,348,080	Soil-Contact_171th.OUT
09/16/2007	11:43 AM	9,896	Soil-Contact_180max.OUT
09/16/2007	11:43 AM	4,348,080	Soil-Contact_180th.OUT
09/16/2007	08:39 AM	9,896	Soil-Contact_18max.OUT
09/16/2007	08:39 AM	4,348,080	Soil-Contact_18th.OUT
09/16/2007	08:49 AM	9,896	Soil-Contact_27max.OUT
09/16/2007	08:49 AM	4,348,080	Soil-Contact_27th.OUT
09/16/2007	08:59 AM	9,896	Soil-Contact_36max.OUT
09/16/2007	08:59 AM	4,348,080	Soil-Contact_36th.OUT
09/16/2007	09:10 AM	9,896	Soil-Contact_45max.OUT
09/16/2007	09:10 AM	4,348,080	Soil-Contact_45th.OUT
09/16/2007	09:20 AM	9,896	Soil-Contact_54max.OUT
09/16/2007	09:20 AM	4,348,080	Soil-Contact_54th.OUT
09/16/2007	09:30 AM	9,896	Soil-Contact_63max.OUT
09/16/2007	09:30 AM	4,348,080	Soil-Contact_63th.OUT
09/16/2007	09:40 AM	9,896	Soil-Contact_72max.OUT
09/16/2007	09:40 AM	4,348,080	Soil-Contact_72th.OUT
09/16/2007	09:50 AM	9,896	Soil-Contact_81max.OUT
09/16/2007	09:50 AM	4,348,080	Soil-Contact_81th.OUT
09/16/2007	10:00 AM	9,896	Soil-Contact_90max.OUT

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09/16/2007	10:00 AM	4,348,080	Soil-Contact_90th.OUT
09/16/2007	10:11 AM	9,896	Soil-Contact_99max.OUT
09/16/2007	10:11 AM	4,348,080	Soil-Contact_99th.OUT
09/16/2007	08:28 AM	9,896	Soil-Contact_9max.OUT
09/16/2007	08:28 AM	4,348,208	Soil-Contact_9th.OUT
11/11/2005	10:36 AM	4,989	Soil-Prop-Mean-Geo.txt
10/13/2005	08:19 AM	5,016	Soil-Prop-UB-Geo.txt
09/07/2006	01:13 PM	1,924	Solve-TH-UBS.txt
09/13/2006	06:12 AM	347	spectra-all.txt
09/13/2006	06:07 AM	3,690	spectra-conc-0.txt
09/13/2006	06:08 AM	3,723	spectra-conc-135.txt
09/13/2006	06:09 AM	3,723	spectra-conc-180.txt
09/13/2006	06:08 AM	3,769	spectra-conc-45.txt
09/13/2006	06:08 AM	3,649	spectra-conc-90.txt
10/17/2006	09:27 AM	1,596	spectra-conc.txt
09/13/2006	06:11 AM	2,076	spectra-concrete.txt
09/13/2006	06:13 AM	3,609	spectra-primary-0.txt
09/13/2006	06:14 AM	3,762	spectra-primary-135.txt
09/13/2006	06:15 AM	3,777	spectra-primary-180.txt
09/13/2006	06:13 AM	3,688	spectra-primary-45.txt
09/13/2006	06:14 AM	3,688	spectra-primary-90.txt
09/13/2006	06:15 AM	3,801	spectra-soil.txt
06/20/2005	09:04 AM	647	spectra-wall.txt
06/20/2005	08:52 AM	679	spectra-waste.txt
01/03/2007	03:40 PM	1,823	strain-backed-principle-bot.txt
01/03/2007	03:40 PM	1,828	strain-backed-principle-mid.txt
01/03/2007	03:41 PM	1,825	strain-backed-principle-top.txt
01/03/2007	04:02 PM	966	strain-backed-principle.txt
08/21/2006	08:02 AM	598	stress-compb.txt
08/21/2006	08:03 AM	608	stress-compm.txt
08/24/2006	03:19 PM	598	stress-compt.txt
08/24/2006	12:05 PM	224	Stress-Primary.txt
09/17/2007	10:40 AM	13,519	Stress-pt_108max-b.OUT
09/17/2007	05:07 AM	13,519	Stress-pt_108max-m.OUT
09/16/2007	11:50 PM	13,519	Stress-pt_108max-t.OUT
09/17/2007	10:40 AM	6,443,068	Stress-pt_108th-b.OUT
09/17/2007	05:07 AM	6,443,068	Stress-pt_108th-m.OUT
09/16/2007	11:50 PM	6,412,940	Stress-pt_108th-t.OUT
09/17/2007	10:56 AM	13,519	Stress-pt_117max-b.OUT
09/17/2007	05:23 AM	13,519	Stress-pt_117max-m.OUT
09/17/2007	12:05 AM	13,519	Stress-pt_117max-t.OUT
09/17/2007	10:56 AM	6,443,068	Stress-pt_117th-b.OUT
09/17/2007	05:23 AM	6,443,068	Stress-pt_117th-m.OUT
09/17/2007	12:05 AM	6,412,940	Stress-pt_117th-t.OUT
09/17/2007	11:11 AM	13,519	Stress-pt_126max-b.OUT
09/17/2007	05:39 AM	13,519	Stress-pt_126max-m.OUT
09/17/2007	12:21 AM	13,519	Stress-pt_126max-t.OUT
09/17/2007	11:11 AM	6,443,068	Stress-pt_126th-b.OUT
09/17/2007	05:39 AM	6,443,068	Stress-pt_126th-m.OUT
09/17/2007	12:21 AM	6,412,940	Stress-pt_126th-t.OUT
09/17/2007	11:26 AM	13,519	Stress-pt_135max-b.OUT
09/17/2007	05:55 AM	13,519	Stress-pt_135max-m.OUT
09/17/2007	12:37 AM	13,519	Stress-pt_135max-t.OUT
09/17/2007	11:26 AM	6,443,068	Stress-pt_135th-b.OUT
09/17/2007	05:55 AM	6,443,068	Stress-pt_135th-m.OUT
09/17/2007	12:37 AM	6,412,940	Stress-pt_135th-t.OUT
09/17/2007	11:42 AM	13,519	Stress-pt_144max-b.OUT
09/17/2007	06:11 AM	13,519	Stress-pt_144max-m.OUT
09/17/2007	12:52 AM	13,519	Stress-pt_144max-t.OUT
09/17/2007	11:42 AM	6,443,068	Stress-pt_144th-b.OUT
09/17/2007	06:11 AM	6,443,068	Stress-pt_144th-m.OUT
09/17/2007	12:52 AM	6,412,940	Stress-pt_144th-t.OUT
09/17/2007	11:57 AM	13,519	Stress-pt_153max-b.OUT
09/17/2007	06:28 AM	13,519	Stress-pt_153max-m.OUT
09/17/2007	01:08 AM	13,519	Stress-pt_153max-t.OUT

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09/17/2007	11:57 AM	6,443,068	Stress-pt_153th-b.OUT
09/17/2007	06:28 AM	6,443,068	Stress-pt_153th-m.OUT
09/17/2007	01:08 AM	6,412,940	Stress-pt_153th-t.OUT
09/17/2007	12:13 PM	13,519	Stress-pt_162max-b.OUT
09/17/2007	06:44 AM	13,519	Stress-pt_162max-m.OUT
09/17/2007	01:24 AM	13,519	Stress-pt_162max-t.OUT
09/17/2007	12:13 PM	6,443,068	Stress-pt_162th-b.OUT
09/17/2007	06:44 AM	6,443,068	Stress-pt_162th-m.OUT
09/17/2007	01:24 AM	6,412,940	Stress-pt_162th-t.OUT
09/17/2007	12:29 PM	13,521	Stress-pt_171max-b.OUT
09/17/2007	07:01 AM	13,521	Stress-pt_171max-m.OUT
09/17/2007	01:40 AM	13,521	Stress-pt_171max-t.OUT
09/17/2007	12:29 PM	6,443,068	Stress-pt_171th-b.OUT
09/17/2007	07:01 AM	6,443,068	Stress-pt_171th-m.OUT
09/17/2007	01:40 AM	6,412,940	Stress-pt_171th-t.OUT
09/17/2007	12:44 PM	13,521	Stress-pt_180max-b.OUT
09/17/2007	07:17 AM	13,521	Stress-pt_180max-m.OUT
09/17/2007	01:56 AM	13,521	Stress-pt_180max-t.OUT
09/17/2007	12:44 PM	6,443,068	Stress-pt_180th-b.OUT
09/17/2007	07:17 AM	6,443,068	Stress-pt_180th-m.OUT
09/17/2007	01:56 AM	6,412,940	Stress-pt_180th-t.OUT
09/17/2007	07:50 AM	13,519	Stress-pt_18max-b.OUT
09/17/2007	02:28 AM	13,519	Stress-pt_18max-m.OUT
09/16/2007	09:11 PM	13,519	Stress-pt_18max-t.OUT
09/17/2007	07:50 AM	6,443,068	Stress-pt_18th-b.OUT
09/17/2007	02:28 AM	6,443,068	Stress-pt_18th-m.OUT
09/16/2007	09:11 PM	6,412,940	Stress-pt_18th-t.OUT
09/17/2007	08:06 AM	13,519	Stress-pt_27max-b.OUT
09/17/2007	02:44 AM	13,519	Stress-pt_27max-m.OUT
09/16/2007	09:27 PM	13,519	Stress-pt_27max-t.OUT
09/17/2007	08:06 AM	6,443,068	Stress-pt_27th-b.OUT
09/17/2007	02:44 AM	6,443,068	Stress-pt_27th-m.OUT
09/16/2007	09:27 PM	6,412,940	Stress-pt_27th-t.OUT
09/17/2007	08:22 AM	13,519	Stress-pt_36max-b.OUT
09/17/2007	03:00 AM	13,519	Stress-pt_36max-m.OUT
09/16/2007	09:43 PM	13,519	Stress-pt_36max-t.OUT
09/17/2007	08:22 AM	6,443,068	Stress-pt_36th-b.OUT
09/17/2007	03:00 AM	6,443,068	Stress-pt_36th-m.OUT
09/16/2007	09:43 PM	6,412,940	Stress-pt_36th-t.OUT
09/17/2007	08:38 AM	13,519	Stress-pt_45max-b.OUT
09/17/2007	03:16 AM	13,519	Stress-pt_45max-m.OUT
09/16/2007	09:59 PM	13,519	Stress-pt_45max-t.OUT
09/17/2007	08:38 AM	6,443,068	Stress-pt_45th-b.OUT
09/17/2007	03:16 AM	6,443,068	Stress-pt_45th-m.OUT
09/16/2007	09:59 PM	6,412,940	Stress-pt_45th-t.OUT
09/17/2007	08:54 AM	13,519	Stress-pt_54max-b.OUT
09/17/2007	03:32 AM	13,519	Stress-pt_54max-m.OUT
09/16/2007	10:15 PM	13,519	Stress-pt_54max-t.OUT
09/17/2007	08:54 AM	6,443,068	Stress-pt_54th-b.OUT
09/17/2007	03:32 AM	6,443,068	Stress-pt_54th-m.OUT
09/16/2007	10:15 PM	6,412,940	Stress-pt_54th-t.OUT
09/17/2007	09:11 AM	13,519	Stress-pt_63max-b.OUT
09/17/2007	03:48 AM	13,519	Stress-pt_63max-m.OUT
09/16/2007	10:31 PM	13,519	Stress-pt_63max-t.OUT
09/17/2007	09:11 AM	6,443,068	Stress-pt_63th-b.OUT
09/17/2007	03:48 AM	6,443,068	Stress-pt_63th-m.OUT
09/16/2007	10:31 PM	6,412,940	Stress-pt_63th-t.OUT
09/17/2007	09:38 AM	13,519	Stress-pt_72max-b.OUT
09/17/2007	04:03 AM	13,519	Stress-pt_72max-m.OUT
09/16/2007	10:46 PM	13,519	Stress-pt_72max-t.OUT
09/17/2007	09:38 AM	6,443,068	Stress-pt_72th-b.OUT
09/17/2007	04:03 AM	6,443,068	Stress-pt_72th-m.OUT
09/16/2007	10:46 PM	6,412,940	Stress-pt_72th-t.OUT
09/17/2007	09:53 AM	13,519	Stress-pt_81max-b.OUT
09/17/2007	04:19 AM	13,519	Stress-pt_81max-m.OUT

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09/16/2007	11:02 PM	13,519	Stress-pt_81max-t.OUT
09/17/2007	09:53 AM	6,443,068	Stress-pt_81th-b.OUT
09/17/2007	04:19 AM	6,443,068	Stress-pt_81th-m.OUT
09/16/2007	11:02 PM	6,412,940	Stress-pt_81th-t.OUT
09/17/2007	10:09 AM	13,519	Stress-pt_90max-b.OUT
09/17/2007	04:35 AM	13,519	Stress-pt_90max-m.OUT
09/16/2007	11:18 PM	13,519	Stress-pt_90max-t.OUT
09/17/2007	10:09 AM	6,443,068	Stress-pt_90th-b.OUT
09/17/2007	04:35 AM	6,443,068	Stress-pt_90th-m.OUT
09/16/2007	11:34 PM	6,412,940	Stress-pt_90th-t.OUT
09/17/2007	10:25 AM	13,519	Stress-pt_99max-b.OUT
09/17/2007	04:51 AM	13,519	Stress-pt_99max-m.OUT
09/16/2007	11:34 PM	13,519	Stress-pt_99max-t.OUT
09/17/2007	10:25 AM	6,443,068	Stress-pt_99th-b.OUT
09/17/2007	04:51 AM	6,443,068	Stress-pt_99th-m.OUT
09/16/2007	11:34 PM	6,412,940	Stress-pt_99th-t.OUT
09/17/2007	07:34 AM	13,519	Stress-pt_9max-b.OUT
09/17/2007	02:12 AM	13,519	Stress-pt_9max-m.OUT
09/16/2007	08:55 PM	13,519	Stress-pt_9max-t.OUT
09/17/2007	07:34 AM	6,443,196	Stress-pt_9th-b.OUT
09/17/2007	02:12 AM	6,443,196	Stress-pt_9th-m.OUT
09/16/2007	08:55 PM	6,413,068	Stress-pt_9th-t.OUT
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05/25/2005	03:32 PM	2,512	Tank-Mesh1.txt
09/14/2007	08:50 AM	102	tank-out.out
08/25/2006	07:52 AM	5,450	Tank-Props-BEC-250.txt
09/14/2007	08:51 AM	4,687	Tank-th.out
08/09/2006	07:43 AM	23,166	TH-266-Mean-Geo-V.txt
08/09/2006	07:31 AM	23,166	TH-266-Mean-Geo.txt
05/16/2005	03:42 PM	41,472	TH-266-UB-Geo-V.txt
05/16/2005	08:45 AM	41,391	TH-266-UB-Geo.txt
09/16/2007	12:12 PM	561,576	Vel-ct-0.out
09/16/2007	12:12 PM	561,576	Vel-ct-135.out
09/16/2007	12:12 PM	561,576	Vel-ct-180.out
09/16/2007	12:12 PM	561,576	Vel-ct-45.out
09/16/2007	12:12 PM	561,576	Vel-ct-90.out
09/16/2007	12:12 PM	290,550	Vel-ct.out
09/16/2007	12:12 PM	561,576	Vel-PT-0.out
09/16/2007	12:13 PM	561,576	Vel-PT-135.out
09/16/2007	12:13 PM	561,576	Vel-PT-180.out
09/16/2007	12:13 PM	561,576	Vel-PT-45.out
09/16/2007	12:13 PM	561,576	Vel-PT-90.out
09/16/2007	12:13 PM	561,576	Vel-Soil.out
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09/16/2007	04:25 AM	4,875,649	Waste-Cont_108th.OUT
09/16/2007	04:38 AM	10,180	Waste-Cont_117max.OUT
09/16/2007	04:38 AM	4,875,649	Waste-Cont_117th.OUT
09/16/2007	04:50 AM	10,180	Waste-Cont_126max.OUT
09/16/2007	04:50 AM	4,875,649	Waste-Cont_126th.OUT
09/16/2007	05:03 AM	10,180	Waste-Cont_135max.OUT
09/16/2007	05:03 AM	4,875,649	Waste-Cont_135th.OUT
09/16/2007	05:16 AM	10,180	Waste-Cont_144max.OUT
09/16/2007	05:16 AM	4,875,649	Waste-Cont_144th.OUT
09/16/2007	05:28 AM	10,180	Waste-Cont_153max.OUT
09/16/2007	05:28 AM	4,875,649	Waste-Cont_153th.OUT
09/16/2007	05:41 AM	10,180	Waste-Cont_162max.OUT
09/16/2007	05:41 AM	4,875,649	Waste-Cont_162th.OUT
09/16/2007	05:54 AM	10,180	Waste-Cont_171max.OUT
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09/16/2007	02:32 AM	10,180	Waste-Cont_27max.OUT
09/16/2007	02:32 AM	4,875,649	Waste-Cont_27th.OUT

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09/16/2007	02:56 AM	4,875,649	Waste-Cont_45th.OUT
09/16/2007	03:08 AM	10,180	Waste-Cont_54max.OUT
09/16/2007	03:08 AM	4,875,649	Waste-Cont_54th.OUT
09/16/2007	03:20 AM	10,180	Waste-Cont_63max.OUT
09/16/2007	03:20 AM	4,875,649	Waste-Cont_63th.OUT
09/16/2007	03:32 AM	10,180	Waste-Cont_72max.OUT
09/16/2007	03:32 AM	4,875,649	Waste-Cont_72th.OUT
09/16/2007	03:45 AM	10,180	Waste-Cont_81max.OUT
09/16/2007	03:45 AM	4,875,649	Waste-Cont_81th.OUT
09/16/2007	03:58 AM	10,180	Waste-Cont_90max.OUT
09/16/2007	03:58 AM	4,875,649	Waste-Cont_90th.OUT
09/16/2007	04:11 AM	10,180	Waste-Cont_99max.OUT
09/16/2007	04:11 AM	4,875,649	Waste-Cont_99th.OUT
09/16/2007	02:07 AM	10,180	Waste-Cont_9max.OUT
09/16/2007	02:07 AM	4,875,777	Waste-Cont_9th.OUT
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08/25/2006	08:47 AM	340	Waste-Reaction.txt
10/12/2006	02:27 PM	10,266	Waste-solid-AP-S.txt
08/21/2006	08:03 AM	776	Waste-Surface-AP.txt
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09/16/2007	11:47 AM	534,133	Waste-Surf_0th.OUT
09/16/2007	11:59 AM	865	Waste-Surf_108max.OUT
09/16/2007	11:59 AM	534,005	Waste-Surf_108th.OUT
09/16/2007	11:59 AM	865	Waste-Surf_117max.OUT
09/16/2007	12:00 PM	534,005	Waste-Surf_117th.OUT
09/16/2007	12:00 PM	865	Waste-Surf_126max.OUT
09/16/2007	12:00 PM	534,005	Waste-Surf_126th.OUT
09/16/2007	12:01 PM	865	Waste-Surf_135max.OUT
09/16/2007	12:01 PM	534,005	Waste-Surf_135th.OUT
09/16/2007	12:02 PM	865	Waste-Surf_144max.OUT
09/16/2007	12:02 PM	534,005	Waste-Surf_144th.OUT
09/16/2007	12:03 PM	865	Waste-Surf_153max.OUT
09/16/2007	12:03 PM	534,005	Waste-Surf_153th.OUT
09/16/2007	12:04 PM	865	Waste-Surf_162max.OUT
09/16/2007	12:04 PM	534,005	Waste-Surf_162th.OUT
09/16/2007	12:05 PM	865	Waste-Surf_171max.OUT
09/16/2007	12:05 PM	534,005	Waste-Surf_171th.OUT
09/16/2007	12:06 PM	865	Waste-Surf_180max.OUT
09/16/2007	12:06 PM	534,005	Waste-Surf_180th.OUT
09/16/2007	12:06 PM	865	Waste-Surf_189max.OUT
09/16/2007	12:06 PM	534,005	Waste-Surf_189th.OUT
09/16/2007	11:49 AM	865	Waste-Surf_18max.OUT
09/16/2007	11:49 AM	534,005	Waste-Surf_18th.OUT
09/16/2007	11:50 AM	865	Waste-Surf_27max.OUT
09/16/2007	11:50 AM	534,005	Waste-Surf_27th.OUT
09/16/2007	11:51 AM	865	Waste-Surf_36max.OUT
09/16/2007	11:51 AM	534,005	Waste-Surf_36th.OUT
09/16/2007	11:52 AM	865	Waste-Surf_45max.OUT
09/16/2007	11:52 AM	534,005	Waste-Surf_45th.OUT
09/16/2007	11:53 AM	865	Waste-Surf_54max.OUT
09/16/2007	11:53 AM	534,005	Waste-Surf_54th.OUT
09/16/2007	11:54 AM	865	Waste-Surf_63max.OUT
09/16/2007	11:54 AM	534,005	Waste-Surf_63th.OUT
09/16/2007	11:55 AM	865	Waste-Surf_72max.OUT
09/16/2007	11:55 AM	534,005	Waste-Surf_72th.OUT
09/16/2007	11:56 AM	865	Waste-Surf_81max.OUT
09/16/2007	11:56 AM	534,005	Waste-Surf_81th.OUT
09/16/2007	11:57 AM	865	Waste-Surf_90max.OUT
09/16/2007	11:57 AM	534,005	Waste-Surf_90th.OUT
09/16/2007	11:58 AM	865	Waste-Surf_99max.OUT
09/16/2007	11:58 AM	534,005	Waste-Surf_99th.OUT
09/16/2007	11:48 AM	865	Waste-Surf_9max.OUT

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09/16/2007 11:48 AM 534,005 Waste-Surf_9th.OUT
617 File(s) 37,554,084,805 bytes
3 Dir(s) 111,027,961,856 bytes free

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Appendix I

Best Estimate Soil, Fully Cracked Concrete

Results Load Case Specific Input Files File Listing

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Appendix I

Best Estimate Soil, Fully Cracked Concrete

Results Load Case Specific Input Files File Listing

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Table I.1. BES-FCC Concrete Forces and Moment, Gravity Load Only

AP Primary Tank, Best Estimate Soil (Geomatrix), Gravity Only, Fully Cracked Concrete, 460 in. Waste Level at 1.83 SpG

ANSYS MAXIMUMS BY PATH

PNNL Section No.	Path (in.)	Gravity Hoop Force (kip/ft) AP-BES-FCC	Gravity Meridonal Force (kip/ft) AP-BES-FCC	Gravity -In- Plane Shear Force (kip/ft) AP-BES-FCC	Gravity Hoop Moment (ft*kip/ft) AP- BES-FCC	Gravity Meridonal Moment (ft*kip/ft) AP-BES-FCC	Gravity Through-Wall Shear Force (kip/ft) AP-BES FCC
2	67.734	-54.230	-65.850	-0.060	-7.563	-6.218	2.491
3	105.676	-42.100	-59.650	-0.060	-4.301	-1.047	2.463
4	137.076	-39.130	-55.280	-0.021	-3.426	3.290	2.192
6	182.856	-32.560	-51.110	-0.063	-2.003	5.501	0.494
8	226.570	-24.750	-48.630	-0.070	-0.368	4.274	-1.235
9	275.574	-29.800	-48.550	-0.032	-1.001	1.605	-1.101
11	325.697	-24.140	-49.250	-0.020	-1.073	-1.526	-0.824
13	372.312	-21.430	-50.160	-0.046	-2.361	-2.161	-0.671
17	423.434	-10.500	-52.830	-0.088	-3.770	-0.557	1.411
20	468.315	6.412	-52.740	-0.103	-1.054	20.020	7.914
22	515.319	15.140	-54.730	-0.076	4.426	27.140	-3.729
24	553.722	0.176	-54.420	-0.043	1.691	9.244	-6.579
26	593.805	-13.620	-56.390	-0.021	-0.328	-1.804	-1.594
30	644.355	-24.390	-58.230	0.008	-0.478	-2.651	0.820
33	693.605	-28.650	-59.600	0.004	-0.101	-0.557	0.304
35	740.705	-30.420	-60.990	0.003	0.019	0.101	-0.026
38	786.205	-28.840	-62.360	-0.003	-0.168	-0.928	-0.285
41	844.605	-27.080	-64.140	-0.004	-0.164	-0.907	-0.265
43	901.355	-12.730	-26.190	0.005	-0.119	-0.661	1.029
46	932.355	-16.040	-63.150	0.026	-0.582	-3.062	-2.114
48	1007.355	-2.505	-7.697	0.430	-2.083	8.061	-4.653
51	1053.855	-1.606	-9.120	0.603	-0.577	3.855	6.516
53	1086.855	0.393	-1.623	0.167	1.094	4.759	-8.257
55	1105.855	0.533	-0.701	0.105	0.077	0.239	-0.217
57	1147.355	0.539	-0.301	0.073	0.012	0.033	-0.021
58	1207.355	0.930	0.628	0.032	0.006	0.003	0.011
59	1267.355	1.014	0.969	0.011	0.012	0.019	-0.007
60	1327.355	1.235	1.336	-0.016	0.012	0.015	0.007
61	1387.355	0.891	1.683	-0.070	0.008	0.008	-0.014
62	1449.355	3.007	3.077	-0.028	0.045	0.222	0.144

Note: Meridonal/Hoop Forces and Meridonal/Hoop Moments are Reversed in Highlighted Sections.

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Table I.2. BES-FCC Concrete Forces and Moments, Gravity Plus Seismic Load

**AP- Primary Tank, Best Estimate Soil (Geomatrix), Fully Cracked Concrete,
460 in. Waste Level at 1.83 SpG**

ANSYS MAXIMUMS BY PATH

PNNL Section No.	Path (in.)	Seismic Hoop Force (kip/ft) AP-BES-FCC	Seismic Meridional Force (kip/ft) AP-BES-FCC	Seismic -In- Plane Shear Force (kip/ft) AP-BES-FCC	Seismic Hoop Moment (ft*kip/ft) AP- BES-FCC	Seismic Meridional Moment (ft*kip/ft) AP-BES-FCC	Seismic Through-Wall Shear Force (kip/ft) AP-BES FCC
2	67.734	-77.070	-90.430	5.360	-14.710	-15.710	4.795
3	105.676	-60.690	-82.590	6.896	-9.053	-6.865	5.197
4	137.076	-55.760	-76.170	7.419	-7.270	7.907	4.812
6	182.856	-45.760	-68.750	7.470	-4.220	10.620	2.477
8	226.570	-36.850	-63.210	7.575	-1.334	11.150	1.968
9	275.574	-48.820	-61.770	8.908	-1.971	4.159	1.873
11	325.697	-38.750	-62.480	11.360	-1.587	-2.370	1.224
13	372.312	-37.400	-63.270	13.710	-3.203	-4.080	1.305
17	423.434	-30.800	-65.750	18.080	-5.077	-4.595	2.320
20	468.315	31.200	-64.790	20.810	-3.356	27.690	9.604
22	515.319	31.480	-65.430	20.700	5.888	33.940	5.434
24	553.722	-7.690	-66.180	20.080	2.047	11.140	8.166
26	593.805	-19.030	-69.070	19.950	-0.484	-2.626	1.913
30	644.355	-29.280	-70.050	20.020	-0.589	-3.212	1.009
33	693.605	-33.380	-70.050	20.250	-0.156	-0.787	0.354
35	740.705	-35.330	-70.100	20.730	0.048	0.253	0.100
38	786.205	-33.280	-71.650	21.270	-0.217	-1.152	0.366
41	844.605	-31.020	-73.680	22.490	-0.258	-1.405	0.450
43	901.355	-14.410	-30.180	10.860	-0.240	-1.331	1.632
46	932.355	-25.230	-72.870	23.900	-0.666	-3.660	3.103
48	1007.355	-11.360	-12.120	8.330	-2.435	9.298	5.368
51	1053.855	-5.454	-12.900	5.970	-0.674	4.451	7.514
53	1086.855	4.081	-5.382	3.233	1.263	5.493	9.506
55	1105.855	3.547	-4.501	2.844	0.109	0.321	0.349
57	1147.355	2.644	-2.742	1.916	0.021	0.057	0.055
58	1207.355	3.226	2.724	1.564	0.010	0.012	0.041
59	1267.355	3.116	2.927	1.260	0.024	0.042	0.033
60	1327.355	3.459	3.362	1.054	0.021	0.035	0.037
61	1387.355	2.317	3.863	0.809	0.015	0.023	0.054
62	1449.355	7.296	6.898	0.958	0.139	0.314	0.263

Note: Meridional/Hoop Forces and Meridional/Hoop Moments are Reversed in Highlighted Sections.

