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Evaluation of Structural Issues Related to Isolation of the 105 KE and 105 KW Discharge/Pickup Chute		ECN No. N/A

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ENGINEERING DATA TRANSMITTAL

1. EDT 140087

2. To: (Receiving Organization) K Basin Cognizant Engineering	3. From: (Originating Organization) ICF KEH SNF Project Engineering	4. Related EDT No.: 152035
5. Proj./Prog./Dept./Div.: Spent Nuclear Fuel/K Basins/Seismic	6. Cog. Engr.: B. V. Winkel	7. Purchase Order No.: NA

8. Originator Remarks:
Addresses various structural/seismic issues associated with isolation of the 105 K East and 105 K West discharge/pickup chutes including the design calculations for the isolation barrier doors.

9. Equip./Component No.: NA

10. System/Bldg./Facility: 59-07/60-07/105 KE/105 KW

11. Receiver Remarks:

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1		QA A. K. Sharma			H5-60						
1		Safety J. C. Hamrick			H3-80						
		Env.									
1		W. A. Frier			X3-74						
1		C. L. Bennet			X3-77						

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ENGINEERING DATA TRANSMITTAL

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10. System/Bldg./Facility: 59-07/60-07/105 KE/105 KW

11. Receiver Remarks:

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1	1	QA A. K. Sharma	A K Sharma	3/6/95	H5-60						
1	1	Safety J. C. Hamrick	J C Hamrick	2/28/95	H3-80						
		Env.									
1	1	W. A. Frier	W A Frier	2/23/95	X3-74						
1	1	C. L. Bennet	C L Bennet	2/28/95	X3-77						

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RELEASE AUTHORIZATION

Document Number:	WHC-SD-SNF-DA-005, REV. 0
Document Title:	EVALUATION OF STRUCTURAL ISSUES RELATED TO ISOLATION OF THE 100 KE AND 100 KW DISCHARGE~~/PICKUP~~ CHUTES
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This document was reviewed following the procedures described in WHC-CM-3-4 and is:

APPROVED FOR PUBLIC RELEASE

WHC Information Release Administration Specialist:

Chris Willingham

C. Willingham 3/6/95

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7. Abstract

The issue of excessive post-seismic leakage in the discharge chute of the K East and K West fuel storage basins was resolved by designing isolation barriers to maintain basin water levels if the discharge chute should drain. This report addresses the structural issues associated with isolation of the discharge chute. The report demonstrates the structural adequacy of the components associated with chute isolation for normal and seismic loading. Associated issues, such as hardware drop accidents and seismic slosh heights are also addressed.

8. RELEASE STAMP

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EVALUATION OF STRUCTURAL ISSUES

RELATED TO ISOLATION OF THE 105 KE/105 KW DISCHARGE/PICKUP CHUTES

Issued by

ICF KAISER HANFORD COMPANY

FEBRUARY 1995

for the

U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
RICHLAND, WASHINGTON

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INDEPENDENT REVIEW CHECKLIST

Document Reviewed WHC-SD-SNF-DA-005, Evaluation of Structural Issues Related to Isolation of the 105-KE and 105-KW Discharge Chutes

Author B. V. Winkel and L. L. Hyde

Yes	No	N/A	
(✓)	( )	( )	Problem completely defined.
(✓)	( )	( )	Necessary assumptions explicitly stated and supported.
(✓)	( )	( )	Are computer analysis applications documented in the report per EP 2.1? (code, version, hardware, input, output files)
(✓)	( )	( )	Is the software verification documentation either referenced or included in the report?
(✓)	( )	( )	Computer code error reports reviewed for impact if any.
(✓)	( )	( )	Data used in calculations explicitly stated in document.
(✓)	( )	( )	Data checked for consistency with original source information as applicable.
(✓)	( )	( )	Mathematical derivations checked, including dimensional consistency of results.
(✓)	( )	( )	Models appropriate and used within range of validity or use outside range of established validity justified.
(✓)	( )	( )	Hand calculations checked for errors.
(✓)	( )	( )	Computer code run streams correct and consistent with analysis documentation.
(✓)	( )	( )	Computer code output consistent with input and with results reported in analysis documentation.
(✓)	( )	( )	Acceptability limits on analytical results applicable and supported. Limits checked against sources.
(✓)	( )	( )	Safety margins consistent with good engineering practices.
(✓)	( )	( )	Conclusions consistent with analytical results and applicable limits.
(✓)	( )	( )	Results and conclusions address all points required in the problem statement.

L. J. Julyk — 2/16/95

Reviewer — Date

Note: Any calculations, notes, or summaries generated as part of this review should be signed, dated, and attached to this checklist. Material should be labeled and recorded so that it is intelligible to a technically qualified third party.

SOFTWARE APPLICATION REPORT

SOFTWARE APPLICATION

ANSYS 5.0A
WHC-SD-SQA-CSWD-30014, Rev. 0 (Design verification report)

HARDWARE CONFIGURATION

MODEL: SGI3, Building ETC2

EDT/DOCUMENT NO.

EDT 140087
WHC-SD-SNF-DA-005

DISCUSSION:

Element types used: SHELL63, MASS21, LINK8, BEAM4

Note: The ANSYS analysis performed on the K Basin center island is not critical, since the structural adequacy was established from the hand/Mathcad calculations. The ANSYS calculations provided confirmation and backup for the hand calculations.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

METRIC CONVERSION CHART		
1 inch	=	2.54 centimeters
1 foot	=	30.48 centimeters
1 lb-force	=	4.45 Newtons
1 ft-lb-force	=	1.36 Joules
1 lb/in^2	=	6894.8 Pascals
1 °F = (9/5)·°C + 32		

EVALUATION OF STRUCTURAL ISSUES

RELATED TO ISOLATION OF THE 105 KE/105 KW DISCHARGE/PICKUP CHUTES

1.0 INTRODUCTION

1.1 STRUCTURAL COMPONENT DESCRIPTIONS

The 105 KE and 105 KW discharge/pickup chutes lie between the north wall of the reactor building and fuel storage basins. When the K reactors were operating, fuel was discharged from the reactors into the discharge/pickup chute. As shown in Figures 1-1 through 1-3, a thick wall, commonly referred to as the center island, separates the discharge/pickup chutes from the fuel storage basins. At the ends of the center island, relatively narrow gateways exist, which allowed for underwater transfers of fuel and equipment from the discharge/pickup chute to the basin.

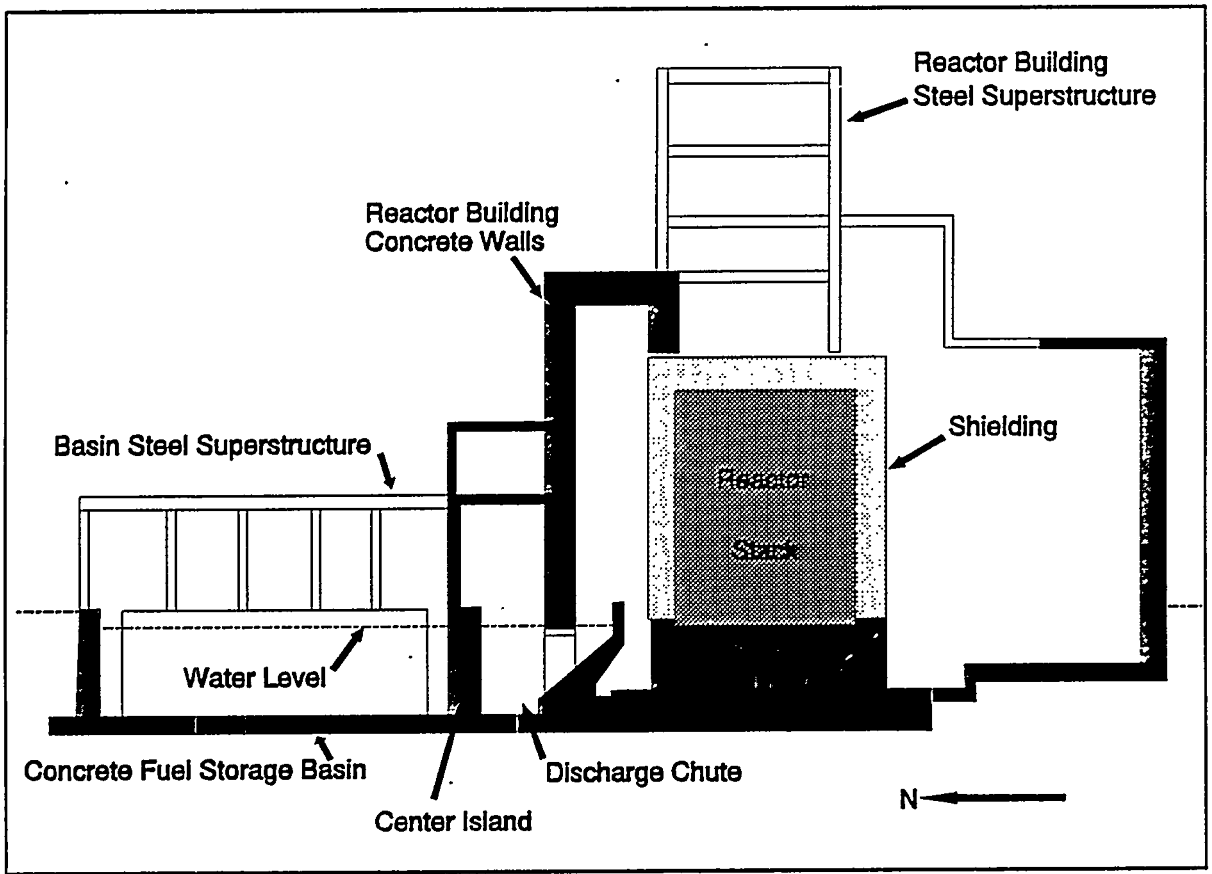

Figure 1-1. North/South Cross Section of the Reactor Building and Basin.

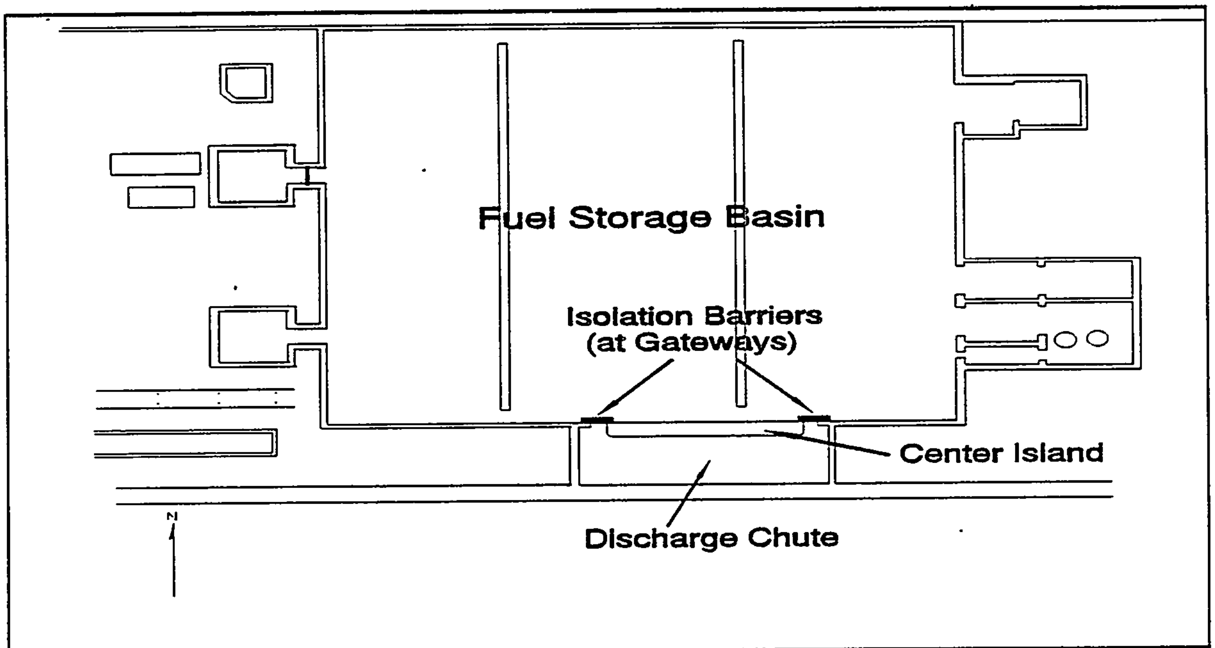

Figure 1-2. Overview Sketch of the Basin Showing the Location of Isolation Barriers.

The interface between the reactor building and the discharge/pickup chute involves non-reinforced construction joints, which were initially sealed with cast-in-place rubber water stops. Because of the seismic vulnerability of these construction joints, the decision has been made to place "isolation barriers" over the narrow gateways, as shown in Figures 1-2 and 1-3. If a significant leak through the construction joint is induced by a seismic event, the isolation barriers would limit the water loss to the discharge/pickup chute region.

In the event of a discharge/pickup chute drainage, the center island and isolation barriers must be capable of carrying the static pressure head from the basin water. If the discharge/pickup chute drainage was induced by a seismic event, seismic aftershocks could occur after the discharge/pickup chute has drained. The aftershock loading would add to the static pressure loading.

Note in Figure 1-3 that a seismic support exists in 105 KE which connects the center island to one of the basin divider walls. Removable seismic supports were also installed in 105 KW, connecting the center island to the north wall of the reactor building. This 105 KW seismic support design concept has been criticized because of the potential for center island damage from reactor building deformations transferred to the center island through the seismic supports.

The purpose of this report is to address the structural concerns associated with the isolation of the discharge/pickup chute. Structural adequacy of the center island, center island seismic supports, isolation barriers, and isolation barrier support walls is addressed. Structural concerns related to chute isolation are also addressed, including hardware handling/drop safety issues, basin hardware relocation concerns, and the issue

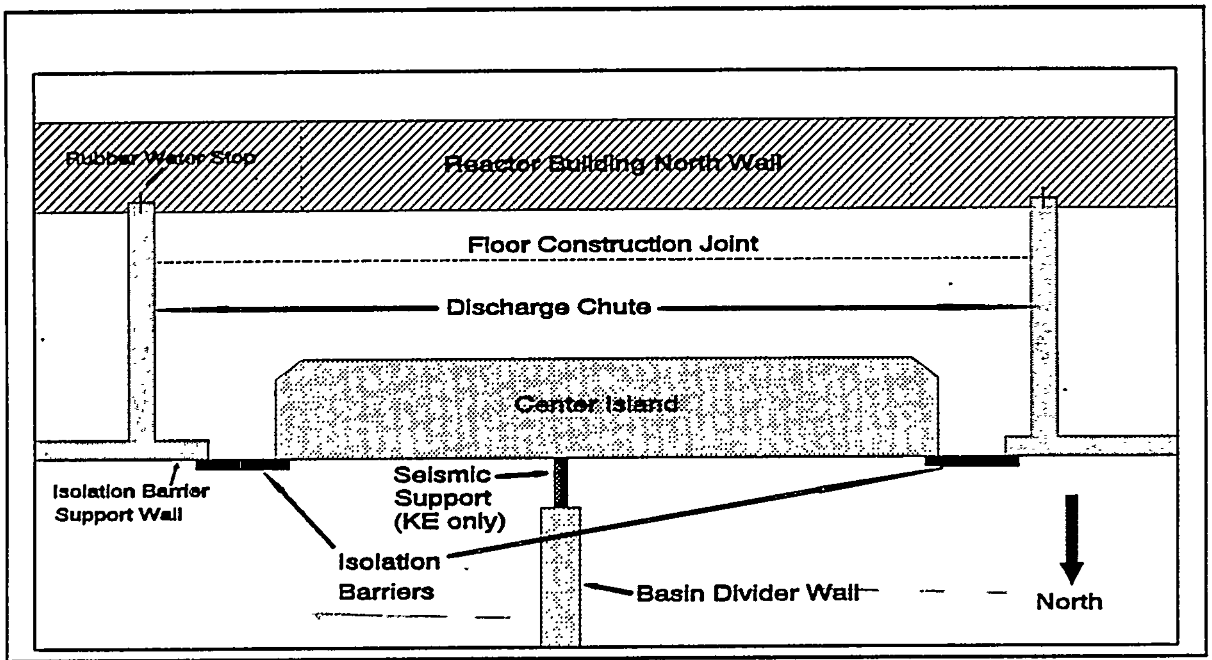

Figure 1-3. Plan View of Discharge Chute Region.

of raising the basin water height for exposure reduction.

A list of the structural components evaluated, and the associated drawings are provided in Table 1-1. A drawing error was discovered which is worthy of note. Drawings H-1-21054, H-1-21057 and H-1-21071 show an eight

Table 1-1. List of Structural Components and Drawings.

Component	Drawing Number	Drawing Title	Rev. No.
Center Island and Adjacent Concrete Structures	H-1-21054	Structural Concrete, Foundation Plan, Storage and Transfer Area	6
	H-1-21057	Structural Concrete, Floor Plan & Sections at Elev. 0'-0", Storage & Transfer Area	4
	H-1-21071	Structural Concrete, Sections & Details Below Elev. 0'-0", Storage & Transfer Area	7
105 KE Seismic Support	H-1-34900	Structural Brace	1
105 KW Seismic Supports.	H-1-34853	Structural Storage Area Conc Wall Hinged Brace	1
Isolation Barriers	H-1-80104	Basin Discharge/Pickup Chute Isolation Barriers	1

inch corner recess in the various basin gateways. As discovered by visual inspections, these corner recesses do not exist. Although limited, this type of problem has been encountered elsewhere within the basins and inspections of plant configuration were routinely performed to support the analyses.

1.2 DISCHARGE/PICKUP CHUTE ISOLATION STRUCTURAL ISSUES

Section 1.1 introduced the structural issues associated with isolation of the discharge/pickup chute, which are expanded upon in this section. The primary issue associated with chute isolation is the transfer of the water retention boundary to the center island. Under normal operations, the resultant lateral load on the center island is zero because there is water on all sides. If a sudden chute drainage resulted from a seismic event, the north boundary of the discharge/pickup chute (center island, isolation barriers, and adjacent stub walls) must carry the basin water pressure head. If a post-drain seismic event occurs, e.g. from an aftershock, then this boundary must support the static and dynamic water pressures as well as the seismic inertia loading.

The center island wall is very thick, with a 69-in. base dimension. However, the amount of reinforcing steel is minimal; specifically, 3/4-in. rebar spaced at 18 in. To provide additional center island structural support, an 18-in. deep beam was added to 105 KE in 1983, which anchors the center island to the adjacent basin divider wall, as shown in Figure 1-3. Because no formal structural documentation was found for this seismic support hardware, it is addressed in this report.

In 1981, "hinged braces" were designed for the 105 KW center island under Project H-508. The hinged design was selected to allow operations to pivot the braces to the side when the braces interfered with hardware movement within the discharge/pickup chute. These braces are anchored to the north wall of the reactor building. Because the reactor building is relatively tall, building rocking will occur during a seismic event, which may impose unacceptable deformations on the center island. Because the center island has such a broad base, there is little concern for center island tipping. However, reactor-building-induced deformations could open up the construction joint at the base of the center island, which could result in unacceptable leakage. Because of this concern, an evaluation of the 105 KW center island was performed both with and without the structural braces in place.

The 105 KE fuel storage basin has a significant contaminated "bathtub ring" which results in high exposures to personnel working above the basin. Due, in part, to the chute isolation activities, one of the options being considered for reducing radiation exposures is to raise the water level about 18 in. To prevent a center island overload, due to excessive water heights on the basin side, weirs in isolation barrier doors have been introduced to prevent basin side water heights from exceeding 16 ft 3 in., when the chute is drained. However, the increased water height on both sides of the center island increases the dynamic water pressures during a seismic event. This increase in the dynamic water pressures is addressed in Section 5.1.1.

Considerable hardware handling was anticipated during installation of the isolation barriers. If hardware is dropped from a significant height, there is a concern that the dropped hardware could punch through the basin floor and drain the basin. This hardware drop issue was addressed in a generic way, to cover both current and future hardware handling concerns. The issue evaluation is documented in Appendix C and summarized in Section 9.0.

Another safety issue associated with discharge/pickup chute isolation is the potential for seismic-induced sliding of hardware which could impact the isolation doors and reduce their post-seismic effectiveness. Therefore, an evaluation of this hardware sliding concern was performed and is documented in Section 7.0.

Safety concerns associated with seismic-induced sloshing were also raised during the chute isolation activities. Although slosh height predictions had been previously performed, they had not been documented. Thus, slosh height calculations are provided in Appendix C and discussed in Section 8.0.

The final structural issue addressed is the structural design adequacy of the isolation barrier hardware. Although there was an existing isolation barrier design dating back to 1979 (Drawing No. H-1-42659), significant modifications to the design were made. The calculations supporting the current design configuration (Drawing No. H-1-80104) are provided in Appendix A.

1.3 STRUCTURAL ACCEPTANCE CRITERIA

The basic design criteria document for Hanford site structures is SDC-4.1 (DOE 1993). The specific guidelines, codes, and standards to be applied to Hanford structures are specified in Section 2.2 of SDC-4.1. For reinforced concrete structures both ACI-318 (ACI 1989) and ACI-349 (ACI 1990) are listed. For steel structures, both the AISC Manual (AISC 1989) and the ANSI/AISC N690 code (ANSI/AISC 1984) are listed. For seismic and other natural phenomena hazard loading, SDC-4.1 specifies UCRL-15910 (Kennedy et al. 1990). Supplemental guideline documents such as ASCE 1980a and BNL 1993 were also utilized.

A listing of the various components/issues evaluated and the corresponding criteria documents is provided in Table 1-2. These issues are addressed, in the order shown, in the Sections 4.0 through 9.0.

Table 1-2. Criteria Documents Utilized in Chute Isolation Issue Resolutions.

Issue	Criteria Document	Reference
Isolation Barrier Design Adequacy	Steel Construction Manual	AISC 1989
Center Island Structural Adequacy	Code Requirements for Nuclear Safety Related Concrete Structures, ACI 349	ACI 1990
Center Island Support Brace Structural Adequacy	Nuclear Facilities, Steel Safety Related Structures for Design Fabrication and Erection, N690-1984	AISC 1984
Isolation Barrier, Concrete Support Wall Structural Adequacy	Code Requirements for Nuclear Safety Related Concrete Structures, ACI 349	ACI 1990
Seismic-Induced Sliding of Discharge/Pickup Chute Hardware	Sliding Response of Rigid Bodies to Earthquake Motions	Aslam et al. 1975
Seismic-Induced Sloshing	Seismic Design and Evaluation Guidelines for The Department of Energy High-Level Waste Storage Tanks and Appurtenances, Section 4.7	BNL 1993
Basin Floor Damage Due to Hardware Handling Accident	Structural Analysis and Design of Nuclear Plant Facilities, ASCE Manuals and Reports on Engineering Practice- No. 58	ASCE 1980b

2.0 SUMMARY AND CONCLUSIONS

The details of the structural issue resolutions addressed in this report are provided in the appendices. Individual summaries of the evaluations are contained in Sections 4.0 through 9.0. The individual summaries were condensed into a single summary which is provided in this section.

A tabular summary of the results is provided in Table 2-1. Table 2-1 was developed by selecting the critical item for each individual component or issue. Note that positive safety margins are reported for all components. A discussion of Table 2-1 items needing additional explanation follows below.

Note the second item in Table 2-1 is associated with a seismic event occurring with water on both sides of the center island: The bounding water depth for this event is 17.5 ft, as discussed in Section 3.1. The safety margin shown is for both K East and K West with no credit being taken for the seismic supports. Thus, even with the K West Basin seismic supports removed, the center island is structurally adequate if the water height is increased to the 17.5 ft level.

Explanations are in order for the safety margins shown for the empty discharge/pickup chute cases. The safety margins for the 105 KE and 105 KW basins are different because the 105 KE center island has a permanent seismic support on the north side of the center island, which doesn't exist for 105 KW. The 105 KW center island has removable seismic supports which anchor to the reactor building. Anchorage to the reactor building results in a potentially inadequate "rattle space" between the reactor building and center island. As discussed in Section 5.2.2, various center island seismic support options have been considered for 105 KW. The simplest and recommended option is to remove the 105 KW seismic supports because of the potential for seismic-induced-deformation damage to the center island. However, as demonstrated in Section 5.2.2, there is an adequate margin against collapse without the seismic supports.

Although all safety margins are shown as positive, there is one potential loading which is not included in the current evaluation. As discussed in Section 3.3 of this report, it may be possible for the fuel racks to move against the center islands and add to the seismic loading. Although the fuel weight is relatively high, the low profile of the fuel racks results in a relatively low moment addition. Further, there are a number of factors mitigating the load transmission to the center island, such as friction. However, since the center island seismic safety margin is small, a negative safety margin is possible. This fuel rack loading issue was not resolved at the time this report was written.

It is recommended that the fuel rack loading issue be reviewed when the fuel rack analysis is completed. If the review indicates that the additional loading results in negative safety margins with no center island seismic support, then a designed solution may be necessary. As examples, seismic supports in both basins or rack modifications which reduce the effective rack moment arm from 17" above the basin floor to the basin floor may be necessary in order to resolve the issue.

Table 2-1. Discharge/Pickup Chute Isolation Issues, Evaluation Results Summary.

Component/Issue	Critical Category	Critical Value	Allowable	Margin of Safety[1]
105 KE/105 KW Isolation Barriers	Support Bracket, Tie Rod Normal Condition Loading	0.68	1.00	+0.46
105 KE/105 KW Center Islands, Full Discharge/Pickup Chute, 17.5 ft Water Depth, No Seismic Support	Seismic Bending Moment at Base	71,000 ft-lbf/ft	81,000 ft-lbf/ft	+0.14
105 KE Center Island, Empty Discharge/Pickup Chute, W/ Seismic Support	Seismic Bending Moment at Base	87,260 ft-lbf/ft	96,930 ft-lbf/ft	+0.10
105 KW Center Island, Empty Discharge/Pickup Chute, No Seismic Support	Seismic Bending Moment at Base	99,800 ft-lbf/ft	100,600 ft-lbf/ft	+0.01[1]
Isolation Barrier Support Wall	Empty Chute Normal Conditions Bending Moment	13,690 ft-lbf/ft	16,100 ft-lbf/ft	+0.18
Isolation Barrier Support Brackets	Seismic-Induced Hardware Sliding Damage	2 ft	4 ft	+1.00
105 KE/105 KW Basins	Seismic-Induced Sloshing Above Freeboard	19 in.	39 in.	+1.05
105 KE/105 KW Basins	Allow. Hardware Handling Height (Drop Accident)	$2/3(h_p)$	h_p: Height to Avoid Floor Penetration	+0.50

[1] Margin of Safety = Allowable Value ÷ Predicted Value - 1.0. A positive margin indicates that the structural allowable has been met. A negative safety margin does not generally imply that a structural failure is predicted. In general, the structural allowable includes a minimum factor of 1.5 against failure.

moment arm from 17" above the basin floor to the basin floor may be necessary in order to resolve the issue.

3.0 LOAD DESCRIPTIONS

3.1 WATER DEPTH

The loading magnitude associated with discharge/pickup chute isolation is very sensitive to basin water depth. Currently, the normal operating water depth is 16 ft ±8 in. (WHC 1993) with normal operations maintaining water levels slightly below 16 ft. As discussed above, a seismic event could result in a rapid drain of the discharge/pickup chute. With the introduction of the isolation barriers, basin drainage would be prevented. The maximum water level in the basins, with the chute drained, is 16 ft 3 in. This basin-side-only water depth is controlled by the placement of drain weirs in the isolation barriers located 16 ft 3 in. above the basin floor. Thus, all load cases involving a drained discharge/pickup chute, assumed a water depth of 16 ft 3 in. The one exception to this design depth was the isolation barrier design calculations which conservatively assumed a maximum water level corresponding to the top of the isolation barrier.

As this report was being prepared, there was an ongoing study evaluating options for reducing the radiation exposures to personnel working in the 105-KE basin area. One of the dose reduction options being considered involves raising the basin water level to 17 ft 6 in. This increased water depth was addressed for the full-chute load case. If this increased water depth is adopted in future operations, it would not affect the empty-chute basin water level because of the drain weirs, discussed above, placed at the 16 ft 3 in. level.

3.2 SEISMIC LOAD DESCRIPTION

The Hanford Site Design Basis Earthquake (DBE) is defined in SDC-4.1 (DOE 1993). For Safety Class 1 non-reactor structures, including the fuel storage basins, the DBE definition is specified in Section 3.1.2.1 of SDC-4.1, which refers to the Figure 3 response spectra. The peak horizontal ground acceleration, per the SDC-4.1 definition, is 0.2 *g*. The peak vertical ground acceleration is specified as 2/3 of the peak horizontal value, or 0.13 *g*.

For the discharge/pickup chute isolation structural issues, the critical load case is associated with a seismic event occurring when there is no water in the discharge/pickup chute. Because a chute drainage is assumed to be seismic induced, an empty chute/seismic event combination would be due to a seismic aftershock. By definition (Bolt 1988), an aftershock should be "smaller" than the DBE. However, there does not appear to be a quantitative definition of a design basis aftershock. Therefore, the aftershock loading considered herein, was conservatively assumed to be equal in magnitude to a DBE.

3.3 LOAD LISTING

The loading considered in addressing discharge/pickup chute isolation issues are all associated with either normal operations or seismically related. A listing of the loads considered is provided in Table 3-1. Additional loading details can be found in the component calculations.

Table 3-1. Discharge/Pickup Chute Isolation Loadings Considered.

Event	Load Description	Comments
Normal	Maximum basin water depth of 17 ft 6 in.	Discharge/Pickup Chute water depth same as basin
	Dead weight	Gravity loading on the center island
	Equipment handling and installation in the discharge/pickup chute & basin	Maximum equipment height handling criteria established as a function of equipment weight
Seismic	Maximum basin water depth of 17 ft 6 in.	Initial shock water depth on both sides of the center island
	Maximum basin water depth of 16 ft 3 in.	Aftershock basin water depth with discharge/pickup chute drained
	Seismic inertial load of 0.2 *g* horizontal and 0.13 *g* vertical	Design Basis Earthquake used for both initial shock and aftershock
	Dynamic water pressure	Dynamic load effects associated with the basin water (sloshing and impulsive loads)
	Hardware sliding	Maximum sliding distances estimated for unanchored equipment resting in the discharge/pickup chute
	Reactor building rocking	Reactor building north wall rocking deformations imposed on 105 KW center island if seismic braces in place

During the preparation of this report, a seismic analysis of the basin fuel racks was initiated. The fuel canisters rest on the basin floor with the racks serving as spacers for the canisters. If fuel canister and rack movement occurs during a seismic event, it is possible for the fuel racks to press against the center island, thus contributing to the overall loading of the center island.

The magnitude of the potential fuel rack loading to the center island is difficult to accurately predict and at the time of this report writing, was being evaluated. The fuel weight for the full width of the basin is about 30,000 lb/ft. The center island/fuel rack contact point would be about 17 in. above the floor, which is the centerline of the fuel rack channel beams. Assuming a 0.2g horizontal acceleration, results in a fuel-generated center island base moment of about 8,000 ft-lbf/ft, which is about 8% of the current maximum value predicted for the center island.

It is expected that further analysis may demonstrate fuel rack loading to the center island to be minimal, and possibly negligible. Factors which are expected to mitigate the above concern include:

- Canister friction with the basin floor will substantially reduce the loads the center island will see. Since canisters are either steel with a nominal static coefficient of friction with concrete on the order of 0.4, or aluminum with a higher static coefficient, a steady side force of 0.2g would not move the canisters. Even taking the weight reduction which results from a vertical acceleration of 0.13g as the basin floor moves downward, movement would not result.

  Practically, however, the canisters can be expected to move as a result of two factors: uneven friction of the rough concrete against the smooth steel or aluminum canister bottom, and impulse loading resulting from shifting of fuel elements within the canisters. Uneven friction will allow the canisters to pivot (commonly described as walking) about different points as the direction of the force changes. Any shifting of the fuel (likely to be highly variable because of mixes of fuel size, damage, etc.) may exacerbate the effect for individual canisters by impact loading the canister as the elements within shift. Once moving, the dynamic coefficient of friction is enough lower that continued motion could be expected until the particular acceleration cycle drops again (most of the force will be required to continue the motion).

  Both uneven surface friction and impact loading from fuel shifting will be variable and are highly unlikely to be isotropic. Hence, the behavior of the elements is likely to be a series of random walks with limited net loading to any individual rack, and limited transmission of forces from multiple racks in the direction necessary to load the center island.

- The mass (30,000 lb/ft) of fuel, canisters and racks assumes nominal maximum loading. The actual loading for these locations are substantially less. Nominal is based on heaviest N-Reactor fuel while the single pass reactor fuel and much of the N-Reactor fuel has a lower mass. Further, a number of fuel storage spaces in the racks (particularly in KE) are empty.

- The loading assumption neglects bridging (load distribution) effects resulting from interference between adjacent racks. These effects would be hard to predict, but can be expected if the racks "walk" during a quake. Bridging will transmit portions of the load to other structures, such as the divider wall.

4.0 ISOLATION BARRIER EVALUATION

A significant part of the isolation of the discharge/pickup chutes involves the placing of isolation barriers in the entry channels (gateways) to the discharge/pickup chutes. These isolation barriers are designed to survive an earthquake and aftershocks (assumed to be of equal magnitude to the initial earthquake) while providing a leak barrier for the basin. The isolation barriers are assumed to be in place at the beginning of the seismic event with a nominal 16 ft of water on both sides. It is anticipated that a DBE will produce significant damage to the discharge/pickup chute construction joints, resulting in drainage of the chute. The isolation barriers will then be left with water pressure on the basin side only with the potential for additional loading from seismic aftershocks. This condition provides the maximum loading on the barrier.

4.1 ISOLATION BARRIER DESCRIPTION

The detailed configuration of the isolation barriers is shown in drawing H-1-80104. The barrier consists of an 18-ft high 0.5-in. thick carbon steel plate that is stiffened by a frame of 3.5- by 3.5-in. structural tubing. As measured in the field, the gross weight of a single barrier is 2475 lb. The barrier has an edge seal that is drawn up tightly against the concrete surfaces of the basin wall and the center island divider wall, using support brackets as illustrated in Figure 4-1. Pressure across the sealing surface is accomplished by the use of threaded tie rods attached to the chute side of the barrier. The tie rods pass through a bracket assembly and provide seal preload by means of torque nuts. The tie rod material is stainless steel.

4.2 ANALYSIS CRITERIA

The isolation barriers are categorized as Safety Class 1. Natural phenomena (seismic) loading for the structure was obtained from Hanford Plant Standard SDC-4.1 (DOE 1993). Acceptance criteria (allowable stresses) for the analysis results are based on the AISC Manual of Steel Construction (AISC 1989).

4.3 LOADING CONDITIONS

Loading conditions for the isolation barriers consisted of normal loading and seismic loading. The critical loading condition is that of complete drainage on the discharge/pickup chute side which subjects the isolation barriers to the full hydrostatic/hydrodynamic pressure developed on the basin side.

Normal loading consists of deadweight, seal clamp forces, tie rod tightening forces and hydrostatic pressure. Of these the hydrostatic pressure is by far the most significant for the barrier. Although the normal water level is approximately 16 ft, a water depth equal to the full height of the barriers (18 ft) was conservatively used for design purposes. The use of this value results in a maximum static pressure of 7.8 lbf/in^2 at the base of the

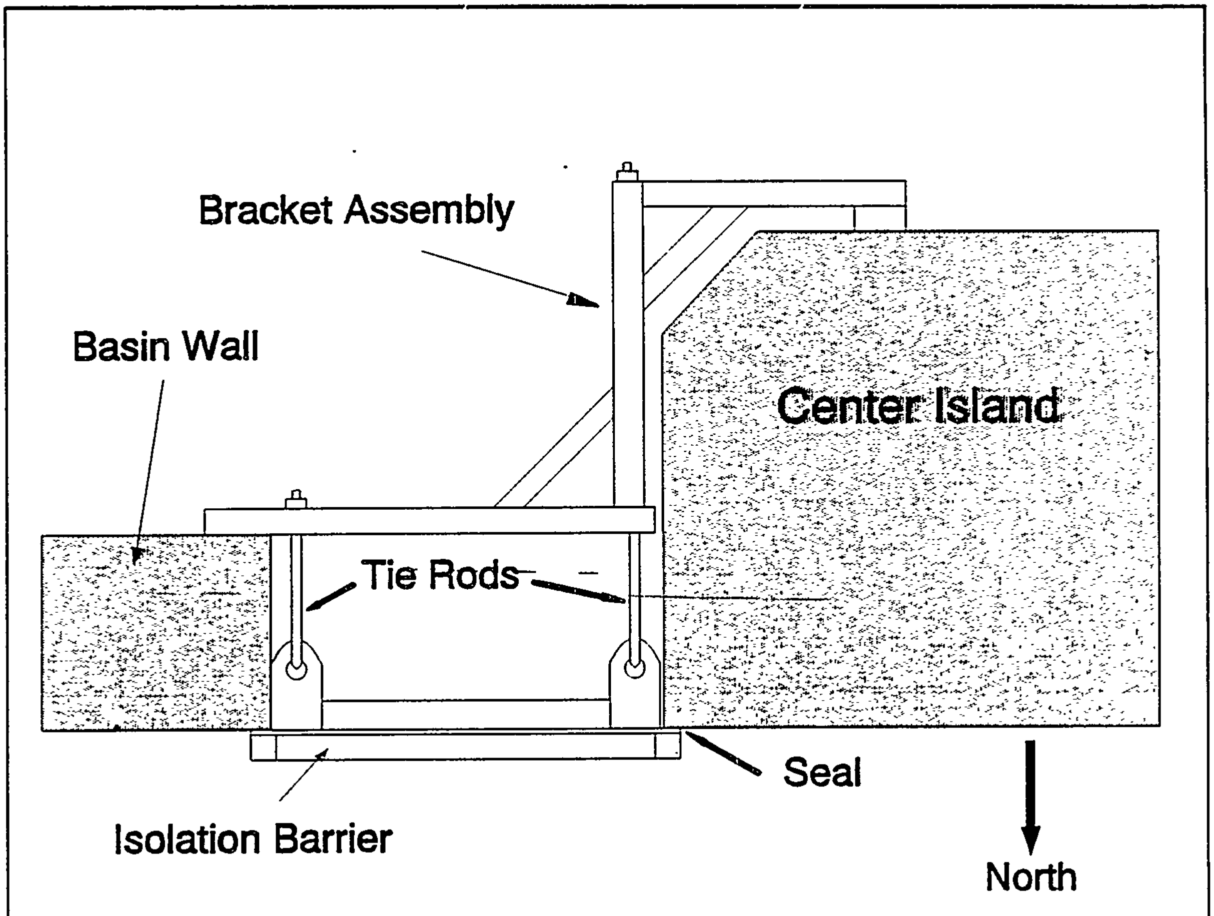

Figure 4-1. Plan View of Isolation Barrier Door and Support Bracket.

barriers. The tie rod, its supporting brackets and attachment to the barrier are critical for the tie rod installation forces.

Inertial and hydrodynamic loading were considered for seismic loading. Inertial loading of the barriers resulted in an effective pressure of 0.23 lbf/in^2. As shown in Appendix A, the peak hydrodynamic pressure on the barriers from the basin water was calculated to be 1.71 lbf/in^2. The total pressure increase due to seismic effects was therefore 1.94 lbf/in^2. In addition, a lateral seismic load was applied to the barrier.

4.4 ANALYSIS

The initial analysis of the barriers is documented in Appendix A, Part 1. It was performed on the design shown on the original barrier drawings H-1-42659. All major load-carrying components of the barriers were evaluated, mainly by conservative hand calculations using standard beam and plate equations. Simple finite-element models were developed to evaluate the tie rod support brackets and the bottom deadweight support. The results of this analysis showed that some items of the barrier required modification in order to meet the acceptance criteria (AISC 1989).

An additional analysis of the barriers is documented in Appendix A, Part 2. It was performed on the design shown on barrier drawings H-1-80104, which incorporated the modifications mentioned above. It addresses the effects of increased tie rod installation loads which were necessary to accommodate revised edge seal compression requirements.

The analysis in Appendix A, Part 3, documents the rework to two items on the chute side of the barrier. Rework was undertaken to ensure clearance with concrete sides of the basin to chute opening.

4.5 CONCLUSION

The isolation barriers shown on drawing H-1-80104 are structurally adequate as defined by the structural acceptance criteria (AISC 1989). The tables given with each of the Appendix A analyses show positive margins of safety for all loading conditions. The minimum margin of safety for the isolation doors was calculated to be +0.46 and is associated with the support brackets which are loaded by the tie rods. See Appendix A, Part 2.

5.0 CENTER ISLAND/SUPPORT BRACE EVALUATIONS

The 105 KE and 105 KW center island configurations are slightly different. The 105 KE center island has an 18-in. I beam connecting the center island to a basin divider wall with anchor bolts. The 105 KW center island has three removable support braces which span between the center island and the reactor building north wall. Because of this support brace design difference, separate evaluations were required as described in Sections 5.1 and 5.2 for 105 KE and 105 KW facilities, respectively.

5.1 105 KE CENTER ISLAND EVALUATION

As discussed in Sections 1.0 and 3.0, the normal operating condition for the basins is to have equal water depths in both the basin and discharge/pickup chute. The maximum water depth considered in this report is 17.5 ft. If a seismic event should induce a chute drain, isolation barrier weirs will prevent a basin water depth in excess of 16 ft 3 in. These two load case situations, i.e. undrained and drained discharge/pickup chutes, are addressed separately in the sections which follow.

5.1.1 Undrained Discharge/Pickup Chute

The load condition of 17.5 ft of water on both sides of the center island is discussed in Section 3.1 and the associated calculation details are provided in Part 1 of Appendix B. Because the increased water depth is being considered only for 105 KE, it technically does not apply to the 105 KW basin. However, the 105 KW basin is also covered by the Appendix B full (undrained) chute evaluation because the increased water depth is conservative for the 105 KW basin.

With water on both sides of the center island, it was anticipated that the drained-chute case would bound the undrained chute, increased water depth case. As shown in Part 1 of the Appendix B calculations, the seismic demand moment for the undrained chute case is approximately 71,000 ft-lbf/ft. This compares to an ACI 349 Code (ACI 1990) capacity of 81,000 ft-lbf/ft. This demand/capacity comparison is conservative in that it takes no credit for the 105 KE support brace. Therefore, the 105-KW full, undrained-chute case is also covered for the case of the support braces removed.

5.1.2 Drained Discharge/Pickup Chute

If a seismic-induced drainage of the discharge/pickup chute should occur, the center island must carry the additional load of the basin water pressure head (16 ft 3 in. maximum water depth for drained chute). This combined pressure, dead weight, and seismic loading case was addressed in Appendix B. Both two-dimensional calculations using MathCad[1] (MathSoft 1993)

[1]Mathcad is a registered trademark of MathSoft, Inc.

and a three-dimensional finite element analysis using ANSYS[2] (Swanson 1993) were utilized.

Demonstration of 105 KE center island structural adequacy is dependent on taking credit for the existing structural brace (drawing no. H-1-34900). The structural brace consists of an 18-in. deep I beam located between the basin divider wall and center island, as shown in Figure 5-1. The beam is

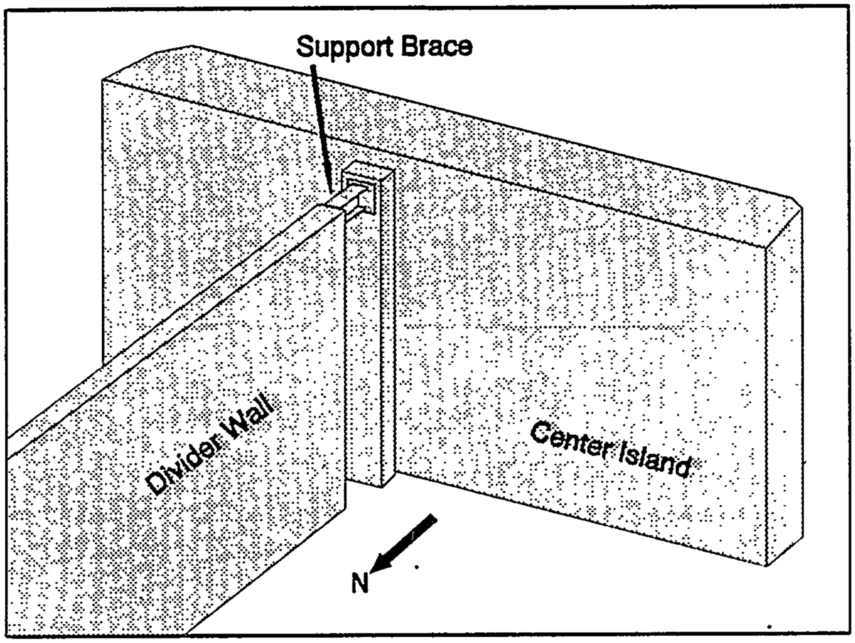

Figure 5-1. 105-KE Center Island Support Brace.

welded to end plates which are anchored to the concrete with twelve anchor bolts. Load capacity calculations for the structural brace design are included in the Appendix B calculations. As demonstrated in the Appendix B calculations, the critical event is the seismic aftershock load case. Therefore, only the seismic load combination is addressed in the discussion below.

5.1.2.1 Analysis Procedure. The initial structural evaluation of the 105 KE center island involved a two-dimensional beam analysis, which is described in Part 2 of Appendix B. Although the beam analysis was a reasonable first approximation of the center island seismic response, it does not account for variations over the length of the center island. For example, the seismic

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[2] ANSYS is a registered trade mark of Swanson Analysis Systems, Inc.

support is not continuous over the length of the center island, but is located at a single point, 2.5 ft east of the center island midpoint. Other three-dimensional effects not addressed by the beam analysis were the isolation barrier support loading and the extra rebar at the ends of the center island.

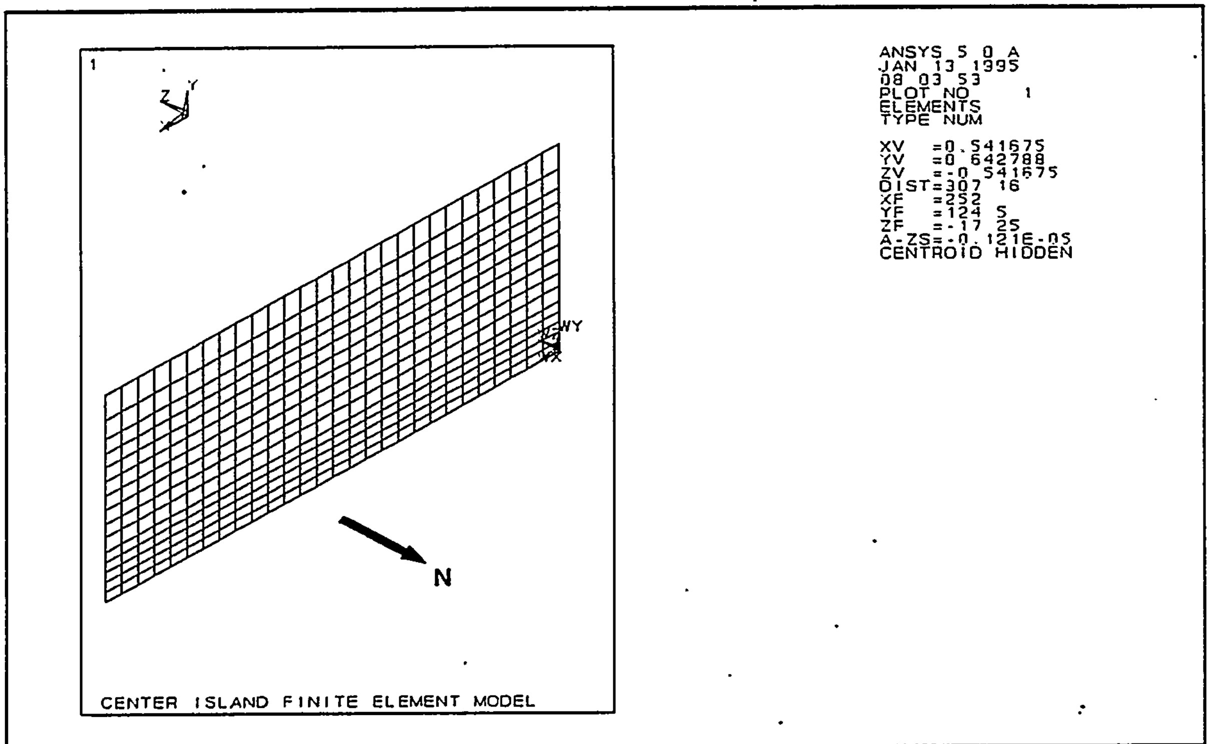

Figure 5-2. Center Island ANSYS Finite Element Model.

The ANSYS (Swanson 1993) model developed for the center island analysis is shown in Figure 5-2. The model is comprised of three-dimensional shell elements (SHELL63). The percentage of the load carried by the support brace is a function of the relative stiffness of the brace and the center island base. The initial analysis was performed assuming that the base was fixed. A more precise model of the base stiffness was developed which accounted for rebar bond slip at the base construction joint is shown in Figure 5-3. Model details are provided in Part 2 of Appendix B.

The capacity of the support brace was evaluated using the ANSI/AISC N690 Code (ANSI/AISC 1984). As shown in Part 3 of Appendix B, the brace capacity is limited by the anchor bolt allowable loading, which yielded an allowable brace capacity of about 29,000 lbf. This load resisting contribution of 29,000 lbf was applied to the center island finite element model at the support brace location in the north direction. All other loads, including static water pressure, hydrodynamic loading, seismic inertial loading, and isolation barrier support loading were applied in the south direction.

5.1.2.2 Analysis Results. The details of the analysis results are presented in Part 2 of Appendix B. A summary of the results is provided in Table 5-1. Note that positive safety margins are reported in all categories. The small safety margin of +0.01 for the base moment is misleading. The maximum moment

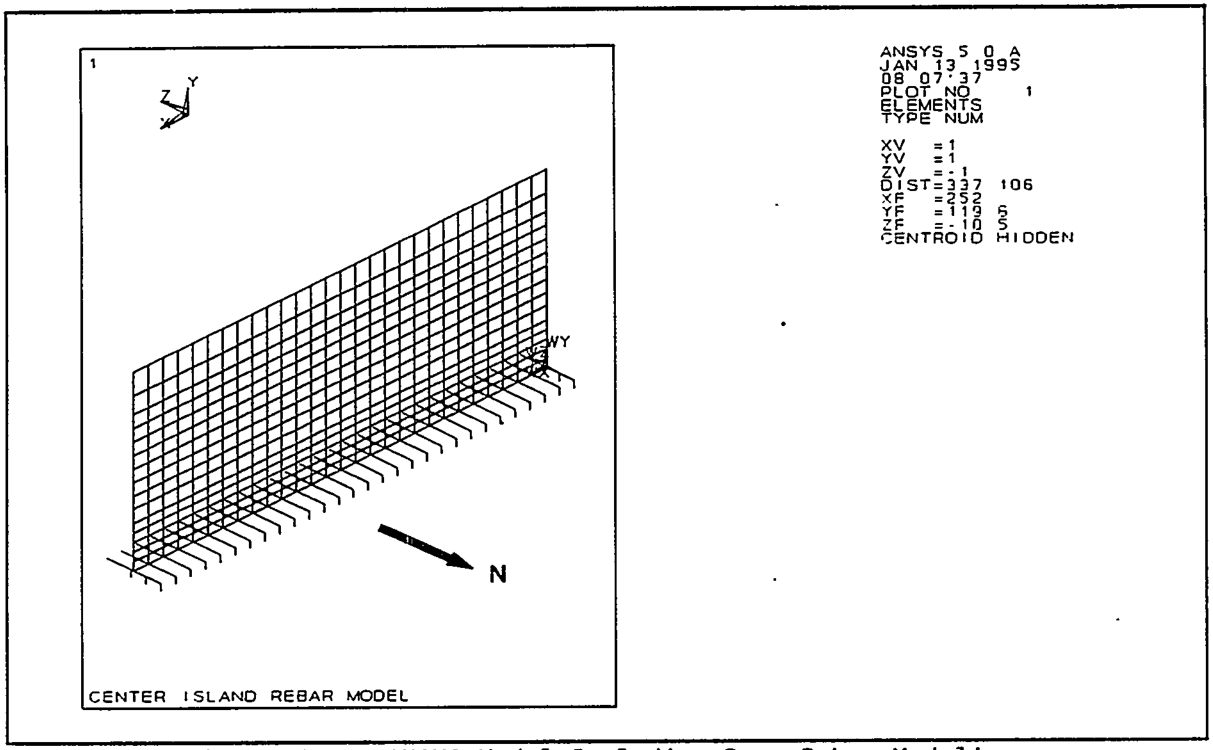

Figure 5-3. ANSYS Model Including Base Rebar Modeling.

Table 5-1. Center Island Analysis Results Summary, Drained Discharge/Pickup Chute.

Model	Category	Max. Value	Allowable	Margin of Safety
Beam	Factored Normal Base Shear	11,720 lbf/ft	32,600 lbf/ft	+1.78
	Seismic Base Shear	17,710 lbf/ft	32,600 lbf/ft	+0.84
	Factored Normal Base Moment	55,640 ft-lbf/ft	100,300 ft-lbf/ft	+0.80
	Seismic Base Moment	87,570 ft-lbf/ft	100,300 ft-lbf/ft	+0.15
3D ANSYS Shell	Moment About Vertical Axis	19,000 ft-lbf/ft	58,400 ft-lbf/ft	+2.07
	Moment About Horizontal Axis	96,000 ft-lbf/ft	100,300 ft-lbf/ft	+0.04
	Individual Rebar Stress	31,070 lbf/in^2	36,000 lbf/in^2	+0.16

occurs at the west end of the center island. The ends of the center island have extra reinforcing bars. By modeling in the extra rebar at the ends, an indication of the bending moment adequacy could be assessed for the full

length of the center island. As indicated, by examining the maximum rebar stress, a significant increase in the safety margin is obtained.

5.1.2.3 105 KE Support Brace Evaluation. The 105 KE support brace anchors the center island to one of the basin interior divider walls, as shown in Figure 1-3. The support brace design details are found in drawing no. H-1-34900. The structural evaluation calculations are provided in Part 3 of Appendix B, which also provides a description of the support brace geometry. The primary component of the support brace assembly consists of an A36, 18W50 beam. The beam is constructed of two segments bolted together with 3/8-in. plate segments and 7/8-in. diameter bolts. The ends of the composite beam are each welded to a one-inch thick base plate. The base plates are each anchored to the concrete with twelve one-inch diameter anchor bolts.

Using ANSI/AISC N690 (ANSI/AISC 1984), the capacity of each of the support brace components was evaluated. A summary of the results of this evaluation is provided in Table 5-2. Note that the capacity of the support brace is limited by the anchor bolts. As shown in the Appendix B calculations, the anchor bolt allowable loading is significantly reduced by the "reduction factors" such as spacing and edge distance. The reduction factors are applied to the nominal allowable, which typically is one-fourth of the ultimate capacity.

Table 5-2. 105 KE Center Island Support Brace Capacity Calculation Results.

Component	Material	Capacity, lbf
Anchor Bolts	HILTI KWIK Bolt, Type HVA Heavy Duty	29,000
18W50 Beam	A36	540,000
Splice Bolts	A325	101,000
Splice Plates	A36	110,000
Anchor Plates	A36	61,600
Fillet Welds	Per AWS D1.1	287,000

The actual load incurred by the support brace for both hydrostatic pressure and seismic loading is very sensitive to the stiffness of the support brace configuration. On the basis of a review of force/deflection testing of anchor bolts, it is difficult to precisely predict the stiffness of the support brace. Initial attempts to model the stiffness of the support brace in the ANSYS 3D model described in Appendix B, resulted in support brace loading in excess of its allowable load. In the event of a support brace overload, yielding and/or slippage of the support brace assembly would result in a load redistribution to the center island base. To assure that the center island structural connection to the floor is adequate for the seismic event loading, no credit was taken for the support brace in excess of its allowable loading.

