



ARKANSAS POWER & LIGHT COMPANY
POST OFFICE BOX 551 LITTLE ROCK, ARKANSAS 72203 (501) 371-4000

March 3, 1983

ØCANØ2831Ø

Director of Nuclear Reactor Regulation
ATTN: Mr. J. F. Stolz, Chief ✓
Operating Reactors Branch #4
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, DC 20555

Director of Nuclear Reactor Regulation
ATTN: Mr. Robert A. Clark, Chief
Operating Reactors Branch #3
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, DC 20555

SUBJECT: Arkansas Nuclear One - Units 1 & 2
Docket Nos. 50-313 and 50-368
License Nos. DPR-51 and NPF-6
Additional Information Concerning
Spent Fuel Storage Expansion

Gentlemen:

Your letter dated January 5, 1983 (ØCNAØ183Ø4) requested additional information concerning the proposed spent fuel storage expansion at Arkansas Nuclear One (ANO). This submittal is in response to that request.

This submittal contains proprietary information of Westinghouse Electric Corporation. In conformance with the requirements of 10CFR Section 2.790, as amended, of the Commission's regulations, enclosed are an application from Westinghouse for withholding from public disclosure and an affidavit. The affidavit sets forth the basis on which the information may be withheld from public disclosure by the Commission.

Regarding the proprietary information, enclosed are:

1. Three (3) copies of Westinghouse Drawings 613ØE41C1, Rev. 1 (sheets 1 thru 3) and 613ØE44C1 Rev. 1 (sheets 1 thru 4)-Proprietary.
2. Three (3) copies of Westinghouse Drawings 613ØE41C2, Rev. 1 (sheets 1 thru 3) and 613ØE44C2, Rev. 1 (sheets 1 thru 4)-Non-Proprietary.

*Accl
1/15
Prop Drawings
TO: G. Vissing
D.T. Lyack
Reg Files*

8303160388 830303
PDR ADOCK 05000313
P PDR

Mr. Stolz/Mr. Clark

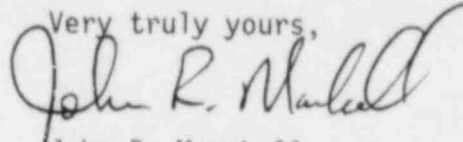
-2-

March 3, 1983

3. One (1) copy of Application for Withholding (CAW-83-16)-Non-Proprietary.
4. One (1) original Affidavit (CAW-83-16)-Non-Proprietary.

Correspondence with respect to the affidavit or application for withholding should reference CAW-83-16 and should be addressed to R.A. Wieseemann, Manager, Regulatory & Legislative Affairs, Westinghouse Electric Corporation, P. O. Box 355, Pittsburgh, PA 15230.

Very truly yours,



John R. Marshall
Manager, Licensing

JRM:DB:s1

Attachments

QUESTIONS RELATING TO THE STRUCTURAL AREA

Question 1:

Provide structural drawings of the racks including fabrication details.

Response:

Spent fuel rack assembly drawings 6130E41C1, Revision 1 (sheets 1 thru 3) and 6130E441C1, Revision 1 (sheets 1 thru 4) contain information considered proprietary to Westinghouse Electric Corporation, and as requested, should be withheld from public disclosure. Non-proprietary copies of these drawings are also enclosed.

Question 2:

Provide structural drawings of the pools including foundation and liner details.

Response:

The following drawings have been transmitted with this submittal:

C-203	C-209	C-214	C-232	C-249
C-204	C-210	C-216	C-233	C-2204
C-205	C-211	C-219	C-235	C-2205
C-206	C-212	C-231	C-236	C-2206

Question 3:

Provide results of an analysis for potential sliding and/or tipping of the racks. If rack-to-rack or rack-to-pool wall/floor impact is postulated, include the resultant loads in the rack analysis as well as the pool structure analysis, as applicable. Describe the analysis procedure.

Response:

The analysis procedure for these loads on the pool structure is as follows:

The fuel rack loads utilized in this analysis consist of a submerged deadweight loading, and a vertical and horizontal reaction loading due to the operating basis earthquake. These reaction loads are distributed to the pool floor node points based on the proximity of each pad to the surrounding nodes. The earthquake loads are distributed in the same proportion as the deadweight loads, with the total force equal to that specified by Westinghouse.

Rack Displacements, Sliding, and Rocking Stability

The support pad vertical and horizontal displacements are tabulated for both high and low friction coefficients. The support pad vertical displacements are used to calculate the overall rack module rocking for partial and full fuel loading conditions. This calculation shows that the minimum factor of safety against overturn is produced by a partial fuel loading of the rack module. The factor of safety is in excess of the 1.5 minimum requirements of the NRC Position Paper.

The horizontal displacements of support pads sliding and top of the rack structural deflection are used in conjunction with thermal displacements to show that the rack module does not collide with another rack or with a pool floor obstruction or the pool wall.

Displacement Results

The rack displacement, pad vertical lift-off, pad horizontal sliding, and rack top lateral displacement are obtained from the nonlinear analysis. The maximum support pad lift-off was obtained for the high coefficient of friction run ($\mu = 0.8$) while the maximum support pad sliding was obtained for the low coefficient of friction run ($\mu = 0.2$). The results are tabulated below:

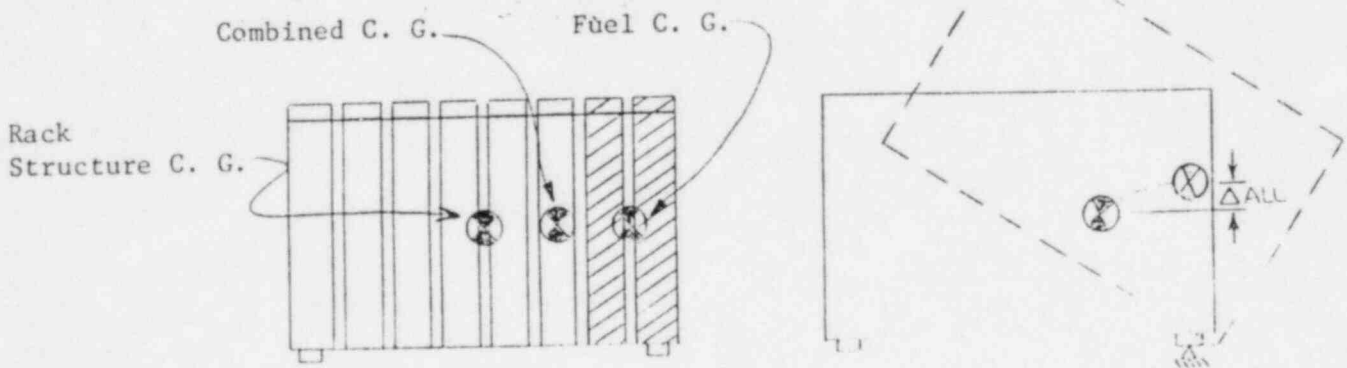
		Unit 2	Unit 1
<u>High Coefficient of Friction Results ($\mu = .8$)</u>			
Support Pad Lift-Off	Δy in	0.055	0.005
Rack Top Lateral Displacement	Δx in	0.200	0.150
<u>Low Coefficient of Friction Results ($\mu = .2$)</u>			
Support Pad Maximum Sliding	Δx in	0.095	0.030
Rack Top Lateral Displacement	Δx in	0.135	0.140

Rack Lift-Off Stability

The energy which produced lift-off of the nonlinear model is applied to the fuel rack module with various fuel loadings in order to obtain the loading configuration which produces the maximum lift-off or minimum factor of safety against overturn. The lift-off energy is equated to the potential energy of lifting the center of gravity of the combined fuel and fuel rack masses to obtain the maximum lift-off of the rack. The maximum allowable lift of the center of gravity is obtained by calculating the lift of the center of gravity from the static position to the point directly above the support pad center line, as shown in the figure below. The factor of safety against overturn is obtained by comparing the allowable lift to the actual lift.

For Arkansas Unit 2, the 8 x 10 rack module was analyzed since it has the minimum support pad spacing (8 cell direction) and the minimum resistance to overturn. The loading condition of two outside rows of fuel produces the minimum factor of safety against overturn of $FS = 59$.

For Arkansas Unit 1, the 10 x 11 rack module was analyzed in the 10 cell direction. The loading condition of three outside rows of fuel produces the minimum factor of safety against overturn of $FS > 100$.



Rack Module Stability

Evaluation of Rack Lateral Displacements

The nonlinear time history analysis calculates the fuel rack sliding distance for the low coefficient of friction, and the top of the rack structural deflection for the high coefficient of friction. In this portion of the evaluation, the rack to rack, rack to floor obstructions, and rack to wall gaps will be examined to show that there is no impact due to the lateral motion.

To evaluate potential impact for the rack to rack, rack to wall, and rack to pool floor obstruction gaps, the gap will be modified to account for thermal growth of hot operating conditions, and compared with the rack's maximum seismic displacement to show that the gap is not closed and impact of a rack module does not occur.

Rack Thermal Displacement

Since the pool temperature during installation is below the hot operating condition, the gap must be reduced by the thermal expansion of the rack. The rack to rack thermal displacement is for maximum normal condition and also the accident condition of cooling system not operational.

			Arkansas Unit 2	Arkansas Unit 1
Rack Thermal Growth Maximum Normal Condition	δ_{T1}	in	0.070	0.090
Rack Thermal Growth Accident Condition	δ_T^2	in	0.150	0.200

Combined Seismic & Thermal Displacement

The condition which produces the maximum fuel rack seismic response is all fuel racks filled with fuel. For this configuration the racks responses (sliding and structural deflection) will be in phase, thus the rack to rack gap is not affected. The major factor which produces the phase relationship for this condition is the hydrodynamic coupling effect of the submerged structure.

However, due to variation of friction or for other than racks full of fuel, there may be a condition where one rack slides and the adjacent rack does not slide. For this condition the rack to rack gap will be reduced by the amount of one rack sliding, two racks structurally deflecting, and the thermal movement of the racks for the installed temperature to the maximum normal temperature. Since the structural displacements of the racks are out of phase or unrelated, the combined seismic displacements will be obtained by the SRSS method.

In addition to this condition, the thermal accident condition must be addressed. Since it is highly unlikely that the thermal accident condition, which requires days of inoperative cooling train to obtain, and the SSE seismic event occur simultaneously, only the sliding distance of the SSE event, without the structural displacements, will be combined with the thermal accident displacement.

Combined Displacement Results

			Unit 2	Unit 1
Combined Thermal & Seismic Displacement	δ	in	0.40	0.35
Limiting Gaps;				
Rack to Rack	G_1	in	1.5	1.5
Rack to Pool Wall	G_2	in	5.0	19.0
Rack to Pool Floor Obstruction	G_3	in	>2.0	>2.0

Question 4:

Provide results of an analysis for impact loads from the heaviest object to be transported over the fuel pool. Evaluate the affects on both rack structure and the pool structure including the liner. Describe the analysis procedure.

*Response:

An analysis has been conducted for dropping a 2000 lb fuel assembly from the maximum height to which it will be raised, based on the Technical Specificaiton requirements that weights no greater than 2000 lbs will be transported over spent fuel. The criticality analysis of drop accidents is performed with dissolved boron in the pool water, since not taking credit for the boron would mean assuming two unlikely independent events. With this credit no credible deformations caused by a fuel drop accident would cause a criticality accident. For the straight or inclined drop on top of the rack, the rack deformations are limited to the top region of the rack. For the straight drop through a cell the fuel assembly impacts the base plate of the rack, causes a portion of it to separate from the bottom of the rack, and impacts the floor of the spent fuel pool. Stresses on the liner, however, are not high enough to cause it to be punctured.

In the analysis the potential energy of the dropped fuel assembly is equated to the strain energy of the energy absorbing structure to obtain the impact force. The energy absorbing structure for this drop is the lower portion of the fuel assembly and the deformed portion of the rack. No credit is taken for water drag on the fuel assembly or for pumping action in the cell.

*This analysis was performed using drop heights above the fuel racks of 2'-1" for Unit 1 and 0'-10" for Unit 2 as determined by AP&L supplied drawings 21943-1 and I-16615-E which defined the maximum heights of the fuel assemblies.

Question 5:

Provide key calculations and results of the seismic analysis. Include sketches of the mathematical model and discuss the method of modeling potential rack-to-rack and rack-to-pool interaction due to sliding and/or tipping, if any.

Response:

The Arkansas spent fuel storage racks are the free standing type. During the seismic event it is possible for the rack to slide or rock and lift a support pad off the floor. Since the support pad boundary conditions as well as the gaps between the fuel assembly and cell assembly are structurally nonlinear, the seismic analysis is a nonlinear time history analysis.

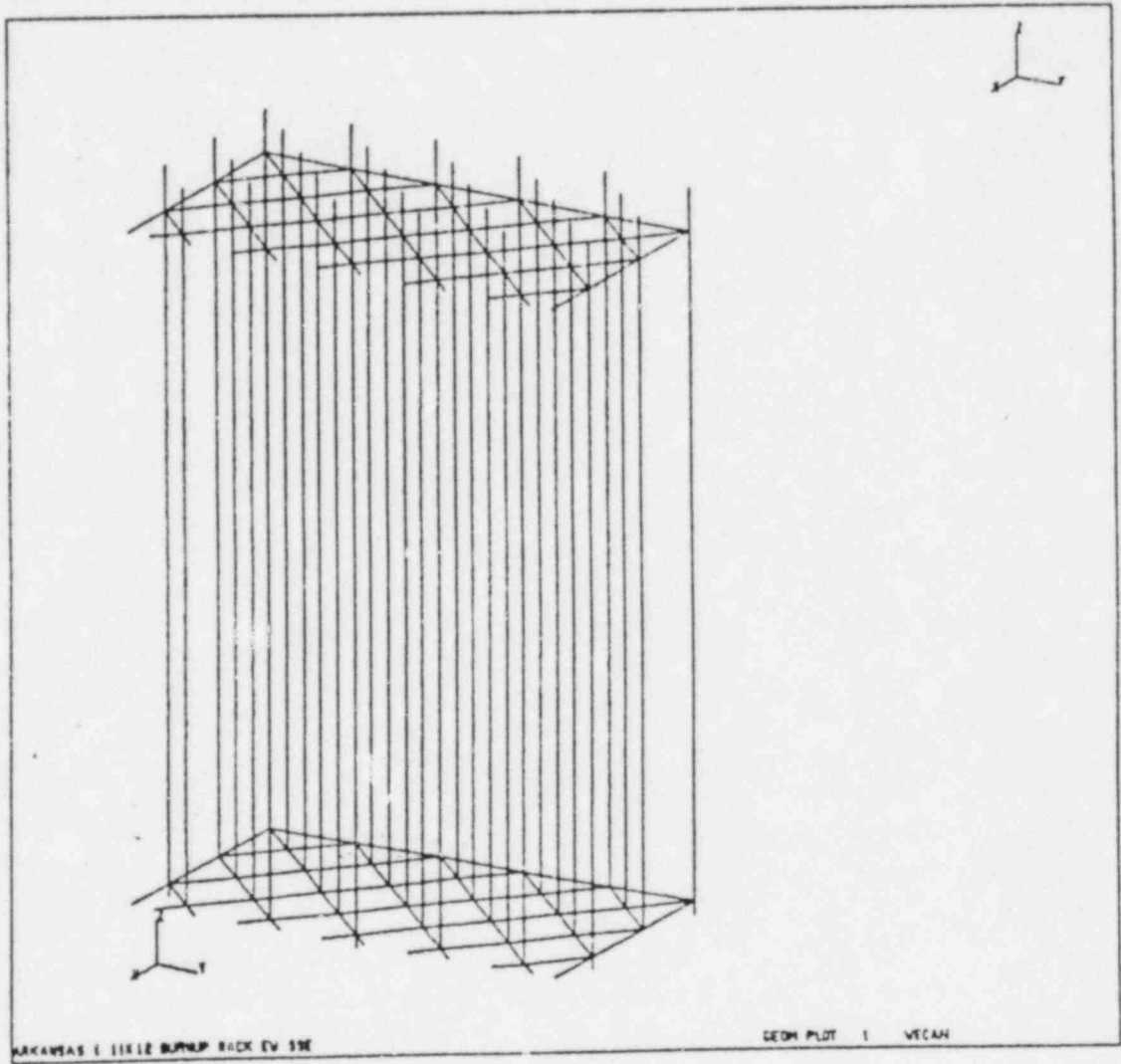
The seismic analysis is performed in two phases. The first is a response spectrum analysis on a linear detail rack model which produces the effective stiffness values for a single cell representation. The second phase is a time history analysis of the single cell model which has been modified to include the nonlinearities of the fuel to cell gaps and the support pad boundary conditions. The analysis is performed for a range of support pad friction coefficients ($\mu = .2 - .8$) to determine the maximum sliding with the low friction and the maximum rocking and lift off with the high friction. This analysis produces the rack response, which is used to calculate overall rack stability, and rack loads, which are used in the structural analysis to calculate stresses. The results of this analysis are given in the response to Question 3.