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Table I.3. BES-FCC Concrete Forces and Moments, Seismic Only

**AP- Primary Tank, Best Estimate Soil (Geomatrix), Fully Cracked Concrete,
460 in. Waste Level at 1.83 SpG**

ANSYS MAXIMUMS BY PATH

PNNL Section No.	Path (in.)	Seismic Only Hoop Force (kip/ft) AP-BES- FCC	Seismic Only Meridonal Force (kip/ft) AP-BES-FCC	Seismic Only - In-Plane Shear Force (kip/ft) AP-BES-FCC	Seismic Only Hoop Moment (ft*kip/ft) AP- BES-FCC	Seismic Only Meridonal Moment (ft*kip/ft) AP-BES- FCC	Seismic Only Through-Wall Shear Force (kip/ft) AP-BES- FCC
2	67.734	24.120	24.670	5.344	7.237	9.492	2.328
3	105.676	21.600	23.110	6.878	4.916	6.361	2.734
4	137.076	19.820	21.140	7.413	4.390	4.769	2.620
6	182.856	13.370	17.900	7.480	2.785	5.119	2.353
8	226.570	12.500	14.800	7.591	0.966	7.077	0.930
9	275.574	19.080	13.790	8.918	1.137	2.738	0.885
11	325.697	14.735	13.270	11.368	0.681	0.906	0.408
13	372.312	19.347	13.150	13.725	0.912	2.052	0.646
17	423.434	22.590	12.930	18.105	1.536	4.168	1.065
20	468.315	24.788	12.080	20.838	2.423	7.710	1.743
22	515.319	18.530	10.760	20.721	1.678	7.040	1.922
24	553.722	7.717	11.790	20.092	0.379	1.943	1.691
26	593.805	5.521	12.690	19.956	0.156	0.822	0.327
30	644.355	5.000	11.820	20.023	0.111	0.566	0.189
33	693.605	5.270	10.450	20.252	0.055	0.233	0.062
35	740.705	5.300	9.810	20.730	0.034	0.153	0.074
38	786.205	4.550	11.740	21.272	0.049	0.224	0.083
41	844.605	4.610	14.120	22.492	0.104	0.550	0.187
43	901.355	2.320	6.300	10.861	0.134	0.769	0.669
46	932.355	10.839	15.300	23.893	0.149	0.743	0.990
48	1007.355	8.890	4.931	7.930	0.532	2.006	1.159
51	1053.855	3.950	4.507	5.621	0.170	1.129	1.543
53	1086.855	4.182	3.761	3.236	0.287	1.195	1.600
55	1105.855	3.456	3.801	2.901	0.033	0.121	0.258
57	1147.355	2.340	2.441	1.981	0.009	0.024	0.035
58	1207.355	2.453	2.293	1.588	0.004	0.015	0.031
59	1267.355	2.102	2.066	1.264	0.012	0.024	0.028
60	1327.355	2.224	2.047	1.046	0.009	0.021	0.031
61	1387.355	1.426	2.206	0.747	0.007	0.015	0.043
62	1449.355	4.294	3.861	0.947	0.104	0.098	0.120

Note: Meridonal/Hoop Forces and Meridonal/Hoop Moments are Reversed in Highlighted Sections.

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Table I.4. BES-FCC Primary Tank Stresses, Shell Top, Gravity Load Only

**AP Primary Tank, Best Estimate Soil, Gravity Only, Fully
Cracked Tank Concrete, 460 in. Waste Level at 1.83 SpG**

M&D Starting Element No.	Path (in.)	Shell Top Surface (inside - waste side)			
		AP-460-BES-FCC Gravity Hoop Stress (lbs/in ²) Top	AP-460-BES-FCC Gravity Meridional Stress (lbs/in ²) Top	AP-460-BES-FCC Gravity Stress Intensity (lbs/in ²) Top	AP-460-BES-FCC Gravity In-Plane Shear Stress (lbs/in ²) Top
762	67.33	-6575.00	-7423.61	7423.61	-24.06
782	105.04	-5793.06	-10395.83	10395.83	-21.16
802	136.24	-4358.33	-9152.78	9152.78	-9.87
822	181.83	-2337.50	-8104.17	8104.17	14.08
842	225.10	-1695.14	-6069.44	6069.44	-15.12
862	273.66	-756.25	-4906.94	4906.94	-5.95
882	323.27	-446.74	-3163.89	3163.89	-2.66
902	369.20	610.14	-2231.25	2836.81	-3.28
922	419.20	1733.33	-811.81	2539.58	-5.73
942	444.31	1458.33	-2512.50	3965.28	-4.51
962	458.66	1252.78	1542.36	1542.36	3.46
982	473.08	897.92	1145.14	1145.14	-1.39
1002	484.80	1605.56	-359.86	1964.58	-0.65
1022	502.48	3093.06	6.49	3100.69	-0.90
1042	526.48	4690.28	92.64	4690.28	-0.67
1062	550.48	6314.58	-57.52	6372.22	-0.43
1082	574.60	7881.94	173.96	7881.94	-0.27
1102	598.28	9569.44	-104.10	9673.61	-0.23
1122	621.38	11118.06	96.11	11118.06	-0.29
1142	644.48	12687.50	-32.22	12722.22	-0.34
1162	667.63	13791.67	-381.04	14173.61	-0.39
1182	690.78	14201.39	392.99	14201.39	-0.38
1202	713.88	15201.39	129.86	15201.39	-0.37
1222	736.98	16562.50	-365.63	16930.56	-0.40
1242	760.13	16500.00	-746.53	17250.00	0.46
1262	782.53	15270.83	1002.08	15270.83	-0.36
1282	804.13	14923.61	315.69	14923.61	-0.45
1302	825.73	15770.83	-45.97	15812.50	0.51
1322	847.33	17131.94	334.79	17131.94	-0.49
1342	868.87	17555.56	-1911.11	19465.28	-0.83
1362	892.10	13298.61	-3065.28	16368.06	1.25
1382	909.20	3745.14	-9722.22	13479.17	1.54
1402	918.38	3794.44	6022.22	6071.53	-1.76
1460	930.48	3545.83	10111.11	10159.72	-520.56
1442	949.48	193.68	-448.89	647.92	50.92
1462	990.98	575.35	866.67	868.75	-23.83
1482	1050.98	398.61	392.99	572.64	1.64
1502	1110.98	434.24	571.88	572.64	-12.16
1522	1170.98	331.94	282.29	332.29	5.38
1542	1230.98	376.74	475.00	475.63	-9.16
1562	1292.98	285.28	284.72	286.32	1.95

Note 1: Meridional, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)

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Table I.5. BES-FCC Primary Tank Stresses, Shell Middle, Gravity Load Only

**AP Primary Tank, Best Estimate Soil, Gravity Only, Fully
Cracked Tank Concrete, 460 in. Waste Level at 1.83 SpG**

M&D Starting Element No.	Path (in.)	Shell Mid-Plane			
		AP-460-BES-FCC Gravity Hoop Stress (lbs/in ²) Mid	AP-460-BES-FCC Gravity Meridional Stress (lbs/in ²) Mid	AP-460-BES-FCC Gravity Stress Intensity (lbs/in ²) Mid	AP-460-BES-FCC Gravity In-Plane Shear Stress (lbs/in ²) Mid
762	67.33	-7006.94	-7875.00	7875.00	16.08
782	105.04	-5915.28	-10270.83	10270.83	-17.90
802	136.24	-4535.42	-9319.44	9319.44	9.00
822	181.83	-2312.50	-7805.56	7805.56	11.40
842	225.10	-1802.78	-6336.81	6336.81	13.49
862	273.66	-726.39	-4761.11	4761.11	5.82
882	323.27	-521.88	-3386.11	3386.11	2.60
902	369.20	614.38	-2184.72	2793.06	-3.25
922	419.20	1716.67	-845.83	2556.94	-5.67
942	444.31	2230.56	18.58	2267.36	-4.02
962	458.66	829.86	59.85	830.56	3.06
982	473.08	570.14	60.53	572.36	-1.58
1002	484.80	1727.78	57.15	1729.86	-0.43
1022	502.48	3106.94	53.15	3109.03	-0.72
1042	526.48	4676.39	46.79	4677.08	-0.61
1062	550.48	6343.06	40.08	6344.44	-0.39
1082	574.60	7840.28	33.26	7840.28	-0.24
1102	598.28	9611.11	26.54	9611.11	-0.20
1122	621.38	11097.22	19.97	11097.22	-0.26
1142	644.48	12701.39	13.35	12708.33	-0.31
1162	667.63	13909.72	6.75	13909.72	-0.36
1182	690.78	14076.39	-1.88	14083.33	-0.35
1202	713.88	15159.72	-8.40	15166.67	-0.35
1222	736.98	16666.67	-14.88	16687.50	-0.39
1242	760.13	16722.22	-21.40	16743.06	-0.44
1262	782.53	14965.28	-21.03	14986.11	-0.34
1282	804.13	14826.39	-27.11	14854.17	-0.42
1302	825.73	15770.83	-33.25	15805.56	0.49
1322	847.33	17020.83	-39.41	17055.56	-0.49
1342	868.87	18111.11	-45.38	18173.61	-0.68
1362	892.10	14208.33	-44.51	14263.89	1.00
1382	909.20	6527.08	-54.41	6704.86	1.18
1402	918.38	1690.97	115.21	2022.22	-1.12
1460	930.48	439.72	380.69	571.25	5.28
1442	949.48	454.72	425.21	455.49	2.70
1462	990.98	522.01	702.78	704.17	-15.01
1482	1050.98	437.15	525.14	443.82	-8.13
1502	1110.98	393.06	443.47	443.82	-5.27
1522	1170.98	363.13	390.90	391.11	-3.59
1542	1230.98	343.06	366.18	366.46	-3.25
1562	1292.98	305.90	368.06	368.82	-6.35

Note 1: Meridonal, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)

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Table I.6. BES-FCC Primary Tank Stresses, Shell Bottom, Gravity Load Only

**AP Primary Tank, Best Estimate Soil, Gravity Only, Fully
Cracked Tank Concrete, 460 in. Waste Level at 1.83 SpG**

M&D Starting Element No.	Path (in.)	Shell Bottom Surface (outside - away from waste)			
		AP-460-BES-FCC Gravity Hoop Stress (lbs/in ²) Bot	AP-460-BES-FCC Gravity Meridional Stress (lbs/in ²) Bot	AP-460-BES-FCC Gravity Stress Intensity (lbs/in ²) Bot	AP-460-BES-FCC Gravity In-Plane Shear Stress (lbs/in ²) Bot
762	67.33	-7458.33	-8361.11	8361.11	-16.56
782	105.04	-6052.08	-10166.67	10166.67	16.44
802	136.24	-4713.89	-9506.94	9506.94	8.33
822	181.83	-2287.50	-7513.89	7513.89	-9.94
842	225.10	-1910.42	-6614.58	6614.58	12.10
862	273.66	-697.22	-4617.36	4617.36	5.73
882	323.27	-597.22	-3612.50	3613.19	2.56
902	369.20	618.68	-2139.58	2750.00	-3.23
922	419.20	1700.00	-880.56	2575.00	-5.60
942	444.31	3002.78	2549.31	3003.47	-3.53
962	458.66	407.43	-1422.92	1822.22	2.66
982	473.08	242.57	-1024.31	1260.42	-1.77
1002	484.80	1850.00	473.40	1850.00	-0.71
1022	502.48	3120.83	102.29	3121.53	-0.54
1042	526.48	4662.50	-1.36	4669.44	-0.55
1062	550.48	6372.22	135.63	6372.92	-0.35
1082	574.60	7798.61	-109.65	7909.72	-0.22
1102	598.28	9645.83	155.28	9645.83	-0.19
1122	621.38	11076.39	-58.25	11131.94	-0.22
1142	644.48	12715.28	57.15	12715.28	-0.28
1162	667.63	14027.78	392.92	14027.78	-0.33
1182	690.78	13965.28	-395.07	14354.17	-0.31
1202	713.88	15118.06	-145.00	15263.89	-0.36
1222	736.98	16770.83	337.71	16770.83	-0.38
1242	760.13	16937.50	706.25	16937.50	-0.42
1262	782.53	14659.72	-1043.06	15701.39	-0.33
1282	804.13	14722.22	-369.24	15090.28	-0.40
1302	825.73	15777.78	-19.61	15798.61	0.46
1322	847.33	16909.72	-412.57	17319.44	-0.48
1342	868.87	18673.61	1823.61	18673.61	0.57
1362	892.10	15111.11	2979.17	15111.11	0.76
1382	909.20	9312.50	9625.00	9625.00	0.88
1402	918.38	-415.90	-5792.36	5843.06	-0.56
1460	930.48	-2672.22	-9354.17	9402.78	529.65
1442	949.48	716.67	1297.92	1301.39	-46.47
1462	990.98	468.89	539.58	540.07	-6.23
1482	1050.98	476.04	658.75	352.50	-15.65
1502	1110.98	352.22	317.01	352.50	4.11
1522	1170.98	394.86	501.67	502.22	-9.83
1542	1230.98	310.14	259.93	310.56	5.51
1562	1292.98	328.47	454.31	455.21	-11.86

Note 1: Meridonal, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)

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Table I.7. BES-FCC Primary Tank Stresses, Shell Top, Gravity Plus Seismic Load

**AP Primary Tank, Best Estimate Soil, Horizontal and Vertical
Seismic, Fully Cracked Tank Concrete, 460 in. Waste Level at
1.83 SpG**

M&D Starting M&D Element No.	Path (in.)	Shell Top Surface (inside - waste side)			
		AP-460-BES-FCC Seismic Hoop Stress (lbs/in ²) Top	AP-460-BES-FCC Seismic Meridional Stress (lbs/in ²) Top	AP-460-BES-FCC Seismic Stress Intensity (lbs/in ²) Top	AP-460-BES-FCC Seismic In-Plane Shear Stress (lbs/in ²) Top
762	67.33	-9194.44	-10750.00	10756.94	-1229.17
782	105.04	-8534.72	-13909.72	13916.67	-2013.89
802	136.24	-6736.81	-12965.28	12965.28	-1964.58
822	181.83	-3820.83	-10840.28	10840.28	-1596.53
842	225.10	-4153.47	-9041.67	9451.39	-1178.47
862	273.66	-2150.69	-6397.92	6397.92	-907.64
882	323.27	-2352.78	-4977.08	6880.56	-1013.89
902	369.20	2184.72	-3354.17	4807.64	-1493.75
922	419.20	4926.39	-1785.42	6716.67	-2691.67
942	444.31	4811.81	-5994.44	6659.03	-2688.89
962	458.66	6188.89	7062.50	12854.17	-2684.03
982	473.08	-6897.92	7930.56	14833.33	-2895.14
1002	484.80	4293.75	-1782.64	6194.44	-3040.28
1022	502.48	5191.67	-895.83	6703.47	-2981.94
1042	526.48	9041.67	1228.47	9048.61	-2763.89
1062	550.48	11465.28	1237.50	11472.22	-2502.78
1082	574.60	13895.83	1667.36	13895.83	-2198.61
1102	598.28	16465.28	-1360.42	16465.28	-1847.22
1122	621.38	18784.72	1751.39	18784.72	-1456.94
1142	644.48	21138.89	1609.03	21138.89	1083.33
1162	667.63	22736.11	-1730.56	22736.11	-909.03
1182	690.78	23131.94	2106.94	23131.94	-725.00
1202	713.88	24298.61	1677.08	24298.61	810.42
1222	736.98	25930.56	-1536.81	25930.56	1062.50
1242	760.13	25437.50	-853.47	25750.00	1432.64
1262	782.53	23138.89	2392.36	23138.89	1365.28
1282	804.13	22173.61	1331.94	22173.61	1670.83
1302	825.73	23020.83	775.00	23020.83	1987.50
1322	847.33	24701.39	1259.72	24701.39	2313.19
1342	868.87	24791.67	-2411.81	27590.28	2678.47
1362	892.10	17451.39	-3443.06	22326.39	2589.58
1382	909.20	5800.69	-11597.22	19548.61	2513.89
1402	918.38	6074.31	9166.67	9194.44	2449.31
1460	930.48	7187.50	15576.39	15652.78	-2946.53
1442	949.48	5072.92	1648.61	5079.17	-2232.64
1462	990.98	4087.50	1193.75	6394.44	-3174.31
1482	1050.98	3297.92	1097.22	2863.19	-2131.25
1502	1110.98	2479.17	684.03	2863.19	-1418.06
1522	1170.98	1974.31	809.72	1975.69	-946.53
1542	1230.98	1347.92	521.39	1350.00	-579.17
1562	1292.98	929.86	700.69	938.19	-308.54

Note 1: Meridonal, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)

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Table I.8. BES-FCC Primary Tank Stresses, Shell Middle, Gravity Plus Seismic Load

**AP Primary Tank, Best Estimate Soil, Horizontal and Vertical
Seismic, Fully Cracked Tank Concrete, 460 in. Waste Level at
1.83 SpG**

M&D Starting M&D Element No.	Path (in.)	Shell Mid-Plane			
		AP-460-BES-FCC Seismic Hoop Stress (lbs/in^2) Mid	AP-460-BES-FCC Seismic Meridional Stress (lbs/in^2) Mid	AP-460-BES-FCC Seismic Stress Intensity (lbs/in^2) Mid	AP-460-BES-FCC Seismic In-Plane Shear Stress (lbs/in^2) Mid
762	67.33	-9812.50	-10750.00	10750.00	-1147.92
782	105.04	-8847.22	-13923.61	13930.56	-1940.97
802	136.24	-7104.17	-12590.28	12597.22	-1890.28
822	181.83	-3754.86	-10479.17	10479.17	-1554.86
842	225.10	-4612.50	-8381.94	8680.56	-1163.19
862	273.66	-2011.11	-6186.81	6260.42	-903.47
882	323.27	-2672.22	-4445.14	6202.78	-1013.89
902	369.20	2097.22	-3044.44	4691.67	-1495.14
922	419.20	5170.14	-1575.00	6131.25	-2693.75
942	444.31	4815.97	1153.47	5930.56	-2737.50
962	458.66	-7666.67	1120.14	8791.67	-2731.25
982	473.08	-9006.94	1011.81	10013.89	-2854.17
1002	484.80	4197.92	973.61	6013.19	-2971.53
1022	502.48	5625.00	1070.14	6427.08	-2948.61
1042	526.48	9034.72	1213.19	9041.67	-2758.33
1062	550.48	11493.06	1345.14	11493.06	-2497.22
1082	574.60	13812.50	1466.67	13812.50	-2191.67
1102	598.28	16493.06	1568.75	16500.00	-1840.28
1122	621.38	18715.28	1651.39	18715.28	-1451.39
1142	644.48	21111.11	1710.42	21111.11	1072.92
1162	667.63	22847.22	1743.75	22847.22	-896.53
1182	690.78	22881.94	1535.42	22881.94	-715.28
1202	713.88	24159.72	1515.28	24159.72	809.72
1222	736.98	25986.11	1468.75	25986.11	1061.11
1242	760.13	25673.61	1398.61	25673.61	1424.31
1262	782.53	22569.44	956.94	22569.44	1353.47
1282	804.13	21916.67	874.31	21916.67	1669.44
1302	825.73	22944.44	-792.36	22944.44	1989.58
1322	847.33	24472.22	-700.69	24472.22	2319.44
1342	868.87	25659.72	-593.26	25666.67	2661.11
1362	892.10	18909.72	-401.46	18930.56	2502.78
1382	909.20	9166.67	-370.97	9520.83	2366.67
1402	918.38	6032.64	455.56	6497.22	2345.83
1460	930.48	4924.31	746.53	5038.89	-2390.28
1442	949.48	4726.39	756.94	4807.64	-2222.92
1462	990.98	4134.72	1234.72	6393.06	-3181.25
1482	1050.98	3238.89	950.69	2859.03	-2125.69
1502	1110.98	2525.00	779.86	2859.03	-1425.00
1522	1170.98	1921.53	663.06	1923.61	-940.28
1542	1230.98	1390.28	587.36	1391.67	-584.79
1562	1292.98	885.42	557.99	886.11	-303.47

Note 1: Meridonal, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)

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Table I.9. BES-FCC Primary Tank Stresses, Shell Bottom, Gravity Plus Seismic Load

**AP Primary Tank, Best Estimate Soil, Horizontal and Vertical
Seismic, Fully Cracked Tank Concrete, 460 in. Waste Level at
1.83 SpG**

M&D Starting M&D Element No.	Path (in.)	Shell Bottom Surface (outside - away from waste)			
		AP-460-BES-FCC Seismic Hoop Stress (lbs/in ²) Bot	AP-460-BES-FCC Seismic Meridional Stress (lbs/in ²) Bot	AP-460-BES-FCC Seismic Stress Intensity (lbs/in ²) Bot	AP-460-BES-FCC Seismic In-Plane Shear Stress (lbs/in ²) Bot
762	67.33	-10444.44	-11430.56	11430.56	-1067.36
782	105.04	-9284.72	-14368.06	14368.06	-1867.36
802	136.24	-7486.11	-12687.50	12687.50	-1816.67
822	181.83	-3688.89	-10277.78	10277.78	-1513.19
842	225.10	-5071.53	-8631.94	8631.94	-1148.61
862	273.66	-1871.53	-6234.72	6400.00	-899.31
882	323.27	-3005.56	-5159.03	5545.83	-1013.89
902	369.20	2045.83	-3018.75	4856.94	-1496.53
922	419.20	5413.19	-2303.47	5765.28	-2695.83
942	444.31	5428.47	8270.83	8270.83	-2785.42
962	458.66	-9263.89	-5260.42	9270.83	-2778.47
982	473.08	-11118.06	-5947.22	11125.00	-2813.89
1002	484.80	4102.08	2731.94	5839.58	-2902.78
1022	502.48	6057.64	3014.58	6247.92	-2914.58
1042	526.48	9027.78	1209.03	9034.72	-2752.08
1062	550.48	11520.83	1452.08	11520.83	-2491.67
1082	574.60	13729.17	-1339.58	13729.17	-2184.72
1102	598.28	16527.78	1790.28	16527.78	-1834.03
1122	621.38	18638.89	-1564.58	18645.83	-1445.83
1142	644.48	21076.39	1812.50	21076.39	-1062.50
1162	667.63	22965.28	2334.03	22965.28	-884.03
1182	690.78	22680.56	-1590.97	22680.56	-705.56
1202	713.88	24111.11	-1527.08	24111.11	-808.33
1222	736.98	26187.50	2019.44	26187.50	-1060.42
1242	760.13	26055.56	2418.06	26062.50	-1415.97
1262	782.53	22180.56	-1588.19	23041.67	-1341.67
1282	804.13	21805.56	-1063.89	21812.50	-1668.75
1302	825.73	22965.28	796.53	22972.22	-1992.36
1322	847.33	24256.94	-856.94	24472.22	-2325.00
1342	868.87	26569.44	4100.00	26569.44	-2644.44
1362	892.10	20375.00	4975.69	20375.00	-2417.36
1382	909.20	12958.33	15159.72	15166.67	-2220.14
1402	918.38	5990.97	-8263.89	8305.56	-2242.36
1460	930.48	-8006.94	-14625.00	14701.39	-2381.94
1442	949.48	4381.25	-1634.72	5572.92	-2213.89
1462	990.98	4181.94	1375.69	6393.06	-3187.50
1482	1050.98	3180.56	859.03	2865.28	-2119.44
1502	1110.98	2571.53	920.83	2865.28	-1431.25
1522	1170.98	1869.44	571.46	1894.44	-934.72
1542	1230.98	1440.97	732.64	1441.67	-590.42
1562	1292.98	845.83	491.60	847.22	-298.40

Note 1: Meridional, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)

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Table I.10. BES-FCC Primary Tank Stresses, Shell Top, Seismic Load Only

**AP Primary Tank, Best Estimate Soil, Horizontal and Vertical
Seismic, Fully Cracked Tank Concrete, 460 in. Waste Level at
1.83 SpG**

M&D Starting M&D Element No.	Path (in.)	Shell Top Surface (inside - waste side)			
		AP-460-BES-FCC Seismic Only Hoop Stress (lbs/in ²) Top	AP-460-BES-FCC Seismic Only Meridional Stress (lbs/in ²) Top	AP-460-BES-FCC Seismic Only Stress Intensity (lbs/in ²) Top	AP-460-BES-FCC Seismic Only In-Plane Shear Stress (lbs/in ²) Top
762	67.33	3352.78	3381.94	3381.94	1219.64
782	105.04	3484.72	3686.11	3678.47	2010.26
802	136.24	2675.00	3881.94	3881.94	1961.98
822	181.83	1639.79	2956.25	2950.00	1599.81
842	225.10	2656.25	3020.14	3429.86	1181.72
862	273.66	1612.50	1830.56	1829.86	909.85
882	323.27	2345.07	1827.08	3730.56	1015.04
902	369.20	1914.93	1737.36	2341.11	1495.04
922	419.20	3193.06	979.86	4177.78	2690.08
942	444.31	5153.47	3482.64	2695.83	2687.42
962	458.66	7381.94	5522.22	11313.19	2683.31
982	473.08	7774.31	6786.81	13689.58	2894.91
1002	484.80	4479.86	1423.40	4243.75	3040.32
1022	502.48	2760.28	900.00	3604.86	2982.06
1042	526.48	5182.43	1136.04	4358.33	2763.93
1062	550.48	6232.71	1293.01	5101.39	2502.80
1082	574.60	7299.31	1493.61	6050.00	2198.60
1102	598.28	8420.83	1448.75	7140.97	1847.19
1122	621.38	9265.97	1655.49	7902.08	1456.89
1142	644.48	9982.64	1639.51	8527.78	1083.41
1162	667.63	10235.42	1532.64	8957.64	908.94
1182	690.78	9881.25	1714.17	8937.50	724.91
1202	713.88	9862.50	1547.43	9097.22	810.40
1222	736.98	10004.17	1282.43	9000.00	1062.64
1242	760.13	9375.00	1129.03	8500.00	1432.77
1262	782.53	8062.50	1406.67	7868.06	1365.38
1282	804.13	7326.39	1016.39	7250.00	1670.95
1302	825.73	7250.00	821.03	7208.33	1987.65
1322	847.33	7569.44	943.26	7569.44	2313.16
1342	868.87	7236.11	1528.75	8187.50	2677.98
1362	892.10	4152.78	2436.18	5965.28	2589.26
1382	909.20	2141.67	6054.86	6076.39	2513.89
1402	918.38	3242.85	7231.94	3376.39	2449.30
1422	930.48	3643.75	5661.81	5500.00	2426.94
1442	949.48	4879.58	2092.43	4436.11	2283.08
1462	990.98	3614.79	1355.28	5526.39	3151.20
1482	1050.98	2899.31	706.53	2291.67	2131.65
1502	1110.98	2095.42	678.54	2291.67	1407.20
1522	1170.98	1642.36	532.29	1643.40	950.46
1542	1230.98	1012.43	465.85	879.72	571.41
1562	1292.98	644.50	420.69	654.10	309.06

Note 1: Meridonal, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)

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Table I.11. BES-FCC Primary Tank Stresses, Shell Middle, Seismic Load Only

**AP Primary Tank, Best Estimate Soil, Horizontal and Vertical
Seismic, Fully Cracked Tank Concrete, 460 in. Waste Level at
1.83 SpG**