5.2 105 KW FACILITY

The 105 KW facility center island differs from the 105 KE center island in its support design. As discussed in Section 1.1, there are three 105 KW supports which are on the south side of the center island and are anchored to the north wall of the reactor building. The 105 KW seismic supports are pinned to support brackets and are easily removed. The design concept of anchorage to the reactor building has been criticized because it is difficult to prove that north-wall seismic displacements, imposed on the center island, will not damage the center island. The center island base is 69 in. wide, which provides considerable tipping stability. However, the seismic-induced displacements could yield the base rebar, which could result in significant leakage from the basin through the base construction joint if discharge/pickup chute drainage occurred.

5.2.1 Seismic Support Options

The simplest and least costly option for center island support is to remove the existing supports and demonstrate seismic adequacy with no support. This approach requires a non-conventional analysis and acceptance criteria, which is provided below. Structural calculations were performed for the existing braces, as options were being considered. The 105 KE seismic support calculations are provided in Appendix B, Part 4.

Other center island support options considered for 105 KW included (1) adding a support brace to 105 KW similar to the 105 KE support, (2) use the existing braces by assuming that the existing play in the brace pin connections provide an adequate "rattle space" to avoid damaging the center island construction joint, (3) increase the play in the support brace pin connections to provide a larger "rattle space", (4) moving the existing supports to the side and reconnecting after a seismic event, if discharge/pickup chute drainage should occur, and (5) designing a completely new support.

5.2.2 Center Island Evaluation with no Seismic Support

The initial evaluation of the center island with no seismic support was addressed in Appendix B with a simple cantilever beam analysis. Because of the marginal results, a more in-depth evaluation was performed using the three-dimensional shell model shown in Figure 5-2. The calculation details are provided in Appendix B, Parts 2 and 5. A summary of the results is shown in Table 5-3.

Table 5-3. Results of Evaluation of K West Center Island with No Support.

Analysis Approach	Demand	Capacity	Margin of Safety
Beam Analysis with no Credit for End Rebar	99,800 ft-lbf/ft (Base Moment)	96,800 ft-lbf/ft	-0.03
Beam Analysis with Credit for End Rebar	99,800 ft-lbf/ft	100,600 ft-lbf/ft	+0.01
Beam Analysis with Credit for Rebar Strain Hardening	99,800 ft-lbf/ft	167,000 ft-lbf/ft	+0.67
3D-Shell Inelastic Analysis	42 kip/in^2 Rebar Stress	70 kip/in^2	+0.67

From Table 5-3, note that a negative safety margin is indicated if no credit is taken for the extra reinforcing which exists at each end of the center island. Justification for taking credit for the extra end reinforcing comes from ACI 349, Paragraph 14.2.4, which states that the effective wall length for a concentrated load is four times the wall thickness. This implies that the local effect of the end reinforcing can be averaged over a distance of four times 5.75-ft wall thickness or 23 ft, which is over half of the length of the center island.

Because of the marginal results indicated by the approximate beam analysis, an additional evaluation was performed using the ANSYS shell model described above. For low probability loads, Appendix F of Section III of the ASME Code (ASME 1992) permits taking credit for material strain hardening if a "plastic instability" analysis is performed. Structural adequacy is demonstrated if it can be shown that 70% of the plastic instability load is not exceeded. As indicated in Table 5-3, this criteria is amply met. Details of the inelastic analysis approach are provided in Appendix B, Part 5.

Note in the third line of Table 5-3, that a beam capacity strain hardening analysis is indicated. This capacity value is based on a detailed cross-section analysis including strain hardening of the rebar, which is included in the Appendix C, Part 4 analysis. In this case, capacity is defined as the initiation of crushing. Note that the capacity is well above the 40% margin (1/0.7) required by Appendix F of the ASME Code.

The above demand/capacity comparisons are for bending mode failures, which is the critical failure mode. Other failure modes, including shear and bond failure, are discussed in Appendix B.

5.2.3 Conclusion

Based upon the evaluation described above, it was concluded that the most reasonable option for the 105 KW center island is to provide no seismic support. The rationale for this conclusion is the following: (1) Using nuclear industry criteria available in ASME Section III, an adequate collapse margin can be demonstrated with no support, as indicated below. (2) The assumption of a full DBE occurring after chute drainage, as an aftershock, is conservative. Seismic aftershocks, are generally significantly less than the initial earthquake. (3) The probability of a full DBE, followed by a chute drainage, is extremely low for the short remaining life of the basins. If a significant seismic event should occur, it is likely that the chute leak rate would be low enough to be controlled, and complete chute drainage would not occur.

6.0 ISOLATION BARRIER SUPPORT WALL EVALUATION

As shown in Figure 1-1, the isolation barrier doors span between the center island and a cantilevered segment of the basin walls. Note that the cantilever length is greater on the east end of the center island than the west end. Hence, the east cantilever support was evaluated for the isolation barrier support loading.

The edge support loading is dominated by the hydrostatic head pressure loading. This pressure loading increases with depth. At the point of maximum pressure (bottom of the door), the loading is shared by the side support wall and a short wall cantilevered from the floor. This floor support was conservatively ignored in the support wall evaluation.

Support wall calculations are provided in Appendix C, Part 1. As indicated in the calculations, the minimum safety margin is associated with the normal operating condition bending moment. The minimum safety margin was predicted to +0.18. Thus, the support wall is structurally adequate for the isolation door loading.

7.0 SEISMIC-INDUCED SLIDING ISSUE RESOLUTION

The 105 KE storage basin has several hardware components stored in the discharge/pickup chute. In the preparations for the installation of the isolation barriers, concerns were raised relative to hardware sliding during a seismic event. If sliding hardware impacted the isolation door support brackets, it is difficult to guarantee that the door seal could be maintained. An evaluation of this sliding concern was addressed earlier and documented in an internal memo. A copy of the memo is provided in Appendix C, Part 1. The evaluation results are summarized in the next paragraph.

Two types of seismic-induced sliding were considered. The first sliding considered is associated with floor motion and the second was due to fluid sloshing. The floor-motion-induced sliding predictions were based on empirically-based methods presented in Aslam et al. 1975. The sloshing-induced sliding predictions were based on fluid sloshing predictions discussed in Weiner 1992. Conservative hardware movement predictions of less than two feet were obtained. To cover analysis uncertainties, this predicted sliding maximum was conservatively doubled, resulting in the establishment of a four-foot "hardware-free" zone surrounding the isolation barrier support brackets. For relatively tall components (height/width ratios > 1.0) anchorage is required.

8.0 SEISMIC SLOSH HEIGHT PREDICTIONS

During recent K Basin readiness reviews, safety issues were raised relative to seismic sloshing. Because there was no apparent documentation of K Basin slosh height predictions, a memo was written to address the issues. A copy of the memo is included in Appendix C. A brief summary of the results of the evaluation follows.

The normal operating freeboard of the basins is 4 ft 9 in. If, for dose reduction purposes, the water height is increased to 17 ft 6 in., the free board reduces to 3 ft 3 in. In the past, this freeboard was considered to have an ample margin against excessive sloshing during a seismic event. Recent slosh height predictions in Part 3 of Appendix C have confirmed this adequacy. Using slosh height prediction methodology contained in BNL 1993, a maximum slosh height of about 19 in. was predicted, which is well below the freeboard. It is recommended that this 19-in. maximum slosh height be used in addressing future K Basin safety issues associated with seismic sloshing.

9.0 HARDWARE HANDLING DROP EVALUATIONS

Recent increases in hardware handling within the K basins has raised concerns relative to the consequences of a drop accident. The specific concern addressed in this section is the potential for basin floor damage resulting in an unacceptable leakage of the basin water. This concern was addressed in an internal memo released in November, 1994. A copy of the memo is provided in Appendix C, Part 4. A summary of the evaluation follows below.

9.1 DISCUSSION

Predicting impact damage to the reinforced concrete basin floor, resulting from a hardware drop, is complex. The magnitude of floor damage can be highly dependent on the hardware orientation at the time of impact. Consider, for example, a drop accident involving an isolation barrier door. A corner impact, with the door center of gravity directly above the point of impact, is much more likely to result in a punch-through than a flat impact.

Most of the data available on concrete slab penetrations involves relatively high velocity impacting of cylindrical missiles. The maximum impact velocity considered for the K basin study was 44 ft/s (30 ft drop), whereas the minimum velocity found in the empirical data was 80 ft/s. Thus, a data extrapolation was necessary to utilize the industry missile penetration data.

Concrete slab missile damage is generally grouped into three categories: "penetration", "scabbing", and "perforation". These terms are illustrated in Figure 9-1. If the surface impact damage and backface scabbing are deep enough, then missile perforation may occur. Various empirical formulas are available for making quantitative estimates of the missile damage. In the Appendix B, Part 4 memo, a penetration formula from (ASCE 1980b) was selected for the K basin application. The basis of the selection was a combination of data appropriateness and relative conservatism found in the K basin penetration predictions. This formula was used to develop handling height limits described in the next section.

9.2 K BASIN EQUIPMENT HANDLING HEIGHT LIMITS

By conservatively assuming a small impact area of 2 in^2 to cover corner drops, an allowable handling height limit versus equipment weight was developed (Figure 9-2). The upper curve is an approximate penetration prediction, based on conservative assumptions. The lower curve is the recommended handling height limit curve for equipment weights up to 150,000 lbf (75 tons). Handling heights up to 30 ft were considered. Note, for example, for equipment weights less than 1,200 lbf, the maximum height of 30 ft would apply. If it is necessary to exceed this height restriction, then the equipment handling would require extra precautions (special handling, additional analysis, etc).

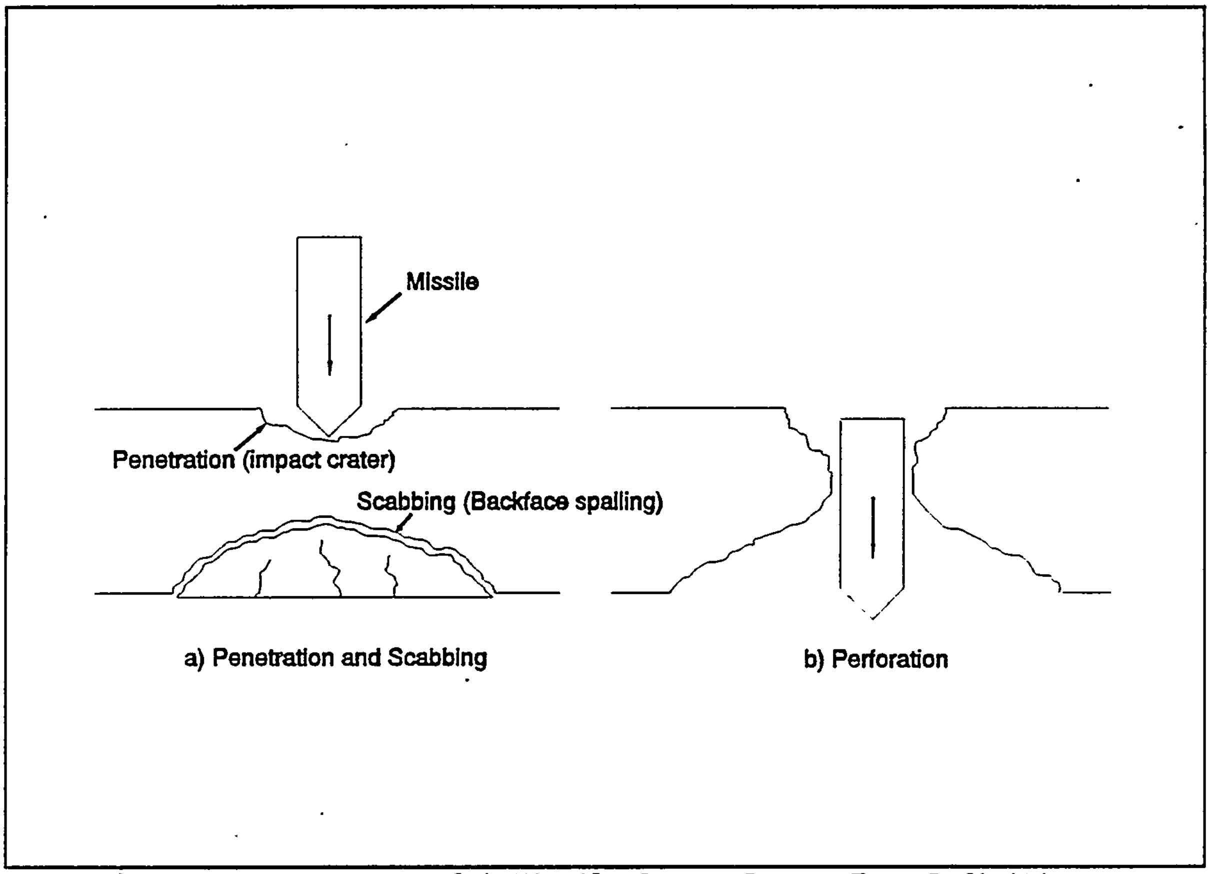

Figure 9-1. Concrete Slab Missile Impact Damage Term Definitions.

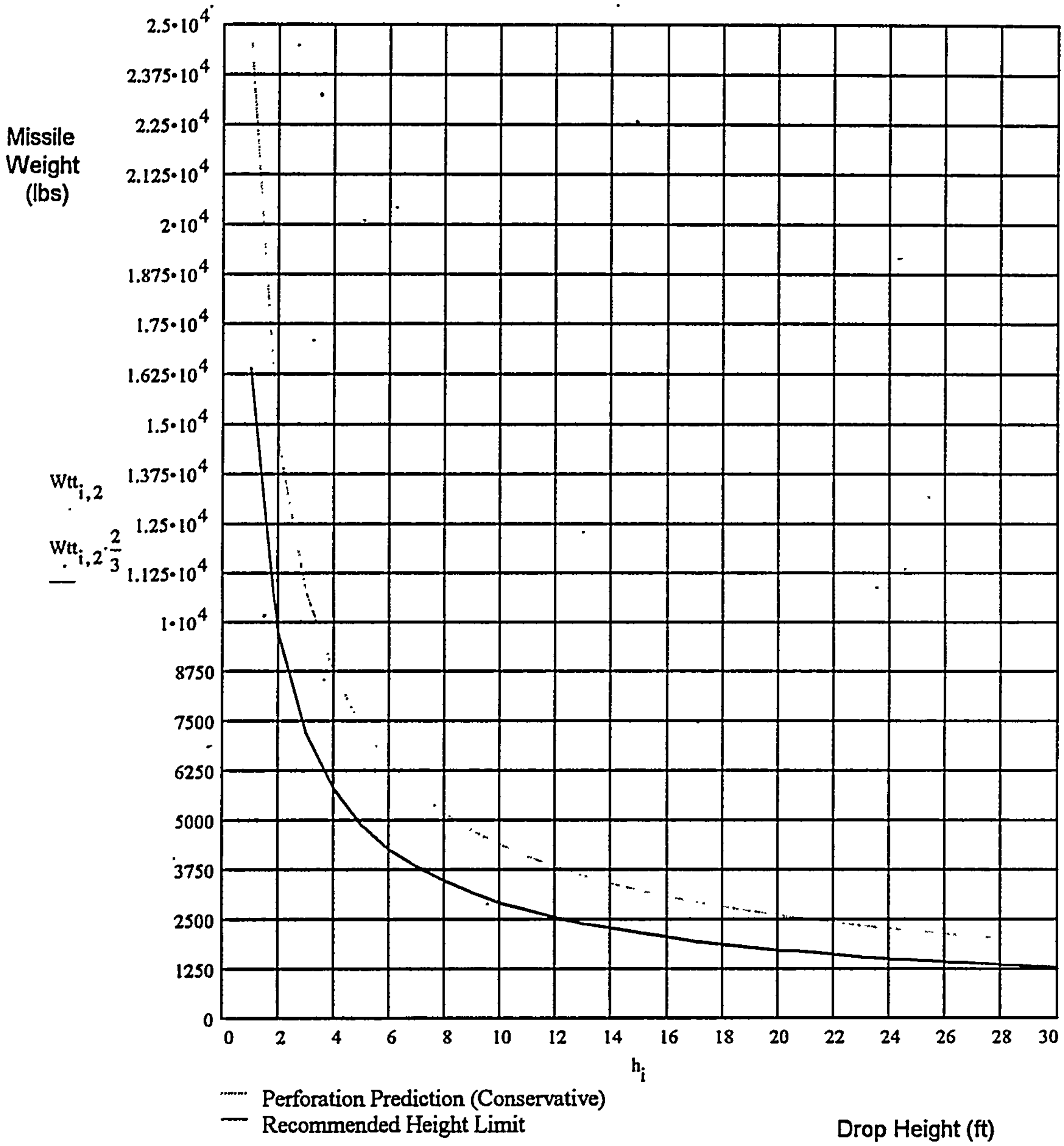

Figure 9-2. Missile Perforation Predictions and Recommended Hardware Handling Height Limitations.

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SDC-4.1, 1993, *Hanford Plant Standards*, HPS-SDC-4.1, Revision 12, *Standard Arch-Civil Design Criteria - Design Loads for Facilities*, U.S. Department of Energy, Richland, Washington.

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Weiner, E. O., 1992, Internal Memo to J. P. Strehlow, "Tank Slosh Displacements," Westinghouse Hanford Company, Richland, Washington (see attachment to Appendix C3).

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APPENDIX A

ISOLATION BARRIER STRUCTURAL CALCULATIONS

APPENDIX A1

STRUCTURAL CALCULATIONS FOR K BASIN ISOLATION DOORS

Westinghouse Hanford Company — **Internal Memo**

From: Facility Stress Analysis — 8D420-MRL-94-005
Phone: 376-3496 H5-57
Date: June 23, 1994
Subject: STRUCTURAL CALCULATION FOR K BASIN ISOLATION DOORS

To: J. C. Wiborg B3-55

cc:

L. W. Bartholf	H5-53*	M. J. Langevin	X3-76
W. F. Brehm	H5-67*	L. A. Rodgers	H5-53
R. A. Cox	R3-56*	J. P. Schmidt	X3-73*
G. M. Davis	X1-80*	D. A. Smith	G3-20*
J. I. Dearing	N1-32	G. C. Sorensen	K8-28
J. C. Hamrick	X0-22*	W. W. Wassberg	R3-82*
L. L. Hyde	H5-57	MRL File/LB	
R. J. Kuhta	X3-76*	* w/o report appendices	

Reference: WHC, 1979, *Basin Discharge Chute Isolation Coffer Dams*, Drawing H-1-42659, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

Transmitted herewith is a letter report containing calculations that provide structural qualification for the K Basin Isolation Doors as described in the reference drawing. All components described in the drawing are qualified with the exception of the tie rod hook, mid lifting pad, lower lifting pad, and top lifting ring. These require design changes as discussed in the report. In addition, corrosion of the door assembly must be prevented by a combination of an anti-corrosion coating and seal welding.

The analysis is performed for Safety Class 1 criteria, with water loading consistent with the full height of the doors (18 ft).

Questions may be referred to the undersigned (376-3496), L. A. Rodgers (376-8469), or L. L. Hyde (376-5047).

M. R. Lindquist, Manager
Facility Stress Analysis

rw

Attachment

STRUCTURAL ANALYSIS
K BASIN ISOLATION DOORS
DRAWING H-1-42659

June 1994

Prepared by: L. A. Rodgers, Senior Engineer, Equipment Stress Analysis — Date 6/13/94

Reviewed by: L. L. Hyde, Principal Engineer, Facility Stress Analysis — Date 6/13/94

Approved by: M. R. Lindquist, Manager, Facility Stress Analysis — Date 6/13/94

Approved by: Quality Assurance GM Davis, Principal Engineer, SNFPQA — Date 6/16/94

Approved by: Safety Assurance, Fellow Engineer — Date 6-28-94

Westinghouse Hanford Company
Hanford Operations and Engineering Contractor
for the
U. S. Department of Energy
Richland, Washington

ENGINEERING ANALYSIS SOFTWARE REPORT FORM

SOFTWARE APPLICATION Images-3D SOFTWARE LOG # 94-21

ANALYSTS LL Hyde EDT #

ANALYST MANAGER MR Lindquist DOCUMENT # 8D420-MRL-94-005

DATE PERFORMED 5-26-94

DESCRIPTION OF ANALYSIS:

Beam elements are used to model a simple structure of tube steel. Loading is by two point forces. Output forces, and moments, and stress, are used to evaluate the stress in the members.

SIGNATURE OF ANALYST L. Hyde DATE 6/16/94

SEND TO:

PAT DAVIS
H5-55

ENGINEERING ANALYSIS SOFTWARE REPORT FORM

SOFTWARE APPLICATION Images-3D SOFTWARE LOG # 94-20

ANALYSTS LL Hyde EDT #

ANALYST MANAGER MR Lindquist DOCUMENT # 8D420-MRL-94-005

DATE PERFORMED 6-7-94

DESCRIPTION OF ANALYSIS:

Beam elements are used to model a tube steel and welds. Loading is by a point force. Output forces, moments and stress are used to evaluate the welds.

SIGNATURE OF ANALYST L. Hyde DATE 6/10/94

SEND TO:

PAT DAVIS
H5-55

TYPICAL CHECKLIST FOR INDEPENDENT REVIEW

Document Reviewed Ltr. 80420-MRL-94-005

Author L. HYDE

Yes	No	N/A	
[✓]	[ ]	[ ]	Problem completely defined.
[✓]	[ ]	[ ]	Necessary assumptions explicitly stated and supported.
[✓]	[ ]	[ ]	Computer codes and data files documented.
[✓]	[ ]	[ ]	Data used in calculations explicitly stated in document.
[✓]	[ ]	[ ]	Data checked for consistency with original source information as applicable.
[✓]	[ ]	[ ]	Mathematical derivations checked including dimensional consistency of results.
[✓]	[ ]	[ ]	Models appropriate and used within range of validity or use outside range of established validity justified.
[✓]	[ ]	[ ]	Hand calculations checked for errors.
[✓]	[ ]	[ ]	Code run streams correct and consistent with analysis documentation.
[✓]	[ ]	[ ]	Code output consistent with input and with results reported in analysis documentation.
[✓]	[ ]	[ ]	Acceptability limits on analytical results applicable and supported. Limits checked against sources.
[✓]	[ ]	[ ]	Safety margins consistent with good engineering practices.
[✓]	[ ]	[ ]	Conclusions consistent with analytical results and applicable limits.
[✓]	[ ]	[ ]	Results and conclusions address all points required in the problem statement.

MANDATORY Software QA Log Number 94-020 & 94-021

Reviewer: [signature] Date: 6/10/94

09/22/93

TYPICAL CHECKLIST FOR INDEPENDENT REVIEW

Document Reviewed Ltr. 80420-MRL-94-005

Author L. Roogers

Yes	No	N/A	
[✓]	[ ]	[ ]	Problem completely defined.
[✓]	[ ]	[ ]	Necessary assumptions explicitly stated and supported.
[ ]	[ ]	[✓]	Computer codes and data files documented.
[✓]	[ ]	[ ]	Data used in calculations explicitly stated in document.
[✓]	[ ]	[ ]	Data checked for consistency with original source information as applicable.
[✓]	[ ]	[ ]	Mathematical derivations checked including dimensional consistency of results.
[ ]	[ ]	[✓]	Models appropriate and used within range of validity or use outside range of established validity justified.
[✓]	[ ]	[ ]	Hand calculations checked for errors.
[ ]	[ ]	[✓]	Code run streams correct and consistent with analysis documentation.
[ ]	[ ]	[✓]	Code output consistent with input and with results reported in analysis documentation.
[✓]	[ ]	[ ]	Acceptability limits on analytical results applicable and supported. Limits checked against sources.
[✓]	[ ]	[ ]	Safety margins consistent with good engineering practices.
[✓]	[ ]	[ ]	Conclusions consistent with analytical results and applicable limits.
[✓]	[ ]	[ ]	Results and conclusions address all points required in the problem statement.

MANDATORY Software QA Log Number N/A

Reviewer: L. Hyde Date: 6/10/94

09/22/93

CONTENTS

APPENDICES

1.0 INTRODUCTION

A part of the 1994 unresolved safety question (USQ) resolution plan for the K Basins involves placing of isolation doors in the entry channels to the discharge chutes. These isolation doors are designed to survive an earthquake and after-shocks (assumed to be of equal magnitude to the initial earthquake) while providing a leak barrier for the basin. The isolation doors will be in place at the beginning of the seismic event with a nominal 16 ft of water on both sides. Following the earthquake, if the construction joint in the discharge chute opens, water will drain through this opened joint. The doors will then be left with water pressure only on the basin side with the potential for seismic after-shocks in this configuration. This condition provides maximum loading on the door.

2.0 SUMMARY

Structural analyses have been performed on the isolation doors described in drawing H-1-42659 (WHC 1979). All members are structurally adequate provided that modifications are made to the tie rod hook, mid lifting pad, lower lifting pad, and top lifting ring, as discussed below. It should also be noted that the maximum load in the tie rods that were assessed was 1,526 lb. Table 1 summarizes the results of the analysis.

3.0 ISOLATION DOOR DESCRIPTION

The detailed configuration of the isolation doors is shown in drawing H-1-42659 (WHC 1979). The door consists of an 18-ft high. 1/2-in.-thick carbon steel plate that is stiffened by a frame of 3 ½- by 3 ½ in. structural tubing. The door has a gasketed surface that is drawn up tightly against the concrete surfaces of the basin wall and the center island divider wall. Even pressure across the sealing surface is accomplished by the use of threaded tie rods attached to the back of the door; the tie rods pass through a bracket assembly and are threaded to allow gasket preload to be achieved by means of torque nuts. Material for the isolation door components is carbon steel, with the exception of the tie rods. The tie rod material is stainless steel.

4.0 ANALYSIS CRITERIA

The isolation doors are considered to be Safety Class 1. Natural phenomena (seismic) loading for the structure was obtained from Hanford Plant Standard SDC-4.1 (DOE-RL 1993). Acceptance criteria (allowable stresses) for the analysis results were those of AISC 1989.

5.0 LOADING CONDITIONS

Loading conditions for the isolation doors, discussed in Appendix B, are summarized below. The critical loading condition is that of complete drainage on the discharge chute side of the isolation doors, i.e., full hydrostatic pressure developed on the basin side of the doors.

Normal Loading

Normal loading consists of deadweight, seal clamp, and hydrostatic loads. Of these, only the hydrostatic pressure is significant. Although the normal water level is approximately 16 ft, a water depth equal to the full height of the doors (18 ft) was chosen for design purposes. The use of these values results in a maximum static pressure of 7.8 lbf/in^2 at the base of the doors.

Seismic Loading

Inertial and hydrodynamic loading were considered for seismic loading (Appendix B). The maximum effective pressure on the doors from the impulsive mass of the water was calculated to be 1.39 lbf/in^2, with the maximum effective pressure from the convective mass calculated as 0.32 lbf/in^2. The inertial loading for the doors was calculated as 0.23 lbf/in^2. Total load increase from seismic effects is therefore 1.94 lbf/in^2.

A 0.24 *g* lateral seismic load was also applied to the door assembly. It was assumed that this load was reacted by the top and bottom pad eyes bearing on the concrete sides of the opening.

6.0 ANALYSIS

Analyses were performed on each of the major load-carrying components of the isolation door structure. The analyses, attached as Appendix A, consist mainly of hand calculations using standard simple beam and plate equations. Simple finite element models were developed for the rear bracket frame structure and the bottom deadweight support.

The allowable stress criterion of AISC 1989 permits an increase of one-third in the allowable stress limits in assessment of an earthquake loading condition. The loading calculations of Appendix B show that the normal loading condition with its allowable stresses is more critical than the seismic loading condition with an increase of one-third in allowable stress.

Because the assembly is to be painted with a corrosion-resistant paint, no corrosion allowance is taken in the analysis (Carlos 1994). Where painting cannot be used, the structural components are to be seal welded.

The preliminary analysis of the door components indicated that some areas were overstressed when the component configurations from the drawing were used (WHC 1979). Modifications have been developed as follows:

> Tie rod hook The tension load for the tie rods was chosen as 1,526 lb on the basis of seal-compression requirements. The load path for the original tie rod design created high bending stresses in the hook body. The design was modified by the addition of a 1-in. stiffening plate in the hook region. Material for the stiffening plate is stainless steel (see Appendix C).

2

Lifting pads The original design of the lifting pads resulted in high bending stresses in the pad. The design was modified by changing the pad to a 1-in. thick plate, 8-in. wide. Side gusset plates 0.5-in. thick also were added to the mid lifting pad (see Appendix C).

Top lifting ring The original design of the lifting ring resulted in high bending stresses in the ring. The design was modified in the same fashion as the mid lifting pad.

A calculation has been made to determine the differential displacement between the vertical sealing surface on the center island divider wall and the vertical sealing surface on the adjacent basin wall. If relative displacements were large, the door plate structure might twist, with possible leakage through the seal. The calculations in Appendix B indicate that the displacements are small. The displacement from seismic loading at the top of the divider wall is calculated as 0.013 in. Appendix A calculations show the door is structurally capable of withstanding this displacement.

Table 1 summarizes the critical components of the isolation door assembly. Shown in the table is the component allowable stress, actual stress, and the resulting margin of safety. Even though the seismic loading condition permits an increase in allowable stress, margins of safety are shown, for reference, for seismic loading using normal allowable stresses.

7.0 CONCLUSIONS

The isolation doors described in drawing H-1-42659 (WHC 1979) are structurally adequate for their intended purpose provided that corrosion of the door assembly is prevented by a combination of an anti-corrosion coating and seal welding and that the tie rod hook, lifting pads, and top lifting ring are modified as discussed above.

8.0 REFERENCES

AISC, 1989, *Manual of Steel Construction*, Ninth Edition, American Institute of Steel Construction, New York, New York.

Carlos, W. C., 1994, *KE Basin Discharge Chute Coffer Dam Corrosion Allowance and Coating Recommendations*, (internal letter 8D330/WCC:kjs:94-3, to C. P. Janett, May 24) Westinghouse Hanford Company, Richland, Washington.

DOE-RL, 1993, "Standard Arch-Civil Design Criteria-Design Loads for Facilities," *Hanford Plant Standards*, DOE-RL 6430.1C, SDC-4.1, Rev. 12, U. S. Department of Energy-Richland Field Office, Richland, Washington.

WHC, 1979, *Basin Discharge Chute Isolation Coffer Dams, July 1979*, drawing H-1-42659, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

STRUCTURAL MARGIN OF SAFETY
K BASIN ISOLATION DOORS

COMPONENTS (No corrosion allowance)					
Drawing H-1-42659, Rev. 1 Component	Allowable Stress, (kip/in^2)	Actual Stress, (kip/in^2)	Margin of Safety (1)	(2)	Comments
Door Assembly (Item 3) - 1/2 in. Plate	27.0	8.7	>2.0	1.48	Center of plate near horizontal frame member
Door Assembly (Item 3) - Tube Steel Frame	30.4	17.3	0.76	0.41	Pressure plus pad eye loads
Bracket Assembly (Items 4 thru 11)	30.4	10.3	1.95	-	
Pad Eye (Item 42)	14.4	1.0	>2.0	-	
Tie Rod (Items 44 thru 62) - (Reinforced)	15.0	13.5	0.11	-	(3)
Mid-Lifting Pad Eye (Item 42) - (Redesigned) and Lifting Eye (Item 43) - (Redesigned)	11.6	10.5	0.09	-	(4)
Bottom Deadweight Support (Item 13)	34.5	7.4	>2.0	>2.0	
WELDS (No corrosion allowance)					
Stitch Weld Around Door Assembly Plate	21.0	4.3	>2.0	>2.0	
Door Assembly Tube Steel Connections	21.0	7.6	1.76	1.38	
Lifting Pad Eye Weld (Redesigned)	21.0	16.4	0.28	-	
Bracket Assembly Welds	21.0	14.0	0.50	-	
Deadweight Support Weld	21.0	10.7	0.96	0.72	

Margin of Safety = (Allowable stress/Actual stress) - 1

(1) Normal loading

(2) Seismic loading using allowable stresses for normal loading (except for deadweight support weld). Seismic loading (hydrodynamic pressure) is applicable to door assembly only. Seismic loads for bracket assembly are negligible.

(3) Hook region reinforced with 1-in. plate.

(4) All three lifting locations use a 1- by 8-in. plate design. In addition, the mid lifting pad and the top lifting eye include 0.5-in. plate gussets.

4

APPENDIX A

STRESS ANALYSIS CALCULATIONS

DESIGN CALCULATION

(1) Drawing H-1-42659 (2) Doc. No. ______ (3) Page 2 of ____
(4) Building K-BASIN (5) Rev. ______ (6) Job No. ______
(7) Subject ISOLATION DAMS
(8) Originator [illegible] Date 5/16/94
(9) Checker L. Hyde Date 6/9/94

(10) THE DESIGN TO BE ANALYZED IS PER H-1-42659 Rev. 1 SHEETS 1&2.

LOAD CONDITIONS

STATIC HEAD DUE TO MAX WATER OF 18'

$$62.428 \frac{lb}{ft^3} (18') \frac{1 ft^2}{144 in^2} = 7.8 \ lb/in^2$$

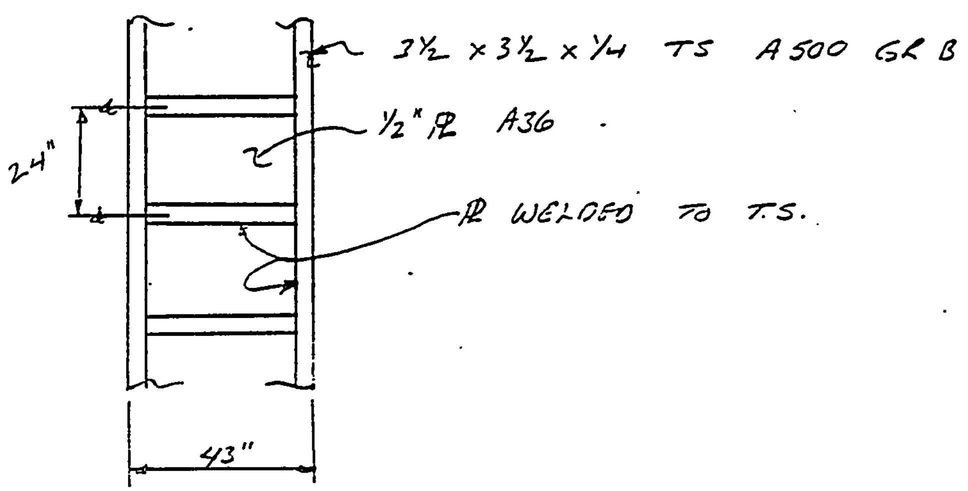
PER APPENDIX B THE COMBINED IMPULSIVE AND CONVECTIVE PRESSURES DUE TO SEISMIC IS:

1.7 PSI

AND CONSIDERING THE DAMS AS PART OF THE K-BASIN STRUCTURE, THE DAMS SELF SEISMIC LOAD IS

0.23 PSI

THE ISOLATION DAMS ARE DESIGNED AS A TUBE STEEL FRAME COVERED WITH A STEEL PLATE. THE STEEL FRAME IS DESIGNED SUCH THAT IT'S DIVIDED INTO SECTIONS. ONE SUCH SECTION WILL BE USED FOR DESIGN ANALYSIS.



BD-6400-060 1 (12 87)

DESIGN CALCULATION

(1) Drawing H-1-42659 (2) Doc. No. ______ (3) Page 1 of ____
(4) Building K-BASIN (5) Rev. ______ (6) Job No. ______
(7) Subject ISOLATION DAMS
(8) Originator [signature] Date 6/3/94
(9) Checker L. Hyde Date 6/8/94

(10)

K-BASIN INTENDS TO USE ISOLATION COFFER DAMS TO SEAL OFF A SECTION OF THE EXISTING BASIN. METAL COFFER DAMS WERE DESIGNED AND USED SEVERAL YEARS AGO. THESE SAME COFFER DAMS ARE TO BE USED AND ADDITIONAL ONES CONSTRUCTED.

THE PRESENT TASK FOR THESE DAMS IS TO SEAL OFF PART OF THE K-BASIN, THE BASIS FOR DESIGN IS THAT AFTER A FIRST SEISMIC EVENT THE WATER WILL DRAIN FOR ONE SIDE OF K-BASIN. A SECOND EVENT HAPPENS, THIS IS THE WORST CASE LOAD CONDITION, WITH WATER ON ONE SIDE ONLY.

PER FIELD INSTRUCTION THIS IS A SAFTEY CLASS ONE STRUCTURE.

THIS EVALUATION IS TO ANALYZE THE EXISTING DESIGN AND MODIFICATIONS AS REQUIRED.

DRAWINGS H-1-42659, Rev. 1, SHT. 1 + 2 & ECNS 194345 & 197611 PLUS FIELD INFO IS USED FOR ANALYSIS

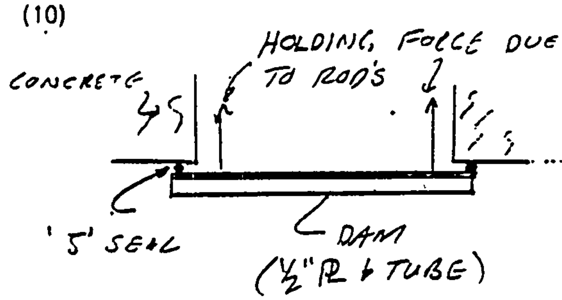
THE DESIGN INFO ON DRAWINGS IS INSUFFICIENT TO DETERMINE ALL THE DETAIL REQUIRED TO DO THE ANALYSIS, ∴ FIELD VERIFICATION WILL BE REQUIRED. ALSO THE OLDER DAMS MAY NOT HAVE HAD ALL THE QC & QA NEED FOR SAFETY CLASS ONE.

BD-6400-060 ' "2 87'

DESIGN CALCULATION

(1) Drawing H-1-42659 (2) Doc. No. (3) Page 3 of
(4) Building K-BASIN (5) Rev. (6) Job No.
(7) Subject ISOLATION DAMS
(8) Originator [signature] Date 5/16/94
(9) Checker L. Hyde Date 6/8/94

(10)



THE DAMS ARE SUPPORTED ON THREE SIDES BY THE K-BASINS CONCRETE WALLS. THERE IS TO BE A 'J'-TYPE SEAL ON EDGES BETWEEN THE GATE AND CONCRETE.

THE GATE FRAME WILL BE CONSIDERED SIMPLY SUPPORTED ON THE EDGES BY THE SEAL. THE PLATE BETWEEN THE FRAMING IS MORE FIXED THAN SIMPLY SUPPORTED. THE TUBE STEEL (3½ × 3½ × ¼ TS) HAS MUCH GREATER STRUCTURAL STIFFNESS THAN THE PLATE AND WILL THEREFORE RESTRAIN THE PLATES EDGES FROM ROTATING. THE RESTRAINED EDGES WILL THEREFORE DEVELOPE FIXED MOMENTS AND STRESSES.

PER AISC MANUAL OF STEEL CONSTRUCTION ALLOWABLE STRESS DESIGN 9th ed. (AISC ASD)

3½ × 3½ × ¼ TS $I = 5.29\ in^4$ P. 1-96

$S = 3.02\ in^3$

ROUND ~½" P 1-91 2t $A = 3.09\ in^2$

$J = 8.82\ in^4$

NORMAL SECTION PROP

$w = 10.51\ lb/ft$

BD-6400-060 1 (12.87)

DESIGN CALCULATION

(1) Drawing H-1-42659 (2) Doc. No. ______ (3) Page 4 of ____
(4) Building K-BASIN (5) Rev. ______ (6) Job No. ______
(7) Subject ISOLATION DAMS
(8) Originator [illegible] Date 5/17/94
(9) Checker L. Hyde Date 6/8/94

(10) FOR THIS ANALYSIS CORROSION COULD BE CONSIDERED AT A RATE OF 2 mils A YEAR FOR THE DESIGN LIFE OF 15 YEARS, BUT WITH THE PAINT PER (CARLOS 1994) NO CORROSION ALLOWANCE IS REQUIRED.

FOR SINGLE SIDED CORROSION

MAX. MAT. LOSS $15(0.002 \text{ in}) = 0.030 \text{ in}$ PAINTED OR SEALED ONE SIDED ONLY

AND FOR DOUBLE SIDED CORROSION

MAX. MAT. LOSS $2(0.030 \text{ in}) = 0.060 \text{ in}$ NO PAINT OR NOT SEALED.

FOR T.S. $1/4'' - 0.06 \text{ in} = 0.19 \text{ in}$

THIS IS CLOSE TO 0.1875 in OR 3/16"

$3\frac{1}{2} \times 3\frac{1}{2} \times \frac{3}{16}$ TS SECTIONAL PROPERTIES WILL BE USED.

$I = 4.29 \text{ in}^4$

$S = 2.45 \text{ in}^3$

$A = 2.39 \text{ in}^2$

$J = 6.99 \text{ in}^4$

$w = 8.15 \text{ lb/ft}$

FOR PL's

$t = 1/2'' - 0.06 \text{ in} = 0.44''$

THESE CORRODED THICKNESSES ARE USED FOR STRESS EVALUATION ONLY, WEIGHT WILL BE CALCULATED ON FULL THICKNESS.

BD-6400-060 1 (12/87)

(1) Drawing H-1-42659 (2) Doc. No. (3) Page 5 of
(4) Building K-BASIN (5) Rev. (6) Job No.
(7) Subject ISOLATION DAMS
(8) Originator [illegible] Date 5/16/94
(9) Checker L. Hyde Date 6/8/94

(10) A 36 $F_y = 36$ KSI $F_u = 58$ KSI P 1-7

A500 GR. B $F_y = 46$KSI $F_u = 58$ KSI P 1-92

ALLOWABLE STRESS

R + ⌀ $F_b = 0.75 F_y$ F2-1 P 5-48

$F_v = 0.40 F_y$ F4-1 P5-49

TS $F_b = 0.66 F_y$ F3-1 P 5-48

$F_v = 0.40 F_y$ F4-1 P 5-49

FOR TENSION

$F_t = 0.60 F_u$ D.1 P 5-40

DESIGN CALCULATION

(1) Drawing H-1-42659 (2) Doc. No. ______ (3) Page 6 of ______
(4) Building K-BASIN (5) Rev. ______ (6) Job No. ______
(7) Subject ISOLATION DAMS
(8) Originator [signature] Date 5/19/94
(9) Checker L. Hyde Date 6/8/94

(10)

LOAD COMBINATIONS

PER AISC ASD 9th ed SECTION A5.2 P.5-30

LOAD CASES WITH SEISMIC INCLUDED ARE COMPARED TO ALLOWABLE STRESS INCREASED BY 1/3.

AS THE COMBINED SEISMIC IS LESS THAN 1/3 OF STATIC PRESSURE AND PRE-LOAD, DUE TO RODS, THE NORMAL LOAD CONDITION IS CONTROLLING.

$$\tfrac{1}{3}(7.8\ PSI) = 2.6\ PSI > (1.7\ PSI + 0.23\ PSI = 1.93\ PSI)$$

SEE APPENDIX B

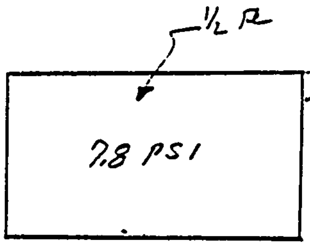
BD-6400-060 (12.87)

7

DESIGN CALCULATION

(1) Drawing H-1-42659 (2) Doc. No. ______ (3) Page 7 of ____
(4) Building K-BASIN (5) Rev. ______ (6) Job No. ______
(7) Subject ISOLATION DAMS
(8) Originator [signature] Date 5/16/94
(9) Checker L. Hyde Date 6/8/94

(10) PLATE ANALYSIS



ALL EDGES FIXED

24" = b

43" − 3½"
~40" = a

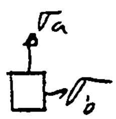
AVERA. EDGE REACT.

$$\frac{7.8\,PSI\,(24")(40")}{(40"+24")\,2} = 58.5\,lb/in$$

SMALL

PER DESIGN OF WELDMENTS
BY O. W. BLODGETT 8th PRINTING
P 4.6 − 4 CASE 4B

$$\alpha = \frac{b}{a} = \frac{24"}{40"} = 0.60$$



@ CENTER

short
$$\sigma_a = -\frac{0.054\,p\,b^2\,(1+2\alpha^2-\alpha^4)}{t^2} \quad \frac{lb}{in^2}\,\frac{in^2}{in^2} - \frac{lb}{in^2}$$

$$= -\frac{0.054\,(7.8PSI)(24")^2(1+2(0.60)^2-(0.60)^4)}{(0.44")^2}$$

$$= \underline{-1793\ PSI}$$

long
$$\sigma_b = -\frac{0.75\,p\,b^2}{t^2(3+4\alpha^4)} \quad \frac{lb}{in^2}\,\frac{in^2}{in^2} - PSI$$

$$= -\frac{0.75(7.8PSI)(24")^2}{(0.44")^2(3+4(0.60)^4)} = \underline{-4947\ PSI}$$

BD-6400-060 1 (12 97)

(1) Drawing H-1-42659 (2) Doc. No. ______ (3) Page 8 of ____
(4) Building K-BASIN (5) Rev. ______ (6) Job No. ______
(7) Subject ISOLATION DAMS
(8) Originator [signature] Date 5/16/94
(9) Checker [signature] Date 6/8/94

(10)

MAX BENDING STRESS, VECTOR SUM

$$f_b = [(-1993\ \text{PSI})^2 + (-4947\ \text{PSI})^2]^{1/2}$$

$$f_b = \underline{\underline{5333\ \text{PSI}}}$$

$$F_b = 0.75\,F_y = 0.75(36\ \text{KSI})$$

$$= 27\ \text{KSI}$$

$$\therefore F_b > f_b$$

· SHEAR STRESS SMALL AND NOT CAL.

STRESS @ EDGES MIDPOINTS

ALONG 'a'

$$\sigma_{b_e} = \frac{0.5\,p\,b^2}{t^2(1+0.623\alpha^6)}$$

$$= \frac{0.5(7.8\,\text{PSI})(24'')^2}{(0.44'')^2(1+0.623(0.60)^6)}$$

$$= \underline{11276\ \text{PSI}}$$ ▷1

ALONG 'b'

$$\sigma_{a_e} = \frac{0.25\,p\,b^2}{t^2}$$

$$= \frac{0.25(7.8\,\text{PSI})(24'')^2}{(0.44'')^2}$$

$$= \underline{5802\ \text{PSI}}$$

$$F_b > \sigma_{b_e}\ ,\ \text{O.K.}$$

▷1 WITHOUT CORROSION ALLOWANCE, $\sigma_{be} = 11276\left(\frac{.44}{.50}\right)^2 = 8732$ PSI

DESIGN CALCULATION

(1) Drawing H-1-42659 (2) Doc. No. ______ (3) Page 9 of ____
(4) Building K-BASIN (5) Rev. ______ (6) Job No. ______
(7) Subject ISOLATION DAMS
(8) Originator [signature] Date 5/16/94
(9) Checker L. Hyde Date 6/8/94

(10) STRESS σ_{be} & σ_{ae} ARE WORST CASE STRESS @ THE MIDPOINT. THE MOMENT AT THIS POINT WILL BE USED FOR WELD AND T.S. EVALUATIONS. THIS QUICK + VERY CONSERVATIVE.

$$\text{FOR A } \mathbb{R} = \frac{M}{S} = \frac{M}{\frac{t^2 b}{6}}$$ FIND MOMENT PER UNIT LENGTH $b = 1$ unit

$$11276 \text{ PSI} = \frac{M \times 6}{(0.44")^2} \Rightarrow M = 364 \text{ lb-}\frac{in}{in} \text{ per length}$$

WELD IS:

1/4" | 1-6

6" | 1"

$$364 \text{ lb-}\frac{in}{in} (6\,in) = 2184 \text{ lb-in}$$

3½" − ¼" ≈ 3¼"

PER DESIGN OF WELDED STRUCTURES BY O. W. BLODGETT 7th printing P 7.4-7

$$S_w = bd = 3\tfrac{1}{4}" (1") = 3\tfrac{1}{4}\,\frac{in^2}{in}$$

$$f_b = \frac{M}{S_w} = \frac{2184 \text{ lb-in}}{3\tfrac{1}{4}\,in^2} = 672 \text{ lb/in}$$

E70xx ROD 0.3 (70KSI) = .21 KSI
0.6 (36KSI) = 21.6 KSI

AISC ASD 9th ed P-5-70 PART. PENT. + FILLET WELD

$$\frac{f_b}{f_{all}} = \frac{672 \text{ lb/in}}{(21 \text{ KSI})} = 0.032 \text{ in}, \; t_{WELD} \text{ REQUIRED}$$

DESIGN CALCULATION

(1) Drawing H-1-42659 (2) Doc. No. ______ (3) Page 10 of ____

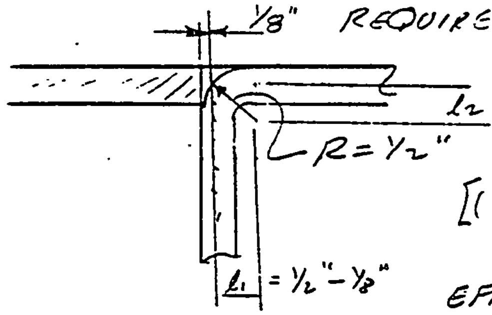
(4) Building K-BASIN (5) Rev. ______ (6) Job No. ______

(7) Subject ISOLATION DAMS

(8) Originator [signature] Date 5/16/94

(9) Checker L. Hyde Date 6/8/94

(10)



REQUIRED OPENING FOR WELD ROD

$$\left[(1/2")^2 - (1/2" - 1/8")^2\right]^{1/2} = l_2 = 0.33"$$

EFFECTIVE WELD

$1/2" - 0.33" = \underline{0.17 \text{ in}}$

UNDERSIDE OF T.S. & CAN NOT BE PAINTED → CORROSION SINGLE SIDE

$(0.17\text{in} - 0.03\text{in} > 0.032\text{in}$

THE REACTION FORCE ALONG EDGE WILL ADD TO WELD STRESS BUT DUE TO VERY LOW STRESS IT'S NOT INCLUDED

∴ WELD ACCEPTABLE.

PER AISC ASD P 5-66

FLARE BEVEL THROAT

SINGLE SIDED CORROSION, CAN'T PAINT BETWEEN & & TS

$5/16\ R = 5/16\ (1/2") = 0.156\text{in}$

$(0.156\text{in} - 0.03\text{in}) > 0.032\text{in}$, O.K.

WITHOUT CORROSION ALLOWANCE, $f_{WELD} = \frac{672}{0.156} = 4307$ psi

PER AISC ASD 9th ed. SECT. J2. P 5-65 & 70

MIN EFFECTIVE THROAT

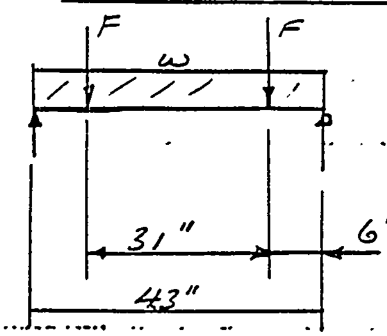
$1/8" \leq (0.156\text{in} - 0.03\text{in}) = 0.126\text{in}$ ok

BD-6400-060 : (12.87)

DESIGN CALCULATION

(1) Drawing H-1-42659 (2) Doc. No. ______ (3) Page 11 of ____
(4) Building K-BASIN (5) Rev. ______ (6) Job No. ______
(7) Subject ISOLATION DAMS
(8) Originator [signature] Date 5/16/94
(9) Checker L. Hyde Date 6/8/94

(10) FRAME SECTION WITH ROD PRE-LOADS



$\omega = 7.8 PSI (24 in) = 187$ lb/in

$F = 1526$ lb

CONSERVATIVE, SINCE WATER PRESSURE WILL COMPRESS SEALS FURTHER AND TEND TO RELIEVE ROD PRE-LOAD

PER AISC ASD 9th ed.

@ CENTER $M = \frac{\omega l^2}{8} + Pa$

$= \frac{187 lb/in (43")^2}{8} + (1526 \text{ lb}) 6 in$

$= 52376$ lb-in

@ WELD $x = 3\frac{1}{2}"$

$M = \frac{\omega x}{2}(l - x) + Px$

$= \frac{(78.7 lb/in)(3\frac{1}{2} in)(43" - 3\frac{1}{2}")}{2} + (1526 \text{ lb}) 3\frac{1}{2} in$

$= 18267$ lb-in

SEAL WELDED NO CORROSION

$f_b = \frac{M}{S} = \frac{52376 \text{ lb-in}}{3.02 in^3} = 17343$ PSI

$F_b = 0.66 F_y = 0.66 (46 KSI) = 30.4 KSI$

$f_b < F_b$ ∴ ACCEPTABLE

BD-6400-060 1 (12 87)

DESIGN CALCULATION

(1) Drawing H-1-42659 (2) Doc. No. ______ (3) Page 12 of ____
(4) Building K-BASIN (5) Rev. ______ (6) Job No. ______
(7) Subject ISOLATION DAMS
(8) Originator [signature] Date 5/20/94
(9) Checker L. Hyde Date 6/4/94

(10) WELDS

PER DESIGN OF WELDED STRUCTURES BY O. W. BLODGETT 7th printing P 7.4-7

$$S_w = bd + \frac{d^2}{3} = (3\tfrac{1}{2}")^2 + \frac{(3\tfrac{1}{2})^2}{3} = 16.3\ in^2$$

$$A_w = (b+d)2 = (3\tfrac{1}{2}" + 3\tfrac{1}{2}")2 = 14\ in$$

SHEAR @ END $R_1 = F + \frac{wl}{2} = 1563\ lb + \frac{(187\ lb)(43")}{2}$

$= 5584\ lb$

$$f_s = \frac{P}{A_w} = \frac{5584\ lb}{14\ in} = 399\ lb/in$$

$$f_b = \frac{M}{S_w} = \frac{18267\ lb\text{-}in}{16.3\ in^2} = 1,121\ lb/in$$

$$f_r = [f_s^2 + f_b^2]^{1/2} = [(399\ lb/in)^2 + (1,121\ lb/in)^2]^{1/2}$$

$= 1190\ lb/in$

FILLET WELD

$$\omega = \frac{f_r}{f_{all}} = \frac{1190\ lb/in}{(0.707)(0.3)(70\ ksi)}$$

E70XX ROD

SINGLE SIDE CORROSION ASSUMED NO PAINT BETWEEN PL & T.S.