The verification of the sliding capability for the WECAN Element 77, Dynamic Friction Element, has been performed by comparing the WECAN results with the results of classical solutions for simplified applications. In addition, the WECAN results of a free standing fuel rack analysis were compared with hand calculation results for a verification of a previous fuel rack license submittal.

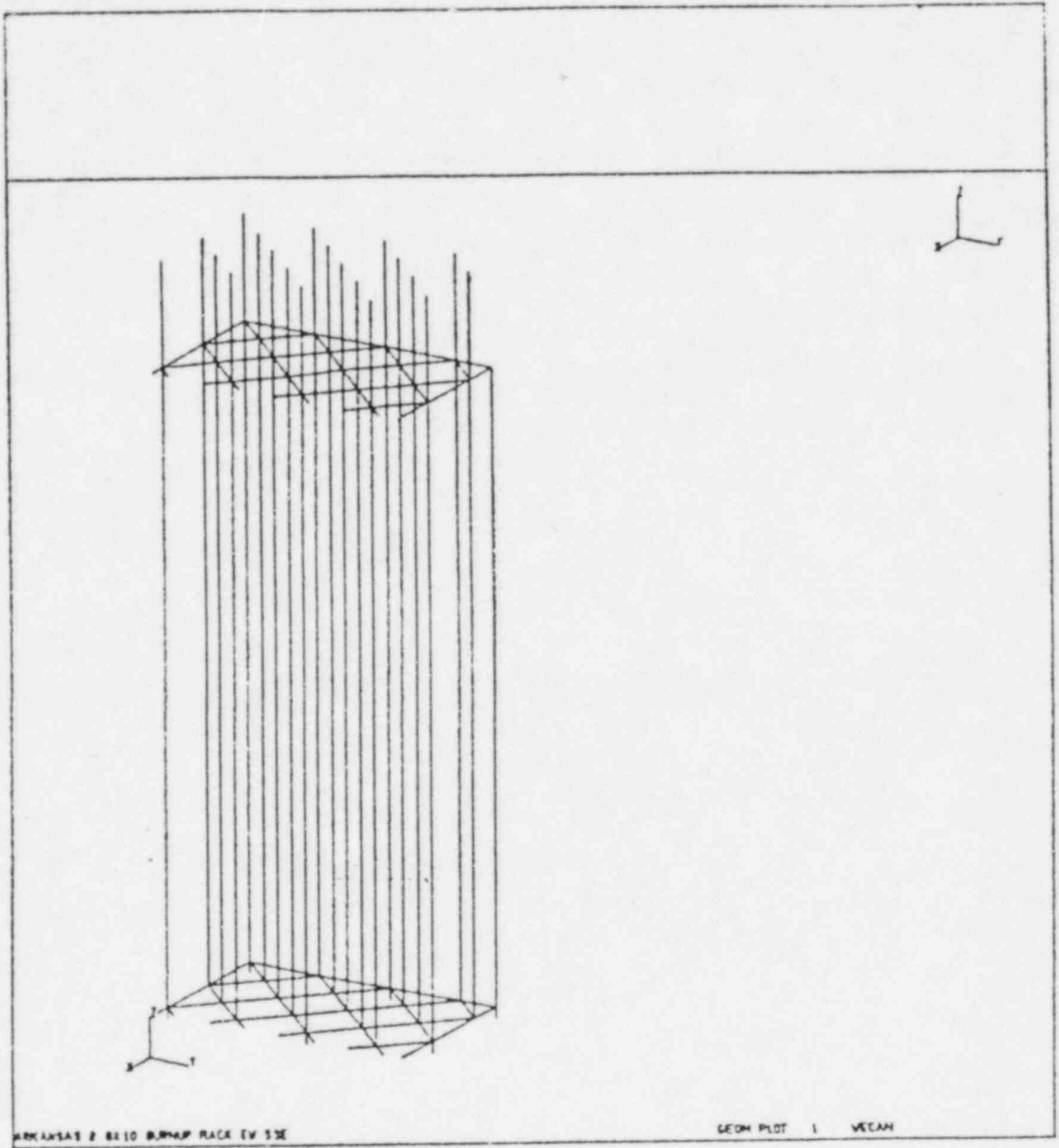
Linear Model

The linear model, shown in the following sketch, is a three-dimensional finite element representation of a rack assembly. The structural properties of the individual beams for the cells, grids, support pads, etc., are calculated from the effective sections. The mass is composed of the structural masses of rack, fuel assembly, and control rod assembly, the water inside the cells, and the hydrodynamic mass between the rack and pool wall. The structural mass and water inside the cells are distributed on the cells, and the hydrodynamic mass between the rack and pool is input with a mass matrix element. The model is constructed for half the rack and divided at the line of symmetry with appropriate boundary conditions. A geometry plot is included to show the construction of the model.

The structural properties of a single cell representation, which are used for the nonlinear model, are obtained from the results of the detail model. The results of the single cell model computer run, frequency and mode shape, are compared with that of the detail model to insure correct structural representation.



Arkansas Unit 1, Linear Model Geometry Plot, (11 x 12) Rack



Arkansas Unit 2, Linear Model Geometry Plot, (8 x 10) Rack

Nonlinear Model

The geometry plot, shown in the following sketch, is the single cell finite elements representation of the nonlinear mathematical model. The structural properties of the rack components are represented by six different finite elements. These elements and their identification number (ITYPE) are listed below:

<u>ITYPE</u>	<u>Finite Element</u>
1	STIF 4, Three-Dimensional Beam
2	STIF 77, Three-Dimensional Dynamic Friction Element
3	STIF 27, General Matrix, Stiffness, Input
4	STIF 27, General Matrix, Mass, Input
5	STIF 37, Three-Dimensional Dynamic Gap Element
6	STIF 34, Two-Dimensional Rotary Spring

The three-dimensional beam element (STIF 4) is a straight uniform cross section element with tension-compression, torsion, and bending capabilities. This element is used to model the fuel beam, cell beam, and rack base beam.

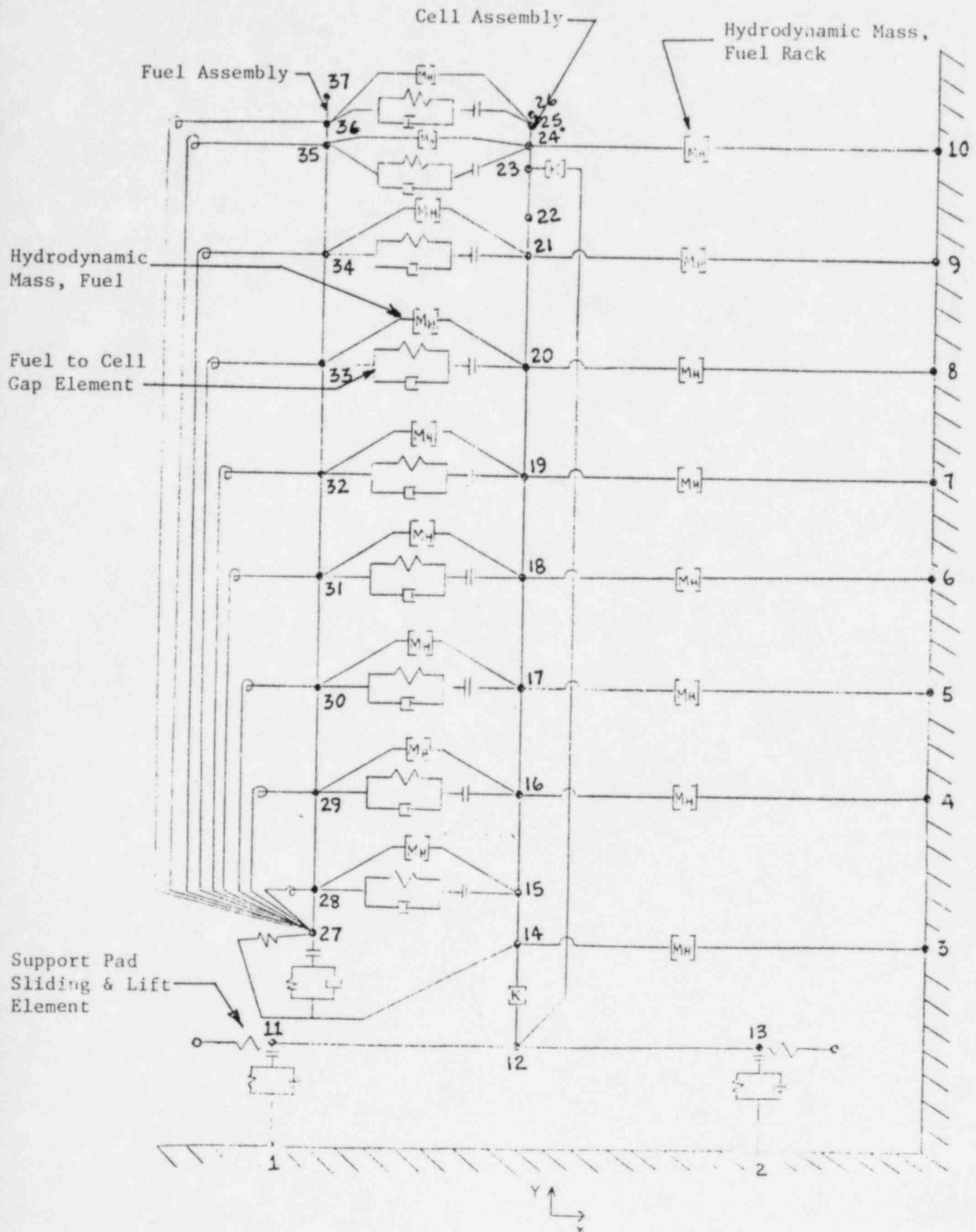
The three-dimensional dynamic friction element (STIF 77) is composed of a gap in series with a parallel combination of impact spring and impact damper with a frictional spring orthogonal to the gap. This element is designed to represent two surfaces which may slide relative to each other, and may separate or contact each other. The friction behavior is represented by a friction spring, and the impact behavior is represented by combination of an impact spring and a dashpot in parallel, coupled to a gap in series. The friction spring is along the direction of sliding which is normal to the direction of impact. The classical Coulomb friction is assumed between the sliding surfaces. The friction behavior is simulated by a stiffness method. The friction spring will transmit the shear forces across the surfaces as long as these forces are below the friction limit. Once sliding takes place, a pseudo force is applied to the sliding surface such that the resultant of the force in the friction spring and the pseudo force will represent the friction force. This element is used to model the sliding and or lift off of the support pads and the fuel base.

The general matrix, stiffness, element (STIF27) is an element whose geometry is undefined, but whose kinematic response is specified by stiffness coefficients. This element is used to represent the connection between the base of the cell and rack base cross beam with rigid vertical and lateral properties and the rotational stiffness of the cell base, and the connection between the top grid and rack base cross beam with the rotational stiffness of the top grid.

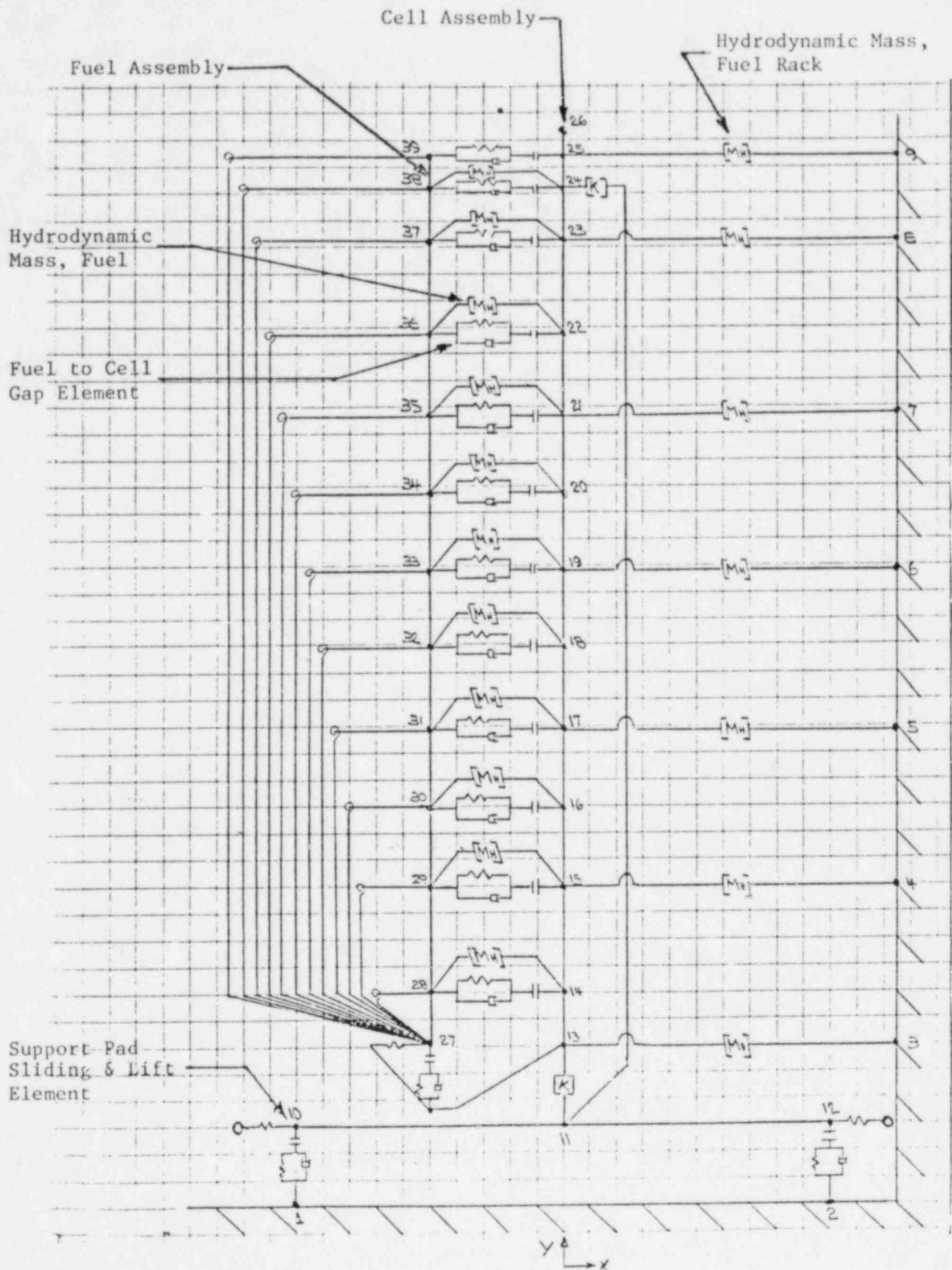
The general matrix, mass, element (STIF27) is an element whose geometry is undefined but whose kinematic response is specified by mass coefficients. This element is used to represent the hydrodynamic mass between the fuel and cell and also between the cell and pool wall.

The three-dimensional dynamic gap element (STIF37) is composed of a gap in series with a parallel combination of impact spring and impact damper. This element is used to model the gap between the fuel and cell.