M&D Starting M&D Element No.	Path (in.)	Shell Mid-Plane			
		AP-460-BES-FCC Seismic Only Hoop Stress (lbs/in ²) Mid	AP-460-BES-FCC Seismic Only Meridional Stress (lbs/in ²) Mid	AP-460-BES-FCC Seismic Only Stress Intensity (lbs/in ²) Mid	AP-460-BES-FCC Seismic Only In-Plane Shear Stress (lbs/in ²) Mid
762	67.33	3700.00	2993.75	2945.14	1143.22
782	105.04	3686.81	3919.44	3877.78	1936.58
802	136.24	2862.50	3566.67	3528.47	1888.40
822	181.83	1538.89	2990.28	2970.14	1557.22
842	225.10	3047.92	2383.33	2372.22	1166.35
862	273.66	1484.03	1739.58	1738.19	905.41
882	323.27	2699.86	1350.69	2824.31	1015.11
902	369.20	1921.25	1313.19	1907.64	1496.36
922	419.20	3453.47	1370.76	3574.31	2692.14
942	444.31	3852.78	1135.35	3664.58	2736.24
962	458.66	8477.08	1060.56	7978.47	2730.59
982	473.08	9553.68	951.58	9462.99	2853.88
1002	484.80	4127.78	916.72	4297.22	2971.50
1022	502.48	3142.57	1017.22	3320.83	2948.70
1042	526.48	5210.97	1166.64	4364.58	2758.39
1062	550.48	6251.81	1305.33	5148.61	2497.25
1082	574.60	7288.89	1433.70	5978.47	2191.67
1102	598.28	8478.47	1542.50	7071.53	1840.26
1122	621.38	9284.72	1631.67	7835.42	1451.34
1142	644.48	10012.50	1697.27	8505.56	1072.98
1162	667.63	10335.42	1737.19	8937.50	896.45
1182	690.78	9831.25	1535.83	8798.61	715.19
1202	713.88	9864.58	1522.26	8993.06	809.69
1222	736.98	10080.56	1482.35	9298.61	1061.25
1242	760.13	9506.94	1418.82	8930.56	1424.44
1262	782.53	7923.61	977.15	7583.33	1353.59
1282	804.13	7298.61	900.68	7062.50	1669.57
1302	825.73	7229.17	813.09	7138.89	1989.74
1322	847.33	7451.39	713.56	7416.67	2319.38
1342	868.87	7548.61	588.26	7493.06	2660.75
1362	892.10	4708.33	408.29	4673.61	2502.82
1382	909.20	2641.67	404.91	2818.75	2366.70
1402	918.38	4343.06	385.83	4476.39	2345.89
1422	930.48	4486.04	567.43	4468.06	2394.72
1442	949.48	4272.22	628.06	4353.47	2225.27
1462	990.98	3612.78	979.86	5689.58	3166.88
1482	1050.98	2801.81	582.74	2415.21	2118.67
1502	1110.98	2131.94	337.78	2415.21	1420.95
1522	1170.98	1558.40	273.89	1535.14	938.05
1542	1230.98	1047.22	223.13	1028.19	582.94
1562	1292.98	579.51	191.67	520.83	298.58

Note 1: Meridional, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)

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Table I.12. BES-FCC Primary Tank Stresses, Shell Bottom, Seismic Load Only

**AP Primary Tank, Best Estimate Soil, Horizontal and Vertical
Seismic, Fully Cracked Tank Concrete, 460 in. Waste Level at
1.83 SpG**

M&D Starting M&D Element No.	Path (in.)	Shell Bottom Surface (outside - away from waste)			
		AP-460-BES-FCC Seismic Only Hoop Stress (lbs/in ²) Bot	AP-460-BES-FCC Seismic Only Meridional Stress (lbs/in ²) Bot	AP-460-BES-FCC Seismic Only Stress Intensity (lbs/in ²) Bot	AP-460-BES-FCC Seismic Only In-Plane Shear Stress (lbs/in ²) Bot
762	67.33	4042.36	3132.64	3129.17	1067.49
782	105.04	3890.28	4319.44	4284.03	1862.20
802	136.24	3054.86	3406.25	3393.75	1815.51
822	181.83	1438.89	3069.44	3056.94	1514.63
842	225.10	3439.58	2552.78	2552.08	1151.66
862	273.66	1355.14	1829.17	1825.00	900.96
882	323.27	3054.65	2182.64	1938.89	1015.19
902	369.20	1927.57	1030.56	2106.94	1497.68
922	419.20	3713.19	2225.69	3193.75	2694.20
942	444.31	2609.03	5722.92	5268.06	2784.37
962	458.66	9649.03	3838.89	7461.81	2777.88
982	473.08	11334.86	4924.31	9883.33	2813.54
1002	484.80	3784.03	2258.96	4003.47	2902.67
1022	502.48	3524.86	2912.92	3127.78	2914.64
1042	526.48	5240.14	1208.32	4365.28	2752.15
1062	550.48	6270.21	1316.88	5148.61	2491.71
1082	574.60	7278.54	1373.68	6017.36	2184.74
1102	598.28	8543.06	1635.49	7106.25	1834.02
1122	621.38	9296.53	1607.82	7823.61	1445.80
1142	644.48	10049.31	1755.72	8511.11	1062.55
1162	667.63	10435.42	1941.39	8983.33	883.95
1182	690.78	9781.94	1357.92	8613.89	705.47
1202	713.88	9867.36	1496.39	8847.22	808.30
1222	736.98	10156.94	1682.01	9416.67	1060.34
1242	760.13	9631.94	1711.81	9125.00	1416.11
1262	782.53	7790.97	673.68	7423.61	1341.79
1282	804.13	7270.83	788.47	6722.22	1668.89
1302	825.73	7243.06	815.57	7173.61	1992.53
1322	847.33	7361.11	529.24	7152.78	2324.90
1342	868.87	7972.22	2602.08	7895.83	2644.60
1362	892.10	5263.89	2331.88	5263.89	2417.40
1382	909.20	3652.78	5541.67	5548.61	2220.21
1402	918.38	6404.10	6460.28	2893.06	2242.47
1422	930.48	5704.17	5372.22	5305.56	2371.74
1442	949.48	4430.56	2927.08	4278.47	2168.10
1462	990.98	3713.06	839.24	5853.75	3181.86
1482	1050.98	2767.71	948.82	2515.56	2104.99
1502	1110.98	2219.31	608.06	2515.56	1434.00
1522	1170.98	1519.86	512.26	1392.29	926.33
1542	1230.98	1130.83	476.81	1131.11	594.46
1562	1292.98	527.71	403.05	396.53	288.10

Note 1: Meridonal, Hoop, and Shear Stresses are Reversed in Highlighted Sections (Floor)

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Table I.13. BES-FCC Anchor Bolt Forces, Gravity Load Only

AP Primary Tank, Best Estimate Soil, Gravity Only, Fully Cracked Tank Concrete, 460 in. Waste Level at 1.83 SpG Gravity Only											
ANSYS MAXIMUMS BY RADIUS											
M&D J-Bolt Radius No.	Mean J-Bolt Radius	Radius of J-Bolts Included		Average Bolts per Element	Min Axial Force (kip) BES-FCC Gravity Only	Max Axial Force (kip) BES-FCC Gravity Only	Shear Force1 (kip) BES- FCC Gravity	Maximum Shear Force1 Model Angle	Shear Force2 (kip) BES- FCC Gravity Only	Maximum Shear Force2 Model Angle	Total Shear (kip) BES FCC Gravity
		min	max								
Radius 2	44.72	22.36	67.29	0.55	-0.105	-0.089	0.005	45	0.739	90	0.739
Radius 3	89.87	67.29	104.93	0.89	-0.081	-0.073	0.015	63	0.834	90	0.834
Radius 4	120.00	104.93	135.98	1.03	-0.018	-0.014	0.023	63	0.458	0	0.458
Radius 5	151.97	135.98	181.01	1.97	-0.051	-0.048	0.024	63	0.248	9	0.248
Radius 6	210.05	181.01	223.79	2.41	-0.044	-0.043	0.009	72	1.299	90	1.299
Radius 7	237.53	223.79	270.98	3.30	0.042	0.043	0.006	144	1.852	90	1.852
Radius 8	304.43	270.98	318.74	4.04	-0.104	-0.104	0.003	144	2.133	45	2.133
Radius 9	333.05	318.74	361.64	4.37	0.056	0.057	0.001	126	2.256	36	2.256
Radius 10	390.22	361.64	406.24	5.36	-0.223	-0.219	0.001	63	2.434	0	2.434
Radius 11	422.26	406.24	431.63	3.60	0.658	0.664	0.001	126	2.659	0	2.659

M&D J-Bolt Radius No.	Mean J-Bolt Radius	Radius of J-Bolts Included		Average Bolts per Element	Bolt Angle (Rad)	Shear Stiffness (kip/ft)	Axial Stiffness (kip/ft)	Shear Disp BES-FCC- Gravity Only	Axial Min Disp BES-FCC- Gravity Only	Axial Max Disp BES-FCC- Gravity Only
		min	max							
Radius 2	44.72	22.36	67.29	0.55	0.0351	780	780	0.01137	-0.00161	-0.00136
Radius 3	89.87	67.29	104.93	0.89	0.0715	780	780	0.01283	-0.00125	-0.00113
Radius 4	120.00	104.93	135.98	1.03	0.0968	780	780	0.00705	-0.00028	-0.00021
Radius 5	151.97	135.98	181.01	1.97	0.1252	780	780	0.00382	-0.00079	-0.00074
Radius 6	210.05	181.01	223.79	2.41	0.1825	780	780	0.01999	-0.00068	-0.00066
Radius 7	237.53	223.79	270.98	3.30	0.2136	780	780	0.02850	0.00065	0.00067
Radius 8	304.43	270.98	318.74	4.04	0.3076	780	780	0.03282	-0.00161	-0.00160
Radius 9	333.05	318.74	361.64	4.37	0.3613	780	780	0.03471	0.00086	0.00088
Radius 10	390.22	361.64	406.24	5.36	0.5235	780	780	0.03745	-0.00344	-0.00336
Radius 11	460.26	406.24	431.63	3.60	0.6938	780	780	0.04091	0.01013	0.01022

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Table I.14. BES-FCC Anchor Bolt Forces, Gravity Plus Seismic Loads

AP Primary Tank, Best Estimate Soil, Horizontal and Vertical Seismic Input, Fully Cracked Tank Concrete, 460 in. Waste Level at 1.83 SpG Seismic											
ANSYS MAXIMUMS BY RADIUS											
M&D J-Bolt Radius No.	Mean J-Bolt Radius	Radius of J-Bolts Included		Average Bolts per Element	Min Axial Force (kip) BES-FCC	Max Axial Force (kip) BES-FCC	Shear Force1 (kip) BES-FCC	Maximum Shear Force1 Model Angle	Shear Force2 (kip) BES-FCC	Maximum Shear Force2 Model Angle	Total Shear (kip) BES-FCC
		min	max								
Radius 2	44.72	22.36	67.29	0.55	-0.307	-0.027	1.302	90	2.184	180	2.184
Radius 3	89.87	67.29	104.93	0.89	-0.265	-0.015	0.907	90	2.105	0	2.141
Radius 4	120.00	104.93	135.98	1.03	-0.317	0.019	0.708	99	1.810	180	1.810
Radius 5	151.97	135.98	181.01	1.97	-0.373	0.004	0.796	99	1.623	0	1.623
Radius 6	210.05	181.01	223.79	2.41	-0.127	-0.012	1.200	90	2.238	0	2.238
Radius 7	237.53	223.79	270.98	3.30	-0.028	0.088	1.510	90	2.827	0	2.833
Radius 8	304.43	270.98	318.74	4.04	-0.173	0.154	2.292	90	3.179	0	3.477
Radius 9	333.05	318.74	361.64	4.37	-0.102	0.341	2.790	90	3.451	0	3.948
Radius 10	390.22	361.64	406.24	5.36	-0.567	0.513	4.047	90	3.786	0	5.014
Radius 11	422.26	406.24	431.63	3.60	-0.059	1.863	5.081	90	4.418	0	6.064

M&D J-Bolt Radius No.	Mean J-Bolt Radius	Radius of J-Bolts Included		Average Bolts per Element	Bolt Angle (Rad)	Shear Stiffness (kip/ft)	Axial Stiffness (kip/ft)	Shear Disp BES-FCC-Seismic	Axial Min Disp BES-FCC-Seismic	Axial Max Disp BES-FCC-Seismic
		min	max							
Radius 2	44.72	22.36	67.29	0.55	0.0351	780	780	0.03360	-0.00472	-0.00042
Radius 3	89.87	67.29	104.93	0.89	0.0715	780	780	0.03293	-0.00407	-0.00023
Radius 4	120.00	104.93	135.98	1.03	0.0968	780	780	0.02784	-0.00488	0.00029
Radius 5	151.97	135.98	181.01	1.97	0.1252	780	780	0.02498	-0.00575	0.00007
Radius 6	210.05	181.01	223.79	2.41	0.1825	780	780	0.03442	-0.00195	-0.00019
Radius 7	237.53	223.79	270.98	3.30	0.2136	780	780	0.04358	-0.00044	0.00135
Radius 8	304.43	270.98	318.74	4.04	0.3076	780	780	0.05349	-0.00266	0.00237
Radius 9	333.05	318.74	361.64	4.37	0.3613	780	780	0.06073	-0.00157	0.00525
Radius 10	390.22	361.64	406.24	5.36	0.5235	780	780	0.07714	-0.00873	0.00789
Radius 11	460.26	406.24	431.63	3.60	0.6938	780	780	0.09329	-0.00090	0.02866

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Table I.15. BES-FCC Anchor Bolt Forces, Seismic Load Only

AP Primary Tank, Best Estimate Soil, Horizontal and Vertical Seismic Input, Fully Cracked Tank Concrete, 460 in. Waste Level at 1.83 SpG Seismic Only											
ANSYS MAXIMUMS BY RADIUS											
M&D J-Bolt Radius No.	Mean J-Bolt Radius	Radius of J-Bolts Included		Average Bolts per Element	Min Axial Force (kip) BES-FCC-Seismic Only	Max Axial Force (kip) BES-FCC-Seismic Only	Shear Force1 (kip) BES-FCC-Seismic Only	Maximum Shear Force1 Model Angle	Shear Force2 (kip) BES-FCC-Seismic Only	Maximum Shear Force2 Model Angle	Total Shear (kip) BES-FCC-Seismic Only
		min	max								
Radius 2	44.72	22.36	67.29	0.55	-0.202	0.061	1.298	108	1.445	0	1.942
Radius 3	89.87	67.29	104.93	0.89	-0.184	0.058	0.892	108	1.271	0	1.552
Radius 4	120.00	104.93	135.98	1.03	-0.299	0.032	0.685	108	1.352	0	1.515
Radius 5	151.97	135.98	181.01	1.97	-0.322	0.052	0.772	108	1.375	0	1.577
Radius 6	210.05	181.01	223.79	2.41	-0.082	0.030	1.191	108	0.938	144	1.516
Radius 7	237.53	223.79	270.98	3.30	-0.070	0.045	1.504	90	0.975	135	1.792
Radius 8	304.43	270.98	318.74	4.04	-0.068	0.258	2.289	117	1.045	117	2.516
Radius 9	333.05	318.74	361.64	4.37	-0.158	0.284	2.789	117	1.195	117	3.035
Radius 10	390.22	361.64	406.24	5.36	-0.344	0.731	4.046	108	1.352	0	4.266
Radius 11	460.26	406.24	431.63	3.60	-0.717	1.199	5.080	108	1.759	0	5.376

M&D J-Bolt Radius No.	Mean J-Bolt Radius	Radius of J-Bolts Included		Average Bolts per Element	Bolt Angle (Rad)	Shear Stiffness (kip/ft)	Axial Stiffness (kip/ft)	Shear Disp BES-FCC-Seismic Only	Axial Min Disp BES-FCC-Seismic Only	Axial Max Disp BES-FCC-Seismic Only
		min	max							
Radius 2	44.72	22.36	67.29	0.55	0.0351	780	780	0.02988	-0.00310	0.00095
Radius 3	89.87	67.29	104.93	0.89	0.0715	780	780	0.02388	-0.00283	0.00090
Radius 4	120.00	104.93	135.98	1.03	0.0968	780	780	0.02331	-0.00460	0.00050
Radius 5	151.97	135.98	181.01	1.97	0.1252	780	780	0.02426	-0.00496	0.00080
Radius 6	210.05	181.01	223.79	2.41	0.1825	780	780	0.02332	-0.00127	0.00047
Radius 7	237.53	223.79	270.98	3.30	0.2136	780	780	0.02758	-0.00108	0.00069
Radius 8	304.43	270.98	318.74	4.04	0.3076	780	780	0.03871	-0.00105	0.00397
Radius 9	333.05	318.74	361.64	4.37	0.3613	780	780	0.04669	-0.00243	0.00437
Radius 10	390.22	361.64	406.24	5.36	0.5235	780	780	0.06563	-0.00529	0.01125
Radius 11	460.26	406.24	431.63	3.60	0.6938	780	780	0.08271	-0.01103	0.01844

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Table I.16. BES-FCC Concrete Backed Steel Strain, Shell Top, Gravity Load Only

**AP Backed Steel, Best Estimate Soil, Gravity Only, Fully Cracked Tank Concrete, 460 In Waste
Level at 1.83SpG**

M&D Starting M&D Element No.	Path (in)	Shell Top Surface (inside - towards waste) Gravity					
		AP-460-BES-FCC EPEL P1 Strain (in/in)	AP-460-BES-FCC EPEL P1 Strain (in/in)	AP-460-BES-FCC EPEL P2 (in/in)	AP-460-BES-FCC EPEL P2 Strain (in/in)	AP-460-BES-FCC EPEL P3 Strain (in/in)	AP-460-BES-FCC EPEL P3 Strain (in/in)
		Gravity Top Min	Gravity Top Max	Gravity Top Min	Gravity Top Max	Gravity Top Min	Gravity Top Max
762	67.33	1.45E-04	1.45E-04	-1.48E-04	-1.48E-04	-1.86E-04	-1.85E-04
782	105.04	1.67E-04	1.67E-04	-9.13E-05	-9.12E-05	-2.97E-04	-2.96E-04
802	136.24	1.40E-04	1.40E-04	-5.50E-05	-5.50E-05	-2.68E-04	-2.68E-04
822	161.71	1.08E-04	1.08E-04	3.43E-06	3.44E-06	-2.54E-04	-2.54E-04
842	225.10	8.01E-05	8.02E-05	4.74E-06	4.76E-06	-1.90E-04	-1.90E-04
862	273.66	5.84E-05	5.85E-05	2.50E-05	2.50E-05	-1.61E-04	-1.61E-04
882	323.27	3.73E-05	3.73E-05	1.75E-05	1.75E-05	-1.04E-04	-1.04E-04
902	369.20	4.40E-05	4.41E-05	1.69E-05	1.69E-05	-8.30E-05	-8.29E-05
922	419.20	6.80E-05	6.81E-05	-9.46E-06	-9.45E-06	-4.57E-05	-4.56E-05
237	463.02						
257	510.03						
277	544.44						
297	560.53						
317	631.08						
337	660.34						
357	727.44						
377	772.93						
397	831.34						
417	894.09						
2132	925.08	2.93E-05	2.93E-05	-2.84E-05	-2.84E-05	-3.37E-05	-3.37E-05
2122	935.67	5.42E-05	5.42E-05	-1.68E-05	-1.67E-05	-2.23E-05	-2.23E-05
2112	944.86	9.37E-05	9.37E-05	-3.39E-06	-3.39E-06	-2.12E-04	-2.12E-04
477	968.95						
497	1002.45						
517	1042.45						
537	1108.60						
557	1178.35						
577	1227.20						
597	1271.50						
617	1313.65						
637	1360.60						

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Table I.17. BES-FCC Concrete Backed Steel Strain, Shell Middle, Gravity Load Only

**AP Backed Steel, Best Estimate Soil, Gravity Only, Fully Cracked Tank Concrete, 460 In Waste
Level at 1.83SpG**

M&D Starting M&D Element No.	Path (in)	Shell Mid-Plane					
		AP-460-BES-FCC EPEL P1 Strain (in/in)	AP-460-BES-FCC EPEL P1 Strain (in/in)	AP-460-BES-FCC EPEL P2 Strain (in/in)	AP-460-BES-FCC EPEL P2 Strain (in/in)	AP-460-BES-FCC EPEL P3 Strain (in/in)	AP-460-BES-FCC EPEL P3 Strain (in/in)
		Gravity Mid Min	Gravity Mid Max	Gravity Mid Min	Gravity Mid Max	Gravity Mid Min	Gravity Mid Max
762	67.33	1.54E-04	1.54E-04	-4.34E-05	-4.33E-05	-4.59E-05	-4.59E-05
782	105.04	1.67E-04	1.67E-04	-3.30E-05	-3.30E-05	-6.59E-05	-6.58E-05
802	136.24	1.43E-04	1.43E-04	-3.97E-05	-3.97E-05	-5.87E-05	-5.87E-05
822	181.71	1.05E-04	1.05E-04	1.36E-06	1.37E-06	-5.57E-05	-5.56E-05
842	225.10	8.40E-05	8.41E-05	3.93E-06	3.95E-06	-4.40E-05	-4.40E-05
862	273.66	5.67E-05	5.67E-05	2.45E-05	2.45E-05	-4.10E-05	-4.10E-05
882	323.27	4.04E-05	4.04E-05	1.72E-05	1.73E-05	-2.90E-05	-2.89E-05
902	369.20	4.37E-05	4.37E-05	1.64E-05	1.64E-05	-2.68E-05	-2.68E-05
922	419.20	6.78E-05	6.79E-05	-6.27E-06	-6.26E-06	-1.97E-05	-1.97E-05
237	463.02	5.70E-05	5.71E-05	3.43E-05	3.44E-05	-7.06E-05	-7.06E-05
257	510.03	8.28E-05	8.29E-05	5.91E-05	5.92E-05	-3.34E-04	-3.34E-04
277	544.44	1.16E-04	1.16E-04	7.39E-05	7.41E-05	-4.83E-04	-4.82E-04
297	580.53	8.16E-05	8.16E-05	-1.09E-05	-1.08E-05	-2.47E-04	-2.46E-04
317	631.08	9.16E-05	9.16E-05	-8.64E-05	-8.64E-05	-2.60E-04	-2.60E-04
337	680.34	1.18E-04	1.18E-04	-1.12E-04	-1.12E-04	-3.23E-04	-3.23E-04
357	727.44	1.21E-04	1.21E-04	-1.21E-04	-1.21E-04	-3.48E-04	-3.48E-04
377	772.93	1.38E-04	1.38E-04	-1.28E-04	-1.28E-04	-3.82E-04	-3.82E-04
397	831.34	1.28E-04	1.28E-04	-1.13E-04	-1.13E-04	-3.98E-04	-3.98E-04
417	894.09	5.95E-05	5.96E-05	-6.40E-05	-6.40E-05	-1.64E-04	-1.64E-04
2132	925.08	2.92E-05	2.92E-05	-1.68E-05	-1.68E-05	-3.37E-05	-3.37E-05
2122	935.67	3.01E-05	3.01E-05	-2.20E-05	-2.20E-05	-3.08E-05	-3.08E-05
2112	944.86	2.19E-05	2.20E-05	-3.62E-06	-3.61E-06	-3.56E-05	-3.56E-05
477	968.95	6.75E-05	6.75E-05	7.27E-06	7.29E-06	-2.61E-04	-2.61E-04
497	1002.45	2.39E-04	2.40E-04	1.64E-05	1.64E-05	-7.43E-05	-7.42E-05
517	1042.45	1.47E-05	1.47E-05	9.76E-06	9.77E-06	-5.55E-06	-5.54E-06
537	1108.60	9.24E-06	9.25E-06	9.30E-07	9.37E-07	-2.20E-06	-2.19E-06
557	1178.35	1.04E-05	1.05E-05	5.65E-06	5.66E-06	-3.48E-06	-3.47E-06
577	1227.20	1.15E-05	1.15E-05	1.12E-05	1.12E-05	-4.93E-06	-4.92E-06
597	1271.50	1.25E-05	1.25E-05	1.10E-05	1.10E-05	-5.09E-06	-5.08E-06
617	1313.65	2.02E-05	2.02E-05	8.21E-06	8.22E-06	-6.16E-06	-6.15E-06
637	1360.60	6.78E-06	6.79E-06	3.99E-06	4.00E-06	-2.21E-06	-2.21E-06

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Table I.18. BES-FCC Concrete Backed Steel Strain, Shell Bottom, Gravity Load Only

AP Backed Steel, Best Estimate Soil, Gravity Only, Fully Cracked Tank Concrete, 460 In Waste Level at 1.83SpG

M&D Starting M&D Element No.	Path (in)	Shell Bottom Surface (outside - away from waste) Gravity					
		AP-460-BES-FCC EPEL P1 Strain (in/in) Gravity Bot Min	AP-460-BES-FCC EPEL P1 Strain (in/in) Gravity Bot Max	AP-460-BES-FCC EPEL P2 (in/in) Gravity Bot Min	AP-460-BES-FCC EPEL P2 Strain (in/in) Gravity Bot Max	AP-460-BES-FCC EPEL P3 Strain (in/in) Gravity Bot Min	AP-460-BES-FCC EPEL P3 Strain (in/in) Gravity Bot Max
762	67.33	1.64E-04	1.64E-04	-4.67E-05	-4.67E-05	-5.21E-05	-5.21E-05
782	105.04	1.68E-04	1.68E-04	-3.36E-05	-3.36E-05	-5.59E-05	-5.58E-05
802	136.24	1.47E-04	1.47E-04	-4.01E-05	-4.01E-05	-6.84E-05	-6.83E-05
822	181.71	1.01E-04	1.01E-04	-6.38E-07	-6.27E-07	-4.94E-05	-4.93E-05
842	225.10	8.81E-05	8.82E-05	3.12E-06	3.15E-06	-5.63E-05	-5.63E-05
862	273.66	5.49E-05	5.49E-05	2.40E-05	2.40E-05	-3.68E-05	-3.67E-05
882	323.27	4.35E-05	4.36E-05	1.70E-05	1.70E-05	-3.74E-05	-3.74E-05
902	369.20	4.33E-05	4.34E-05	1.59E-05	1.59E-05	-2.47E-05	-2.46E-05
922	419.20	6.76E-05	6.77E-05	-5.18E-06	-5.17E-06	-2.21E-05	-2.20E-05
237	463.02						
257	510.03						
277	544.44						
297	580.53						
317	631.08						
337	680.34						
357	727.44						
377	772.93						
397	831.34						
417	894.09						
2132	925.08	2.79E-05	2.79E-05	-4.91E-06	-4.91E-06	-3.37E-05	-3.37E-05
2122	935.67	6.41E-05	6.41E-05	-2.17E-05	-2.17E-05	-9.95E-05	-9.95E-05
2112	944.86	1.54E-04	1.54E-04	-3.84E-06	-3.84E-06	-6.32E-05	-6.31E-05
477	968.95						
497	1002.45						
517	1042.45						
537	1108.60						
557	1178.35						
577	1227.20						
597	1271.50						
617	1313.65						
637	1360.60						

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Table I.19. BES-FCC Concrete Backed Steel Strain, Shell Top, Gravity Plus Seismic Load