$= 0.08\ in$ REQUIRED

$(\tfrac{1}{4}"$ Less $0.03\ in) > 0.08\ in$ ∴ ACCEPTABLE

BD-6400-060 (12 87)

DESIGN CALCULATION

(1) Drawing H-1-42659 (2) Doc. No. ______ (3) Page 13 of ____
(4) Building K-BASIN (5) Rev. ______ (6) Job No. ______
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(10)

FLAIR BEVEL

AISC ASD SECT. D1 P 5-16

$$5/16\,R = 5/16\,(2t) = 5/16\,(2 \times 1/4") = 0.156\,in$$

$$w = (0.08\,in.)\underbrace{(0.707)}_{\text{FILLET FACTOR}} = 0.06\,in \text{ req.}$$

$$(0.156\,in - 0.03 = 0.126") > 1/8"\,MIN > 0.06\,in$$

SINGLE SIDE CORROSION ASSUMED. NO PAINT BETWEEN PL & T.S

∴ WELD ACCEPTABLE

WITHOUT CORROSION ALLOWANCE, $f_{WELD} = \frac{1190}{0.156} = 7625\,psi$

BD-6400-060 1 (12.87)

DESIGN CALCULATION

(1) Drawing H-1-42659 (2) Doc. No. ______ (3) Page 14 of ______
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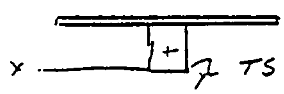
(7) Subject ISOLATION DAMS
(8) Originator [signature] Date 5/16/94
(9) Checker L. Hyde Date 6/3/94

(10)

DEFLECTION OF T.S. & PL~~ATE AS~~ A BEAM



PL ½" × 24"

TS 3½ × 3½ × ¼

$A = 24''(.44'') = 10.56\ in^2$

$I = \frac{bd^3}{12} = \frac{(24'')(0.44\ in)^3}{12}$

$= 0.17\ in^4$

	Y (in)	A in²	M = AY (in³)	$I_y = Ay^2$ (in⁴)	I_{xi} in⁴	
PL	3¾	10.56	39.6	148.5	0.17	
T.S.	1.75	2.39	4.18	7.32	4.29	
		12.95	43.78	155.82	4.46	TOTAL

$$n = \frac{M}{A} = \frac{43.78\ in^3}{12.95\ in^2} = 3.33''$$

$$I = I_{xi} + I_y - \frac{M^2}{A} = 155.82\ in^4 + 4.46\ in^4 - \frac{(43.78\ in^3)^2}{12.95\ in^2}$$

$$= 12.3\ in^4$$

$$\Delta = \frac{5 w l^4}{384 E I} = \frac{5(18.7\ lb/in)(43'')^4}{384\ (30E6)(12.3\ in^4)}$$

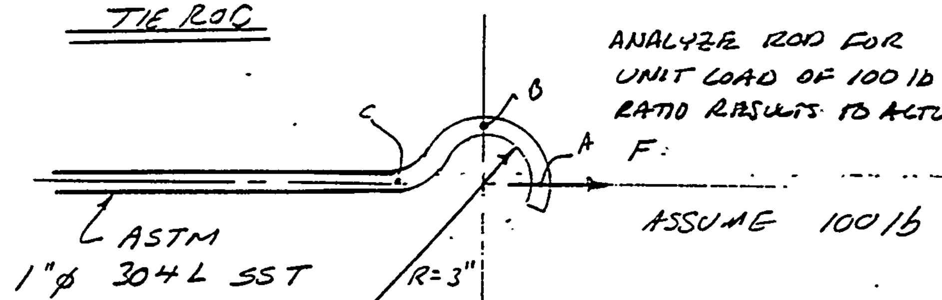
$= 0.023$ in DEFLECTION SMALL, T.S. WILL PROVIDE ROTATIONAL STIFFNESS FOR THE PL EDGE.

STRESS NOT REVIEWED AS THEY WOULD BE LESS THAN SHOWN ON INDIVIDUAL ELEMENTS.

DESIGN CALCULATION

(1) Drawing H-1-42659 (2) Doc. No. ______ (3) Page 15 of ____
(4) Building K-BASIN (5) Rev. ______ (6) Job No. ______
(7) Subject ISOLATION DAMS
(8) Originator [signature] Date 5/19/94
(9) Checker L. Hyde Date 6/8/94

(10) TIE ROD



ANALYZE ROD FOR UNIT LOAD OF 100 lb AND RATIO RESULTS TO ACTUAL LOAD F:

ASSUME 100 lb

ROD IS SST ∴ NO CORROSION ASSUMED.

@ A $M = 0$ $T = 0$. SHEAR = F = 100 lb

@ B $M = F(R + \frac{1}{2}") = 100\,lb(3" + \frac{1}{2}") = 350\,lb\text{-}in$

TEN = F = 100 lb $S = 0$

@ C $M = 0$ TEN = F = 100 lb $S = 0$

PER ASME SECTION III 1983 SUBSECTION NCA TABLE I-2.2 & BAR

$S_y = F_y = 25$ KSI FOR 304L MIN

TAB I-3.2 BAR

$S_u = F_u = 70$ KSI

$$S = \frac{I}{c} = \frac{\pi}{4} R^4 \frac{1}{R} = \frac{\pi}{4} R^3 = \frac{\pi}{4} (\tfrac{1}{2}")^3$$

$$= 0.0982\,in^3$$

$$A = \pi R^2 = \pi (\tfrac{1}{2}")^2 = 0.785\,in^2$$

$$f_b = \frac{M}{S} = \frac{350\,lb\text{-}in}{0.0982\,in^3} = 3564\ PSI$$

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(8) Originator [signature] Date 5/19/94
(9) Checker L. Hyde Date 6/9/94

(10)

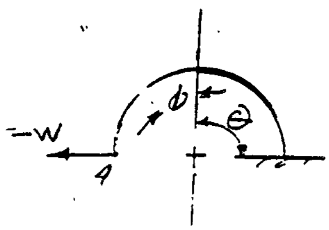
$$f_t = \frac{P}{A} = \frac{100\ lb}{0.785\ in^2} = 127\ PSI$$

∴ THESE WILL BE FACTORED WITH THE TIEROD TENSION LOAD WHEN PROVIDED.

DEFLECTION

PER FORMULAS FOR STRESS & STRAIN 6th ed. by W.C. YOUNG

TABLE 18 CASE 12 LOAD CONDITION 5c



$\theta = 90°$ $\phi = 90°$

THE MAX ARC IS 135°

$$\delta_{HA} = \frac{-R^3}{EI} LF_H$$

$R = 3'' + \frac{1}{2}'' = 3\frac{1}{2}''$

$E = 30E6\ PSI$

$I = \frac{\pi}{4} r^4$

$= \frac{\pi}{4} (\frac{1}{2}'')^4$

$= 0.0491\ in^4$

LOAD CASE TABLE 18 CASE 5c

let $\phi = 90°$ $\theta = 90°$

BD-6400-060.1 (12/87)

DESIGN CALCULATION

(1) Drawing H-1-42659 (2) Doc. No. ________ (3) Page 17 of ____

(4) Building K-BASIN (5) Rev. ________ (6) Job No. ________

(7) Subject ISOLATION DAMS

(8) Originator [signature] Date 5/19/94

(9) Checker L. Hulle Date 6/8/94

(10)

$$\angle F_H = W\left[\frac{K_1}{2}(\theta n + \phi n - scn - s^2c) + k_2(e-c)\right]$$

$$\phi = \theta = 90° = \frac{\pi}{4}$$

$$n = \sin\phi = \sin 90° = 1.0$$

$$s = \sin\theta = \sin 90° = 1.0$$

$$c = \cos\theta = \cos 90° = 0.0$$

$$e = \cos\phi = \cos 90° = 0.0$$

$$K_1 = 1 - \alpha + \beta \quad \text{\&} \quad K_2 = 1 - \alpha$$

$$\alpha = \frac{I}{AR^2} = \frac{\frac{\pi}{4}r^4}{A\,R^2} = \frac{\frac{\pi}{4}(0.5\,in)^4}{(0.785\,in^2)(3\tfrac{1}{2}'')^2} = 0.0051$$

$$\beta = \frac{FEI}{GAR^2} \qquad G = \text{SHEAR MODULUS} = \frac{E}{2(1+\mu)}$$

$\mu = 0.3$ for STEEL

$$G = \frac{30E6\,PSI}{2(1+0.3)} = 11.5E6\,PSI$$

$$F = \frac{10}{9} \quad \text{SECT. 7.10 } \phi \text{ BAR}$$

$$\beta = \frac{\frac{10}{9}(30E6\,PSI)\left(\frac{\pi}{4}(0.5\,in)^4\right)}{(11.5E6\,PSI)(0.785\,in^2)(3\tfrac{1}{2}\,in)^2} = 0.0148$$

$$K_1 = 1 - 0.0051 + .0148 = 1.01$$

$$K_2 = 1 - 0.0051 = 0.995$$

DESIGN CALCULATION

(1) Drawing H-1-42659 (2) Doc. No. ______ (3) Page 18 of ______
(4) Building K-BASIN (5) Rev. ______ (6) Job No. ______
(7) Subject ISOLATION DAMS
(8) Originator [signature] Date 5/19/94
(9) Checker L. Hyde Date 6/8/94

(10)

$$\angle F_H = 100lb\left[\frac{1.01}{2}\cdot\left(\frac{\pi}{4}(1.0)+\frac{\pi}{4}(1.0)-1.0(0.0)1.0-(1.0)^2 0.0\right) + 0.992\,(1.0(0.0)+0.0(1.0))\right]$$

$$= 100lb\left[\frac{1.01}{2}\left(\frac{\pi}{4}\right)2 + 0.0\right] = 79.33$$

$$\angle F_V = W\left[\frac{K_1}{2}\left(\theta c + \phi c + sce + c^2 n\right) + K_2\left(s + n - 2sce - 2c^2 n\right)\right]$$

$$= 100lb\left[0.995(1.0+1.0)\right] = 199$$

$$\angle F_W = W\left[K_2(1 + sn - \phi e)\right] = 100lb\left[0.995(1.0 + (1.0)(1.0)\right] = 199$$

$$\delta_{HA} = \frac{-R^3}{EI}\angle F_H = \frac{-(3\tfrac{1}{2}\,in)^3}{(30E6\,psi)\left(\frac{\pi}{4}(0.5\,in)^4\right)}\,79.33$$

$$= -0.0023\ in$$

$$\delta_{VA} = \frac{-R^3}{EI}\angle F_V = \frac{-(3\tfrac{1}{2}\,in)^3}{(30E6\,psi)\left(\frac{\pi}{4}(0.5\,in)^4\right)}\,199$$

$$= -0.0058\ in$$

$$\psi_A = \frac{-R^2}{EI}\angle F_M = \frac{-(3\tfrac{1}{2}\,in)^2}{(30E6\,psi)\left(\frac{\pi}{4}(0.5\,in)^4\right)}\,199 = -0.0017\,RAD$$

$$(-0.0017\ RAD)(57.3\ DEG/RAD) = -0.097^\circ$$

BD-6400-060 1 (12.87)

DESIGN CALCULATION

(1) Drawing H-1-42659 (2) Doc. No. (3) Page 19 of
(4) Building K-Basin (5) Rev. (6) Job No.
(7) Subject Isolation Dams
(8) Originator [illegible] Date [illegible]
(9) Checker L. Hyde Date 6/9/94

(10) THE TIE-ROD LOAD HAS BEEN CALCULATED TO BE 1526 lb SEE ATTACH. A. RATIO

$$f_b = 3564\,PSI\left(\frac{1526\,lb}{100\,lb}\right) = 54387\,PSI$$

$$F_b = 0.75\,F_y = 0.75(25\,KSI) = 18.75\,KSI$$

$$f_b > F_b$$

∴ UNACCEPTABLE.
SEE NEXT PAGE

END ROTATION/DEFLECTION

$$\delta_{HA} = 0.0023\,in\left(\frac{1526\,lb}{100\,lb}\right) = 0.035\,in$$

$$\delta_{VA} = 0.0058\,in\left(\frac{1526\,lb}{100\,lb}\right) = 0.089\,in$$

$$\psi_A = 0.097^\circ\left(\frac{1526\,lb}{100\,lb}\right) = 1.48^\circ$$

THE ABOVE APPROXIMATIONS OF THE TIE-ROD ROTATION/DEFLECTION SHOWS THAT THE HOOKED END WILL REMAIN IN PLACE UPON LOADING, IF MATERIAL IS BELOW YIELDING.

BD-6400-060 1 (12-87)

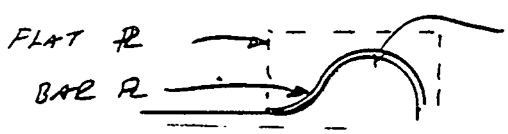
DESIGN CALCULATION

(1) Drawing H-1-72659 (2) Doc. No. ______ (3) Page 20 of ____
(4) Building K-BASIN (5) Rev. ______ (6) Job No. ______
(7) Subject ISOLATION DAMS
(8) Originator LAPorteous Date 6/3/94
(9) Checker L. Hyde Date 6/3/94

(10) TIE - RODS Item 44 to 62

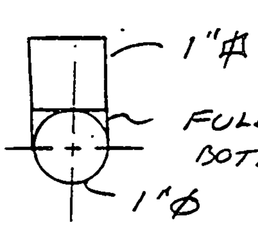
MODIFICATION

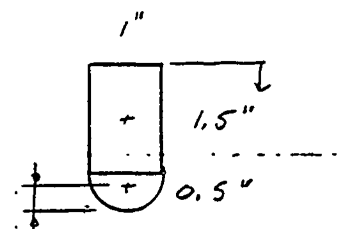
ASSUME A PL OR ⊡ BAR ADDED TO CURVED TIE-ROD



AT CRITICAL POINT A MIN. OF 1"×1" MATERIAL. MIN

SECTION PROP.





$c = 0.575587 R$ AISC ASD
$= 0.575587(0.5") $ 9th ed p 6-20
$= 0.288$ in

$\square \quad \bar{y} = \frac{1}{2}(1.5") = 0.75$ in

$\bigcirc \quad \bar{y} = 1.5" + (0.5" - 0.288") = 1.712$ in

$A_{\square} = bd = 1" \times 1\frac{1}{2}" = 1.5\,in^2$

$A_{\bigcirc} = \frac{\pi}{2} r^2 = \frac{\pi}{2}(0.5")^2 = 0.393\,in^2$

$I_{y\square} = \frac{bd^3}{12} = \frac{1"(1\frac{1}{2}")^3}{12} = 0.281\,in^4$

$I_{y\bigcirc} = 0.109757\, r^4 = 0.109757(0.5")^4 = 0.007\,in^4$

AISC ASD 9th ed P 6-20

EFFECT OF CURVATURE ON STRESS, ASSUME A 1"×2" SECT. PER ROARK 3rd ed. TABLE III Item 1

$\square 2"$ $\frac{R}{c} = \frac{3"+1"}{1"} = 4 \Rightarrow k_i = 1.20 \quad \sigma_i = k_i \sigma = k_i \frac{Mc}{I}$

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(9) Checker L. Hyde Date 6/3/94

(10)

Σ	A	$\bar{Y}$	$A\bar{Y}$ (M)	$A\bar{Y}^2$ (I_y)	I_g
□	1.5 in²	0.75 in	1.125 in³	0.844 in⁴	0.281 in⁴
▽	0.393 in²	1.712 in	0.673 in³	1.152 in⁴	0.007 in⁴
Σ	1.893 in²		1.798 in³	1.996 in⁴	0.288 in⁴

$$\bar{y} = \frac{M}{A} = \frac{1.798\ in^3}{1.893\ in^2} = 0.950\ in.$$

$$\bar{I} = I_y + I_g - \frac{M^2}{A} = 1.996\ in^4 + 0.288\ in^4 - \frac{(1.798\ in^3)^2}{1.893\ in^2}$$
$$= 0.578\ in^4$$

MOMENT AT CRITICAL POINT

$$M = P\ell = 1526\ lb\ (3" + 2" - 0.950\ in)$$
$$= 6180\ lb\text{-}in$$

MAX. STRESS (ON CONCAVE SIDE)

$$f_b = k_t \frac{Mc}{I} = \frac{(6180\ lb\text{-}in)(2" - 0.950")}{0.578\ in^4}(1.20)$$
$$= 13472\ PSI < F_b = 0.6(25\ KSI) = 15\ KSI$$

∴ ACCEPTABLE

WELD STRESS

$$f = \frac{Vay}{In}$$

$V = 1526\ lb$ $t = 1\ in$

$I = 0.578\ in^4$ $A = 1.0\ in$

PER DESIGN OF WELD STRUCTURES BY O.W. BLODGETT 7th prt. P 7.4-13

$y = 0.95\ in - \frac{1\ in}{2} = 0.45\ in$

$n = 2$

DESIGN CALCULATION

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(8) Originator [signature] Date 6/3/94
(9) Checker L. Hulle Date 6/8/94

(10)

THIS IS HORIZONTAL SHEAR @ WELD

$$f_r = \frac{(1526\ lb)(1.0\ in)(0.45\ in)}{(0.578\ in^4)(2)} = 594\ lb/in$$

PER AISC ASD 9th ed P 5-70

$$F_s = 0.4(25\ KSI) = 10.0\ KSI$$

$$w = \frac{f_r}{F_{vn}} = \frac{594\ lb/in}{10.0\ KSI} = 0.0594\ in\ req$$

PER AISC ASD 9th ed P 5-66

$$w_{eff} = 5/16\ R = 5/16(0.5\ in) = 0.156\ in$$

$$0.156\ in > 0.0594\ in \quad \therefore \text{ACCEPTABLE}$$

WELD STRESS

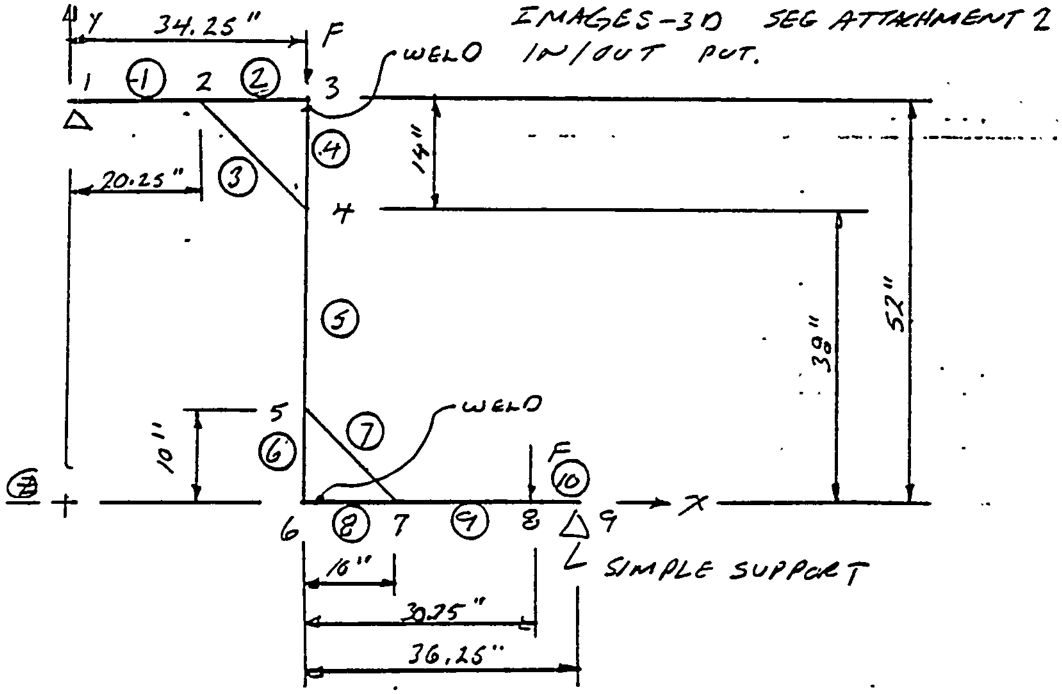
$$f = \frac{594\ lb/in}{0.156\ in} = 3.8\ KSI < 10.0\ KSI$$

BD-6400-060

DESIGN CALCULATION

(1) Drawing H-1-42659 (2) Doc. No. (3) Page 23 of
(4) Building K-BASIN (5) Rev. (6) Job No.
(7) Subject ISOLATION DAMS
(8) Originator [signature] Date 5/26/94
(9) Checker L Hyde Date 6/8/94

(10) THE BRACKET ASSEMBLYS ARE MODEL BY THE WORST CASE WITH TWO TIE-RODS EACH ROD IS ASSUMED TO HAVE 1526 lb OF FORCE.



ALL MEMEMBER / ELEMENT MODELED TS 3½ x 3½ x ¼ WITH A CORROSION OF 0.06 in SO TS 3½ x 3½ x 3/16 ARE USED

THE MAX MOMENT AND STRESS ARE IN ELEMENT 5

$$M = 31.21 \text{ K-in}$$

$$f_b = 12.7 \text{ KSI} \quad ^{(1)} < F_b = 0.66 F_y = 30.4 \text{KSI}$$

$$f_t = 0.26 \text{ KSI} \quad \text{VERY LOW}$$

(1) WITHOUT CORROSION ALLOWANCE, $f_b = 12.7\,(2.45/3.02) = 10.3^{KSI}$

BD-6400-060 1 (12.87)

DESIGN CALCULATION

(1) Drawing H-1-42659 (2) Doc. No. ______ (3) Page 24 of ______
(4) Building K-BASIN (5) Rev. ______ (6) Job No. ______
(7) Subject ISOLATION DAMS
(8) Originator [signature] Date 5/26/94
(9) Checker L. Hyde Date 6/8/94

(10) WELDS MAIN FRAME ARE AT

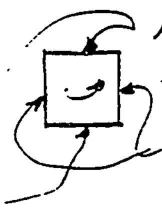
ELEM 4 NODE 3 & ELEM 8 NODE 6

WITH ELEM 4 HAVING WORST CASE ......

$F_x = 1894$ lb AXIAL $F_z = 0 = M_x = M_y$

$F_y = -3024$ lb SHEAR

$M_z = 6504$ lb-in



FLARE BEVEL $5/16\,R = 5/16\,(1/2") = 0.156"$
AISC ASD 9th ed.

FILLET 1/4" LEG

PER DESIGN OF WELD STRUCTURES BY O.W BLODGETT
7th printing P 7.4-7

$$S_w = bd + d^2/3 = (3\tfrac{1}{2}")^2 + \frac{(3\tfrac{1}{2}")^2}{3} = 16.3\,in^2$$

$$A_w = (b+d)2 = (2 \cdot 3\tfrac{1}{2}") \cdot 2 = 14\,in$$

$$f_t = \frac{P}{A_w} = \frac{1894\,lb}{14\,in} = 135\,lb/in$$

$$f_s = \frac{P}{A_w} = \frac{3024\,lb}{14\,in} = 216\,lb/in$$

$$f_b = \frac{M}{S_w} = \frac{6504\,lb\text{-}in}{16.3\,in^2} = 399\,lb/in$$

$$f_r = [(f_t + f_b)^2 + f_s^2]^{1/2} = [(135\,lb/in + 399\,lb/in)^2 + (216\,lb/in)^2]^{1/2}$$

$$= 576\,lb/in$$

$$w = \frac{f_r}{f_{all}} = \frac{576\,lb/in}{0.3(70000\,PSI)\,0.707} = 0.039\,in$$

AISC ASD 9th — E70XX ROD. — FILLET

VERY SMALL WELD ACCEPTABLE

BD-6400-060 1 (12.87)

DESIGN CALCULATION

(1) Drawing H-1-42659 (2) Doc. No. ______ (3) Page ~~25~~ of ______
(4) Building K-BASIN (5) Rev. ______ (6) Job No. ______
(7) Subject ISOLATION DAMS
(8) Originator [signature] Date 5/26/94
(9) Checker L. Hyde Date 6/9/94

(10) WELD OF BRACE'S

ELEM. 3 & 7 W/ ELEM 3 HAVING THE HIGHEST BENDING STRESS, AND 1 WELD CHECK IS AT ELEM 7 NODE 5

$F_A = 2621\ lb$ $\qquad F_{S_2} = M_{B_2} - M_T = 0$

$F_{S_1} = 2989\ lb$

$M_{B_1} = 11010\ lb-in$

FLAIR BEVAL $5/16 R = 5/16(1/2") = 0.156 in$

3½" FILLET @ 45° EFFECT THROAT 0"

$L\ (3½" - ½")/\cos 45° = 4.2\ in$

$$S_w = d^2/3 = \frac{(4.2 in)^2}{3} = 5.88 in^2$$

$$A_w = 2d = 2(4.2 in) = 8.4 in$$

$$f_t = \frac{P}{A_w} = \frac{2621 lb}{8.4 in} = 312\ lb/in$$

$$f_s = \frac{P}{A_w} = \frac{2989 lb}{8.4 in} = 356\ lb/in \quad \text{SMALL}$$

$$f_b = \frac{M}{S} = \frac{11010\ lb-in}{5.88 in^2} = 1872\ lb/in$$

$$T_{en} = f_b + f_t = 312\ lb/in + 1872\ lb/in = 2184\ lb/in$$

$$w = \frac{f_t}{f_{an}} = \frac{2184\ lb/in}{0.30(70000 PSI)} = 0.104 in$$

E70XX ROD

0.104 in < 0.156 in ∴ ACCEPTABLE

$$f_{STRESS} = \frac{2184\ lb/in}{0.156 in} = 14 KSI < 0.3(70 KSI) = 21 KSI$$

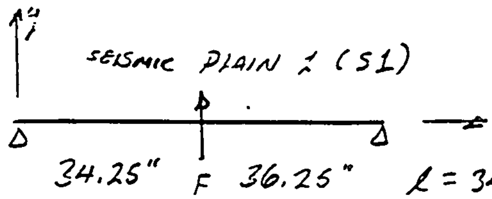
BD-6400-060 1 (12/87)

(1) Drawing H-1-42659 (2) Doc. No. ______ (3) Page 26 of ____
(4) Building K-BASIN (5) Rev. ______ (6) Job No. ______
(7) Subject ISOLATION DAMS
(8) Originator [signature] Date 5/26/94
(9) Checker L. H[signature] Date 6/9/94

(10)

ADDITIONAL SEISMIC STRESS DUE TO STRUCTURE SELF WEIGHT.

SEISMIC PLAIN 1 (S1)



SEISMIC HORIZ.

TS $\omega = 10.51\ lb/ft$

$\ell = 34.25" + 36.25" = 70.5"$

WEIGHT OF TUBE STEEL $F = \left[52" + \frac{(10" + 14")}{\cos 45°}\right] \frac{ft}{12\ in}\ 10.51\ lb/ft = 75\ lb$

$M_{max} = \frac{Fab}{\ell} + \frac{w\ell^2}{8}$ 2 MAX MOMENTS

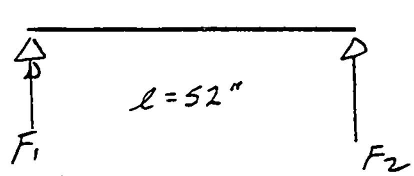
$= \frac{(75 lb)(34.25")(36.25")}{70.5"} + \frac{(10.51\ lb/ft)(70.5")^2}{8}\left(\frac{ft}{12 in}\right)$

$= 1865\ lb\text{-}in$

$R_{MAX} = \frac{Fb}{\ell} + \frac{w\ell}{2} = \frac{75 lb(36.25")}{(70.5")} + \frac{(10.51\ lb/ft)\ 70.5}{2}\left(\frac{ft}{12 in}\right)$

$= 69\ lb$

SEISMIC PLAIN 2 (S2)



$F_1 = \left(34.25" + \frac{14"}{\cos 45°}\right) 10.51\ lb/ft \left(\frac{ft}{12 in}\right)$

$= 47\ lb$

$F_2 = \left(36.25" + \frac{10"}{\cos 45°}\right) 10.51\ lb/ft \left(\frac{ft}{12 in}\right)$

$= 44\ lb$

$R_{MAX} = F_1 + \frac{w\ell}{2} = 47 lb + \frac{(10.51\ lb/ft)(52")}{2}\ \frac{ft}{12 in}$

$= 70\ lb$

BD-6400-060

(1) Drawing H-1-42659 (2) Doc. No. ______ (3) Page 27 of ____
(4) Building K-BASIN (5) Rev. ______ (6) Job No. ______
(7) Subject ISOLATION DAMS
(8) Originator [signature] Date 5/27/94
(9) Checker L. Hyde Date 6/8/94

(10)

$$M = 2\ \frac{wl^2}{8} = \frac{(10.51\ lb/ft)(52'')^2}{8}\ \frac{ft}{12in} = 296\ lb\text{-}in$$

VERTICAL DEADWEIGHT / SEISMIC

$$(l\,w) = \left(l + \frac{14''+10''}{\cos 45}\right) 10.51\,lb/ft\ \frac{ft}{12in}$$

$l = 34.25'' + 52'' + 36.25''$

$= 122.5''$

$= 137\ lb$

$$R = \frac{wl}{2} = \frac{137\,lb}{2} = 69\,lb$$

$$M = \frac{wl^2}{8} = \frac{(137\,lb \cdot 122.5'')}{8} = 2098\ lb\text{-}in$$

PER. UCRL-15910 JUNE 1990 P 4-31
THE SUMMATION OF SEISMIC FORCES
PER APPENDIX B THE SEISMIC HORIZONTAL
IS 0.24g.
PER UCRL-15910 JUNE 1990 P 4-31
SEISMIC COMPONENTS ARE
HORIZ. 100% & 80% VERTICAL 60%
& SEISMIC SUMMATION IS BY
100%, 40% & 40%

DEADWEIGHT PLUS LIVE LOAD

$M_z = 31.21\ k\text{-}in$ $f_b = 17.7\ KSI$
$f_t = 0.26\,KSI$

LIVE LOAD
GLGM. 5
IMAGE RUN
ATTACH. 2

$M_x = 2098\ lb\text{-}in$

$$f_b = \frac{M}{S} = \frac{2098\,lb\text{-}in}{3.02\,in} = 0.7\ KSI$$

(1) Drawing H-1-42459 (2) Doc. No. ________ (3) Page 28 of ____
(4) Building K-BASIN (5) Rev. ________ (6) Job No. ________
(7) Subject ISOLATION DAMS
(8) Originator [signature] Date 6/2/94
(9) Checker L.C. Hyde Date 6/8/94

(10) AISC ASD 7th ed P 5-54 & 55

Eq H1-3 or H2-1 AS f_a IS VERY SMALL

$$\frac{f_a}{F_{t \text{ or } a}} + \frac{f_{bx}}{F_{bx}} + \frac{f_{by}}{F_{by}} \le 1.0$$

AS f_a IS SMALL USE $F_t = 0.6F_y = 0.6(46\text{KSI})$
$= 27.6\text{KSI}$

$$\frac{0.26\text{KSI}}{27.6\text{KSI}} + \frac{12.7\text{KSI}}{30.4\text{KSI}} + \frac{0.7\text{KSI}}{30.4\text{KSI}} = 0.45 \le 1.0$$

SEISMIC

$M_z = [(186\text{lb-in})1.0(1.0) + (296\text{lb-in})0.8(0.4)]0.24g$ SECOND HORIZ SEIS. E

$M_z = 470 \text{ lb-in}$

$M_y = 0$

$M_x = (209 \text{lb-in})0.6(0.4)\ 0.24g = 121 \text{ lb-in}$ VERT. 2 SEIS. E

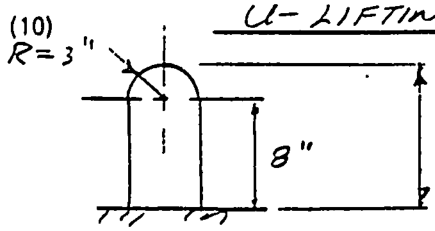
$$f_{bz} = \frac{M}{S} = \frac{470 \text{ lb-in}}{3.02\text{in}^3} = 0.16\text{KSI}$$

$$f_{bx} = \frac{M}{S} = \frac{121 \text{ lb-in}}{3.02\text{in}^3} = 0.04\text{KSI}$$

THESE ARE INSIGNIFICANT STRESS LEVEL AND WILL NOT CHANGE THE ABOVE INTERACTION.

(1) Drawing H-1-42659 (2) Doc. No. ______ (3) Page 29 of ____
(4) Building K-BASIN (5) Rev. ______ (6) Job No. ______
(7) Subject ISOLATION DAMS
(8) Originator [signature] Date 5/19/94
(9) Checker L. Hyde Date 6/8/94

(10) U-LIFTING RING



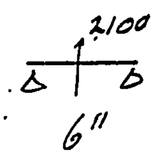
1"⌀ ROD A36

IF USED FOR VERTICAL PICK LOAD WILL BEND SO THAT CABLE POINT AND MASS CENTROID ARE IN STRAIGHT LINE. THIS MAY YIELD 1"⌀ ROD HOWEVER IT'S A SELF LIMITING LOAD AND ACCEPTABLE.

IF BENDING DUE TO ANY OTHER HORIZONTAL LOADS OR PICK POINTS ARE CONSIDERED THIS ITEM WILL FAIL CODE CHECK, AND MAY BREAK.

CHECK STRESS

USE A VERY SIMPLE MODEL



$$M = \frac{Pl}{4} = \frac{2100\,lb\,(6")}{4} = 3150\ lb\text{-}in$$

$$\sigma_b = \frac{M}{S} = \frac{3150\ lb\text{-}in}{\frac{\pi}{4}(.5)^3} = 32086\ PSI$$

HOISTING & RIGGING REQUIRES 5 LOAD FACTOR

A36 $F_u = 58\ KSI$

$$F_{AU} = \tfrac{1}{5} F_u = \tfrac{1}{5}(58\ KSI) = 11.6\ KSI$$

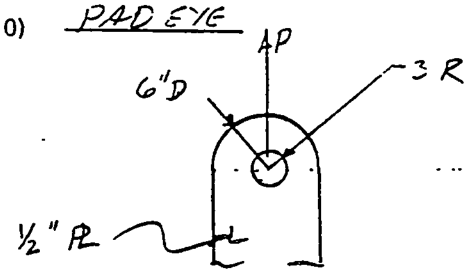
U-LIFTING RING ∴ UNACCEPTABLE
SEE FOLLOWING PAGE

BD-6400-060 (12.87)

DESIGN CALCULATION

(1) Drawing H-1-42655 (2) Doc. No. ______ (3) Page 30 of ____
(4) Building K-BASIN (5) Rev. ______ (6) Job No. ______
(7) Subject ISOLATION DAMS
(8) Originator [signature] Date 5/19/94
(9) Checker L. Hyde Date 6/8/94

(10) PAD EYE



PAD EYE

$P = 1526\ lb$

AS THE HOLE DIA. IS LARGE AND LOAD AREA MAY BE SMALL USE ONLY ONE AREA FOR SHEAR TEARCUT

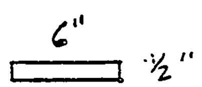
$$\tau = \frac{P}{t\,d} = \frac{1526\ lb}{(0.5 - 0.06")\ 3"}$$

— ℄ DOUBLE CORROSION

$d = 6" - 3" = 3"$

$= 1156\ PSI \ll F_v = 0.4 F_y = 14.4\ KSI$

WELD ¼" ALL-AROUND



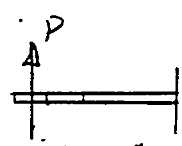
PER DESIGN OF WELDED STRUCTURES BY O.W. BLODGETT, P 7.4-7

$A_w = b \cdot 2 = 6in \times 2 = 12in.$

$$f_t = \frac{P}{A_w} = \frac{1526 lb}{12} = 127\ lb/in \quad \text{VERY SMALL}$$

PAD EYE ACCEPTABLE FOR THIS CONDITION

ASSUME PAD EYE IN BENDING, DUE TO PICK LOADING



$$6" + \frac{3"}{2} + \frac{3 - 1.5"}{2} = l = 8.25"$$

P = DAMS WEIGHT

$$PL\ (½" \times 18' \times 43")\ 455\ lb/ft^3 \left(\frac{ft}{12 in}\right)^2$$

$= 1236\ lb$

$$T.S.\ (18' \times 2 + 10 (36") \frac{ft}{12 in} + (17" \frac{ft}{12"}))\ 10.51 lb/ft$$

$= 709\ lb$

$P = \Sigma\ 1945\ lb$

BD-6400-060 1 (12 87)

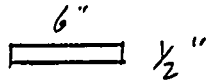
DESIGN CALCULATION

(1) Drawing H-1-42659 (2) Doc. No. ______ (3) Page 31 of ____
(4) Building K-BASIN (5) Rev. ______ (6) Job No. ______
(7) Subject ISOLATION DAMS
(8) Originator [illegible signature] Date 5/19/94
(9) Checker L. Hyde Date 6/8/94

(10)

FIELD INFO.

$$M = PL = 2100\,lb\,(8.25\,in) = 17325\ lb\text{-}in$$



$$S = \frac{bd^2}{6} = \frac{6"(1/2")^2}{6} = 0.25\ in^3$$

$$f_b = \frac{M}{S} - \frac{17325\,lb\text{-}in}{0.25\,in^3} = 17325\ PSI$$

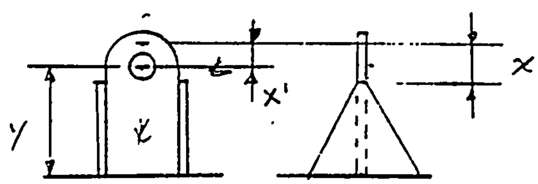
$$F_{all} = F_u\ 1/5 = 58000\,PSI\ 1/5 = 11.6\,KSI$$

FOR HOISTING AND RIGGING, LOAD FACTOR 5

THE EXISTING PAD EYE'S IS OVER STRESSED, BY HORIZONTAL LOADING WHEN USED TO PICK-UP DAMS

REDESIGN OF U-LIFTING RING & LIFTING PAD-EYES

SEE APPENDIX C



NEW PAD EYE 1"x8" PL WITH GUSSETS AS-REQUIRED

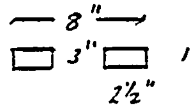
$$X' = 3/2" + \frac{3"-1.5"}{2} = 2.25"$$

y = 6" PAD EYE

y = 7" REPLACEMENT LIFTING RING

CHECK STRESS @ ℄ HOLE

$$M = PL = 2100\,lb\,(2.25") = 4725\ lb\text{-}in$$



$$S = \Sigma \frac{bd^2}{6} = 2\,\frac{(2\tfrac{1}{2}")(1")^2}{6} = 0.83\bar{3}\,in^3$$

(1) Drawing H-1-42659 (2) Doc. No. ______ (3) Page ~~32~~ of ____
(4) Building K-BASIN (5) Rev. ______ (6) Job No. ______
(7) Subject ISOLATION DAMS
(8) Originator [signature] Date 6/3/94
(9) Checker L. Hyde Date 6/8/94

(10)

$$f_b = \frac{M}{S} = \frac{4725\ lb-in}{0.833\ in^3} = 5.67\ KSI < 11.6\ KSI$$

$\therefore$ ACCEPTABLE

@ BASE (W/O GUSSET)

$$\ell = 7'' + \frac{3''}{2} + \frac{4'' - 1.5''}{2} = 9.75''$$

$$M = P\ell = 2100\ lb\,(9.75'') = 20475\ lb-in$$

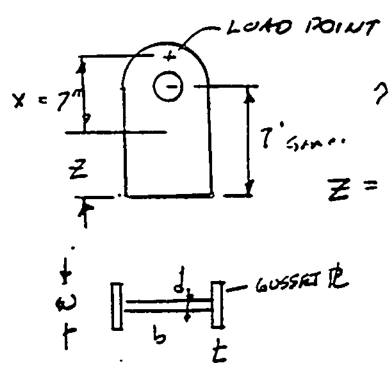
$$S = \frac{bd^2}{6} = \frac{8''(1'')^2}{6} = 1.3\bar{3}\ in^3$$

$$f_b = \frac{M}{S} = \frac{20475\ lb-in}{1.33\ in^3} = 15.4\ KSI \not< 11.6\ KSI$$

FIND 'x' TOP OF GUST PL

$$f_b = \frac{M}{S} = \frac{(2100\ lb)(x)}{1.33\ in^3} = 11.6\ KSI$$

$$\Rightarrow x = 7.35\ in \quad \text{USE } 7''$$



$$7'' - \left(\frac{3''}{2} + \frac{4'' - 1\tfrac{1}{2}''}{2}\right) = 4.25$$

$$Z = Y - 4.25 = 2.75''$$

$$I = \frac{bd^3}{12} + 2\,\frac{t\omega^3}{12}$$

$$S = \frac{I}{c} = \frac{\frac{(8'')(1'')^3}{12} + 2\,\frac{\frac{1}{2}''(\omega)^3}{12}}{(\omega/2)} = \frac{8 + \omega^3}{6\omega}$$

$$f_b = \frac{M}{S} < f_{ALL}$$

$$\Rightarrow \frac{20475\ lb-in}{\left(\frac{8 + \omega^3}{6\omega}\right)} \geq 11.6\ KSI$$

$$\omega^3 - \frac{6\,(20475\ lb-in)}{(11600\ PSI)}\,\omega + 8 \geq 0$$

$$\omega \geq 2.78'' \quad \text{USE } 3''$$

DESIGN CALCULATION

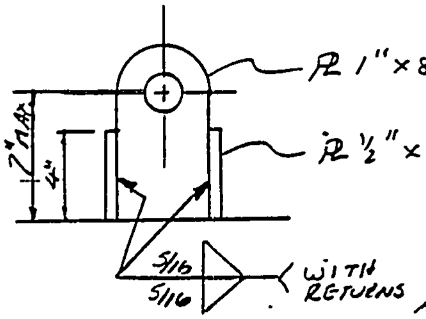
(1) Drawing H-1-42659 (2) Doc. No. ______ (3) Page 33 of ____
(4) Building K-BASIN (5) Rev. ______ (6) Job No. ______
(7) Subject ISOLATION DAMS
(8) Originator R A Pitmans Date 6/3/94
(9) Checker L. Hyde Date 6/5/94

(10) STRESS

$$S = \frac{8 + w^3}{6w} = \frac{8 + (3\,in)^3}{6(3\,in)} = 1.94\,in^3$$

$$f_b = \frac{M}{S} = \frac{20475\,lb\text{-}in}{1.94\,in^3} = 10.6\,KSI < 11.6\,KSI$$

∴ ACCEPTABLE



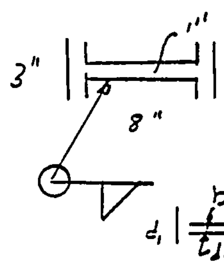
WELD GUSSETS & PAD PL ARE CLOSE TO NEUTRAL AXIS ∴ STRESSES LOW

5/16" FILLET MIN PER AISC ASD P. 5-67

ALLOW. AISC ASD 9th 0.3 (70000PSI) = 21000PSI

RIGGING 1/5 (70 000PSI) = 14000 PSI ← CONTROLS

BASE WELDS



¼" FILLET MIN PER AISC ASD P 5-67 THINNESS PART

PER DESIGN OF WELDED STRUCTURES P 7.4-7

$$S_w = \frac{I}{c} = \frac{2b\left(\frac{d_2}{2}\right)^2 + 2\frac{d_1^3}{12}}{(d_1/2)} = \frac{bd_2^2}{d_1} + \frac{d^2}{3} = \frac{8"(1")^2}{3"} + \frac{(3")^2}{3} = 5.67$$

$$A_w = 2(b + d) = 2(8" + 3") = 22\,in$$

Ten $f_b = \frac{M}{S_w} = \frac{20\,475\,lb\text{-}in}{5.67\,in^2} = 3611\ lb/in$

Shear $f_s = \frac{P}{A_w} = \frac{2100\,lb}{22\,in.} = 95\ lb/in$

$0.30\,(70KSI) = 21\,KSI$
← E70xx ROD

$$f_r = [f_b^{\,2} + f_s^{\,2}]^{1/2} = [(3611\,lb/in)^2 + (95\,lb/in)^2]^{1/2}$$

$$= 3612\ lb/in$$

34

DESIGN CALCULATION

(1) Drawing H-1-42659 (2) Doc. No. ______ (3) Page 34 of ____
(4) Building K-BASIN (5) Rev. ______ (6) Job No. ______
(7) Subject ISOLATION DAMS
(8) Originator [signature] Date 6/3/94
(9) Checker L. Hyde Date 6/9/94

(10)

AISC ASD 7TH
0.3 (70000 PSI)

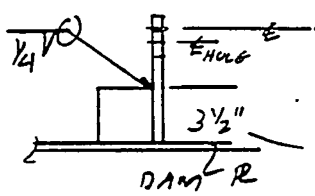
$$w = \frac{f_r}{f_{w}} = \frac{3612\ lb/in}{0.707\ (21000\ PSI)} = 0.243\ in\ \text{REQ.}$$

USE 5/16" FILLET ALL AROUND
SEE APPENDIX C

WELD STRESS $\frac{3612\ lb/in}{0.707\ (5/16\ in)} = 16.4\ KSI < 21\ KSI$

LOWER LIFTING PAD EYE

THE LOWER PAD EYE IS WELDED TO
TS 3½ × 3½ × ¼ × 24" L

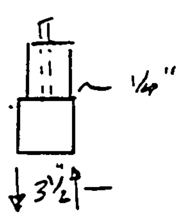


ASSUME ℞ WELDED TO T.S.

EXIST ℞ ½" IS OVER STRESSED ∴ 1" × 8" ℞
REQUIRED.

GUSSETS ARE NOT REQUIRED AS T.S.
WILL PERFORM SAME FUNCTION.

WITH GUSSETS PLATES LOCAL STRESS IN T.S.
ARE SMALL AND ACCEPTABLE.

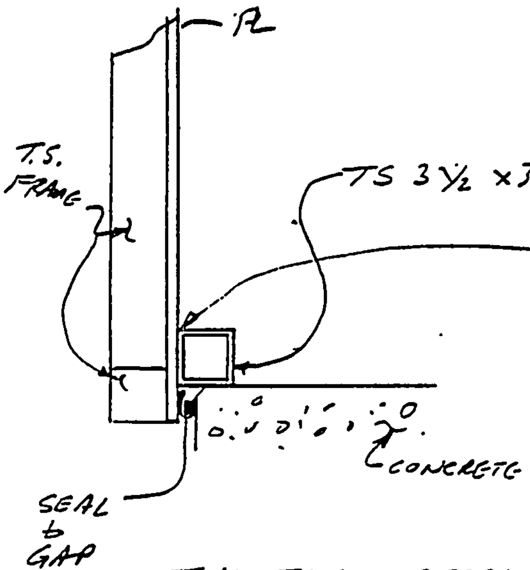


WELDS ARE LONGER AND ACCEPTABLE
BY COMPARISON.

BD-6400 060 (12 87)

(1) Drawing H-1-42659 (2) Doc. No. ________ (3) Page 35 of ____
(4) Building K-BASIN (5) Rev. ________ (6) Job No. ________
(7) Subject ISOLATION DAM
(8) Originator L.H. Burdens Date 6/9/94
(9) Checker L. Hyde Date 6/10/94

(10) ITEM 13 DEAD WEIGHT SUPPORT
PER DRAWING H-1-42659



DRAWING SHOWS ¼ FILLET WELD ALONG BOTH EDGES
ASSUME @ MIN. FULL FLAIR BEVEL WELDS.

THE TUBE STEEL MEMBER & WELD USED IN THIS CONFIGURATION ACTS AS A RIGID FRAME.
THE PARTIAL PENTRATION WELDS, FLAIR BEVELS ALSO ACT AS FLEXIBLE ELEMENTS OF THE DEAD WEIGHT SUPPORT.

AN IMAGES-3D MODEL WITH BEAM ELEMENTS WAS DEVELOPED TO EVALUATE STRESS IN THE TUBE STEEL AS BEAM ELEMENTS. THE WELDS ACT AS FLEXIBLE ELEMENTS IN THIS MODEL TO ALLOW FOR ROTATION. SEE ATTACHMENT 3

MAX STRESS IN T.S. BEAM ELEMENTS.
ELE. 2 thru 5 & 7

EL. 2 NODE 2 $f_b = 7{,}350$ PSI $f_t = 132$ PSI $f_s = 195$ PSI

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(1) Drawing H-1-42659 (2) Doc. No. ______ (3) Page 36 of ____

(4) Building K-BASIN (5) Rev. ______ (6) Job No. ______

(7) Subject ISOLATION DAM

(8) Originator [signature] Date 6/9/94

(9) Checker L. Hyde Date 6/10/94

(10)

$$F_b = 0.75 F_y = 0.75\,(46\,KSI) = 34.5\,KSI$$

$f_b << F_b$ STRESS VERY LOW ∴ ACCEPTABLE

<u>WITH SEISMIC</u> PER UCRL-15910 JUNE 1990 P 4-31

$0.24g\,(0.6) = 0.14g$ THE VERTICAL SEIS. FACT. IS $0.6 \times$ HORIZ g

DW+SEIS.

$f_b = 7350\,PSI\,(1.14) = 8379\,PSI << 34.5\,KSI$ ∴ ACCEPT.

<u>WELD</u> ELE. 1 & 6

ELE. 1 NODE 1 $f_b = 10320\,PSI$ $f_t = 369\,PSI$

$f_s = 233\,PSI$

TOT. $f_{t_T} = f_b + f_t = 10320\,PSI + 369\,PSI = 10689\,PSI$

$F_{ALL} = 0.6 F_y = 0.6\,(36\,KSI) = 21.6\,KSI$

$\angle$ PL MIN BASEMAT.

or $F_{ALL} = 0.3 F_u = 0.3\,(70\,KSI) = 21\,KSI$ CONTROLS

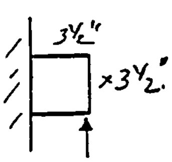
$\angle$ E70XX

$10.7\,KSI < 21\,KSI$ ∴ ACCEPTABLE

W/SEIS. $10.7\,KSI\,(1.14) = 12.2\,KSI < 21\,KSI$

<u>END PL'S</u>

IF END PL 3/8" WERE ADDED TO DEAD WEIGHT T.S. DESIGN AND THE ONE CARRIED ALL LOAD



$$S = \frac{bd^2}{6} = \frac{(3/8")(3")^2}{6} = 0.563\,in^3$$

$M = P\ell = 2100\,lb\,(3½") = 7350\,lb\text{-}in$

$$f_b = \frac{M}{S} = \frac{7350\,lb\text{-}in}{0.563\,in^3} = 13.1\,KSI < F_b = 0.6 F_y = 21.6\,KSI$$ (A36)

$13.1\,KSI\,(1.14) = 14.9\,KSI < 21.6\,KSI$

<u>WELD</u>

$$S_w = d^2/6 = \frac{(3½)^2}{6} = 2.04\,in^2 \qquad f_r = [f_b^2 + f_s^2]^{1/2} = \left[\left(\frac{7350\,lb\text{-}in}{2.04\,in^2}\right)^2 + \left(\frac{2100\,lb}{3½"}\right)^2\right]^{1/2}$$

$= 3653\,lb/in$

3½" $A_w = 3½"$

$$\omega = \frac{f_r}{f_{AL}} = \frac{3653\,lb/in}{0.707\,(.3)\,(70\,KSI)} = 0.246\,in$$ ∴ USE 5/16" MIN.

BD-6400-060

DESIGN CALCULATION

(1) Drawing H-1-42659 (2) Doc. No. ______ (3) Page 37 of ____
(4) Building K-BASIN (5) Rev. ______ (6) Job No. ______
(7) Subject ISOLATION DAMS
(8) Originator [signature] Date 5/20/94
(9) Checker L. Hyde Date 6/9/94

(10) J SEAL

WITH WATER ON ONLY ONE SIDE THE J-SEAL WILL SEE ALL THE WATER'S HYDROSTATIC LOADING

FOR ONE 24" LENGTH OF SEAL AND ONE TIE-ROD TRIB. AREA.

$$7.8\ lb/in^2 \left(\frac{43''}{2} \times 24'' \right) = 4025\ lb / \text{24" SEAL + 1 TIE-ROD}$$

PER GIVEN SEAL DATA "SEE ATTACHMENT 1"

$$\frac{15\ lb/in}{0.125\ in} (0.53\ in)\ 24\ in = 1526\ lb / \text{24" SEAL + 1 TIE-ROD}$$

AS 1526 lb < 4025 lb THE TIE-RODS WILL BE UNLOADED.

ASSUMING J-SEAL IS TOTAL ELASTIC HOW FAR WILL IT BE COMPRESSED.

$$\frac{15\ lb/in}{1.125\ in} (c)\ 24\ in = 4025\ lb$$

$$c = 1.398''$$

AS THE TOTAL HEIGTH IS ONLY 1.75" CAN THE J-SEAL TAKE THIS LOAD. THE LOAD IS OFF THE PROVIDED CHART.

THE VENDER OF SEAL NEEDS TO BE CONSULTED. CALCULATION ABOVE IS FOR INFO ONLY AS NO CRITERIA FOR ACCEPTANCE IS AVAILABLE.

(1) Drawing H-1-42659 (2) Doc. No. ______ (3) Page 38 of ____
(4) Building K-BASIN (5) Rev. ______ (6) Job No. ______
(7) Subject ISOLATION DAMS
(8) Originator [signature] Date 6/3/94
(9) Checker L. Hyde Date 6/8/94

(10)

SUMMARY

Item	ALLOW/DESIGNED USED FOR NOR. & SEIS. CASES.	CAL./REQ	SEIS. COMP.	M.S. $\frac{ALL}{CAL} - 1 \geq 0$
(WORST CASE) PL SEGMENT Item 14 PL 1/2" (P.8)	$F_b = 27KSI$	$f_b = 11.3KSI$	PER ATT. 2 SEIS. INCREASE 1.93 PSI · 7.8 + 1.93 = 9.73 PSI · $\frac{9.73}{7.8}(11.3KSI) = 14.1KSI$	NOR. 1.39 · W/SEIS. 0.91
WELD PL to T.S. FLAIR BEVEL (SEE RECOMMENDATIONS) (P 9&10)	$F_w = 21KSI$ (0.126 in)	$f_w = \frac{672 lb/in}{0.126 in} = 5.3KSI$ (0.032 in) ← THROATS	$\frac{9.73}{7.8}(5.3KSI) = 6.6KSI$	NOR 2.96 · W/SEIS. 2.18
CROSSING T.S. Item 16 (P. 11)	$F_b = 30.4KSI$	$f_b = 17.3KSI$	$\frac{9.73}{7.8}(17.3KSI) = 21.6KSI$	NOR 0.76 · W/SEIS. 0.41
WELD CROSSING T.S. to VERTICAL T.S. (FILLET) (P. 12)	$F_w = 21KSI$ (0.22 in)	$f_w = \frac{(190 lb/in)}{(0.707 \cdot \frac{1}{8}") - 0.03"} = 8.1KSI$ (0.08 in)	$\frac{9.73}{7.8}(8.1KSI) = 10.1KSI$	NOR. 1.59 · W/SEIS 1.08
TIE-ROD Item 44 to 62 AS DESIGNED (P. 19)	$F = 18.75KSI$	$f = 54.4KSI$ ← FAILS → SEE RECOMMENDATIONS		
AS REDESIGNED 1" THICKER (P. 21)	$F = 15KSI$	$f = 13.5KSI$	~SAME	0.11
WELD BETWEEN TIE-ROD & STIFF. FULL FLAIR BEVEL (P-22)	$F = 10.0KSI$	$f = 3.8KSI$	~SAME	1.63

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DESIGN CALCULATION

(1) Drawing H-1-42659 (2) Doc. No. ______ (3) Page 39 of ____
(4) Building K-BASIN (5) Rev. ______ (6) Job No. ______
(7) Subject ISOLATION DAMS
(8) Originator [signature] Date 6/3/94
(9) Checker L. Hyde Date 6/8/94

(10)

SUMMARY CONT.