The two-dimensional rotary spring element (STIF45) is an element which has only one degree of freedom, rotation about the Z axis, and is defined by a rotational stiffness. This element is used to model the rotational stiffness of the fuel assembly grid members.



Arkansas Unit 1, Nonlinear Model Geometry Plot



Arkansas Unit 2, Nonlinear Model Geometry Plot

The structural properties for the rack are specified as real constants in the model inputs. The real constants are listed in the input under the following numbers.

TBL	Component
1	Base Beam
2	Support Pad Sliding and Impact
3	Cell Beam at Top and Bottom Weld Zones
4	Cell Beam Between Top and Bottom Weld Zones
5	Fuel Base Slider and Vertical Impact
6	Fuel Beam
7	Fuel Grid to Rods Rotational Stiffness
8	Fuel Bottom Nozzle Impact
9	Fuel Grid Impact
10	Fuel Top Nozzle Impact

Note: Some of the stiffnesses properties are input through the STIF 27 elements.

STIF 27 (K) - Support Pad Horizontal and Cell-Bottom Grid Rotational Stiffnesses

STIF 27 (K) - Cell-Top Grid Rotational Stiffness

Question 6:

Provide a tabulation of allowable vs computed stresses for the racks.

Response:

The load combinations applicable to spent fuel racks are shown below.

ELASTIC ANALYSIS	ACCEPTANCE LIMITS
(1) $D + L$	Normal Limits of NF 3231.1a
(2) $D + L + E$	Normal Limits of NF 3231.1a
(3) $D + L + T_o$	Lesser of $2 S_y$ and S_u
(4) $D + L + T_o + E$	Lesser of $2 S_y$ and S_u
(5) $D + L + T_a + E$	Lesser of $2 S_y$ or S_u
(6) $D + L + T_a + E'$	Faulted Condition Limits of NF 3231.1c

The margin of safety tables on the following pages show case 2 ($D + L + E$) and case 4 ($D + L + T_o + E$). Case 2 envelopes case 1 ($D + L$) and case 4 envelopes case 3 ($D + L + T_o$). Thermal loads are caused by differential thermal expansion between the rack and pool floor (which loads are limited by friction between the rack and floor) and by differential thermal expansion between a loaded cell and an empty cell. Both of these loads are the same for T_a and T_o and thus case 5 ($D + L + T_a + E$) is the same as case 4. Thermal loads are self limiting in nature and the fuel rack material is ductile so they are not considered for faulted conditions, case 6 ($D + L + T_a + E'$). The SSE seismic loads are less than twice the OBE loads and since the SSE allowables are twice the OBE allowables the margins of safety for case 6 are greater than for case 2.

The margin of safties for the Unit 1 racks will be of similar magnitude as those shown in the attached tables and will meet all of the above acceptance limits.

MARGINS OF SAFETY

Arkansas Unit 2

Region 1 Rack

ITEM	TYPE OF STRESS	D+L+E			D+L+E+To		
		APPLIED STRESS	ALLOWABLE STRESS	MARGIN OF SAFETY	APPLIED STRESS	ALLOWABLE STRESS	MARGIN OF SAFETY
Cell	Axial	.564*	1.0*	.77*	11160	55000	3.93
Seam Weld	Shear	10095	24000	1.38	10095	31740	2.14
Wrapper Weld	Shear	6483	11000	.70	6483	31740	3.90
Cell to Grid Welds	Shear	16968	24000	.41	22466	31740	.41
Grids							
Top Grid Member	Axial	2296	16500	6.19	2296	55000	23.0
Welds	Shear	5049	24000	3.75	5049	31740	5.29
Belt	Axial	2469	16500	5.68	2469	55000	21.3
Bottom Grid Member	Axial	7370	16500	1.24	7370	55000	6.46
Welds	Shear	12939	24000	.85	12939	31740	1.45
Belt	Axial	10878	16500	.52	10878	55000	4.06
Support Pad and Support Plate See Region 2 Rack							

* Load Combination per ASME III Appendix XVII 2215.1 eqn (22)

MARGINS OF SAFETY

Arkansas Unit 2

Region 2 Rack

ITEM	TYPE OF STRESS	D+L+E			D+L+E+To		
		APPLIED STRESS	ALLOWABLE STRESS	MARGIN OF SAFETY	APPLIED STRESS	ALLOWABLE STRESS	MARGIN OF SAFETY
Cell	Axial	.650*	1.0*	.54*	13121	55000	3.19
Seam Weld	Shear	14430	24000	.66	14430	31740	1.20
Wrapper Weld	Shear	8616	11000	.28	8616	31740	2.68
Cell to Cell Welds							
Near Top of Cell	Shear	9620	24000	1.49	16948	31740	.87
At Bottom of Cell	Shear	14066	24000	.71	20335	31740	.58
Support Pad							
Minimum Section	Axial	4542	16500	2.63	4622	55000	10.9
	Shear	1494	11000	6.36	1367	31740	22.2
Bearing Surface	Bearing	6364	24750	2.89	4793	55000	10.5
Threads	Shear	4727	11000	1.33	3597	31740	7.8
Support Plate	Shear	1786	11000	5.16	1500	31740	20.2
Welds	Shear	11580	24000	1.07	10620	31740	1.99

* Load combination per ASME III Appendix XVII 2215.1 eqn (22)

Question 6:

Provide a tabulation of allowable vs. computed stresses for the racks and pool.

Response:

Attached are the appropriate Tables and Figures showing computer models for the pool area only.

TABLE 6-1
Arkansas Power and Light Company
Arkansas Nuclear One - Unit 1
Spent Fuel Storage Facility Evaluation
Tabulation of Controlling Section Resultant Moments (1)

Location	Section Axial Force	Section Resultant Moment ^(2,4)	Section Allowable Moment ⁽³⁾	Moment Code Ratio
Pool Floor Slab: (AFPST1A2-09)				
East - West Section at South End (Element 320)	-47.58	1005.	1321.	0.76
North - South Section at Mid-span (Element 320)	-35.50	1093.	1869.	0.59
Pool Foundation: (AFPST1A2-10)				
South Wall, Horizontal Section at Top (Element 2865)	-17.31	315.7	811.8	0.39
East Wall, Horizontal Section at Top (Element 2877)	-18.30	351.2	827.4	0.42
West Wall, Horizontal Section at Top (Element 2857)	-16.68	391.8	801.7	0.49

Units: Kips/Inch, Kip-inches/Inch

- Notes: 1) NUREG-0800 Load Combination (D + L + T_a + 1.25E')
- 2) Positive moment causes tension on outside surface of walls and lower surface of floor slab.
- 3) Allowable moment is based on strength design method per ACI 349/80.
- 4) T_a moments are relieved, maintaining equilibrium and curvature of section.

Table 6-1 (continued)
Arkansas Power and Light Company
Arkansas Nuclear One - Unit 1
Spent Fuel Storage Facility Evaluation
Tabulation of Controlling Section Resultant Moments (1)

Location	Section Axial Force	Section Resultant Moment ^(2,4)	Section Allowable Moment ⁽³⁾	Moment Code Ratio
East Pool Wall: (AFPSTA1A2-05)				
Vertical Section at Bottom North Corner (Element 2823)	-35.58	1262.	2235.	0.57
Horizontal Section at Bottom North Corner (Element 2329)	-38.51	1284.	2121.	0.61
Vertical Section at Top Center Span (Average Elements 6324, 5824, 5324, 4824 - AFPSTA1A2-12)	14.58	219.8	1027.	0.21

Units: Kips/Inch, Kip-inches/Inch

- Notes: 1) NUREG-0800 Load Combination (D + L + T_a + 1.25E')
- 2) Positive moment causes tension on outside surface of walls and lower surface of floor slab.
- 3) Allowable moment is based on strength design method per ACI 349/80.
- 4) T_a moments are relieved, maintaining equilibrium and curvature of section.

Table 6-1 (continued)
Arkansas Power and Light Company
Arkansas Nuclear One - Unit 1
Spent Fuel Storage Facility Evaluation
Tabulation of Controlling Section Resultant Moments (1)

Location	Section Axial Force	Section Resultant Moment(2,4)	Section Allowable Moment(3)	Moment Code Ratio
West Pool Wall: (AFPSTAlA2-08)				
Vertical Section at Bottom Mid-span (Element 2306)	-32.89	1298.	2219.	0.58
Horizontal Section near Bottom South End (Element 2808)	-34.82	1217.	2059.	0.59
Vertical Section at Top Mid-span (Average Elements 6304, 5804, 5304, 4804 - AFPSTAlA2-12)	14.97	205.0	1015.	0.20

Units: Kips/Inch, Kip-inches/Inch

- Notes:
- 1) NUREG-0800 Load Combination (D + L + T_a + 1.25E')
 - 2) Positive moment causes tension on outside surface of walls and lower surface of floor slab.
 - 3) Allowable moment is based on strength design method per ACI 349/80.
 - 4) T_a moments are relieved, maintaining equilibrium and curvature of section.

Table 6-1 (continued)
Arkansas Power and Light Company
Arkansas Nuclear One - Unit 1
Spent Fuel Storage Facility Evaluation
Tabulation of Controlling Section Resultant Moments (1)

Location	Section Axial Force	Section Resultant Moment ^(2,4)	Section Allowable Moment ⁽³⁾	Moment Code Ratio
Fuel Transfer Canal Separation Wall: (AFPSTA1A2-07)				
Vertical Section Below Elevation of Bottom of Gate Opening (Element 3313)	-40.93	769.2	1147.	0.67
Horizontal Section at Bottom of Wall (Element 2818)	-31.80	540.0	872.5	0.62
Vertical Section at Top East End (Average Elements 4818, 5318, 5818, 6318 - AFPSTA1A2-12A)	-6.624	166.0	397.6	0.42
Horizontal Section at West End of Wall Above Elevation of Bottom of Gate Opening (Average Elements 4314 thru 4318 - AFPSTA1A2-12A)	-16.58	369.4	537.0	0.63

Units: Kips/Inch, Kip-inches/Inch

- Notes:
- 1) NUREG-0800 Load Combination (D + L + T_a + 1.25E')
 - 2) Positive moment causes tension on outside surface of walls and lower surface of floor slab.
 - 3) Allowable moment is based on strength design method per ACI 349/80.
 - 4) T_a moments are relieved, maintaining equilibrium and curvature of section.

Table 6-1 (continued)
Arkansas Power and Light Company
Arkansas Nuclear One - Unit 1
Spent Fuel Storage Facility Evaluation
Tabulation of Controlling Section Resultant Moments (1)

Location	Section Axial Force	Section Resultant Moment ^(2,4)	Section Allowable Moment ⁽³⁾	Moment Code Ratio
Cask Laydown Separation Wall: (AFPSTAL2-06)				
Vertical Section Below Elevation of Bottom of Gate Opening (Element 3335)	-34.62	466.3	664.6	0.70
Horizontal Section at Bottom Mid-span (Element 2335)	-34.35	396.7	572.4	0.69
Vertical Section at East End of Wall Above Elevation Of Bottom of Gate Opening (Element 3834)	-13.41	188.4	367.0	0.51

Units: Kips/Inch, Kip-inches/Inch

- Notes:
- 1) NUREG-0800 Load Combination (D + L + T_a + 1.25E')
 - 2) Positive moment causes tension on outside surface of walls and lower surface of floor slab.
 - 3) Allowable moment is based on strength design method per ACI 349/80.
 - 4) T_a moments are relieved, maintaining equilibrium and curvature of section.

Table 6-1 (continued)
Arkansas Power and Light Company
Arkansas Nuclear One - Unit 1
Spent Fuel Storage Facility Evaluation
Tabulation of Controlling Section Resultant Moments (1)

Location	Section Axial Force	Section Resultant Moment(2,4)	Section Allowable Moment(3)	Moment Code Ratio
Pool North Wall: (AFPSTA2-11)				
Vertical Section at Middle West Edge (Element 3839)	-3.483	292.1	433.5	0.67
Horizontal Section at Middle West Edge (Element 3839)	-38.50	1002.	1384.	0.72
Vertical Section at Top West End (Average Elements 6339, 5839, 5339, 4839 - AFPSTA1A2-12)	0.496	170.2	307.3	0.55

Units: Kips/Inch, Kip-inches/Inch

- Notes: 1) NUREG-0800 Load Combination (D + L + T_a + 1.25E')
- 2) Positive moment causes tension on outside surface of walls and lower surface of floor slab.
- 3) Allowable moment is based on strength design method per ACI 349/80.
- 4) T_a moments are relieved, maintaining equilibrium and curvature of section.

TABLE 6-1
Arkansas Power and Light Company
Arkansas Nuclear One - Unit 2
Spent Fuel Storage Facility Evaluation
Tabulation of Controlling Section Resultant Moments (1)

Location	Section Axial Force	Section Resultant Moment ^(2,4)	Section Allowable Moment ⁽³⁾	Moment Code Ratio
Pool Floor Slab: (AFPSTA2A2-11)				
East - West Section at 1/3 span (Element 330)	-49.67	893.5	1646.	0.54
North - South Section at Mid-span (Element 320)	-29.67	810.5	1670.	0.49
Pool Foundation: (AFPSTA2A2-12)				
North Wall, Horizontal Section at Top (Element 1367)	-15.40	-165.4	-904.5	0.18
East Wall, Horizontal Section at Top (Element 2878)	-7.222	181.1	599.2	0.30
West Wall, Horizontal Section at Top (Element 2857)	-27.69	315.4	869.7	0.36

Units: Kips/Inch, Kip-inches/Inch

- Notes:
- 1) NUREG-0800 Load Combination (D + L + T_a + 1.25E')
 - 2) Positive moment causes tension on outside surface of walls and lower surface of floor slab.
 - 3) Allowable moment is based on strength design method per ACI 349/80.
 - 4) T_a moments are relieved, maintaining equilibrium and curvature of section.

Table 6-1 (continued)
Arkansas Power and Light Company
Arkansas Nuclear One - Unit 2
Spent Fuel Storage Facility Evaluation
Tabulation of Controlling Section Resultant Moments (1)

Location	Section Axial Force	Section Resultant Moment(2,4)	Section Allowable Moment(3)	Moment Code Ratio
West Pool Wall: (AFPSTA2A2-10)				
Vertical Section at Bottom Mid-span (Element 2305)	-20.80	849.6	1771.	0.48
Horizontal Section near Bottom North End (Element 2808)	-32.17	922.6	1935.	0.48
Vertical Section at Top Mid-span (Average Elements 6304,5804 5304,4804 - AFPSTA2A2-14)	13.88	206.8	879.7	0.24

Units: Kips/Inch, Kip-inches/Inch

- Notes:
- 1) NUREG-0800 Load Combination ($D + L + T_a + 1.25E'$)
 - 2) Positive moment causes tension on outside surface of walls and lower surface of floor slab.
 - 3) Allowable moment is based on strength design method per ACI 349/80.
 - 4) T_a moments are relieved, maintaining equilibrium and curvature of section.

Table 6-1 (continued)
Arkansas Power and Light Company
Arkansas Nuclear One - Unit 2
Spent Fuel Storage Facility Evaluation
Tabulation of Controlling Section Resultant Moments (1)

Location	Section Axial Force	Section Resultant Moment(2,4)	Section Allowable Moment(3)	Moment Code Ratio
East Pool Wall: (AFPSTA2A2-07)				
Vertical Section at Bottom Mid-span (Element 2327)	-44.48	901.5	1750.	0.52
Horizontal Section at Bottom South Corner (Element 2329)	-32.00	902.4	1711.	0.53
Vertical Section at Top Center Span (Average Elements 6326, 5826, 5326, 4826 - AFPSTA2A2-14)	14.18	234.2	875.2	0.27

Units: Kips/Inch, Kip-inches/Inch

- Notes:
- 1) NUREG-0800 Load Combination (D + L + T_a + 1.25E')
 - 2) Positive moment causes tension on outside surface of walls and lower surface of floor slab.
 - 3) Allowable moment is based on strength design method per ACI 349/80.
 - 4) T_a moments are relieved, maintaining equilibrium and curvature of section.