**AP Backed Steel, Best Estimate Soil, Seismic Only, Fully Cracked Tank Concrete, 460 In Waste
Level at 1.83SpG**

M&D Starting M&D Element No.	Path (in)	Shell Top Surface (inside - towards waste) Seismic					
		AP-460-BES-FCC EPEL P1 Strain (in/in)	AP-460-BES-FCC EPEL P1 Strain (in/in)	AP-460-BES-FCC EPEL P2 (in/in)	AP-460-BES-FCC EPEL P2 Strain (in/in)	AP-460-BES-FCC EPEL P3 Strain (in/in)	AP-460-BES-FCC EPEL P3 Strain (in/in)
		Seismic Top Min	Seismic Top Max	Seismic Top Min	Seismic Top Max	Seismic Top Min	Seismic Top Max
762	67.33	9.44E-05	1.98E-04	-1.79E-04	-5.00E-05	-2.72E-04	-1.09E-04
782	105.04	1.16E-04	2.23E-04	-1.22E-04	-3.62E-07	-3.83E-04	-1.89E-04
802	136.24	9.56E-05	1.88E-04	-9.48E-05	3.55E-05	-3.89E-04	-1.46E-04
822	181.71	7.96E-05	1.39E-04	-3.88E-05	7.10E-05	-3.34E-04	-1.56E-04
842	225.10	5.91E-05	1.20E-04	-5.57E-05	9.11E-05	-2.84E-04	-7.70E-05
862	273.66	4.61E-05	8.22E-05	-6.33E-06	6.09E-05	-2.00E-04	-9.79E-05
882	323.27	2.94E-05	1.17E-04	-1.58E-05	4.47E-05	-1.54E-04	-4.05E-05
902	369.20	1.77E-05	9.83E-05	1.19E-05	3.37E-05	-1.07E-04	-1.60E-05
922	419.20	4.05E-05	1.88E-04	-1.71E-05	8.04E-06	-9.05E-05	-4.41E-06
237	463.02						
257	510.03						
277	544.44						
297	580.53						
317	631.08						
337	680.34						
357	727.44						
377	772.93						
397	831.34						
417	894.09						
2132	925.08	2.57E-05	3.66E-05	-3.24E-05	1.38E-05	-5.21E-05	-2.75E-05
2122	935.67	4.16E-05	9.45E-05	-1.85E-05	1.09E-05	-3.87E-05	-1.51E-05
2112	944.86	8.11E-05	1.47E-04	-7.06E-06	4.22E-05	-2.58E-04	-4.86E-05
477	968.95						
497	1002.45						
517	1042.45						
537	1108.60						
557	1178.35						
577	1227.20						
597	1271.50						
617	1313.65						
637	1360.60						

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Table I.20. BES-FCC Concrete Backed Steel Strain, Shell Middle, Gravity Plus Seismic Load

**AP Backed Steel, Best Estimate Soil, Seismic Only, Fully Cracked Tank Concrete, 460 In Waste
Level at 1.83SpG**

M&D Starting M&D Element No.	Path (in)	Shell Mid-Plane					
		AP-460-BES-FCC EPEL P1 Strain (in/in)	AP-460-BES-FCC EPEL P1 Strain (in/in)	AP-460-BES-FCC EPEL P2 (in/in)	AP-460-BES-FCC EPEL P2 Strain (in/in)	AP-460-BES-FCC EPEL P3 Strain (in/in)	AP-460-BES-FCC EPEL P3 Strain (in/in)
		Seismic Mid Min	Seismic Mid Max	Seismic Mid Min	Seismic Mid Max	Seismic Mid Min	Seismic Mid Max
762	67.33	1.02E-04	2.11E-04	-1.93E-04	-5.38E-05	-2.74E-04	-1.24E-04
782	105.04	1.12E-04	2.28E-04	-1.27E-04	-1.16E-06	-3.95E-04	-1.81E-04
802	136.24	1.02E-04	1.89E-04	-9.76E-05	3.09E-05	-3.76E-04	-1.65E-04
822	181.71	7.60E-05	1.36E-04	-4.03E-05	6.84E-05	-3.30E-04	-1.45E-04
842	225.10	6.61E-05	1.19E-04	-5.64E-05	8.45E-05	-2.71E-04	-1.09E-04
862	273.66	4.36E-05	8.19E-05	-6.89E-06	6.13E-05	-2.01E-04	-9.10E-05
882	323.27	3.21E-05	1.17E-04	-1.64E-05	4.44E-05	-1.48E-04	-5.50E-05
902	369.20	1.74E-05	9.80E-05	1.30E-05	2.79E-05	-1.08E-04	-2.38E-05
922	419.20	4.03E-05	1.88E-04	-2.09E-05	1.52E-05	-8.21E-05	-5.19E-06
237	463.02	3.19E-05	1.01E-04	2.74E-05	4.11E-05	-2.42E-04	-1.41E-04
257	510.03	5.32E-05	1.09E-04	4.06E-05	6.97E-05	-3.87E-04	-2.57E-04
277	544.44	8.74E-05	1.16E-04	2.68E-05	8.86E-05	-5.54E-04	-4.03E-04
297	580.53	5.34E-05	7.07E-05	-3.60E-05	4.00E-05	-2.89E-04	-2.06E-04
317	631.08	6.86E-05	8.94E-05	-1.02E-04	9.41E-06	-3.06E-04	-2.15E-04
337	680.34	8.51E-05	1.09E-04	-1.26E-04	-1.80E-05	-3.75E-04	-2.73E-04
357	727.44	9.12E-05	1.17E-04	-1.35E-04	-2.60E-05	-4.01E-04	-2.87E-04
377	772.93	9.86E-05	1.28E-04	-1.40E-04	-1.19E-05	-4.40E-04	-3.02E-04
397	831.34	9.82E-05	1.28E-04	-1.23E-04	4.95E-06	-4.52E-04	-2.96E-04
417	894.09	4.46E-05	6.33E-05	-6.92E-05	1.36E-05	-1.92E-04	-1.14E-04
2132	925.08	2.24E-05	3.34E-05	-2.48E-05	1.12E-05	-4.88E-05	-2.21E-05
2122	935.67	2.37E-05	3.43E-05	-2.62E-05	1.11E-05	-5.63E-05	-2.41E-05
2112	944.86	1.85E-05	4.21E-05	-6.55E-06	2.31E-05	-5.57E-05	-2.06E-05
477	968.95	5.86E-05	7.69E-05	-9.78E-08	4.36E-05	-2.96E-04	-1.90E-04
497	1002.45	2.06E-04	2.85E-04	4.07E-06	4.82E-05	-8.47E-05	-5.53E-05
517	1042.45	7.44E-06	4.57E-05	-5.72E-06	3.50E-05	-2.73E-05	-9.66E-07
537	1108.60	3.11E-06	3.55E-05	-4.13E-06	2.62E-05	-2.53E-05	-3.70E-07
557	1178.35	4.05E-06	3.39E-05	-4.06E-06	2.55E-05	-1.70E-05	-2.54E-07
577	1227.20	5.07E-06	3.31E-05	-4.16E-06	3.28E-05	-1.12E-05	-3.20E-07
597	1271.50	5.48E-06	3.04E-05	-3.04E-06	2.93E-05	-8.84E-06	-3.05E-07
617	1313.65	6.31E-06	4.59E-05	-2.61E-06	2.17E-05	-1.08E-05	-1.13E-06
637	1360.60	2.93E-06	1.18E-05	-1.13E-07	1.08E-05	-4.17E-06	-3.64E-07

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Table I.21. BES-FCC Concrete Backed Steel Strain, Shell Bottom, Gravity Plus Seismic Load

**AP Backed Steel, Best Estimate Soil, Seismic Only, Fully Cracked Tank Concrete, 460 In Waste
Level at 1.83SpG**

M&D Starting M&D Element No.	Path (in)	Shell Bottom Surface (outside - away from waste) Seismic					
		AP-460-BES-FCC EPEL P1 Strain (in/in) Seismic Bot Min	AP-460-BES-FCC EPEL P1 Strain (in/in) Seismic Bot Max	AP-460-BES-FCC EPEL P2 (in/in) Seismic Bot Min	AP-460-BES-FCC EPEL P2 Strain (in/in) Seismic Bot Max	AP-460-BES-FCC EPEL P3 Strain (in/in) Seismic Bot Min	AP-460-BES-FCC EPEL P3 Strain (in/in) Seismic Bot Max
762	67.33	1.11E-04	2.25E-04	-2.10E-04	-5.76E-05	-2.75E-04	-1.34E-04
782	105.04	1.07E-04	2.43E-04	-1.33E-04	-1.95E-06	-4.04E-04	-1.65E-04
802	136.24	1.07E-04	1.95E-04	-1.01E-04	2.63E-05	-3.61E-04	-1.76E-04
822	181.71	7.15E-05	1.34E-04	-4.16E-05	6.58E-05	-3.25E-04	-1.32E-04
842	225.10	7.06E-05	1.24E-04	-5.70E-05	7.69E-05	-2.61E-04	-1.30E-04
862	273.66	4.11E-05	8.16E-05	-7.45E-06	6.39E-05	-2.02E-04	-8.10E-05
882	323.27	3.13E-05	1.17E-04	-1.69E-05	4.73E-05	-1.44E-04	-5.57E-05
902	369.20	1.71E-05	9.76E-05	1.25E-05	2.60E-05	-1.11E-04	-3.05E-05
922	419.20	4.02E-05	1.88E-04	-2.61E-05	2.50E-05	-8.82E-05	-6.37E-06
237	463.02						
257	510.03						
277	544.44						
297	580.53						
317	631.08						
337	680.34						
357	727.44						
377	772.93						
397	831.34						
417	894.09						
2132	925.08	2.12E-05	3.52E-05	-1.71E-05	1.07E-05	-4.62E-05	-1.55E-05
2122	935.67	4.53E-05	7.69E-05	-2.66E-05	1.16E-05	-1.16E-04	-4.05E-05
2112	944.86	1.31E-04	2.47E-04	-1.05E-05	4.18E-05	-7.68E-05	-2.71E-05
477	968.95						
497	1002.45						
517	1042.45						
537	1108.60						
557	1178.35						
577	1227.20						
597	1271.50						
617	1313.65						
637	1360.60						

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Table I.22. BES-FCC Concrete Backed Steel Strain, Shell Top, Seismic Load Only

**AP Backed Steel, Best Estimate Soil, Seismic Only, Fully Cracked Tank Concrete, 460 In
Waste Level at 1.83SpG**

M&D Starting M&D Element No.	Path (in)	Shell Top Surface (inside - towards waste) Seismic					
		AP-460-BES-FCC EPEL P1 Strain (in/in) Seismic Only Top Min	AP-460-BES-FCC EPEL P1 Strain (in/in) Seismic Only Top Max	AP-460-BES-FCC EPEL P2 Strain (in/in) Seismic Only Top Min	AP-460-BES-FCC EPEL P2 Strain (in/in) Seismic Only Top Max	AP-460-BES-FCC EPEL P3 Strain (in/in) Seismic Only Top Min	AP-460-BES-FCC EPEL P3 Strain (in/in) Seismic Only Top Max
762	67.33	-5.02E-05	5.32E-05	-3.08E-05	9.77E-05	-8.63E-05	7.69E-05
782	105.04	-5.08E-05	5.61E-05	-3.08E-05	9.09E-05	-8.64E-05	1.08E-04
802	136.24	-4.39E-05	4.87E-05	-3.98E-05	9.04E-05	-1.21E-04	1.21E-04
822	181.71	-2.83E-05	3.09E-05	-4.22E-05	6.75E-05	-7.94E-05	9.79E-05
842	225.10	-2.11E-05	4.02E-05	-6.04E-05	8.63E-05	-9.39E-05	1.13E-04
862	273.66	-1.23E-05	2.37E-05	-3.13E-05	3.59E-05	-3.94E-05	6.26E-05
882	323.27	-7.84E-06	7.98E-05	-3.32E-05	2.72E-05	-5.00E-05	6.33E-05
902	369.20	-2.63E-05	5.42E-05	-4.96E-06	1.68E-05	-2.43E-05	6.69E-05
922	419.20	-2.75E-05	1.20E-04	-7.63E-06	1.75E-05	-4.48E-05	4.12E-05
237	463.02						
257	510.03						
277	544.44						
297	580.53						
317	631.08						
337	680.34						
357	727.44						
377	772.93						
397	831.34						
417	894.09						
2062	925.08	-3.55E-06	7.34E-06	-4.01E-06	4.22E-05	-1.84E-05	6.15E-06
2052	935.67	-1.27E-05	4.03E-05	-1.73E-06	2.76E-05	-1.64E-05	7.22E-06
2042	944.86	-1.26E-05	5.29E-05	-3.67E-06	4.56E-05	-4.63E-05	1.63E-04
477	968.95						
497	1002.45						
517	1042.45						
537	1108.60						
557	1178.35						
577	1227.20						
597	1271.50						
617	1313.65						
637	1360.60						

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Table I.23. BES-FCC Concrete Backed Steel Strain, Shell Middle, Seismic Load Only

**AP Backed Steel, Best Estimate Soil, Seismic Only, Fully Cracked Tank Concrete, 460 In
Waste Level at 1.83SpG**

M&D Starting M&D Element No.	Path (in)	Shell Mid-Plane					
		AP-460-BES- FCC EPEL P1 Strain (in/in) Seismic Only	AP-460-BES-FCC EPEL P1 Strain (in/in) Seismic Only	AP-460-BES-FCC EPEL P2 Strain (in/in) Seismic Only	AP-460-BES-FCC EPEL P2 Strain (in/in) Seismic Only	AP-460-BES-FCC EPEL P3 Strain (in/in) Seismic Only	AP-460-BES-FCC EPEL P3 Strain (in/in) Seismic Only
		Mid Min	Mid Max	Mid Min	Mid Max	Mid Min	Mid Max
762	67.33	-5.15E-05	5.67E-05	-1.50E-04	-1.04E-05	-2.28E-04	-7.84E-05
782	105.04	-5.50E-05	6.08E-05	-9.44E-05	3.18E-05	-3.29E-04	-1.15E-04
802	136.24	-4.15E-05	4.57E-05	-5.79E-05	7.05E-05	-3.18E-04	-1.06E-04
822	181.71	-2.86E-05	3.14E-05	-4.17E-05	6.70E-05	-2.74E-04	-8.94E-05
842	225.10	-1.79E-05	3.52E-05	-6.03E-05	8.06E-05	-2.27E-04	-6.52E-05
862	273.66	-1.31E-05	2.52E-05	-3.13E-05	3.68E-05	-1.60E-04	-5.00E-05
882	323.27	-8.31E-06	7.64E-05	-3.36E-05	2.71E-05	-1.19E-04	-2.61E-05
902	369.20	-2.63E-05	5.42E-05	-3.41E-06	1.15E-05	-8.07E-05	3.02E-06
922	419.20	-2.74E-05	1.20E-04	-1.46E-05	2.15E-05	-6.24E-05	1.45E-05
237	463.02	-2.51E-05	4.39E-05	-6.90E-06	6.72E-06	-1.71E-04	-7.03E-05
257	510.03	-2.96E-05	2.65E-05	-1.86E-05	1.05E-05	-5.27E-05	7.67E-05
277	544.44	-2.88E-05	-5.00E-07	-4.72E-05	1.46E-05	-7.07E-05	7.94E-05
297	580.53	-2.82E-05	-1.10E-05	-2.51E-05	5.08E-05	-4.26E-05	4.06E-05
317	631.08	-2.30E-05	-2.27E-06	-1.55E-05	9.58E-05	-4.59E-05	4.46E-05
337	680.34	-3.26E-05	-8.40E-06	-1.49E-05	9.35E-05	-5.16E-05	4.95E-05
357	727.44	-2.99E-05	-3.90E-06	-1.36E-05	9.50E-05	-5.26E-05	6.09E-05
377	772.93	-3.92E-05	-1.00E-05	-1.25E-05	1.16E-04	-5.79E-05	8.00E-05
397	831.34	-3.00E-05	-4.00E-07	-1.04E-05	1.18E-04	-5.40E-05	1.02E-04
417	894.09	-1.50E-05	3.68E-06	-5.20E-06	7.76E-05	-2.87E-05	4.96E-05
2062	925.08	-6.80E-06	4.12E-06	-7.99E-06	2.80E-05	-1.52E-05	1.16E-05
2052	935.67	-6.41E-06	4.14E-06	-4.21E-06	3.31E-05	-2.55E-05	6.71E-06
2042	944.86	-3.45E-06	2.01E-05	-2.94E-06	2.67E-05	-2.01E-05	1.49E-05
477	968.95	-8.87E-06	9.31E-06	-7.37E-06	3.63E-05	-3.45E-05	7.10E-05
497	1002.45	-3.34E-05	4.54E-05	-1.24E-05	3.18E-05	-1.04E-05	1.89E-05
517	1042.45	-7.28E-06	3.10E-05	-1.55E-05	2.52E-05	-2.18E-05	4.57E-06
537	1108.60	-6.13E-06	2.62E-05	-5.05E-06	2.52E-05	-2.31E-05	1.82E-06
557	1178.35	-6.38E-06	2.35E-05	-9.70E-06	1.99E-05	-1.36E-05	3.22E-06
577	1227.20	-6.45E-06	2.15E-05	-1.53E-05	2.17E-05	-6.25E-06	4.60E-06
597	1271.50	-7.00E-06	1.79E-05	-1.40E-05	1.83E-05	-3.75E-06	4.77E-06
617	1313.65	-1.39E-05	2.57E-05	-1.08E-05	1.35E-05	-4.65E-06	5.02E-06
637	1360.60	-3.85E-06	5.02E-06	-4.10E-06	6.78E-06	-1.96E-06	1.84E-06

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Table I.24. BES-FCC Concrete Backed Steel Strain, Shell Bottom, Seismic Load Only

**AP Backed Steel, Best Estimate Soil, Seismic Only, Fully Cracked Tank Concrete, 460 In Waste
Level at 1.83SpG**

M&D Starting M&D Element No.	Path (in)	Shell Bottom Surface (outside - away from waste) Seismic					
		AP-460-BES-FCC EPEL P1 Strain (in/in)	AP-460-BES-FCC EPEL P1 Strain (in/in)	AP-460-BES-FCC EPEL P2 (in/in)	AP-460-BES-FCC EPEL P2 Strain (in/in)	AP-460-BES-FCC EPEL P3 Strain (in/in)	AP-460-BES-FCC EPEL P3 Strain (in/in)
		Seismic Only Bot Min	Seismic Only Bot Max	Seismic Only Bot Min	Seismic Only Bot Max	Seismic Only Bot Min	Seismic Only Bot Max
762	67.33	-5.30E-05	6.11E-05	-1.63E-04	-1.09E-05	-2.23E-04	-8.20E-05
782	105.04	-6.05E-05	7.53E-05	-9.92E-05	3.16E-05	-3.48E-04	-1.10E-04
802	136.24	-3.97E-05	4.80E-05	-6.11E-05	6.63E-05	-2.92E-04	-1.08E-04
822	181.71	-2.98E-05	3.24E-05	-4.10E-05	6.64E-05	-2.75E-04	-8.24E-05
842	225.10	-1.75E-05	3.60E-05	-6.01E-05	7.37E-05	-2.05E-04	-7.33E-05
862	273.66	-1.38E-05	2.66E-05	-3.14E-05	3.99E-05	-1.65E-04	-4.43E-05
882	323.27	-1.22E-05	7.31E-05	-3.39E-05	3.02E-05	-1.06E-04	-1.83E-05
902	369.20	-2.62E-05	5.43E-05	-3.41E-06	1.02E-05	-8.61E-05	-5.81E-06
922	419.20	-2.74E-05	1.20E-04	-2.09E-05	3.01E-05	-6.62E-05	1.56E-05
237	463.02						
257	510.03						
277	544.44						
297	580.53						
317	631.08						
337	680.34						
357	727.44						
377	772.93						
397	831.34						
417	894.09						
2062	925.08	-6.71E-06	7.33E-06	-1.22E-05	1.56E-05	-1.25E-05	1.82E-05
2052	935.67	-1.88E-05	1.28E-05	-4.90E-06	3.33E-05	-1.62E-05	5.90E-05
2042	944.86	-2.32E-05	9.24E-05	-6.69E-06	4.57E-05	-1.36E-05	3.60E-05
477	968.95						
497	1002.45						
517	1042.45						
537	1108.60						
557	1178.35						
577	1227.20						
597	1271.50						
617	1313.65						
637	1360.60						

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Table I.25. BES-FCC Concrete Wall/Footing Contact Forces, Gravity Only

Tank AY, 460 Inch Waste Level
 SpG = 1.83
 Best Estimate Soil
 Fully Cracked Concrete

Angle	Vertical Min AP- BES-FCC Gravity	Vertical Max AP- BES-FCC Gravity	Shear Y Min AP- BES-FCC Gravity	Shear Y Max AP- BES-FCC Gravity	Shear X Min AP- BES-FCC Gravity	Shear X Max AP- BES-FCC Gravity	Shear Y Max AP- BES-FCC Gravity	Shear X Max AP- BES-FCC Gravity	Shear Max AP- BES-FCC Gravity	Vertical Force Max AP-BES- FCC Gravity	Vertical Force Min AP-BES- FCC Gravity
0	-204.10	-203.90	0.00	0.00	-2.24	-2.24	0.00	0.70	0.70	-63.78	-63.72
9	-408.10	-407.70	-0.69	-0.69	-4.48	-4.47	0.11	0.70	0.71	-63.77	-63.70
18	-408.10	-407.70	-1.20	-1.20	-4.15	-4.14	0.19	0.65	0.67	-63.77	-63.70
27	-408.10	-407.80	-1.78	-1.77	-3.89	-3.88	0.28	0.61	0.67	-63.77	-63.72
36	-408.10	-407.70	-2.63	-2.62	-3.69	-3.69	0.41	0.58	0.71	-63.77	-63.70
45	-408.00	-407.70	-3.12	-3.12	-3.21	-3.20	0.49	0.50	0.70	-63.75	-63.70
54	-408.00	-407.70	-3.63	-3.62	-2.74	-2.73	0.57	0.43	0.71	-63.75	-63.70
63	-408.00	-407.70	-3.93	-3.92	-2.08	-2.08	0.61	0.33	0.69	-63.75	-63.70
72	-408.10	-407.70	-4.30	-4.29	-1.41	-1.41	0.67	0.22	0.71	-63.77	-63.70
81	-408.00	-407.60	-4.23	-4.22	-0.79	-0.79	0.66	0.12	0.67	-63.75	-63.69
90	-408.00	-407.60	-4.53	-4.52	0.02	0.02	0.71	0.00	0.71	-63.75	-63.69
99	-408.00	-407.70	-4.46	-4.45	0.75	0.75	0.70	0.12	0.71	-63.75	-63.70
108	-408.00	-407.70	-4.11	-4.10	1.27	1.28	0.64	0.20	0.67	-63.75	-63.70
117	-408.10	-407.70	-3.99	-3.99	2.12	2.12	0.62	0.33	0.71	-63.77	-63.70
126	-408.10	-407.70	-3.53	-3.53	2.69	2.70	0.55	0.42	0.69	-63.77	-63.70
135	-408.00	-407.70	-3.11	-3.10	3.27	3.27	0.49	0.51	0.70	-63.75	-63.70
144	-408.00	-407.60	-2.59	-2.58	3.71	3.71	0.40	0.58	0.71	-63.75	-63.69
153	-408.00	-407.70	-2.00	-1.99	4.02	4.03	0.31	0.63	0.70	-63.75	-63.70
162	-408.10	-407.70	-1.32	-1.32	4.26	4.27	0.21	0.67	0.70	-63.77	-63.70
171	-408.00	-407.70	-0.65	-0.65	4.43	4.44	0.10	0.69	0.70	-63.75	-63.70
180	-204.10	-203.90	0.00	0.00	2.26	2.26	0.00	0.71	0.71	-63.78	-63.72

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Table I.26. BES-FCC Concrete Wall/Footing Contact Forces, Gravity Plus Seismic

Tank AY, 460 Inch Waste Level

SpG = 1.83

Best Estimate Soil

Fully Cracked Concrete

Angle	Vertical Min AP- BES-FCC Seismic	Vertical Max AP- BES-FCC Seismic	Shear Y Min AP- BES-FCC Seismic	Shear Y Max AP- BES-FCC Seismic	Shear X Min AP- BES-FCC Seismic	Shear X Max AP- BES-FCC Seismic	Shear Y Min AP- BES-FCC Seismic	Shear X Max AP- BES-FCC Seismic	Shear Max AP- BES-FCC Seismic	Vertical Force Max AP-BES- FCC Seismic	Vertical Force Min AP-BES- FCC Seismic
0	-235.40	-154.90	0.00	0.00	-7.76	4.78	0.00	2.43	2.43	-73.56	-48.41
9	-470.70	-310.60	-21.35	19.11	-18.37	12.72	3.34	2.87	4.40	-73.55	-48.53
18	-470.50	-313.00	-40.49	36.57	-26.61	22.57	6.33	4.16	7.57	-73.52	-48.91
27	-470.20	-316.90	-55.95	50.39	-40.36	37.59	8.74	6.31	10.78	-73.47	-49.52
36	-469.70	-322.10	-66.49	58.87	-58.35	56.52	10.39	9.12	13.82	-73.39	-50.33
45	-469.00	-328.20	-70.52	61.66	-78.08	78.00	11.02	12.20	16.44	-73.28	-51.28
54	-468.30	-335.10	-68.02	57.97	-97.86	99.79	10.63	15.59	18.87	-73.17	-52.36
63	-467.50	-341.90	-59.06	48.34	-115.40	120.10	9.23	18.77	20.91	-73.05	-53.42
72	-466.60	-347.50	-44.55	33.40	-129.20	136.70	6.96	21.36	22.47	-72.91	-54.30
81	-465.70	-349.50	-25.20	15.17	-137.60	148.00	3.94	23.13	23.46	-72.77	-54.61
90	-464.70	-350.80	-6.46	-3.33	-139.70	152.80	1.01	23.88	23.90	-72.61	-54.81
99	-463.80	-351.30	-25.49	18.36	-135.20	150.30	3.98	23.48	23.82	-72.47	-54.89
108	-463.00	-351.40	-43.03	38.39	-124.70	140.80	6.72	22.00	23.00	-72.34	-54.91
117	-462.20	-351.10	-56.79	53.91	-108.70	125.60	8.87	19.63	21.54	-72.22	-54.86
126	-461.40	-350.50	-64.85	63.92	-89.54	105.80	10.13	16.53	19.39	-72.09	-54.77
135	-460.80	-349.60	-66.94	67.09	-68.80	84.11	10.48	13.14	16.81	-72.00	-54.63
144	-460.30	-348.80	-62.84	63.50	-48.59	62.61	9.92	9.78	13.93	-71.92	-54.50
153	-460.40	-348.30	-52.94	53.67	-31.01	43.51	8.39	6.80	10.80	-71.94	-54.42
162	-461.30	-346.80	-38.17	38.74	-17.40	28.61	6.05	4.47	7.52	-72.08	-54.19
171	-461.90	-345.80	-19.97	20.28	-8.59	19.15	3.17	2.99	4.36	-72.17	-54.03
180	-231.10	-172.80	0.00	0.00	-2.80	8.06	0.00	2.52	2.52	-72.22	-54.00

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Table I.27. BES-FCC Concrete Wall/Footing Contact Forces, Seismic Only

Tank AY, 460 Inch Waste Level
 SpG = 1.83
 Best Estimate Soil
 Fully Cracked Concrete