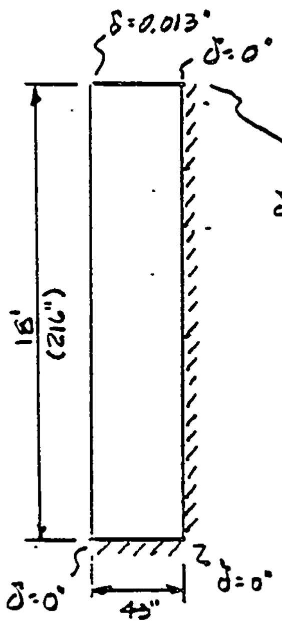
Item	ALLOW/DESIGNED	CAL/REQ	+ SEIS:	M.S.
BRACKET ASS. Items 17 & 25 · T.S. SUPPORT FRAMES (P 23 & 28)	F_b = 30.4 KSI I	$f_T \simeq$ 12.7 KSI Interaction $\frac{12.7}{30.4}$ = ~0.42 < 1.0	~SAME	$\frac{1.0}{0.42} - 1$ = 1.4
WELDS WORST CASE BRACE MEMBERS (P 25)	F = 21 KSI (0.156 in)	f = 14 KSI (0.104 in)	~SAME	0.5
U-LIFTING RING Item 43 (P 29)	F = 11.6 KSI	f = 32.1 KSI	FAILS → SEE RECOMMENDATIONS	
PAD-EYES FOR USE WITH TIE-RODS (P 30)	F = 14.4 KSI	f 1.16 KSI	~SAME	11.4
AS LIFTING LUGS (P 31)	F = 11.6 KSI	f = 17.3 KSI	FAILS → SEE RECOMMENDATIONS	
PAD-EYES LIFTING & U-LIFTING RING REDESIGN. (P 33)	F = 11.6 KSI	f = 10.6 KSI	N/A	0.10
WELD REDESIGN (P 34)	F = 21 KSI (0.3125 in)	F = 16.4 KSI (0.243 in)	N/A	0.28
DEAD WEIGHT SUPPORT (P 35 & 36)	F_b = 34.5 KSI	f_b = 7.4 KSI → 3.66	f_b = 8.4 KSI → 3.1	3.66 / 3.1
WELD	F_t = 21 KSI	f_t = 10.7 KSI → 0.96	f_t = 12.2 KSI → 0.72	0.96 / 0.72

BD-6400-060 : (12.87)

(1) Drawing H-1-42659 (2) Doc. No: (3) Page 40 of
(4) Building K-BASIN (5) Rev. (6) Job No.
(7) Subject COFFER DAMS
(8) Originator L. Hyde Date 6/7/94
(9) Checker [signature] Date 6/8/94

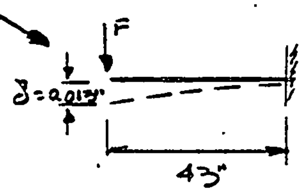
(10) EVALUATE THE EFFECTS ON THE DAM OF THE RELATIVE HORIZONTAL MOTION BETWEEN THE ISLAND AND WALL SUPPORTS DURING A SEISMIC EVENT.

THE APPENDIX B CALCULATIONS SHOW THIS MOTION TO BE APPROXIMATING 0.013 INCHES



ASSUMED CONDITION

WORST STRUCTURAL CASE IS TOP TUBE STEEL TREATED AS A CANTILEVER –



3½" SQ. T.S.

DEFLECTION

$$\delta = 0.013'' = \frac{F\ell^3}{2EI}$$

STRESS,

$$f_b = \frac{Mc}{I} = \frac{(F\ell)c}{I}$$

$$= \frac{\left(\frac{2EI(.013)}{\ell^2}\right)c}{I} = \frac{2E(0.013)c}{\ell^2}$$

$$= \frac{2(30\times10^6)(0.013)(3.5/2)}{(43)^2} = 738 \text{ psi}$$

AISC-9th ED.

$$F_b = 0.66F_y = 0.66(46{,}000) = 30{,}360 \text{ psi}$$

$$f_b << F_b \text{ , O.K.}$$

THE RESULTING STRESS LEVELS ARE VERY LOW SO THIS WARPING WILL NOT DAMAGE THE DAM

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(1) Drawing H-1-42659 (2) Doc. No. ______ (3) Page 41 of ____

(4) Building K BASIN (5) Rev. ______ (6) Job No. ______

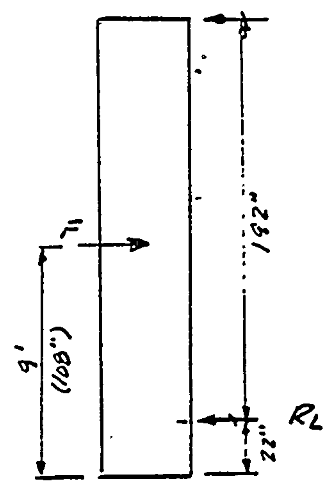
(7) Subject COFFER DAMS

(8) Originator L. Hyde Date 6/7/94

(9) Checker [signature] Date 6/8/94

(10) EVALUATE THE EFFECTS ON THE DAM OF A HORIZONTAL SEISMIC EVENT IN THE PLANE OF THE DAM

THE APPENDIX B CALCULATIONS SHOW THIS ACCELERATION IS 0.24g. SINCE THE DAM IS RECESSED 8" NO HYDRODYNAMIC FORCES IN THIS PLANE ARE PREDICTED.



THIS MOTION IS RESTRAINED BY THE PAD EYES BEARING ON THE CONCRETE FOR THE TOP AND BOTTOM PAD EYES REACTING ALL THE LOAD –

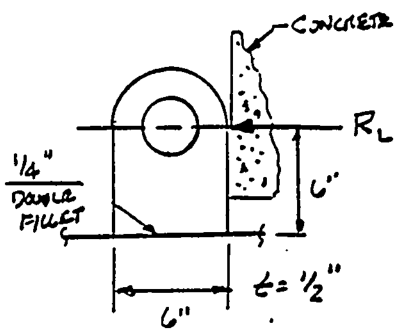
$F = (\text{DAM WT.})\ 0.24g$

$= 2100 \times 0.24 = 504$ LB.

$R_L = F \times \frac{106}{192} = 504 \times \frac{106}{192} = 278$ LB.

WORST CASE, $R_L = F = 504$ LB.

WORST CASE LOADING OF PAD EYE AT ITS TANGENT POINT –



PAD EYE
(ITEM 42)

WELD STRESS WILL BE MOST CRITICAL PER O. W. BLODGETT PG. 7.4-7

$S' = \frac{d^2}{3} = \frac{(6)^2}{3} = 12\ \text{IN}^2$

$A' = 2d = 2(6) = 12\ \text{IN}^2$

$M = 6R_L = 6(504) = 3024$ IN-LB

$f'_b = \frac{M}{S'} = \frac{3024}{12} = 252$ LB/IN

$f'_s = \frac{R_L}{A'} = \frac{504}{12} = 42$ LB/IN

$f'_{TOTAL} = (252^2 + 42^2)^{1/2} = 256$ LB/IN

WELD STRESS $= \frac{f'_{TOTAL}}{t} = \frac{256}{0.707 \times 1/4} = 1448$ PSI

ALLOWABLE STRESS $= 0.3 \times 70000 = 21{,}000$ PSI, O.K.

(1) Drawing H-1-42659 (2) Doc. No. ______ (3) Page 42 of ____
(4) Building K-BASIN (5) Rev. ______ (6) Job No. ______
(7) Subject COFFER DAMS
(8) Originator L. Hyde Date 6/7/94
(9) Checker [signature] Date 6/8/94

(10)

BEARING ON CONCRETE

REF. ACI 318, SECTION 10.15

CONCRETE BEARING STRENGTH $= \phi\left(0.85 f'_c A_1 \left(\frac{A_2}{A_1}\right)^{1/2}\right)$

$\phi = 0.70$

$f'_c = 3000$ PSI

$A_1 =$ (PAD THICKNESS)(LENGTH OF CONTACT WITH CONCRETE)
$= (1/2)(\ell_c)$

CONSERVATIVELY ASSUME $\left(\frac{A_2}{A_1}\right)^{1/2} = 1.0$

REQUIRED BRG. STR. IS $R_L = 504$ LB.

$504 = (0.7)(0.85)(3000)(\frac{1}{2} \times \ell_c)$

$\ell_c = 0.6$ INCHES (MIN. CONTACT LENGTH)

THE AVAILABLE CONTACT LENGTH WITH THE CONCRETE IS 6" MINUS THE COMPRESSED HEIGHT OF THE SEAL WHICH IS MUCH GREATER THAN THE MIN. ℓ_c CALCULATED. IT CAN BE REASONABLY CONCLUDED THE CONCRETE BEARING STRENGTH IS ADEQUATE

(1) Drawing H-1-4?55? (2) Doc. No. ______ (3) Page 43 of ____
(4) Building K-BASIN (5) Rev. ______ (6) Job No. ______
(7) Subject ISOLATION DAMS
(8) Originator [signature] Date 6/3/94
(9) Checker L. Hylle Date 6/8/94

RECOMMENDATIONS.

(10)

1) WELD BETWEEN TS & PL SHOWN AS ALL AROUND (3/16") FLAIR BEVEL 1-6 INTERMITTENT WELD. THE 1" WELD LENGTH ON A PENTRATION WELD IS TO SMALL TO BE CONSIDERED A STRUCTURAL WELD, FOR FILLET 1½" IS MIN LENGTH BECAUSE THE ENDS OF WELD DON'T HAVE FULL STRENGTH AND HEAT ABSORPTION OF WELDED STEEL.
AT MIN. THIS WELD SHOULD BE 1½", ALSO SEAL WELD PL to T.S. TO STOP CORROSION IS RECOMMENDED.

2.) THE U-LIFTING RING Item 43 & THE TWO PAD EYES USED FOR LIFTING NEED TO BE REVISED AS SHOWN ON P. 33 & 34. (USE PL 1" x 8" AND GUSITS PL ½" x 3" x 4") ▷1

3.) THE TIE-RODS REQUIRE A STIFF-BACK ADDED FOR THE FULL CURVE. (SEE, P. 20) ▷1

▷1 SEE APPENDIX C

BD-6400-060 (12 97)

DESIGN CALCULATION

(1) Drawing H-1-4265? (2) Doc. No. ______ (3) Page 44 of ____
(4) Building K-BASIN (5) Rev. ______ (6) Job No. ______
(7) Subject ISOLATION DAMS
(8) Originator [signature] Date 6/3/94
(9) Checker L. Hyde Date 6/8/94

(10) SUPPORT FRAMES / BRACKET ASSEMBLYS

REACTIONS AT SUPPORT POINTS

PER ATTACH. 3

NODE 1 — 911.3 lb

NODE 9 — 2141 lb

S1 (P 26) $(69\,lb\ MAX)\,1.0(1.0)(0.24g) = 17\,lb$

S2 (P 26) $(70\,lb\ MAX)(0.80)(0.40)(0.24g) = 5\,lb$

S3 P27 (VERT) $(69\,lb\ MAX)(0.60)(0.40)(0.24g) = 4\,lb$

DEADWEIGHT ~70 lb

MAX HORIZ FORCE ON FRICTION CONNECTION

$$\left[(70\,lb + 4\,lb)^2 + (17\,lb)^2\right]^{1/2} = 76\,lb$$

REQUIRED FRICTION FACTOR

$$\frac{76\,lb}{911.3\,lb} = 0.08 = \mu.$$

ASSUME FULL PRETENSION ON TIE RODS

NO KNOWN REF. USES FRICTION FOR SEISMIC CONDITIONS ∴ UNKNOWN IF μ IS REASONABLE

UCRL-15910 JUNE 1990 REQUIRES POSITIVE ANCHORAGE THIS DESIGN DOES NOT HAVE IT, (SEE P.4-35)

DESIGN CALCULATION

(1) Drawing H-1-42657 (2) Doc. No. ________ (3) Page 45 of ____
(4) Building K-BASIN (5) Rev. ________ (6) Job No. ________
(7) Subject COFFER DAMS
(8) Originator L. Hyde Date 6/9/94
(9) Checker [signature] Date 6/10/94

(10) EVALUATE EFFECT OF DIFFERENTIAL DISPLACEMENT BETWEEN THE STEEL DAM AND THE CONCRETE SUPPORTS DUE TO TEMPERATURE OF THE BASIN WATER.

- ASSUME THE MAXIMUM INCREASE IN BASIN WATER TEMPERATURE FROM THE TEMPERATURE DURING INSTALLATION OF THE DAM IS 50°F
- ASSUME THE COEFFICIENT OF THERMAL EXPANSION OF THE "HANFORD" CONCRETE IS 3.2×10^{-6} TO 4.2×10^{-6} IN/IN/°F REFERENCE IOM BVW-23430-94-002, "MULTI-FUNCTION WASTE TANK FACILITY CONCRETE PRELIMINARY CHARACTERIZATION REPORT, FINAL DRAFT"; B.V. WINKEL TO J.M. LIGHT, (1/17/94)
- THE COEFFICIENT OF THERMAL EXPANSION OF A-36 STEEL IS 6.5×10^{-6} PER AISC, 9TH EDITION, PG. 6-4

DIFFERENTIAL DISPLACEMENT BETWEEN STEEL DAM AND CONCRETE SUPPORT IS,

$$\Delta\delta = (\Delta\alpha)(\Delta T) \quad \text{IN/IN}$$

WORST CASE IS

$$\Delta\delta = (\alpha_S - \alpha_C)(\Delta T)$$
$$= (6.5 \times 10^{-6} - 3.2 \times 10^{-6})(50) = 0.000165 \text{ IN/IN}$$

IF THE DAM WAS RIGIDLY ATTACHED TO THE CONCRETE THIS RESTRAINT OF THIS DISPLACEMENT WOULD INDUCE COMPRESSION STRESSES IN THE DAM AND TENSILE STRESSES IN THE CONCRETE. BUT THEY ARE ISOLATED FROM EACH OTHER BY THE J-SEAL. IT IS THE J-SEAL WHICH WILL PROVIDE THE FLEXIBILITY TO ACCOMODATE THIS DISPLACEMENT. THE WORST CASE IS THE SEAL MUST ACCOMODATE THE DISPLACEMENT OF ENTIRE 18 FOOT HEIGHT OF THE DOOR AT ONE LOCATION —

VERTICAL DISPLACEMENT = $(18 \times 12)(0.000165) = 0.0356$ IN.
LATERAL DISPLACEMENT = $(43/2)(0.000165) = 0.0036$ IN.

IT IS JUDGED THE 1 3/4" J-SEAL CAN EASILY ACCOMODATE THESE MINOR DISPLACEMENTS

DESIGN CALCULATION

(1) Drawing ______ (2) Doc. No. ______ (3) Page 1 of 1
(4) Building ______ (5) Rev. ______ (6) Job No. ______
(7) Subject K-BASIN POOL GATE
(8) Originator E. RUFF Date MAY 19, 1994
(9) Checker ______ Date ______

(10)

REF. PRESRAY GRAPH.
PR15415 J-SEAL

$$\frac{0.125''}{15\text{ LB}} \Longleftrightarrow \frac{0.53''}{X}$$

$X = 63.60$ LBF/0.53'' DEFLECTION (PER INCH OF SEAL)

1.75'' SEAL DIA
x .30 (% COMPRESSION)

0.53'' SEAL DISPLACEMENT DURING COMPRESSION.

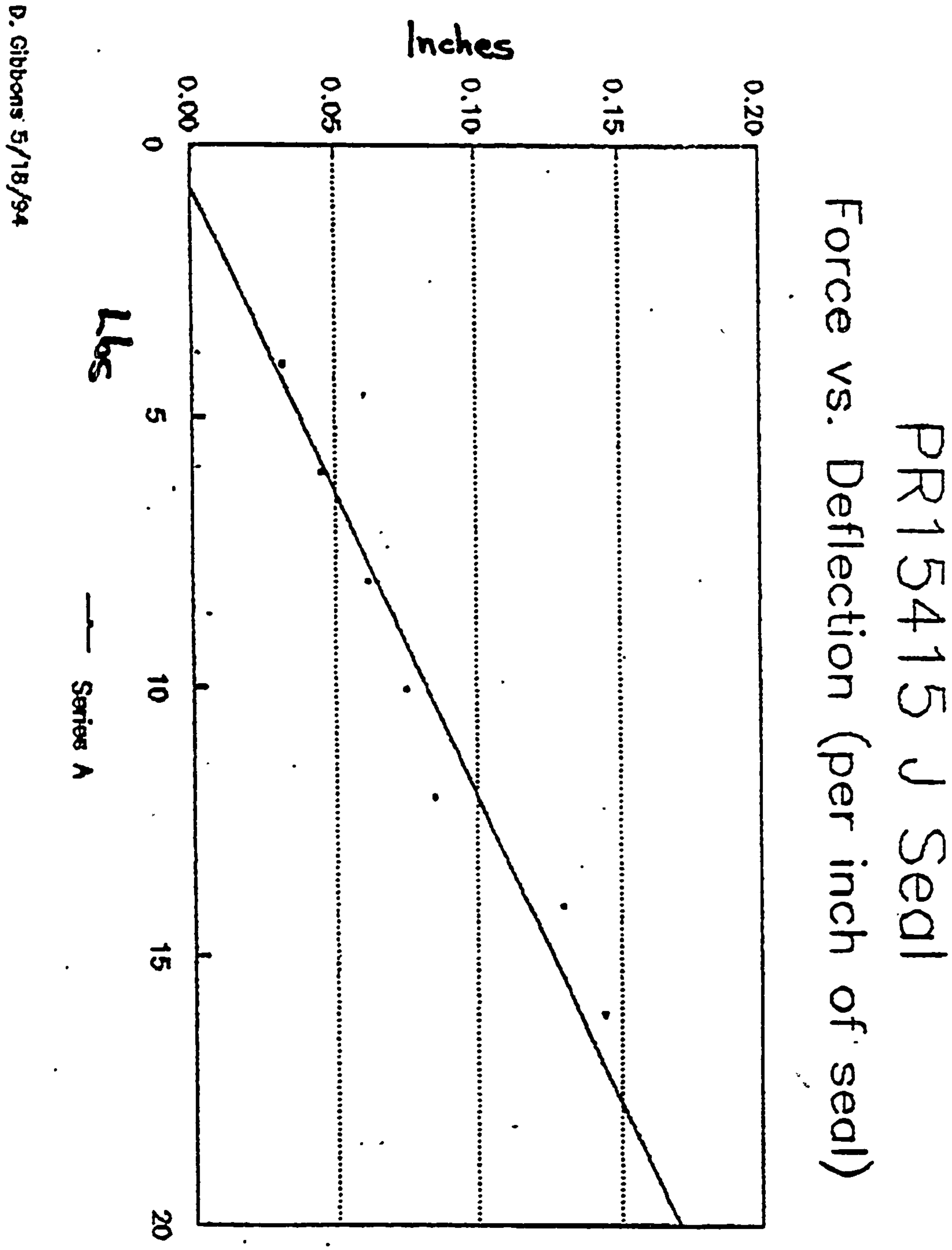
REF. DR. FREDRICK COLLINS –
ELASTOMERS EXHIBIT LINEAR BEHAVIOR UP TO ≅ 150% DEFORMATION
30% IS WELL WITHIN LINEAR RANGE.

$$\text{TOTAL FORCE} = \left(63.6\ \frac{\text{LB}}{\text{IN}}\right)(40\text{ FT})\left(12\ \frac{\text{IN}}{\text{FT}}\right) = 30{,}528\text{ LB}$$

$$\frac{\text{FORCE}}{\text{HOOK}} = \left(\frac{30{,}528}{20}\right) = 1{,}526\ \frac{\text{LB}}{\text{HOOK}}$$

MAY-18-94 WED 8:13 P.02

ATTN: ED RUFF, W. HANFORD (376-1943)
FAX - 7382



PRESRAY 159 CHARLES COLMAN BLVD., PAWLING, NY (914) 855-1220

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========================== I M A G E S - 3 D =================================
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5-26-1994                      Run ID=BI94363                        15:08:45

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WESTINGHOUSE HANFORD COMPANY S/N:801657

Job Information

Project	: K-BASIN
Client	: COFFER DAM
Job Name	: H-1-42659, REV.1
Remarks	:
Engineer	: L. Hyde / 5/26/94
Chk'd by	: [illegible] / 6/7/94
Appr'd by	: /
Comments	:

=========================== I M A G E S - 3 D ===========================

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= be addressed to:                             =
=                                              =
=           Celestial Software Inc.            =
=             125 University Ave.              =
=                Berkeley,CA                   =
=                   94710                      =
=                                              =
=                415-843-0977                  =
================================================
```

WESTINGHOUSE HANFORD COMPANY S/N:801657 05/26/94
PAGE 1 RUN ID=BI94363 15:08:56

=============== I M A G E S 3 D ===============

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CHECK GEOMETRY Version 2.0 07/01/90

KBASIN DAM SUPPORT FRAME

MATERIAL PROPERTIES

Material No	Modulus of Elasticity	Weight Density	Coeff of Thermal Exp.	Poisson's Ratio	Shear Web Modulus
1	3.00000E+07	2.83000E-01	6.33000E-06	3.00E-01	0.00000E+00

NODE COORDINATES

Node	X-Coord.	Y-Coord.	Z-Coord.
1	0.00000E+00	5.20000E+01	0.00000E+00
2	2.02500E+01	5.20000E+01	0.00000E+00
3	3.42500E+01	5.20000E+01	0.00000E+00
4	3.42500E+01	3.80000E+01	0.00000E+00
5	3.42500E+01	1.00000E+01	0.00000E+00
6	3.42500E+01	0.00000E+00	0.00000E+00
7	4.42500E+01	0.00000E+00	0.00000E+00
8	6.50000E+01	0.00000E+00	0.00000E+00
9	7.07500E+01	0.00000E+00	0.00000E+00

BEAM PROPERTIES

Multiplier = 1 (For AISC database properties only)

Prop No	X-Section Area	Moment of Inertia Iy	Iz	Torsional Const.- J
1	2.390E+00	4.290E+00	4.290E+00	6.990E+00

Prop No	Max. Fiber Dist Cy	Cz	Shear Shape Fact SSFy	SSFz	Ctors	Shear Stress Factor SSTRFy	SSTRFz
1	1.75E+00	1.75E+00	0.00E+00	0.00E+00	1.00E+00	1.00E+00	1.00E+00

WESTINGHOUSE HANFORD COMPANY S/N:801657 05/26/94
PAGE 2 RUN ID=BI94363 15:09:10

=============== I M A G E S 3 D ===============

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CHECK GEOMETRY Version 2.0 07/01/90

KBASIN DAM SUPPORT FRAME

BEAM CONNECTIVITY

Beam No	Nodes From/	To /	Ref	Prop No	Mat No	pincodes I / J	Rigid End Offset I /	J	Length	Beam Type
1	1	2	9	1	1		0.00E+00	0.00E+00	0.20E+02	Beam
2	2	3	9	1	1		0.00E+00	0.00E+00	0.14E+02	Beam
3	2	4	9	1	1		0.00E+00	0.00E+00	0.20E+02	Beam
4	3	4	9	1	1		0.00E+00	0.00E+00	0.14E+02	Beam
5	4	5	9	1	1		0.00E+00	0.00E+00	0.28E+02	Beam
6	5	6	9	1	1		0.00E+00	0.00E+00	0.10E+02	Beam
7	5	7	9	1	1		0.00E+00	0.00E+00	0.14E+02	Beam
8	6	7	1	1	1		0.00E+00	0.00E+00	0.10E+02	Beam
9	7	8	1	1	1		0.00E+00	0.00E+00	0.21E+02	Beam
10	8	9	1	1	1		0.00E+00	0.00E+00	0.58E+01	Beam

RESTRAINTS

Node No	Global/Local	Restraint Directions
1	GLOBAL	- Y Z - - -
2	GLOBAL	- - Z - - -
3	GLOBAL	- - Z - - -
4	GLOBAL	- - Z - - -
5	GLOBAL	- - Z - - -
6	GLOBAL	- - Z - - -
7	GLOBAL	- - Z - - -
8	GLOBAL	- - Z - - -
9	GLOBAL	X Y Z - - -

WESTINGHOUSE HANFORD COMPANY S/N:801657 05/26/94
PAGE 3 Run ID=BI94363 15:10:33

=============== I M A G E S 3 D ===============
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===

SOLVE DISPLACEMENTS Version 2.0 07/01/90

KBASIN DAM SUPPORT FRAME

L O A D C A S E 1
1526 LB INSTALLATION LOADING

DISPLACEMENTS

Node	Translations X	Translations Y	Translations Z	/	Rotations X	Rotations Y	Rotations Z
1	.4732E-01	.0000E+00	.0000E+00	/	.0000E+00	.0000E+00	-.6586E-02
2	.4732E-01	-.1236E+00	.0000E+00	/	.0000E+00	.0000E+00	-.5134E-02
3	.4695E-01	-.1897E+00	.0000E+00	/	.0000E+00	.0000E+00	-.4701E-02
4	-.1708E-01	-.1891E+00	.0000E+00	/	.0000E+00	.0000E+00	-.3966E-02
5	-.3307E-01	-.1889E+00	.0000E+00	/	.0000E+00	.0000E+00	.2824E-02
6	-.3655E-03	-.1892E+00	.0000E+00	/	.0000E+00	.0000E+00	.3376E-02
7	.5016E-16	-.1547E+00	.0000E+00	/	.0000E+00	.0000E+00	.3832E-02
8	.1088E-16	-.4041E-01	.0000E+00	/	.0000E+00	.0000E+00	.6845E-02
9	.0000E+00	.0000E+00	.0000E+00	/	.0000E+00	.0000E+00	.7120E-02

WESTINGHOUSE HANFORD COMPANY S/N:801657 05/26/94
PAGE 4 Run ID=BI94363 15:10:38

=============== I M A G E S 3 D ===============

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SOLVE BEAM LOADS/STRESSES Version 2.0 07/01/90

KBASIN DAM SUPPORT FRAME

Load Case 1:1526 LB INSTALLATION LOADING

BEAM LOADS AND/OR STRESSES

GLoads / LLoads / Stress / Stress	Node	Fx / Axial / Axial / Maximum	Fy / Y-Shear / Y-Shear / Minimum	Fz / Z-Shear / Z-Shear / Cmb. Shear	Mx / Torsion / Torsion	My / Y-Bending / Y-Bending	Mz / Z-Bending / Z-Bending
			BEAM NO. 1				
GLoads	1	.2066E-10	.9113E+03	.0000E+00	.0000E+00	.0000E+00	.4277E-11
GLoads	2	-.2066E-10	-.9113E+03	.0000E+00	.0000E+00	.0000E+00	.1845E+05
LLoads	1	.2066E-10	-.9113E+03	.0000E+00	.0000E+00	.0000E+00	-.4277E-11
LLoads	2	-.2066E-10	.9113E+03	.0000E+00	.0000E+00	.0000E+00	-.1845E+05
Stress	1	-.8645E-11	-.3813E+03	.0000E+00	.0000E+00	.0000E+00	.1745E-11
Stress	1	-.6901E-11	-.1039E-10	.5195E-11			
Stress	2	-.8645E-11	-.3813E+03	.0000E+00	.0000E+00	.0000E+00	-.7528E+04
Stress	2	.7528E+04	-.7528E+04	.3764E+04			
			BEAM NO. 2				
oads	2	.1894E+04	-.1498E+04	.0000E+00	.0000E+00	.0000E+00	-.1447E+05
GLoads	3	-.1894E+04	.1498E+04	.0000E+00	.0000E+00	.0000E+00	-.6504E+04
LLoads	2	.1894E+04	.1498E+04	.0000E+00	.0000E+00	.0000E+00	.1447E+05
LLoads	3	-.1894E+04	-.1498E+04	.0000E+00	.0000E+00	.0000E+00	.6504E+04
Stress	2	-.7924E+03	.6269E+03	.0000E+00	.0000E+00	.0000E+00	-.5903E+04
Stress	2	.5111E+04	-.6696E+04	.3348E+04			
Stress	3	-.7924E+03	.6269E+03	.0000E+00	.0000E+00	.0000E+00	.2653E+04
Stress	3	.1861E+04	-.3446E+04	.1723E+04			
			BEAM NO. 3				
GLoads	2	-.1894E+04	.2410E+04	.0000E+00	.0000E+00	.0000E+00	-.3983E+04
GLoads	4	.1894E+04	-.2410E+04	.0000E+00	.0000E+00	.0000E+00	.1120E+05
LLoads	2	-.3043E+04	-.3646E+03	.0000E+00	.0000E+00	.0000E+00	.3983E+04
LLoads	4	.3043E+04	.3646E+03	.0000E+00	.0000E+00	.0000E+00	-.1120E+05
Stress	2	.1273E+04	-.1526E+03	.0000E+00	.0000E+00	.0000E+00	-.1625E+04
Stress	2	.2898E+04	-.3514E+03	.1449E+04			
Stress	4	.1273E+04	-.1526E+03	.0000E+00	.0000E+00	.0000E+00	-.4569E+04
Stress	4	.5843E+04	-.3296E+04	.2921E+04			
			BEAM NO. 4				
GLoads	3	.1894E+04	-.3024E+04	.0000E+00	.0000E+00	.0000E+00	.6504E+04
GLoads	4	-.1894E+04	.3024E+04	.0000E+00	.0000E+00	.0000E+00	.2001E+05
LLoads	3	.3024E+04	.1894E+04	.0000E+00	.0000E+00	.0000E+00	.6504E+04
LLoads	4	-.3024E+04	-.1894E+04	.0000E+00	.0000E+00	.0000E+00	.2001E+05
Stress	3	-.1265E+04	.7924E+03	.0000E+00	.0000E+00	.0000E+00	-.2653E+04
Stress	3	.1388E+04	-.3919E+04	.1959E+04			
Stress	4	-.1265E+04	.7924E+03	.0000E+00	.0000E+00	.0000E+00	.8163E+04
ess	4	.6897E+04	-.9428E+04	.4714E+04			

WESTINGHOUSE HANFORD COMPANY S/N:801657 05/26/94
PAGE 5 Run ID=BI94363 15:10:48

=============== I M A G E S 3 D =============

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SOLVE BEAM LOADS/STRESSES Version 2.0 07/01/90

KBASIN DAM SUPPORT FRAME

Load Case 1:1526 LB INSTALLATION LOADING

GLoads LLoads Stress Stress	Node Node Node Node	Fx Axial Axial Maximum	Fy Y-Shear Y-Shear Minimum	Fz Z-Shear Z-Shear Cmb. Shear	Mx Torsion Torsion	My Y-Bending Y-Bending	Mz Z-Bending Z-Bending
			BEAM NO. 5				
GLoads	4	.1150E-09	-.6147E+03	.0000E+00	.0000E+00	.0000E+00	-.3121E+05
GLoads	5	-.1150E-09	.6147E+03	.0000E+00	.0000E+00	.0000E+00	.3121E+05
LLoads	4	.6147E+03	.1150E-09	.0000E+00	.0000E+00	.0000E+00	-.3121E+05
LLoads	5	-.6147E+03	-.1150E-09	.0000E+00	.0000E+00	.0000E+00	.3121E+05
Stress	4	-.2572E+03	.4811E-10	.0000E+00	.0000E+00	.0000E+00	.1273E+05
Stress	4	.1247E+05	-.1299E+05	.6495E+04			
Stress	5	-.2572E+03	.4811E-10	.0000E+00	.0000E+00	.0000E+00	.1273E+05
Stress	5	.1247E+05	-.1299E+05	.6495E+04			
			BEAM NO. 6				
GLoads	5	-.2621E+04	.2374E+04	.0000E+00	.0000E+00	.0000E+00	-.2020E+05
GLoads	6	.2621E+04	-.2374E+04	.0000E+00	.0000E+00	.0000E+00	-.6004E+04
oads	5	-.2374E+04	-.2621E+04	.0000E+00	.0000E+00	.0000E+00	-.2020E+05
LLoads	6	.2374E+04	.2621E+04	.0000E+00	.0000E+00	.0000E+00	-.6004E+04
Stress	5	.9933E+03	-.1097E+04	.0000E+00	.0000E+00	.0000E+00	.8242E+04
Stress	5	.9235E+04	-.7248E+04	.4618E+04			
Stress	6	.9933E+03	-.1097E+04	.0000E+00	.0000E+00	.0000E+00	-.2449E+04
Stress	6	.3443E+04	-.1456E+04	.1721E+04			
			BEAM NO. 7				
GLoads	5	.2621E+04	-.2989E+04	.0000E+00	.0000E+00	.0000E+00	-.1101E+05
GLoads	7	-.2621E+04	.2989E+04	.0000E+00	.0000E+00	.0000E+00	.7329E+04
LLoads	5	.3967E+04	-.2601E+03	.0000E+00	.0000E+00	.0000E+00	-.1101E+05
LLoads	7	-.3967E+04	.2601E+03	.0000E+00	.0000E+00	.0000E+00	.7329E+04
Stress	5	-.1660E+04	-.1088E+03	.0000E+00	.0000E+00	.0000E+00	.4490E+04
Stress	5	.2831E+04	-.6150E+04	.3075E+04			
Stress	7	-.1660E+04	-.1088E+03	.0000E+00	.0000E+00	.0000E+00	.2990E+04
Stress	7	.1330E+04	-.4649E+04	.2325E+04			
			BEAM NO. 8				
GLoads	6	-.2621E+04	.2374E+04	.0000E+00	.0000E+00	.0000E+00	.6004E+04
GLoads	7	.2621E+04	-.2374E+04	.0000E+00	.0000E+00	.0000E+00	.1774E+05
LLoads	6	-.2621E+04	.2374E+04	.0000E+00	.0000E+00	.0000E+00	.6004E+04
LLoads	7	.2621E+04	-.2374E+04	.0000E+00	.0000E+00	.0000E+00	.1774E+05
Stress	6	.1097E+04	.9933E+03	.0000E+00	.0000E+00	.0000E+00	-.2449E+04
Stress	6	.3546E+04	-.1353E+04	.1773E+04			
Stress	7	.1097E+04	.9933E+03	.0000E+00	.0000E+00	.0000E+00	.7235E+04
Stress	7	.8331E+04	-.6138E+04	.4166E+04			
			BEAM NO. 9				
ads	7	.1357E-09	-.6147E+03	.0000E+00	.0000E+00	.0000E+00	-.2506E+05

WESTINGHOUSE HANFORD COMPANY S/N:801657 05/26/94
PAGE 6 Run ID=BI94363 15:10:58

=============== I M A G E S 3 D ===============

===

SOLVE BEAM LOADS/STRESSES Version 2.0 07/01/90

KBASIN DAM SUPPORT FRAME

Load Case 1:1526 LB INSTALLATION LOADING

GLoads / LLoads / Stress / Stress	Node	Fx / Axial / Axial / Maximum	Fy / Y-Shear / Y-Shear / Minimum	Fz / Z-Shear / Z-Shear / Cmb. Shear	Mx / Torsion / Torsion	My / Y-Bending / Y-Bending	Mz / Z-Bending / Z-Bending
GLoads	8	-.1357E-09	.6147E+03	.0000E+00	.0000E+00	.0000E+00	.1231E+05
LLoads	7	.1357E-09	-.6147E+03	.0000E+00	.0000E+00	.0000E+00	-.2506E+05
LLoads	8	-.1357E-09	.6147E+03	.0000E+00	.0000E+00	.0000E+00	.1231E+05
Stress	7	-.5679E-10	-.2572E+03	.0000E+00	.0000E+00	.0000E+00	.1022E+05
Stress	7	.1022E+05	-.1022E+05	.5112E+04			
Stress	8	-.5679E-10	-.2572E+03	.0000E+00	.0000E+00	.0000E+00	.5021E+04
Stress	8	.5021E+04	-.5021E+04	.2511E+04			
			BEAM NO. 10				
GLoads	8	.1357E-09	-.2141E+04	.0000E+00	.0000E+00	.0000E+00	-.1231E+05
GLoads	9	-.1357E-09	.2141E+04	.0000E+00	.0000E+00	.0000E+00	-.1115E-09
LLoads	8	.1357E-09	-.2141E+04	.0000E+00	.0000E+00	.0000E+00	-.1231E+05
LLoads	9	-.1357E-09	.2141E+04	.0000E+00	.0000E+00	.0000E+00	-.1115E-09
Stress	8	-.5679E-10	-.8957E+03	.0000E+00	.0000E+00	.0000E+00	.5021E+04
Stress	8	.5021E+04	-.5021E+04	.2511E+04			
Stress	9	-.5679E-10	-.8957E+03	.0000E+00	.0000E+00	.0000E+00	-.4547E-10
Stress	9	-.1132E-10	-.1023E-09	.5113E-10			

WESTINGHOUSE HANFORD COMPANY S/N:801657 05/26/94
PAGE 7 Run ID=BI94363 15:11:04

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SOLVE BEAM LOADS/STRESSES Version 2.0 07/01/90

KBASIN DAM SUPPORT FRAME

Load Case 1:1526 LB INSTALLATION LOADING

MAXIMUM STRESS SUMMARY FOR BEAMS/TRUSSES
WITHIN SPECIFIED RANGE 1- 10

Maximum (absolute) Stress = .1299E+05 at BEAM 5

Beam	Axial	Y-Shear	Z-Shear	Torsion	Y-Bending	Z-Bending
5	-.2572E+03	.4811E-10	.0000E+00	.0000E+00	.0000E+00	.1273E+05
	Maximum	Minimum	Cmb. Shear			
	.1247E+05	-.1299E+05	.6495E+04			

WESTINGHOUSE HANFORD COMPANY S/N:801657 05/26/94
PAGE 8 Run ID=BI94363 15:11:07

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SOLVE REACTIONS Version 2.0 07/01/90

KBASIN DAM SUPPORT FRAME

Load Case 1:1526 LB INSTALLATION LOADING

REACTIONS

Node	Fx	Fy	Fz	Mx	My	Mz
1	.0000E+00	.9113E+03	.0000E+00	.0000E+00	.0000E+00	.0000E+00
2	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00
3	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00
4	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00
5	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00
6	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00
7	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00
8	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00
9	-.1357E-09	.2141E+04	.0000E+00	.0000E+00	.0000E+00	.0000E+00

ATTACHMENT 3

```
==============================================================================
=--======================== I M A G E S - 3 D ================================
 =============================================================================

06-09-1994                     Run ID=JE97421                         12:57:30

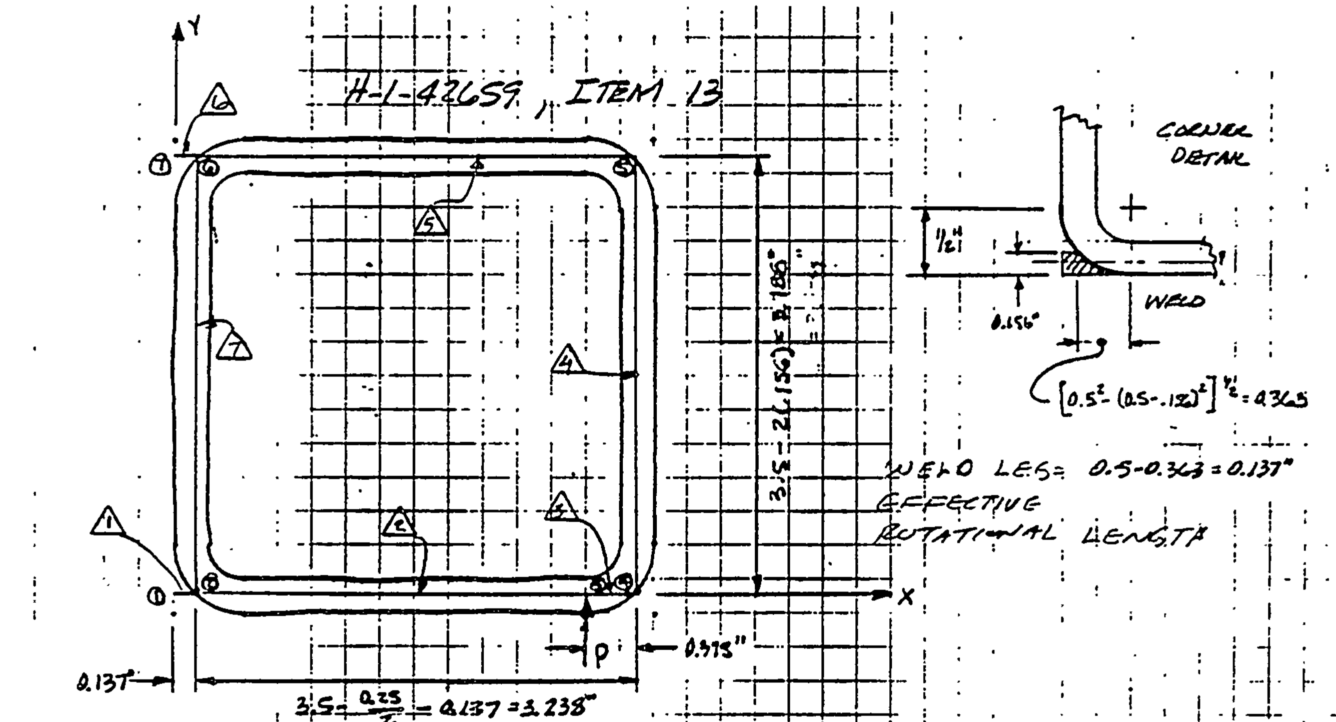

-------------------------------------------------------------------------------
!                                                                             !
!         JJ EEEEEEEEEE   999999   77777777   44     44     222222       11   !
!         JJ EEEEEEEEEE   999999   77777777   44     44     222222       11   !
!         JJ EE         99      99       77 44     44   22      22    1111   !
!         JJ EE         99      99       77 44     44   22      22    1111   !
!         JJ EE         99      99       77 44     44           22      11   !
!         JJ EE         99      99       77 44     44           22      11   !
!         JJ EEEEEEEE     99999999      77    4444444444       22       11   !
!         JJ EEEEEEEE     99999999      77    4444444444       22       11   !
! JJ      JJ EE                 99    77            44      22          11   !
! JJ      JJ EE                 99    77            44      22          11   !
! JJ      JJ EE                 99  77              44    22            11   !
! JJ      JJ EE                 99  77              44    22            11   !
!   JJJJJJ   EEEEEEEEEE   999999   77               44    2222222222  111111  !
!   JJJJJJ   EEEEEEEEEE   999999   77               44    2222222222  111111  !
!                                                                             !
-------------------------------------------------------------------------------
```

WESTINGHOUSE HANFORD COMPANY S/N:801657

Job Information

Project :	K-BASIN
Client :	COFFER DAM
Job Name :	H-1-42659, REV.1
Remarks :	
Engineer :	L. Hyde / 6/9/94
Chk'd by :	[illegible] / 6/9/94
Appr'd by :	/
Comments :	

================================ I M A G E S - 3 D ================================



NODE	X (IN)	Y (IN)
1	0	0
2	0.137"	0
3	3.000	0
4	3.375	0
5	3.375	3.188
6	0.137"	3.188
7	0	3.188

$A_1 = 24 \times 1/4 = 6\ IN^2$

P_Y @3 = 2100 LB.

$I_1 = \frac{24(1/4)^3}{12} = 0.0313\ IN^4$

$A_2 = 24 \times 0.156 = 3.744\ IN^2$

$I_2 = \frac{24(0.156)^3}{12} = 0.0076\ IN^4$

```
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Interactive Microcomputer Analysis & Graphics of Engineering Systems