Table 6-1 (continued)
Arkansas Power and Light Company
Arkansas Nuclear One - Unit 2
Spent Fuel Storage Facility Evaluation
Tabulation of Controlling Section Resultant Moments (1)

Location	Section Axial Force	Section Resultant Moment(2,4)	Section Allowable Moment(3)	Moment Code Ratio
Fuel Transfer Canal Separation Wall: (AFPSTA2A2-09)				
Vertical Section Below Elevation of Bottom of Gate Opening (Element 3313)	-40.95	518.4	768.3	0.68
Horizontal Section at Bottom of Wall (Element 2813)	-23.83	403.9	758.3	0.56
Vertical Section at West End of Wall Above Elevation of Bottom of Gate Opening (Element 3818)	-11.63	267.8	447.7	0.60
Horizontal Section at West End of Wall Above Elevation of Bottom of Gate Opening (Element 3818)	-26.31	379.2	680.7	0.56

Units: Kips/Inch, Kip-inches/Inch

- Notes: 1) NUREG-0800 Load Combination (D + L + T_a + 1.25E')
- 2) Positive moment causes tension on outside surface of walls and lower surface of floor slab.
- 3) Allowable moment is based on strength design method per ACI 349/80.
- 4) T_a moments are relieved, maintaining equilibrium and curvature of section.



Table 6-1 (continued)
Arkansas Power and Light Company
Arkansas Nuclear One - Unit 2
Spent Fuel Storage Facility Evaluation
Tabulation of Controlling Section Resultant Moments (1)

Location	Section Axial Force	Section Resultant Moment(2,4)	Section Allowable Moment(3)	Moment Code Ratio
Cask Laydown Separation Wall: (AFPSTA2A2-08)				
Vertical Section Below Elevation of Bottom of Gate Opening (Element 3335)	-36.39	469.1	653.9	0.72
Horizontal Section at Bottom Mid-span (Element 2335)	-35.86	405.7	689.7	0.59
Vertical Section at East End of Wall Above Elevation Of Bottom of Gate Opening (Element 3834)	-13.99	205.3	392.2	0.52

Units: Kips/Inch, Kip-inches/Inch

- Notes:
- 1) NUREG-0800 Load Combination (D + L + T_a + 1.25E')
 - 2) Positive moment causes tension on outside surface of walls and lower surface of floor slab.
 - 3) Allowable moment is based on strength design method per ACI 349/80.
 - 4) T_a moments are relieved, maintaining equilibrium and curvature of section.

Table 6-1 (continued)
Arkansas Power and Light Company
Arkansas Nuclear One - Unit 2
Spent Fuel Storage Facility Evaluation
Tabulation of Controlling Section Resultant Moments (1)

Location	Section Axial Force	Section Resultant Moment ^(2,4)	Section Allowable Moment ⁽³⁾	Moment Code Ratio
Pool South Wall: (AFPSTA2A2-13)				
Vertical Section at Bottom East Corner (Element 2338)	-15.77	745.8	1787.	0.42
Horizontal Section at Bottom East Corner (Element 2338)	-31.36	837.8	1703.	0.49
Vertical Section at Top West End (Average Elements 6339, 5839, 5339, 4839 - AFPSTA2A2-15)	6.866	127.7	1543.	0.08

Units: Kips/Inch, Kip-inches/Inch

- Notes:
- 1) NUREG-0800 Load Combination ($D + L + T_a + 1.25E'$)
 - 2) Positive moment causes tension on outside surface of walls and lower surface of floor slab.
 - 3) Allowable moment is based on strength design method per ACI 349/80.
 - 4) T_a moments are relieved, maintaining equilibrium and curvature of section.

Question 7:

Are any modifications to the pool structure or liner contemplated?

Response:

No modifications are planned.

Question 8:

In the seismic analysis, describe the methods for estimating effects due to fluid motion on both the pool structure and racks.

Response:

For the pool structure the earthquake response of the pool water is defined based on the methodology outlined in TID-7024, Appendix F. The hydrodynamic loads are calculated as pressure profiles over the pool wetted surface and distributed to each node based on nodal tributary area. The resulting nodal forces were summed to determine the net resulting hydrodynamic forces in orthogonal directions, and these force resultants were verified using additional methodology in TID-7024, which defines the integrated pressure resultants.

The effect of water upon the dynamic response of submerged structures is significant. Two major items of concern are the virtual mass, which affects the structural frequency, and the fluid structural coupling of adjacent bodies, which affects the loads. In order to include both these effects, a hydrodynamic mass matrix element is used in the mathematical model.

The hydrodynamic mass matrix is composed of 4 terms. The M_{11} term is the virtual mass of the fluid on the racks and is calculated such that the kinetic energy of the virtual mass is the same as the kinetic energy of the moving fluid. The M_{12} and M_{21} terms represent interaction between the racks and the pool walls. The M_{22} term has a similar meaning to the M_{11} but applies to the spent fuel pool. Both horizontal flow (around the racks) and vertical flow (over the racks) are considered in the calculation. The proximity of the pool walls to the racks is also considered. The calculation is based on potential flow theory, reference "The Effects of Liquids on the Dynamic Motions of Immersed Solids," R. J. Fritz, Journal of Engineering for Industry, February 1972.

QUESTIONS RELATING TO THE NUCLEAR PHYSICS AREA

Question 1:

Provide the calculated value of K_{eff} for Region 1 as well as the maximum enrichment assumed and the values of all biases and 95/95 uncertainties.

Response:

The maximum enrichment assumed in the analysis is 4.10 w/o U-235. The K_{eff} for the Region 1 rack is determined in the following manner:

$$K_{\text{eff}} = K_{\text{nominal}} + B_{\text{method}} + B_{\text{part}} + \left[(k_{\text{s nominal}})^2 + (k_{\text{s method}})^2 + (k_{\text{s mech}})^2 \right]^{1/2}$$

where:

- K_{nominal} = nominal case KENO K_{eff}
- B_{method} = method bias determined from benchmark critical comparisons
- B_{part} = bias to account for poison particle self-shielding
- $k_{\text{s nominal}}$ = 95/95 uncertainty in the nominal case KENO K_{eff}
- $k_{\text{s method}}$ = 95/95 uncertainty in the method bias
- $k_{\text{s mech}}$ = 95/95 uncertainty due to construction and material tolerances.

Substituting calculated values in the order listed above, the result is:

$$\begin{aligned} K_{\text{eff}} &= 0.9169 + 0.0025 + \left[(.00388)^2 + (.013)^2 + (.0171)^2 \right]^{1/2} \\ &= 0.9412 - \text{For Unit 1 B \& W 15 x 15 Fuel} \end{aligned}$$

$$\begin{aligned} K_{\text{eff}} &= 0.9260 + 0.0025 + \left[(.00388)^2 + (.013)^2 + (.00904)^2 \right]^{1/2} \\ &= 0.9448 - \text{For Unit 2 CE 16 x 16 Fuel} \end{aligned}$$

Question 2:

Provide the calculated values of K_{eff} for Region 2 for the checkerboard storage configuration with 4.1 w/o enrichment assemblies and for any other configuration used to determine the final K_{eff} as well as the values of all biases and 95/95 uncertainties.

Response:

The K_{eff} for Region 2 with the checkerboard configuration and 4.1 w/o U-235 is determined in the following manner:

$$K_{eff} = K_{nominal} + B_{method} + \left[(ks)_{nominal}^2 + (ks)_{method}^2 + (ks)_{mech}^2 + (ks)_{asym}^2 \right]^{1/2}$$

where:

$K_{nominal}$ = nominal case KENO K_{eff}

B_{method} = method bias determined from benchmark critical comparisons

$ks_{nominal}$ = 95/95 uncertainty in the nominal case KENO K_{eff}

ks_{method} = 95/95 uncertainty in the method bias

ks_{mech} = 95/95 uncertainty to account for tolerances in thickness

ks_{asym} = 95/95 uncertainty to account for asymmetric assembly position

Substituting calculated values in the order listed above, the result is:

$$K_{eff} = 0.9068 + 0.0 + \left[(.0059)^2 + (.013)^2 + (.0288)^2 + (.009)^2 \right]^{1/2}$$

= 0.9402 - For Unit 1 B & W 15 x 15 Fuel

$$K_{eff} = 0.8860 + 0.0 + \left[(.0064)^2 + (.013)^2 + (.0212)^2 + (.0173)^2 \right]^{1/2}$$

= 0.9169 - For Unit 2 CE 16 x 16 Fuel

The second configuration used to determine the final K_{eff} consists of spent fuel assemblies in every cell of the rack. The final K_{eff} for spent fuel in Region 2 is constructed according to the following formula:

$$K_{eff} = K_{nom} + B_{method} + \left[(ks_{meth})^2 + (ks_{nom})^2 + (ks_{mech})^2 + (ks_{asym})^2 + (ks_{pu})^2 + (ks_{bu})^2 \right]^{1/2}$$

where:

- K_{nom} = the nominal case KENO eigenvalue
- B_{meth} = the bias in the method
- ks_{meth} = the method uncertainty (95/95)
- ks_{nom} = the uncertainty (95/95) on the nominal eigenvalue
- ks_{mech} = the uncertainty (95/95) due to construction and material tolerance
- ks_{asym} = the uncertainty (95/95) due to asymmetric assembly positioning within the cell
- ks_{pu} = the uncertainty on the plutonium reactivity
- ks_{bu} = the uncertainty on the reactivity as a function of irradiation.

Substituting calculated values in the equation of Attachment 1 for spent fuel in the rack results in:

$$K_{eff} = 0.8892 + 0.0 + [(.013)^2 + (.00332)^2 + (.01212)^2 + (.01137)^2 + (.009)^2 + (.009)^2]^{1/2}$$

= 0.914 - For Unit 1 B & W 15 x 15 Fuel

$$K_{eff} = 0.9068 + 0.00 + [(.013)^2 + (.00391)^2 + (.01341)^2 + (.00948)^2 + (.009)^2 + (.009)^2]^{1/2}$$

= 0.9316 - For Unit 2 CE 16 x 16 Fuel

As can be seen from comparing the K_{eff} formulas in the licensing submittal with those used in the response to questions 1 and 2, the term used to account for construction and material tolerances is included as an uncertainty term in lieu of a direct bias. The same is true for the term used for the potential placement of the assemblies asymmetrically in the can. Both of these phenomenon occur randomly and are not biased in any one direction.

Please amend the original submittal to reflect these changes in both Region 1 and Region 2 K_{eff} formulas and definition of terms. Attached are pages 29, 30, 36, 37 and 38 which have been corrected to reflect these changes.

between the four cans is reduced. The reactivity increase of this configuration is found and is included as an uncertainty term in calculating the K_{eff} of the rack.

Some mechanical tolerances are not included in the analysis because worst case assumptions are used in the nominal case analysis. An example of this is eccentric assembly position. Calculations were performed which show that the most reactive condition is the assembly centered in the can which is assumed in the nominal case. Another example is the reduced width of the poison plates. No bias is included here since the nominal KENO case models the reduced width explicitly.

The final result of the uncertainty analysis is that the criticality design criteria are met when the calculated effective multiplication factor, plus the total uncertainty (TU) and any biases, is less than 0.95.

These methods conform with ANSI N18.2-1973, "Nuclear Safety Criteria for the Design of Stationary Pressurized Water Reactor Plants," Section 5.7, Fuel Handling System; ANSI N210-1976, "Design Objectives for LWR Spent Fuel Storage Facilities at Nuclear Power Stations," Section 5.1.12; ANSI N16.9-1975, "Validation of Computational Methods for Nuclear Criticality Safety;" NRC Standard Review Plan, Section 9.1.2, "Spent Fuel Storage;" and the NRC Guidance, "NRC Position for Review and Acceptance of Spent Fuel Storage and Handling Applications."

4.25 Rack Modification

For normal operation and using the method described in the above sections, the K_{eff} for the rack is determined in the following manner:

$$K_{\text{eff}} = K_{\text{nominal}} + B_{\text{method}} + B_{\text{part}} + \left[(k_{\text{s nominal}})^2 + (k_{\text{s method}})^2 + (k_{\text{s mech}})^2 \right]^{1/2}$$

where:

K_{nominal} = nominal case KENO K_{eff}

B_{method} = method bias determined from benchmark critical comparisons

B_{part} = bias to account for poison particle self-shielding.

$k_{\text{s nominal}}$ = 95/95 uncertainty in the nominal case KENO K_{eff} .

$k_{\text{s method}}$ = 95/95 uncertainty in the method bias.

$k_{\text{s mech}}$ = 95/95 uncertainty due to construction and material tolerances.

The presence of the approximately 1600 ppm boron in the pool water will decrease reactivity by approximately 30% ΔK . Thus, $K_{eff} \leq 0.95$ can be easily met for postulated accidents, since any reactivity increase will be much less than the negative worth of the dissolved boron.

For fuel storage applications, water is usually present. However, accidental criticality when fuel assemblies are stored in the dry condition is also accounted for. For this case, possible sources of moderation, such as those that could arise during fire fighting operations, are included in the analysis.

This "optimum moderation" accident is not a problem in fuel storage racks because possible water densities are too low ($\sim 0.01 \text{ gm/cm}^3$) to yield K_{eff} values higher than for full density water and the rack design prevents the preferential reduction of water density between the cells of a rack (e.g., boiling between cells).

4.3.5 Manufacturing Biases

The construction tolerances for the spacer pocket racks allow for the nominal center-to-center spacing to be randomly reduced for individual cells. This change will result in an increase in K_{eff}

which will be treated as an uncertainty. The effect of the tolerances on pocket height and material thicknesses also result in an increase in K_{eff} which will be treated as an uncertainty.

Another center-to-center spacing reduction can be caused by the asymmetric assembly position within the storage cell. The inside dimensions of a nominal storage cell are such that if a fuel assembly is loaded into the corner of the cell, the assembly centerline will be displaced from the cell centerline. This means that adjacent asymmetric fuel assemblies would have their center-to-center distance reduced from the nominal. Analysis shows this reduction may increase reactivity. This will be treated as an uncertainty because the asymmetric positioning of assemblies within storage cells will be random.

The final K_{eff} for Region 2 is constructed according to the following formula:

$$K_{eff} = K_{nom} + B_{meth} + [(k_{s_{mech}})^2 + (k_{s_{asym}})^2 + (k_{s_{meth}})^2 + (k_{s_{nom}})^2 + (k_{s_{pu}})^2 + (k_{s_{bu}})^2]^{1/2}$$

where:

K_{nom} is the eigenvalue from KENO for the nominal storage configuration,

B_{meth} is the bias in the method,

ks_{meth} is the method uncertainty (95/95),

ks_{nom} is the uncertainty (95/95) on the nominal eigenvalue,

ks_{mech} is the uncertainty (95/95) due to construction and material tolerance.

ks_{asym} is the uncertainty (95/95) due to asymmetric assembly positioning within the cell.

ks_{pu} is the uncertainty on the plutonium reactivity, and

ks_{bu} is the uncertainty on reactivity as a function of irradiation.

While it may be argued that ks_{bu} and ks_{pu} are not independent and should not be combined statistically, it should be considered that the reactivity of fuel as a function of burnup depends implicitly on the production rate of plutonium. The two uncertainties are so closely related that accounting for them twice is a conservative form of double accounting.

QUESTIONS RELATED TO RADWASTE AREA

Question 1:

What is the average annual volume of solid radwastes shipped off-site from Units No. 1 and 2?

Response:

Arkansas Nuclear One's average annual volume of solid radwastes shipped off-site from 1978 to 1982 is 24,199 cubic feet. However, we believe that a realistic average annual volume of solid radwaste shipments for future years will range between 30,000 - 35,000 cubic ft.

Question 2:

What is the approximate volume of old fuel assembly racks to be disposed with and without volume reduction?

Response:

The estimated volume of old fuel assembly racks to be disposed of without any volume reduction is 18,700 cubic ft. It is estimated that this can be reduced to approximately 950 cubic feet (95% volume reduction) through dismantling and decontamination by electropolishing.