Angle	Vertical Min AP- BES-FCC Seismic Only	Vertical Max AP- BES-FCC Seismic Only	Shear Y Min AP- BES-FCC Seismic Only	Shear Y Max AP- BES-FCC Seismic Only	Shear X Min AP- BES-FCC Seismic Only	Shear X Max AP- BES-FCC Seismic Only	Shear Y Max AP- BES-FCC Seismic Only	Shear X Max AP- BES-FCC Seismic Only	Shear Max AP- BES-FCC Seismic Only	Vertical Force Max AP-BES- FCC Seismic Only	Vertical Force Min AP-BES- FCC Seismic Only
0	-31.30	49.00	0.00	0.00	-5.52	7.02	0.00	2.19	2.19	-9.78	15.31
9	-62.60	97.10	-20.66	19.80	-13.90	17.19	3.23	2.69	4.20	-9.78	15.17
18	-62.40	94.70	-39.29	37.77	-22.46	26.71	6.14	4.17	7.42	-9.75	14.80
27	-62.10	90.90	-54.17	52.16	-36.47	41.47	8.46	6.48	10.66	-9.70	14.20
36	-61.60	85.60	-63.86	61.49	-54.66	60.21	9.98	9.41	13.71	-9.62	13.38
45	-61.00	79.50	-67.40	64.78	-74.88	81.20	10.53	12.69	16.49	-9.53	12.42
54	-60.30	72.60	-64.39	61.59	-95.12	102.52	10.06	16.02	18.92	-9.42	11.34
63	-59.50	65.80	-55.13	52.26	-113.32	122.18	8.61	19.09	20.94	-9.30	10.28
72	-58.50	60.20	-40.25	37.69	-127.79	138.11	6.29	21.58	22.48	-9.14	9.41
81	-57.70	58.10	-20.97	19.39	-136.81	148.79	3.28	23.25	23.48	-9.02	9.08
90	-56.70	56.80	-1.93	1.20	-139.72	152.78	0.30	23.87	23.87	-8.86	8.88
99	-55.80	56.40	-21.04	22.81	-135.95	149.55	3.56	23.37	23.64	-8.72	8.81
108	-55.00	56.30	-38.92	42.49	-125.97	139.53	6.64	21.80	22.79	-8.59	8.80
117	-54.10	56.60	-52.80	57.90	-110.82	123.48	9.05	19.29	21.31	-8.45	8.84
126	-53.30	57.20	-61.32	67.45	-92.23	103.10	10.54	16.11	19.25	-8.33	8.94
135	-52.80	58.10	-63.84	70.19	-72.07	80.84	10.97	12.63	16.73	-8.25	9.08
144	-52.30	58.80	-60.25	66.08	-52.30	58.90	10.33	9.20	13.83	-8.17	9.19
153	-52.40	59.40	-50.95	55.66	-35.03	39.48	8.70	6.17	10.66	-8.19	9.28
162	-53.20	60.90	-36.85	40.06	-21.66	24.34	6.26	3.80	7.32	-8.31	9.52
171	-53.90	61.90	-19.32	20.93	-13.02	14.71	3.27	2.30	4.00	-8.42	9.67
180	-27.00	31.10	0.00	0.00	-5.06	5.79	0.00	1.81	1.81	-8.44	9.72

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Table I.28. BES-FCC Soil/Concrete Tank Contact Forces, Gravity Only

Tank AP, 460 Inch Waste Level
 SpG = 1.83
 Best Estimate Soil
 Fully Cracked Concrete

1.7											1.19	
	Angle (rad)	Path	Max Pressure Soil (BES-FCC) AP Gravity (PSI)	MIn Pressure Soil (BES-FCC) AP Gravity (PSI)	Max Meridional Friction Soil (BES-FCC) AP Gravity (PSI)	Max Tangential Friction Soil (BES-FCC) AP Gravity (PSI)	Max Contact Displacement Soil (BES-FCC) AP Gravity (PSI)	0.70g Dome Vertical	0.19g Haunch Vertical	Active Pressure Phi = 49 deg		
568	-0.035089	67.727	9.85	9.67	2.05	0.04	0.08	16.75	11.73	7.11		
565.8	-0.07135	105.668	8.26	8.03	1.80	0.04	0.12	14.05	9.83	7.26		
563.21	-0.096521	137.069	8.87	8.44	2.03	0.06	0.12	15.08	10.55	7.42		
559.7	-0.124516	182.849	5.62	4.42	1.20	0.04	0.08	9.56	6.69	7.65		
550.7	-0.180521	226.563	5.94	5.04	1.58	0.11	0.05	10.10	7.07	8.22		
545.2	-0.210395	275.566	8.26	7.65	1.78	0.08	0.04	14.04	9.83	8.55		
527.68	-0.298426	325.690	7.61	7.27	1.56	0.03	0.04	12.94	9.06	9.56		
518.2	-0.34673	372.305	9.25	9.16	2.34	0.02	0.04	15.73	11.01	10.04		
494.5	-0.482293	423.427	16.41	16.26	3.30	0.08	0.03	27.90	19.53	10.97		
476.2	-0.606571	468.308	28.08	27.99	3.18	0.12	0.02	47.74	33.42	11.27		
447.4	-0.656685	515.312	31.94	31.77	5.02	0.21	0.03	54.29	38.01	12.51		
407.1	-0.710341	549.725	25.44	25.38	5.31	0.16	0.04	43.26	30.28	14.18		
382.1	-1.570796	585.819	12.38	12.36	3.23	0.06	0.04	21.04	14.73	2.85		
335	-1.570796	636.369	4.39	4.38	1.06	0.01	0.04	7.46	5.22	3.32		
281	-1.570796	685.619	3.84	3.83	0.88	0.00	0.05	6.53	4.57	3.86		
236.5	-1.570796	732.719	4.74	4.74	0.96	0.00	0.05	8.06	5.64	4.30		
186.8	-1.570796	778.219	4.41	4.40	0.92	0.00	0.05	7.50	5.25	4.80		
145.5	-1.570796	821.369	5.67	5.66	1.31	0.01	0.05	9.64	6.75	5.21		
70	-1.570796	874.169	9.10	9.08	2.04	0.03	0.04	15.47	10.83	5.96		
24	-1.570796	930.544	12.02	11.95	2.51	0.05	0.03	20.44	14.30	6.42		

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Table I.29. BES-FCC Soil/Concrete Tank Contact Forces, Gravity Plus Seismic

Tank AP, 460 Inch Waste Level
 SpG = 1.83
 Best Estimate Soil
 Fully Cracked Concrete

	Angle (rad)	Path	Max Pressure Soil (BES-FCC) AP Seismic (PSI)	Min Pressure Soil (BES-FCC) AP Seismic (PSI)	Max Meridional Friction Soil (BES-FCC) AP Seismic (PSI)	Max Tangential Friction Soil (BES-FCC) AP Seismic (PSI)	Max Contact Displacement Soil (BES-FCC) AP Seismic (inch)	Vertical Pressure	Active Pressure Phi = 33 deg	Active Pressure Phi = 49 deg
568	-0.035089	67.727	17.85	2.42	8.94	5.75	0.13	7.12	7.11	7.11
565.8	-0.07135	105.668	13.85	2.14	8.13	3.97	0.15	7.27	7.26	7.26
563.21	-0.096521	137.069	15.17	1.43	8.35	3.53	0.15	7.46	7.43	7.42
559.7	-0.124516	182.849	8.58	2.71	5.33	3.61	0.10	7.71	7.65	7.65
550.7	-0.180521	226.563	10.62	1.81	4.50	5.17	0.06	8.35	8.23	8.22
545.2	-0.210395	275.566	10.22	5.46	4.54	4.74	0.05	8.74	8.57	8.55
527.68	-0.298426	325.690	9.78	4.55	4.06	4.28	0.05	9.99	9.59	9.56
518.2	-0.34673	372.305	11.45	6.91	4.52	4.03	0.04	10.66	10.09	10.04
494.5	-0.482293	423.427	19.74	13.06	5.90	3.54	0.04	12.35	11.07	10.97
476.2	-0.606571	468.308	34.19	22.11	7.01	3.01	0.03	13.65	11.45	11.27
447.4	-0.656685	515.312	38.73	26.94	11.67	3.07	0.05	15.70	12.75	12.51
407.1	-0.710341	549.725	31.28	20.55	12.78	2.56	0.06	18.57	14.53	14.18
382.1	-1.570796	585.819	14.84	10.34	8.19	1.80	0.07	20.35	6.00	2.85
335	-1.570796	636.369	5.12	3.74	3.33	1.42	0.08	23.70	6.99	3.32
281	-1.570796	665.619	4.52	3.17	2.89	1.35	0.08	27.55	8.13	3.86
236.5	-1.570796	732.719	5.41	4.17	3.09	1.39	0.08	30.71	9.06	4.30
186.8	-1.570796	778.219	4.93	3.75	2.92	1.61	0.08	34.25	10.10	4.80
145.5	-1.570796	821.369	6.65	4.78	4.36	2.57	0.08	37.19	10.97	5.21
70	-1.570796	874.169	12.31	5.41	7.36	2.75	0.06	42.57	12.56	5.96
24	-1.570796	930.544	20.06	2.62	6.52	2.84	0.04	45.84	13.52	6.42

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Table I.30. BES-FCC Soil/Concrete Tank Contact Forces, Seismic Only

Tank AP, 460 Inch Waste Level
 SpG = 1.83
 Best Estimate Soil
 Fully Cracked Concrete

	Angle (rad)	Path	Max Pressure Soil (BES-FCC) AP Seismic Only (PSI)	Min Pressure Soil (BES-FCC) AP Seismic Only (PSI)	Max Meridional Friction (BES-FCC) AP Seismic Only (PSI)	Max Tangential Friction (BES- FCC) AP Seismic Only (PSI)	Max Contact Displacement (BES-FCC) AP Seismic Only (Inch)
568	-0.035089	67.727	7.99	-7.43	6.89	5.72	0.05
565.8	-0.07135	105.668	5.58	-6.12	6.33	3.93	0.03
563.21	-0.096521	137.069	6.30	-7.44	6.33	3.47	0.03
559.7	-0.124516	182.849	2.96	-2.91	4.13	3.57	0.01
550.7	-0.180521	226.563	4.68	-4.14	2.93	5.06	0.01
545.2	-0.210395	275.566	1.96	-2.80	2.76	4.65	0.01
527.68	-0.298426	325.690	2.17	-3.06	2.50	4.25	0.01
518.2	-0.34673	372.305	2.20	-2.34	2.18	4.01	0.01
494.5	-0.482293	423.427	3.33	-3.35	2.60	3.46	0.01
476.2	-0.606571	468.308	6.11	-5.97	3.83	2.89	0.01
447.4	-0.656685	515.312	6.79	-5.00	6.65	2.86	0.02
407.1	-0.710341	549.725	5.84	-4.90	7.48	2.40	0.02
382.1	-1.570796	585.819	2.47	-2.03	4.97	1.74	0.03
335	-1.570796	636.369	0.73	-0.65	2.27	1.42	0.03
281	-1.570796	685.619	0.68	-0.67	2.01	1.36	0.03
236.5	-1.570796	732.719	0.66	-0.57	2.13	1.39	0.03
186.8	-1.570796	778.219	0.52	-0.66	2.01	1.60	0.03
145.5	-1.570796	821.369	0.98	-0.89	3.04	2.56	0.03
70	-1.570796	874.169	3.21	-3.69	5.32	2.72	0.02
24	-1.570796	930.544	8.03	-9.40	4.00	2.79	0.01

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Table I.31. BES-FCC Primary Tank/Concrete Dome Contact Data, Gravity Only

Tank AP, 460 Inch Waste Level
SpG = 1.83
Best Estimate Soil
Fully Cracked Concrete

Radius	Max Pressure Primary Tank/Concrete Tank Dome AP Gravity (PSI)	Min Pressure Primary Tank/Concrete Tank Dome AP Gravity (PSI)	Max Gap Lateral Displacement Primary Tank /Concrete Tank Dome Gravity (in)	Max Gap Displacement Primary Tank/Concrete Tank Dome AP Gravity (Inches)
67.727	6.206	5.996	0.012252	0.000000
105.668	3.552	3.466	0.020988	0.000000
137.069	2.334	2.293	0.026196	0.000000
182.849	2.368	2.323	0.030204	0.000000
226.563	1.501	1.469	0.016440	-0.000324
275.566	1.645	1.626	0.036612	0.000000
325.690	0.379	0.362	0.007492	-0.000555
372.305	0.684	0.666	0.020580	-0.000059
423.427	0.000	0.000	0.000000	-1.054920

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Table I.32. BES-FCC Primary Tank/Concrete Dome Contact Data, Gravity Plus Seismic

Tank AP, 460 Inch Waste Level
 SpG = 1.83
 Best Estimate Soil
 Fully Cracked Concrete

Radius	Max Pressure Primary Tank/Concrete Tank Dome AP Seismic (PSI)	Min Pressure Primary Tank/Concrete Tank Dome AP Seismic (PSI)	Max Gap Lateral Displacement Primary Tank /Concrete Tank Dome Seismic (in)	Max Gap Displacement Primary Tank/Concrete Tank Dome AP Seismic (Inches)
67.727	12.035	3.152	0.016296	0.000000
105.668	11.729	1.253	0.027036	-0.000006
137.069	8.340	0.656	0.033300	-0.000028
182.849	6.250	1.116	0.037944	-0.000001
226.563	3.858	0.931	0.020532	-0.000589
275.566	3.751	0.673	0.045120	-0.001006
325.690	2.542	0.000	0.027684	-0.002582
372.305	9.563	0.000	0.035004	-0.005564
423.427	10.424	0.000	0.015444	-1.069560

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Table I.33. BES-FCC Primary Tank/Concrete Dome Contact Data, Seismic Only

Tank AP, 460 Inch Waste Level
SpG = 1.83
Best Estimate Soil
Fully Cracked Concrete

Radius	Max Pressure Primary Tank/Concrete Tank Dome AP Seismic Only (PSI)	Min Pressure Primary Tank/Concrete Tank Dome AP Seismic Only (PSI)	Max Gap Lateral Displacement Primary Tank /Concrete Tank Dome Seismic Only (in)	Max Gap Displacement Primary Tank/Concrete Tank Dome AP Seismic Only (Inches)
67.727	5.829	-2.844	0.004044	0.000000
105.668	8.177	-2.213	0.006048	-0.000006
137.069	6.006	-1.637	0.007104	-0.000028
182.849	3.882	-1.207	0.007740	-0.000001
226.563	2.356	-0.539	0.004092	-0.000264
275.566	2.106	-0.953	0.008508	-0.001006
325.690	2.162	-0.362	0.020192	-0.002027
372.305	8.879	-0.666	0.014424	-0.005506
423.427	10.424	0.000	0.015444	-0.014640

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Table I.34. BES-FCC Primary Tank/Insulating Concrete Contact Forces, Gravity Only

Tank AP, 460 Inch Waste Level
SpG = 1.83
Best Estimate Soil
Fully Cracked Concrete

Radius	Max Pressure Primary Tank/Insulating Concrete AP Gravity (PSI)	Min Pressure Primary Tank/Insulating Concrete AP Gravity (PSI)	Max Lateral Displacement Primary Tank / Insulating Concrete AP Gravity (Inches)	Min Lateral Displacement Primary Tank / Insulating Concrete AP Gravity (Inches)
424.00	76.111	75.972	0.011204	0.011182
384.00	12.931	12.917	0.000215	0.000138
317.85	33.451	33.417	0.003043	0.003030
248.10	29.681	29.660	0.002262	0.002251
199.25	30.764	30.736	0.000995	0.000988
154.95	30.479	30.451	0.000732	0.000726
112.80	30.451	30.417	0.000337	0.000330
65.85	30.972	30.882	0.000346	0.000334

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Table I.35. BES-FCC Primary Tank/Insulating Concrete Contact Data, Gravity Plus Seismic

Tank AP, 460 Inch Waste Level
SpG = 1.83
Best Estimate Soil
Fully Cracked Concrete

Radius	Max Pressure Primary Tank/Insulating Concrete AP Seismic (PSI)	Min Pressure Primary Tank/Insulating Concrete AP Seismic (PSI)	Max Lateral Displacement Primary Tank/Insulating Concrete AP Seismic (Inches)	Min Lateral Displacement Primary Tank/Insulating Concrete AP Seismic (Inches)
424.00	100.208	42.028	0.076152	0.002960
384.00	25.951	8.104	0.162840	0.001160
317.85	42.319	22.201	0.051528	0.000932
248.10	37.611	20.722	0.032700	0.000779
199.25	37.479	21.618	0.021708	0.000160
154.95	36.361	22.431	0.015156	0.000171
112.80	36.326	23.951	0.011286	0.000027
65.85	35.500	23.681	0.009168	0.000037

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Table I.36. BES-FCC Primary Tank/Insulating Concrete Contact Forces, Seismic Only

Tank AP, 460 Inch Waste Level
SpG = 1.83
Best Estimate Soil
Fully Cracked Concrete

Radius	Max Pressure Primary Tank/Insulating Concrete AP Seismic Only (PSI)	Min Pressure Primary Tank/Insulating Concrete AP Seismic Only (PSI)	Max Lateral Displacement Primary Tank/Insulating Concrete AP Seismic Only (Inches)	Min Lateral Displacement Primary Tank/Insulating Concrete AP Seismic Only (Inches)
424.00	24.097	-33.944	0.065	-0.008
384.00	13.021	-4.813	0.163	0.001
317.85	8.868	-11.215	0.048	-0.002
248.10	7.931	-8.938	0.030	-0.001
199.25	6.715	-9.118	0.021	-0.001
154.95	5.882	-8.021	0.014	-0.001
112.80	5.875	-6.465	0.011	0.000
65.85	4.528	-7.201	0.009	0.000

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Table I.37. BES-FCC Insulating Concrete/Concrete Backed Steel Contact Data, Gravity Only

Tank AP, 460 Inch Waste Level
SpG = 1.83
Best Estimate Soil
Fully Cracked Concrete

Radius	Max Pressure Insulating Concrete/Secondary Liner AP Gravity (PSI)	Min Pressure Insulating Concrete/Secondary Liner AP Gravity (PSI)	Max Lateral Displacement Insulating Concrete/Secondary Liner AP Gravity (Inches)	Min Lateral Displacement Insulating Concrete/Secondary Liner AP Gravity (Inches)
424.00	97.222	96.944	0.006835	0.006791
384.00	36.493	36.410	0.005813	0.005773
317.85	26.840	26.806	0.004486	0.004454
248.10	31.514	31.486	0.003389	0.003366
199.25	30.944	30.910	0.002450	0.002435
154.95	30.806	30.764	0.001607	0.001598
112.80	31.153	31.063	0.000703	0.000700
65.85	30.542	30.306	0.000090	0.000084

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Table I.38. BES-FCC Insulating Concrete/Concrete Backed Steel Contact Data, Gravity Plus Seismic

Tank AP, 460 Inch Waste Level
SpG = 1.83
Best Estimate Soil
Fully Cracked Concrete

Radius	Max Pressure Insulating Concrete/Secondary Liner AP Seismic (PSI)	Min Pressure Insulating Concrete/Secondary Liner AP Seismic (PSI)	Max Lateral Displacement Insulating Concrete/Secondary Liner AP Seismic (Inches)	Min Lateral Displacement Insulating Concrete/Secondary Liner AP Seismic (Inches)
424.00	109.931	81.319	0.024732	0.000354
384.00	45.451	27.924	0.023232	0.000384
317.85	35.563	16.368	0.020484	0.000331
248.10	39.674	22.056	0.017304	0.000288
199.25	37.660	21.903	0.014628	0.000226
154.95	36.722	22.618	0.012288	0.000156
112.80	36.931	24.375	0.010303	0.000174
65.85	35.653	23.924	0.009026	0.000040

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Table I.39. BES-FCC Insulating Concrete/Concrete Backed Steel Contact Data, Seismic Only

Tank AP, 460 Inch Waste Level
SpG = 1.83
Best Estimate Soil
Fully Cracked Concrete

Radius	Max Pressure Insulating Concrete/Secondary Liner AP Seismic Only (PSI)	Min Pressure Insulating Concrete/Secondary Liner AP Seismic Only (PSI)	Max Lateral Displacement Insulating Concrete/Secondary Liner AP Seismic Only (Inches)	Min Lateral Displacement Insulating Concrete/Secondary Liner AP Seismic Only (Inches)
424.00	12.708	-15.625	0.018	-0.006
384.00	8.958	-8.486	0.017	-0.005
317.85	8.722	-10.438	0.016	-0.004
248.10	8.160	-9.431	0.014	-0.003
199.25	6.715	-9.007	0.012	-0.002
154.95	5.917	-8.146	0.011	-0.001
112.80	5.778	-6.688	0.010	-0.001
65.85	5.111	-6.382	0.009	0.000

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Table I.40. BES-FCC Waste Contact Pressure, Gravity Plus Seismic

Tank AY, 460 Inch Waste Level
 SpG = 1.83
 Best Estimate Soil
 Fully Cracked Concrete

Waste Height Ratio		Max Pressure AP Tank, 460 in Waste Level, SpG = 1.83 Time History (PSI)	Min Pressure AP Tank, 460 in Waste Level, SpG = 1.83 Time History (PSI)				
	Waste Height			Hydrostatic (psi)	Hydrodynamic (psi)	Theoretical Min (SRSS)	Theoretical Max (SRSS)
0.99	454.35	9.194	-8.375	0.37	1.75	0.00	2.13
0.96	443.05	13.444	-12.167	1.12	1.94	0.00	3.06
0.94	431.7625	14.528	-10.340	1.87	2.20	0.00	4.07
0.90	414.125	11.938	-6.713	3.03	2.68	0.35	5.71
0.85	390.125	9.083	-0.898	4.62	3.35	1.27	7.97
0.80	366.125	11.708	0.095	6.20	4.00	2.20	10.20
0.74	342	13.840	0.489	7.80	4.62	3.18	12.42
0.69	318.325	16.056	1.160	9.36	5.19	4.17	14.55
0.64	295.225	18.736	1.796	10.89	5.70	5.19	16.59
0.59	272.125	20.646	2.802	12.41	6.17	6.24	18.59
0.54	248.975	23.271	3.713	13.94	6.61	7.33	20.56
0.49	225.825	25.979	4.672	15.47	7.01	8.46	22.48
0.44	202.725	26.688	5.980	17.00	7.37	9.63	24.37
0.39	179.625	28.417	7.313	18.53	7.70	10.83	26.22
0.34	156.475	31.889	8.653	20.06	7.98	12.07	28.04
0.29	134.075	33.340	10.208	21.54	8.22	13.31	29.76
0.24	112.475	33.208	11.694	22.96	8.42	14.54	31.38
0.20	90.875	35.590	13.319	24.39	8.58	15.81	32.97
0.15	69.275	36.382	14.660	25.82	8.71	17.11	34.53
0.10	47.738	38.521	16.493	27.24	8.80	18.44	36.04
0.05	24.500	41.014	16.910	28.78	8.87	19.91	37.64
0.02	7.755	46.979	24.917	29.88	8.89	20.99	38.77
0.00	1.755	40.417	24.736	30.28	8.89	21.39	39.17

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Table I.41. BES-FCC Waste Contact Pressure, Theoretical Pressures

Tank Radius, Hr	450	HI/Hr	1.02222222			Waste Dens	1.71E-04					
Waste Depth, HI	460	Conv 1st	Conv 2nd	Conv 3rd	Impul H	Pressure						
Centroid	Conv 1st		Conv 2nd	Conv 3rd		Conv 1st	Conv 2nd	Conv 3rd	Impul H	Impul V		
	Lamda	1.841	5.331	8.536	Sa=	0.064	0.108	0.163	0.29	0.25		
Height	nu	con0(n)	con1(n)	con2(n)	ci(n)	24.7296	41.7312	62.9832	112.06	96.6	SRSS	
	454.35	0.98771739	0.82	0.07	0.03	0.09	1.56	0.22	0.12	0.76	0.12 1.75	
	443.05	0.96315217	0.78	0.06	0.02	0.14	1.49	0.19	0.10	1.18	0.35 1.94	
	431.7625	0.93861413	0.75	0.05	0.02	0.18	1.43	0.17	0.08	1.56	0.59 2.20	
	414.125	0.90027174	0.70	0.04	0.01	0.24	1.33	0.14	0.06	2.11	0.95 2.68	
	390.125	0.84809783	0.64	0.03	0.01	0.32	1.22	0.10	0.04	2.77	1.44 3.35	
	366.125	0.79592391	0.59	0.02	0.00	0.39	1.11	0.08	0.02	3.33	1.92 4.00	
	342	0.74347826	0.54	0.02	0.00	0.44	1.02	0.06	0.01	3.82	2.38 4.62	
	318.325	0.69201087	0.49	0.01	0.00	0.49	0.94	0.04	0.01	4.25	2.83 5.19	
	295.225	0.64179348	0.45	0.01	0.00	0.53	0.86	0.03	0.01	4.61	3.24 5.70	
	272.125	0.59157609	0.42	0.01	0.00	0.57	0.80	0.03	0.00	4.92	3.64 6.17	
	248.975	0.54125	0.39	0.01	0.00	0.60	0.74	0.02	0.00	5.20	4.01 6.61	
	225.825	0.49092391	0.36	0.00	0.00	0.63	0.69	0.01	0.00	5.45	4.36 7.01	
	202.725	0.44070652	0.34	0.00	0.00	0.66	0.65	0.01	0.00	5.66	4.68 7.37	
	179.625	0.39048913	0.32	0.00	0.00	0.68	0.61	0.01	0.00	5.84	4.97 7.70	
	156.475	0.34016304	0.30	0.00	0.00	0.70	0.57	0.01	0.00	6.00	5.23 7.98	
	134.075	0.29146739	0.29	0.00	0.00	0.71	0.55	0.01	0.00	6.13	5.45 8.22	
	112.475	0.24451087	0.28	0.00	0.00	0.72	0.53	0.00	0.00	6.23	5.64 8.42	
	90.875	0.19755435	0.27	0.00	0.00	0.73	0.51	0.00	0.00	6.31	5.79 8.58	
	69.275	0.15059783	0.26	0.00	0.00	0.74	0.49	0.00	0.00	6.38	5.91 8.71	
	47.7375	0.10377717	0.25	0.00	0.00	0.75	0.48	0.00	0.00	6.43	6.00 8.80	
	24.5	0.05326087	0.25	0.00	0.00	0.75	0.48	0.00	0.00	6.46	6.06 8.87	
	7.755	0.0168587	0.25	0.00	0.00	0.75	0.47	0.00	0.00	6.47	6.08 8.89	
	1.755	0.00381522	0.25	0.00	0.00	0.75	0.47	0.00	0.00	6.47	6.08 8.89	

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Table I.42. BES-FCC Waste Surface Displacement, Gravity Plus Seismic

Tank AP, 460 Inch Waste Level
 SpG = 1.83
 Best Estimate Soil
 Fully Cracked Concrete

Waste Radius	Max Vertical Displacement AP-460-BES-FCC Time History (in)	Min Vertical Displacement AP-460-BES-FCC Time History (in)
95.7	6.59	-11.64
129.9	7.53	-10.70
180	8.10	-12.12
218.5	7.40	-13.10
277.7	8.12	-13.19
358	8.60	-13.21
410	7.10	-12.44
450	5.04	-9.38