           IMAGES-3D  Version 2.0  07/01/90

                  RUN ID=JE97421

===============================================
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=                                             =
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===============================================
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= of IMAGES-3D or the users manual should     =
= be addressed to:                            =
=                                             =
=           Celestial Software Inc.           =
=            125 University Ave.              =
=               Berkeley,CA                   =
=                 94710                       =
=                                             =
=              415-843-0977                   =
===============================================
```

WESTINGHOUSE HANFORD COMPANY S/N:801657 06/09/94
PAGE 1 RUN ID=JE97421 12:57:41

I M A G E S 3 D

CHECK GEOMETRY Version 2.0 07/01/90

K-BASIN COFFER DAM DW SUPPORT

MATERIAL PROPERTIES

Material No	Modulus of Elasticity	Weight Density	Coeff of Thermal Exp.	Poisson's Ratio	Shear Web Modulus
1	3.00000E+07	2.83000E-01	6.33000E-06	3.00E-01	0.00000E+00

NODE COORDINATES

Node	X-Coord.	Y-Coord.	Z-Coord.
1	0.00000E+00	0.00000E+00	0.00000E+00
2	1.37000E-01	0.00000E+00	0.00000E+00
3	3.00000E+00	0.00000E+00	0.00000E+00
4	3.37500E+00	0.00000E+00	0.00000E+00
5	3.37500E+00	3.18800E+00	0.00000E+00
6	1.37000E-01	3.18800E+00	0.00000E+00
7	0.00000E+00	3.18800E+00	0.00000E+00

BEAM PROPERTIES

Multiplier = 1 (For AISC database properties only)

Prop No	X-Section Area	Moment of Inertia Iy	/ Iz	Torsional Const.- J
1	6.000E+00	1.000E+00	3.130E-02	1.000E+00
2	3.744E+00	1.000E+00	7.600E-03	1.000E+00

Prop No	Max. Fiber Dist Cy	/ Cz	Shear Shape Fact SSFy	/ SSFz	Ctors	Shear Stress Factor SSTRFy	/ SSTRFz
1	1.25E-01	1.25E-01	0.00E+00	0.00E+00	1.00E+00	1.00E+00	1.00E+00
2	7.80E-02	7.80E-02	0.00E+00	0.00E+00	1.00E+00	1.00E+00	1.00E+00

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PAGE 2 RUN ID=JE97421 12:57:55

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CHECK GEOMETRY Version 2.0 07/01/90

K-BASIN COFFER DAM DW SUPPORT

BEAM CONNECTIVITY

Beam No	Nodes From/	To /	Ref	Prop No	Mat No	pincodes I / J	Rigid End Offset I	/ J	Length	Beam Type
1	1	2	7	2	1		0.00E+00	0.00E+00	0.14E+00	Beam
2	2	3	7	1	1		0.00E+00	0.00E+00	0.29E+01	Beam
3	3	4	7	1	1		0.00E+00	0.00E+00	0.38E+00	Beam
4	4	5	7	1	1		0.00E+00	0.00E+00	0.32E+01	Beam
5	5	6	1	1	1		0.00E+00	0.00E+00	0.32E+01	Beam
6	6	7	1	2	1		0.00E+00	0.00E+00	0.14E+00	Beam
7	2	6	7	1	1		0.00E+00	0.00E+00	0.32E+01	Beam

RESTRAINTS

Node No	Global/Local	Restraint Directions
1	GLOBAL	X Y Z RX RY RZ
2	GLOBAL	- - Z - - -
3	GLOBAL	- - Z - - -
4	GLOBAL	- - Z - - -
5	GLOBAL	- - Z - - -
6	GLOBAL	- - Z - - -
7	GLOBAL	X Y Z RX RY RZ

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SOLVE DISPLACEMENTS Version 2.0 07/01/90

K-BASIN COFFER DAM DW SUPPORT

L O A D C A S E 1

2100 LB DEADWEIGHT

DISPLACEMENTS

Node	Translations X	Translations Y	Translations Z	Rotations X	Rotations Y	Rotations Z
1	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00
2	.1684E-05	.3975E-04	.0000E+00	.0000E+00	.0000E+00	.5683E-03
3	.1436E-04	.4827E-02	.0000E+00	.0000E+00	.0000E+00	.1074E-02
4	.1602E-04	.5125E-02	.0000E+00	.0000E+00	.0000E+00	.5411E-03
5	-.1602E-04	.5109E-02	.0000E+00	.0000E+00	.0000E+00	.9169E-03
6	-.1684E-05	.3446E-04	.0000E+00	.0000E+00	.0000E+00	.4863E-03
7	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00

WESTINGHOUSE HANFORD COMPANY S/N:801657 06/09/94
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=============== I M A G E S 3 D ===============

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SOLVE BEAM LOADS/STRESSES Version 2.0 07/01/90

K-BASIN COFFER DAM DW SUPPORT

Load Case 1:2100 LB DEADWEIGHT

BEAM LOADS AND/OR STRESSES

GLoads LLoads Stress Stress	Node Node Node Node	Fx Axial Axial Maximum	Fy Y-Shear Y-Shear Minimum	Fz Z-Shear Z-Shear Cmb. Shear	Mx Torsion Torsion	My Y-Bending Y-Bending	Mz Z-Bending Z-Bending
			BEAM NO. 1				
GLoads	1	-.1381E+04	-.8713E+03	.0000E+00	.0000E+00	.0000E+00	-.1006E+04
GLoads	2	.1381E+04	.8713E+03	.0000E+00	.0000E+00	.0000E+00	.8862E+03
Stress	1	.3687E+03	-.2327E+03	.0000E+00	.0000E+00	.0000E+00	.1032E+05
Stress	1	.1069E+05	-.9951E+04	.5344E+04			
Stress	2	.3687E+03	-.2327E+03	.0000E+00	.0000E+00	.0000E+00	.9095E+04
Stress	2	.9463E+04	-.8726E+04	.4732E+04			
			BEAM NO. 2				
GLoads	2	-.7971E+03	-.1170E+04	.0000E+00	.0000E+00	.0000E+00	-.1840E+04
GLoads	3	.7971E+03	.1170E+04	.0000E+00	.0000E+00	.0000E+00	-.1509E+04
Stress	2	.1328E+03	-.1950E+03	.0000E+00	.0000E+00	.0000E+00	.7350E+04
Stress	2	.7482E+04	-.7217E+04	.3741E+04			
Stress	3	.1328E+03	-.1950E+03	.0000E+00	.0000E+00	.0000E+00	-.6025E+04
Stress	3	.6158E+04	-.5892E+04	.3079E+04			
			BEAM NO. 3				
GLoads	3	-.7971E+03	.9302E+03	.0000E+00	.0000E+00	.0000E+00	.1509E+04
GLoads	4	.7971E+03	-.9302E+03	.0000E+00	.0000E+00	.0000E+00	-.1160E+04
Stress	3	.1328E+03	.1550E+03	.0000E+00	.0000E+00	.0000E+00	-.6025E+04
Stress	3	.6158E+04	-.5892E+04	.3079E+04			
Stress	4	.1328E+03	.1550E+03	.0000E+00	.0000E+00	.0000E+00	-.4632E+04
Stress	4	.4765E+04	-.4499E+04	.2382E+04			
			BEAM NO. 4				
GLoads	4	-.7971E+03	.9302E+03	.0000E+00	.0000E+00	.0000E+00	.1160E+04
GLoads	5	.7971E+03	-.9302E+03	.0000E+00	.0000E+00	.0000E+00	.1381E+04
Stress	4	-.1550E+03	.1328E+03	.0000E+00	.0000E+00	.0000E+00	-.4632E+04
Stress	4	.4477E+04	-.4787E+04	.2393E+04			
Stress	5	-.1550E+03	.1328E+03	.0000E+00	.0000E+00	.0000E+00	.5516E+04
Stress	5	.5361E+04	-.5671E+04	.2836E+04			
			BEAM NO. 5				
GLoads	5	-.7971E+03	.9302E+03	.0000E+00	.0000E+00	.0000E+00	-.1381E+04
GLoads	6	.7971E+03	-.9302E+03	.0000E+00	.0000E+00	.0000E+00	-.1631E+04
Stress	5	-.1328E+03	-.1550E+03	.0000E+00	.0000E+00	.0000E+00	.5516E+04
Stress	5	.5383E+04	-.5649E+04	.2824E+04			
Stress	6	-.1328E+03	-.1550E+03	.0000E+00	.0000E+00	.0000E+00	-.6513E+04
Stress	6	.6380E+04	-.6646E+04	.3323E+04			
			BEAM NO. 6				
GLoads	6	-.1381E+04	.1229E+04	.0000E+00	.0000E+00	.0000E+00	.7251E+03

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SOLVE BEAM LOADS/STRESSES Version 2.0 07/01/90

K-BASIN COFFER DAM DW SUPPORT

Load Case 1:2100 LB DEADWEIGHT

GLoads / LLoads / Stress / Stress	Node	Fx Axial / Axial / Maximum	Fy Y-Shear / Y-Shear / Minimum	Fz Z-Shear / Z-Shear / Cmb. Shear	Mx Torsion / Torsion	My Y-Bending / Y-Bending	Mz Z-Bending / Z-Bending
GLoads	7	.1381E+04	-.1229E+04	.0000E+00	.0000E+00	.0000E+00	-.8934E+03
Stress	6	-.3687E+03	-.3282E+03	.0000E+00	.0000E+00	.0000E+00	-.7442E+04
Stress	6	.7073E+04	-.7811E+04	.3905E+04			
Stress	7	-.3687E+03	-.3282E+03	.0000E+00	.0000E+00	.0000E+00	-.9169E+04
Stress	7	.8801E+04	-.9538E+04	.4769E+04			
BEAM NO. 7							
GLoads	2	-.5834E+03	.2984E+03	.0000E+00	.0000E+00	.0000E+00	.9542E+03
GLoads	6	.5834E+03	-.2984E+03	.0000E+00	.0000E+00	.0000E+00	.9058E+03
Stress	2	-.4974E+02	.9724E+02	.0000E+00	.0000E+00	.0000E+00	-.3811E+04
Stress	2	.3761E+04	-.3860E+04	.1930E+04			
Stress	6	-.4974E+02	.9724E+02	.0000E+00	.0000E+00	.0000E+00	.3618E+04
Stress	6	.3568E+04	-.3667E+04	.1834E+04			

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SOLVE BEAM LOADS/STRESSES Version 2.0 07/01/90

K-BASIN COFFER DAM DW SUPPORT

Load Case 1:2100 LB DEADWEIGHT

MAXIMUM STRESS SUMMARY FOR BEAMS/TRUSSES
WITHIN SPECIFIED RANGE 1- 7

Maximum (absolute) Stress = .1069E+05 at BEAM 1

Beam	Axial	Y-Shear	Z-Shear	Torsion	Y-Bending	Z-Bending
1	.3687E+03	-.2327E+03	.0000E+00	.0000E+00	.0000E+00	.1032E+05
	Maximum	Minimum	Cmb. Shear			
	.1069E+05	-.9951E+04	.5344E+04			

WESTINGHOUSE HANFORD COMPANY S/N:801657 06/09/94
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SOLVE REACTIONS Version 2.0 07/01/90

K-BASIN COFFER DAM DW SUPPORT

Load Case 1:2100 LB DEADWEIGHT

REACTIONS

Node	Fx	Fy	Fz	Mx	My	Mz
1	-.1381E+04	-.8713E+03	.0000E+00	.0000E+00	.0000E+00	-.1006E+04
2	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00
3	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00
4	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00
5	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00
6	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00
7	.1381E+04	-.1229E+04	.0000E+00	.0000E+00	.0000E+00	-.8934E+03

APPENDIX B

LOAD CALCULATIONS

DON'T SAY IT --- *Write It!* DATE: 5/18/94

TO: L. A. Rodgers H5-53 FROM: B. V. Winkel H5-57

Telephone: 376-5736

cc: M. R. Lindquist H5-57

SUBJECT: KBASIN CLOSURE GATE DESIGN LOADING

The design loading for the K Basin closure gates was generated as requested. The design load definitions and basis follow below. As indicated, both normal and seismic loadings are addressed. Normal loading is expected to control design, since AISC allows a 1/3 increase in allowables for seismic loading. Correspondingly, if ANSI/AISC N690 is used, a stress limit coefficient of 1.6 is allowed for an "extreme" load combination involving Ess.

Normal Loading

Other than dead weight and seal clamp loading, the only significant normal condition loading is hydrostatic pressure. Although the normal water level is near 16 ft., for design purposes, a water depth equal to the full height of the closure doors (18 ft.) was assumed. This results in a maximum pressure, at the base, of 62.4 x 18 = 1123 psf or 7.8 psi.

Seismic Loading

For a seismic event, two categories of loadings were considered, inertial and hydrodynamic pressures. Based upon an ANSYS model of the divider wall, including the impulsive hydrodynamic water mass, the fundamental frequency of the divider wall is 23.5 hz. From Figure 3 of SDC-4.1, Rev. 12, at 23 hz, 7% damping, a spectral value is 0.24 g's was obtained, which is the seismic inertial design load.

Using the ASCE Manual No. 58, Structural Analysis and Design of Nuclear Plant Facilities, Table 5.5, an impulsive mass of 11,640 lbs/ft was calculated for a water depth of 18 ft. The effective height of the mass is 0.4 x 18 = 7.2 ft. As recommended in ASCE 4-86, the weight of the impulsive mass should be spread over twice the effective height, when "local stresses are of interest". This results in a pressure of (11,640 x 0.24)/14.4 = 194 psf or 1.35 psi. An alternative impulsive pressure can be obtained from the base pressure equation on p. 265 of Guidelines for the Seismic Design of Oil and Gas Pipeline Systems:

$$p_i = 0.742\rho_l Ha = 0.742\text{x}62.4\text{x}18\text{x}0.24 = 200.0 \text{ psf} = 1.39 \text{ psi.}$$

The convective pressure component can be estimated by spreading the convective mass over "twice the distance from the top of the fluid to the center of the sloshing fluid mass" (ASCE 4-86):

$$p_c = 26{,}260\text{x}0.03/17 = 46.3 \text{ psf} = 0.32 \text{ psi.}$$

54-3000-101 (12/92) GEF014

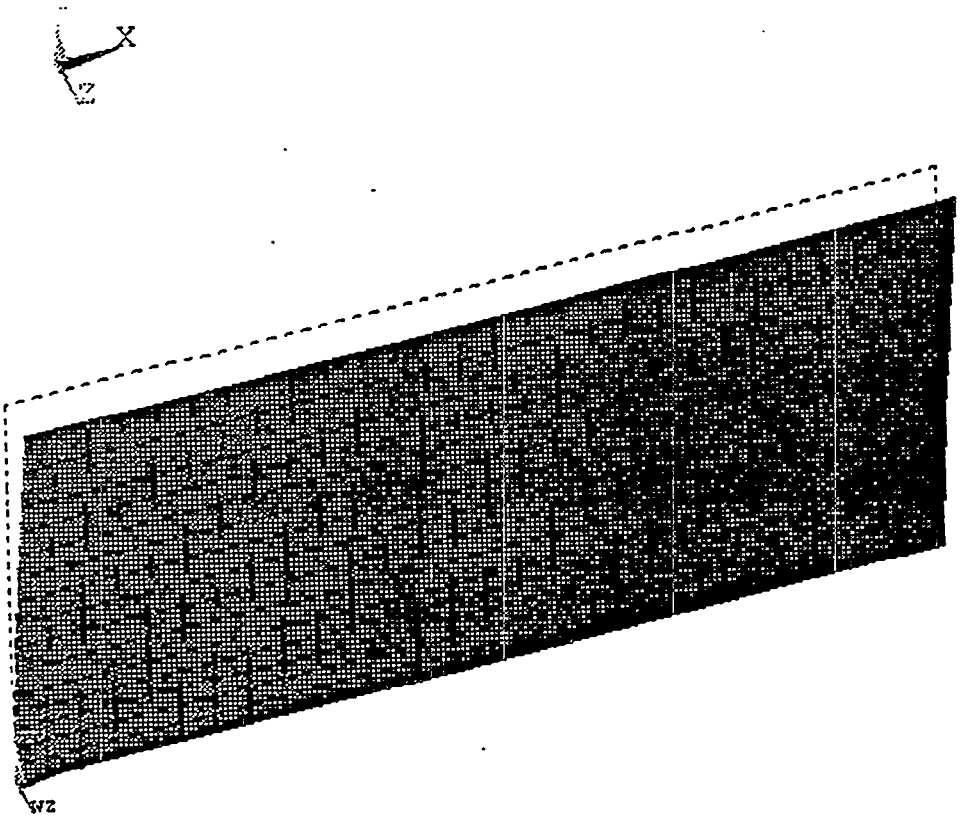
Thus, the combined impulsive and convective pressures are about 1.7 psi. The 0.24g inertial loading for a half-inch plate is equivalent to about 0.23 psi. One-third of the normal pressure is 7.8/3 = 2.6 psi, which is greater than 1.7 + 0.23 = 1.93 psi. Therefore, the normal operating condition loading controls.

Other Potential Off-Normal Loading Conditions

Table Q1.5.7.1 lists several different types of off-normal loadings and load combinations to be considered for nuclear facilities. The only potential loading brought to mind, by a review of this table, was the possibility of an impact load due to handling of fuel canisters, etc. Since canister/equipment handling is performed under water and is carefully controlled, these loads should be relatively small. Since the allowables for such an off-normal event is higher than for the normal operating condition, the normal condition would again be expected to control.

Wall Deformations

Questions have arisen relative to potential detrimental effects associated with deformations in the concrete walls at the closure gate seal locations. At the outside seals, away from the divider walls, the deformations would be negligible, since the wall segments are very short and attach to the chute side walls, which act as shear walls. The divider wall deformation predictions from an ANSYS analysis are attached. The attached deformation predictions are due to static water pressure plus seismic inertia. Seismic-induced sloshing loads are not included, but, since the sloshing frequency is very low, deformations due to sloshing are low. Note that the maximum deformation in the divider wall occurs at the top, and is equal to 0.013 inches (< 1/64 inch). The majority of this deformation is due to seismic inertial loading. I would be very surprised if this small deformation could significantly affect the closure walls. Depending on the seal flexibility, there may be a small possibility that some seal leakage could occur during an aftershock.



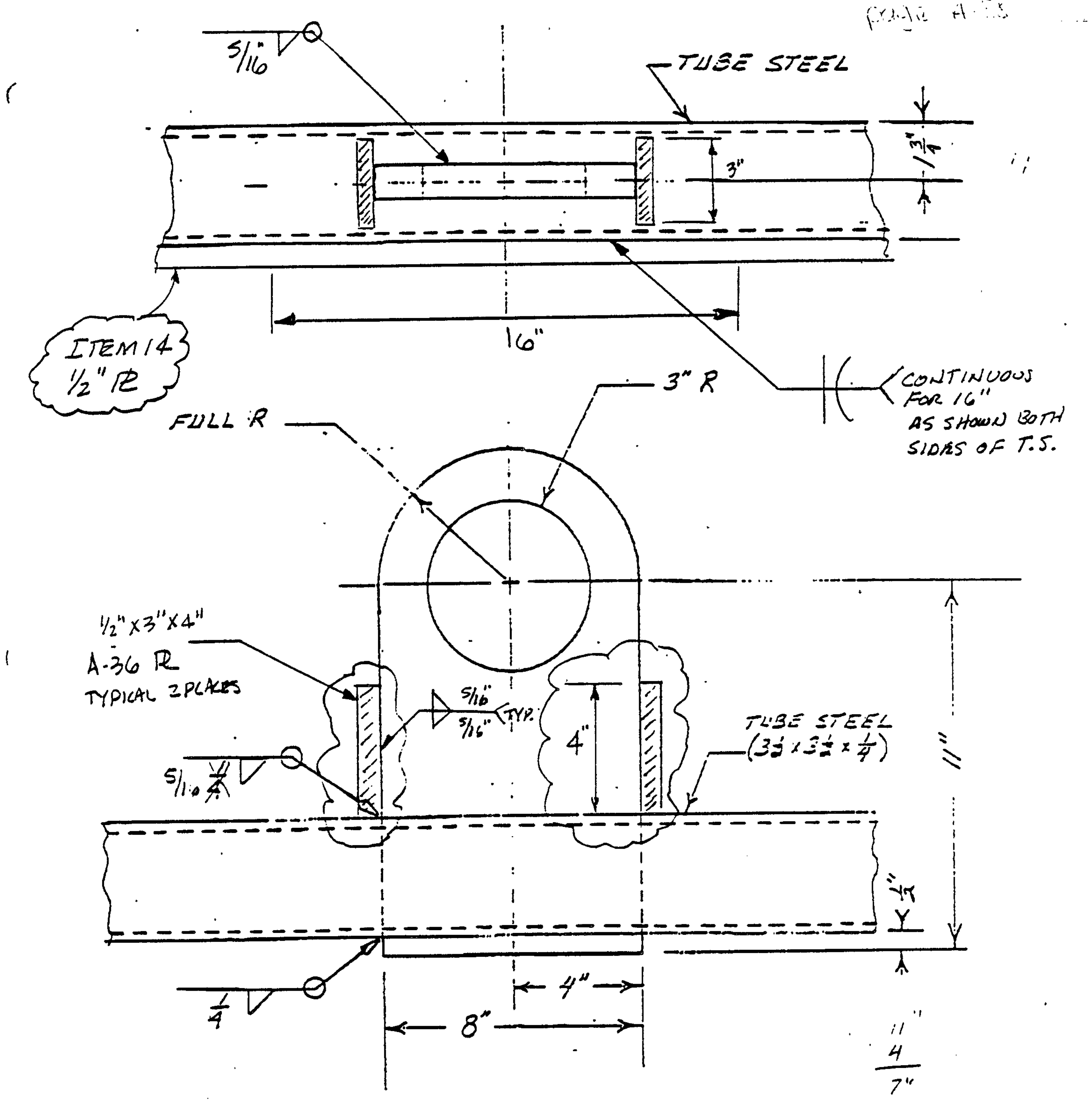
ANSYS 5.0 A
MAY 26 1994
13:05:18
DISPLACEMENT
STEP=1
SUB =1
TIME=1
RSYS=0
DMX =0.013245
SEPC=2.699

DSCA=2035
XV =-0.262003
YV =0.642788
ZV =0.719846
DIST=274.845
XF =252
YF =124.5
ZF =13.48
CENTROID HIDDEN

DIVIDER WALL, LOADS: STAT. PRES., SEISMIC (NOT SLOSHING)

APPENDIX C

DESIGN MODIFICATIONS

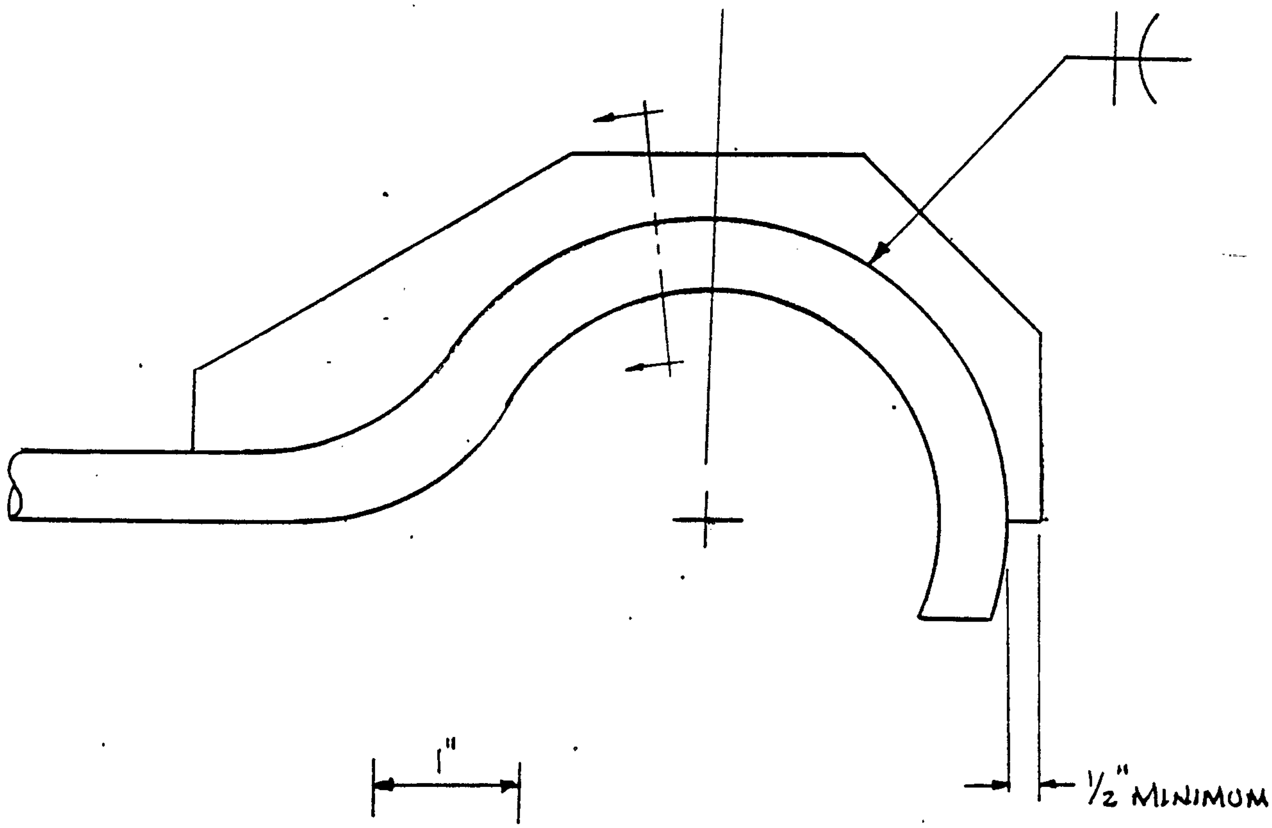


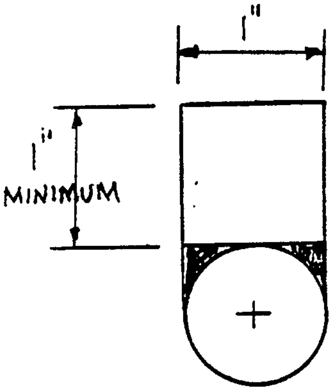
LIFTING EYE (REVISED DESIGN)
1" STOCK

NOTE: THIS INSTALLATION APPLIES TO THE LIFTING EYE AND TO THE UPPER LIFTING PAD EYE. THE LOWER LIFTING PAD EYE INSTALLATION IS O.K. EXCEPT USE THIS 1" x 8" EYE.

TIE ROD (ITEMS 44 THRU 62) REINFORCEMENT

DWG. H-1-42659





TYPICAL SECTION

REINFORCEMENT MAT'L SAME AS ROD

APPENDIX A2

STRUCTURAL CALCULATIONS FOR K BASIN ISOLATION BARRIERS

Westinghouse Hanford Company **Internal Memo**

From: Facility Stress Analysis LLH-8D420-94-001
Phone: 376-5047 H5-57
Date: November 11, 1994
Subject: STRUCTURAL CALCULATION FOR K BASIN ISOLATION BARRIERS

To: J. C. Wiborg B3-55

cc: W. F. Brehm	H5-67*	M. J. Langevin	X3-76
T. J. Conrads	H5-55*	D. C. Marburger	H4-63
R. A. Cox	R3-56*	J. P. Schmidt	X3-73*
G. M. Davis	X1-80*	D. A. Smith	G3-20*
J. I. Dearing	N1-32	G. C. Sorensen	K8-28
J. C. Hamrick	X0-22*	W. W. Wassberg	R3-82*
R. J. Kuhta	X3-76*	LLH File/LB	
M. R. Lindquist	H5-57 MRL	* w/o att.	

References:

1. Internal Memo, M. R. Lindquist to J. C. Wiborg, *Structural Calculation for K Basin Isolation Doors*, dated June 23, 1994.

2. WHC, 1994, *Basin Discharge Chute Isolation Barriers*, Drawing H-1-80104, Rev. X, Westinghouse Hanford Company, Richland, Washington.

3. DSI, Ed Ruff to Distribution, "DSI, Tie Rod Data - to 100 FT-LB, K-Basin Isolation Barrier Door," dated September 1, 1994.

Transmitted herewith are supplemental calculations to the Reference 1 letter report. These calculations address the increased tie-rod loads necessary to accommodate revised J-Seal compression requirements. Only those components shown on the Reference 2 drawing which are affected by this loading change are included. The analysis for other components remains unchanged and is shown in Reference 1.

J. C. Wiborg
Page 2
November 11, 1994

LLH-8D420-94-001

Currently the installation torque for the tie-rod nuts is less than 100 ft-lbf (±15%). Reference 3 establishes the relationship between tie-rod nut torque and preload experimentally. Based upon the data, the analysis included here was conservatively performed using a tie-rod torque of 115 ft-lbf and an upper-bound preload of 3,000 lbf.

Larry Hyde

L. L. Hyde, Principal Engineer
Facility Stress Analysis

rw

Attachments (3)

J. C. Wiborg
Page 3
November 11, 1994

LLH-8D420-94-001

ATTACHMENT 1

STRUCTURAL MARGIN OF SAFETY
K BASIN ISOLATION BARRIERS

Margins of Safety given below are for those components of the Barriers which are affected by the change in J-Seal compression load addressed in these calculations. Margins of Safety for other components of the Barriers are as previously given in Reference 1.

COMPONENTS (No corrosion allowance)				
Component Drawing H-1-80104	Material	Allowable Stress (kip/in^2)	Actual Stress (kip/in^2)	Margin of Safety Normal Loading
Door Assembly (Item 4) - Tube Steel Frame	Carbon Steel A500, GR. B	30.4	20.3	0.50
Bracket Assembly (Items 5 thru 14)	Carbon Steel A500, GR. B	*	*	0.46
Pad Eye (Item 60)	Carbon Steel A36	14.4	2.9	>2.0
Tie-Rod (Items 69 thru 87)	Stainless Steel 304L or 316L	*	*	0.68
WELDS (No corrosion allowance)				
Door Assembly Tube Steel Connections	-------	21.0	9.8	1.14
Bracket Assembly Welds	-------	21.0	12.6	0.66

MARGIN OF SAFETY = (Allowable Stress/Actual Stress) - 1

* MARGIN OF SAFETY BASED ON THE INTERACTION OF AXIAL LOAD AND BENDING MOMENT OR COMBINED BENDING

DESIGN CALCULATION

(1) Drawing H-1-80104 (2) Doc. No. ______ (3) Page 1 of ______
(4) Building K BASIN (5) Rev. ______ (6) Job No. ______
(7) Subject BASIN ISOLATION BARRIERS
(8) Originator L. Hyde Date 9/1/94
(9) Checker [signature] Date 9/2/94

(10) The revised installation for the K-Basin Isolation Barriers (Doors) provides a stop to which the J-seals are compressed. The tie-rod load required to compress the seal to this stop has been calculated, by others, to be 2520 lbs. This is substantially above the original tie-rod load of 1526 lbs used for the analysis of the components and documented by Memo 8D420-MRL-94-005 "Structural Calculation for K Basin Isolation Doors" M.R. Lindquist to J.C. Wiborg (7/23/94). It is the intent of the calculations provided here to revise these original calculations as necessary to reflect the higher tie-rod loading.

In order to determine the component most critical for the tie-rod load, the stresses from the analysis in Memo 8D420-MRL-94-005 were ratioed to their allowable. The pages referenced herein are from that analysis. The tie-rod hook was marginal for the original 1526 lb load so it was redesigned. Tests were conducted on the tie-rods to determine the torque/preload relationship. The results are given in the attached DSI. Based on these tests and the installation procedure torque, the tie-rod load used for this analysis was 3000 lbs.

Frame Section with Rod Pre-Loads (pg. 11)

$M_{allow} = 52276 \left(\frac{30.4 \text{ in}}{17.31 \text{ in}}\right) = 91{,}808$ in-lb. @CENTER

$M = \frac{187 \text{ lb/in} (43 \text{ in})^2}{8} + P_{rod}(6 \text{ in}) < 91{,}808$ in-lb

$P_{rod\,allow} = 8098$ lb

FOR $P_{ROD} = 3000$#

$M = 61220$ in-lb $f = 20{,}270$ PSI

$M.S. = \frac{30{,}400}{20{,}270} - 1 = +0.50$

Welds (pgs. 12 & 13)

$f_r = 1190$ lb/in

for 1/4" fillet

throat ⇒ $f = \frac{1190}{.707(1/4)} = 6732$ psi

vs. $F_{allow} = .3 \times 70{,}000 = 21{,}000$ psi

base metal ⇒ $f = \frac{1190}{1/4} = 4760$ psi

vs. $F_{allow} = .4 \times 36{,}000 = 14{,}400$ psi

for flare bevel ⇒ $f = \frac{1190}{.156} = 7628$ psi

vs $F_{allow} = .3 \cdot 70{,}000 = 21{,}000$ psi

(1) Drawing H-1-80104 (2) Doc. No. ______ (3) Page 2 of ____
(4) Building K-BASIN (5) Rev. ______ (6) Job No. ______
(7) Subject BASIN ISOLATION BARRIERS
(8) Originator L. Hyde Date 9/1/94
(9) Checker [signature] Date 9/1/94

(10) FRAME SECTION (CONT'D)

Moment contributea most to weld Load

Approx. $M_{Allow} = 18267 \times \frac{21{,}000}{7628} = 50289$ in-lb

$$50289 - \frac{187(3\tfrac{1}{2})(43-3\tfrac{1}{2})}{2} = P_{allow}\,(3\tfrac{1}{2})$$

$P_{allow} = 10675$ lb > than P_{rod} at center

FOR $P_{ROD} = 3000$ LB $M = 23{,}426$ IN-LB $f = 9782$ PSI

$MS. = \frac{21000}{9782} - 1 = 1.14$

Z-BRACKET (PG. 23)

ELEMENT 5

FOR $P_{Rod} = 1526$ LB

$P_c = -615$ LB $M = 31{,}210$ IN-LB

$3\tfrac{1}{2}" \times 3\tfrac{1}{2}" \times \tfrac{1}{4}"$ T.S. $A = 3.09$ IN², $S = 3.02$ IN³

$f_a = -615/3.09 = 199$ PSI, $f_b = 31{,}210/3.02 = 10{,}334$ psi

$Kl/r = 1.0 \times 25/1.31 = 21.4$

$$C_c = \left(\frac{2\pi^2 E}{F_Y}\right)^{1/2} = \left(\frac{2\pi^2 29\times10^6}{46{,}000}\right)^{1/2} = 111.55$$

$$X = \frac{Kl/r}{C_c} = 0.192$$

$$F_a = \frac{1-\frac{1}{2}X^2}{5/3 + 3/8X - \frac{1}{8}X^3} F_Y = \frac{1-\frac{1}{2}0.192^2}{\frac{5}{3}+\frac{3}{8}(0.192)-\frac{1}{8}(0.192)^3}\ (46000)$$

$F_a = 25{,}984$ PSI

$F_b = 0.66 F_Y = 0.66\,(46000) = 30{,}360$ psi

$$\frac{f_a}{F_a} + \frac{f_b}{F_b} < 1.0;\ \left(\frac{199}{25984} + \frac{10334}{30360}\right)\frac{P_{ROD\,ALLOW}}{1526} \le 1.0$$

$P_{ROD\,ALLOW} = 4385$ LBS.

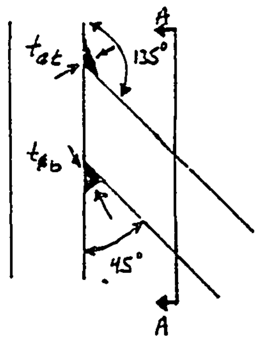
FOR $P_{ROD} = 3000$#

$MS = \frac{4385}{3000} - 1 = +0.46$

DESIGN CALCULATION

(1) Drawing H-1-80104 (2) Doc. No. ______ (3) Page 3 of ____
(4) Building K-BASIN (5) Rev. ______ (6) Job No. ______
(7) Subject BASIN ISOLATION BARRIERS
(8) Originator L. [signature] Date 9/1/94
(9) Checker [signature] Date 9/1/94

(10) Z-BRACKET (PG. 23) (CONT'D.)



REANALYZE WELD AT NODE 5

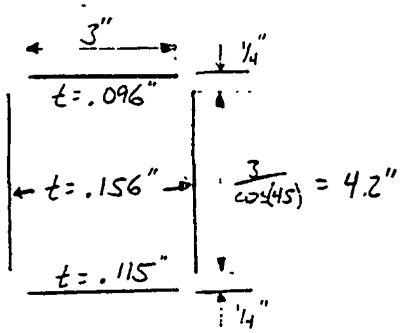
1/4" fillet
effective throat
top - 135°

$$t_{e_t} = \frac{1}{4}\left(\cos\frac{135}{2}\right) = .096 \text{ in}$$

$$t_{e_b} = \frac{1}{8}\left(\cos\frac{45}{2}\right) = .115 \text{ in}$$

ASSUME 1/8" lack of fusion IN CROTCH

View A-A



flair bevel welds

$$t_e = 5/16\left(\tfrac{1}{2}\right) = .156 \text{ in.}$$

A in²	$\bar{y}$ in	$A\bar{y}$ in³	$A\bar{y}^2$ in⁴	I_o in⁴
3 (.096) = .288	—	—	—	—
2× 4.2(.156) = 1.310	2.302	3.017	6.944	1.926
3(.115) = .345	4.595	1.585	7.283	—
Total 1.943		4.602	14.227	1.926

DESIGN CALCULATION

(1) Drawing H-1-80104 (2) Doc. No. ______ (3) Page 4 of ____
(4) Building K-BASIN (5) Rev. ______ (6) Job No. ______
(7) Subject BASIN ISOLATION BARRIERS
(8) Originator L. Hyde Date 9/1/94
(9) Checker [signature] Date 9/1/94

(10) Z-BRACKET WELD, CONT'D.

$$\bar{y} = \frac{4.602}{1.943} = 2.368 \text{ in}$$

$$I = 1.926 + 14.227 - \frac{(4.602)^2}{1.943} = 5.253 \text{ in}^4$$

$$S = \frac{5.253}{2.416} = 2.174 \text{ in}^3$$

$$f_t = \frac{2621}{1.926} + \frac{11010}{2.176} = 6425 \text{ psi}$$

$$F_{all} = .3(70{,}000 \text{ psi}) = 21{,}000 \text{ psi}$$

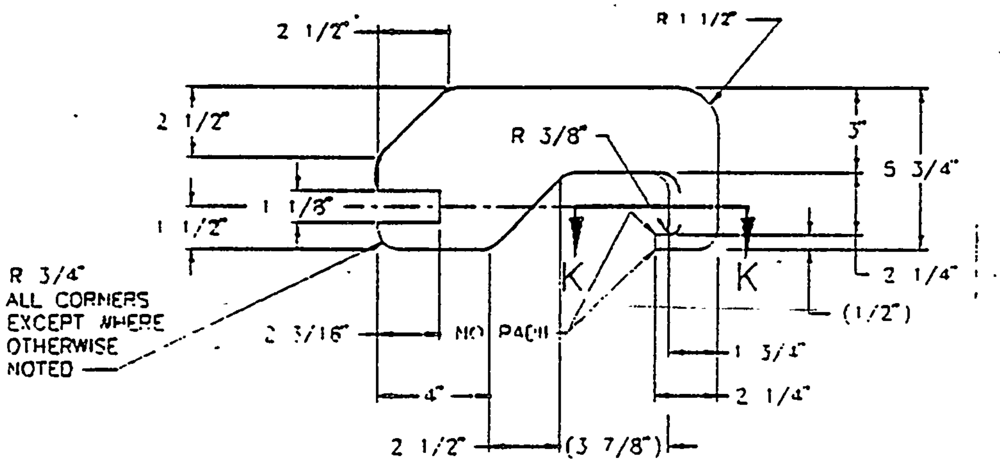
$$P_{ROD\ ALLOW} = 1526 \times \frac{21{,}000}{6425} = 4988 \text{ LBS}$$

FOR $P_{ROD} = 3000^{\#}$, $M.S. = \dfrac{21000}{6425 \times \frac{3000}{1526}} - 1 = +0.66$

THE "MINIMUM" CALCULATED ROD ALLOWABLE LOAD IS 4385 LBS. BASED ON THE Z-BRACKET MEMBER STRESS.

(1) Drawing H-1-30104 (2) Doc. No. (3) Page 5 of
(4) Building K-BASIN (5) Rev. (6) Job No.
(7) Subject BASIN ISOLATION BARRIERS
(8) Originator L. Hyde Date 9/1/94
(9) Checker [signature] Date 9/1/94

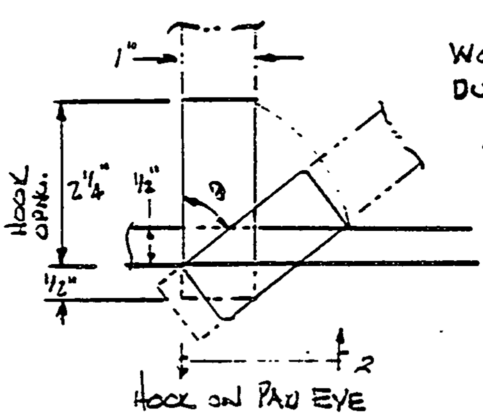
(10) TIE ROD HOOK (ITEM 65) 304L - A276
$F_y = 25{,}000$ psi.



PROPOSED INSTALLATION TORQUE = 100 FT-LB (±15%)
THIS RESULTS IN A TIE-ROD LOAD OF: REF. ATTACHED DSI

AVE. ROD LOAD @ 100'-# = 2659 LB
" " " " 85'-# = 2428 LB
LOAD @ 115'-# = 2659 + (2659-2428) = 2890#

CHECK FOR 115 FT-LBS TORQUE AND 3000 LB.
CONSERVATIVELY ASSUME NO FRICTIONAL LOSS IN TIE-ROD SYSTEM SO ALL TORQUE REACTED BY HOOK.



WORST CASE ROTATION OF HOOK IN PAD EYE DUE TO TORQUING OF TIE-ROD

$$\theta = 90° - \sin^{-1}\frac{0.5}{(2\tfrac{1}{4}^2+1^2)^{1/2}} - \tan^{-1}\frac{1}{2\tfrac{1}{4}} = 54.3°$$

OR FOR 1" THK. PAD EYE $\theta = 42.1°$

FOR 1" PAD EYE $R = \frac{T}{L} = \frac{115 \times 12}{(2\tfrac{1}{4}^2+1^2)^{1/2}} = 340$ LB.

THE BOTTOM "LIP" OF HOOK REACTS THIS LOAD $f_s = \frac{R}{A} = \frac{340}{\frac{1}{2}\times\frac{1}{2}} = 1360$ psi << $0.4F_y$

DESIGN CALCULATION

(1) Drawing H-1-30104 (2) Doc. No. ________ (3) Page 6 of ____

(4) Building K-BASIN (5) Rev. ________ (6) Job No. ________

(7) Subject BASIN ISOLATION BARRIERS

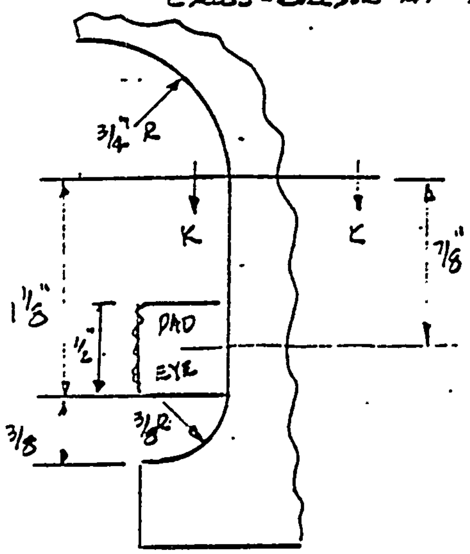
(8) Originator L. Hyde Date 9/1/94

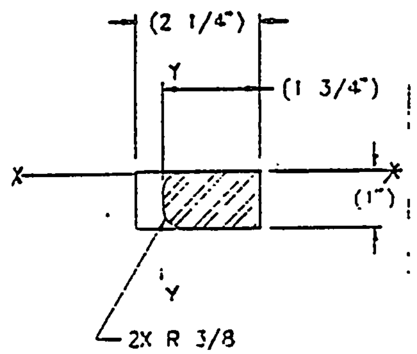
(9) Checker [signature] Date 9/1/94

(10) TIE ROD HOOK (CONT'D.)

COMBINE BENDING DUE TO TORQUE WITH THAT DUE TO ROD AXIAL LOAD -

CROSS-SECTION AT BOTTOM OF 3/4" RADIUS





SECTION K-K

NEGLECT CORNER RADII

$$f_{bx} = \frac{T}{S_x} = \frac{6(115 \times 12)}{1.75(1)^2} = 4731 \text{ PSI}$$

$$F_{bx} = 0.75 F_y = 0.75(25000) = 18750 \text{ PSI}$$

$$f_{by} = \frac{M}{S_y} = \frac{6(3000 \times 7/8)}{1(1.75)^2} = 5143 \text{ PSI}$$

$$F_{by} = 0.6 F_y = 0.6(25{,}000) = 15000 \text{ PSI}$$

$$\frac{f_{bx}}{F_{bx}} + \frac{f_{by}}{F_{by}} = \frac{4731}{18750} + \frac{5143}{15000} = 0.60 < 1.0, \text{ O.K.}$$

$$M.S. = \frac{1}{0.6} - 1 = +0.68$$

THIS IS THE CRITICAL SECTION SINCE THE SECTION MODULUS INCREASES FASTER THAN THE MOMENT THROUGH THE 3/4" RADIUS.

DESIGN CALCULATION

(1) Drawing H-1-80104 (2) Doc. No. ______ (3) Page 7 of ____

(4) Building K BASIN (5) Rev. ______ (6) Job No. ______

(7) Subject BASIN ISOLATION BARRIERS

(8) Originator L. Hyde Date 9/1/94

(9) Checker [signature] Date 9/2/94

(10) TIE ROD HOOK (CONT'D)

COMBINED STRESS IN TOP OF HOOK

$P = 3000$ LB.

$M = 3000(5^3/_4 - 3) = 8250$ IN-LB.

$f_A = \frac{P}{A} = \frac{3000}{3 \times 1} = 1000$ PSI

$f_b = \frac{M}{S} = \frac{6(8250)}{1\,(3)^2} = 5500$ PSI

$F_A = F_B = 0.6 F_Y = 0.6(25{,}000) = 15{,}000$ PSI.

$M.S. = \frac{F}{f_a + f_b} - 1 = \frac{15000}{1000 + 5500} - 1 = 1.31$

SHEAR DUE TO TORQUE IS LOW

WELD TO TIE-ROD

4-FLARE BEVEL WELDS - 2 IN LONG

$t = 5/16\,(R) = 5/16\,(1/2) = 0.156$ IN.

$A_W = 4(2 \times 0.156) = 1.25$ IN^2

$f = \left[\left(\frac{P}{A_W}\right)^2 + \left(\frac{T}{\ell A_W}\right)^2\right]^{1/2}$

$\ell = 1'' \sin 45° = 0.707$ IN.

$f = \left[\left(\frac{3000}{1.25}\right)^2 + \left(\frac{115 \times 12}{0.707(1.25)}\right)^2\right]^{1/2} = 2863$ PSI

$F = 0.4 \times 25000 = 10000$ PSI

$M.S. = \frac{10000}{2863} - 1 = 2.5$

BD-6400-060

DESIGN CALCULATION

(1) Drawing H-1-80104 (2) Doc. No. ______ (3) Page 8 of ____
(4) Building K-BASIN (5) Rev. ______ (6) Job No. ______
(7) Subject BASIN ISOLATION BARRIERS
(8) Originator L. Hyde Date 9/1/94
(9) Checker [signature] Date 9/1/94

(10) PAD EYE (ITEM 60)

FOR HOOK LOADS OF 3000 LB. AXIAL AND 115 FT-LB TORQUE

PAD IS 6"x½" A36

TORSION –

REF. 3RD EDITION ROARK

$$K = ab^3\left[\frac{16}{3} - 3.36\frac{b}{a}\left(1 - \frac{b^4}{12a^4}\right)\right]$$

$a = 6/2$, $b = ½/2$

$$K = 3\left(\frac{1}{4}\right)^3\left[\frac{16}{3} - 3.36\frac{1/4}{3}\left(1 - \frac{(1/4)^4}{12(3)^4}\right)\right] = 0.24$$

ROTATION –

$$\theta = \frac{Tl}{KG} = \frac{(115\times12)(7.5)}{0.24(12\times10^6)} = 0.00359 \text{ RAD}$$

(0.2°) NOT CRITICAL

$$f_s = \frac{T(3a+1.8b)}{8a^2b^2} = \frac{(115\times12)(3\times3+1.8\times1/4)}{8(3)^2(1/4)^2} = 2900 \text{ PSI}$$

$$F_s = 0.4F_y = 0.4(36{,}000) = 14{,}400 \text{ PSI}$$

$$M.S. = \frac{14400}{2900} - 1 = \text{LARGE}$$

WELD – ¼" FILLET ALL AROUND

$$J_W = \frac{(2a+2b)^3}{6} = \frac{(6+1/2)^3}{6} = 45.77 \text{ IN}^3$$

$$A_W = 2(6+1/2) = 13 \text{ IN.}$$

$$q = \frac{P}{A_W} + \frac{T(2a)}{J_W} = \left[\left(\frac{3000}{13}\right)^2 + \left(\frac{(115\times12)(6)}{45.77}\right)^2\right]^{1/2} =$$

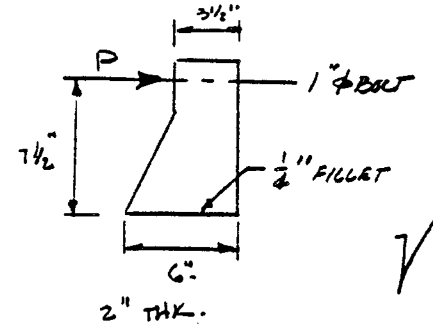
$= 293$ LB/IN

$$f_s = \frac{293}{0.707(1/4)} = 1659 \text{ PSI} \ll 0.3F_W = 0.3(70{,}000) = 21{,}000 \text{ PSI}$$

DESIGN CALCULATION

(1) Drawing H-1-80104 (2) Doc. No. ______ (3) Page 9 of ____
(4) Building K-BASIN (5) Rev. ______ (6) Job No. ______
(7) Subject BASIN ISOLATION BARRIERS
(8) Originator L. Hyde Date 9/1/94
(9) Checker B. Filing Date 9/1/94

(10) SIDE STOP (ITEM 67)



CAPABILITY OF WELD

$A' = 2(6+2) = 16$ IN

$S' = 2\times 6 + \frac{6^2}{3} = 24$ IN²

$$\sqrt{\left(\frac{P}{A'}\right)^2 + \left(\frac{M}{S'}\right)^2} \le 0.3F_W t_t$$

STAINLESS TO C.S. WELD
USE $F_W = F_Y = 25{,}000$ PSI OF 304L

$$\left(\frac{P}{16}\right)^2 + \left(\frac{7.5P}{24}\right)^2 \le \left[(0.3\times 25{,}000)(\tfrac{1}{4}\times .707)\right]^2$$

$P \le 4{,}160$ LB. AXIAL

DOOR LATERAL SEISMIC FORCE = 504 LBS (PG. 41)

BEARING STRENGTH OF CONCRETE = $\phi\left(0.85 f'_c A_1 \left(\frac{A_2}{A_1}\right)^{1/2}\right)$ (PG. 42)

LEVELING PADS ARE 3½" DIA.

ASSUME $A_2/A_1 = 1.0$ (CONSERVATIVE), $f'_c = 3000$ psi, $\phi = 0.7$

ALLOW. BRG. $= 0.7(.85\times 3000)(\frac{\pi}{4}\times 3.5^2) = 17{,}173$ LB.

ADJUSTING BOLT EXTENDS NOMINALLY 3" TO BASIN WALL
MAX. DRAG FORCE ON BOLT IS - V

1"-8UNC $A_{TENSION} = 0.606$ IN² $D_T = \left(\frac{4}{\pi}(.606)\right)^{1/2} = 0.878$ IN.

$$\frac{32(3\times V)}{\pi (D_t)^3} \le 0.75F_Y$$

$$V \le \frac{0.75(25{,}000)\,\pi(.878)^3}{32(3)} = 417 \text{ LB.}$$

MUST INSTALL DOOR WITH ADJUSTING SCREWS BACKED-OUT THEN BRING UP TO WALL SNUG TIGHT ONLY

BD-6400-060

ATTACHMENT 3

DON'T SAY IT --- *Write It!*

DATE: September 1, 1994

TO: Distribution

FROM: Ed Ruff H5-67

Telephone: 376-1943

cc: Bob Kuhta, Mike Langevin, Dave Cooley, Bill Brehm, Dick Cox, Jim Wiborg, Larry Hyde, H5-58 Duane Koehler, Steve Jordan, Bill Monroe

SUBJECT: TIE ROD DATA - TO 100 FT-LB, K-BASIN ISOLATION BARRIER DOOR

Attached find the results of a tie rod torque/tensioning test performed on August 29th, 1994 in the 305 Equipment Testing Lab. Test personnel were: Steve Jordan, and Ed Ruff. The test was performed using a conventional "unplated" Flex-Loc nut, and a carbon steel flat washer. Tie rod and nut threads were lubricated with nickel anti seize compound.

BRIEF SUMMARY OF RESULTS:

Based on test data, it will take 90 (average) to 95 (max.) ft-lbf of torque to obtain 2,500 lbf of clamping force (equivalent to 50% seal compression based on Presray data).

This test was conducted up to 2,600 lbs actual applied load.

No thread galling was observed.

An unexpected finding: the nut/washer interface is the critical lubrication area. Incipient galling of the nut/washer surface was observed when examined at 15x magnification.

BRIEF CONCLUSIONS

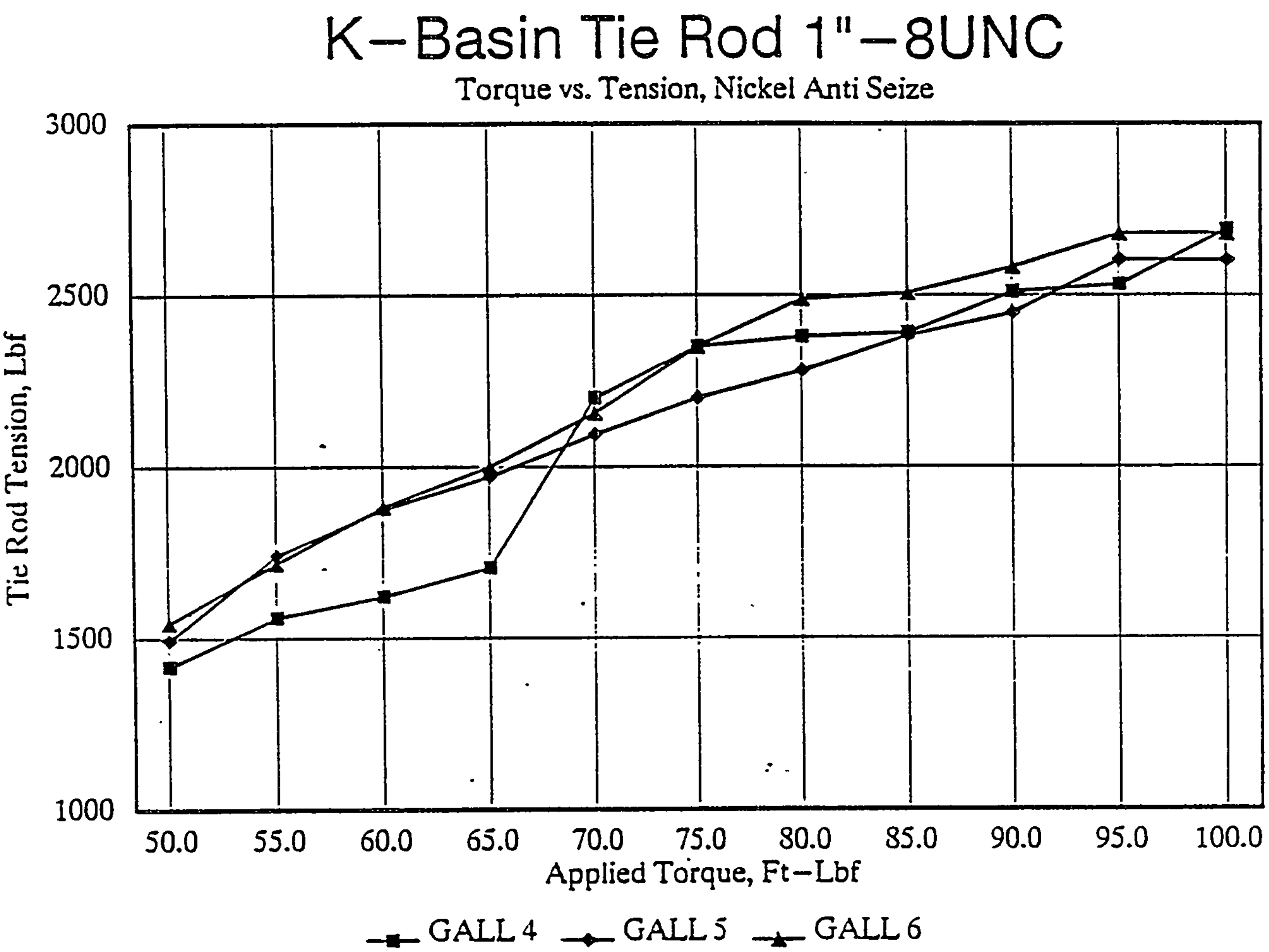
Don't over torque the tie rods. Too much torque WILL gall the nut/washer surface.

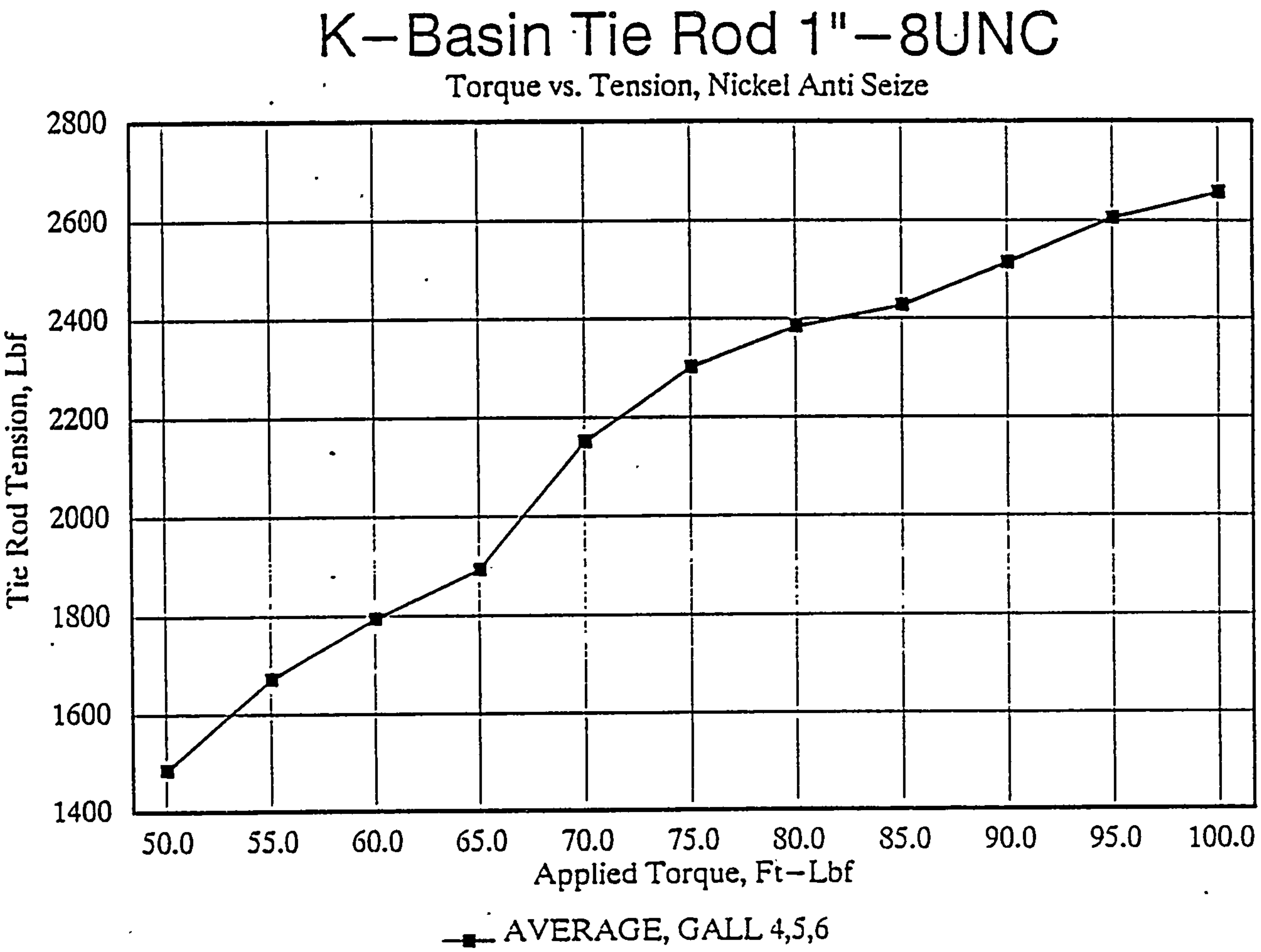
Tension tests should be performed using the actual stainless steel washers that were procured for the installation. Stainless steel washers will be more susceptible to galling, therefore, tests must be done to verify performance of the nut/washer interface.

Consider using flanged nuts to increase the bearing surface area of the nuts.

Inspect the bearing surface of all nuts and washers to be used on the tie rods. Use fine emery paper to remove sharp edges and asperities.

54-3000-101 (12/92) GEF014


K-Basin Tie Rod 1"-8UNC
Torque vs. Tension, Nickel Anti Seize
3000
2500
2000
1500
1000
Tie Rod Tension, Lbf
50.0
55.0
60.0
65.0
70.0
75.0
80.0
85.0
90.0
95.0
100.0
Applied Torque, Ft-Lbf
GALL 4
GALL 5
GALL 6


K–Basin Tie Rod 1"–8UNC
Torque vs. Tension, Nickel Anti Seize
Tie Rod Tension, Lbf
2800
2600
2400
2200
2000
1800
1600
1400
50.0
55.0
60.0
65.0
70.0
75.0
80.0
85.0
90.0
95.0
100.0
Applied Torque, Ft–Lbf
AVERAGE, GALL 4,5,6

DATE: AUG 29, 1994
GALL TESTING OF K-BASIN ISOLATION BARRIER TIE RODS

GALL TEST 4

TORQUE MEASUREMENT WITH MANUAL 3 FT. TORQUE WRENCH. "CLICK DETENT"
STANDARDS LAB # 750-88-01-004 HEDL # ERG00508
CALIBRATED AUG. 16, 1994 EXPIRES: AUG. 16, 1995

LUBRICATION: CHESTERSON NICKEL BASED ANTI SEIZE COMPOUND
304L STAINLESS STEEL THREADED ROD 1" DIA.- 8 UNC THREAD
304L STAINLESS STEEL FLEX-LOC NUT, UNPLATED

NUT BEARING SURFACE O.D.	1.541 INCHES
NUT BEARING SURFACE I.D.	1.062 INCHES
NUT BEARING AREA	0.979 SQUARE INCHES

APPLIED TORQUE FT-LBF DATA	GALL 4 TIE ROD TENSION LBF DATA	DIAMETER OF BOLT INCHES DATA	FRICTION FACTOR K CALCULATE	NUT BEARING PRESSURE PSI CALCULATE
50.0	1418	1.00	0.42	1448
55.0	1561	1.00	0.42	1594
60.0	1623	1.00	0.44	1657
65.0	1706	1.00	0.46	1742
70.0	2202	1.00	0.38	2249
75.0	2352	1.00	0.38	2402
80.0	2381	1.00	0.40	2431
85.0	2393	1.00	0.43	2444
90.0	2512	1.00	0.43	2565
95.0	2532	1.00	0.45	2586
100.0	2693	1.00	0.45	2750

DATE: AUG 29, 1994
GALL TESTING OF K-BASIN ISOLATION BARRIER TIE RODS

GALL TEST 5

TORQUE MEASUREMENT WITH MANUAL 3 FT. TORQUE WRENCH. "CLICK DETENT"
STANDARDS LAB # 750-88-01-004 HEDL # ERG00508
CALIBRATED AUG. 16, 1994 EXPIRES: AUG. 16, 1995

LUBRICATION: CHESTERSON NICKEL BASED ANTI SEIZE COMPOUND
304L STAINLESS STEEL THREADED ROD 1" DIA.- 8 UNC THREAD
304L STAINLESS STEEL FLEX-LOC NUT, UNPLATED

NUT BEARING SURFACE O.D.	1.541	INCHES
NUT BEARING SURFACE I.D.	1.062	INCHES
NUT BEARING AREA	0.979	SQUARE INCHES

APPLIED TORQUE FT-LBF DATA	GALL 5 TIE ROD TENSION LBF DATA	DIAMETER OF BOLT INCHES DATA	FRICTION FACTOR K CALCULATE	NUT BEARING PRESSURE PSI CALCULATE
50.0	1495	1.00	0.40	1527
55.0	1742	1.00	0.38	1779
60.0	1878	1.00	0.38	1918
65.0	1971	1.00	0.40	2013
70.0	2096	1.00	0.40	2140
75.0	2203	1.00	0.41	2250
80.0	2281	1.00	0.42	2329
85.0	2383	1.00	0.43	2433
90.0	2451	1.00	0.44	2503
95.0	2603	1.00	0.44	2658
100.0	2602	1.00	0.46	2657

DATE: AUG 29, 1994
GALL TESTING OF K-BASIN ISOLATION BARRIER TIE RODS

GALL TEST 6

TORQUE MEASUREMENT WITH MANUAL 3 FT. TORQUE WRENCH. "CLICK DETENT"
STANDARDS LAB # 750-88-01-004 HEDL # ERG00508
CALIBRATED AUG. 16, 1994 EXPIRES: AUG. 16, 1995

LUBRICATION: CHESTERSON NICKEL BASED ANTI SEIZE COMPOUND
304L STAINLESS STEEL THREADED ROD 1" DIA.- 8 UNC THREAD
304L STAINLESS STEEL FLEX-LOC NUT, UNPLATED

NUT BEARING SURFACE O.D. 1.541 INCHES
NUT BEARING SURFACE I.D. 1.062 INCHES
NUT BEARING AREA 0.979 SQUARE INCHES

APPLIED TORQUE FT-LBF DATA	GALL 6 TIE ROD TENSION LBF DATA	DIAMETER OF BOLT INCHES DATA	FRICTION FACTOR K CALCULATE	NUT BEARING PRESSURE PSI CALCULATE
50.0	1545	1.00	0.39	1578
55.0	1718	1.00	0.38	1754
60.0	1885	1.00	0.38	1925
65.0	2002	1.00	0.39	2044
70.0	2158	1.00	0.39	2204
75.0	2353	1.00	0.38	2403
80.0	2490	1.00	0.39	2543
85.0	2508	1.00	0.41	2561
90.0	2583	1.00	0.42	2638
95.0	2681	1.00	0.43	2738

DATE: AUG 29, 1994
GALL TESTING OF K-BASIN ISOLATION BARRIER TIE RODS

AVERAGES OF GALL TESTS 4. , 5, AND 6

TORQUE MEASUREMENT WITH MANUAL 3 FT. TORQUE WRENCH. "CLICK DETENT"
STANDARDS LAB # 750-88-01-004 HEDL # ERG00508
CALIBRATED AUG. 16, 1994 EXPIRES: AUG. 16, 1995

LUBRICATION: CHESTERSON NICKEL BASED ANTI SEIZE COMPOUND
304L STAINLESS STEEL THREADED ROD 1" DIA.- 8 UNC THREAD
304L STAINLESS STEEL FLEX-LOC NUT, UNPLATED

NUT BEARING SURFACE O.D.	1.541	INCHES
NUT BEARING SURFACE I.D.	1.062	INCHES
NUT BEARING AREA	0.979	SQUARE INCHES

APPLIED TORQUE FT-LBF DATA	GALL 4 TIE ROD TENSION LBF DATA	GALL 5 TIE ROD TENSION LBF DATA	GALL 6 TIE ROD TENSION LBF DATA	AVERAGE TIE ROD TENSION LBF DATA	DIAMETER OF BOLT INCHES DATA
50.0	1418	1495	1545	1486	1.00
55.0	1561	1742	1718	1674	1.00
60.0	1623	1878	1885	1795	1.00
65.0	1706	1971	2002	1893	1.00
70.0	2202	2096	2158	2152	1.00
75.0	2352	2203	2353	2303	1.00
80.0	2381	2281	2490	2384	1.00
85.0	2393	2383	2508	2428	1.00
90.0	2512	2451	2583	2515	1.00
95.0	2532	2603	2681	2605	1.00
100.0	2693	2602	2681	2659	1.00

DATE: AUG 31, 1994

K-BASIN ISOLATION BARRIER TIE RODS
CALCULATION OF HYPOTHETICAL NUT BEARING PRESSURES
ASSUMING THAT FLANGE NUTS ARE USED.

LUBRICATION: CHESTERSON NICKEL BASED ANTI SEIZE COMPOUND
304L STAINLESS STEEL THREADED ROD 1" DIA.- 8 UNC THREAD
304L STAINLESS STEEL FLEX-LOC NUT, UNPLATED

NUT BEARING SURFACE O.D.	2.25	INCHES	FLANGE NUT
NUT BEARING SURFACE I.D.	1.062	INCHES	
NUT BEARING AREA	3.090	SQUARE INCHES	

APPLIED TORQUE FT-LBF DATA	USING GALL 6 TIE ROD TENSION LBF DATA	DIAMETER OF BOLT INCHES DATA	FRICTION FACTOR K CALCULATE	HYPOTHETICAL NUT BEARING PRESSURE PSI CALCULATE
50.0	1545	1.00	0.39	500
55.0	1718	1.00	0.38	556
60.0	1885	1.00	0.38	610
65.0	2002	1.00	0.39	648
70.0	2158	1.00	0.39	698
75.0	2353	1.00	0.38	761
80.0	2490	1.00	0.39	806
85.0	2508	1.00	0.41	812
90.0	2583	1.00	0.42	836
95.0	2681	1.00	0.43	868

APPENDIX A3

STRUCTURAL EVALUATION OF ISOLATION BARRIER MODIFICATIONS

ICF KAISER

ICF Kaiser Hanford Company
P.O. Box 888
Richland, WA 99352

SNF-W-95-757

January 26, 1995

James C. Wiborg
Westinghouse Hanford Company
P. O. Box 1970
Richland, Washington 99352

Dear Mr. Wiborg:

STRUCTURAL EVALUATION OF ISOLATION BARRIER MODIFICATIONS (ECN 607290)

References:
(1) Drawing Number H-1-80104, Rev. X, Basin Discharge Chute Isolation Barriers

(2) Westinghouse Hanford Company Internal Memo 8D420-MRL-94-005, M. R. Lindquist to J. C. Wiborg, Structural Calculation for K Basin Isolation Doors, dated June 23, 1994.

(3) Westinghouse Hanford Company Internal Memo LLH-8D420-94-001, L. L. Hyde to J. C. Wiborg, Structural Calculation for K Basin Isolation Barriers, dated November 11, 1994.

Per your request of January 21, 1995, we have performed a structural evaluation of the proposed modifications to the Isolation Barrier padeyes and side-stops outlined in Engineering Change Notice 607290. These parts are identified as Items 60 and 67, respectively, on the Reference (1) drawing. In order to expedite the required rework we faxed our concurrence to you on January 23, 1995. This letter documents our findings.

References (2) and (3) transmitted our initial structural evaluations of the Isolation Barriers, including the two items now being modified. To comply with your request, additional in-depth, but very conservative, analyses were performed for the modified padeyes. These analyses, which were subjected to peer review, are attached.

In summary, the results of the analyses show both items are structurally adequate when modified per ECN 607290. The minimum margin of safety for the modified padeyes is +0.17. The very minor modification of the side-stops will not effect their structural capability, which was reported in Reference (3).

James C. Wiborg
January 25, 1995
Page 2, SNF-W-95-757

Questions concerning this evaluation may be referred to the undersigned (373-4289) or to L. L. Hyde (376-5047).

Sincerely,

John I. Dearing

John I. Dearing, Manager/Engineering
Spent Nuclear Fuel Project Engineering and Construction

JID:tmb

Enclosure

cc:	D. L. Cooley	X3-76 - WHC	
	G. M. Davis	X1-80 - WHC	(w/o encl.)
	J. C. Hamrick	X0-22 - WHC	(w/o encl.)
	L. L. Hyde	H5-58	
	R. J. Kuhta	X3-76 - WHC	
	M. J. Langevin	X3-76 - WHC	(w/o encl.)
	D. C. Marburger	H4-63 - WEC	
	J. P. Schmidt	X3-73 - WHC	(w/o encl.)
	D. A. Smith	G3-20 - WHC	(w/o encl.)
	G. C. Sorensen	K8-28 - PNL	
	R. E. Tiller	E6-61	(w/o encl.)
	W. W. Wassberg	R3-82 - MACTC	(w/o encl.)

James C. Wiborg
January 25, 1995
Page 2, SNF-W-95-757

bcc:	B. L. Evans	G7-15 (w/o encl.)
	KATS	E6-61 (w/o encl.)
	JID/LB	

DESIGN CALCULATION

(1) Drawing H-1-42659/H-1-80104 (2) Doc. No. ECN 607290 (3) Page ____ of ____
(4) Building 105KE/105KW (5) Rev. ____ (6) Job No. ____
(7) Subject BASIN DISCHARGE CHUTE ISOLATION BARRIERS
(8) Originator L. Hyde Date 1/23/95
(9) Checker [signature] Date 1/23/95

(10)

PADEYE AND SIDE-STOP MODIFICATION

(Padeye: Dwg. H-1-42659, Item 42 and Dwg. H-1-80104, Item 60)
(Side-Stop: Dwg. H-1-80104, Item 67)

During preparation of the K Basin Chute for installation of the Isolation Barriers it was found that interference of the padeyes and/or the side-stops might occur with the Chute opening. To provide a margin of clearance it was proposed to trim 1/2" from the outside edge of each padeye and to grind 1/8" from the lower shoulder of each side-stop. This analysis addresses these proposed modifications.

The padeyes are spaced about 24" apart along each vertical edge of the Barrier plate. Each is constructed from a 6"x 9"x 1/2" carbon steel plate with a 3" diameter hole located 3" on center from one end. They are welded perpendicular to the Barrier plate, on the Chute side, with a 1/4" fillet. The hole accepts the tie-rod hook, permitting the padeye to transmit tie-rod installation forces to the Barrier plate.

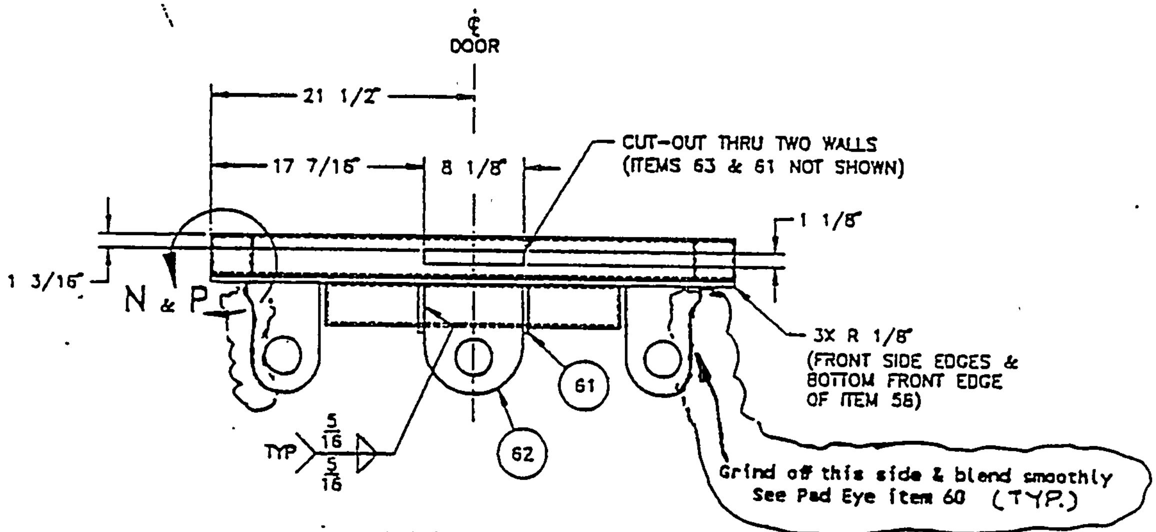
The Tie-Rod Tightening Procedure specifies an initial nominal tie-rod installation force of 2300 lbf. WHC Internal Memo LLH-8D420-94-001 (L. Hyde to J. Wiborg, November 11,1994) established the upper limit of the tie-rod force at 4385 lbf based on the structural capability of the bracket assembly. For conservatism, the padeye modification addressed here was analyzed for a tie-rod force of 5000 lbf. Additionally, to account for potential misalignment of the tie-rod, forces of 500 lbf (10%) acting normal to the tie-rod, in-plane and out-of-plane, were included.

A linear finite-element model of the modified padeye was generated using the IMAGES computer code. The model, which utilized plate elements, was statically loaded along the edge of a 1" segment of the hole since this is the width of the tie-rod hook. The model included fixed boundary conditions at its attachment to the Barrier plate.

The results of this very conservative analysis show the modified padeye meets code stress allowables with a minimum margin of safety of +0.17. The critical stress occurs at the edge of the hole adjacent to the padeye edge which is being trimmed. The weld attaching the padeye to the Barrier plate has a minimum margin of safety of +0.70 for this same conservative loading.

The side-stop is constructed of 2" stainless steel plate. It was analyzed for resistance to lateral seismic forces in WHC Internal Memo LLH-8D420-94-001 and shown to have a large margin of safety. The very minor proposed modification will have no effect on its structural capability.

ENGINEERING CHANGE NOTICE CONTINUATION SHEET Page of	1. ECN 607290



VIEW E–E

FOR CLARITY ITEMS 18, 67, 88 & 89 (SIDE STOPS) NOT SHOWN

SCALE 1:8

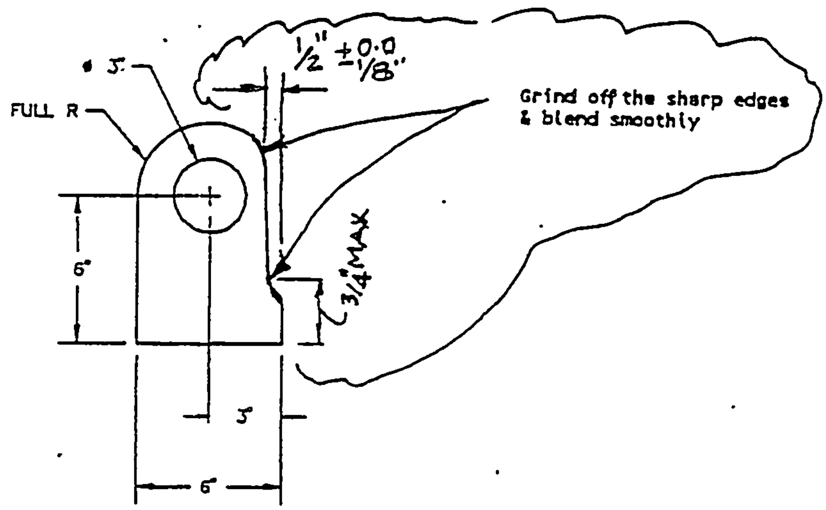
(REF. DRAWING. H-1-80104 SHT. 3)

SKETCH # SK-1

ENGINEERING CHANGE NOTICE CONTINUATION SHEET

Page of

1. ECN 607290



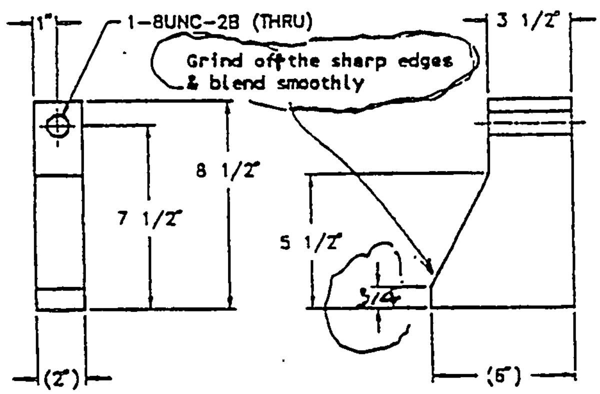
60 PAD EYE
SCALE 1:4

(REF. DRAWING H-1-80104 SHT. 4

SKETCH # SK- 2

ENGINEERING CHANGE NOTICE CONTINUATION SHEET Page of

1. ECN 607290



67 MOUNTING BLOCK (SIDE STOP)

DIMENSIONAL TOLERANCE ±1/16"

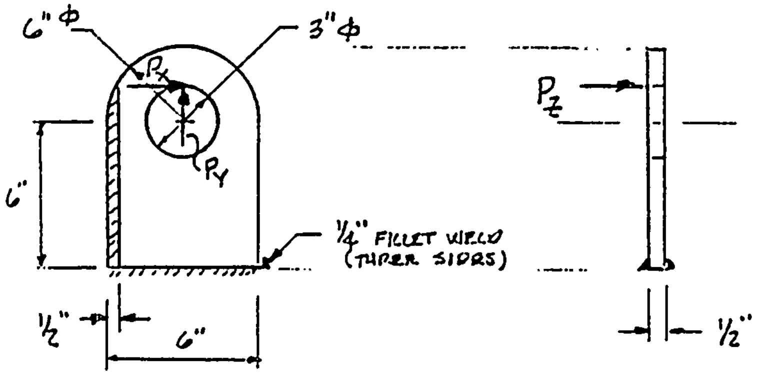
SCALE 1:4

(REF. DRAWING H-1-80104 SHT 5)

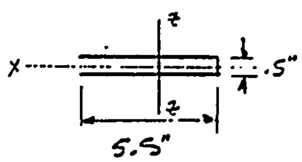
DESIGN CALCULATION

(1) Drawing H-1-42659/H-1-80104 (2) Doc. No. ECN 607290 (3) Page ____ of ____
(4) Building 105KE/105KW (5) Rev. ________ (6) Job No. ________
(7) Subject BASIN DISCHARGE CHUTE ISOLATION BARRIERS
(8) Originator L. Hyde Date 1/23/95
(9) Checker [signature] Date 1/23/95

(10) PADEYE MODIFICATION (ITEM 42, H-1-42659)
TRIMMED 1/2" AS SHOWN . (ITEM 60, H-1-80104)



CHECK PADEYE WELD FOR A POTENTIAL MAXIMUM TIE-ROD LOAD (P_Y) OF 5000 LBS. ADDITIONALLY INCLUDE POTENTIAL MISALIGNMENT LOADS (P_X & P_Z) OF 500 LBS (10%).



WELD: $A' = 2(5.5) + 0.5 = 11.5$ IN.

$$S'_x = 0.5(5.5) + 0.5^2/6 = 2.79 \text{ IN}^2$$

$$S'_z = \frac{5.5^2(2\times0.5+5.5)}{3\ (0.5+5.5)} = 10.92 \text{ IN}^2$$

$$f_{t_Y} = \frac{P_Y}{A'} + \frac{M_x}{S'_x} + \frac{M_z}{S'_z}$$

$$= \frac{5000}{11.5} + \frac{500\times7.5}{2.79} + \frac{500\times7.5}{10.92} = 2121 \text{ LB/IN}$$

$$f_{s_X} = f_{s_Z} = \frac{500}{11.5} = 43.5 \text{ LB/IN}$$

$$f_T = (2121^2 + 43.5^2 + 43.5^2)^{1/2} = 2122 \text{ LB/IN}$$

STRESS ON LEG OF FILLET, $\sigma_S = 2122/0.25 = 8488$ PSI
$F_{ALLOW} = 0.4F_Y = 0.4(36000) = 14400$ PSI
$M.S. = \frac{14400}{8488} - 1 = +0.70$

STRESS IN FILLET THROAT, $\sigma_S = 2122/.707\times0.25 = 12004$ PSI
$F_{ALLOW} = 0.3F_U = 0.3(70000) = 21,000$ PSI