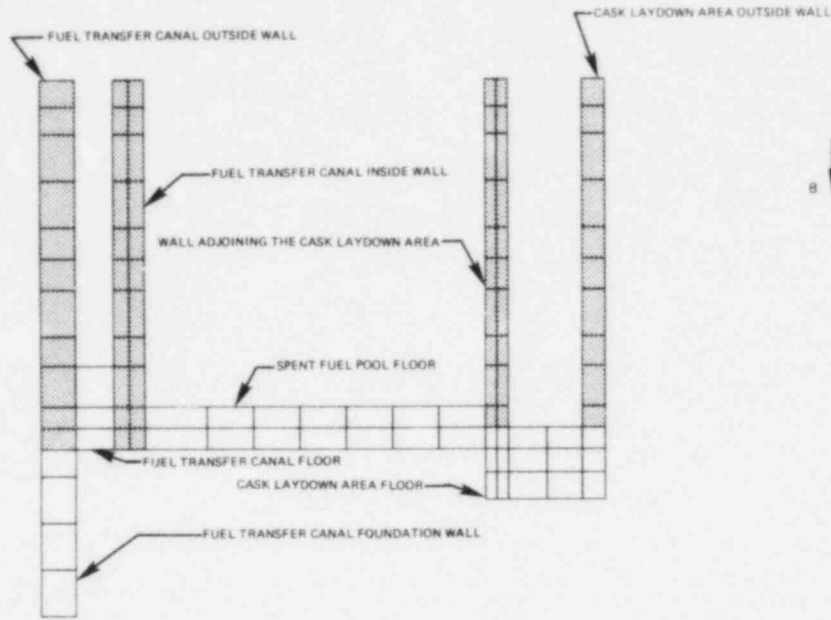
Question 3:

What is the average design burnup in MWD/MTU for Unit No. 2?

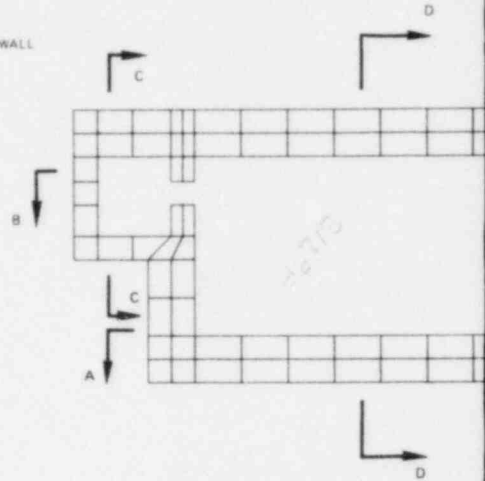
Response:

Currently Unit No. 2's average design Batch burnup is expected to be approximately 34,000 MWD/MTU. However, this value may be increased when fuel test programs have demonstrated that it is safe to do so.

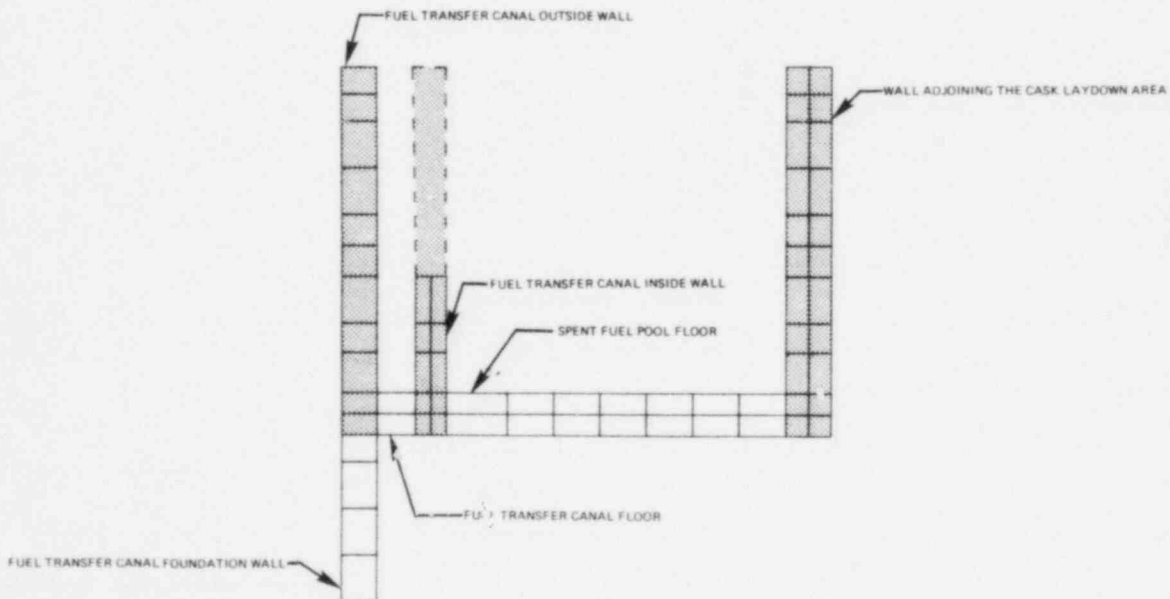
ARKANSAS NUCLEAR
SPENT FUEL STORAGE FACILITY



SECTION B-B



PLAN AT ELEVATION 40



SECTION A-A

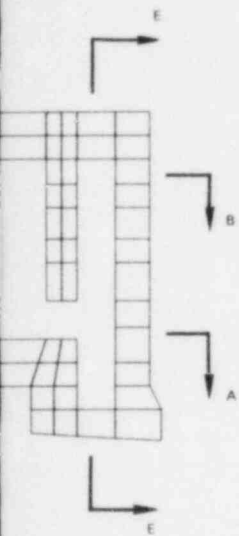


PLAN AT ELEVATION

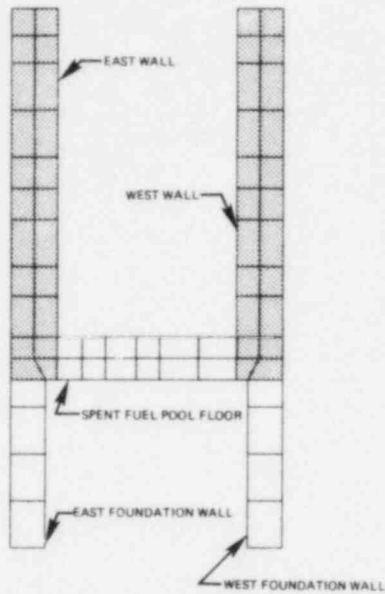
APL-01-004
REVISION 1
JUNE 7, 1982
ENCLOSURE

FIGURE
PLANS AND

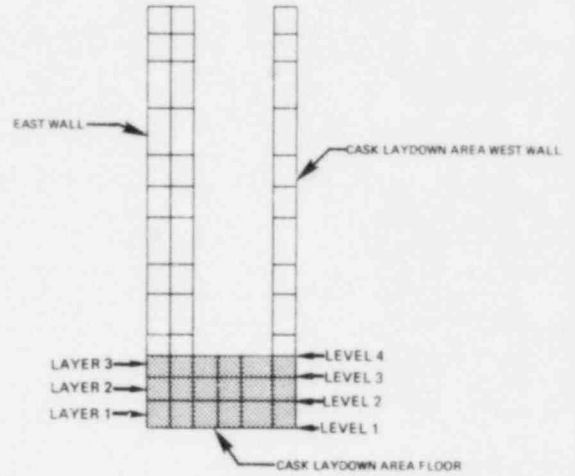
AR ONE-UNIT ONE
 ITY FINITE ELEMENT MODEL



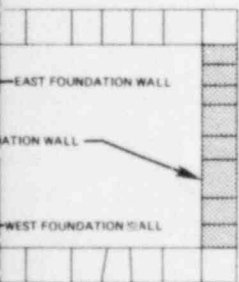
4'-0"



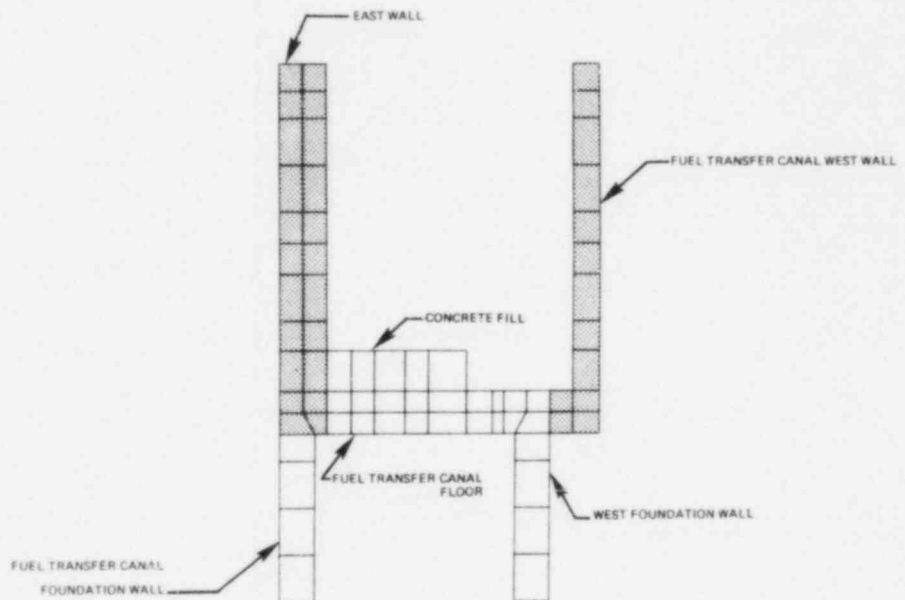
SECTION D-D



SECTION C-C



SECTION 352'-0"



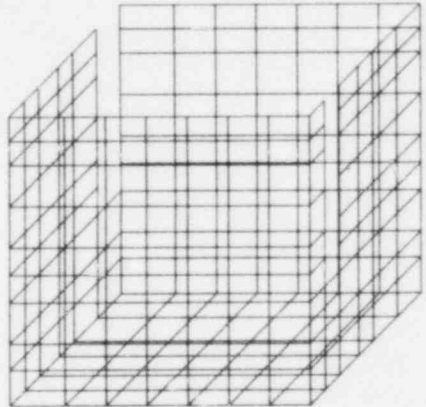
SECTION E-E

RE 1

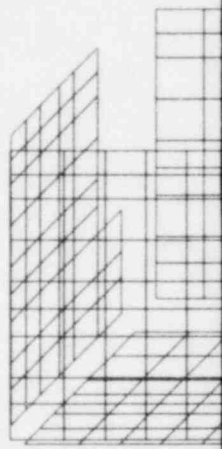
SECTIONS

ARKANSAS NUCLE
SPENT FUEL STORAGE FAC

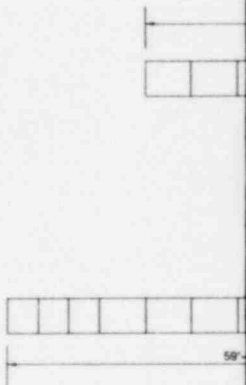
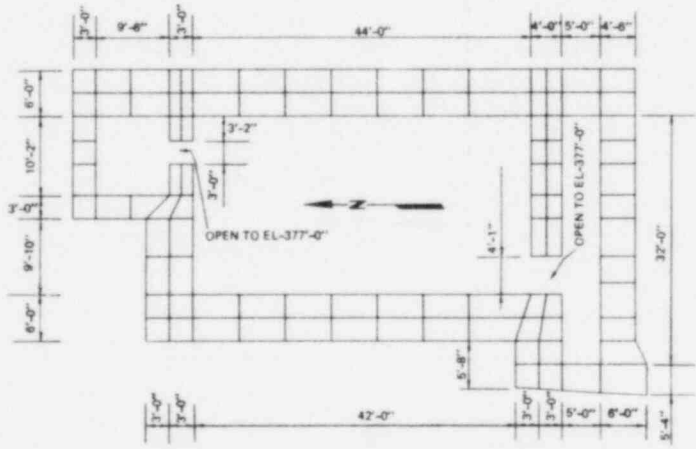
ISOMETRIC VIEWS OF SU



INSIDE MEMBRANES



MIDDLE



PLAN AT ELEV

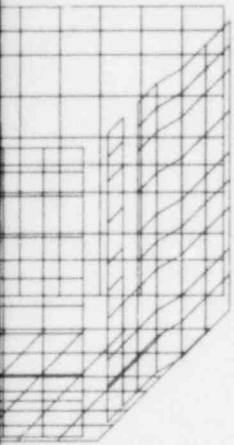
APL-01-004
REVISION 1
JUNE 7, 1982
ENCLOSURE

PLAN AT ELEVATION 404'-0"

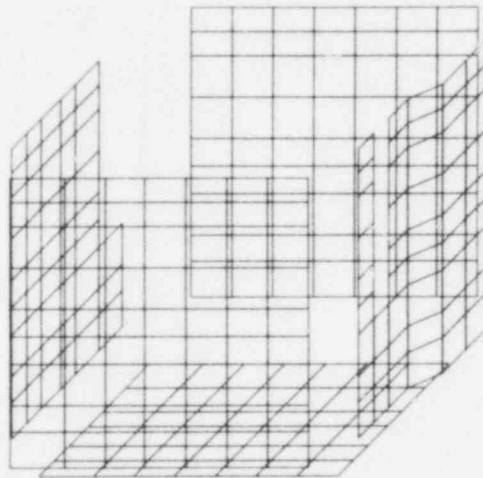
KEY DIAGR

AR ONE-UNIT ONE
ILITY FINITE ELEMENT MODEL

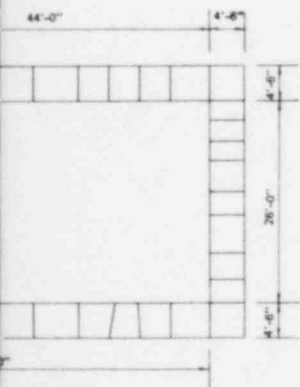
RFACE MEMBRANE ELEMENTS



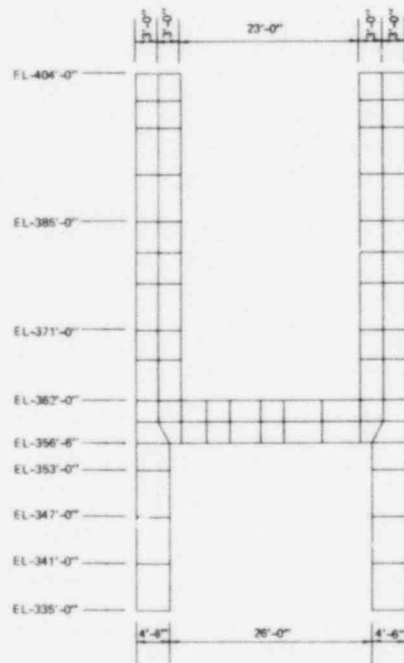
MEMBRANES



OUTSIDE MEMBRANES



SECTION 352'-0"



SECTION D-D

FIGURE 2
MEMBRANES AND DIMENSIONS

ARKANSAS NUCLEAR
SPENT FUEL STORAGE FACILITY

NODE NUMBERS

1209	1208	1207	1206	1205	1204	1203	1202
1214	1255	1254	1253	1252	1251	1250	1234
1215	1261	1260	1259	1258	1257	1256	1238
1216	1267	1266	1265	1264	1263	1262	1237
1217	1273	1272	1271	1270	1269	1268	1236
1218	1279	1278	1277	1276	1275	1274	1235
1223	1224	1225	1226	1227	1228	1229	1230

INSIDE SURFACE

1109	1108	1107	1106	1105	1104	1103	1102
1114	2055	2054	2053	2052	2051	2050	1139
1115	2061	2060	2059	2058	2057	2056	1138
1116	2067	2066	2065	2064	2063	2062	1137
1117	2073	2072	2071	2070	2069	2068	1136
1118	2079	2078	2077	2076	2075	2074	1135
1123	1124	1125	1126	1127	1128	1129	1130

MIDDLE SURFACE

1009	1008	1007	1006	1005	1004	1003	1002
1014	3055	3054	3053	3052	3051	3050	1039
1015	3061	3060	3059	3058	3057	3056	1038
1016	3067	3066	3065	3064	3063	3062	1037
1017	3073	3072	3071	3070	3069	3068	1036
1018	3079	3078	3077	3076	3075	3074	1035
1023	1024	1025	1026	1027	1028	1029	1030

OUTSIDE SURFACE

CUBE EL

206	205	204	203
213	212	211	210
220	219	218	217
227	226	225	224
234	233	232	231
241	240	239	238

INSIDE

406	405	404	403
413	412	411	410
420	419	418	417
427	426	425	424
434	433	432	431
441	440	439	438

OUTSIDE

APL-01-004
REVISION 1
JUNE 7, 1982
ENCLOSURE

FIGURE
FLOOR ELEMENT A

AR ONE-UNIT ONE
TY FINITE ELEMENT MODEL

SURFACE MEMBRANE ELEMENTS

106	105	104	103	102	101	100
113	112	111	110	109	108	107
120	119	118	117	116	115	114
127	126	125	124	123	122	121
134	133	132	131	130	129	128
141	140	139	138	137	136	135

INSIDE SURFACE

306	305	304	303	302	301	300
313	312	311	310	309	308	307
320	319	318	317	316	315	314
327	326	325	324	323	322	321
334	333	332	331	330	329	328
341	340	339	338	337	336	335

MIDDLE SURFACE

506	505	504	503	502	501	500
513	512	511	510	509	508	507
520	519	518	517	516	515	514
527	526	525	524	523	522	521
534	533	532	531	530	529	528
541	540	539	538	537	536	535

OUTSIDE SURFACE

ELEMENTS

203	202	201	200
210	209	208	207
217	216	215	214
224	223	222	221
231	230	229	228
238	237	236	235

LAYER

403	402	401	400
410	409	408	407
417	416	415	414
424	423	422	421
431	430	429	428
438	437	436	435

E LAYER

RE 3

ND NODE NUMBERS



Structural
Dynamics
Technology, Inc.