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Near-Soil-1.txt

```
et,8,solid45                                ! Use Element SOLID45 for Near Soil Elements
/input,soil-prop-Mean-geo,txt                ! Read Soil Properties

ksel,u,kp,,1,kmaxjb                          ! Unselect existing Keypoints
asel,u,area,,1,amaxjb                       ! Unselect existing Area
lsel,u,line,,1,lmaxjb                       ! Unselect existing Lines
vsel,u,volu,,1,vmaxw                        ! Unselect existing Volumes

/COM - Create Keypoints to match concrete tank profile
*do,i,1,bm_kp
k,kmaxjb+i,ctx(i),0,ctx(i)
*enddo

/COM - Create Keypoints above top of tank
k,kmaxjb+bm_kp+1,0,0,0                      ! Keypoint at origin (surface)
k,kmaxjb+bm_kp+2,0,0,soilz(2)              ! Keypoint at to divide soil above tank
*get,KMAXtemp1,KP,0,num,max                 ! Get maximum keypoint number for counter

/COM - Create Keypoints at outside of excavated soil
*do,i,1,tanksoil
k,kmaxtemp1+i,soilx(i),0,soilz(i)
*enddo
*get,KMAXtemp2,KP,0,num,max                 ! Get maximum keypoint number for counter

/COM - Create additional keypoint in soil above tank
k,kmaxtemp2+1,ctx(2),0,soilz(1)
k,kmaxtemp2+2,ctx(9),0,soilz(1)
k,kmaxtemp2+3,ctx(12),0,soilz(1)
k,kmaxtemp2+4,ctx(2),0,soilz(2)
k,kmaxtemp2+5,ctx(9),0,soilz(2)
k,kmaxtemp2+6,ctx(12),0,soilz(2)
k,kmaxtemp2+7,ctx(12),0,soilz(3)
k,kmaxtemp2+8,ctx(bm_kp+1),0,ctx(bm_kp+1)

a,kmaxtemp2+1,kmaxtemp2+2,kmaxtemp2+5,kmaxtemp2+4
a,kmaxtemp2+2,kmaxtemp2+3,kmaxtemp2+6,kmaxtemp2+5
a,kmaxtemp2+3,kmaxtemp1+1,kmaxtemp1+2,kmaxtemp2+6
a,kmaxtemp2+4,kmaxtemp2+5,kmaxjb+9,kmaxjb+8,kmaxjb+7,kmaxjb+6,kmaxjb+5,kmaxjb+4,kmaxjb+3,kmaxjb+2
!a,740,741,712,711,710,709,708,707,706,705
a,kmaxtemp2+5,kmaxtemp2+6,kmaxtemp2+7,kmaxjb+12,kmaxjb+11,kmaxjb+10,kmaxjb+9
a,kmaxtemp2+6,kmaxtemp1+2,kmaxtemp1+3,kmaxtemp2+7
a,kmaxtemp2+7,kmaxtemp1+3,kmaxtemp1+4,kmaxjb+12
a,kmaxjb+12,kmaxtemp1+4,kmaxtemp1+5,kmaxjb+14,kmaxjb+13
a,kmaxjb+14,kmaxtemp1+5,kmaxtemp1+6,kmaxjb+16,kmaxjb+15
a,kmaxjb+16,kmaxtemp1+6,kmaxtemp1+7,kmaxjb+18,kmaxjb+17
a,kmaxjb+18,kmaxtemp1+7,kmaxtemp1+8,kmaxjb+20,kmaxjb+19
a,kmaxjb+20,kmaxtemp1+8,kmaxtemp1+9,kmaxtemp2+8,kmaxjb+22,kmaxjb+21

cm,top-soil-area,area
lsla
cm,top-soil,line
type,1
real,1

/COM - Define line divisions to control meshing
lsel,s,loc,z,soilz(1),soilz(2)
lsel,r,loc,x,ctx(3),ctx(8)
lesize,all,,,14                            ! soil above tank top, match tank meshing
lsel,s,loc,z,soilz(1),soilz(2)
lsel,r,loc,x,ctx(10),ctx(11)
lesize,all,,,3                             ! soil above tank top, match tank meshing
cmsel,s,top-soil                           ! Reselect lines in near soil
lsel,r,loc,x,ctx(2)
lesize,all,,,2                             ! Control vertical element size, above tank
cmsel,s,top-soil
lsel,s,loc,x,ctx(9)
lesize,all,,,2                             ! Control vertical element size, above tank
```


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```

cmsel,s,top-soil
lsel,r,loc,x,ctx(12)
lesize,all,,,2                                ! Control vertical element size, above tank
cmsel,s,top-soil
lsel,r,loc,z,ctz(2),ctz(12)
lsel,r,loc,x,ctx(2),ctx(12)
lesize,all,,,1                                ! Control vertical element size, outside excavation mesh
lsel,s,line,,lmaxjb+8,lmaxjb+10,2
lsel,a,line,,lmaxjb+26,lmaxjb+28,2
lsel,a,line,,lmaxjb+30,lmaxjb+38,4
lesize,all,,,9
lsel,s,line,,lmaxjb+42,lmaxjb+42,4
lesize,all,,,7                                ! Control horizontal meshing in soil
lsel,s,line,,lmaxjb+9
lsel,a,line,,lmaxjb+25,lmaxjb+27,2
lsel,a,line,,lmaxjb+29,lmaxjb+45,4
lesize,all,,,1                                ! Control horizontal meshing in soil
lsel,s,line,,lmaxjb+6
lsel,a,line,,lmaxjb+20,lmaxjb+21
lsel,a,line,,lmaxjb+32,lmaxjb+44,4
lsel,a,line,,lmaxjb+31,lmaxjb+43,4
lsel,a,line,,lmaxjb+47,lmaxjb+49
lesize,all,,,1                                ! Control meshing to match tank
lsel,s,line,,lmaxjb+46
lesize,all,,,4                                ! Control mesh size at bottom of excavated soil

cmsel,s,top-soil-area

amesh,all                                      ! Mesh area to develop pattern for volume meshing

type,8
ksel,a,kp,,1                                  ! Select Keypoint for rotation axis
ksel,a,kp,,ct_kps                             ! Select Keypoint for rotation axis
vrotat,all,,,,,1,ct_kps,180,2                ! Generate Volumes for excavated soil
lsla
lsel,r,loc,x,ctx(2)
lesize,all,,arcsz                             ! Define meshing for slices
lsla
lsel,r,loc,x,ctx(9)
lesize,all,,arcsz                             ! Define meshing for slices
lsla
lsel,r,loc,x,ctx(12)
lesize,all,,arcsz                             ! Define meshing for slices
vsweep,all                                    ! Sweep pattern into volume
aclear,all                                    ! Delete elements used for sweep
cm,top-soil-vol,volu

*get,VMAXtemp,VOLU,0,num,max
/COM - Generate element above top center of tank
asel,u,area,,all
vsel,u,volu,,all
a,kmaxjb+bm_kp+1,kmaxtemp2+1,kmaxtemp2+4,kmaxjb+bm_kp+2
a,kmaxjb+bm_kp+2,kmaxtemp2+4,kmaxjb+2,kmaxjb+1
vrotat,all,,,,,1,ct_kps,180,2
vsel,s,volu,,vmaxtemp+1,vmaxtemp+3,2
vatt,801,,8                                  ! Assign material properties
vsel,s,volu,,vmaxtemp+2,vmaxtemp+4,2
vatt,802,,8                                  ! Assign material properties
vsel,s,volu,,vmaxtemp+1,vmaxtemp+4
allsel
asel,s,loc,z,ctz(1),ctz(2)
type,1
asel,r,loc,x,0,4
asel,r,loc,z,ctz(1),ctz(2)
cmsel,u,conc-tank-a
*get,atemp,area,,num,max
*get,atempl,area,,num,min
asel,a,area,,1,22,21
mshcopy,2,1,atempl                            ! copy mesh top match top of concrete tank
mshcopy,2,22,atemp                            ! copy mesh top match top of concrete tank
asel,u,area,,1,22,21

```

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```

vsel,s,volu,,vmaxtemp+1,vmaxtemp+4
vsweep,all ! Generate elements by sweeping area
aclear,atemp
aclear,atempl

/COM - Assign soil properties by layer
*do,i,1,tanksoil-1
cmsel,s,top-soil-vol
vsel,r,loc,z,soilz(i),soilz(i+1)
eslv
emodif,all,mat,800+i
esys,0
*enddo

cmsel,s,top-soil-vol
vsel,a,loc,z,soilz(1),ctz(2)
eslv
cm,excav-soil,elem
nsle
nummrg,node

/COM - Define component for excavated soil - tank walls only
cmsel,s,excav-soil
nsle,s,1
nsel,r,loc,z,soilz(5),soilz(9)
esln,r,1
cm,excav-wall,elem

/COM - Define component for excavated soil - tank dome only
cmsel,s,excav-soil
cmsel,u,excav-wall
cm,excav-dome,elem

csys,1
cmsel,s,excav-wall
nsle
nsel,r,loc,x,ctx(14)
cm,excav-wall-n,node

esel,s,type,,8
nsle
nsel,s,loc,x,soilx(1)
nsel,r,loc,z,soilz(1)
cm,near-soil-face-node,node
*do,i,2,9
esel,s,type,,8
nsle
nsel,r,loc,x,soilx(i)
nsel,r,loc,z,soilz(i)
cmsel,a,near-soil-face-node
cm,near-soil-face-node,node
*enddo

esel,s,type,,8
nsle
nsel,r,loc,z,soilz(9)
nsel,r,loc,x,41,68
cm,near-soil-bot-node,node

allsel
*get,KMAXns,KP,0,num,max ! Get maximum Keypoint number
*get,LMAXns,LINE,0,num,max ! Get maximum line number
*get,AMAXns,AREA,0,num,max ! Get maximum Area number
*get,VMAXns,volu,0,num,max ! Get maximum Volume number

```

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Run-Tank.txt

```
!/batch
! PNNL DST Seismic Analysis, Gravity Inputs, Best Est Soil, Fully Cracked Concrete Properties, AP
Primary Tank Geometry, Dome Friction=0.0
!
fini
/clear
/filename,AP-460-BES-FCC-Seismic,1
/config,nres,3000          ! Increase allowable number of results to 3000
/config,nproc,2            ! Activate 2 processors for solution
/config,fsplit,1024        ! Split binary file at 4.2GB
/prep7
g=32.2                    ! Gravity (ft/sec)

DF=40                     ! Factor for beta (stiffness) damping
ALPHA=0.4                 ! Alpha damping

/out,tank-out,out
/sys,"X:\07.00 - Quality Assurance\ANSYS QA\usrcfg.bat" > QA.out
/out,QA,out,,append
/input,tank-coordinates-AP,txt      ! Run file defining tank coordinates (concrete and primary)
/input,tank-props-crack.txt        ! Run file defining fully cracked concrete properties (PNNL
Concrete Properties)
/input,tank-mesh1,txt              ! Develop concrete tank
/input,primary-props-AP,txt        ! Run file defining AP Primary tank properties
/input,primary,txt                ! Develop Primary tank
/input,insulate,txt               ! Develop insulating concrete model
/input,liner,txt                  ! Develop Liner model
/input,waste-solid-AP-s,txt        ! Develop waste model
/input,bolts-friction,txt          ! Develop J-Bolt model
/input,near-soil-1,txt             ! Develop excavated soil model
/input,far-soil,txt               ! Develop Far-Field soil model
/input,interfacel,txt             ! Develop Soil and Concrete Interfaces
/input,interface-gap1,txt          ! Develop Primary Tank Interfaces
/input,slave,txt                  ! Develop slaved boundary conditions
/input,boundary,txt               ! Place base and symmetry boundary conditions
/input,outer-spar,txt             ! Connect soil model to symmetry plane
/input,live_load,txt              ! Apply live load over a 10ft radius over dome center
/input,fix-soil,txt
/out
ALLSEL

/out,Tank-th,out

save

/input,solve-TH-BES,txt           ! Run solution Phase

/input,post-tank,txt

/out
/exit
```

Soil-Prop-BES-Geo.txt

```
Tanksoil=9
deepsoil=20
soil_radius=320
mass=1e8

*dim,soilx,,30
*dim,soilz,,30

soilz(1)=0
soilz(2)=-5
soilz(3)=ctz(9)
```

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```
soilz(4)=ctz(12)
soilz(5)=ctz(14)
soilz(6)=ctz(16)
soilz(7)=ctz(18)
soilz(8)=ctz(20)
soilz(9)=ctz(23)
soilz(10)=-73.5
soilz(11)=-90.5
soilz(12)=-106.5
soilz(13)=-123.5
soilz(14)=-139.5
soilz(15)=-156
soilz(16)=-178
soilz(17)=-200
soilz(18)=-222
soilz(19)=-244
soilz(20)=-266
```

```
soilx(9)=68
soilx(8)=soilx(9)-(soilz(9)-soilz(8))/1.5
soilx(7)=soilx(9)-(soilz(9)-soilz(7))/1.5
soilx(6)=soilx(9)-(soilz(9)-soilz(6))/1.5
soilx(5)=soilx(9)-(soilz(9)-soilz(5))/1.5
soilx(4)=soilx(9)-(soilz(9)-soilz(4))/1.5
soilx(3)=soilx(9)-(soilz(9)-soilz(3))/1.5
soilx(2)=soilx(9)-(soilz(9)-soilz(2))/1.5
soilx(1)=soilx(9)-(soilz(9)-soilz(1))/1.5
```

/COM Excavated Soil Properties

```
mp,ex,801,18*144
mp,nuxy,801,0.27
mp,dens,801,125/(1000*g)
mp,damp,801,0.017/df
```

/COM - Material 802, Soil

```
mp,ex,802,22.5*144
mp,nuxy,802,0.27
mp,dens,802,125/(1000*g)
mp,damp,802,0.027/df
```

/COM - Material 803, Soil

```
mp,ex,803,29.25*144
mp,nuxy,803,0.27
mp,dens,803,125/(1000*g)
mp,damp,803,0.039/df
```

/COM - Material 804, Soil

```
mp,ex,804,36*144
mp,nuxy,804,0.27
mp,dens,804,125/(1000*g)
mp,damp,804,0.031/df
```

/COM - Material 805, Soil

```
mp,ex,805,42*144
mp,nuxy,805,0.27
mp,dens,805,125/(1000*g)
mp,damp,805,0.035/df
```

/COM - Material 806, Soil

```
mp,ex,806,48.75*144
mp,nuxy,806,0.27
mp,dens,806,125/(1000*g)
mp,damp,806,0.042/df
```

/COM - Material 807, Soil

```
mp,ex,807,55.5*144
mp,nuxy,807,0.27
mp,dens,807,125/(1000*g)
mp,damp,807,0.047/df
```

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```
/COM - Material 808, Soil
mp,ex,808,60*144
mp,nuxy,808,0.27
mp,dens,808,125/(1000*g)
mp,damp,808,0.037/df

/COM - Material 810, Soil
mp,ex,810,250
mp,nuxy,810,0.27
mp,dens,810,125/(1000*g)
mp,damp,810,0.037/df

/COM - Material Definitions
/COM - Material 811, Soil      (Top Layer)
mp,ex,811,9958
mp,nuxy,811,0.27
mp,dens,811,125/(1000*g)
mp,damp,811,0.019/df

/COM - Material 812, Soil
mp,ex,812,8797
mp,nuxy,812,0.27
mp,dens,812,125/(1000*g)
mp,damp,812,0.035/df

/COM - Material 813, Soil
mp,ex,813,7845
mp,nuxy,813,0.27
mp,dens,813,125/(1000*g)
mp,damp,813,0.048/df

/COM - Material 814, Soil
mp,ex,814,8209
mp,nuxy,814,0.27
mp,dens,814,125/(1000*g)
mp,damp,814,0.039/df

/COM - Material 815, Soil
mp,ex,815,7634
mp,nuxy,815,0.27
mp,dens,815,125/(1000*g)
mp,damp,815,0.048/df

/COM - Material 816, Soil
mp,ex,816,7188
mp,nuxy,816,0.27
mp,dens,816,125/(1000*g)
mp,damp,816,0.055/df

/COM - Material 817, Soil
mp,ex,817,6933
mp,nuxy,817,0.27
mp,dens,817,125/(1000*g)
mp,damp,817,0.059/df

/COM - Material 818, Soil
mp,ex,818,7667
mp,nuxy,818,0.27
mp,dens,818,125/(1000*g)
mp,damp,818,0.045/df

/COM - Mean Soil Properties Geomatrix Soil Data
/COM - 19 Layer Mode
/COM - Material Definitions

/COM - Material 901, Soil      (Top Layer)
mp,ex,901,16423
mp,nuxy,901,0.24
mp,dens,901,110/(1000*g)
```

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mp,damp,901,0.017/df

/COM - Material 902, Soil
mp,ex,902,15479
mp,nuxy,902,0.24
mp,dens,902,110/(1000*g)
mp,damp,902,0.025/df

/COM - Material 903, Soil
mp,ex,903,14481
mp,nuxy,903,0.24
mp,dens,903,110/(1000*g)
mp,damp,903,0.034/df

/COM - Material 904, Soil
mp,ex,904,14707
mp,nuxy,904,0.24
mp,dens,904,110/(1000*g)
mp,damp,904,0.028/df

/COM - Material 905, Soil
mp,ex,905,13625
mp,nuxy,905,0.19
mp,dens,905,110/(1000*g)
mp,damp,905,0.032/df

/COM - Material 906, Soil
mp,ex,906,15456
mp,nuxy,906,0.19
mp,dens,906,110/(1000*g)
mp,damp,906,0.033/df

/COM - Material 907, Soil
mp,ex,907,17532
mp,nuxy,907,0.19
mp,dens,907,110/(1000*g)
mp,damp,907,0.033/df

/COM - Material 908, Soil
mp,ex,908,20972
mp,nuxy,908,0.19
mp,dens,908,110/(1000*g)
mp,damp,908,0.025/df

/COM - Material 909, Soil
mp,ex,909,23447
mp,nuxy,909,0.19
mp,dens,909,110/(1000*g)
mp,damp,909,0.026/df

/COM - Material 910, Soil
mp,ex,910,23138
mp,nuxy,910,0.19
mp,dens,910,110/(1000*g)
mp,damp,910,0.027/df

/COM - Material 911, Soil
mp,ex,911,22753
mp,nuxy,911,0.19
mp,dens,911,110/(1000*g)
mp,damp,911,0.029/df

/COM - Material 912, Soil
mp,ex,912,22069
mp,nuxy,912,0.19
mp,dens,912,110/(1000*g)
mp,damp,912,0.033/df

/COM - Material 913, Soil
mp,ex,913,25780
mp,nuxy,913,0.19

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```
mp,dens,913,110/(1000*g)
mp,damp,913,0.025/df
```

```
/COM - Material 914, Soil
mp,ex,914,25333
mp,nuxy,914,0.19
mp,dens,914,110/(1000*g)
mp,damp,914,0.027/df
```

```
/COM - Material 915, Soil
mp,ex,915,35501
mp,nuxy,915,0.28
mp,dens,915,120/(1000*g)
mp,damp,915,0.022/df
```

```
/COM - Material 916, Soil
mp,ex,916,39465
mp,nuxy,916,0.28
mp,dens,916,120/(1000*g)
mp,damp,916,0.021/df
```

```
/COM - Material 917, Soil
mp,ex,917,38565
mp,nuxy,917,0.28
mp,dens,917,120/(1000*g)
mp,damp,917,0.023/df
```

```
/COM - Material 918, Soil
mp,ex,918,37715
mp,nuxy,918,0.28
mp,dens,918,120/(1000*g)
mp,damp,918,0.025/df
```

```
/COM - Material 919, Soil
mp,ex,919,41496
mp,nuxy,919,0.28
mp,dens,919,120/(1000*g)
mp,damp,919,0.024/df
```

Solve-Gravity-BES.txt

```
/prep7
massm_z=148414.59
d,master_node,all
allsel

cmsel,s,excav-soil
nsle
csys,0
nsel,r,loc,x,-ctx(6)-1,ctx(6)+1
nsel,r,loc,y,0,-ctx(6)-1
esln,r,1
mpchg,810,all

cmsel,s,excav-soil
nsle
csys,1
nsel,r,loc,x,ctx(11)-1,ctx(13)+1
nsel,r,loc,z,soilz(1),soilz(3)-1
esln,r,1
mpchg,810,all

*do,i,801,808
esel,s,mat,,i
mpchg,i+10,all
*enddo
allsel

/out,AP-460-FCC-BES-Gravity,out
```

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```

/solu
antype,trans
TRNOPT,FULL
lumpm,OFF
!nlgeom,on
NROPT,auto
NTIM=10 !NUMBER OF TIME STEPS
DT=0.01
TIM=1e-06
autots,on
KBC,on
TIMINT,ON,STRU
solcontrol,ON,off,,
ncnv,0,200
LNSRCH,OFF
PRED,on,,on

/COM - Time File

/COM - Dimension Horizontal Input
*DIM,A_1_x,,2148
*DIM,A_1_z,,2148

*VREAD,A_1_x(1),th-266-Mean-geo,txt
(8(F9.6))
*VREAD,A_1_z(1),th-266-Mean-geo-v,txt
(8(F9.6))

/Title,Load Case: AP-460-BES-FCC, Full Non-linear, Dome Contact Friction = 0.0, Gravity
OUTPR,all,NONE,
OUTRES, ALL,NONE,
OUTRES,RSOL,last
OUTRES,NSOL,last
OUTRES,ESOL,last,conc-tank
OUTRES,esol,last,Primary-tank
OUTRES,ESOL,last,J_bolts
OUTRES,Epel,last,liner
outres,esol,last,wall-int-gap
outres,esol,last,conc-excav-wall-gap
outres,esol,last,conc-excav-dome-gap
!outres, strs,last,excav-soil
!outres, strs,last,bottom-soil
outres,esol,last,bolt-friction
outres,esol,last,waste-surf
outres, strs,last,insul-conc
outres,esol,last,primary-int-gap
outres,esol,last,conc-liner-gap
outres,esol,last,far-soil-contact
!outres,esol,last,soil-contact-foot-elem

alphad,alpha
NSUBST,20,200,5,ON
TIME,100
TIMINT,off
acel,0,0,g
SOLVE
SAVE
TIMINT,on
ITIM=1
DS=TIM
NSUBST,1,20,1,ON

!ddelete, master_node,ux
!ddelete, master_node,uz

esel,s,type,,61,63,2
mpchg,64,all

esel,s,type,,91,93,2
mpchg,92,all

```


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```

allsel

*DO, ITIM, 1, NTIM, 1

TIM=DT*ITIM

TIME, TIM+100

!F, master_node, FX, A_1_X(itim) * mass * g
!F, master_node, Fz, (A_1_Z(itim) + 1) * (mass + massm_z) * g

SOLVE
SAVE
*ENDDO
FINISH
/out

```

Solve-TH-BES

```

/prep7
massm_z=148414.59
d, master_node, all
allsel

cmsel, s, excav-soil
nsle
csys, 0
nsel, r, loc, x, -ctx(6) - 1, ctx(6) + 1
nsel, r, loc, y, 0, -ctx(6) - 1
esln, r, 1
mpchg, 810, all

cmsel, s, excav-soil
nsle
csys, 1
nsel, r, loc, x, ctx(11) - 1, ctx(13) + 1
nsel, r, loc, z, soilz(1), soilz(3) - 1
esln, r, 1
mpchg, 810, all

*do, i, 801, 808
esel, s, mat, , i
mpchg, i + 10, all
*enddo
allsel

/out, AP-460-FCC-BES-Seismic, out
/solu
antype, trans
TRNOPT, FULL
lumpm, OFF
!nlgeom, on
NROPT, auto
NTIM=2148
DT=0.01
TIM=1e-06
autots, on
KBC, on
TIMINT, ON, STRU
solcontrol, ON, off, ,
ncnv, 0, 200
LNSRCH, OFF
PRED, on, , on

/COM - Time File

/COM - Dimension Horizontal Input
*DIM, A_1_x, , 2148
*DIM, A_1_z, , 2148

```

RPP-RPT-32239, Rev. 1
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```

*VREAD,A_1_x(1),th-266-Mean-geo,txt
(8(F9.6))
*VREAD,A_1_Z(1),th-266-Mean-geo-v,txt
(8(F9.6))

/Title,Load Case: AP-460-BES-FCC, Full Non-linear, Dome Contact Friction = 0.0
OUTPR,all,NONE,
OUTRES, ALL,NONE,
OUTRES,RSOL,last
OUTRES,NSOL,last
OUTRES,ESOL,last,conc-tank
OUTRES,esol,last,Primary-tank
OUTRES,ESOL,last,J_bolts
OUTRES,Epel,last,liner
outres,esol,last,wall-int-gap
outres,esol,last,conc-excav-wall-gap
outres,esol,last,conc-excav-dome-gap
!outres, strs,last,excav-soil
!outres, strs,last,bottom-soil
outres,esol,last,bolt-friction
outres,esol,last,waste-surf
outres, strs,last,insul-conc
outres,esol,last,primary-int-gap
outres,esol,last,conc-liner-gap
outres,esol,last,far-soil-contact
!outres,esol,last,soil-contact-foot-elem

alphad,alpha
NSUBST,20,200,5,ON
TIME,100
TIMINT,off
acel,0,0,g
SOLVE
SAVE
TIMINT,on
ITIM=1
DS=TIM
NSUBST,1,20,1,ON

ddelete, master_node, ux
ddelete, master_node, uz

esel,s,type,,61,63,2
mpchg,64,all

esel,s,type,,91,93,2
mpchg,92,all

allsel

*DO, ITIM, 1, NTIM, 1

TIM=DT*ITIM

TIME, TIM+100

F, master_node, FX, A_1_X(itim) * mass * g
F, master_node, Fz, (A_1_Z(itim) + 1) * (mass + massm_z) * g

SOLVE
SAVE
*ENDDO
FINISH
/out

```

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Tank-Props-Crack

/COM - Tank Concrete Properties

/COM - Material Definitions

! EX - Youngs Modulus, (k/ft2)
! NUXY - Poissons ratio
! DENS - Density (1000*slugs/ft3)
! DAMP - Beta (Stiffness) Damping

/COM - Material 1, Tank Concrete - Dome Center

mp,ex,1,156131
mp,nuxy,1,0.18
mp,dens,1,170/(1000*g)
mp,damp,1,0.07/df

/COM - Material 2, Tank Concrete

mp,ex,2,134843
mp,nuxy,2,0.18
mp,dens,2,1864/(1000*g)
mp,damp,2,0.07/df

/COM - Material 3, Tank Concrete

mp,ex,3,122210
mp,nuxy,3,0.18
mp,dens,3,196/(1000*g)
mp,damp,3,0.07/df

/COM - Material 4, Tank Concrete

mp,ex,4,134181
mp,nuxy,4,0.18
mp,dens,4,181/(1000*g)
mp,damp,4,0.07/df

/COM - Material 5, Tank Concrete

mp,ex, 5,156781
mp,nuxy, 5,0.18
mp,dens, 5,169/(1000*g)
mp,damp,5,0.07/df

/COM - Material 6, Tank Concrete

mp,ex,6,148115
mp,nuxy,6,0.18
mp,dens,6,172/(1000*g)
mp,damp,6,0.07/df

/COM - Material 7, Tank Concrete

mp,ex,7,219124
mp,nuxy,7,0.18
mp,dens,7,151/(1000*g)
mp,damp,7,0.07/df

/COM - Material 8, Tank Concrete

mp,ex,8,209367
mp,nuxy,8,0.18
mp,dens,8,154/(1000*g)
mp,damp,8,0.07/df

/COM - Material 9, Tank Concrete

mp,ex,9,212206
mp,nuxy,9,0.18
mp,dens,9,155/(1000*g)
mp,damp,9,0.07/df

/COM - Material,10, Tank Concrete

mp,ex,10,195944
mp,nuxy,10,0.18
mp,dens,10,139/(1000*g)
mp,damp,10,0.07/df

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/COM - Material,11, Tank Concrete
mp,ex,11,182924
mp,nuxy,11,0.18
mp,dens,11,138/(1000*g)
mp,damp,11,0.07/df

/COM - Material,12, Tank Concrete
mp,ex,12,187438
mp,nuxy,12,0.18
mp,dens,12,156/(1000*g)
mp,damp,12,0.07/df

/COM - Material,13, Tank Concrete
mp,ex,13,143402
mp,nuxy,13,0.18
mp,dens,13,190/(1000*g)
mp,damp,13,0.07/df

/COM - Material,14, Tank Concrete
mp,ex,14,142377
mp,nuxy,14,0.18
mp,dens,14,172/(1000*g)
mp,damp,14,0.07/df

/COM - Material,15, Tank Concrete
mp,ex,15,126463
mp,nuxy,15,0.18
mp,dens,15,178/(1000*g)
mp,damp,15,0.07/df

/COM - Material,16, Tank Concrete
mp,ex,16,126463
mp,nuxy,16,0.18
mp,dens,16,178/(1000*g)
mp,damp,16,0.07/df

/COM - Material,17, Tank Concrete
mp,ex,17,126463
mp,nuxy,17,0.18
mp,dens,17,178/(1000*g)
mp,damp,17,0.07/df

/COM - Material,18, Tank Concrete
mp,ex,18,113881
mp,nuxy,18,0.18
mp,dens,18,186/(1000*g)
mp,damp,18,0.07/df

/COM - Material,19, Tank Concrete
mp,ex,19,113881
mp,nuxy,19,0.18
mp,dens,19,186/(1000*g)
mp,damp,19,0.07/df

/COM - Material,20, Tank Concrete
mp,ex,20,113629
mp,nuxy,20,0.18
mp,dens,20,205/(1000*g)
mp,damp,20,0.07/df