```
==========================================================================
========================== I M A G E S - 3 D =============================
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01-22-1995          Filename=PADEYE          Run ID=ET00018          00:18:20

--------------------------------------------------------------------------
!                                                                        !
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!  EE            T     00     00 00     00 00     00      11     88   88  !
!  EE            T     00     00 00     00 00     00      11     88   88  !
!  EE            T     00   0000 00   0000 00   0000     1 1     88   88  !
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!  EEEEEEEEE     T       00000      00000      00000     11111    88888   !
!                                                                        !
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```

WESTINGHOUSE HANFORD COMPANY S/N:802406

J o b   I n f o r m a t i o n

Project : K BASIN

Client : J. WIBORG

Job Name : PADEYE MODIFICATION

Remarks : ECN 607290

DWG. H-1-80104

Engineer : Larry Hyde / 1/22/95
LARRY HYDE

Chk'd by : [illegible] / 1/23/95

Appr'd by : ____________ / ________

Comments : ____________________

____

```
==========================================================================
========================== I M A G E S - 3 D =============================
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================= I M A G E S - 3 D =================
= Copyright (c) 1984-1993.   RLCA/Celestial Software =
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Interactive Microcomputer Analysis & Graphics of Engineering Systems

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IMAGES-3D              Version 3.0              12/31/93

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=----------------------------------------------------=
=     RLCA/Celestial Software assumes no responsi-   =
=     bility for the validity, accuracy, or          =
=     applicability of the results obtained from     =
=     IMAGES-3D.                                     =
======================================================

======================================================
=     Any questions or comments concerning the use   =
=     of IMAGES-3D or the users manual should        =
=     be addressed to:                               =
=                                                    =
=             RLCA/Celestial Software                =
=               2150 Shattuck Ave.                   =
=                   Suite 1200                       =
=                  Berkeley, CA                      =
=                     94704                          =
=                                                    =
=                  510-843-0977                      =
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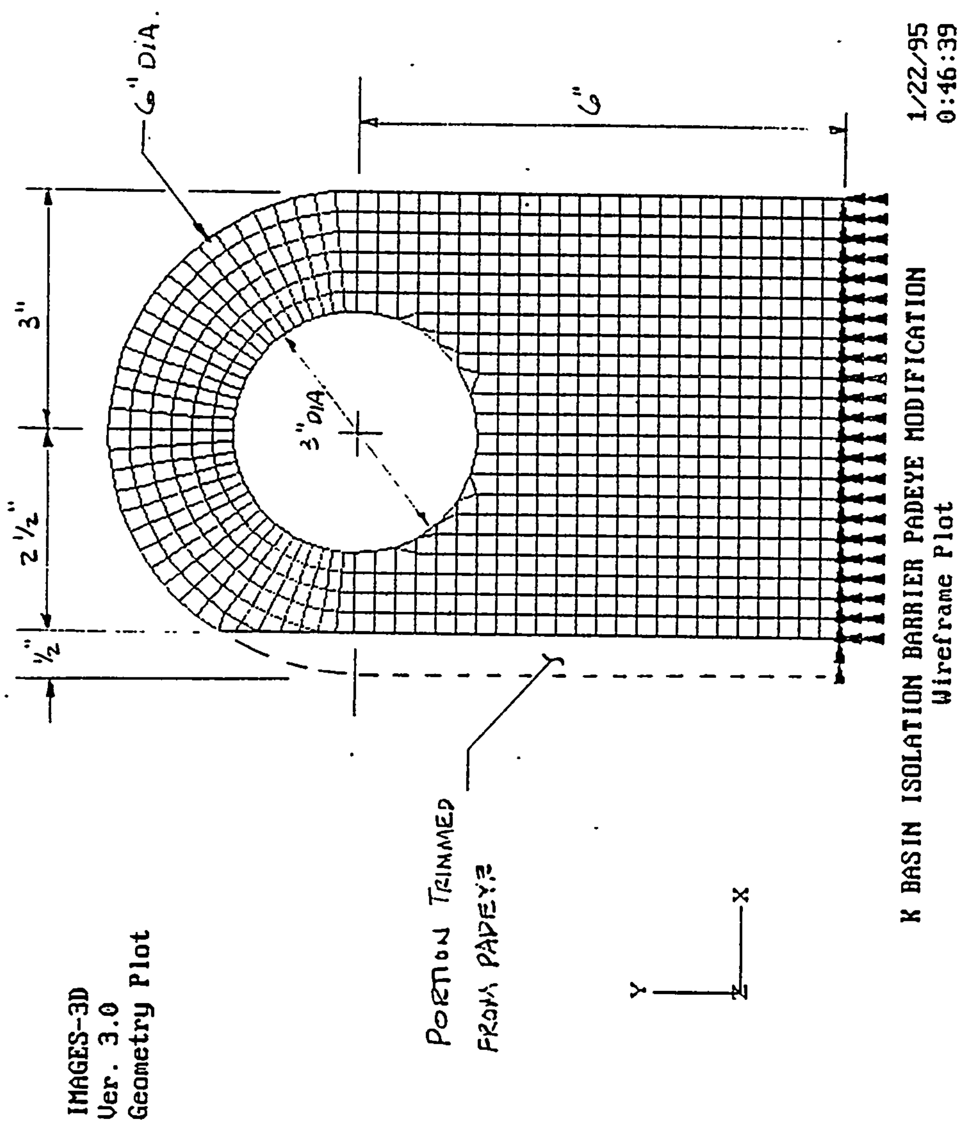
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Wireframe Plot
1/22/95
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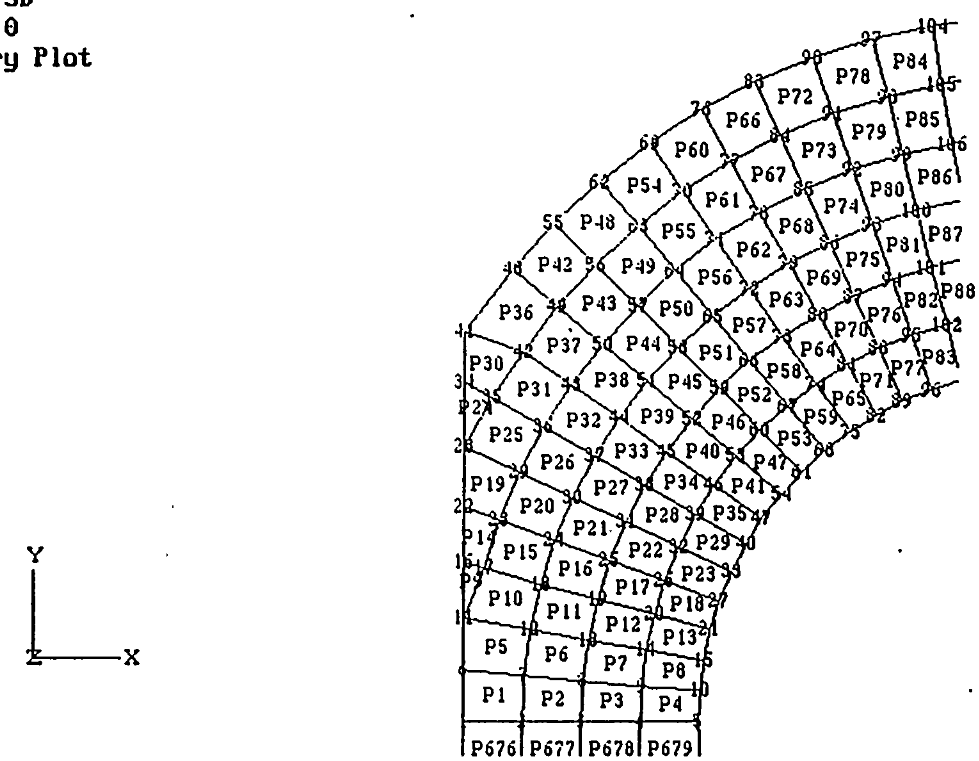
IMAGES-3D
Ver. 3.0
Geometry Plot
6" DIA.
3" DIA.
6"
3"
2 1/2"
1/2"
PORTION TRIMMED FROM PADEYE
X
Y
Z

IMAGES-3D
Ver. 3.0
Geometry Plot



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1/22/95
0:52: 9

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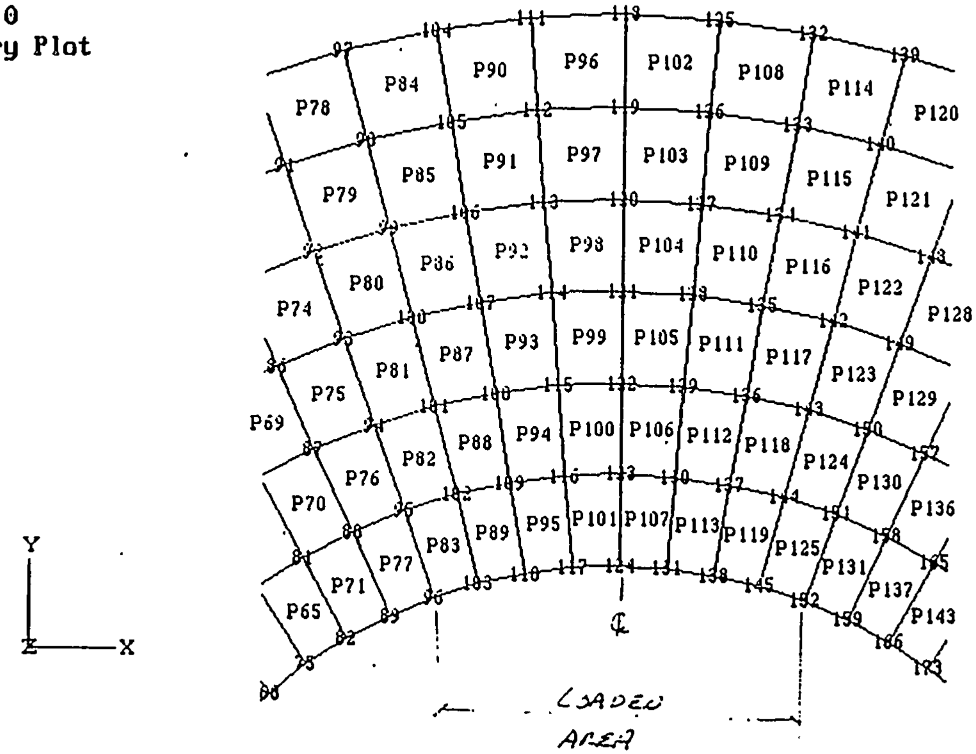
Ver. 3.0
Geometry Plot



K BASIN ISOLATION BARRIER PADEYE MODIFICATION
Wireframe Plot

1/22/95
0:53:54

FOR 5000#

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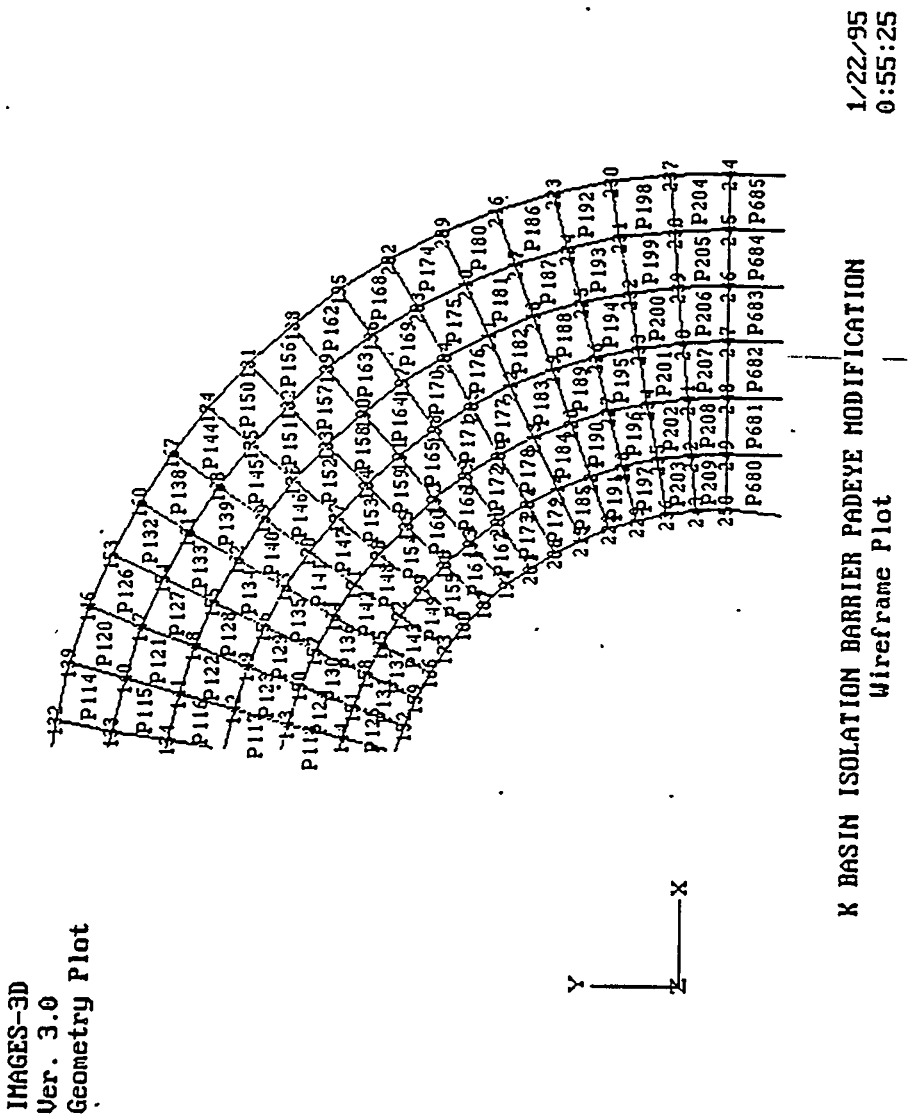
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Ver. 3.0
Geometry Plot
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1/22/95
0:55:25
Y
X
Z

IMAGES-3D
Ver. 3.0
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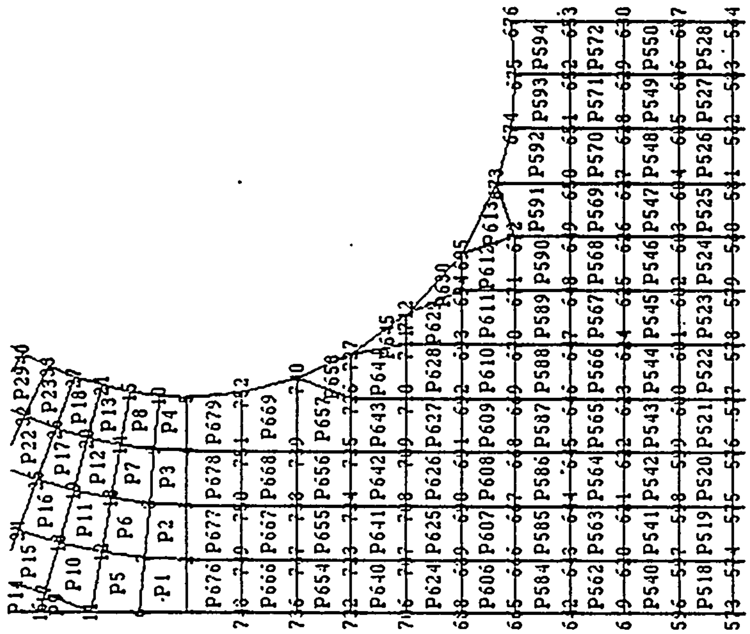

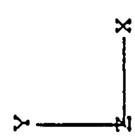

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Wireframe Plot

1/22/95
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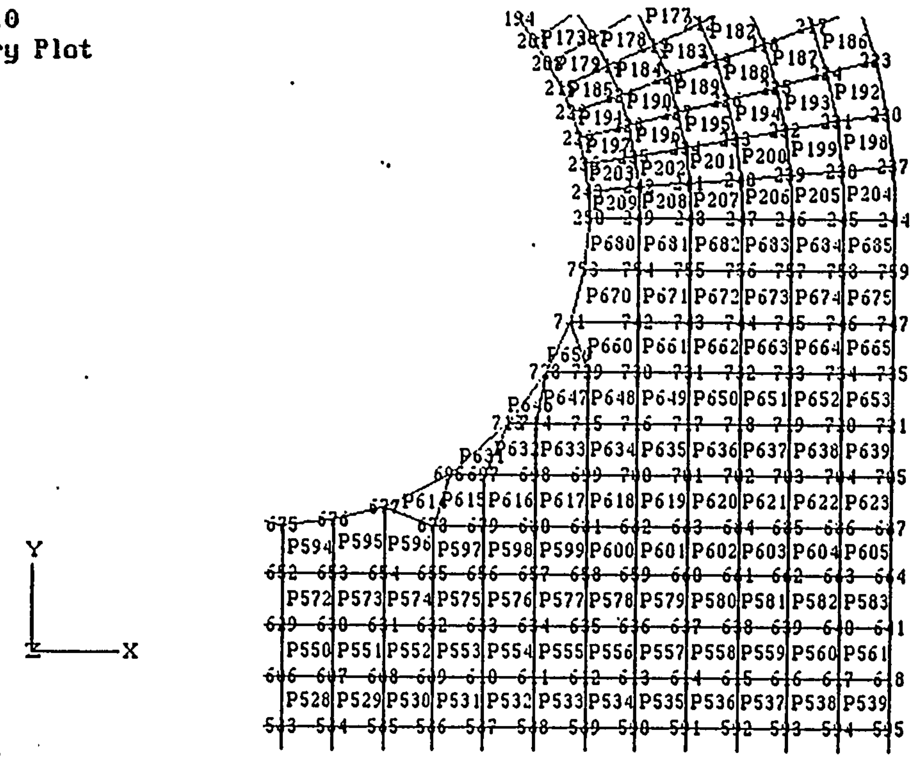

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1/22/95
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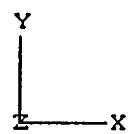
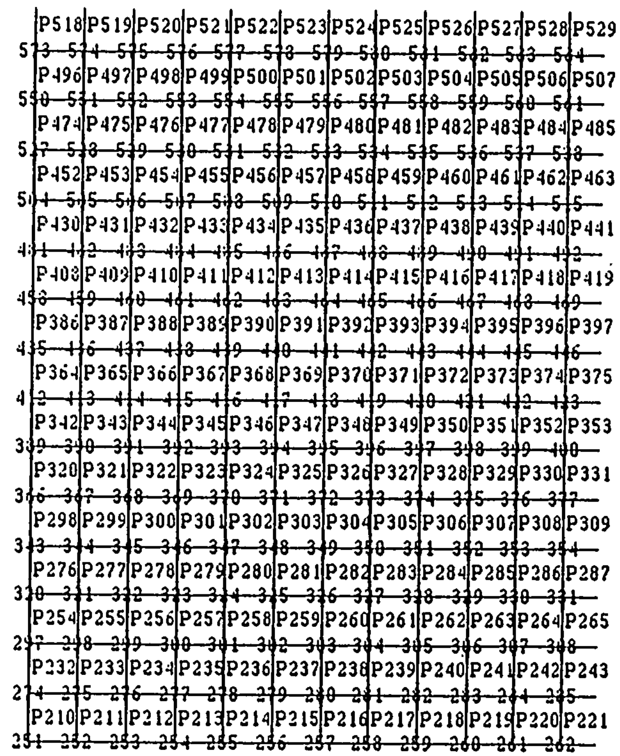
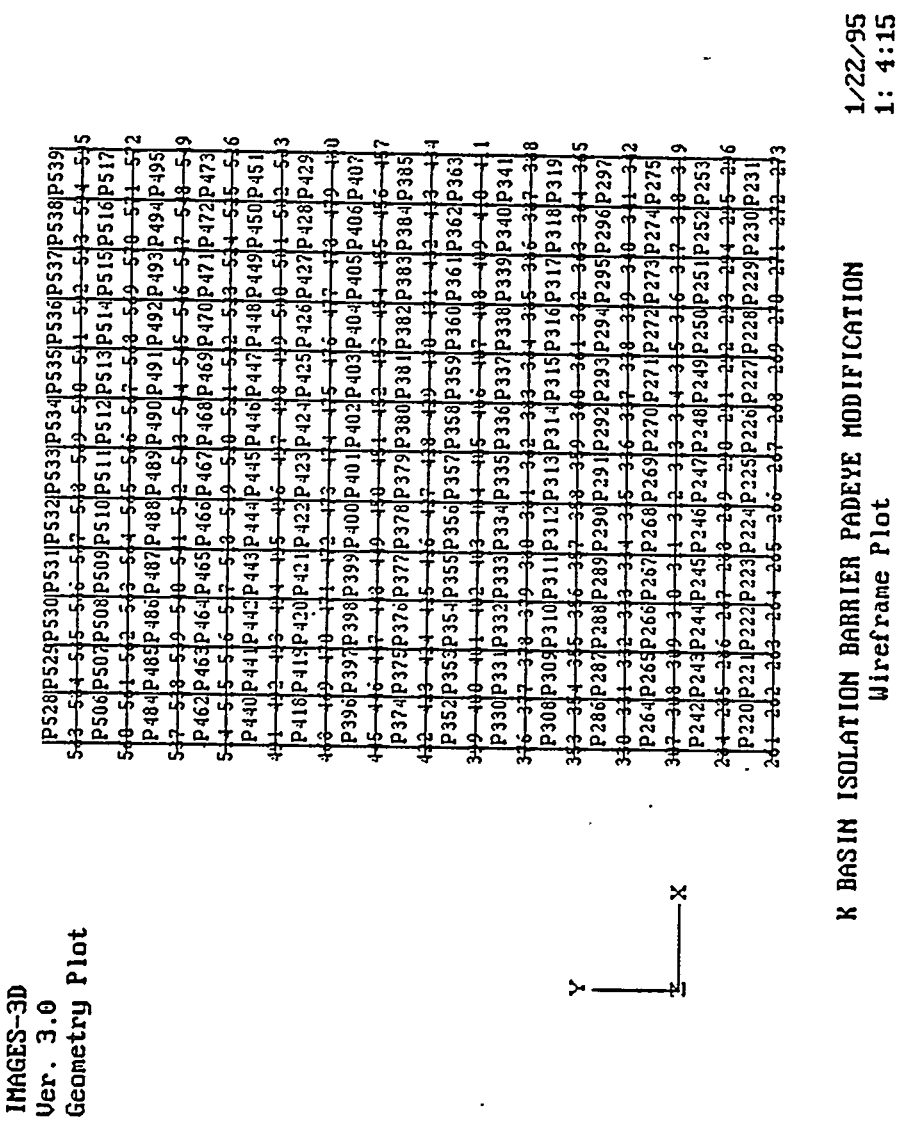
Ver. 3.0
Geometry Plot





K BASIN ISOLATION BARRIER PADEYE MODIFICATION
Wireframe Plot

1/22/95
1: 1:20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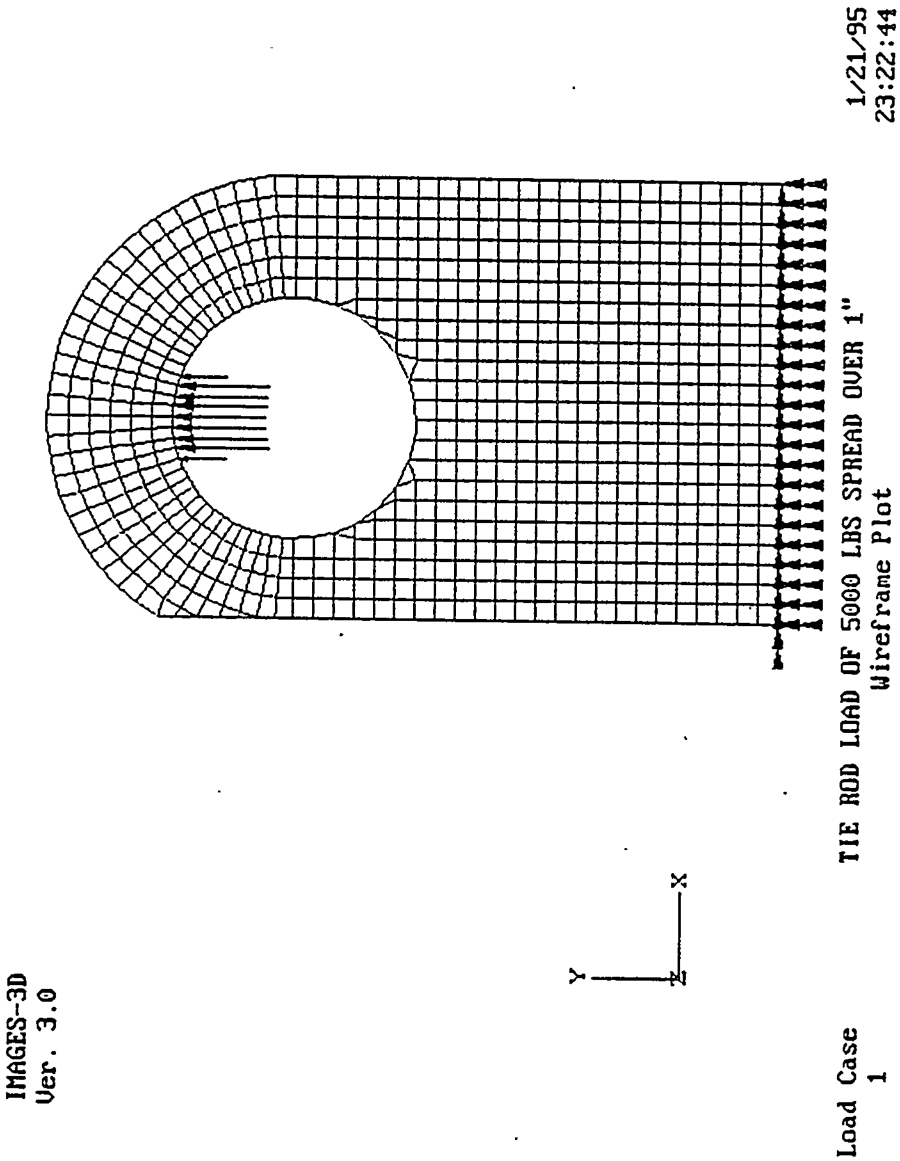
Ver. 3.0
Geometry Plot
1/22/95
1: 4:15
K BASIN ISOLATION BARRIER PADEYE MODIFICATION
Wireframe Plot
X
Y


1/21/95
23:22:44
TIE ROD LOAD OF 5000 LBS SPREAD OVER 1"
Wireframe Plot
X
Y
Z
IMAGES-3D
Ver. 3.0
Load Case
1

WESTINGHOUSE HANFORD COMPANY S/N:802406 01/22/95
PAGE 1 RUN ID=ET00018 00:18:21

================== I M A G E S - 3 D ==================

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CHECK GEOMETRY Version 3.0 12/31/93

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(For database properties only)

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Mat No	Ex Gxy	Ey Gyz	Ez Gzx	nxy axy	nyz ayz	nzx azx	Density
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	1.120E+07	1.120E+07	1.120E+07	6.500E-06	6.500E-06	6.500E-06	

PLATE THICKNESS SETS

Layer No	Mat No	Thickness	Angle
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NODE COORDINATES

Node	X-Coord.	Y-Coord.	Z-Coord.
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2	-2.25000E+00	6.00000E+00	0.00000E+00
3	-2.00000E+00	6.00000E+00	0.00000E+00
4	-1.75000E+00	6.00000E+00	0.00000E+00
5	-1.50000E+00	6.00000E+00	0.00000E+00
6	-2.50000E+00	6.21870E+00	0.00000E+00
7	-2.24144E+00	6.19610E+00	0.00000E+00
8	-1.99239E+00	6.17431E+00	0.00000E+00
9	-1.74334E+00	6.15252E+00	0.00000E+00
10	-1.49429E+00	6.13073E+00	0.00000E+00
11	-2.50000E+00	6.44080E+00	0.00000E+00
12	-2.21582E+00	6.39071E+00	0.00000E+00
13	-1.96962E+00	6.34730E+00	0.00000E+00
14	-1.72341E+00	6.30388E+00	0.00000E+00

WESTINGHOUSE HANFORD COMPANY S/N:802406 01/22/95
PAGE 2 RUN ID=ET00018 00:18:21

================== I M A G E S - 3 D ==================

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CHECK GEOMETRY Version 3.0 12/31/93

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17	-2.41481E+00	6.64705E+00	0.00000E+00
18	-2.17333E+00	6.58234E+00	0.00000E+00
19	-1.93185E+00	6.51764E+00	0.00000E+00
20	-1.69037E+00	6.45293E+00	0.00000E+00
21	-1.44889E+00	6.38823E+00	0.00000E+00
22	-2.50000E+00	6.90990E+00	0.00000E+00
23	-2.34923E+00	6.85505E+00	0.00000E+00
24	-2.11431E+00	6.76955E+00	0.00000E+00
25	-1.87938E+00	6.68404E+00	0.00000E+00
26	-1.64446E+00	6.59854E+00	0.00000E+00
27	-1.40954E+00	6.51303E+00	0.00000E+00
28	-2.50000E+00	7.16580E+00	0.00000E+00
29	-2.26577E+00	7.05654E+00	0.00000E+00
30	-2.03919E+00	6.95089E+00	0.00000E+00
31	-1.81262E+00	6.84524E+00	0.00000E+00
32	-1.58604E+00	6.73958E+00	0.00000E+00
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36	-2.16506E+00	7.25000E+00	0.00000E+00
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WESTINGHOUSE HANFORD COMPANY S/N:802406 01/22/95
PAGE 3 RUN ID=ET00018 00:18:22

================ I M A G E S - 3 D ================

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Title =K BASIN ISOLATION BARRIER PADEYE MODIFICATION

Node	X-Coord.	Y-Coord.	Z-Coord.
57	-1.76777E+00	7.76777E+00	0.00000E+00
58	-1.59099E+00	7.59099E+00	0.00000E+00
59	-1.41421E+00	7.41422E+00	0.00000E+00
60	-1.23744E+00	7.23744E+00	0.00000E+00
61	-1.06066E+00	7.06066E+00	0.00000E+00
62	-1.92836E+00	8.29813E+00	0.00000E+00
63	-1.76767E+00	8.10662E+00	0.00000E+00
64	-1.60697E+00	7.91511E+00	0.00000E+00
65	-1.44627E+00	7.72360E+00	0.00000E+00
66	-1.28558E+00	7.53209E+00	0.00000E+00
67	-1.12488E+00	7.34058E+00	0.00000E+00
68	-9.64182E-01	7.14907E+00	0.00000E+00
69	-1.72073E+00	8.45746E+00	0.00000E+00
70	-1.57734E+00	8.25267E+00	0.00000E+00
71	-1.43394E+00	8.04788E+00	0.00000E+00
72	-1.29055E+00	7.84309E+00	0.00000E+00
73	-1.14715E+00	7.63831E+00	0.00000E+00
74	-1.00376E+00	7.43352E+00	0.00000E+00
75	-8.60365E-01	7.22873E+00	0.00000E+00
76	-1.50000E+00	8.59808E+00	0.00000E+00
77	-1.37500E+00	8.38157E+00	0.00000E+00
78	-1.25000E+00	8.16506E+00	0.00000E+00
79	-1.12500E+00	7.94856E+00	0.00000E+00
80	-1.00000E+00	7.73205E+00	0.00000E+00
81	-8.75001E-01	7.51554E+00	0.00000E+00
82	-7.50000E-01	7.29904E+00	0.00000E+00
83	-1.26786E+00	8.71893E+00	0.00000E+00
84	-1.16220E+00	8.49235E+00	0.00000E+00
85	-1.05655E+00	8.26577E+00	0.00000E+00
86	-9.50892E-01	8.03919E+00	0.00000E+00
87	-8.45236E-01	7.81262E+00	0.00000E+00
88	-7.39583E-01	7.58604E+00	0.00000E+00
89	-6.33928E-01	7.35946E+00	0.00000E+00
90	-1.02606E+00	8.81908E+00	0.00000E+00
91	-9.40556E-01	8.58416E+00	0.00000E+00
92	-8.55051E-01	8.34923E+00	0.00000E+00
93	-7.69546E-01	8.11431E+00	0.00000E+00
94	-6.84040E-01	7.87939E+00	0.00000E+00
95	-5.98536E-01	7.64446E+00	0.00000E+00
96	-5.13030E-01	7.40954E+00	0.00000E+00
97	-7.76457E-01	8.89778E+00	0.00000E+00
98	-7.11753E-01	8.65630E+00	0.00000E+00

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CHECK GEOMETRY Version 3.0 12/31/93

Filename=PADEYE
Title =K BASIN ISOLATION BARRIER PADEYE MODIFICATION

Node	X-Coord.	Y-Coord.	Z-Coord.
99	-6.47048E-01	8.41481E+00	0.00000E+00
100	-5.82343E-01	8.17333E+00	0.00000E+00
101	-5.17638E-01	7.93185E+00	0.00000E+00
102	-4.52934E-01	7.69037E+00	0.00000E+00
103	-3.88229E-01	7.44889E+00	0.00000E+00
104	-5.20945E-01	8.95442E+00	0.00000E+00
105	-4.77533E-01	8.70822E+00	0.00000E+00
106	-4.34121E-01	8.46202E+00	0.00000E+00
107	-3.90709E-01	8.21582E+00	0.00000E+00
108	-3.47296E-01	7.96962E+00	0.00000E+00
109	-3.03885E-01	7.72341E+00	0.00000E+00
110	-2.60472E-01	7.47721E+00	0.00000E+00
111	-2.61467E-01	8.98859E+00	0.00000E+00
112	-2.39678E-01	8.73954E+00	0.00000E+00
113	-2.17890E-01	8.49049E+00	0.00000E+00
114	-1.96101E-01	8.24144E+00	0.00000E+00
115	-1.74311E-01	7.99239E+00	0.00000E+00
116	-1.52523E-01	7.74334E+00	0.00000E+00
117	-1.30734E-01	7.49429E+00	0.00000E+00
118	0.00000E+00	9.00000E+00	0.00000E+00
119	0.00000E+00	8.75000E+00	0.00000E+00
120	0.00000E+00	8.50000E+00	0.00000E+00
121	0.00000E+00	8.25000E+00	0.00000E+00
122	0.00000E+00	8.00000E+00	0.00000E+00
123	0.00000E+00	7.75000E+00	0.00000E+00
124	0.00000E+00	7.50000E+00	0.00000E+00
125	2.61467E-01	8.98859E+00	0.00000E+00
126	2.39678E-01	8.73954E+00	0.00000E+00
127	2.17889E-01	8.49049E+00	0.00000E+00
128	1.96101E-01	8.24144E+00	0.00000E+00
129	1.74312E-01	7.99239E+00	0.00000E+00
130	1.52523E-01	7.74334E+00	0.00000E+00
131	1.30734E-01	7.49429E+00	0.00000E+00
132	5.20945E-01	8.95443E+00	0.00000E+00
133	4.77533E-01	8.70822E+00	0.00000E+00
134	4.34120E-01	8.46202E+00	0.00000E+00
135	3.90709E-01	8.21582E+00	0.00000E+00
136	3.47297E-01	7.96962E+00	0.00000E+00
137	3.03884E-01	7.72341E+00	0.00000E+00
138	2.60472E-01	7.47721E+00	0.00000E+00
139	7.76458E-01	8.89778E+00	0.00000E+00
140	7.11753E-01	8.65630E+00	0.00000E+00

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================== I M A G E S - 3 D ==================

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CHECK GEOMETRY Version 3.0 12/31/93

Filename=PADEYE
Title =K BASIN ISOLATION BARRIER PADEYE MODIFICATION

Node	X-Coord.	Y-Coord.	Z-Coord.
141	6.47048E-01	8.41481E+00	0.00000E+00
142	5.82343E-01	8.17333E+00	0.00000E+00
143	5.17638E-01	7.93185E+00	0.00000E+00
144	4.52933E-01	7.69037E+00	0.00000E+00
145	3.88229E-01	7.44889E+00	0.00000E+00
146	1.02606E+00	8.81908E+00	0.00000E+00
147	9.40556E-01	8.58416E+00	0.00000E+00
148	8.55050E-01	8.34923E+00	0.00000E+00
149	7.69546E-01	8.11431E+00	0.00000E+00
150	6.84041E-01	7.87939E+00	0.00000E+00
151	5.98535E-01	7.64446E+00	0.00000E+00
152	5.13031E-01	7.40954E+00	0.00000E+00
153	1.26786E+00	8.71893E+00	0.00000E+00
154	1.16220E+00	8.49235E+00	0.00000E+00
155	1.05655E+00	8.26577E+00	0.00000E+00
156	9.50891E-01	8.03919E+00	0.00000E+00
157	8.45237E-01	7.81262E+00	0.00000E+00
158	7.39582E-01	7.58604E+00	0.00000E+00
159	6.33928E-01	7.35946E+00	0.00000E+00
160	1.50000E+00	8.59808E+00	0.00000E+00
161	1.37500E+00	8.38157E+00	0.00000E+00
162	1.25000E+00	8.16506E+00	0.00000E+00
163	1.12500E+00	7.94856E+00	0.00000E+00
164	1.00000E+00	7.73205E+00	0.00000E+00
165	8.75000E-01	7.51554E+00	0.00000E+00
166	7.50000E-01	7.29904E+00	0.00000E+00
167	1.72073E+00	8.45746E+00	0.00000E+00
168	1.57734E+00	8.25267E+00	0.00000E+00
169	1.43394E+00	8.04788E+00	0.00000E+00
170	1.29055E+00	7.84309E+00	0.00000E+00
171	1.14715E+00	7.63831E+00	0.00000E+00
172	1.00376E+00	7.43352E+00	0.00000E+00
173	8.60365E-01	7.22873E+00	0.00000E+00
174	1.92836E+00	8.29814E+00	0.00000E+00
175	1.76767E+00	8.10662E+00	0.00000E+00
176	1.60697E+00	7.91511E+00	0.00000E+00
177	1.44627E+00	7.72360E+00	0.00000E+00
178	1.28558E+00	7.53209E+00	0.00000E+00
179	1.12488E+00	7.34058E+00	0.00000E+00
180	9.64182E-01	7.14907E+00	0.00000E+00
181	2.12132E+00	8.12132E+00	0.00000E+00
182	1.94455E+00	7.94454E+00	0.00000E+00

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================== I M A G E S - 3 D ==================

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CHECK GEOMETRY Version 3.0 12/31/93

Filename=PADEYE
Title =K BASIN ISOLATION BARRIER PADEYE MODIFICATION

Node	X-Coord.	Y-Coord.	Z-Coord.
183	1.76777E+00	7.76777E+00	0.00000E+00
184	1.59099E+00	7.59099E+00	0.00000E+00
185	1.41421E+00	7.41422E+00	0.00000E+00
186	1.23744E+00	7.23744E+00	0.00000E+00
187	1.06066E+00	7.06066E+00	0.00000E+00
188	2.29814E+00	7.92837E+00	0.00000E+00
189	2.10662E+00	7.76767E+00	0.00000E+00
190	1.91511E+00	7.60697E+00	0.00000E+00
191	1.72360E+00	7.44627E+00	0.00000E+00
192	1.53209E+00	7.28558E+00	0.00000E+00
193	1.34058E+00	7.12488E+00	0.00000E+00
194	1.14907E+00	6.96418E+00	0.00000E+00
195	2.45746E+00	7.72073E+00	0.00000E+00
196	2.25267E+00	7.57734E+00	0.00000E+00
197	2.04788E+00	7.43394E+00	0.00000E+00
198	1.84309E+00	7.29055E+00	0.00000E+00
199	1.63830E+00	7.14715E+00	0.00000E+00
200	1.43352E+00	7.00376E+00	0.00000E+00
201	1.22873E+00	6.86036E+00	0.00000E+00
202	2.59808E+00	7.50000E+00	0.00000E+00
203	2.38157E+00	7.37500E+00	0.00000E+00
204	2.16506E+00	7.25000E+00	0.00000E+00
205	1.94856E+00	7.12500E+00	0.00000E+00
206	1.73205E+00	7.00000E+00	0.00000E+00
207	1.51555E+00	6.87500E+00	0.00000E+00
208	1.29904E+00	6.75000E+00	0.00000E+00
209	2.71893E+00	7.26786E+00	0.00000E+00
210	2.49235E+00	7.16220E+00	0.00000E+00
211	2.26577E+00	7.05655E+00	0.00000E+00
212	2.03919E+00	6.95089E+00	0.00000E+00
213	1.81262E+00	6.84524E+00	0.00000E+00
214	1.58604E+00	6.73958E+00	0.00000E+00
215	1.35946E+00	6.63393E+00	0.00000E+00
216	2.81908E+00	7.02606E+00	0.00000E+00
217	2.58416E+00	6.94056E+00	0.00000E+00
218	2.34923E+00	6.85505E+00	0.00000E+00
219	2.11431E+00	6.76955E+00	0.00000E+00
220	1.87939E+00	6.68404E+00	0.00000E+00
221	1.64446E+00	6.59854E+00	0.00000E+00
222	1.40954E+00	6.51303E+00	0.00000E+00
223	2.89778E+00	6.77646E+00	0.00000E+00
224	2.65630E+00	6.71175E+00	0.00000E+00

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================= I M A G E S - 3 D =================

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CHECK GEOMETRY Version 3.0 12/31/93

Filename=PADEYE
Title =K BASIN ISOLATION BARRIER PADEYE MODIFICATION

Node	X-Coord.	Y-Coord.	Z-Coord.
225	2.41481E+00	6.64705E+00	0.00000E+00
226	2.17333E+00	6.58234E+00	0.00000E+00
227	1.93185E+00	6.51764E+00	0.00000E+00
228	1.69037E+00	6.45293E+00	0.00000E+00
229	1.44889E+00	6.38823E+00	0.00000E+00
230	2.95443E+00	6.52095E+00	0.00000E+00
231	2.70822E+00	6.47753E+00	0.00000E+00
232	2.46202E+00	6.43412E+00	0.00000E+00
233	2.21582E+00	6.39071E+00	0.00000E+00
234	1.96962E+00	6.34730E+00	0.00000E+00
235	1.72342E+00	6.30388E+00	0.00000E+00
236	1.47721E+00	6.26047E+00	0.00000E+00
237	2.98859E+00	6.26147E+00	0.00000E+00
238	2.73954E+00	6.23968E+00	0.00000E+00
239	2.49049E+00	6.21789E+00	0.00000E+00
240	2.24144E+00	6.19610E+00	0.00000E+00
241	1.99239E+00	6.17431E+00	0.00000E+00
242	1.74334E+00	6.15252E+00	0.00000E+00
243	1.49429E+00	6.13073E+00	0.00000E+00
244	3.00000E+00	6.00000E+00	0.00000E+00
245	2.75000E+00	6.00000E+00	0.00000E+00
246	2.50000E+00	6.00000E+00	0.00000E+00
247	2.25000E+00	6.00000E+00	0.00000E+00
248	2.00000E+00	6.00000E+00	0.00000E+00
249	1.75000E+00	6.00000E+00	0.00000E+00
250	1.50000E+00	6.00000E+00	0.00000E+00
251	-2.50000E+00	0.00000E+00	0.00000E+00
252	-2.25000E+00	0.00000E+00	0.00000E+00
253	-2.00000E+00	0.00000E+00	0.00000E+00
254	-1.75000E+00	0.00000E+00	0.00000E+00
255	-1.50000E+00	0.00000E+00	0.00000E+00
256	-1.25000E+00	0.00000E+00	0.00000E+00
257	-1.00000E+00	0.00000E+00	0.00000E+00
258	-7.50000E-01	0.00000E+00	0.00000E+00
259	-5.00000E-01	0.00000E+00	0.00000E+00
260	-2.50000E-01	0.00000E+00	0.00000E+00
261	-3.27825E-07	0.00000E+00	0.00000E+00
262	2.50000E-01	0.00000E+00	0.00000E+00
263	5.00000E-01	0.00000E+00	0.00000E+00
264	7.50000E-01	0.00000E+00	0.00000E+00
265	1.00000E+00	0.00000E+00	0.00000E+00
266	1.25000E+00	0.00000E+00	0.00000E+00

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================= I M A G E S - 3 D =================

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CHECK GEOMETRY Version 3.0 12/31/93

Filename=PADEYE
Title =K BASIN ISOLATION BARRIER PADEYE MODIFICATION

Node	X-Coord.	Y-Coord.	Z-Coord.
267	1.50000E+00	0.00000E+00	0.00000E+00
268	1.75000E+00	0.00000E+00	0.00000E+00
269	2.00000E+00	0.00000E+00	0.00000E+00
270	2.25000E+00	0.00000E+00	0.00000E+00
271	2.50000E+00	0.00000E+00	0.00000E+00
272	2.75000E+00	0.00000E+00	0.00000E+00
273	3.00000E+00	0.00000E+00	0.00000E+00
274	-2.50000E+00	2.50000E-01	0.00000E+00
275	-2.25000E+00	2.50000E-01	0.00000E+00
276	-2.00000E+00	2.50000E-01	0.00000E+00
277	-1.75000E+00	2.50000E-01	0.00000E+00
278	-1.50000E+00	2.50000E-01	0.00000E+00
279	-1.25000E+00	2.50000E-01	0.00000E+00
280	-1.00000E+00	2.50000E-01	0.00000E+00
281	-7.50000E-01	2.50000E-01	0.00000E+00
282	-5.00000E-01	2.50000E-01	0.00000E+00
283	-2.50000E-01	2.50000E-01	0.00000E+00
284	-2.81259E-07	2.50000E-01	0.00000E+00
285	2.50000E-01	2.50000E-01	0.00000E+00
286	5.00000E-01	2.50000E-01	0.00000E+00
287	7.50000E-01	2.50000E-01	0.00000E+00
288	1.00000E+00	2.50000E-01	0.00000E+00
289	1.25000E+00	2.50000E-01	0.00000E+00
290	1.50000E+00	2.50000E-01	0.00000E+00
291	1.75000E+00	2.50000E-01	0.00000E+00
292	2.00000E+00	2.50000E-01	0.00000E+00
293	2.25000E+00	2.50000E-01	0.00000E+00
294	2.50000E+00	2.50000E-01	0.00000E+00
295	2.75000E+00	2.50000E-01	0.00000E+00
296	3.00000E+00	2.50000E-01	0.00000E+00
297	-2.50000E+00	5.00000E-01	0.00000E+00
298	-2.25000E+00	5.00000E-01	0.00000E+00
299	-2.00000E+00	5.00000E-01	0.00000E+00
300	-1.75000E+00	5.00000E-01	0.00000E+00
301	-1.50000E+00	5.00000E-01	0.00000E+00
302	-1.25000E+00	5.00000E-01	0.00000E+00
303	-1.00000E+00	5.00000E-01	0.00000E+00
304	-7.50000E-01	5.00000E-01	0.00000E+00
305	-5.00000E-01	5.00000E-01	0.00000E+00
306	-2.50000E-01	5.00000E-01	0.00000E+00
307	-3.24100E-07	5.00000E-01	0.00000E+00
308	2.50000E-01	5.00000E-01	0.00000E+00

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================== I M A G E S - 3 D ==================

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CHECK GEOMETRY Version 3.0 12/31/93

Filename=PADEYE
Title =K BASIN ISOLATION BARRIER PADEYE MODIFICATION

Node	X-Coord.	Y-Coord.	Z-Coord.
309	5.00000E-01	5.00000E-01	0.00000E+00
310	7.50000E-01	5.00000E-01	0.00000E+00
311	1.00000E+00	5.00000E-01	0.00000E+00
312	1.25000E+00	5.00000E-01	0.00000E+00
313	1.50000E+00	5.00000E-01	0.00000E+00
314	1.75000E+00	5.00000E-01	0.00000E+00
315	2.00000E+00	5.00000E-01	0.00000E+00
316	2.25000E+00	5.00000E-01	0.00000E+00
317	2.50000E+00	5.00000E-01	0.00000E+00
318	2.75000E+00	5.00000E-01	0.00000E+00
319	3.00000E+00	5.00000E-01	0.00000E+00
320	-2.50000E+00	7.50000E-01	0.00000E+00
321	-2.25000E+00	7.50000E-01	0.00000E+00
322	-2.00000E+00	7.50000E-01	0.00000E+00
323	-1.75000E+00	7.50000E-01	0.00000E+00
324	-1.50000E+00	7.50000E-01	0.00000E+00
325	-1.25000E+00	7.50000E-01	0.00000E+00
326	-1.00000E+00	7.50000E-01	0.00000E+00
327	-7.50000E-01	7.50000E-01	0.00000E+00
328	-5.00000E-01	7.50000E-01	0.00000E+00
329	-2.50000E-01	7.50000E-01	0.00000E+00
330	-3.65078E-07	7.50000E-01	0.00000E+00
331	2.50000E-01	7.50000E-01	0.00000E+00
332	5.00000E-01	7.50000E-01	0.00000E+00
333	7.50000E-01	7.50000E-01	0.00000E+00
334	1.00000E+00	7.50000E-01	0.00000E+00
335	1.25000E+00	7.50000E-01	0.00000E+00
336	1.50000E+00	7.50000E-01	0.00000E+00
337	1.75000E+00	7.50000E-01	0.00000E+00
338	2.00000E+00	7.50000E-01	0.00000E+00
339	2.25000E+00	7.50000E-01	0.00000E+00
340	2.50000E+00	7.50000E-01	0.00000E+00
341	2.75000E+00	7.50000E-01	0.00000E+00
342	3.00000E+00	7.50000E-01	0.00000E+00
343	-2.50000E+00	1.00000E+00	0.00000E+00
344	-2.25000E+00	1.00000E+00	0.00000E+00
345	-2.00000E+00	1.00000E+00	0.00000E+00
346	-1.75000E+00	1.00000E+00	0.00000E+00
347	-1.50000E+00	1.00000E+00	0.00000E+00
348	-1.25000E+00	1.00000E+00	0.00000E+00
349	-1.00000E+00	1.00000E+00	0.00000E+00
350	-7.50000E-01	1.00000E+00	0.00000E+00

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================= I M A G E S - 3 D =================

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CHECK GEOMETRY Version 3.0 12/31/93

Filename=PADEYE
Title =K BASIN ISOLATION BARRIER PADEYE MODIFICATION

Node	X-Coord.	Y-Coord.	Z-Coord.
351	-5.00000E-01	1.00000E+00	0.00000E+00
352	-2.50000E-01	1.00000E+00	0.00000E+00
353	-3.20375E-07	1.00000E+00	0.00000E+00
354	2.50000E-01	1.00000E+00	0.00000E+00
355	5.00000E-01	1.00000E+00	0.00000E+00
356	7.50000E-01	1.00000E+00	0.00000E+00
357	1.00000E+00	1.00000E+00	0.00000E+00
358	1.25000E+00	1.00000E+00	0.00000E+00
359	1.50000E+00	1.00000E+00	0.00000E+00
360	1.75000E+00	1.00000E+00	0.00000E+00
361	2.00000E+00	1.00000E+00	0.00000E+00
362	2.25000E+00	1.00000E+00	0.00000E+00
363	2.50000E+00	1.00000E+00	0.00000E+00
364	2.75000E+00	1.00000E+00	0.00000E+00
365	3.00000E+00	1.00000E+00	0.00000E+00
366	-2.50000E+00	1.25000E+00	0.00000E+00
367	-2.25000E+00	1.25000E+00	0.00000E+00
368	-2.00000E+00	1.25000E+00	0.00000E+00
369	-1.75000E+00	1.25000E+00	0.00000E+00
370	-1.50000E+00	1.25000E+00	0.00000E+00
371	-1.25000E+00	1.25000E+00	0.00000E+00
372	-1.00000E+00	1.25000E+00	0.00000E+00
373	-7.50000E-01	1.25000E+00	0.00000E+00
374	-5.00000E-01	1.25000E+00	0.00000E+00
375	-2.50000E-01	1.25000E+00	0.00000E+00
376	-2.68221E-07	1.25000E+00	0.00000E+00
377	2.50000E-01	1.25000E+00	0.00000E+00
378	5.00000E-01	1.25000E+00	0.00000E+00
379	7.50000E-01	1.25000E+00	0.00000E+00
380	1.00000E+00	1.25000E+00	0.00000E+00
381	1.25000E+00	1.25000E+00	0.00000E+00
382	1.50000E+00	1.25000E+00	0.00000E+00
383	1.75000E+00	1.25000E+00	0.00000E+00
384	2.00000E+00	1.25000E+00	0.00000E+00
385	2.25000E+00	1.25000E+00	0.00000E+00
386	2.50000E+00	1.25000E+00	0.00000E+00
387	2.75000E+00	1.25000E+00	0.00000E+00
388	3.00000E+00	1.25000E+00	0.00000E+00
389	-2.50000E+00	1.50000E+00	0.00000E+00
390	-2.25000E+00	1.50000E+00	0.00000E+00
391	-2.00000E+00	1.50000E+00	0.00000E+00
392	-1.75000E+00	1.50000E+00	0.00000E+00

================== I M A G E S - 3 D ==================

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CHECK GEOMETRY Version 3.0 12/31/93

Filename=PADEYE
Title =K BASIN ISOLATION BARRIER PADEYE MODIFICATION

Node	X-Coord.	Y-Coord.	Z-Coord.
393	-1.50000E+00	1.50000E+00	0.00000E+00
394	-1.25000E+00	1.50000E+00	0.00000E+00
395	-1.00000E+00	1.50000E+00	0.00000E+00
396	-7.50000E-01	1.50000E+00	0.00000E+00
397	-5.00000E-01	1.50000E+00	0.00000E+00
398	-2.50000E-01	1.50000E+00	0.00000E+00
399	-3.12924E-07	1.50000E+00	0.00000E+00
400	2.50000E-01	1.50000E+00	0.00000E+00
401	5.00000E-01	1.50000E+00	0.00000E+00
402	7.50000E-01	1.50000E+00	0.00000E+00
403	1.00000E+00	1.50000E+00	0.00000E+00
404	1.25000E+00	1.50000E+00	0.00000E+00
405	1.50000E+00	1.50000E+00	0.00000E+00
406	1.75000E+00	1.50000E+00	0.00000E+00
407	2.00000E+00	1.50000E+00	0.00000E+00
408	2.25000E+00	1.50000E+00	0.00000E+00
409	2.50000E+00	1.50000E+00	0.00000E+00
410	2.75000E+00	1.50000E+00	0.00000E+00
411	3.00000E+00	1.50000E+00	0.00000E+00
412	-2.50000E+00	1.75000E+00	0.00000E+00
413	-2.25000E+00	1.75000E+00	0.00000E+00
414	-2.00000E+00	1.75000E+00	0.00000E+00
415	-1.75000E+00	1.75000E+00	0.00000E+00
416	-1.50000E+00	1.75000E+00	0.00000E+00
417	-1.25000E+00	1.75000E+00	0.00000E+00
418	-1.00000E+00	1.75000E+00	0.00000E+00
419	-7.50000E-01	1.75000E+00	0.00000E+00
420	-5.00000E-01	1.75000E+00	0.00000E+00
421	-2.50000E-01	1.75000E+00	0.00000E+00
422	-2.23517E-07	1.75000E+00	0.00000E+00
423	2.50000E-01	1.75000E+00	0.00000E+00
424	5.00000E-01	1.75000E+00	0.00000E+00
425	7.50000E-01	1.75000E+00	0.00000E+00
426	1.00000E+00	1.75000E+00	0.00000E+00
427	1.25000E+00	1.75000E+00	0.00000E+00
428	1.50000E+00	1.75000E+00	0.00000E+00
429	1.75000E+00	1.75000E+00	0.00000E+00
430	2.00000E+00	1.75000E+00	0.00000E+00
431	2.25000E+00	1.75000E+00	0.00000E+00
432	2.50000E+00	1.75000E+00	0.00000E+00
433	2.75000E+00	1.75000E+00	0.00000E+00
434	3.00000E+00	1.75000E+00	0.00000E+00

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================= I M A G E S - 3 D =================

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CHECK GEOMETRY Version 3.0 12/31/93

Filename=PADEYE
Title =K BASIN ISOLATION BARRIER PADEYE MODIFICATION

Node	X-Coord.	Y-Coord.	Z-Coord.
435	-2.50000E+00	2.00000E+00	0.00000E+00
436	-2.25000E+00	2.00000E+00	0.00000E+00
437	-2.00000E+00	2.00000E+00	0.00000E+00
438	-1.75000E+00	2.00000E+00	0.00000E+00
439	-1.50000E+00	2.00000E+00	0.00000E+00
440	-1.25000E+00	2.00000E+00	0.00000E+00
441	-1.00000E+00	2.00000E+00	0.00000E+00
442	-7.50000E-01	2.00000E+00	0.00000E+00
443	-5.00000E-01	2.00000E+00	0.00000E+00
444	-2.50000E-01	2.00000E+00	0.00000E+00
445	-2.98023E-07	2.00000E+00	0.00000E+00
446	2.50000E-01	2.00000E+00	0.00000E+00
447	5.00000E-01	2.00000E+00	0.00000E+00
448	7.50000E-01	2.00000E+00	0.00000E+00
449	1.00000E+00	2.00000E+00	0.00000E+00
450	1.25000E+00	2.00000E+00	0.00000E+00
451	1.50000E+00	2.00000E+00	0.00000E+00
452	1.75000E+00	2.00000E+00	0.00000E+00
453	2.00000E+00	2.00000E+00	0.00000E+00
454	2.25000E+00	2.00000E+00	0.00000E+00
455	2.50000E+00	2.00000E+00	0.00000E+00
456	2.75000E+00	2.00000E+00	0.00000E+00
457	3.00000E+00	2.00000E+00	0.00000E+00
458	-2.50000E+00	2.25000E+00	0.00000E+00
459	-2.25000E+00	2.25000E+00	0.00000E+00
460	-2.00000E+00	2.25000E+00	0.00000E+00
461	-1.75000E+00	2.25000E+00	0.00000E+00
462	-1.50000E+00	2.25000E+00	0.00000E+00
463	-1.25000E+00	2.25000E+00	0.00000E+00
464	-1.00000E+00	2.25000E+00	0.00000E+00
465	-7.50000E-01	2.25000E+00	0.00000E+00
466	-5.00000E-01	2.25000E+00	0.00000E+00
467	-2.50000E-01	2.25000E+00	0.00000E+00
468	-2.53320E-07	2.25000E+00	0.00000E+00
469	2.50000E-01	2.25000E+00	0.00000E+00
470	5.00000E-01	2.25000E+00	0.00000E+00
471	7.50000E-01	2.25000E+00	0.00000E+00
472	1.00000E+00	2.25000E+00	0.00000E+00
473	1.25000E+00	2.25000E+00	0.00000E+00
474	1.50000E+00	2.25000E+00	0.00000E+00
475	1.75000E+00	2.25000E+00	0.00000E+00
476	2.00000E+00	2.25000E+00	0.00000E+00

CHECK GEOMETRY Version 3.0 12/31/93

Filename=PADEYE
Title =K BASIN ISOLATION BARRIER PADEYE MODIFICATION

Node	X-Coord.	Y-Coord.	Z-Coord.
477	2.25000E+00	2.25000E+00	0.00000E+00
478	2.50000E+00	2.25000E+00	0.00000E+00
479	2.75000E+00	2.25000E+00	0.00000E+00
480	3.00000E+00	2.25000E+00	0.00000E+00
481	-2.50000E+00	2.50000E+00	0.00000E+00
482	-2.25000E+00	2.50000E+00	0.00000E+00
483	-2.00000E+00	2.50000E+00	0.00000E+00
484	-1.75000E+00	2.50000E+00	0.00000E+00
485	-1.50000E+00	2.50000E+00	0.00000E+00
486	-1.25000E+00	2.50000E+00	0.00000E+00
487	-1.00000E+00	2.50000E+00	0.00000E+00
488	-7.50000E-01	2.50000E+00	0.00000E+00
489	-5.00000E-01	2.50000E+00	0.00000E+00
490	-2.50000E-01	2.50000E+00	0.00000E+00
491	-2.68221E-07	2.50000E+00	0.00000E+00
492	2.50000E-01	2.50000E+00	0.00000E+00
493	5.00000E-01	2.50000E+00	0.00000E+00
494	7.50000E-01	2.50000E+00	0.00000E+00
495	1.00000E+00	2.50000E+00	0.00000E+00
496	1.25000E+00	2.50000E+00	0.00000E+00
497	1.50000E+00	2.50000E+00	0.00000E+00
498	1.75000E+00	2.50000E+00	0.00000E+00
499	2.00000E+00	2.50000E+00	0.00000E+00
500	2.25000E+00	2.50000E+00	0.00000E+00
501	2.50000E+00	2.50000E+00	0.00000E+00
502	2.75000E+00	2.50000E+00	0.00000E+00
503	3.00000E+00	2.50000E+00	0.00000E+00
504	-2.50000E+00	2.75000E+00	0.00000E+00
505	-2.25000E+00	2.75000E+00	0.00000E+00
506	-2.00000E+00	2.75000E+00	0.00000E+00
507	-1.75000E+00	2.75000E+00	0.00000E+00
508	-1.50000E+00	2.75000E+00	0.00000E+00
509	-1.25000E+00	2.75000E+00	0.00000E+00
510	-1.00000E+00	2.75000E+00	0.00000E+00
511	-7.50000E-01	2.75000E+00	0.00000E+00
512	-5.00000E-01	2.75000E+00	0.00000E+00
513	-2.50000E-01	2.75000E+00	0.00000E+00
514	-3.12924E-07	2.75000E+00	0.00000E+00
515	2.50000E-01	2.75000E+00	0.00000E+00
516	5.00000E-01	2.75000E+00	0.00000E+00
517	7.50000E-01	2.75000E+00	0.00000E+00
518	1.00000E+00	2.75000E+00	0.00000E+00

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================== I M A G E S - 3 D ==================

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CHECK GEOMETRY Version 3.0 12/31/93

Filename=PADEYE
Title =K BASIN ISOLATION BARRIER PADEYE MODIFICATION

Node	X-Coord.	Y-Coord.	Z-Coord.
519	1.25000E+00	2.75000E+00	0.00000E+00
520	1.50000E+00	2.75000E+00	0.00000E+00
521	1.75000E+00	2.75000E+00	0.00000E+00
522	2.00000E+00	2.75000E+00	0.00000E+00
523	2.25000E+00	2.75000E+00	0.00000E+00
524	2.50000E+00	2.75000E+00	0.00000E+00
525	2.75000E+00	2.75000E+00	0.00000E+00
526	3.00000E+00	2.75000E+00	0.00000E+00
527	-2.50000E+00	3.00000E+00	0.00000E+00
528	-2.25000E+00	3.00000E+00	0.00000E+00
529	-2.00000E+00	3.00000E+00	0.00000E+00
530	-1.75000E+00	3.00000E+00	0.00000E+00
531	-1.50000E+00	3.00000E+00	0.00000E+00
532	-1.25000E+00	3.00000E+00	0.00000E+00
533	-1.00000E+00	3.00000E+00	0.00000E+00
534	-7.50000E-01	3.00000E+00	0.00000E+00
535	-5.00000E-01	3.00000E+00	0.00000E+00
536	-2.50000E-01	3.00000E+00	0.00000E+00
537	-2.38419E-07	3.00000E+00	0.00000E+00
538	2.50000E-01	3.00000E+00	0.00000E+00
539	5.00000E-01	3.00000E+00	0.00000E+00
540	7.50000E-01	3.00000E+00	0.00000E+00
541	1.00000E+00	3.00000E+00	0.00000E+00
542	1.25000E+00	3.00000E+00	0.00000E+00
543	1.50000E+00	3.00000E+00	0.00000E+00
544	1.75000E+00	3.00000E+00	0.00000E+00
545	2.00000E+00	3.00000E+00	0.00000E+00
546	2.25000E+00	3.00000E+00	0.00000E+00
547	2.50000E+00	3.00000E+00	0.00000E+00
548	2.75000E+00	3.00000E+00	0.00000E+00
549	3.00000E+00	3.00000E+00	0.00000E+00
550	-2.50000E+00	3.25000E+00	0.00000E+00
551	-2.25000E+00	3.25000E+00	0.00000E+00
552	-2.00000E+00	3.25000E+00	0.00000E+00
553	-1.75000E+00	3.25000E+00	0.00000E+00
554	-1.50000E+00	3.25000E+00	0.00000E+00
555	-1.25000E+00	3.25000E+00	0.00000E+00
556	-1.00000E+00	3.25000E+00	0.00000E+00
557	-7.50000E-01	3.25000E+00	0.00000E+00
558	-5.00000E-01	3.25000E+00	0.00000E+00
559	-2.50000E-01	3.25000E+00	0.00000E+00
560	-2.68221E-07	3.25000E+00	0.00000E+00

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PAGE 15 RUN ID=ET00018 00:19:37

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CHECK GEOMETRY Version 3.0 12/31/93

Filename=PADEYE
Title =K BASIN ISOLATION BARRIER PADEYE MODIFICATION

Node	X-Coord.	Y-Coord.	Z-Coord.
561	2.50000E-01	3.25000E+00	0.00000E+00
562	5.00000E-01	3.25000E+00	0.00000E+00
563	7.50000E-01	3.25000E+00	0.00000E+00
564	1.00000E+00	3.25000E+00	0.00000E+00
565	1.25000E+00	3.25000E+00	0.00000E+00
566	1.50000E+00	3.25000E+00	0.00000E+00
567	1.75000E+00	3.25000E+00	0.00000E+00
568	2.00000E+00	3.25000E+00	0.00000E+00
569	2.25000E+00	3.25000E+00	0.00000E+00
570	2.50000E+00	3.25000E+00	0.00000E+00
571	2.75000E+00	3.25000E+00	0.00000E+00
572	3.00000E+00	3.25000E+00	0.00000E+00
573	-2.50000E+00	3.50000E+00	0.00000E+00
574	-2.25000E+00	3.50000E+00	0.00000E+00
575	-2.00000E+00	3.50000E+00	0.00000E+00
576	-1.75000E+00	3.50000E+00	0.00000E+00
577	-1.50000E+00	3.50000E+00	0.00000E+00
578	-1.25000E+00	3.50000E+00	0.00000E+00
579	-1.00000E+00	3.50000E+00	0.00000E+00
580	-7.50000E-01	3.50000E+00	0.00000E+00
581	-5.00000E-01	3.50000E+00	0.00000E+00
582	-2.50000E-01	3.50000E+00	0.00000E+00
583	-2.98023E-07	3.50000E+00	0.00000E+00
584	2.50000E-01	3.50000E+00	0.00000E+00
585	5.00000E-01	3.50000E+00	0.00000E+00
586	7.50000E-01	3.50000E+00	0.00000E+00
587	1.00000E+00	3.50000E+00	0.00000E+00
588	1.25000E+00	3.50000E+00	0.00000E+00
589	1.50000E+00	3.50000E+00	0.00000E+00
590	1.75000E+00	3.50000E+00	0.00000E+00
591	2.00000E+00	3.50000E+00	0.00000E+00
592	2.25000E+00	3.50000E+00	0.00000E+00
593	2.50000E+00	3.50000E+00	0.00000E+00
594	2.75000E+00	3.50000E+00	0.00000E+00
595	3.00000E+00	3.50000E+00	0.00000E+00
596	-2.50000E+00	3.75000E+00	0.00000E+00
597	-2.25000E+00	3.75000E+00	0.00000E+00
598	-2.00000E+00	3.75000E+00	0.00000E+00
599	-1.75000E+00	3.75000E+00	0.00000E+00
600	-1.50000E+00	3.75000E+00	0.00000E+00
601	-1.25000E+00	3.75000E+00	0.00000E+00
602	-1.00000E+00	3.75000E+00	0.00000E+00

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PAGE 16 RUN ID=ET00018 00:19:44

================= I M A G E S - 3 D =================

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CHECK GEOMETRY Version 3.0 12/31/93

Filename=PADEYE
Title =K BASIN ISOLATION BARRIER PADEYE MODIFICATION

Node	X-Coord.	Y-Coord.	Z-Coord.
603	-7.50000E-01	3.75000E+00	0.00000E+00
604	-5.00000E-01	3.75000E+00	0.00000E+00
605	-2.50000E-01	3.75000E+00	0.00000E+00
606	-3.27825E-07	3.75000E+00	0.00000E+00
607	2.50000E-01	3.75000E+00	0.00000E+00
608	5.00000E-01	3.75000E+00	0.00000E+00
609	7.50000E-01	3.75000E+00	0.00000E+00
610	1.00000E+00	3.75000E+00	0.00000E+00
611	1.25000E+00	3.75000E+00	0.00000E+00
612	1.50000E+00	3.75000E+00	0.00000E+00
613	1.75000E+00	3.75000E+00	0.00000E+00
614	2.00000E+00	3.75000E+00	0.00000E+00
615	2.25000E+00	3.75000E+00	0.00000E+00
616	2.50000E+00	3.75000E+00	0.00000E+00
617	2.75000E+00	3.75000E+00	0.00000E+00
618	3.00000E+00	3.75000E+00	0.00000E+00
619	-2.50000E+00	4.00000E+00	0.00000E+00
620	-2.25000E+00	4.00000E+00	0.00000E+00
621	-2.00000E+00	4.00000E+00	0.00000E+00
622	-1.75000E+00	4.00000E+00	0.00000E+00
623	-1.50000E+00	4.00000E+00	0.00000E+00
624	-1.25000E+00	4.00000E+00	0.00000E+00
625	-1.00000E+00	4.00000E+00	0.00000E+00
626	-7.50000E-01	4.00000E+00	0.00000E+00
627	-5.00000E-01	4.00000E+00	0.00000E+00
628	-2.50000E-01	4.00000E+00	0.00000E+00
629	-2.68221E-07	4.00000E+00	0.00000E+00
630	2.50000E-01	4.00000E+00	0.00000E+00
631	5.00000E-01	4.00000E+00	0.00000E+00
632	7.50000E-01	4.00000E+00	0.00000E+00
633	1.00000E+00	4.00000E+00	0.00000E+00
634	1.25000E+00	4.00000E+00	0.00000E+00
635	1.50000E+00	4.00000E+00	0.00000E+00
636	1.75000E+00	4.00000E+00	0.00000E+00
637	2.00000E+00	4.00000E+00	0.00000E+00
638	2.25000E+00	4.00000E+00	0.00000E+00
639	2.50000E+00	4.00000E+00	0.00000E+00
640	2.75000E+00	4.00000E+00	0.00000E+00
641	3.00000E+00	4.00000E+00	0.00000E+00
642	-2.50000E+00	4.25000E+00	0.00000E+00
643	-2.25000E+00	4.25000E+00	0.00000E+00
644	-2.00000E+00	4.25000E+00	0.00000E+00

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PAGE 17 RUN ID=ET00018 00:19:51

================= I M A G E S - 3 D =================
= Copyright (c) 1984-1993. RLCA/Celestial Software =
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CHECK GEOMETRY Version 3.0 12/31/93

Filename=PADEYE
Title =K BASIN ISOLATION BARRIER PADEYE MODIFICATION

Node	X-Coord.	Y-Coord.	Z-Coord.
645	-1.75000E+00	4.25000E+00	0.00000E+00
646	-1.50000E+00	4.25000E+00	0.00000E+00
647	-1.25000E+00	4.25000E+00	0.00000E+00
648	-1.00000E+00	4.25000E+00	0.00000E+00
649	-7.50000E-01	4.25000E+00	0.00000E+00
650	-5.00000E-01	4.25000E+00	0.00000E+00
651	-2.50000E-01	4.25000E+00	0.00000E+00
652	-2.98023E-07	4.25000E+00	0.00000E+00
653	2.50000E-01	4.25000E+00	0.00000E+00
654	5.00000E-01	4.25000E+00	0.00000E+00
655	7.50000E-01	4.25000E+00	0.00000E+00
656	1.00000E+00	4.25000E+00	0.00000E+00
657	1.25000E+00	4.25000E+00	0.00000E+00
658	1.50000E+00	4.25000E+00	0.00000E+00
659	1.75000E+00	4.25000E+00	0.00000E+00
660	2.00000E+00	4.25000E+00	0.00000E+00
661	2.25000E+00	4.25000E+00	0.00000E+00
662	2.50000E+00	4.25000E+00	0.00000E+00
663	2.75000E+00	4.25000E+00	0.00000E+00
664	3.00000E+00	4.25000E+00	0.00000E+00
665	-2.50000E+00	4.50000E+00	0.00000E+00
666	-2.25000E+00	4.50000E+00	0.00000E+00
667	-2.00000E+00	4.50000E+00	0.00000E+00
668	-1.75000E+00	4.50000E+00	0.00000E+00
669	-1.50000E+00	4.50000E+00	0.00000E+00
670	-1.25000E+00	4.50000E+00	0.00000E+00
671	-1.00000E+00	4.50000E+00	0.00000E+00
672	-7.50000E-01	4.50000E+00	0.00000E+00
673	-5.00000E-01	4.58580E+00	0.00000E+00
674	-2.50000E-01	4.52100E+00	0.00000E+00
675	-2.98023E-07	4.50000E+00	0.00000E+00
676	2.50000E-01	4.52100E+00	0.00000E+00
677	5.00000E-01	4.58580E+00	0.00000E+00
678	7.50000E-01	4.50000E+00	0.00000E+00
679	1.00000E+00	4.50000E+00	0.00000E+00
680	1.25000E+00	4.50000E+00	0.00000E+00
681	1.50000E+00	4.50000E+00	0.00000E+00
682	1.75000E+00	4.50000E+00	0.00000E+00
683	2.00000E+00	4.50000E+00	0.00000E+00
684	2.25000E+00	4.50000E+00	0.00000E+00
685	2.50000E+00	4.50000E+00	0.00000E+00