ARKANSAS NUCLE
SPENT FUEL STORAGE FACI

CUBE E

827	829	6228	6229	6228	6227	6226	6225	6224	6223	6018	9013
815	817	5228	5229	5228	5227	5226	5225	5224	5223	5018	8013
803	805	4228	4229	4228	4227	4226	4225	4224	4223	4018	8013
791	793	3228	3229	3228	3227	3226	3225	3224	3223	3018	8013
779	781	2228	2229	2228	2227	2226	2225	2224	2223	2018	8013
767	769	1228	1229	1228	1227	1226	1225	1224	1223	1018	8013
755	757	0228	0229	0228	0227	0226	0225	0224	0223	0018	8013
743	745	9228	9229	9228	9227	9226	9225	9224	9223	9018	8013
731	733	8228	8229	8228	8227	8226	8225	8224	8223	8018	8013
719	721	7228	7229	7228	7227	7226	7225	7224	7223	7018	8013

INSIDE LAYER

SURFACE MEMB

6129	6128	6127	6126	6125	6124	6123
5629	5628	5627	5626	5625	5624	5623
5129	5128	5127	5126	5125	5124	5123
4629	4628	4627	4626	4625	4624	4623
4129	4128	4127	4126	4125	4124	4123
3629	3628	3627	3626	3625	3624	3623
3129	3128	3127	3126	3125	3124	3123
2629	2628	2627	2626	2625	2624	2623
2129	2128	2127	2126	2125	2124	2123

INSIDE SURFACE

6329	6328	6327
5829	5828	5827
5329	5328	5327
4829	4828	4827
4329	4328	4327
3829	3828	3827
3329	3328	3327
2829	2828	2827
2329	2328	2327

MIDD

APL-01-004
REVISION 1
JUNE 7, 1982
ENCLOSURE

FIGU
EAST WALL EL

AR ONE-UNIT ONE
 LITY FINITE ELEMENT MODEL

ELEMENTS

828	836	828 836 837 838	6429	6428	6427	6426	6425	6424	6423	8028 8029 8030	9065
816	818	816 818 819 820	5929	5928	5927	5926	5925	5924	5923	8028 8029 8030	8865
804	806	804 806 807 808	5429	5428	5427	5426	5425	5424	5423	8028 8029 8030	8865
792	794	792 794 795 796	4929	4928	4927	4926	4925	4924	4923	8028 8029 8030	8765
780	782	780 782 783 784	4429	4428	4427	4426	4425	4424	4423	8028 8029 8030	8665
768	770	768 770 771 772	3929	3928	3927	3926	3925	3924	3923	8028 8029 8030	8565
756	758	756 758 759 760	3429	3428	3427	3426	3425	3424	3423	8028 8029 8030	8465
744	746	744 746 747 748	2929	2928	2927	2926	2925	2924	2923	8028 8029 8030	8365
732	734	732 734 735 736	2429	2428	2427	2426	2425	2424	2423	8028 8029 8030	8265
720	722	720 722 723 724	1929	1928	1927	1926	1925	1924	1923	8028 8029 8030	8165
			1429	1428	1427	1426	1425	1424	1423	8028 8029 8030	8065

OUTSIDE LAYER

PLANE ELEMENTS

626	6325	6324	6323
606	5825	5824	5823
586	5325	5324	5323
566	4825	4824	4823
546	4325	4324	4323
526	3825	3824	3823
506	3325	3324	3323
486	2825	2824	2823
466	2325	2324	2323

6529	6528	6527	6526	6525	6524	6523
6029	6028	6027	6026	6025	6024	6023
5529	5528	5527	5526	5525	5524	5523
5029	5028	5027	5026	5025	5024	5023
4529	4528	4527	4526	4525	4524	4523
4029	4028	4027	4026	4025	4024	4023
3529	3528	3527	3526	3525	3524	3523
3029	3028	3027	3026	3025	3024	3023
2529	2528	2527	2526	2525	2524	2523

INSIDE SURFACE

OUTSIDE SURFACE

FIGURE 4

ELEMENT NUMBERS



Structural Dynamics Technology, Inc.

ARKANSAS NUCLE SPENT FUEL STORAGE FACI

2694	1694		1679	1678	1677	1676	1675	1674		169
2694	1694	2680 1630 1580	1629	1628	1627	1626	1625	1624	2689 1619 1569	169
2594	1594	2680 1630 1580	1579	1578	1577	1576	1575	1574	2689 1619 1569	239
2544	1544	2680 1630 1580	1529	1528	1527	1526	1525	1524	2689 1619 1569	239
2494	1494	2680 1630 1580	1479	1478	1477	1476	1475	1474	2689 1619 1569	189
2444	1444	2680 1630 1580	1429	1428	1427	1426	1425	1424	2689 1619 1569	139
2394	1394	2680 1630 1580	1379	1378	1377	1376	1375	1374	2689 1619 1569	89
2344	1344	2680 1630 1580	1329	1328	1327	1326	1325	1324	2689 1619 1569	39
2294	1294	2680 1630 1580	1279	1278	1277	1276	1275	1274	2689 1619 1569	2969
2244	1244	2680 1630 1580	1229	1228	1227	1226	1225	1224	2689 1619 1569	2919
2194	1194	2680 1630 1580	1179	1178	1177	1176	1175	1174	2689 1619 1569	2819
			1029	1028	1027	1026	1025	1024		2719

INSIDE SURFACE

2693	1693		2679	2678	267
2643	1643	2680 1630 1580	2629	2628	262
2593	1593	2680 1630 1580	2579	2578	257
2543	1543	2680 1630 1580	2529	2528	252
2493	1493	2680 1630 1580	2479	2478	247
2443	1443	2680 1630 1580	2429	2428	242
2393	1393	2680 1630 1580	2379	2378	237
2343	1343	2680 1630 1580	2329	2328	232
2293	1293	2680 1630 1580	2279	2278	227
2243	1243	2680 1630 1580	2229	2228	222
2193	1193	2680 1630 1580	2179	2178	217
			2029	2028	202

MIDDLE

APL-01-004
REVISION 1
JUNE 7, 1982
ENCLOSURE

FIGU
EAST WALL N

AR ONE-UNIT ONE
 LITY FINITE ELEMENT MODEL

2697	1692		3679	3678	3677	3676	3675	3674		391
2642	1642		3629	3628	3627	3626	3625	3624		341
2592	1592		3579	3578	3577	3576	3575	3574		291
2542	1542		3529	3528	3527	3526	3525	3524		241
2492	1492		3479	3478	3477	3476	3475	3474		191
2442	1442		3429	3428	3427	3426	3425	3424		141
2392	1392		3379	3378	3377	3376	3375	3374		91
2342	1342		3329	3328	3327	3326	3325	3324		41
2292	1292		3279	3278	3277	3276	3275	3274		2971
2242	1242		3229	3228	3227	3226	3225	3224		2921
2192	1192		3179	3178	3177	3176	3175	3174		2821
			3029	3028	3027	3026	3025	3024		2721

OUTSIDE SURFACE

2676	2675	2674		390
2626	2625	2624		340
2576	2575	2574		290
2526	2525	2524		240
2476	2475	2474		190
2426	2425	2424		140
2376	2375	2374		90
2326	2325	2324		40
2276	2275	2274		2970
2226	2225	2224		2920
2126	2125	2124		2820
2026	2025	2024		2720

SURFACE

URE 5

ODE NUMBERS



Structural
 Dynamics
 Technology, Inc.

ARKANSAS NUCLE
SPENT FUEL STORAGE FACIL

CUBE E

6209	6208	6207	6206	6205	6204	6203	6202	6201
5709	5708	5707	5706	5705	5704	5703	5702	5701
5209	5208	5207	5206	5205	5204	5203	5202	5201
4709	4708	4707	4706	4705	4704	4703	4702	4701
4209	4208	4207	4206	4205	4204	4203	4202	4201
3709	3708	3707	3706	3705	3704	3703	3702	3701
3209	3208	3207	3206	3205	3204	3203	3202	3201
2709	2708	2707	2706	2705	2704	2703	2702	2701
2209	2208	2207	2206	2205	2204	2203	2202	2201
1709	1708	1707	1706	1705	1704	1703	1702	1701
1209	1208	1207	1206	1205	1204	1203	1202	1201

INSIDE LAYER

SURFACE MEMB

6108	6107	6106	6105	6104	6103	6102
5608	5607	5606	5605	5604	5603	5602
5108	5107	5106	5105	5104	5103	5102
4608	4607	4606	4605	4604	4603	4602
4108	4107	4106	4105	4104	4103	4102
3608	3607	3606	3605	3604	3603	3602
3108	3107	3106	3105	3104	3103	3102
2608	2607	2606	2605	2604	2603	2602
2108	2107	2106	2105	2104	2103	2102

INSIDE SURFACE

6308	6307	6306
5808	5807	5806
5308	5307	5306
4808	4807	4806
4308	4307	4306
3808	3807	3806
3308	3307	3306
2808	2807	2806
2308	2307	2306

MID

APL-01-004
REVISION 1
JUNE 7, 1982
ENCLOSURE

FIGU
WEST WALL ELE

AR ONE-UNIT ONE
 ITY FINITE ELEMENT MODEL

ELEMENTS

6400	6401	6402	6403	6404	6405	6406	6407	6408	6409
5900	5901	5902	5903	5904	5905	5906	5907	5908	5909
5400	5401	5402	5403	5404	5405	5406	5407	5408	5409
4900	4901	4902	4903	4904	4905	4906	4907	4908	4909
4400	4401	4402	4403	4404	4405	4406	4407	4408	4409
3900	3901	3902	3903	3904	3905	3906	3907	3908	3909
3400	3401	3402	3403	3404	3405	3406	3407	3408	3409
2900	2901	2902	2903	2904	2905	2906	2907	2908	2909
2400	2401	2402	2403	2404	2405	2406	2407	2408	2409
1900	1901	1902	1903	1904	1905	1906	1907	1908	1909
1400	1401	1402	1403	1404	1405	1406	1407	1408	1409

OUTSIDE LAYER

PLANE ELEMENTS

6305	6304	6303	6302
5805	5804	5803	5802
5305	5304	5303	5302
4805	4804	4803	4802
4305	4304	4303	4302
3805	3804	3803	3802
3305	3304	3303	3302
2805	2804	2803	2802
2305	2304	2303	2302

6508	6507	6506	6505	6504	6503	6502
6008	6007	6006	6005	6004	6003	6002
5508	5507	5506	5505	5504	5503	5502
5008	5007	5006	5005	5004	5003	5002
4508	4507	4506	4505	4504	4503	4502
4008	4007	4006	4005	4004	4003	4002
3508	3507	3506	3505	3504	3503	3502
3008	3007	3006	3005	3004	3003	3002
2508	2507	2506	2505	2504	2503	2502

INSIDE SURFACE

OUTSIDE SURFACE

RE 6
 ELEMENT NUMBERS



Structural
 Dynamics
 Technology, Inc.

ARKANSAS NUCLE
SPENT FUEL STORAGE FACIL

1659	1658	1657	1656	1655	1654	1653	1652
1609	1608	1607	1606	1605	1604	1603	1602
1559	1558	1557	1556	1555	1554	1553	1552
1509	1508	1507	1506	1505	1504	1503	1502
1459	1458	1457	1456	1455	1454	1453	1452
1409	1408	1407	1406	1405	1404	1403	1402
1359	1358	1357	1356	1355	1354	1353	1352
1309	1308	1307	1306	1305	1304	1303	1302
1259	1258	1257	1256	1255	1254	1253	1252
1209	1208	1207	1206	1205	1204	1203	1202
1109	1108	1107	1106	1105	1104	1103	1102
1009	1008	1007	1006	1005	1004	1003	1002

INSIDE SURFACE

2660	2659	2658	2657	2656
2610	2609	2608	2607	2606
2560	2559	2558	2557	2556
2510	2509	2508	2507	2506
2460	2459	2458	2457	2456
2410	2409	2408	2407	2406
2360	2359	2358	2357	2356
2310	2309	2308	2307	2306
2260	2259	2258	2257	2256
2210	2209	2208	2207	2206
2110	2109	2108	2107	2106
2010	2009	2008	2007	2006

MIDDLE

APL-01-004
REVISION 1
JUNE 7, 1982
ENCLOSURE

FIGU
WEST WALL N

AR ONE-UNIT ONE
 ITY FINITE ELEMENT MODEL

2855	2854	2853	2852	2851
2805	2804	2803	2802	2801
2555	2554	2553	2552	2551
2505	2504	2503	2502	2501
2455	2454	2453	2452	2451
2405	2404	2403	2402	2401
2355	2354	2353	2352	2351
2305	2304	2303	2302	2301
2255	2254	2253	2252	2251
2205	2204	2203	2202	2201
2105	2104	2103	2102	2101
2005	2004	2003	2002	2001

3663	3662	3659	3658	3657	3656	3655	3654	3653	3652	3651	3650
3613	3612	3609	3608	3607	3606	3605	3604	3603	3602	3601	3600
3563	3562	3559	3558	3557	3556	3555	3554	3553	3552	3551	3550
3513	3512	3509	3508	3507	3506	3505	3504	3503	3502	3501	3500
3463	3462	3459	3458	3457	3456	3455	3454	3453	3452	3451	3450
3413	3412	3409	3408	3407	3406	3405	3404	3403	3402	3401	3400
3363	3362	3359	3358	3357	3356	3355	3354	3353	3352	3351	3350
3313	3312	3309	3308	3307	3306	3305	3304	3303	3302	3301	3300
3263	3262	3259	3258	3257	3256	3255	3254	3253	3252	3251	3250
3213	3212	3209	3208	3207	3206	3205	3204	3203	3202	3201	3200
3113	3112	3109	3108	3107	3106	3105	3104	3103	3102	3101	3100
3013	3012	3009	3008	3007	3006	3005	3004	3003	3002	3001	3000

SURFACE

OUTSIDE SURFACE

RE 7

ODE NUMBERS



Structural
 Dynamics
 Technology, Inc.