/COM - Material,21, Tank Concrete
mp,ex,21,134235
mp,nuxy,21,0.18
mp,dens,21,182/(1000*g)
mp,damp,21,0.07/df

/COM - Material,22, Tank Concrete
mp,ex,22,139096
mp,nuxy,22,0.18
mp,dens,22,181/(1000*g)
mp,damp,22,0.07/df

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```
/COM - Material,23, Tank Concrete
mp,ex,23,93743
mp,nuxy,23,0.18
mp,dens,23,229/(1000*g)
mp,damp,23,0.060/df
```

```
/COM - Material,24, Tank Concrete
mp,ex,24,118250
mp,nuxy,24,0.18
mp,dens,24,244/(1000*g)
mp,damp,24,0.07/df
```

```
/COM - Material,25, Tank Concrete
mp,ex,25,165097
mp,nuxy,25,0.18
mp,dens,25,342/(1000*g)
mp,damp,25,0.07/df
```

```
/COM - Material,26, Tank Concrete
mp,ex,26,179441
mp,nuxy,26,0.18
mp,dens,26,317/(1000*g)
mp,damp,26,0.07/df
```

```
/COM - Material,27, Tank Concrete
mp,ex,27,199781
mp,nuxy,27,0.18
mp,dens,27,381/(1000*g)
mp,damp,27,0.07/df
```

```
/COM - Material,28, Tank Concrete
mp,ex,28,149439
mp,nuxy,28,0.18
mp,dens,28,293/(1000*g)
mp,damp,28,0.07/df
```

```
/COM - Material,29, Tank Concrete
mp,ex,29,171940
mp,nuxy,29,0.18
mp,dens,29,282/(1000*g)
mp,damp,29,0.07/df
```

```
/COM - Material,30, Tank Concrete
mp,ex,30,144316
mp,nuxy,30,0.18
mp,dens,30,301/(1000*g)
mp,damp,30,0.07/df
```

```
/COM - Material,31, Tank Concrete
mp,ex,31,790720
mp,nuxy,31,0.18
mp,dens,31,150/(1000*g)
mp,damp,31,0.07/df
```

```
/COM - Material,32, Tank Concrete
mp,ex,32,790720
mp,nuxy,32,0.18
mp,dens,32,150/(1000*g)
mp,damp,32,0.07/df
```

```
!/COM - Material,33, Tank Concrete
!mp,ex,33,731952
!mp,nuxy,33,0.18
!mp,dens,33,150/(1000*g)
!mp,damp,33,0.07/df
```

```
!/COM - Material,34, Tank Concrete
!mp,ex,34,731952
!mp,nuxy,34,0.18
!mp,dens,34,150/(1000*g)
```

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```

!mp,damp,34,0.07/df

!/COM - Material,35, Tank Concrete
!mp,ex,35,731952
!mp,nuxy,35,0.18
!mp,dens,35,150/(1000*g)
!mp,damp,35,0.07/df

!/COM - Material,36, Tank Concrete
!mp,ex,36,731952
!mp,nuxy,36,0.18
!mp,dens,36,150/(1000*g)
!mp,damp,36,0.07/df

!/COM - Material,37, Tank Concrete
!mp,ex,37,731952
!mp,nuxy,37,0.18
!mp,dens,37,150/(1000*g)
!mp,damp,37,0.07/df

/COM - Concrete Real Values, t in ft
r,1,1.10 ! 13.21 in
r,2,1.01 ! 12.10 in
r,3,.96 ! 11.49 in
r,4,1.03 ! 12.41 in
r,5,1.11 ! 13.32 in
r,6,1.09 ! 13.08 in
r,7,1.24 ! 14.86 in
r,8,1.22 ! 14.59 in
r,9,1.64 ! 19.67 in
r,10,1.64,1.64,2.65,2.65 ! 31.78 in to
r,11,2.65,2.65,2.69,2.69 !
r,12,2.69,2.69,1.53,1.53 !
r,13,1.53,1.53,1.19,1.19
r,14,1.31 ! 15.72 in
r,15,1.27 ! 15.21 in
r,16,1.27 ! 15.21 in
r,17,1.27 ! 15.21 in
r,18,1.21 ! 14.54 in
r,19,1.21 ! 14.54 in
r,20,1.10 ! 13.17 in
r,21,1.79 ! 21.54 in
r,22,1.71 ! 20.46 in
r,23,1.20 ! 14.43 in
r,24,1.20,0.81,0.81,1.20 !
r,25,0.81,0.41,0.41,0.81 !
r,26,0.41,0.42,0.42,0.41 !
r,27,0.43 ! 5.18 in
r,28,0.56 ! 6.73 in
r,29,0.58 ! 6.99 in
r,30,0.55 ! 6.57 in
r,31,0.55,1.02,1.02,0.55 ! 12.18 in to
r,32,1.02 !
!r,34,1
!r,35,1
!r,36,1
!r,37,1
!r,39,1

/COM - Material,50, Insulating Concrete
mp,ex,50,23760
mp,nuxy,50,0.15
mp,dens,50,50/(1000*g)
mp,damp,50,0.07/df

```

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TH-266-Mean-Geo.txt

```
-0.000046 0.000024 0.000044-0.000025-0.000044 0.000024 0.000042-0.000025    1
-0.000042 0.000024 0.000040-0.000025-0.000040 0.000024 0.000037-0.000025    2
-0.000037 0.000024 0.000033-0.000025-0.000033 0.000023 0.000030-0.000026    3
.....
-0.000054 0.000023 0.000053-0.000023-0.000053 0.000023 0.000052-0.000023   510
-0.000052 0.000023 0.000051-0.000024-0.000051 0.000023 0.000050-0.000024   511
-0.000049 0.000023 0.000048-0.000024-0.000048 0.000023 0.000046-0.000024   512
```

TH-266-Mean-Geo-V.txt

```
-0.000029 0.000124 0.000029-0.000125-0.000029 0.000126 0.000030-0.000127    1
-0.000030 0.000128 0.000030-0.000128-0.000030 0.000130 0.000031-0.000130    2
-0.000031 0.000131 0.000032-0.000132-0.000032 0.000133 0.000033-0.000134    3
.....
-0.000026 0.000116 0.000026-0.000116-0.000026 0.000117 0.000027-0.000118   510
-0.000027 0.000118 0.000027-0.000119-0.000027 0.000120 0.000028-0.000120   511
-0.000028 0.000121 0.000028-0.000122-0.000028 0.000123 0.000029-0.000123   512
```