686	2.75000E+00	4.50000E+00	0.00000E+00

WESTINGHOUSE HANFORD COMPANY

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================= I M A G E S - 3 D =================

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CHECK GEOMETRY Version 3.0 12/31/93

Filename=PADEYE
Title =K BASIN ISOLATION BARRIER PADEYE MODIFICATION

Node	X-Coord.	Y-Coord.	Z-Coord.
687	3.00000E+00	4.50000E+00	0.00000E+00
688	-2.50000E+00	4.75000E+00	0.00000E+00
689	-2.25000E+00	4.75000E+00	0.00000E+00
690	-2.00000E+00	4.75000E+00	0.00000E+00
691	-1.75000E+00	4.75000E+00	0.00000E+00
692	-1.50000E+00	4.75000E+00	0.00000E+00
693	-1.25000E+00	4.75000E+00	0.00000E+00
694	-1.00000E+00	4.75000E+00	0.00000E+00
695	-8.28200E-01	4.75000E+00	0.00000E+00
696	8.29200E-01	4.75000E+00	0.00000E+00
697	1.00000E+00	4.75000E+00	0.00000E+00
698	1.25000E+00	4.75000E+00	0.00000E+00
699	1.50000E+00	4.75000E+00	0.00000E+00
700	1.75000E+00	4.75000E+00	0.00000E+00
701	2.00000E+00	4.75000E+00	0.00000E+00
702	2.25000E+00	4.75000E+00	0.00000E+00
703	2.50000E+00	4.75000E+00	0.00000E+00
704	2.75000E+00	4.75000E+00	0.00000E+00
705	3.00000E+00	4.75000E+00	0.00000E+00
706	-2.50000E+00	5.00000E+00	0.00000E+00
707	-2.25000E+00	5.00000E+00	0.00000E+00
708	-2.00000E+00	5.00000E+00	0.00000E+00
709	-1.75000E+00	5.00000E+00	0.00000E+00
710	-1.50000E+00	5.00000E+00	0.00000E+00
711	-1.25000E+00	5.00000E+00	0.00000E+00
712	-1.11800E+00	5.00000E+00	0.00000E+00
713	1.11800E+00	5.00000E+00	0.00000E+00
714	1.25000E+00	5.00000E+00	0.00000E+00
715	1.50000E+00	5.00000E+00	0.00000E+00
716	1.75000E+00	5.00000E+00	0.00000E+00
717	2.00000E+00	5.00000E+00	0.00000E+00
718	2.25000E+00	5.00000E+00	0.00000E+00
719	2.50000E+00	5.00000E+00	0.00000E+00
720	2.75000E+00	5.00000E+00	0.00000E+00
721	3.00000E+00	5.00000E+00	0.00000E+00
722	-2.50000E+00	5.25000E+00	0.00000E+00
723	-2.25000E+00	5.25000E+00	0.00000E+00
724	-2.00000E+00	5.25000E+00	0.00000E+00
725	-1.75000E+00	5.25000E+00	0.00000E+00
726	-1.50000E+00	5.25000E+00	0.00000E+00
727	-1.29900E+00	5.25000E+00	0.00000E+00
728	1.29900E+00	5.25000E+00	0.00000E+00

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================= I M A G E S - 3 D =================

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CHECK GEOMETRY Version 3.0 12/31/93

Filename=PADEYE
Title =K BASIN ISOLATION BARRIER PADEYE MODIFICATION

Node	X-Coord.	Y-Coord.	Z-Coord.
729	1.50000E+00	5.25000E+00	0.00000E+00
730	1.75000E+00	5.25000E+00	0.00000E+00
731	2.00000E+00	5.25000E+00	0.00000E+00
732	2.25000E+00	5.25000E+00	0.00000E+00
733	2.50000E+00	5.25000E+00	0.00000E+00
734	2.75000E+00	5.25000E+00	0.00000E+00
735	3.00000E+00	5.25000E+00	0.00000E+00
736	-2.50000E+00	5.50000E+00	0.00000E+00
737	-2.25000E+00	5.50000E+00	0.00000E+00
738	-2.00000E+00	5.50000E+00	0.00000E+00
739	-1.75000E+00	5.50000E+00	0.00000E+00
740	-1.41420E+00	5.50000E+00	0.00000E+00
741	1.41420E+00	5.50000E+00	0.00000E+00
742	1.75000E+00	5.50000E+00	0.00000E+00
743	2.00000E+00	5.50000E+00	0.00000E+00
744	2.25000E+00	5.50000E+00	0.00000E+00
745	2.50000E+00	5.50000E+00	0.00000E+00
746	2.75000E+00	5.50000E+00	0.00000E+00
747	3.00000E+00	5.50000E+00	0.00000E+00
748	-2.50000E+00	5.75000E+00	0.00000E+00
749	-2.25000E+00	5.75000E+00	0.00000E+00
750	-2.00000E+00	5.75000E+00	0.00000E+00
751	-1.75000E+00	5.75000E+00	0.00000E+00
752	-1.47900E+00	5.75000E+00	0.00000E+00
753	1.47900E+00	5.75000E+00	0.00000E+00
754	1.75000E+00	5.75000E+00	0.00000E+00
755	2.00000E+00	5.75000E+00	0.00000E+00
756	2.25000E+00	5.75000E+00	0.00000E+00
757	2.50000E+00	5.75000E+00	0.00000E+00
758	2.75000E+00	5.75000E+00	0.00000E+00
759	3.00000E+00	5.75000E+00	0.00000E+00

PLATE ELEMENT CONNECTIVITY

Plate No	Nodes I	J	K	L	Thk Set	Dir	Thickness	Area	Aspect Ratio	Plate Type
1	1	2	7	6	1	1	5.000E-01	5.279E-02	1.227E+00	QUAD Plate
2	2	3	8	7	1	1	5.000E-01	4.630E-02	1.347E+00	QUAD Plate
3	3	4	9	8	1	1	5.000E-01	4.085E-02	1.527E+00	QUAD Plate

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CHECK GEOMETRY Version 3.0 12/31/93

Filename=PADEYE
Title =K BASIN ISOLATION BARRIER PADEYE MODIFICATION

late No	Nodes I	J	K	L	Thk Set	Dir	Thickness	Area	Aspect Ratio	Plate Type
4	4	5	10	9	1	1	5.000E-01	3.541E-02	1.762E+00	QUAD Plate
5	6	7	12	11	1	1	5.000E-01	5.701E-02	1.312E+00	QUAD Plate
6	7	8	13	12	1	1	5.000E-01	4.630E-02	1.347E+00	QUAD Plate
7	8	9	14	13	1	1	5.000E-01	4.085E-02	1.527E+00	QUAD Plate
8	9	10	15	14	1	1	5.000E-01	3.541E-02	1.762E+00	QUAD Plate
9	11	17	16		1	1	5.000E-01	9.758E-03	1.678E+00	TRI Plate
10	11	12	18	17	1	1	5.000E-01	5.595E-02	1.288E+00	QUAD Plate
11	12	13	19	18	1	1	5.000E-01	4.630E-02	1.347E+00	QUAD Plate
12	13	14	20	19	1	1	5.000E-01	4.085E-02	1.527E+00	QUAD Plate
13	14	15	21	20	1	1	5.000E-01	3.541E-02	1.762E+00	QUAD Plate
14	16	17	23	22	1	1	5.000E-01	2.770E-02	5.487E-01	QUAD Plate
15	17	18	24	23	1	1	5.000E-01	5.175E-02	1.205E+00	QUAD Plate
16	18	19	25	24	1	1	5.000E-01	4.630E-02	1.347E+00	QUAD Plate
17	19	20	26	25	1	1	5.000E-01	4.085E-02	1.527E+00	QUAD Plate
18	20	21	27	26	1	1	5.000E-01	3.541E-02	1.762E+00	QUAD Plate
19	22	23	29	28	1	1	5.000E-01	4.745E-02	9.001E-01	QUAD Plate
20	23	24	30	29	1	1	5.000E-01	5.175E-02	1.205E+00	QUAD Plate
21	24	25	31	30	1	1	5.000E-01	4.630E-02	1.347E+00	QUAD Plate
22	25	26	32	31	1	1	5.000E-01	4.085E-02	1.527E+00	QUAD Plate
23	26	27	33	32	1	1	5.000E-01	3.541E-02	1.762E+00	QUAD Plate
24	28	35	34		1	1	5.000E-01	1.644E-02	1.315E+00	TRI Plate
25	28	29	36	35	1	1	5.000E-01	5.821E-02	1.108E+00	QUAD Plate
26	29	30	37	36	1	1	5.000E-01	5.175E-02	1.205E+00	QUAD Plate
27	30	31	38	37	1	1	5.000E-01	4.630E-02	1.347E+00	QUAD Plate
28	31	32	39	38	1	1	5.000E-01	4.085E-02	1.527E+00	QUAD Plate
29	32	33	40	39	1	1	5.000E-01	3.541E-02	1.762E+00	QUAD Plate
30	34	35	42	41	1	1	5.000E-01	4.297E-02	9.047E-01	QUAD Plate
31	35	36	43	42	1	1	5.000E-01	5.720E-02	1.091E+00	QUAD Plate
32	36	37	44	43	1	1	5.000E-01	5.175E-02	1.205E+00	QUAD Plate
33	37	38	45	44	1	1	5.000E-01	4.630E-02	1.347E+00	QUAD Plate
34	38	39	46	45	1	1	5.000E-01	4.085E-02	1.527E+00	QUAD Plate
35	39	40	47	46	1	1	5.000E-01	3.541E-02	1.762E+00	QUAD Plate
36	41	42	49	48	1	1	5.000E-01	7.153E-02	8.682E-01	QUAD Plate
37	42	43	50	49	1	1	5.000E-01	5.720E-02	1.091E+00	QUAD Plate
38	43	44	51	50	1	1	5.000E-01	5.175E-02	1.205E+00	QUAD Plate
39	44	45	52	51	1	1	5.000E-01	4.630E-02	1.347E+00	QUAD Plate
40	45	46	53	52	1	1	5.000E-01	4.085E-02	1.527E+00	QUAD Plate
41	46	47	54	53	1	1	5.000E-01	3.541E-02	1.762E+00	QUAD Plate
42	48	49	56	55	1	1	5.000E-01	6.264E-02	9.958E-01	QUAD Plate
43	49	50	57	56	1	1	5.000E-01	5.720E-02	1.091E+00	QUAD Plate
44	50	51	58	57	1	1	5.000E-01	5.175E-02	1.205E+00	QUAD Plate

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================= I M A G E S - 3 D =================

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CHECK GEOMETRY Version 3.0 12/31/93

Filename=PADEYE
Title =K BASIN ISOLATION BARRIER PADEYE MODIFICATION

Plate No	Nodes I	J	K	L	Thk Set	Dir	Thickness	Area	Aspect Ratio	Plate Type
45	51	52	59	58	1	1	5.000E-01	4.630E-02	1.347E+00	QUAD Plate
46	52	53	60	59	1	1	5.000E-01	4.085E-02	1.527E+00	QUAD Plate
47	53	54	61	60	1	1	5.000E-01	3.541E-02	1.762E+00	QUAD Plate
48	55	56	63	62	1	1	5.000E-01	6.264E-02	9.958E-01	QUAD Plate
49	56	57	64	63	1	1	5.000E-01	5.720E-02	1.091E+00	QUAD Plate
50	57	58	65	64	1	1	5.000E-01	5.175E-02	1.205E+00	QUAD Plate
51	58	59	66	65	1	1	5.000E-01	4.630E-02	1.347E+00	QUAD Plate
52	59	60	67	66	1	1	5.000E-01	4.085E-02	1.527E+00	QUAD Plate
53	60	61	68	67	1	1	5.000E-01	3.541E-02	1.762E+00	QUAD Plate
54	62	63	70	69	1	1	5.000E-01	6.264E-02	9.958E-01	QUAD Plate
55	63	64	71	70	1	1	5.000E-01	5.720E-02	1.091E+00	QUAD Plate
56	64	65	72	71	1	1	5.000E-01	5.175E-02	1.205E+00	QUAD Plate
57	65	66	73	72	1	1	5.000E-01	4.630E-02	1.347E+00	QUAD Plate
58	66	67	74	73	1	1	5.000E-01	4.085E-02	1.527E+00	QUAD Plate
59	67	68	75	74	1	1	5.000E-01	3.541E-02	1.762E+00	QUAD Plate
60	69	70	77	76	1	1	5.000E-01	6.264E-02	9.958E-01	QUAD Plate
61	70	71	78	77	1	1	5.000E-01	5.720E-02	1.091E+00	QUAD Plate
62	71	72	79	78	1	1	5.000E-01	5.175E-02	1.205E+00	QUAD Plate
63	72	73	80	79	1	1	5.000E-01	4.630E-02	1.347E+00	QUAD Plate
64	73	74	81	80	1	1	5.000E-01	4.085E-02	1.527E+00	QUAD Plate
65	74	75	82	81	1	1	5.000E-01	3.541E-02	1.762E+00	QUAD Plate
66	76	77	84	83	1	1	5.000E-01	6.264E-02	9.958E-01	QUAD Plate
67	77	78	85	84	1	1	5.000E-01	5.720E-02	1.091E+00	QUAD Plate
68	78	79	86	85	1	1	5.000E-01	5.175E-02	1.205E+00	QUAD Plate
69	79	80	87	86	1	1	5.000E-01	4.630E-02	1.347E+00	QUAD Plate
70	80	81	88	87	1	1	5.000E-01	4.085E-02	1.527E+00	QUAD Plate
71	81	82	89	88	1	1	5.000E-01	3.541E-02	1.762E+00	QUAD Plate
72	83	84	91	90	1	1	5.000E-01	6.264E-02	9.958E-01	QUAD Plate
73	84	85	92	91	1	1	5.000E-01	5.720E-02	1.091E+00	QUAD Plate
74	85	86	93	92	1	1	5.000E-01	5.175E-02	1.205E+00	QUAD Plate
75	86	87	94	93	1	1	5.000E-01	4.630E-02	1.347E+00	QUAD Plate
76	87	88	95	94	1	1	5.000E-01	4.085E-02	1.527E+00	QUAD Plate
77	88	89	96	95	1	1	5.000E-01	3.541E-02	1.762E+00	QUAD Plate
78	90	91	98	97	1	1	5.000E-01	6.264E-02	9.958E-01	QUAD Plate
79	91	92	99	98	1	1	5.000E-01	5.720E-02	1.091E+00	QUAD Plate
80	92	93	100	99	1	1	5.000E-01	5.175E-02	1.205E+00	QUAD Plate
81	93	94	101	100	1	1	5.000E-01	4.630E-02	1.347E+00	QUAD Plate
82	94	95	102	101	1	1	5.000E-01	4.085E-02	1.527E+00	QUAD Plate
83	95	96	103	102	1	1	5.000E-01	3.541E-02	1.762E+00	QUAD Plate
84	97	98	105	104	1	1	5.000E-01	6.264E-02	9.958E-01	QUAD Plate
85	98	99	106	105	1	1	5.000E-01	5.720E-02	1.091E+00	QUAD Plate

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================= I M A G E S - 3 D =================

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CHECK GEOMETRY Version 3.0 12/31/93

Filename=PADEYE
Title =K BASIN ISOLATION BARRIER PADEYE MODIFICATION

Plate No	Nodes I	J	K	L	Thk Set	Dir	Thickness	Area	Aspect Ratio	Plate Type
86	99	100	107	106	1	1	5.000E-01	5.175E-02	1.205E+00	QUAD Plate
87	100	101	108	107	1	1	5.000E-01	4.630E-02	1.347E+00	QUAD Plate
88	101	102	109	108	1	1	5.000E-01	4.085E-02	1.527E+00	QUAD Plate
89	102	103	110	109	1	1	5.000E-01	3.541E-02	1.762E+00	QUAD Plate
90	104	105	112	111	1	1	5.000E-01	6.264E-02	9.958E-01	QUAD Plate
91	105	106	113	112	1	1	5.000E-01	5.720E-02	1.091E+00	QUAD Plate
92	106	107	114	113	1	1	5.000E-01	5.175E-02	1.205E+00	QUAD Plate
93	107	108	115	114	1	1	5.000E-01	4.630E-02	1.347E+00	QUAD Plate
94	108	109	116	115	1	1	5.000E-01	4.085E-02	1.527E+00	QUAD Plate
95	109	110	117	116	1	1	5.000E-01	3.541E-02	1.762E+00	QUAD Plate
96	111	112	119	118	1	1	5.000E-01	6.264E-02	9.958E-01	QUAD Plate
97	112	113	120	119	1	1	5.000E-01	5.720E-02	1.091E+00	QUAD Plate
98	113	114	121	120	1	1	5.000E-01	5.175E-02	1.205E+00	QUAD Plate
99	114	115	122	121	1	1	5.000E-01	4.630E-02	1.347E+00	QUAD Plate
100	115	116	123	122	1	1	5.000E-01	4.085E-02	1.527E+00	QUAD Plate
101	116	117	124	123	1	1	5.000E-01	3.541E-02	1.762E+00	QUAD Plate
102	118	119	126	125	1	1	5.000E-01	6.264E-02	9.958E-01	QUAD Plate
103	119	120	127	126	1	1	5.000E-01	5.720E-02	1.091E+00	QUAD Plate
104	120	121	128	127	1	1	5.000E-01	5.175E-02	1.205E+00	QUAD Plate
105	121	122	129	128	1	1	5.000E-01	4.630E-02	1.347E+00	QUAD Plate
106	122	123	130	129	1	1	5.000E-01	4.085E-02	1.527E+00	QUAD Plate
107	123	124	131	130	1	1	5.000E-01	3.541E-02	1.762E+00	QUAD Plate
108	125	126	133	132	1	1	5.000E-01	6.264E-02	9.958E-01	QUAD Plate
109	126	127	134	133	1	1	5.000E-01	5.720E-02	1.091E+00	QUAD Plate
110	127	128	135	134	1	1	5.000E-01	5.175E-02	1.205E+00	QUAD Plate
111	128	129	136	135	1	1	5.000E-01	4.630E-02	1.347E+00	QUAD Plate
112	129	130	137	136	1	1	5.000E-01	4.085E-02	1.527E+00	QUAD Plate
113	130	131	138	137	1	1	5.000E-01	3.541E-02	1.762E+00	QUAD Plate
114	132	133	140	139	1	1	5.000E-01	6.264E-02	9.958E-01	QUAD Plate
115	133	134	141	140	1	1	5.000E-01	5.720E-02	1.091E+00	QUAD Plate
116	134	135	142	141	1	1	5.000E-01	5.175E-02	1.205E+00	QUAD Plate
117	135	136	143	142	1	1	5.000E-01	4.630E-02	1.347E+00	QUAD Plate
118	136	137	144	143	1	1	5.000E-01	4.085E-02	1.527E+00	QUAD Plate
119	137	138	145	144	1	1	5.000E-01	3.541E-02	1.762E+00	QUAD Plate
120	139	140	147	146	1	1	5.000E-01	6.264E-02	9.958E-01	QUAD Plate
121	140	141	148	147	1	1	5.000E-01	5.720E-02	1.091E+00	QUAD Plate
122	141	142	149	148	1	1	5.000E-01	5.175E-02	1.205E+00	QUAD Plate
123	142	143	150	149	1	1	5.000E-01	4.630E-02	1.347E+00	QUAD Plate
124	143	144	151	150	1	1	5.000E-01	4.085E-02	1.527E+00	QUAD Plate
125	144	145	152	151	1	1	5.000E-01	3.541E-02	1.762E+00	QUAD Plate
126	146	147	154	153	1	1	5.000E-01	6.264E-02	9.958E-01	QUAD Plate

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CHECK GEOMETRY Version 3.0 12/31/93

Filename=PADEYE
Title =K BASIN ISOLATION BARRIER PADEYE MODIFICATION

Plate No	Nodes I	J	K	L	Thk Set	Dir	Thickness	Area	Aspect Ratio	Plate Type
127	147	148	155	154	1	1	5.000E-01	5.720E-02	1.091E+00	QUAD Plate
128	148	149	156	155	1	1	5.000E-01	5.175E-02	1.205E+00	QUAD Plate
129	149	150	157	156	1	1	5.000E-01	4.630E-02	1.347E+00	QUAD Plate
130	150	151	158	157	1	1	5.000E-01	4.085E-02	1.527E+00	QUAD Plate
131	151	152	159	158	1	1	5.000E-01	3.541E-02	1.762E+00	QUAD Plate
132	153	154	161	160	1	1	5.000E-01	6.264E-02	9.958E-01	QUAD Plate
133	154	155	162	161	1	1	5.000E-01	5.720E-02	1.091E+00	QUAD Plate
134	155	156	163	162	1	1	5.000E-01	5.175E-02	1.205E+00	QUAD Plate
135	156	157	164	163	1	1	5.000E-01	4.630E-02	1.347E+00	QUAD Plate
136	157	158	165	164	1	1	5.000E-01	4.085E-02	1.527E+00	QUAD Plate
137	158	159	166	165	1	1	5.000E-01	3.541E-02	1.762E+00	QUAD Plate
138	160	161	168	167	1	1	5.000E-01	6.264E-02	9.958E-01	QUAD Plate
139	161	162	169	168	1	1	5.000E-01	5.720E-02	1.091E+00	QUAD Plate
140	162	163	170	169	1	1	5.000E-01	5.175E-02	1.205E+00	QUAD Plate
141	163	164	171	170	1	1	5.000E-01	4.630E-02	1.347E+00	QUAD Plate
142	164	165	172	171	1	1	5.000E-01	4.085E-02	1.527E+00	QUAD Plate
143	165	166	173	172	1	1	5.000E-01	3.541E-02	1.762E+00	QUAD Plate
144	167	168	175	174	1	1	5.000E-01	6.264E-02	9.958E-01	QUAD Plate
145	168	169	176	175	1	1	5.000E-01	5.720E-02	1.091E+00	QUAD Plate
146	169	170	177	176	1	1	5.000E-01	5.175E-02	1.205E+00	QUAD Plate
147	170	171	178	177	1	1	5.000E-01	4.630E-02	1.347E+00	QUAD Plate
148	171	172	179	178	1	1	5.000E-01	4.085E-02	1.527E+00	QUAD Plate
149	172	173	180	179	1	1	5.000E-01	3.541E-02	1.762E+00	QUAD Plate
150	174	175	182	181	1	1	5.000E-01	6.264E-02	9.958E-01	QUAD Plate
151	175	176	183	182	1	1	5.000E-01	5.720E-02	1.091E+00	QUAD Plate
152	176	177	184	183	1	1	5.000E-01	5.175E-02	1.205E+00	QUAD Plate
153	177	178	185	184	1	1	5.000E-01	4.630E-02	1.347E+00	QUAD Plate
154	178	179	186	185	1	1	5.000E-01	4.085E-02	1.527E+00	QUAD Plate
155	179	180	187	186	1	1	5.000E-01	3.541E-02	1.762E+00	QUAD Plate
156	181	182	189	188	1	1	5.000E-01	6.264E-02	9.958E-01	QUAD Plate
157	182	183	190	189	1	1	5.000E-01	5.720E-02	1.091E+00	QUAD Plate
158	183	184	191	190	1	1	5.000E-01	5.175E-02	1.205E+00	QUAD Plate
159	184	185	192	191	1	1	5.000E-01	4.630E-02	1.347E+00	QUAD Plate
160	185	186	193	192	1	1	5.000E-01	4.085E-02	1.527E+00	QUAD Plate
161	186	187	194	193	1	1	5.000E-01	3.541E-02	1.762E+00	QUAD Plate
162	188	189	196	195	1	1	5.000E-01	6.264E-02	9.958E-01	QUAD Plate
163	189	190	197	196	1	1	5.000E-01	5.720E-02	1.091E+00	QUAD Plate
164	190	191	198	197	1	1	5.000E-01	5.175E-02	1.205E+00	QUAD Plate
165	191	192	199	198	1	1	5.000E-01	4.630E-02	1.347E+00	QUAD Plate
166	192	193	200	199	1	1	5.000E-01	4.085E-02	1.527E+00	QUAD Plate
167	193	194	201	200	1	1	5.000E-01	3.541E-02	1.762E+00	QUAD Plate

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CHECK GEOMETRY Version 3.0 12/31/93

Filename=PADEYE
Title =K BASIN ISOLATION BARRIER PADEYE MODIFICATION

Plate No	Nodes I	J	K	L	Thk Set	Dir	Thickness	Area	Aspect Ratio	Plate Type
168	195	196	203	202	1	1	5.000E-01	6.264E-02	9.958E-01	QUAD Plate
169	196	197	204	203	1	1	5.000E-01	5.720E-02	1.091E+00	QUAD Plate
170	197	198	205	204	1	1	5.000E-01	5.175E-02	1.205E+00	QUAD Plate
171	198	199	206	205	1	1	5.000E-01	4.630E-02	1.347E+00	QUAD Plate
172	199	200	207	206	1	1	5.000E-01	4.085E-02	1.527E+00	QUAD Plate
173	200	201	208	207	1	1	5.000E-01	3.541E-02	1.762E+00	QUAD Plate
174	202	203	210	209	1	1	5.000E-01	6.264E-02	9.958E-01	QUAD Plate
175	203	204	211	210	1	1	5.000E-01	5.720E-02	1.091E+00	QUAD Plate
176	204	205	212	211	1	1	5.000E-01	5.175E-02	1.205E+00	QUAD Plate
177	205	206	213	212	1	1	5.000E-01	4.630E-02	1.347E+00	QUAD Plate
178	206	207	214	213	1	1	5.000E-01	4.085E-02	1.527E+00	QUAD Plate
179	207	208	215	214	1	1	5.000E-01	3.541E-02	1.762E+00	QUAD Plate
180	209	210	217	216	1	1	5.000E-01	6.264E-02	9.958E-01	QUAD Plate
181	210	211	218	217	1	1	5.000E-01	5.720E-02	1.091E+00	QUAD Plate
182	211	212	219	218	1	1	5.000E-01	5.175E-02	1.205E+00	QUAD Plate
183	212	213	220	219	1	1	5.000E-01	4.630E-02	1.347E+00	QUAD Plate
184	213	214	221	220	1	1	5.000E-01	4.085E-02	1.527E+00	QUAD Plate
185	214	215	222	221	1	1	5.000E-01	3.541E-02	1.762E+00	QUAD Plate
186	216	217	224	223	1	1	5.000E-01	6.264E-02	9.958E-01	QUAD Plate
187	217	218	225	224	1	1	5.000E-01	5.720E-02	1.091E+00	QUAD Plate
188	218	219	226	225	1	1	5.000E-01	5.175E-02	1.205E+00	QUAD Plate
189	219	220	227	226	1	1	5.000E-01	4.630E-02	1.347E+00	QUAD Plate
190	220	221	228	227	1	1	5.000E-01	4.085E-02	1.527E+00	QUAD Plate
191	221	222	229	228	1	1	5.000E-01	3.541E-02	1.762E+00	QUAD Plate
192	223	224	231	230	1	1	5.000E-01	6.264E-02	9.958E-01	QUAD Plate
193	224	225	232	231	1	1	5.000E-01	5.720E-02	1.091E+00	QUAD Plate
194	225	226	233	232	1	1	5.000E-01	5.175E-02	1.205E+00	QUAD Plate
195	226	227	234	233	1	1	5.000E-01	4.630E-02	1.347E+00	QUAD Plate
196	227	228	235	234	1	1	5.000E-01	4.085E-02	1.527E+00	QUAD Plate
197	228	229	236	235	1	1	5.000E-01	3.541E-02	1.762E+00	QUAD Plate
198	230	231	238	237	1	1	5.000E-01	6.264E-02	9.958E-01	QUAD Plate
199	231	232	239	238	1	1	5.000E-01	5.720E-02	1.091E+00	QUAD Plate
200	232	233	240	239	1	1	5.000E-01	5.175E-02	1.205E+00	QUAD Plate
201	233	234	241	240	1	1	5.000E-01	4.630E-02	1.347E+00	QUAD Plate
202	234	235	242	241	1	1	5.000E-01	4.085E-02	1.527E+00	QUAD Plate
203	235	236	243	242	1	1	5.000E-01	3.541E-02	1.762E+00	QUAD Plate
204	237	238	245	244	1	1	5.000E-01	6.264E-02	9.958E-01	QUAD Plate
205	238	239	246	245	1	1	5.000E-01	5.720E-02	1.091E+00	QUAD Plate
206	239	240	247	246	1	1	5.000E-01	5.175E-02	1.205E+00	QUAD Plate
207	240	241	248	247	1	1	5.000E-01	4.630E-02	1.347E+00	QUAD Plate
208	241	242	249	248	1	1	5.000E-01	4.085E-02	1.527E+00	QUAD Plate

CHECK GEOMETRY Version 3.0 12/31/93

Filename=PADEYE
Title =K BASIN ISOLATION BARRIER PADEYE MODIFICATION

Plate No	Nodes I	J	K	L	Thk Set	Dir	Thickness	Area	Aspect Ratio	Plate Type
209	242	243	250	249	1	1	5.000E-01	3.541E-02	1.762E+00	QUAD Plate
210	251	252	275	274	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
211	252	253	276	275	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
212	253	254	277	276	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
213	254	255	278	277	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
214	255	256	279	278	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
215	256	257	280	279	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
216	257	258	281	280	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
217	258	259	282	281	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
218	259	260	283	282	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
219	260	261	284	283	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
220	261	262	285	284	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
221	262	263	286	285	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
222	263	264	287	286	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
223	264	265	288	287	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
224	265	266	289	288	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
225	266	267	290	289	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
226	267	268	291	290	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
227	268	269	292	291	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
228	269	270	293	292	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
229	270	271	294	293	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
230	271	272	295	294	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
231	272	273	296	295	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
232	274	275	298	297	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
233	275	276	299	298	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
234	276	277	300	299	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
235	277	278	301	300	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
236	278	279	302	301	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
237	279	280	303	302	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
238	280	281	304	303	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
239	281	282	305	304	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
240	282	283	306	305	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
241	283	284	307	306	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
242	284	285	308	307	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
243	285	286	309	308	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
244	286	287	310	309	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
245	287	288	311	310	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
246	288	289	312	311	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
247	289	290	313	312	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
248	290	291	314	313	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
249	291	292	315	314	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate

CHECK GEOMETRY Version 3.0 12/31/93

Filename=PADEYE
Title =K BASIN ISOLATION BARRIER PADEYE MODIFICATION

late No	Nodes I	J	K	L	Thk Set	Dir	Thickness	Area	Aspect Ratio	Plate Type
250	292	293	316	315	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
251	293	294	317	316	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
252	294	295	318	317	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
253	295	296	319	318	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
254	297	298	321	320	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
255	298	299	322	321	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
256	299	300	323	322	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
257	300	301	324	323	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
258	301	302	325	324	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
259	302	303	326	325	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
260	303	304	327	326	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
261	304	305	328	327	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
262	305	306	329	328	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
263	306	307	330	329	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
264	307	308	331	330	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
265	308	309	332	331	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
266	309	310	333	332	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
267	310	311	334	333	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
268	311	312	335	334	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
269	312	313	336	335	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
270	313	314	337	336	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
271	314	315	338	337	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
272	315	316	339	338	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
273	316	317	340	339	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
274	317	318	341	340	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
275	318	319	342	341	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
276	320	321	344	343	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
277	321	322	345	344	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
278	322	323	346	345	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
279	323	324	347	346	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
280	324	325	348	347	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
281	325	326	349	348	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
282	326	327	350	349	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
283	327	328	351	350	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
284	328	329	352	351	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
285	329	330	353	352	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
286	330	331	354	353	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
287	331	332	355	354	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
288	332	333	356	355	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
289	333	334	357	356	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
290	334	335	358	357	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate

================= I M A G E S - 3 D =================

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CHECK GEOMETRY Version 3.0 12/31/93

Filename=PADEYE
Title =K BASIN ISOLATION BARRIER PADEYE MODIFICATION

Plate No	Nodes I	J	K	L	Thk Set	Dir	Thickness	Area	Aspect Ratio	Plate Type
291	335	336	359	358	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
292	336	337	360	359	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
293	337	338	361	360	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
294	338	339	362	361	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
295	339	340	363	362	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
296	340	341	364	363	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
297	341	342	365	364	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
298	343	344	367	366	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
299	344	345	368	367	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
300	345	346	369	368	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
301	346	347	370	369	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
302	347	348	371	370	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
303	348	349	372	371	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
304	349	350	373	372	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
305	350	351	374	373	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
306	351	352	375	374	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
307	352	353	376	375	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
308	353	354	377	376	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
309	354	355	378	377	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
310	355	356	379	378	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
311	356	357	380	379	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
312	357	358	381	380	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
313	358	359	382	381	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
314	359	360	383	382	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
315	360	361	384	383	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
316	361	362	385	384	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
317	362	363	386	385	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
318	363	364	387	386	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
319	364	365	388	387	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
320	366	367	390	389	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
321	367	368	391	390	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
322	368	369	392	391	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
323	369	370	393	392	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
324	370	371	394	393	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
325	371	372	395	394	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
326	372	373	396	395	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
327	373	374	397	396	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
328	374	375	398	397	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
329	375	376	399	398	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
330	376	377	400	399	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
331	377	378	401	400	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate

================== I M A G E S - 3 D ==================

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CHECK GEOMETRY Version 3.0 12/31/93

Filename=PADEYE
Title =K BASIN ISOLATION BARRIER PADEYE MODIFICATION

Plate No	Nodes I	J	K	L	Thk Set	Dir	Thickness	Area	Aspect Ratio	Plate Type
332	378	379	402	401	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
333	379	380	403	402	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
334	380	381	404	403	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
335	381	382	405	404	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
336	382	383	406	405	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
337	383	384	407	406	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
338	384	385	408	407	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
339	385	386	409	408	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
340	386	387	410	409	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
341	387	388	411	410	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
342	389	390	413	412	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
343	390	391	414	413	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
344	391	392	415	414	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
345	392	393	416	415	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
346	393	394	417	416	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
347	394	395	418	417	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
348	395	396	419	418	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
349	396	397	420	419	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
350	397	398	421	420	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
351	398	399	422	421	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
352	399	400	423	422	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
353	400	401	424	423	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
354	401	402	425	424	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
355	402	403	426	425	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
356	403	404	427	426	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
357	404	405	428	427	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
358	405	406	429	428	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
359	406	407	430	429	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
360	407	408	431	430	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
361	408	409	432	431	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
362	409	410	433	432	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
363	410	411	434	433	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
364	412	413	436	435	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
365	413	414	437	436	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
366	414	415	438	437	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
367	415	416	439	438	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
368	416	417	440	439	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
369	417	418	441	440	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
370	418	419	442	441	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
371	419	420	443	442	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
372	420	421	444	443	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate

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PAGE 29 RUN ID=ET00018 00:21:12

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CHECK GEOMETRY Version 3.0 12/31/93

Filename=PADEYE
Title =K BASIN ISOLATION BARRIER PADEYE MODIFICATION

Plate No	Nodes I	J	K	L	Thk Set	Dir	Thickness	Area	Aspect Ratio	Plate Type
373	421	422	445	444	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
374	422	423	446	445	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
375	423	424	447	446	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
376	424	425	448	447	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
377	425	426	449	448	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
378	426	427	450	449	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
379	427	428	451	450	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
380	428	429	452	451	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
381	429	430	453	452	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
382	430	431	454	453	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
383	431	432	455	454	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
384	432	433	456	455	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
385	433	434	457	456	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
386	435	436	459	458	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
387	436	437	460	459	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
388	437	438	461	460	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
389	438	439	462	461	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
390	439	440	463	462	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
391	440	441	464	463	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
392	441	442	465	464	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
393	442	443	466	465	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
394	443	444	467	466	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
395	444	445	468	467	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
396	445	446	469	468	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
397	446	447	470	469	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
398	447	448	471	470	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
399	448	449	472	471	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
400	449	450	473	472	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
401	450	451	474	473	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
402	451	452	475	474	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
403	452	453	476	475	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
404	453	454	477	476	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
405	454	455	478	477	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
406	455	456	479	478	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
407	456	457	480	479	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
408	458	459	482	481	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
409	459	460	483	482	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
410	460	461	484	483	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
411	461	462	485	484	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
412	462	463	486	485	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
413	463	464	487	486	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate

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PAGE 30 RUN ID=ET00018 00:21:19

================= I M A G E S - 3 D =================

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CHECK GEOMETRY Version 3.0 12/31/93

Filename=PADEYE
Title =K BASIN ISOLATION BARRIER PADEYE MODIFICATION

Plate No	Nodes I	J	K	L	Thk Set	Dir	Thickness	Area	Aspect Ratio	Plate Type
414	464	465	488	487	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
415	465	466	489	488	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
416	466	467	490	489	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
417	467	468	491	490	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
418	468	469	492	491	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
419	469	470	493	492	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
420	470	471	494	493	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
421	471	472	495	494	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
422	472	473	496	495	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
423	473	474	497	496	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
424	474	475	498	497	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
425	475	476	499	498	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
426	476	477	500	499	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
427	477	478	501	500	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
428	478	479	502	501	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
429	479	480	503	502	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
430	481	482	505	504	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
431	482	483	506	505	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
432	483	484	507	506	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
433	484	485	508	507	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
434	485	486	509	508	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
435	486	487	510	509	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
436	487	488	511	510	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
437	488	489	512	511	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
438	489	490	513	512	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