ARKANSAS NUCLEAR
SPENT FUEL STORAGE FACILITY

NODE NUMBERS

1652	1689	1688	1687	1686	1685	1680
1602	1639	1638	1637	1636	1635	1630
1552	1589	1588	1587	1586	1585	1580
1502	1539	1538	1537	1536	1535	1530
1452	1489	1488	1487	1486	1485	1480
1402	1439	1438	1437	1436	1435	1430
1352	1389	1388	1387	1386	1385	1380
1302	1339	1338	1337	1336	1335	1330
1252	1289	1288	1287	1286	1285	1280
1202	1239	1238	1237	1236	1235	1230
1102	1139	1138	1137	1136	1135	1130
1002	1039	1038	1037	1036	1035	1030

INSIDE SURFACE

3650	3691	3690	3689	3688	3687	3686	3685	3684
3600	3641	3640	3639	3638	3637	3636	3635	3634
3550	3591	3590	3589	3588	3587	3586	3585	3584
3500	3541	3540	3539	3538	3537	3536	3535	3534
3450	3491	3490	3489	3488	3487	3486	3485	3484
3400	3441	3440	3439	3438	3437	3436	3435	3434
3350	3391	3390	3389	3388	3387	3386	3385	3384
3300	3341	3340	3339	3338	3337	3336	3335	3334
3250	3291	3290	3289	3288	3287	3286	3285	3284
3200	3241	3240	3239	3238	3237	3236	3235	3234
3100	3141	3140	3139	3138	3137	3136	3135	3134
3000	3041	3040	3039	3038	3037	3036	3035	3034

OUTSIDE SURFACE

2651	2690	2689	2688	2687	2686	2685	2684
2601	2640	2639	2638	2637	2636	2635	2634
2551	2590	2589	2588	2587	2586	2585	2584
2501	2540	2539	2538	2537	2536	2535	2534
2451	2490	2489	2488	2487	2486	2485	2484
2401	2440	2439	2438	2437	2436	2435	2434
2351	2390	2389	2388	2387	2386	2385	2384
2301	2340	2339	2338	2337	2336	2335	2334
2251	2290	2289	2288	2287	2286	2285	2284
2201	2240	2239	2238	2237	2236	2235	2234
2101	2140	2139	2138	2137	2136	2135	2134
2001	2040	2039	2038	2037	2036	2035	2034

MIDDLE SURFACE

APL-01-004
REVISION 1
JUNE 7, 1982
ENCLOSURE

FIGURE
POOL WALL ADJOINING THE CASK LAYDOWN

AR ONE-UNIT ONE
ITY FINITE ELEMENT MODEL

CUBE ELEMENTS

6239	6238	6237	6236	6235
5739	5738	5737	5736	5735
5239	5238	5237	5236	5235
4739	4738	4737	4736	4735
4239	4238	4237	4236	4235
3739	3738	3737	3736	3735
3239	3238	3237	3236	3235
2739	2738	2737	2736	2735
2239	2238	2237	2236	2235
1739	1738	1737	1736	1735
1239	1238	1237	1236	1235

6440	6439	6438	6437	6436	6435
5940	5939	5938	5937	5936	5935
5440	5439	5438	5437	5436	5435
4940	4939	4938	4937	4936	4935
4440	4439	4438	4437	4436	4435
3940	3939	3938	3937	3936	3935
3440	3439	3438	3437	3436	3435
2940	2939	2938	2937	2936	2935
2440	2439	2438	2437	2436	2435
1940	1939	1938	1937	1936	1935
1440	1439	1438	1437	1436	1435

INSIDE LAYER

OUTSIDE LAYER

SURFACE MEMBRANE ELEMENTS

6139	6138	6137	6136	6135
5639	5638	5637	5636	5635
5139	5138	5137	5136	5135
4639	4638	4637	4636	4635
4139	4138	4137	4136	4135
3639	3638	3637	3636	3635
3139	3138	3137	3136	3135
2639	2638	2637	2636	2635
2139	2138	2137	2136	2135

INSIDE SURFACE

6339	6338	6337	6336	6335
5839	5838	5837	5836	5835
5339	5338	5337	5336	5335
4839	4838	4837	4836	4835
4339	4338	4337	4336	4335
3839	3838	3837	3836	3835
3339	3338	3337	3336	3335
2839	2838	2837	2836	2835
2339	2338	2337	2336	2335

MIDDLE SURFACE

6539	6538	6537	6536	6535
6039	6038	6037	6036	6035
5539	5538	5537	5536	5535
5039	5038	5037	5036	5035
4539	4538	4537	4536	4535
4039	4038	4037	4036	4035
3539	3538	3537	3536	3535
3039	3038	3037	3036	3035
2539	2538	2537	2536	2535

OUTSIDE SURFACE

ARKANSAS NUCLE SPENT FUEL STORAGE FACIL

NODE NUMBERS

1673	1688	1667	1668	1665	1664
1623	1610	1617	1618	1615	1614
1573	1560	1567	1568	1565	1564
1523	1510	1517	1518	1515	1514
1473	1460	1467	1468	1465	1464
1423	1410	1417	1418	1415	1414
1373	1360	1367	1368	1365	1364
1323	1310	1317	1318	1315	1314
1273	1260	1267	1268	1265	1264
1223	1210	1217	1218	1215	1214
1173	1160	1167	1168	1165	1164
1123	1110	1117	1118	1115	1114
1073	1060	1067	1068	1065	1064

INSIDE SURFACE

3669	3668	3667	3668	3665	3664	3663	3662	3661
3619	3618	3617	3618	3615	3614	3613	3612	3611
3569	3568	3567	3568	3565	3564	3563	3562	3561
3519	3518	3517	3518	3515	3514	3513	3512	3511
3469	3468	3467	3468	3465	3464	3463	3462	3461
3419	3418	3417	3418	3415	3414	3413	3412	3411
3369	3368	3367	3368	3365	3364	3363	3362	3361
3319	3318	3317	3318	3315	3314	3313	3312	3311
3269	3268	3267	3268	3265	3264	3263	3262	3261
3219	3218	3217	3218	3215	3214	3213	3212	3211
3169	3168	3167	3168	3165	3164	3163	3162	3161
3119	3118	3117	3118	3115	3114	3113	3112	3111
3069	3068	3067	3068	3065	3064	3063	3062	3061

OUTSIDE SURFACE

2669	2668	2667	2668	2665	2664	2663	2660
2619	2618	2617	2618	2615	2614	2613	2610
2569	2568	2567	2568	2565	2564	2563	2560
2519	2518	2517	2518	2515	2514	2513	2510
2469	2468	2467	2468	2465	2464	2463	2460
2419	2418	2417	2418	2415	2414	2413	2410
2369	2368	2367	2368	2365	2364	2363	2360
2319	2318	2317	2318	2315	2314	2313	2310
2269	2268	2267	2268	2265	2264	2263	2260
2219	2218	2217	2218	2215	2214	2213	2210
2169	2168	2167	2168	2165	2164	2163	2160
2119	2118	2117	2118	2115	2114	2113	2110
2069	2068	2067	2068	2065	2064	2063	2060

MIDDLE SURFACE

APL-01-004
REVISION 1
JUNE 7, 1982
ENCLOSURE

FIGU
FUEL TRANSFER CANAL INSIDE W

AR ONE-UNIT ONE
TY FINITE ELEMENT MODEL

CUBE ELEMENTS

62186217	6218	6215	6214		
57185717	5718	5715	5714		
52185217	5218	5215	5214		
47184717	4718	4715	4714		
42184217	4218	4215	4214		
37183717	3718	3715	3714		
32183217	3218	3215	3214	3213	
27182717	2718	2715	2714	2713	
22182217	2218	2215	2214	2213	
17181717	1718	1715	1714	1713	
12181217	1218	1215	1214	1213	
64186417	6418	6415	6414		6412
59185917	5918	5915	5914		5912
54185417	5418	5415	5414		5412
49184917	4918	4915	4914		4912
44184417	4418	4415	4414		4412
39183917	3918	3915	3914		3912
34183417	3418	3415	3414	3413	3412
29182917	2918	2915	2914	2913	2912
24182417	2418	2415	2414	2413	2412
19181917	1918	1915	1914	1913	1912
14181417	1418	1415	1414	1413	1412

INSIDE LAYER

OUTSIDE LAYER

SURFACE MEMBRANE ELEMENTS

81188117	8118	8115	8114		
58185817	5818	5815	5814		
51185117	5118	5115	5114		
46184617	4618	4615	4614		
41184117	4118	4115	4114		
36183617	3618	3615	3614		
31183117	3118	3115	3114	3113	
26182617	2618	2615	2614	2613	
21182117	2118	2115	2114	2113	
83188317	8318	8315	8314		
58185817	5818	5815	5814		
53185317	5318	5315	5314		
48184817	4818	4815	4814		
43184317	4318	4315	4314		
38183817	3818	3815	3814		
33183317	3318	3315	3314	3313	
28182817	2818	2815	2814	2813	
23182317	2318	2315	2314	2313	
65186517	6518	6515	6514		
60186017	6018	6015	6014		
55185517	5518	5515	5514		
50185017	5018	5015	5014		
45184517	4518	4515	4514		
40184017	4018	4015	4014		
35183517	3518	3515	3514	3513	
30183017	3018	3015	3014	3013	
25182517	2518	2515	2514	2513	

INSIDE SURFACE

MIDDLE SURFACE

OUTSIDE SURFACE

ARKANSAS NUCLEAR
SPENT FUEL STORAGE FACILITY

WEST FOUNDATION WALL

2861	2860	2859	2858	2857	2856	2855	2854	2853	2852	2851	2850
2361	2360	2359	2358	2357	2356	2355	2354	2353	2352	2351	2350
1861	1860	1859	1858	1857	1856	1855	1854	1853	1852	1851	1850
1361	1360	1359	1358	1357	1356	1355	1354	1353	1352	1351	1350

INSIDE MEMBRANES

3061	3060	3059	3058	3057	3056	3055	3054	3053	3052	3051	3050
2561	2560	2559	2558	2557	2556	2555	2554	2553	2552	2551	2550
2061	2060	2059	2058	2057	2056	2055	2054	2053	2052	2051	2050
1561	1560	1559	1558	1557	1556	1555	1554	1553	1552	1551	1550

OUTSIDE MEMBRANES

2962	2961	2960	2959	2958	2957	2956	2955	2954	2953	2952	2951	2950
2462	2461	2460	2459	2458	2457	2456	2455	2454	2453	2452	2451	2450
1962	1961	1960	1959	1958	1957	1956	1955	1954	1953	1952	1951	1950
1462	1461	1460	1459	1458	1457	1456	1455	1454	1453	1452	1451	1450

CUBE ELEMENTS

FUEL TRANSFER CANALS

2871	2868	2865	2862	2859	2856	2853	2850
2371	2368	2365	2362	2359	2356	2353	2350
1871	1868	1865	1862	1859	1856	1853	1850
1371	1368	1365	1362	1359	1356	1353	1350

INSIDE

3071	3068	3065	3062	3059	3056	3053	3050
2571	2568	2565	2562	2559	2556	2553	2550
2071	2068	2065	2062	2059	2056	2053	2050
1571	1568	1565	1562	1559	1556	1553	1550

OUTSIDE

2971	2968	2965	2962	2959	2956	2953	2950
2471	2468	2465	2462	2459	2456	2453	2450
1971	1968	1965	1962	1959	1956	1953	1950
1471	1468	1465	1462	1459	1456	1453	1450

CUBE

APL-01-004
REVISION 1
JUNE 7, 1982
ENCLOSURE

FIGURE
FOUNDATION WALLS

AR ONE-UNIT ONE
ITY FINITE ELEMENT MODEL

FOUNDATION WALL

2864	2364	1864	1364
2865	2365	1865	1365
2866	2366	1866	1366
2867	2367	1867	1367

MEMBRANES

3064	2564	2064	1564
3065	2565	2065	1565
3066	2566	2066	1566

MEMBRANES

2964	2464	1964	1464
2965	2465	1965	1465
2966	2466	1966	1466
2967	2467	1967	1467

ELEMENTS

RE 10

ELEMENT NUMBERS

EAST FOUNDATION WALL

2881	2880	2879	2878	2877	2876	2875	2874
2381	2380	2379	2378	2377	2376	2375	2374
1881	1880	1879	1878	1877	1876	1875	1874
1381	1380	1379	1378	1377	1376	1375	1374

INSIDE MEMBRANES

3081	3080	3079	3078	3077	3076	3075	3074	3073
2581	2580	2579	2578	2577	2576	2575	2574	2573
2081	2080	2079	2078	2077	2076	2075	2074	2073
1581	1580	1579	1578	1577	1576	1575	1574	1573

OUTSIDE MEMBRANES

2981	2980	2979	2978	2977	2976	2975	2974	2973
2481	2480	2479	2478	2477	2476	2475	2474	2473
1981	1980	1979	1978	1977	1976	1975	1974	1973
1481	1480	1479	1478	1477	1476	1475	1474	1473

CUBE ELEMENTS



Structural
Dynamics
Technology, Inc.

ARKANSAS NUCLEAR
SPENT FUEL STORAGE FACILITY

WEST FOUNDATION WALL

2712	301201009	2008	2007	2006	2005	2004	2003	2002	2001	3041
813	812811810	809	808	807	806	805	804	803	802	801
813	812811810	809	808	807	806	805	804	803	802	801
713	712711710	709	708	707	706	705	704	703	702	701
613	612611610	609	608	607	606	605	604	603	602	601

INSIDE SURFACE NODE NUMBERS

FUEL TRANSFER CANAL

2720	2719	2718	2717	2716
821	820	819	818	817
821	820	819	818	817
721	720	719	718	717
621	620	619	618	617

INSIDE SURFACE

1711	2711	3011	3010	3009	3008	3007	3006	3005	3004	3003	3002	3001	3000
864	863	862	861	860	859	858	857	856	855	854	853	852	851
864	863	862	861	860	859	858	857	856	855	854	853	852	851
764	763	762	761	760	759	758	757	756	755	754	753	752	751
664	663	662	661	660	659	658	657	656	655	654	653	652	651

OUTSIDE SURFACE NODE NUMBERS

1721	1720	718	718	717	716
874	873	872	871	870	869
874	873	872	871	870	869
774	773	772	771	770	769
674	673	672	671	670	669

OUTSIDE SURFACE

APL-01-004
REVISION 1
JUNE 7, 1982
ENCLOSURE

FIGURE
FOUNDATION WALL

AR ONE-UNIT ONE
ITY FINITE ELEMENT MODEL

WEST FOUNDATION WALL

2715	2714	2713	2712
816	815	814	813
816	815	814	813
716	715	714	713
616	615	614	613

NODE NUMBERS

161715	1714	1713	1712	1711
968	967	966	965	964
968	967	966	965	964
768	767	766	765	764
668	667	666	665	664

NODE NUMBERS

EAST FOUNDATION WALL

2028	2027	2026	2025	2024	2023	2022	2020	2720
829	828	827	826	825	824	823	822	821
829	828	827	826	825	824	823	822	821
729	728	727	726	725	724	723	722	721
629	628	627	626	625	624	623	622	621

INSIDE SURFACE NODE NUMBERS

3020	3027	3026	3025	3024	3023	3022	3021	2721	1721
883	882	881	880	879	878	877	876	875	874
883	882	881	880	879	878	877	876	875	874
783	782	781	780	779	778	777	776	775	774
683	682	681	680	679	678	677	676	675	674

OUTSIDE SURFACE NODE NUMBERS

RE 11

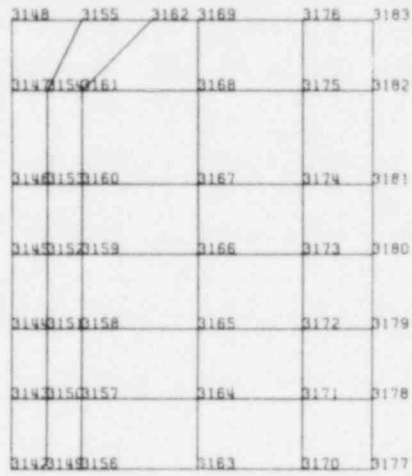
LS NODE NUMBERS



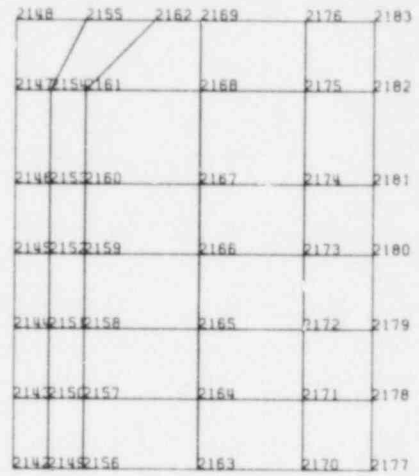
Structural
Dynamics
Technology, Inc.