BES-FCC Seismic File Listing

Volume in drive C is 320GB 2xRAID0
Volume Serial Number is D4F8-03B9

Directory of C:\Users\FGA\DST Seismic\AP-460-BES-FCC-780 Secant

```
11/28/2007  04:20 PM  <DIR>          .
11/28/2007  04:20 PM  <DIR>          ..
09/02/2007  02:32 PM          561,576 Accel-ct-0.out
09/02/2007  02:33 PM          561,828 Accel-ct-135.out
09/02/2007  02:33 PM          561,828 Accel-ct-180.out
09/02/2007  02:32 PM          561,576 Accel-ct-45.out
09/02/2007  02:32 PM          561,828 Accel-ct-90.out
09/02/2007  02:32 PM          290,676 Accel-ct.out
09/02/2007  02:33 PM          561,828 Accel-PT-0.out
09/02/2007  02:33 PM          561,828 Accel-PT-135.out
09/02/2007  02:33 PM          561,828 Accel-PT-180.out
09/02/2007  02:33 PM          561,828 Accel-PT-45.out
09/02/2007  02:33 PM          561,828 Accel-PT-90.out
09/02/2007  02:34 PM          561,828 Accel-Soil.out
09/22/2006  01:00 PM              74 All-Forces.txt
11/28/2007  04:15 PM          751,616 AP-460-BES-FCC J Bolt Forces Seismic 780Secant.xls
11/26/2007  11:25 AM          791,552 AP-460-BES-FCC J-Bolt-Contact-Seismic.xls
09/02/2007  07:50 AM              2,998 AP-460-BES-FCC-Seismic.BCS
09/03/2007  04:35 AM        43,909,120 AP-460-BES-FCC-Seismic.db
09/02/2007  07:50 AM        63,897,600 AP-460-BES-FCC-Seismic.dbb
09/02/2007  07:50 AM        12,713,984 AP-460-BES-FCC-Seismic.emat
09/03/2007  04:35 AM          59,494 AP-460-BES-FCC-Seismic.err
09/02/2007  07:50 AM       111,607,808 AP-460-BES-FCC-Seismic.esav
09/02/2007  07:50 AM       30,081,024 AP-460-BES-FCC-Seismic.full
09/02/2007  07:49 AM       340,804,299 AP-460-BES-FCC-Seismic.ldhi
08/31/2007  11:06 AM              10 AP-460-BES-FCC-Seismic.log
09/02/2007  07:50 AM          198,991 AP-460-BES-FCC-Seismic.mntr
09/02/2007  07:49 AM       111,607,808 AP-460-BES-FCC-Seismic.osav
09/02/2007  07:50 AM           1,507 AP-460-BES-FCC-Seismic.PVTS
09/02/2007  07:50 AM       112,656,384 AP-460-BES-FCC-Seismic.r001
08/31/2007  11:07 AM       43,974,656 AP-460-BES-FCC-Seismic.rdb
09/02/2007  07:50 AM       4,294,967,296 AP-460-BES-FCC-Seismic.rst
08/31/2007  09:18 PM       4,294,967,296 AP-460-BES-FCC-Seismic.rst02
09/01/2007  02:25 AM       4,294,967,296 AP-460-BES-FCC-Seismic.rst03
09/01/2007  07:39 AM       4,294,967,296 AP-460-BES-FCC-Seismic.rst04
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09/01/2007	01:03 PM	4,294,967,296	AP-460-BES-FCC-Seismic.rst05
09/01/2007	06:34 PM	4,294,967,296	AP-460-BES-FCC-Seismic.rst06
09/02/2007	12:12 AM	4,294,967,296	AP-460-BES-FCC-Seismic.rst07
09/02/2007	05:58 AM	4,294,967,296	AP-460-BES-FCC-Seismic.rst08
09/02/2007	07:50 AM	1,388,445,696	AP-460-BES-FCC-Seismic.rst09
09/02/2007	07:50 AM	4,654,721	AP-460-FCC-BES-Seismic.out
01/02/2007	08:44 AM	59,216	BES-FCC-File.txt
08/15/2007	10:18 AM	6,120	Bolts-Friction.txt
09/08/2006	07:10 AM	277	Boundary.txt
08/25/2006	08:48 AM	220	Contact-AP.txt
08/21/2006	07:59 AM	586	Contact-Footing.txt
08/25/2006	01:28 PM	704	Contact-Insul.txt
08/25/2006	01:27 PM	704	Contact-J-Bolts.txt
08/25/2006	01:28 PM	708	Contact-Primary.txt
08/21/2006	07:59 AM	742	Contact-Soil.txt
08/21/2006	12:44 PM	632	Contact-Waste-AP.txt
11/28/2007	04:20 PM	0	dir_listing.txt
09/02/2007	02:32 PM	561,576	Disp-ct-0.out
09/02/2007	02:33 PM	561,576	Disp-ct-135.out
09/02/2007	02:33 PM	561,576	Disp-ct-180.out
09/02/2007	02:32 PM	561,576	Disp-ct-45.out
09/02/2007	02:32 PM	561,576	Disp-ct-90.out
09/02/2007	02:32 PM	290,550	Disp-ct.out
01/03/2006	11:17 AM	1,616	Disp-J-Bolts.txt
09/02/2007	02:33 PM	561,576	Disp-PT-0.out
09/02/2007	02:33 PM	561,576	Disp-PT-135.out
09/02/2007	02:33 PM	561,576	Disp-PT-180.out
09/02/2007	02:33 PM	561,576	Disp-PT-45.out
09/02/2007	02:33 PM	561,576	Disp-PT-90.out
09/02/2007	02:34 PM	561,576	Disp-Soil.out
05/08/2006	01:31 PM	8,616	Far-Soil.txt
09/04/2007	08:07 AM	340	file.err
09/04/2007	08:28 AM	1,878	file.log
10/13/2005	06:54 AM	562	Fix-Soil.txt
09/02/2007	02:31 PM	10,342	Footing-Cont_max.OUT
09/02/2007	02:31 PM	4,346,248	Footing-Cont_th.OUT
08/21/2006	08:00 AM	894	Force-c.txt
09/02/2007	06:29 PM	4,996	Force-c_108amax.OUT
09/02/2007	06:29 PM	2,905,500	Force-c_108ath.OUT
09/02/2007	04:03 PM	14,716	Force-c_108max.OUT
09/02/2007	04:03 PM	6,519,180	Force-c_108th.OUT
09/02/2007	06:36 PM	4,996	Force-c_117amax.OUT
09/02/2007	06:36 PM	2,905,500	Force-c_117ath.OUT
09/02/2007	04:10 PM	14,716	Force-c_117max.OUT
09/02/2007	04:10 PM	6,519,180	Force-c_117th.OUT
09/02/2007	06:44 PM	4,996	Force-c_126amax.OUT
09/02/2007	06:44 PM	2,905,500	Force-c_126ath.OUT
09/02/2007	04:17 PM	14,716	Force-c_126max.OUT
09/02/2007	04:17 PM	6,519,180	Force-c_126th.OUT
09/02/2007	06:51 PM	4,996	Force-c_135amax.OUT
09/02/2007	06:51 PM	2,905,500	Force-c_135ath.OUT
09/02/2007	04:25 PM	14,716	Force-c_135max.OUT
09/02/2007	04:25 PM	6,519,180	Force-c_135th.OUT
09/02/2007	06:59 PM	4,996	Force-c_144amax.OUT
09/02/2007	06:59 PM	2,905,500	Force-c_144ath.OUT
09/02/2007	04:33 PM	14,716	Force-c_144max.OUT
09/02/2007	04:33 PM	6,519,180	Force-c_144th.OUT
09/02/2007	07:06 PM	4,996	Force-c_153amax.OUT
09/02/2007	07:06 PM	2,905,500	Force-c_153ath.OUT
09/02/2007	04:40 PM	14,716	Force-c_153max.OUT
09/02/2007	04:40 PM	6,519,180	Force-c_153th.OUT
09/02/2007	07:13 PM	4,996	Force-c_162amax.OUT
09/02/2007	07:13 PM	2,905,500	Force-c_162ath.OUT
09/02/2007	04:47 PM	14,716	Force-c_162max.OUT
09/02/2007	04:47 PM	6,519,180	Force-c_162th.OUT

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09/02/2007	07:20	PM	4,996	Force-c_171amax.OUT
09/02/2007	07:20	PM	2,905,500	Force-c_171ath.OUT
09/02/2007	04:55	PM	14,716	Force-c_171max.OUT
09/02/2007	04:55	PM	6,519,180	Force-c_171th.OUT
09/02/2007	07:28	PM	4,996	Force-c_180amax.OUT
09/02/2007	07:28	PM	2,905,500	Force-c_180ath.OUT
09/02/2007	05:03	PM	14,716	Force-c_180max.OUT
09/02/2007	05:03	PM	6,519,180	Force-c_180th.OUT
09/02/2007	05:17	PM	4,996	Force-c_18amax.OUT
09/02/2007	05:17	PM	2,905,500	Force-c_18ath.OUT
09/02/2007	02:48	PM	14,716	Force-c_18max.OUT
09/02/2007	02:48	PM	6,519,180	Force-c_18th.OUT
09/02/2007	05:25	PM	4,996	Force-c_27amax.OUT
09/02/2007	05:25	PM	2,905,500	Force-c_27ath.OUT
09/02/2007	02:56	PM	14,716	Force-c_27max.OUT
09/02/2007	02:56	PM	6,519,180	Force-c_27th.OUT
09/02/2007	05:32	PM	4,996	Force-c_36amax.OUT
09/02/2007	05:32	PM	2,905,500	Force-c_36ath.OUT
09/02/2007	03:03	PM	14,716	Force-c_36max.OUT
09/02/2007	03:03	PM	6,519,180	Force-c_36th.OUT
09/02/2007	05:39	PM	4,996	Force-c_45amax.OUT
09/02/2007	05:39	PM	2,905,500	Force-c_45ath.OUT
09/02/2007	03:11	PM	14,716	Force-c_45max.OUT
09/02/2007	03:11	PM	6,519,180	Force-c_45th.OUT
09/02/2007	05:46	PM	4,996	Force-c_54amax.OUT
09/02/2007	05:46	PM	2,905,500	Force-c_54ath.OUT
09/02/2007	03:18	PM	14,716	Force-c_54max.OUT
09/02/2007	03:18	PM	6,519,180	Force-c_54th.OUT
09/02/2007	05:54	PM	4,996	Force-c_63amax.OUT
09/02/2007	05:54	PM	2,905,500	Force-c_63ath.OUT
09/02/2007	03:26	PM	14,716	Force-c_63max.OUT
09/02/2007	03:26	PM	6,519,180	Force-c_63th.OUT
09/02/2007	06:00	PM	4,996	Force-c_72amax.OUT
09/02/2007	06:00	PM	2,905,500	Force-c_72ath.OUT
09/02/2007	03:32	PM	14,716	Force-c_72max.OUT
09/02/2007	03:33	PM	6,519,180	Force-c_72th.OUT
09/02/2007	06:07	PM	4,996	Force-c_81amax.OUT
09/02/2007	06:08	PM	2,905,500	Force-c_81ath.OUT
09/02/2007	03:40	PM	14,716	Force-c_81max.OUT
09/02/2007	03:40	PM	6,519,180	Force-c_81th.OUT
09/02/2007	06:15	PM	4,996	Force-c_90amax.OUT
09/02/2007	06:15	PM	2,905,500	Force-c_90ath.OUT
09/02/2007	03:48	PM	14,716	Force-c_90max.OUT
09/02/2007	03:48	PM	6,519,180	Force-c_90th.OUT
09/02/2007	06:22	PM	4,996	Force-c_99amax.OUT
09/02/2007	06:22	PM	2,905,500	Force-c_99ath.OUT
09/02/2007	03:55	PM	14,716	Force-c_99max.OUT
09/02/2007	03:55	PM	6,519,180	Force-c_99th.OUT
09/02/2007	05:10	PM	4,996	Force-c_9amax.OUT
09/02/2007	05:10	PM	2,905,628	Force-c_9ath.OUT
09/02/2007	02:41	PM	14,716	Force-c_9max.OUT
09/02/2007	02:41	PM	6,519,308	Force-c_9th.OUT
09/04/2007	10:22	AM	134,656	force-jb.xls
09/03/2007	04:34	AM	2,666,244	Force-jb_r10-th.OUT
09/03/2007	04:34	AM	5,239	Force-jb_r10_max.OUT
09/03/2007	04:35	AM	2,666,244	Force-jb_r11-th.OUT
09/03/2007	04:35	AM	5,239	Force-jb_r11_max.OUT
09/03/2007	04:30	AM	2,666,372	Force-jb_r2-th.OUT
09/03/2007	04:30	AM	5,239	Force-jb_r2_max.OUT
09/03/2007	04:30	AM	2,666,244	Force-jb_r3-th.OUT
09/03/2007	04:30	AM	5,239	Force-jb_r3_max.OUT
09/03/2007	04:31	AM	2,666,244	Force-jb_r4-th.OUT
09/03/2007	04:31	AM	5,239	Force-jb_r4_max.OUT
09/03/2007	04:31	AM	2,666,244	Force-jb_r5-th.OUT
09/03/2007	04:31	AM	5,239	Force-jb_r5_max.OUT

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09/03/2007	04:32 AM	2,666,244	Force-jb_r6-th.OUT
09/03/2007	04:32 AM	5,239	Force-jb_r6_max.OUT
09/03/2007	04:32 AM	2,666,244	Force-jb_r7-th.OUT
09/03/2007	04:32 AM	5,239	Force-jb_r7_max.OUT
09/03/2007	04:33 AM	2,666,244	Force-jb_r8-th.OUT
09/03/2007	04:33 AM	5,239	Force-jb_r8_max.OUT
09/03/2007	04:33 AM	2,666,244	Force-jb_r9-th.OUT
09/03/2007	04:33 AM	5,239	Force-jb_r9_max.OUT
08/21/2006	08:00 AM	661	Force-j_bolt.txt
11/21/2007	02:57 PM	<DIR>	Gravity
09/02/2007	11:11 AM	4,024	Insul-Cont_108max.OUT
09/02/2007	11:11 AM	1,738,448	Insul-Cont_108th.OUT
09/02/2007	11:12 AM	4,024	Insul-Cont_117max.OUT
09/02/2007	11:12 AM	1,738,448	Insul-Cont_117th.OUT
09/02/2007	11:13 AM	4,024	Insul-Cont_126max.OUT
09/02/2007	11:13 AM	1,738,448	Insul-Cont_126th.OUT
09/02/2007	11:14 AM	4,024	Insul-Cont_135max.OUT
09/02/2007	11:14 AM	1,738,448	Insul-Cont_135th.OUT
09/02/2007	11:15 AM	4,024	Insul-Cont_144max.OUT
09/02/2007	11:15 AM	1,738,448	Insul-Cont_144th.OUT
09/02/2007	11:16 AM	4,024	Insul-Cont_153max.OUT
09/02/2007	11:16 AM	1,738,448	Insul-Cont_153th.OUT
09/02/2007	11:17 AM	4,024	Insul-Cont_162max.OUT
09/02/2007	11:17 AM	1,738,448	Insul-Cont_162th.OUT
09/02/2007	11:18 AM	4,024	Insul-Cont_171max.OUT
09/02/2007	11:18 AM	1,738,448	Insul-Cont_171th.OUT
09/02/2007	11:19 AM	4,024	Insul-Cont_180max.OUT
09/02/2007	11:19 AM	1,738,448	Insul-Cont_180th.OUT
09/02/2007	11:03 AM	4,024	Insul-Cont_18max.OUT
09/02/2007	11:03 AM	1,738,448	Insul-Cont_18th.OUT
09/02/2007	11:04 AM	4,024	Insul-Cont_27max.OUT
09/02/2007	11:04 AM	1,738,448	Insul-Cont_27th.OUT
09/02/2007	11:05 AM	4,024	Insul-Cont_36max.OUT
09/02/2007	11:05 AM	1,738,448	Insul-Cont_36th.OUT
09/02/2007	11:06 AM	4,024	Insul-Cont_45max.OUT
09/02/2007	11:06 AM	1,738,448	Insul-Cont_45th.OUT
09/02/2007	11:06 AM	4,024	Insul-Cont_54max.OUT
09/02/2007	11:06 AM	1,738,448	Insul-Cont_54th.OUT
09/02/2007	11:07 AM	4,024	Insul-Cont_63max.OUT
09/02/2007	11:07 AM	1,738,448	Insul-Cont_63th.OUT
09/02/2007	11:08 AM	4,024	Insul-Cont_72max.OUT
09/02/2007	11:08 AM	1,738,448	Insul-Cont_72th.OUT
09/02/2007	11:08 AM	4,024	Insul-Cont_81max.OUT
09/02/2007	11:09 AM	1,738,448	Insul-Cont_81th.OUT
09/02/2007	11:10 AM	4,024	Insul-Cont_90max.OUT
09/02/2007	11:10 AM	1,738,448	Insul-Cont_90th.OUT
09/02/2007	11:10 AM	4,024	Insul-Cont_99max.OUT
09/02/2007	11:10 AM	1,738,448	Insul-Cont_99th.OUT
09/02/2007	11:02 AM	4,024	Insul-Cont_9max.OUT
09/02/2007	11:02 AM	1,738,576	Insul-Cont_9th.OUT
09/22/2006	03:37 PM	1,672	Insulate.txt
07/20/2006	06:36 AM	4,030	interface-gap1.txt
09/22/2006	04:02 PM	2,411	interfacel.txt
11/23/2007	12:35 PM	116,736	J-Bolt-Contact_0-90.xls
11/23/2007	12:39 PM	116,736	J-Bolt-Contact_99-180.xls
09/02/2007	12:02 PM	4,519	J-Bolt-Cont_108max.OUT
09/02/2007	12:02 PM	1,685,484	J-Bolt-Cont_108th.OUT
09/02/2007	12:04 PM	4,519	J-Bolt-Cont_117max.OUT
09/02/2007	12:04 PM	1,685,484	J-Bolt-Cont_117th.OUT
09/02/2007	12:05 PM	4,519	J-Bolt-Cont_126max.OUT
09/02/2007	12:05 PM	1,685,484	J-Bolt-Cont_126th.OUT
09/02/2007	12:07 PM	4,519	J-Bolt-Cont_135max.OUT
09/02/2007	12:07 PM	1,685,484	J-Bolt-Cont_135th.OUT
09/02/2007	12:08 PM	4,519	J-Bolt-Cont_144max.OUT
09/02/2007	12:08 PM	1,685,484	J-Bolt-Cont_144th.OUT

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09/02/2007	12:09 PM	4,519	J-Bolt-Cont_153max.OUT
09/02/2007	12:09 PM	1,685,484	J-Bolt-Cont_153th.OUT
09/02/2007	12:09 PM	4,519	J-Bolt-Cont_162max.OUT
09/02/2007	12:09 PM	1,685,484	J-Bolt-Cont_162th.OUT
09/02/2007	12:11 PM	4,519	J-Bolt-Cont_171max.OUT
09/02/2007	12:11 PM	1,685,484	J-Bolt-Cont_171th.OUT
09/02/2007	12:12 PM	4,519	J-Bolt-Cont_180max.OUT
09/02/2007	12:12 PM	1,685,484	J-Bolt-Cont_180th.OUT
09/02/2007	11:49 AM	4,519	J-Bolt-Cont_18max.OUT
09/02/2007	11:49 AM	1,685,484	J-Bolt-Cont_18th.OUT
09/02/2007	11:50 AM	4,519	J-Bolt-Cont_27max.OUT
09/02/2007	11:50 AM	1,685,484	J-Bolt-Cont_27th.OUT
09/02/2007	11:51 AM	4,519	J-Bolt-Cont_36max.OUT
09/02/2007	11:51 AM	1,685,484	J-Bolt-Cont_36th.OUT
09/02/2007	11:53 AM	4,519	J-Bolt-Cont_45max.OUT
09/02/2007	11:53 AM	1,685,484	J-Bolt-Cont_45th.OUT
09/02/2007	11:55 AM	4,519	J-Bolt-Cont_54max.OUT
09/02/2007	11:55 AM	1,685,484	J-Bolt-Cont_54th.OUT
09/02/2007	11:57 AM	4,519	J-Bolt-Cont_63max.OUT
09/02/2007	11:57 AM	1,685,484	J-Bolt-Cont_63th.OUT
09/02/2007	11:58 AM	4,519	J-Bolt-Cont_72max.OUT
09/02/2007	11:58 AM	1,685,484	J-Bolt-Cont_72th.OUT
09/02/2007	12:00 PM	4,519	J-Bolt-Cont_81max.OUT
09/02/2007	12:00 PM	1,685,484	J-Bolt-Cont_81th.OUT
09/02/2007	12:01 PM	4,519	J-Bolt-Cont_90max.OUT
09/02/2007	12:01 PM	1,685,484	J-Bolt-Cont_90th.OUT
09/02/2007	12:01 PM	4,519	J-Bolt-Cont_99max.OUT
09/02/2007	12:01 PM	1,685,484	J-Bolt-Cont_99th.OUT
09/02/2007	11:48 AM	4,519	J-Bolt-Cont_9max.OUT
09/02/2007	11:48 AM	1,685,612	J-Bolt-Cont_9th.OUT
08/23/2006	07:47 AM	1,971	Liner.txt
05/02/2005	02:19 PM	667	live_load.txt
07/21/2006	10:03 AM	6,214	Near-Soil-1.txt
04/20/2005	01:14 PM	508	outer-spar.txt
10/13/2006	07:45 AM	147	Post-Tank.txt
09/02/2007	11:35 AM	4,024	Primary-Cont_108max.OUT
09/02/2007	11:35 AM	1,738,448	Primary-Cont_108th.OUT
09/02/2007	11:37 AM	4,024	Primary-Cont_117max.OUT
09/02/2007	11:37 AM	1,738,448	Primary-Cont_117th.OUT
09/02/2007	11:38 AM	4,024	Primary-Cont_126max.OUT
09/02/2007	11:38 AM	1,738,448	Primary-Cont_126th.OUT
09/02/2007	11:39 AM	4,024	Primary-Cont_135max.OUT
09/02/2007	11:39 AM	1,738,448	Primary-Cont_135th.OUT
09/02/2007	11:41 AM	4,024	Primary-Cont_144max.OUT
09/02/2007	11:41 AM	1,738,448	Primary-Cont_144th.OUT
09/02/2007	11:41 AM	4,024	Primary-Cont_153max.OUT
09/02/2007	11:41 AM	1,738,448	Primary-Cont_153th.OUT
09/02/2007	11:43 AM	4,024	Primary-Cont_162max.OUT
09/02/2007	11:43 AM	1,738,448	Primary-Cont_162th.OUT
09/02/2007	11:44 AM	4,024	Primary-Cont_171max.OUT
09/02/2007	11:44 AM	1,738,448	Primary-Cont_171th.OUT
09/02/2007	11:46 AM	4,024	Primary-Cont_180max.OUT
09/02/2007	11:46 AM	1,738,448	Primary-Cont_180th.OUT
09/02/2007	11:22 AM	4,024	Primary-Cont_18max.OUT
09/02/2007	11:22 AM	1,738,448	Primary-Cont_18th.OUT
09/02/2007	11:24 AM	4,024	Primary-Cont_27max.OUT
09/02/2007	11:24 AM	1,738,448	Primary-Cont_27th.OUT
09/02/2007	11:25 AM	4,024	Primary-Cont_36max.OUT
09/02/2007	11:25 AM	1,738,448	Primary-Cont_36th.OUT
09/02/2007	11:27 AM	4,024	Primary-Cont_45max.OUT
09/02/2007	11:27 AM	1,738,448	Primary-Cont_45th.OUT
09/02/2007	11:28 AM	4,024	Primary-Cont_54max.OUT
09/02/2007	11:28 AM	1,738,448	Primary-Cont_54th.OUT
09/02/2007	11:29 AM	4,024	Primary-Cont_63max.OUT
09/02/2007	11:29 AM	1,738,448	Primary-Cont_63th.OUT

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09/02/2007	11:30 AM	4,024	Primary-Cont_72max.OUT
09/02/2007	11:30 AM	1,738,448	Primary-Cont_72th.OUT
09/02/2007	11:32 AM	4,024	Primary-Cont_81max.OUT
09/02/2007	11:32 AM	1,738,448	Primary-Cont_81th.OUT
09/02/2007	11:33 AM	4,024	Primary-Cont_90max.OUT
09/02/2007	11:33 AM	1,738,448	Primary-Cont_90th.OUT
09/02/2007	11:34 AM	4,024	Primary-Cont_99max.OUT
09/02/2007	11:34 AM	1,738,448	Primary-Cont_99th.OUT
09/02/2007	11:21 AM	4,024	Primary-Cont_9max.OUT
09/02/2007	11:21 AM	1,738,576	Primary-Cont_9th.OUT
10/12/2006	02:28 PM	6,028	Primary-Props-AP.txt
09/27/2005	03:52 PM	1,538	Primary.txt
08/31/2007	11:07 AM	450,409	QA.out
09/02/2007	02:32 PM	47,121	RS-ct-0.out
09/02/2007	02:33 PM	47,121	RS-ct-135.out
09/02/2007	02:33 PM	47,121	RS-ct-180.out
09/02/2007	02:32 PM	47,121	RS-ct-45.out
09/02/2007	02:32 PM	47,121	RS-ct-90.out
09/02/2007	02:32 PM	27,591	RS-ct.out
09/02/2007	02:33 PM	47,121	RS-PT-0.out
09/02/2007	02:33 PM	47,121	RS-PT-135.out
09/02/2007	02:33 PM	47,121	RS-PT-180.out
09/02/2007	02:33 PM	47,121	RS-PT-45.out
09/02/2007	02:33 PM	47,121	RS-PT-90.out
09/02/2007	02:34 PM	47,121	RS-Soil.out
10/31/2005	10:31 AM	1,108	RS_FREQ.txt
08/31/2007	11:04 AM	1,819	Run-Tank.txt
09/04/2007	08:07 AM	0	scratch.hlp
02/11/2005	01:22 PM	1,053	Slave.txt
09/02/2007	01:21 PM	9,896	Soil-Contact_108max.OUT
09/02/2007	01:21 PM	4,348,080	Soil-Contact_108th.OUT
09/02/2007	01:27 PM	9,896	Soil-Contact_117max.OUT
09/02/2007	01:27 PM	4,348,080	Soil-Contact_117th.OUT
09/02/2007	01:33 PM	9,896	Soil-Contact_126max.OUT
09/02/2007	01:33 PM	4,348,080	Soil-Contact_126th.OUT
09/02/2007	01:38 PM	9,896	Soil-Contact_135max.OUT
09/02/2007	01:38 PM	4,348,080	Soil-Contact_135th.OUT
09/02/2007	01:44 PM	9,896	Soil-Contact_144max.OUT
09/02/2007	01:44 PM	4,348,080	Soil-Contact_144th.OUT
09/02/2007	01:50 PM	9,896	Soil-Contact_153max.OUT
09/02/2007	01:50 PM	4,348,080	Soil-Contact_153th.OUT
09/02/2007	01:56 PM	9,896	Soil-Contact_162max.OUT
09/02/2007	01:56 PM	4,348,080	Soil-Contact_162th.OUT
09/02/2007	02:02 PM	9,896	Soil-Contact_171max.OUT
09/02/2007	02:02 PM	4,348,080	Soil-Contact_171th.OUT
09/02/2007	02:07 PM	9,896	Soil-Contact_180max.OUT
09/02/2007	02:07 PM	4,348,080	Soil-Contact_180th.OUT
09/02/2007	12:23 PM	9,896	Soil-Contact_18max.OUT
09/02/2007	12:23 PM	4,348,080	Soil-Contact_18th.OUT
09/02/2007	12:29 PM	9,896	Soil-Contact_27max.OUT
09/02/2007	12:29 PM	4,348,080	Soil-Contact_27th.OUT
09/02/2007	12:35 PM	9,896	Soil-Contact_36max.OUT
09/02/2007	12:35 PM	4,348,080	Soil-Contact_36th.OUT
09/02/2007	12:41 PM	9,896	Soil-Contact_45max.OUT
09/02/2007	12:41 PM	4,348,080	Soil-Contact_45th.OUT
09/02/2007	12:47 PM	9,896	Soil-Contact_54max.OUT
09/02/2007	12:47 PM	4,348,080	Soil-Contact_54th.OUT
09/02/2007	12:52 PM	9,896	Soil-Contact_63max.OUT
09/02/2007	12:52 PM	4,348,080	Soil-Contact_63th.OUT
09/02/2007	12:58 PM	9,896	Soil-Contact_72max.OUT
09/02/2007	12:58 PM	4,348,080	Soil-Contact_72th.OUT
09/02/2007	01:04 PM	9,896	Soil-Contact_81max.OUT
09/02/2007	01:04 PM	4,348,080	Soil-Contact_81th.OUT
09/02/2007	01:10 PM	9,896	Soil-Contact_90max.OUT
09/02/2007	01:10 PM	4,348,080	Soil-Contact_90th.OUT

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09/02/2007	01:16 PM	9,896	Soil-Contact_99max.OUT
09/02/2007	01:16 PM	4,348,080	Soil-Contact_99th.OUT
09/02/2007	12:18 PM	9,896	Soil-Contact_9max.OUT
09/02/2007	12:18 PM	4,348,208	Soil-Contact_9th.OUT
11/11/2005	10:36 AM	4,989	Soil-Prop-Mean-Geo.txt
08/31/2007	11:05 AM	1,922	Solve-TH-BES.txt
09/13/2006	06:12 AM	347	spectra-all.txt
09/13/2006	06:07 AM	3,690	spectra-conc-0.txt
09/13/2006	06:08 AM	3,723	spectra-conc-135.txt
09/13/2006	06:09 AM	3,723	spectra-conc-180.txt
09/13/2006	06:08 AM	3,769	spectra-conc-45.txt
09/13/2006	06:08 AM	3,649	spectra-conc-90.txt
09/13/2006	06:09 AM	1,590	spectra-conc.txt
08/28/2006	09:38 AM	2,076	spectra-concrete.txt
09/13/2006	06:13 AM	3,609	spectra-primary-0.txt
09/13/2006	06:14 AM	3,762	spectra-primary-135.txt
09/13/2006	06:15 AM	3,777	spectra-primary-180.txt
09/13/2006	06:13 AM	3,688	spectra-primary-45.txt
09/13/2006	06:14 AM	3,688	spectra-primary-90.txt
09/13/2006	06:15 AM	3,801	spectra-soil.txt
06/20/2005	09:04 AM	647	spectra-wall.txt
06/20/2005	08:52 AM	679	spectra-waste.txt
01/03/2007	03:40 PM	1,823	strain-backed-principle-bot.txt
01/03/2007	03:40 PM	1,828	strain-backed-principle-mid.txt
01/03/2007	03:41 PM	1,825	strain-backed-principle-top.txt
01/03/2007	04:02 PM	966	strain-backed-principle.txt
08/21/2006	08:02 AM	598	stress-compb.txt
08/21/2006	08:03 AM	608	stress-compm.txt
08/24/2006	03:19 PM	598	stress-compt.txt
08/24/2006	12:05 PM	224	Stress-Primary.txt
09/03/2007	03:16 AM	13,519	Stress-pt_108max-b.OUT
09/03/2007	12:16 AM	13,519	Stress-pt_108max-m.OUT
09/02/2007	09:16 PM	13,519	Stress-pt_108max-t.OUT
09/03/2007	03:16 AM	6,443,068	Stress-pt_108th-b.OUT
09/03/2007	12:16 AM	6,443,068	Stress-pt_108th-m.OUT
09/02/2007	09:16 PM	6,412,940	Stress-pt_108th-t.OUT
09/03/2007	03:25 AM	13,519	Stress-pt_117max-b.OUT
09/03/2007	12:25 AM	13,519	Stress-pt_117max-m.OUT
09/02/2007	09:25 PM	13,519	Stress-pt_117max-t.OUT
09/03/2007	03:25 AM	6,443,068	Stress-pt_117th-b.OUT
09/03/2007	12:25 AM	6,443,068	Stress-pt_117th-m.OUT
09/02/2007	09:25 PM	6,412,940	Stress-pt_117th-t.OUT
09/03/2007	03:34 AM	13,519	Stress-pt_126max-b.OUT
09/03/2007	12:34 AM	13,519	Stress-pt_126max-m.OUT
09/02/2007	09:34 PM	13,519	Stress-pt_126max-t.OUT
09/03/2007	03:34 AM	6,443,068	Stress-pt_126th-b.OUT
09/03/2007	12:34 AM	6,443,068	Stress-pt_126th-m.OUT
09/02/2007	09:34 PM	6,412,940	Stress-pt_126th-t.OUT
09/03/2007	03:43 AM	13,519	Stress-pt_135max-b.OUT
09/03/2007	12:42 AM	13,519	Stress-pt_135max-m.OUT
09/02/2007	09:42 PM	13,519	Stress-pt_135max-t.OUT
09/03/2007	03:43 AM	6,443,068	Stress-pt_135th-b.OUT
09/03/2007	12:43 AM	6,443,068	Stress-pt_135th-m.OUT
09/02/2007	09:43 PM	6,412,940	Stress-pt_135th-t.OUT
09/03/2007	03:52 AM	13,519	Stress-pt_144max-b.OUT
09/03/2007	12:52 AM	13,519	Stress-pt_144max-m.OUT
09/02/2007	09:52 PM	13,519	Stress-pt_144max-t.OUT
09/03/2007	03:52 AM	6,443,068	Stress-pt_144th-b.OUT
09/03/2007	12:52 AM	6,443,068	Stress-pt_144th-m.OUT
09/02/2007	09:52 PM	6,412,940	Stress-pt_144th-t.OUT
09/03/2007	04:01 AM	13,519	Stress-pt_153max-b.OUT
09/03/2007	01:01 AM	13,519	Stress-pt_153max-m.OUT
09/02/2007	10:01 PM	13,519	Stress-pt_153max-t.OUT
09/03/2007	04:01 AM	6,443,068	Stress-pt_153th-b.OUT
09/03/2007	01:01 AM	6,443,068	Stress-pt_153th-m.OUT

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09/02/2007	10:01 PM	6,412,940	Stress-pt_153th-t.OUT
09/03/2007	04:10 AM	13,519	Stress-pt_162max-b.OUT
09/03/2007	01:10 AM	13,519	Stress-pt_162max-m.OUT
09/02/2007	10:10 PM	13,519	Stress-pt_162max-t.OUT
09/03/2007	04:10 AM	6,443,068	Stress-pt_162th-b.OUT
09/03/2007	01:10 AM	6,443,068	Stress-pt_162th-m.OUT
09/02/2007	10:10 PM	6,412,940	Stress-pt_162th-t.OUT
09/03/2007	04:19 AM	13,521	Stress-pt_171max-b.OUT
09/03/2007	01:19 AM	13,521	Stress-pt_171max-m.OUT
09/02/2007	10:19 PM	13,521	Stress-pt_171max-t.OUT
09/03/2007	04:19 AM	6,443,068	Stress-pt_171th-b.OUT
09/03/2007	01:19 AM	6,443,068	Stress-pt_171th-m.OUT
09/02/2007	10:19 PM	6,412,940	Stress-pt_171th-t.OUT
09/03/2007	04:28 AM	13,521	Stress-pt_180max-b.OUT
09/03/2007	01:28 AM	13,521	Stress-pt_180max-m.OUT
09/02/2007	10:28 PM	13,521	Stress-pt_180max-t.OUT
09/03/2007	04:28 AM	6,443,068	Stress-pt_180th-b.OUT
09/03/2007	01:28 AM	6,443,068	Stress-pt_180th-m.OUT
09/02/2007	10:28 PM	6,412,940	Stress-pt_180th-t.OUT
09/03/2007	01:46 AM	13,519	Stress-pt_18max-b.OUT
09/02/2007	10:46 PM	13,519	Stress-pt_18max-m.OUT
09/02/2007	07:46 PM	13,519	Stress-pt_18max-t.OUT
09/03/2007	01:46 AM	6,443,068	Stress-pt_18th-b.OUT
09/02/2007	10:46 PM	6,443,068	Stress-pt_18th-m.OUT
09/02/2007	07:46 PM	6,412,940	Stress-pt_18th-t.OUT
09/03/2007	01:55 AM	13,519	Stress-pt_27max-b.OUT
09/02/2007	10:55 PM	13,519	Stress-pt_27max-m.OUT
09/02/2007	07:55 PM	13,519	Stress-pt_27max-t.OUT
09/03/2007	01:55 AM	6,443,068	Stress-pt_27th-b.OUT
09/02/2007	10:55 PM	6,443,068	Stress-pt_27th-m.OUT
09/02/2007	07:55 PM	6,412,940	Stress-pt_27th-t.OUT
09/03/2007	02:04 AM	13,519	Stress-pt_36max-b.OUT
09/02/2007	11:04 PM	13,519	Stress-pt_36max-m.OUT
09/02/2007	08:04 PM	13,519	Stress-pt_36max-t.OUT
09/03/2007	02:04 AM	6,443,068	Stress-pt_36th-b.OUT
09/02/2007	11:04 PM	6,443,068	Stress-pt_36th-m.OUT
09/02/2007	08:04 PM	6,412,940	Stress-pt_36th-t.OUT
09/03/2007	02:13 AM	13,519	Stress-pt_45max-b.OUT
09/02/2007	11:13 PM	13,519	Stress-pt_45max-m.OUT
09/02/2007	08:13 PM	13,519	Stress-pt_45max-t.OUT
09/03/2007	02:13 AM	6,443,068	Stress-pt_45th-b.OUT
09/02/2007	11:13 PM	6,443,068	Stress-pt_45th-m.OUT
09/02/2007	08:13 PM	6,412,940	Stress-pt_45th-t.OUT
09/03/2007	02:22 AM	13,519	Stress-pt_54max-b.OUT
09/02/2007	11:22 PM	13,519	Stress-pt_54max-m.OUT
09/02/2007	08:22 PM	13,519	Stress-pt_54max-t.OUT
09/03/2007	02:22 AM	6,443,068	Stress-pt_54th-b.OUT
09/02/2007	11:22 PM	6,443,068	Stress-pt_54th-m.OUT
09/02/2007	08:22 PM	6,412,940	Stress-pt_54th-t.OUT
09/03/2007	02:31 AM	13,519	Stress-pt_63max-b.OUT
09/02/2007	11:31 PM	13,519	Stress-pt_63max-m.OUT
09/02/2007	08:31 PM	13,519	Stress-pt_63max-t.OUT
09/03/2007	02:31 AM	6,443,068	Stress-pt_63th-b.OUT
09/02/2007	11:31 PM	6,443,068	Stress-pt_63th-m.OUT
09/02/2007	08:31 PM	6,412,940	Stress-pt_63th-t.OUT
09/03/2007	02:40 AM	13,519	Stress-pt_72max-b.OUT
09/02/2007	11:40 PM	13,519	Stress-pt_72max-m.OUT
09/02/2007	08:40 PM	13,519	Stress-pt_72max-t.OUT
09/03/2007	02:40 AM	6,443,068	Stress-pt_72th-b.OUT
09/02/2007	11:40 PM	6,443,068	Stress-pt_72th-m.OUT
09/02/2007	08:40 PM	6,412,940	Stress-pt_72th-t.OUT
09/03/2007	02:49 AM	13,519	Stress-pt_81max-b.OUT
09/02/2007	11:49 PM	13,519	Stress-pt_81max-m.OUT
09/02/2007	08:49 PM	13,519	Stress-pt_81max-t.OUT
09/03/2007	02:49 AM	6,443,068	Stress-pt_81th-b.OUT

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09/02/2007	11:49 PM	6,443,068	Stress-pt_81th-m.OUT
09/02/2007	08:49 PM	6,412,940	Stress-pt_81th-t.OUT
09/03/2007	02:58 AM	13,519	Stress-pt_90max-b.OUT
09/02/2007	11:58 PM	13,519	Stress-pt_90max-m.OUT
09/02/2007	08:58 PM	13,519	Stress-pt_90max-t.OUT
09/03/2007	02:58 AM	6,443,068	Stress-pt_90th-b.OUT
09/02/2007	11:58 PM	6,443,068	Stress-pt_90th-m.OUT
09/02/2007	08:58 PM	6,412,940	Stress-pt_90th-t.OUT
09/03/2007	03:07 AM	13,519	Stress-pt_99max-b.OUT
09/03/2007	12:07 AM	13,519	Stress-pt_99max-m.OUT
09/02/2007	09:07 PM	13,519	Stress-pt_99max-t.OUT
09/03/2007	03:07 AM	6,443,068	Stress-pt_99th-b.OUT
09/03/2007	12:07 AM	6,443,068	Stress-pt_99th-m.OUT
09/02/2007	09:07 PM	6,412,940	Stress-pt_99th-t.OUT
09/03/2007	01:37 AM	13,519	Stress-pt_9max-b.OUT
09/02/2007	10:37 PM	13,519	Stress-pt_9max-m.OUT
09/02/2007	07:37 PM	13,519	Stress-pt_9max-t.OUT
09/03/2007	01:37 AM	6,443,196	Stress-pt_9th-b.OUT
09/02/2007	10:37 PM	6,443,196	Stress-pt_9th-m.OUT
09/02/2007	07:37 PM	6,413,068	Stress-pt_9th-t.OUT
10/12/2006	02:29 PM	4,009	Tank-Coordinates-AP.txt
05/25/2005	03:32 PM	2,512	Tank-Mesh1.txt
08/31/2007	11:06 AM	102	tank-out.out
12/05/2005	10:51 AM	5,495	Tank-Props-Crack.txt
07/21/2006	09:41 AM	5,591	Tank-Props-Rigid.txt
08/31/2007	11:07 AM	4,973	Tank-th.out
08/09/2006	07:43 AM	23,166	TH-266-Mean-Geo-V.txt
08/09/2006	07:31 AM	23,166	TH-266-Mean-Geo.txt
09/02/2007	02:32 PM	561,576	Vel-ct-0.out
09/02/2007	02:33 PM	561,576	Vel-ct-135.out
09/02/2007	02:33 PM	561,576	Vel-ct-180.out
09/02/2007	02:32 PM	561,576	Vel-ct-45.out
09/02/2007	02:32 PM	561,576	Vel-ct-90.out
09/02/2007	02:32 PM	290,550	Vel-ct.out
09/02/2007	02:33 PM	561,576	Vel-PT-0.out
09/02/2007	02:33 PM	561,576	Vel-PT-135.out
09/02/2007	02:33 PM	561,576	Vel-PT-180.out
09/02/2007	02:33 PM	561,576	Vel-PT-45.out
09/02/2007	02:33 PM	561,576	Vel-PT-90.out
09/02/2007	02:34 PM	561,576	Vel-Soil.out
09/02/2007	10:05 AM	10,180	Waste-Cont_108max.OUT
09/02/2007	10:05 AM	4,875,649	Waste-Cont_108th.OUT
09/02/2007	10:12 AM	10,180	Waste-Cont_117max.OUT
09/02/2007	10:12 AM	4,875,649	Waste-Cont_117th.OUT
09/02/2007	10:18 AM	10,180	Waste-Cont_126max.OUT
09/02/2007	10:18 AM	4,875,649	Waste-Cont_126th.OUT
09/02/2007	10:25 AM	10,180	Waste-Cont_135max.OUT
09/02/2007	10:26 AM	4,875,649	Waste-Cont_135th.OUT
09/02/2007	10:33 AM	10,180	Waste-Cont_144max.OUT
09/02/2007	10:33 AM	4,875,649	Waste-Cont_144th.OUT
09/02/2007	10:39 AM	10,180	Waste-Cont_153max.OUT
09/02/2007	10:39 AM	4,875,649	Waste-Cont_153th.OUT
09/02/2007	10:46 AM	10,180	Waste-Cont_162max.OUT
09/02/2007	10:46 AM	4,875,649	Waste-Cont_162th.OUT
09/02/2007	10:53 AM	10,180	Waste-Cont_171max.OUT
09/02/2007	10:53 AM	4,875,649	Waste-Cont_171th.OUT
09/02/2007	11:00 AM	10,180	Waste-Cont_180max.OUT
09/02/2007	11:00 AM	4,875,649	Waste-Cont_180th.OUT
09/02/2007	08:54 AM	10,180	Waste-Cont_18max.OUT
09/02/2007	08:54 AM	4,875,649	Waste-Cont_18th.OUT
09/02/2007	09:02 AM	10,180	Waste-Cont_27max.OUT
09/02/2007	09:02 AM	4,875,649	Waste-Cont_27th.OUT
09/02/2007	09:09 AM	10,180	Waste-Cont_36max.OUT
09/02/2007	09:09 AM	4,875,649	Waste-Cont_36th.OUT
09/02/2007	09:16 AM	10,180	Waste-Cont_45max.OUT

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09/02/2007 09:16 AM      4,875,649 Waste-Cont_45th.OUT
09/02/2007 09:23 AM      10,180 Waste-Cont_54max.OUT
09/02/2007 09:23 AM      4,875,649 Waste-Cont_54th.OUT
09/02/2007 09:30 AM      10,180 Waste-Cont_63max.OUT
09/02/2007 09:30 AM      4,875,649 Waste-Cont_63th.OUT
09/02/2007 09:37 AM      10,180 Waste-Cont_72max.OUT
09/02/2007 09:37 AM      4,875,649 Waste-Cont_72th.OUT
09/02/2007 09:44 AM      10,180 Waste-Cont_81max.OUT
09/02/2007 09:44 AM      4,875,649 Waste-Cont_81th.OUT
09/02/2007 09:51 AM      10,180 Waste-Cont_90max.OUT
09/02/2007 09:51 AM      4,875,649 Waste-Cont_90th.OUT
09/02/2007 09:57 AM      10,180 Waste-Cont_99max.OUT
09/02/2007 09:57 AM      4,875,649 Waste-Cont_99th.OUT
09/02/2007 08:24 AM      10,180 Waste-Cont_9max.OUT
09/02/2007 08:24 AM      4,875,777 Waste-Cont_9th.OUT
09/02/2007 08:08 AM      45,117 Waste-Reaction-460-SD3.out
09/25/2006 10:41 AM      340 Waste-Reaction.txt
10/12/2006 02:27 PM      10,266 Waste-solid-AP-S.txt
08/21/2006 08:03 AM      776 Waste-Surface-AP.txt
09/02/2007 02:10 PM      865 Waste-Surf_0max.OUT
09/02/2007 02:10 PM      534,133 Waste-Surf_0th.OUT
09/02/2007 02:21 PM      865 Waste-Surf_108max.OUT
09/02/2007 02:21 PM      534,005 Waste-Surf_108th.OUT
09/02/2007 02:22 PM      865 Waste-Surf_117max.OUT
09/02/2007 02:22 PM      534,005 Waste-Surf_117th.OUT
09/02/2007 02:23 PM      865 Waste-Surf_126max.OUT
09/02/2007 02:23 PM      534,005 Waste-Surf_126th.OUT
09/02/2007 02:24 PM      865 Waste-Surf_135max.OUT
09/02/2007 02:24 PM      534,005 Waste-Surf_135th.OUT
09/02/2007 02:25 PM      865 Waste-Surf_144max.OUT
09/02/2007 02:25 PM      534,005 Waste-Surf_144th.OUT
09/02/2007 02:26 PM      865 Waste-Surf_153max.OUT
09/02/2007 02:26 PM      534,005 Waste-Surf_153th.OUT
09/02/2007 02:27 PM      865 Waste-Surf_162max.OUT
09/02/2007 02:27 PM      534,005 Waste-Surf_162th.OUT
09/02/2007 02:28 PM      865 Waste-Surf_171max.OUT
09/02/2007 02:28 PM      534,005 Waste-Surf_171th.OUT
09/02/2007 02:29 PM      865 Waste-Surf_180max.OUT
09/02/2007 02:29 PM      534,005 Waste-Surf_180th.OUT
09/02/2007 02:29 PM      865 Waste-Surf_189max.OUT
09/02/2007 02:29 PM      534,005 Waste-Surf_189th.OUT
09/02/2007 02:12 PM      865 Waste-Surf_18max.OUT
09/02/2007 02:12 PM      534,005 Waste-Surf_18th.OUT
09/02/2007 02:13 PM      865 Waste-Surf_27max.OUT
09/02/2007 02:13 PM      534,005 Waste-Surf_27th.OUT
09/02/2007 02:13 PM      865 Waste-Surf_36max.OUT
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09/02/2007 02:14 PM      865 Waste-Surf_45max.OUT
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09/02/2007 02:15 PM      865 Waste-Surf_54max.OUT
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09/02/2007 02:16 PM      865 Waste-Surf_63max.OUT
09/02/2007 02:16 PM      534,005 Waste-Surf_63th.OUT
09/02/2007 02:17 PM      865 Waste-Surf_72max.OUT
09/02/2007 02:17 PM      534,005 Waste-Surf_72th.OUT
09/02/2007 02:18 PM      865 Waste-Surf_81max.OUT
09/02/2007 02:18 PM      534,005 Waste-Surf_81th.OUT
09/02/2007 02:19 PM      865 Waste-Surf_90max.OUT
09/02/2007 02:19 PM      534,005 Waste-Surf_90th.OUT
09/02/2007 02:20 PM      865 Waste-Surf_99max.OUT
09/02/2007 02:20 PM      534,005 Waste-Surf_99th.OUT
09/02/2007 02:11 PM      865 Waste-Surf_9max.OUT
09/02/2007 02:11 PM      534,005 Waste-Surf_9th.OUT
615 File(s) 37,553,864,623 bytes
3 Dir(s) 157,616,623,616 bytes free

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