ARKANSAS NUCLEAR
SPENT FUEL STORAGE FACILITY

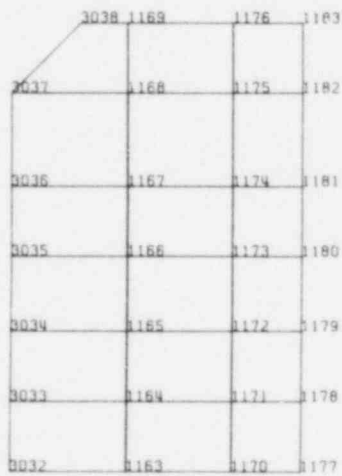
NODE NUMBERS



LEVEL 1



LEVEL 2



LEVEL 3



LEVEL 4

APL-01-004
REVISION 1
JUNE 7, 1982
ENCLOSURE

FIGURE
CASK LAYDOWN AREA FLOOR

AR ONE-UNIT ONE
TY FINITE ELEMENT MODEL

CUBE ELEMENTS

7004	7003	7002	7001	7000
7009	7008	7007	7006	7005
7014	7013	7012	7011	7010
7019	7018	7017	7016	7015
7024	7023	7022	7021	7020
7029	7028	7027	7026	7025

LAYER 1

7034	7033	7032	7031	7030
7039	7038	7037	7036	7035
7044	7043	7042	7041	7040
7049	7048	7047	7046	7045
7054	7053	7052	7051	7050
7059	7058	7057	7056	7055

LAYER 2

7062	7061	7060
7067	7066	7065
7072	7071	7070
7077	7076	7075
7082	7081	7080
7087	7086	7085

LAYER 3



ARKANSAS NUCLEAR
SPENT FUEL STORAGE FACILITY

CASK LAYDOWN AREA OUTSIDE WALL

2697	2696	2695	2694	2693	2692
2647	2646	2645	2644	2643	2642
2597	2596	2595	2594	2593	2592
2547	2546	2545	2544	2543	2542
2497	2496	2495	2494	2493	2492
2447	2446	2445	2444	2443	2442
2397	2396	2395	2394	2393	2392
2347	2346	2345	2344	2343	2342
2297	2296	2295	2294	2293	2292
2247	2246	2245	2244	2243	2242
2197	2196	2195	2194	2193	2192

INSIDE SURFACE NODE NUMBERS

3697	3696	3695	3694	3693	3692
3647	3646	3645	3644	3643	3642
3597	3596	3595	3594	3593	3592
3547	3546	3545	3544	3543	3542
3497	3496	3495	3494	3493	3492
3447	3446	3445	3444	3443	3442
3397	3396	3395	3394	3393	3392
3347	3346	3345	3344	3343	3342
3297	3296	3295	3294	3293	3292
3247	3246	3245	3244	3243	3242
3197	3196	3195	3194	3193	3192

OUTSIDE SURFACE NODE NUMBERS

822	823	824	825	826
810	811	812	813	814
798	799	800	801	802
786	787	788	789	790
774	775	776	777	778
762	763	764	765	766
750	751	752	753	754
738	739	740	741	742
726	727	728	729	730
714	715	716	717	718

CUBE ELEMENTS

APL-01-004
REVISION 1
JUNE 7, 1982
ENCLOSURE

FIGURE
CASK LAYDOWN AREA WALLS

R ONE-UNIT ONE
ITY FINITE ELEMENT MODEL

WEST WALL

2687	1697	2697	3697
2637	1647	2647	3647
3587	1597	2597	3597
0537	1547	2547	3547
2487	1497	2497	3497
2437	1447	2447	3447
3387	1397	2397	3397
3337	1347	2347	3347
3287	1297	2297	3297
3237	1247	2247	3247
3187	1197	2197	3197

INSIDE SURFACE NODE NUMBERS

2698	1698	2698	3698
2648	1648	2648	3648
2598	1598	2598	3598
2548	1548	2548	3548
2498	1498	2498	3498
2448	1448	2448	3448
2398	1398	2398	3398
2348	1348	2348	3348
2298	1298	2298	3298
2248	1248	2248	3248
2198	1198	2198	3198

OUTSIDE SURFACE NODE NUMBERS

819	820	821
807	808	809
795	796	797
783	784	785
771	772	773
759	760	761
747	748	749
735	736	737
723	724	725
711	712	713

CUBE ELEMENTS

RE 13

ELEMENT AND NODE NUMBERS



Structural
Dynamics
Technology, Inc.

AR ONE-UNIT ONE
 TTY FINITE ELEMENT MODEL

CUBE ELEMENTS

9064	9063	9062	9061	9060	9059	9058	9057	9056	9055
8964	8963	8962	8961	8960	8959	8958	8957	8956	8955
8864	8863	8862	8861	8860	8859	8858	8857	8856	8855
8764	8763	8762	8761	8760	8759	8758	8757	8756	8755
8664	8663	8662	8661	8660	8659	8658	8657	8656	8655
8564	8563	8562	8561	8560	8559	8558	8557	8556	8555
8464	8463	8462	8461	8460	8459	8458	8457	8456	8455
8364	8363	8362	8361	8360	8359	8358	8357	8356	8355
8264	8263	8262	8261	8260	8259	8258	8257	8256	8255
8164	8163	8162	8161	8160	8159	8158	8157	8156	8155
8064	8063	8062	8061	8060	8059	8058	8057	8056	8055

8212	8211	8210	8209	8208					
8112	8111	8110	8109	8108	8107	8106	8105		
8012	8011	8010	8009	8008	8007	8006	8005		

FLOOR CROSS SECTION ELEMENTS

FUEL TRANSFER CANAL OUTSIDE WALL

RE 14

OUTSIDE WALL AND FLOOR
 NODE NUMBERS



Structural
 Dynamics
 Technology, Inc.

ARKANSAS NUCLE SPENT FUEL STORAGE FACIL

NODE NUMBERS

361	381	3661	3680	3659
011	031	0611	0610	0609
261	281	0561	0560	0559
211	231	0511	0510	0509
161	181	0461	0460	0459
111	131	0411	0410	0409
61	81	0361	0360	0359
11	31	0311	0310	0309
1961	1961	0261	0260	0259
1811	1811	0211	0210	0209
1711	1711	0111	0110	0109
0711	0711	0011	0010	0009

INSIDE SURFACE

353	358	357	356	355
009	008	007	006	005
259	258	257	256	255
209	208	207	206	205
159	158	157	156	155
109	108	107	106	105
59	58	57	56	55
9	8	7	6	5
1959	1958	1957	1956	1955
1809	1808	1807	1806	1805
1709	1708	1707	1706	1705

OUTSIDE SURFACE

360	380	379	378	377
010	030	029	028	027
260	280	279	278	277
210	230	229	228	227
160	180	179	178	177
110	130	129	128	127
60	80	79	78	77
10	30	29	28	27
1960	1960	1959	1958	1957
1810	1810	1809	1808	1807
1710	1710	1709	1708	1707

MIDDLE SURFACE

APL-01-004
REVISION 1
JUNE 7, 1982
ENCLOSURE

FIGUR
FUEL TRANSFE
WEST WALL ELEMENT

AR ONE-UNIT ONE
 TY FINITE ELEMENT MODEL

CUBE ELEMENTS

9054		9001	9000
8954		8901	8900
8854		8801	8800
8754		8701	8700
8654		8601	8600
8554		8501	8500
8454		8401	8400
8354		8301	8300
8254		8201	8200
8154	8102	8101	8100
8054	8002	8001	8000

INSIDE LAYER

9053	9052	9051	9050
8953	8952	8951	8950
8853	8852	8851	8850
8753	8752	8751	8750
8653	8652	8651	8650
8553	8552	8551	8550
8453	8452	8451	8450
8353	8352	8351	8350
8253	8252	8251	8250
8153	8152	8151	8150
8053	8052	8051	8050

OUTSIDE LAYER

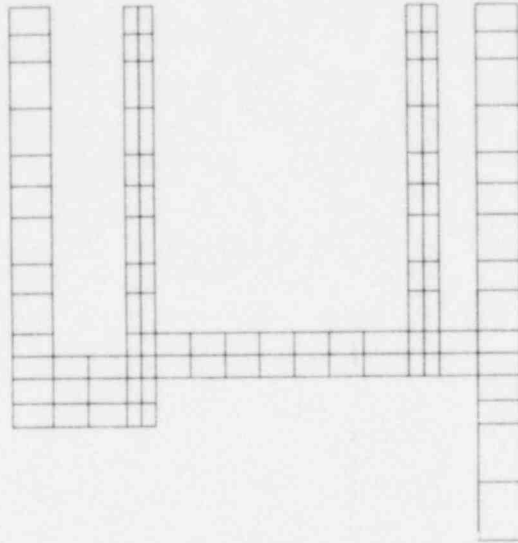
E 15

R CANAL AREA
 AND NODE NUMBERS

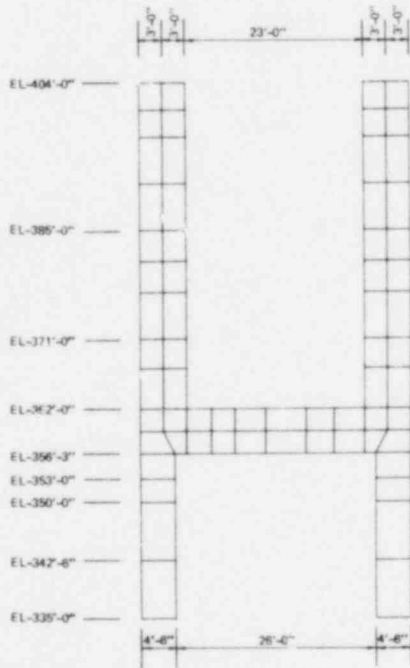


Structural
 Dynamics
 Technology, Inc.

ARKANSAS NUCLEAR
SPENT FUEL STORAGE FACILITY



SECTION A-A



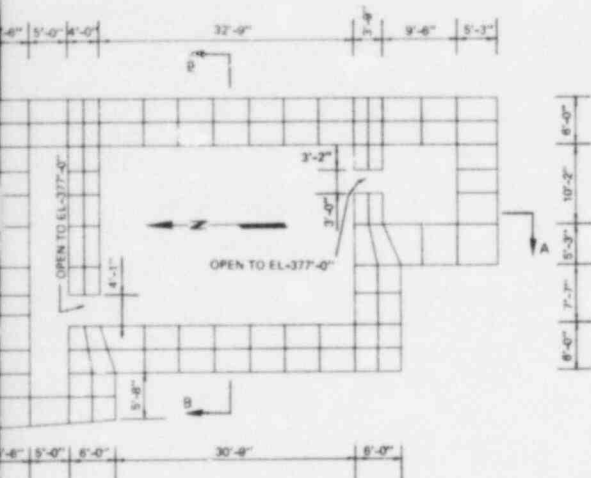
SECTION B-B



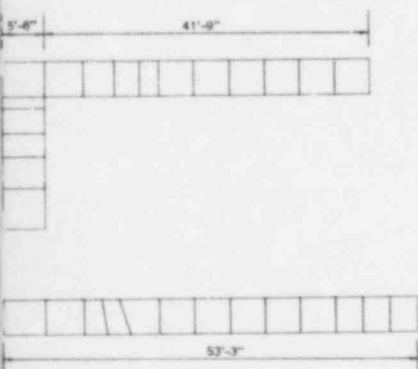
APL-02-002
REVISION 1
JUNE 7, 1982
ENCLOSURE

FIGURE
KEY DIAGRAMS

AR ONE-UNIT TWO
 NITY FINITE ELEMENT MODEL



PLAN AT ELEVATION 404'-0"



PLAN AT ELEVATION 335'-0"

RE 1

AND DIMENSIONS

NOTES:

DRAWINGS OF ANO - UNIT 1 FROM SDT LETTER APL-01-004 ENCLOSURE SHALL BE USED FOR ANO - UNIT 2 FINITE ELEMENT MODEL, EXCEPT AS NOTED:

1. ALL UNIT 1 PLOTS REPRESENT THE MIRROR IMAGE OF THE ACTUAL PLOTS FOR ANO - UNIT 2 FINITE ELEMENT MODEL.
2. FOR DIMENSIONS, ELEVATIONS AND ORIENTATION OF UNIT 2 MODEL, SEE FIGURE 1.
3. EAST FOUNDATION WALL SHOWN IN FIGURE 2 WILL REPLACE THE PLOTS OF THIS WALL SHOWN IN FIGURES 10 AND 11 OF THE UNIT 1 DRAWINGS.
4. OPENING IN FUEL TRANSFER CANAL FOUNDATION WALL FOR UNIT 2 WAS REPRESENTED BY ADJUSTING ELEVATIONS OF NODES AS SHOWN IN FIGURE 1, SECTION B-B, AND REMOVING CUBE ELEMENTS 1464 THROUGH 1466, 1964 THROUGH 1966, AND THEIR CORRESPONDING SURFACE MEMBRANE ELEMENTS FROM THE UNIT 1 MODEL (SEE FIGURE 10 OF UNIT 1 DRAWINGS).
5. CONCRETE FILL IN FUEL TRANSFER CANAL HAS BEEN REMOVED.



Structural
 Dynamics
 Technology, Inc.

ARKANSAS NUCLE
SPENT FUEL STORAGE FACI

NODE NUMBERS

2720	3020	3022	3023		2024	2025	2026	2027	2028	2029	2030
821	822	823	824	825	826	827	828	829	830	831	2143
821	822	823	824	825	826	827	828	829	830	831	2143
721	722	723	724	725	726	727	728	729	730	731	
621	622	623	624	625	626	627	628	629	630	631	

INSIDE SURFACE

CUBE E

2973	2974	2975	2976	2977	2978
2473	2474	2475	2476	2477	2478
1973	1974	1975	1976	1977	1978
1473	1474	1475	1476	1477	1478

1721	2721	3021	3022	3023		3024	3025	3026	3027	3028	3029	2030
874	875	876	877	878	879	880	881	882	883	884	885	2142
874	875	876	877	878	879	880	881	882	883	884	885	2142
774	775	776	777	778	779	780	781	782	783	784	785	
674	675	676	677	678	679	680	681	682	683	684	685	

OUTSIDE SURFACE

APL-02-002
REVISION 1
JUNE 7, 1982
ENCLOSURE

FIGU
EAST FOUNDATION WALL E

AR ONE-UNIT TWO
 LITY FINITE ELEMENT MODEL

SURFACE MEMBRANE ELEMENTS

2874	2875	2876	2877	2878	2879	2880	2881	2882	2883
2374	2375	2376	2377	2378	2379	2380	2381	2382	2383
1874	1875	1876	1877	1878	1879	1880	1881	1882	1883
1374	1375	1376	1377	1378	1379	1380	1381	1382	1383

INSIDE SURFACE

LEMENTS

78	2979	2980	2981	2982	2983
78	2479	2480	2481	2482	2483
78	1979	1980	1981	1982	1983
78	1479	1480	1481	1482	1483

3073	3074	3075	3076	3077	3078	3079	3080	3081	3082	3083
2573	2574	2575	2576	2577	2578	2579	2580	2581	2582	2583
2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083
1573	1574	1575	1576	1577	1578	1579	1580	1581	1582	1583

OUTSIDE SURFACE

RE 2

LEMENT AND NODE NUMBERS



Structural
 Dynamics
 Technology, Inc.