439	490	491	514	513	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
440	491	492	515	514	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
441	492	493	516	515	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
442	493	494	517	516	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
443	494	495	518	517	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
444	495	496	519	518	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
445	496	497	520	519	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
446	497	498	521	520	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
447	498	499	522	521	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
448	499	500	523	522	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
449	500	501	524	523	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
450	501	502	525	524	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
451	502	503	526	525	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
452	504	505	528	527	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
453	505	506	529	528	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
454	506	507	530	529	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate

WESTINGHOUSE HANFORD COMPANY S/N:802406 01/22/95
PAGE 31 RUN ID=ET00018 00:21:26

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CHECK GEOMETRY Version 3.0 12/31/93

Filename=PADEYE
Title =K BASIN ISOLATION BARRIER PADEYE MODIFICATION

Plate No	Nodes I	J	K	L	Thk Set	Dir	Thickness	Area	Aspect Ratio	Plate Type
455	507	508	531	530	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
456	508	509	532	531	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
457	509	510	533	532	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
458	510	511	534	533	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
459	511	512	535	534	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
460	512	513	536	535	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
461	513	514	537	536	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
462	514	515	538	537	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
463	515	516	539	538	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
464	516	517	540	539	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
465	517	518	541	540	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
466	518	519	542	541	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
467	519	520	543	542	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
468	520	521	544	543	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
469	521	522	545	544	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
470	522	523	546	545	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
471	523	524	547	546	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
472	524	525	548	547	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
473	525	526	549	548	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
474	527	528	551	550	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
475	528	529	552	551	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
476	529	530	553	552	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
477	530	531	554	553	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
478	531	532	555	554	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
479	532	533	556	555	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
480	533	534	557	556	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
481	534	535	558	557	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
482	535	536	559	558	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
483	536	537	560	559	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
484	537	538	561	560	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
485	538	539	562	561	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
486	539	540	563	562	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
487	540	541	564	563	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
488	541	542	565	564	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
489	542	543	566	565	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
490	543	544	567	566	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
491	544	545	568	567	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
492	545	546	569	568	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
493	546	547	570	569	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
494	547	548	571	570	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
495	548	549	572	571	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate

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================== I M A G E S - 3 D ==================

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CHECK GEOMETRY Version 3.0 12/31/93

Filename=PADEYE
Title =K BASIN ISOLATION BARRIER PADEYE MODIFICATION

Plate No	Nodes I	J	K	L	Thk Set	Dir	Thickness	Area	Aspect Ratio	Plate Type
496	550	551	574	573	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
497	551	552	575	574	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
498	552	553	576	575	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
499	553	554	577	576	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
500	554	555	578	577	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
501	555	556	579	578	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
502	556	557	580	579	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
503	557	558	581	580	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
504	558	559	582	581	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
505	559	560	583	582	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
506	560	561	584	583	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
507	561	562	585	584	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
508	562	563	586	585	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
509	563	564	587	586	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
510	564	565	588	587	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
511	565	566	589	588	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
512	566	567	590	589	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
513	567	568	591	590	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
514	568	569	592	591	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
515	569	570	593	592	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
516	570	571	594	593	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
517	571	572	595	594	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
518	573	574	597	596	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
519	574	575	598	597	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
520	575	576	599	598	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
521	576	577	600	599	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
522	577	578	601	600	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
523	578	579	602	601	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
524	579	580	603	602	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
525	580	581	604	603	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
526	581	582	605	604	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
527	582	583	606	605	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
528	583	584	607	606	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
529	584	585	608	607	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
530	585	586	609	608	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
531	586	587	610	609	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
532	587	588	611	610	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
533	588	589	612	611	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
534	589	590	613	612	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
535	590	591	614	613	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
536	591	592	615	614	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate

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CHECK GEOMETRY Version 3.0 12/31/93

Filename=PADEYE
Title =K BASIN ISOLATION BARRIER PADEYE MODIFICATION

Plate No	Nodes I	J	K	L	Thk Set	Dir	Thickness	Area	Aspect Ratio	Plate Type
537	592	593	616	615	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
538	593	594	617	616	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
539	594	595	618	617	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
540	596	597	620	619	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
541	597	598	621	620	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
542	598	599	622	621	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
543	599	600	623	622	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
544	600	601	624	623	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
545	601	602	625	624	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
546	602	603	626	625	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
547	603	604	627	626	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
548	604	605	628	627	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
549	605	606	629	628	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
550	606	607	630	629	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
551	607	608	631	630	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
552	608	609	632	631	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
553	609	610	633	632	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
554	610	611	634	633	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
555	611	612	635	634	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
556	612	613	636	635	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
557	613	614	637	636	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
558	614	615	638	637	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
559	615	616	639	638	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
560	616	617	640	639	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
561	617	618	641	640	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
562	619	620	643	642	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
563	620	621	644	643	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
564	621	622	645	644	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
565	622	623	646	645	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
566	623	624	647	646	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
567	624	625	648	647	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
568	625	626	649	648	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
569	626	627	650	649	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
570	627	628	651	650	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
571	628	629	652	651	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
572	629	630	653	652	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
573	630	631	654	653	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
574	631	632	655	654	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
575	632	633	656	655	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
576	633	634	657	656	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
577	634	635	658	657	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate

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CHECK GEOMETRY Version 3.0 12/31/93

Filename=PADEYE
Title =K BASIN ISOLATION BARRIER PADEYE MODIFICATION

Plate No	Nodes I	J	K	L	Thk Set	Dir	Thickness	Area	Aspect Ratio	Plate Type
578	635	636	659	658	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
579	636	637	660	659	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
580	637	638	661	660	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
581	638	639	662	661	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
582	639	640	663	662	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
583	640	641	664	663	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
584	642	643	666	665	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
585	643	644	667	666	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
586	644	645	668	667	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
587	645	646	669	668	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
588	646	647	670	669	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
589	647	648	671	670	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
590	648	649	672	671	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
591	649	650	673	672	1	1	5.000E-01	7.323E-02	8.660E-01	QUAD Plate
592	650	651	674	673	1	1	5.000E-01	7.585E-02	8.309E-01	QUAD Plate
593	651	652	675	674	1	1	5.000E-01	6.512E-02	9.605E-01	QUAD Plate
594	652	653	676	675	1	1	5.000E-01	6.513E-02	9.605E-01	QUAD Plate
595	653	654	677	676	1	1	5.000E-01	7.585E-02	8.309E-01	QUAD Plate
596	654	655	678	677	1	1	5.000E-01	7.323E-02	8.660E-01	QUAD Plate
597	655	656	679	678	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
598	656	657	680	679	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
599	657	658	681	680	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
600	658	659	682	681	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
601	659	660	683	682	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
602	660	661	684	683	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
603	661	662	685	684	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
604	662	663	686	685	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
605	663	664	687	686	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
606	665	666	689	688	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
607	666	667	690	689	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
608	667	668	691	690	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
609	668	669	692	691	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
610	669	670	693	692	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
611	670	671	694	693	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
612	671	672	695	694	1	1	5.000E-01	5.272E-02	8.335E-01	QUAD Plate
613	672	673	695		1	1	5.000E-01	3.460E-02	9.110E-01	TRI Plate
614	677	678	696		1	1	5.000E-01	3.465E-02	9.088E-01	TRI Plate
615	678	679	697	696	1	1	5.000E-01	5.260E-02	8.312E-01	QUAD Plate
616	679	680	698	697	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
617	680	681	699	698	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
618	681	682	700	699	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate

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================== I M A G E S - 3 D ==================

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CHECK GEOMETRY Version 3.0 12/31/93

Filename=PADEYE
Title =K BASIN ISOLATION BARRIER PADEYE MODIFICATION

Plate No	Nodes I	J	K	L	Thk Set	Dir	Thickness	Area	Aspect Ratio	Plate Type
619	682	683	701	700	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
620	683	684	702	701	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
621	684	685	703	702	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
622	685	686	704	703	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
623	686	687	705	704	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
624	688	689	707	706	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
625	689	690	708	707	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
626	690	691	709	708	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
627	691	692	710	709	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
628	692	693	711	710	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
629	693	694	712	711	1	1	5.000E-01	4.775E-02	7.436E-01	QUAD Plate
630	694	695	712		1	1	5.000E-01	2.148E-02	5.325E-01	TRI Plate
631	696	697	713		1	1	5.000E-01	2.135E-02	5.300E-01	TRI Plate
632	697	698	714	713	1	1	5.000E-01	4.775E-02	7.436E-01	QUAD Plate
633	698	699	715	714	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
634	699	700	716	715	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
635	700	701	717	716	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
636	701	702	718	717	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
637	702	703	719	718	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
638	703	704	720	719	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
639	704	705	721	720	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
640	706	707	723	722	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
641	707	708	724	723	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
642	708	709	725	724	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
643	709	710	726	725	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
644	710	711	727	726	1	1	5.000E-01	5.637E-02	8.977E-01	QUAD Plate
645	711	712	727		1	1	5.000E-01	1.650E-02	4.797E-01	TRI Plate
646	713	714	728		1	1	5.000E-01	1.650E-02	4.797E-01	TRI Plate
647	714	715	729	728	1	1	5.000E-01	5.637E-02	8.977E-01	QUAD Plate
648	715	716	730	729	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
649	716	717	731	730	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
650	717	718	732	731	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
651	718	719	733	732	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
652	719	720	734	733	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
653	720	721	735	734	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
654	722	723	737	736	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
655	723	724	738	737	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
656	724	725	739	738	1	1	5.000E-01	6.250E-02	1.000E+00	QUAD Plate
657	725	726	740	739	1	1	5.000E-01	7.323E-02	1.155E+00	QUAD Plate
658	726	727	740		1	1	5.000E-01	2.512E-02	8.026E-01	TRI Plate
659	728	729	741		1	1	5.000E-01	2.512E-02	8.026E-01	TRI Plate

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================= I M A G E S - 3 D =================

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CHECK GEOMETRY Version 3.0 12/31/93

Filename=PADEYE
Title =K BASIN ISOLATION BARRIER PADEYE MODIFICATION

Node No	Global/Local	Restraint Directions
259	GLOBAL	X Y Z RX RY RZ
260	GLOBAL	X Y Z RX RY RZ
261	GLOBAL	X Y Z RX RY RZ
262	GLOBAL	X Y Z RX RY RZ
263	GLOBAL	X Y Z RX RY RZ
264	GLOBAL	X Y Z RX RY RZ
265	GLOBAL	X Y Z RX RY RZ
266	GLOBAL	X Y Z RX RY RZ
267	GLOBAL	X Y Z RX RY RZ
268	GLOBAL	X Y Z RX RY RZ
269	GLOBAL	X Y Z RX RY RZ
270	GLOBAL	X Y Z RX RY RZ
271	GLOBAL	X Y Z RX RY RZ
272	GLOBAL	X Y Z RX RY RZ
273	GLOBAL	X Y Z RX RY RZ

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================ I M A G E S - 3 D ================

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SOLVE DISPLACEMENTS Version 3.0 12/31/93

Filename=PADEYE
Title =K BASIN ISOLATION BARRIER PADEYE MODIFICATION

L O A D C A S E 1
5000 # IN-PLANE WITH 500 # NORMAL IN-PLANE & OUT-OF-PLANE

GRAVITY LOADING

X	Y	Z
.0000E+00	.0000E+00	.0000E+00

REFERENCE TEMPERATURE = .0000E+00

PLATE SIDE LOADS/UNIT OF LENGTH

Plate	Side	Dir.	Load1	Load2
83	2	2	.4775E+04	.4775E+04
83	2	1	.4775E+03	.4775E+03
83	2	3	.4775E+03	.4775E+03
89	2	2	.4775E+04	.4775E+04
89	2	1	.4775E+03	.4775E+03
89	2	3	.4775E+03	.4775E+03
95	2	2	.4775E+04	.4775E+04
95	2	1	.4775E+03	.4775E+03
95	2	3	.4775E+03	.4775E+03
101	2	2	.4775E+04	.4775E+04
101	2	1	.4775E+03	.4775E+03
101	2	3	.4775E+03	.4775E+03
107	2	2	.4775E+04	.4775E+04
107	2	1	.4775E+03	.4775E+03
107	2	3	.4775E+03	.4775E+03
113	2	2	.4775E+04	.4775E+04
113	2	1	.4775E+03	.4775E+03
113	2	3	.4775E+03	.4775E+03
119	2	2	.4775E+04	.4775E+04
119	2	1	.4775E+03	.4775E+03
119	2	3	.4775E+03	.4775E+03
125	2	2	.4775E+04	.4775E+04
125	2	1	.4775E+03	.4775E+03
125	2	3	.4775E+03	.4775E+03

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================ I M A G E S - 3 D ================

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SOLVE DISPLACEMENTS Version 3.0 12/31/93

Filename=PADEYE
Title =K BASIN ISOLATION BARRIER PADEYE MODIFICATION

L O A D C A S E 1
5000 # IN-PLANE WITH 500 # NORMAL IN-PLANE & OUT-OF-PLANE
APPLIED LOAD VECTOR

Node	Fx	Fy	Fz	Mx	My	Mz
96	.3124E+02	.3124E+03	.3124E+02	.0000E+00	.0000E+00	.0000E+00
103	.6248E+02	.6248E+03	.6248E+02	.0000E+00	.0000E+00	.0000E+00
110	.6248E+02	.6248E+03	.6248E+02	.0000E+00	.0000E+00	.0000E+00
117	.6248E+02	.6248E+03	.6248E+02	.0000E+00	.0000E+00	.0000E+00
124	.6248E+02	.6248E+03	.6248E+02	.0000E+00	.0000E+00	.0000E+00
131	.6248E+02	.6248E+03	.6248E+02	.0000E+00	.0000E+00	.0000E+00
138	.6248E+02	.6248E+03	.6248E+02	.0000E+00	.0000E+00	.0000E+00
145	.6248E+02	.6248E+03	.6248E+02	.0000E+00	.0000E+00	.0000E+00
152	.3124E+02	.3124E+03	.3124E+02	.0000E+00	.0000E+00	.0000E+00

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================= I M A G E S - 3 D =================

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SOLVE PLATE LOADS/STRESSES Version 3.0 12/31/93

Filename=PADEYE
Title =K BASIN ISOLATION BARRIER PADEYE MODIFICATION

Load Case 1:5000 # IN-PLANE WITH 500 # NORMAL IN-PLANE & OUT-OF-PLANE

MAXIMUM STRESS SUMMARY FOR PLATES
WITHIN SPECIFIED RANGE 1- 685

Element	Type	Stress Type	Value	
13	PLATE	Local Membrane	.1302E+05	
219	PLATE	Local Bending	-.1803E+05	
630	PLATE	Local Trns. Shear	-.4152E+04	$\leftarrow f_s$
4	PLATE	Max. Princ. Strs.	.2036E+05	
107	PLATE	Min. Princ. Strs.	-.2012E+05	
4	PLATE	Von Mises	.2002E+05	

$$F_s = 0.4 F_Y = 0.4(36{,}000) = 14{,}400 \text{ psi}$$

$$MS = \frac{14400}{4152} - 1 > 2.0$$

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================= I M A G E S - 3 D =================

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SOLVE PLATE LOADS/STRESSES Version 3.0 12/31/93

Filename=PADEYE
Title =K BASIN ISOLATION BARRIER PADEYE MODIFICATION

Load Case 1:5000 # IN-PLANE WITH 500 # NORMAL IN-PLANE & OUT-OF-PLANE

PLATE LOADS AND/OR STRESSES

Stress Stress	Surf	Sigma X Sigma Z	Sigma Y Von Mises	Tau XY Tau XZ	Sigma 1 Tau YZ	Sigma 2	Angle
			PLATE NO. 13				
Stress	TOP	.9523E+03	.7542E+04 .7556E+04	.1471E+04	.7855E+04	.6390E+03	77.97
Stress	MID	.1512E+04	.1302E+05 .1335E+05	.2947E+04 .1524E+03	.1373E+05 .1480E+04	.8010E+03	76.44
Stress	BOT	.2071E+04	.1851E+05 .1916E+05	.4424E+04	.1962E+05	.9560E+03	75.85

$f_a = 13{,}020$ psi

$f_b = 18{,}510 - 13020 = 5490$ psi

$$\frac{f_a}{F_a} + \frac{f_b}{F_b} = \frac{13020}{21{,}600} + \frac{5490}{27000} = 0.81 < 1.0$$

$$M.S. = \frac{1}{0.81} - 1 = +0.24$$

$F_A = 0.6F_Y = 0.6(36{,}000) = 21{,}600$ psi

$F_B = 0.75F_Y = 0.75(36{,}000) = 27{,}000$ psi

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================ I M A G E S - 3 D ================
= Copyright (c) 1984-1993. RLCA/Celestial Software =
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SOLVE PLATE LOADS/STRESSES Version 3.0 12/31/93

Filename=PADEYE
Title =K BASIN ISOLATION BARRIER PADEYE MODIFICATION

Load Case 1:5000 # IN-PLANE WITH 500 # NORMAL IN-PLANE & OUT-OF-PLANE

PLATE LOADS AND/OR STRESSES

Stress Stress	Surf	Sigma X Sigma Z	Sigma Y Von Mises	Tau XY Tau XZ	Sigma 1 Tau YZ	Sigma 2	Angle
			PLATE NO. 219				
Stress	TOP	-.4839E+04	-.1633E+05	.8148E+02	-.4838E+04	-.1633E+05	.41
			.1453E+05				
Stress	MID	.5376E+03	.1702E+04	.8707E+02	.1709E+04	.5311E+03	85.75
			.1515E+04	-.8603E+01	.6956E+03		
Stress	BOT	.5914E+04	.1973E+05	.9265E+02	.1973E+05	.5913E+04	89.62
			.1754E+05				

$f_a = 1702$ PSI

$f_b = 19{,}730 - 1702 = 18{,}028$ PSI

$$\frac{f_a}{F_A} + \frac{f_b}{F_B} = \frac{1702}{21600} + \frac{18028}{27000} = 0.75 < 1.0$$

$$M.S. = \frac{1}{0.75} - 1 = +0.33$$

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================= I M A G E S - 3 D =================

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SOLVE PLATE LOADS/STRESSES Version 3.0 12/31/93

Filename=PADEYE
Title =K BASIN ISOLATION BARRIER PADEYE MODIFICATION

Load Case 1:5000 # IN-PLANE WITH 500 # NORMAL IN-PLANE & OUT-OF-PLANE

PLATE LOADS AND/OR STRESSES

Stress Stress	Surf	Sigma X Sigma Z	Sigma Y Von Mises	Tau XY Tau XZ	Sigma 1 Tau YZ	Sigma 2	Angle
			PLATE NO. 4				
Stress	TOP	.6228E+03	.4324E+04 .4129E+04	.4666E+03	.4382E+04	.5649E+03	82.92
Stress	MID	.8532E+03	.1215E+05 .1206E+05	.1582E+04 -.1350E+03	.1237E+05 .1808E+04	.6358E+03	82.18
Stress	BOT	.1084E+04	.1998E+05 .2002E+05	.2698E+04	.2036E+05	.7059E+03	82.03

$$f_a = 12150 \text{ PSI}$$

$$f_b = 19980 - 12150 = 7830 \text{ PSI}$$

$$\frac{f_a}{F_A} + \frac{f_b}{F_B} = \frac{12150}{21600} + \frac{7830}{27000} = 0.85 < 1.0$$

$$M.S. = \frac{1}{0.85} - 1 = +0.17$$

APPENDIX B

CENTER ISLAND CALCULATIONS

APPENDIX B1

FULL CHUTE, 17.5 FT WATER DEPTH

(1) Drawing H-1-21054 & H-1-21071 (2) Doc. No. ______ (3) Page 1 of 8
(4) Building 105-KE (5) Rev. ______ (6) Job No. ______
(7) Subject KE-Basin Center Island Seismic Evaluation, Increased Water Depth
(8) Originator B. V. Winkel BVW Date 2/14/95
(9) Checker S. K. Kanjilal SK Kanjilal Date 2/21/95

K-EAST BASIN CENTER ISLAND SEISMIC CALCULATIONS
INCREASED WATER DEPTH

(MathCad Calculations)

CALCULATION OBJECTIVE:

Evaluate the structural adequacy of the K-East Basin center island for a water height of 17.5 feet. Assume that a seismic event occurs with this water depth on both sides of the center island. The 17.5 ft water height on one side of the basin cannot exist for a drained discharge chute, due to the positioning of a drain weir in the isolation doors.

DESCRIPTION OF PROBLEM PARAMETERS:

Note: See Kanjilal, S. K., 1990, *Seismic Evaluation of 5.5 Ft. Thick Concrete Divider Wall in Pickup Chute Area, 100 K Fuel Storage Basin*, WHC-SD-NR-DA-013, for geometry details. A listing of pertinent geometry parameters, used in the calculations, follows below:

$h := 17.5 \cdot ft$	Maximum water height
$a := 0.2$	DBE peak ground accel. magnitude
$lc := 9.25 \cdot ft$	Chute north/south width
$lb := 68.5 \cdot ft$	Basin north/south interior width
$hw := 20.75 \cdot ft$	Height of center island
$twt := 5.5 \cdot ft$	Center island thickness for top 15 ft, 9 in.
$twb := 5.75 \cdot ft$	Center island thickness for bottom 5 ft.
$fy := 40000 \cdot \frac{lbf}{in^2}$	Rebar yield strength (Ref.: Spec. HW-4739)
$fc := 3000 \cdot \frac{lbf}{in^2}$	Concrete nominal design strength (Spec. HW-4740)
$As := 0.293 \cdot in^2$	Rebar area per foot (#6 @ 18", Dwg.: H-1-21071)
$\gamma c := 150 \cdot \frac{lbf}{ft^3}$	Concrete unit weight
$\gamma w := 62.4 \cdot \frac{lbf}{ft^3}$	Water unit weight

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(8) Originator B. V. Winkel BVW Date 2/14/95
(9) Checker S. K. Kanjilal S K Kanjilal Date 2/28/95

CENTER ISLAND NATURAL FREQUENCY CALCULATIONS

An initial estimate of the center island fundamental frequency can be obtained by considering a one foot wide, 20.75 ft. long cantilever beam of constant thickness (66 in.):

$E := 150^{1.5}\cdot 33\cdot\sqrt{3000}$ $E = 3.321\cdot 10^{6}$ Concrete Elas. Mod., psi

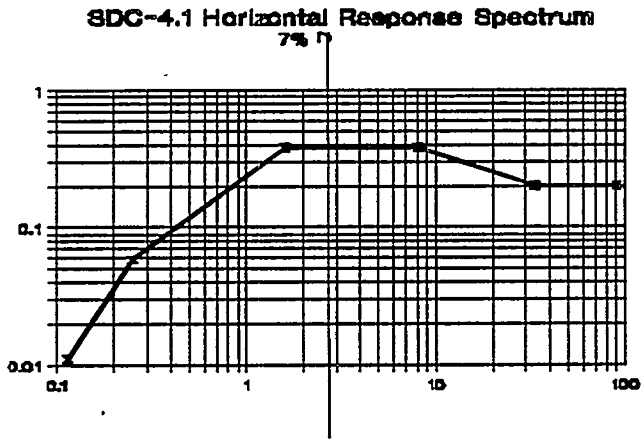
$I := \dfrac{12\cdot 66^{3}}{12}$ $I = 2.875\cdot 10^{5}$ $l := 12\cdot 20.75$

$w := 5.5\cdot\dfrac{150}{12}$ $w = 68.75$

$fn := 0.56\cdot\sqrt{\dfrac{386.4\cdot E\cdot I}{w\cdot l^{4}}}$ Ref.: Standard Handbook for Mech. Engrs., 7th Ed., p.5-101, Eq. (38)

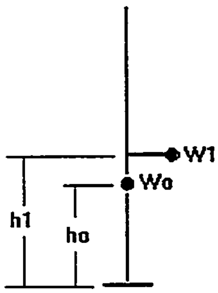
$fn = 20.922$ Fund. frequency, hz (no added mass from water)

This natural frequency calculation ignores the support from the structural brace (conservative), and the added mass of the water (unconservative). A more precise ANSYS model of the center island (empty chute calcs.) indicated that the structural brace increased the frequency more than the decrease caused by the water added mass. Therefore, the above frequency is conservative. From the SDC-4.1, 0.2g seismic spectra shown below, the corresponding acceleration is 0.24 g's.



$as := 0.24$

Hydrodynamic Forces:



The impulsive and convective weight magnitudes (Wo and W1) and effective heights (ho and h1), shown on the sketch on the left, are calculated below for both the chute and basin regions (north/south cross-section, unit width).

(1) Drawing H-1-21054 & H-1-21071 (2) Doc. No. ______ (3) Page 3 of 8
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$$Wb := \frac{\gamma w \cdot lb \cdot h}{2} \qquad Wc := \frac{\gamma w \cdot lc \cdot h}{2}$$

$$Wb = 3.74 \cdot 10^4 \cdot \frac{lbf}{ft} \qquad Wc = 5.051 \cdot 10^3 \cdot \frac{lbf}{ft}$$

Half of weight of the basin and chute water in lbs. per foot. Half of the water weight is applied to the divider wall per Fig. 5.9(c) of ASCE Manual No. 58, "Structural Analysis and Design of Nuclear Plant Facilities".

Impulsive Component:

$$Lb := \frac{lb}{2} \qquad Lb = 34.25 \cdot ft \qquad Lc := \frac{lc}{2} \qquad Lc = 4.625 \cdot ft$$

$$Wob := \frac{\tanh\left[\sqrt{3} \cdot \left(\frac{Lb}{h}\right)\right]}{\sqrt{3} \cdot \left(\frac{Lb}{h}\right)} \cdot Wb \qquad Woc := \frac{\tanh\left[\sqrt{3} \cdot \left(\frac{Lc}{h}\right)\right]}{\sqrt{3} \cdot \left(\frac{Lc}{h}\right)} \cdot Wc$$

$$Wob = 1.101 \cdot 10^4 \cdot \frac{lbf}{ft} \qquad Woc = 4.725 \cdot 10^3 \cdot \frac{lbf}{ft}$$

Impulsive water weights for the basin and chute, respectively

$$ho := (0.4) \cdot h \qquad ho = 7 \cdot ft$$

Effective ht. = 0.4h, Ref.: ASCE, "Guidelines for the Seismic Design of Oil and Gas Pipeline Systems, Table 7.1.

$$Mbo := (Wob + Woc) \cdot ho \cdot as$$

$$Mbo = 2.643 \cdot 10^4 \cdot lbf \cdot \frac{ft}{ft}$$

Base moment due to impulsive pressure

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(9) Checker S. K. Kanjilal SKKanjilal Date 2/21/95

Convective Component:

$$W1b := 0.527\cdot\frac{Lb}{h}\cdot\tanh\left(1.58\cdot\frac{h}{Lb}\right)\cdot Wb \qquad W1c := 0.527\cdot\frac{Lc}{h}\cdot\tanh\left(1.58\cdot\frac{h}{Lc}\right)\cdot Wc$$

$$W1b = 2.577\cdot10^{4}\cdot\frac{lbf}{ft} \qquad W1c = 703.417\cdot\frac{lbf}{ft}$$ Convective weights, basin & chute, respectively

$$h1b := \left[1-\frac{\cosh\left(1.58\cdot\frac{h}{Lb}\right)-1}{1.58\cdot\frac{h}{Lb}\cdot\sinh\left(1.58\cdot\frac{h}{Lb}\right)}\right]\cdot h \qquad h1c := \left[1-\frac{\cosh\left(1.58\cdot\frac{h}{Lc}\right)-1}{1.58\cdot\frac{h}{Lc}\cdot\sinh\left(1.58\cdot\frac{h}{Lc}\right)}\right]\cdot h$$

$$\omega b := \sqrt{1.58\cdot\frac{32.2\cdot\frac{ft}{sec^2}}{Lb}\cdot\tanh\left(1.58\cdot\frac{h}{Lb}\right)} \qquad \omega c := \sqrt{1.58\cdot\frac{32.2\cdot\frac{ft}{sec^2}}{Lc}\cdot\tanh\left(1.58\cdot\frac{h}{Lc}\right)}$$

$$h1b = 9.196\cdot ft \qquad h1c = 14.588\cdot ft$$ Convective mass heights, basin & chute

$$Tb := 2\cdot\frac{\pi}{\omega b} \qquad Tc := 2\cdot\frac{\pi}{\omega c}$$

$$Tb = 6.307\cdot sec \qquad Tc = 1.894\cdot sec$$ Convective mass nat. periods, basin & chute

$$ab := .037 \qquad ac := .21$$ From SDC-4.1, 0.5% damping. (spectra plots on following page)

$$Mb1 := \left[(W1b\cdot h1b\cdot ab)^2+(W1c\cdot h1c\cdot ac)^2\right]^{.5}$$ Root sum square combination to account for phase differences

$$Mb1 = 9.03\cdot10^{3}\cdot ft\cdot\frac{lbf}{ft}$$ Convective mass base moment

BASE MOMENT DUE TO CENTER ISLAND WALL SEISMIC INERTIA:

$$W := twt\cdot\gamma c\cdot hw \qquad W = 1.712\cdot10^{4}\cdot\frac{lbf}{ft}$$

$$Mb := W\cdot\frac{hw}{2}\cdot as \qquad Mb = 4.263\cdot10^{4}\cdot ft\cdot\frac{lbf}{ft}$$

(1) Drawing H-1-21054 & H-1-21071 (2) Doc. No. ______ (3) Page 5 of 8
(4) Building 105-KE (5) Rev. ______ (6) Job No. ______
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(8) Originator B. V. Winkel BVW Date 2/14/95
(9) Checker L. J. Julyk LJJ Date 2/15/95

DEVELOPMENT OF 0.5% RESPONSE SPECTRA CURVE AT DBE ZPA

Horizontal Response Spectra Control Points - Median Centered ZPA = 0.2
Newmark-Hall (SDC-4.1 1989, Rev. 11, Table 3 or Figure 3)

DOE, 1984, *Natural Phenomena Hazards Modeling Project: Seismic Hazard Models for Departement of Energy Sites, UCRL-53582, Rev. 1, D. W. Coats and R. C. Murry, Lawrence Livermore National Laboratory, Livermore, California, for U.S. Department of Energy.*

$ZPA = 0.2$ $kk := 0..7$

$A(\beta) := 3.21 - 0.68 \cdot \ln(\beta)$ $V(\beta) := 2.31 - 0.41 \cdot \ln(\beta)$ $D(\beta) := 1.82 - 0.27 \cdot \ln(\beta)$

$a_g := ZPA\ (g)$ $v_g := 48 \cdot a_g\ \left(\frac{in}{s}\right)$ $d_g := 36 \cdot a_g\ (in)$ $g_c := \frac{g}{\left(\frac{in}{sec^2}\right)}$

$a_{max}(\beta) := a_g \cdot A(\beta)$ $v_{max}(\beta) := v_g \cdot V(\beta)$ $d_{max}(\beta) := d_g \cdot D(\beta)$

$f_E(\beta) := 0.1$ $S_{aE}(\beta) := \frac{0.395}{g_c} \cdot d_{max}(\beta)$

$f_D(\beta) := \frac{v_{max}(\beta)}{2 \cdot \pi \cdot d_{max}(\beta)}$ $S_{aD}(\beta) := \frac{v_{max}(\beta)^2}{g_c \cdot d_{max}(\beta)}$

$f_C(\beta) := \frac{g_c \cdot a_{max}(\beta)}{2 \cdot \pi \cdot v_{max}(\beta)}$ $S_{aC}(\beta) := a_{max}(\beta)$

$f_B(\beta) := 8$ $S_{aB}(\beta) := a_{max}(\beta)$

$f_A(\beta) := 33$ $S_{aA}(\beta) := a_g$

$f_{A'}(\beta) := 100$ $S_{aA'}(\beta) := a_g$

Damping (%) β_{kk} =	$A(\beta_{kk})$	$V(\beta_{kk})$	$D(\beta_{kk})$
0.5	3.68	2.59	2.01
1	3.21	2.31	1.82
2	2.74	2.03	1.63
3	2.46	1.86	1.52
5	2.12	1.65	1.39
7	1.89	1.51	1.29
10	1.64	1.37	1.2
20	1.17	1.08	1.01

$kk := 0..5$

$f_{ZPA2\%_{kk}} :=$	$S_{aZPA2\%_{kk}} :=$	$f_{ZPA2\%_{kk}}$	$S_{aZPA2\%_{kk}}$
$f_E(2)$	$S_{aE}(2)$	0.1	0.012
$f_D(2)$	$S_{aD}(2)$	0.26	0.083
$f_C(2)$	$S_{aC}(2)$	1.73	0.548
$f_B(2)$	$S_{aB}(2)$	8	0.548
$f_A(2)$	$S_{aA}(2)$	33	0.2
$f_{A'}(2)$	$S_{aA'}(2)$	100	0.2

$f_{ZPA0.5\%_{kk}} :=$	$S_{aZPA0.5\%_{kk}} :=$	$f_{ZPA0.5\%_{kk}}$	$S_{aZPA0.5\%_{kk}}$
$f_E(0.5)$	$S_{aE}(0.5)$	0.1	0.015
$f_D(0.5)$	$S_{aD}(0.5)$	0.27	0.111
$f_C(0.5)$	$S_{aC}(0.5)$	1.82	0.736
$f_B(0.5)$	$S_{aB}(0.5)$	8	0.736
$f_A(0.5)$	$S_{aA}(0.5)$	33	0.2
$f_{A'}(0.5)$	$S_{aA'}(0.5)$	100	0.2

$logf_{ZPA2\%} := \overrightarrow{\log(f_{ZPA2\%})}$ $logf_{ZPA0.5\%} := \overrightarrow{\log(f_{ZPA0.5\%})}$

$logS_{aZPA2\%} := \overrightarrow{\log(S_{aZPA2\%})}$ $logS_{aZPA0.5\%} := \overrightarrow{\log(S_{aZPA0.5\%})}$

$vS_{aZPA2\%}(f) := 10^{\text{linterp}(logf_{ZPA2\%}, logS_{aZPA2\%}, \log(f))}$

$vS_{aZPA0.5\%}(f) := 10^{\text{linterp}(logf_{ZPA0.5\%}, logS_{aZPA0.5\%}, \log(f))}$

$vS_{aZPA2\%}(.6) = 0.19$

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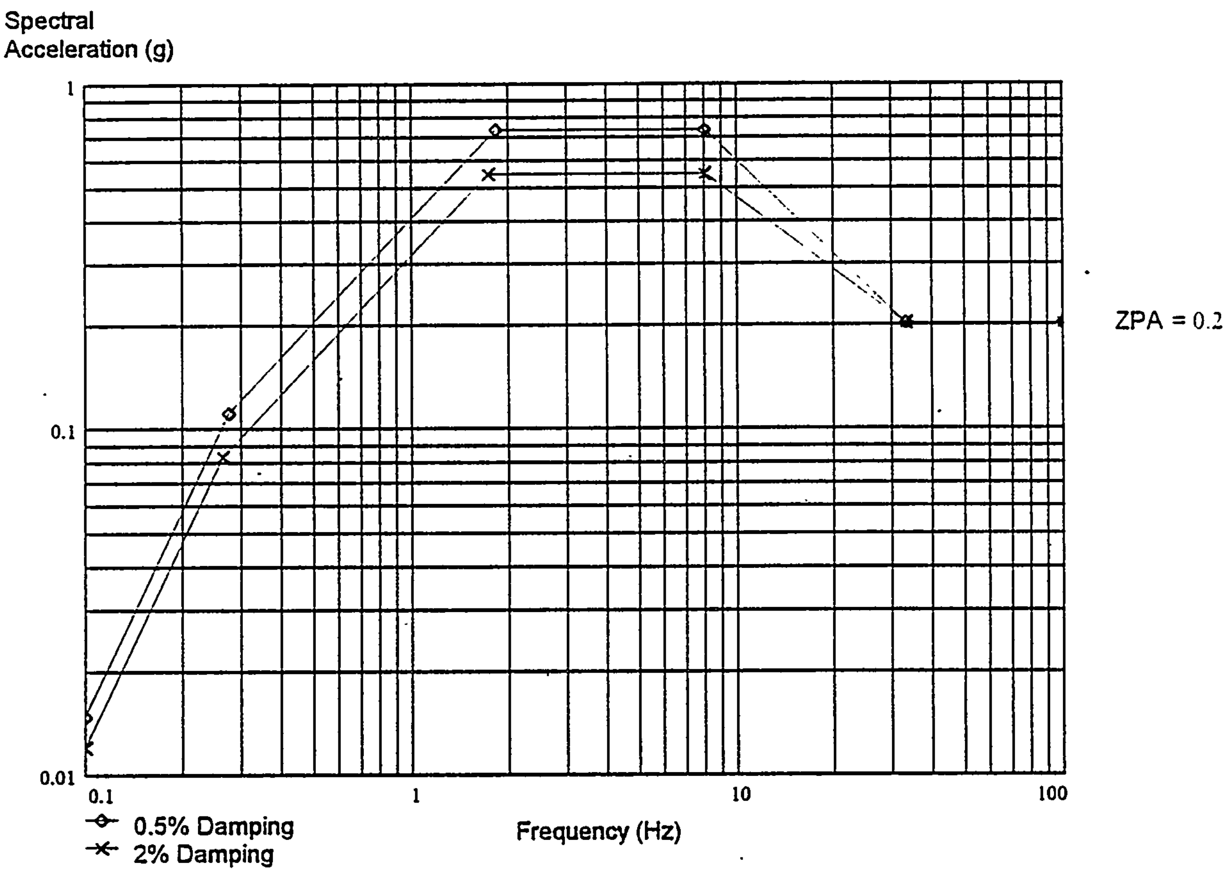
(8) Originator B. V. Winkel BW Date 2/14/95
(9) Checker L. J. Julyk Date 2/15/95

Horizontal Response Spectra Control Points
- Median Centered Newmark-Hall



$$vS_{aZPA0.5\%}\left(\frac{1}{6.307}\right) = 0.0372$$

$$vS_{aZPA0.5\%}\left(\frac{1}{1.894}\right) = 0.214$$

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CENTER ISLAND COMBINED BASE MOMENT:

To account for phase differences between the convective and impulsive modes, a root-sum-square combination was utilized:

$$Mt := Mb + \sqrt{(Mb1)^2 + (Mbo)^2}$$

$$Mt = 7.056 \cdot 10^4 \cdot ft \cdot \frac{lbf}{ft}$$

Note that during normal operations the divider wall is subjected to deadweight column loads which would reduce the base moment. However, during a seismic event, the column reactions are not predicted to maintain a downward reaction on the divider wall, and were not included.

CENTER ISLAND BASE MOMENT CAPACITY:

Due to the massive proportions of the center island wall, the wall dead weight significantly contributes to the base moment capacity. Using ACI 349 criteria, the capacity calculations follow:

$$\phi = 0.9$$

$$a := \frac{As \cdot fy}{0.85 \cdot fc \cdot 12 \cdot in} \qquad a = 0.383 \cdot in$$

$$d := (69 - 2 - .375) \cdot in \qquad d = 66.625 \cdot in$$

$$Mc := As \cdot fy \cdot \left(d - \frac{a}{2}\right) \cdot \frac{1}{12 \cdot in} \qquad Mc = 6.488 \cdot 10^4 \cdot ft \cdot \frac{lbf}{ft}$$

Contribution from dead weight load (Bouyancy & 0.13g vertical seismic uplift included):

$$Mdw := 5.5 \cdot ft \cdot (\gamma c - \gamma w) \cdot 20.75 \cdot ft \cdot \frac{5.75}{2} \cdot ft \cdot .87 \qquad Mdw = 2.501 \cdot 10^4 \cdot ft \cdot \frac{lbf}{ft}$$

Combining and adding the strength reduction factor,

$$Mct := \phi \cdot (Mc + Mdw) \qquad Mct = 8.09 \cdot 10^4 \cdot ft \cdot \frac{lbf}{ft}$$

Center Island Mom. Cap. (Note: A more precise cap. calculation was performed for the empty chute evaluation)

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Comparing the demand and capacity, a positive safety margin is indicated. However, the center island must also support the static and dynamic pressures applied to the isolation barrier doors. This additional loading is addressed below.

CONTRIBUTION FROM ISOLATION BARRIER DOORS:

The door openings are 3 ft., 2 in. in width. Assuming half of the static and dynamic loading imposed on the 2475 lb, 18 foot high gates are carried by the center island, the additional moment contribution is

$$Mg := 3.17 \cdot ft \cdot \left[\sqrt{(Mb1)^2 + (Mbo)^2}\right] + 2475 \cdot lbf \cdot as \cdot 9 \cdot ft$$

$$Mg = 9.389 \cdot 10^4 \cdot ft \cdot lbf$$

If each isolation door loading is spread over half of the center island wall (effective width = 4 times wall thickness per ACI 349, Para. 14.2.4), the additional base moment per foot, dMg, is calculated and added to the total demand:

$$dMg := \frac{Mg}{42.17 \cdot ft} \qquad dMg = 2.226 \cdot 10^3 \cdot ft \cdot \frac{lbf}{ft}$$

$$Mt := Mt + dMg \qquad Mt = 7.278 \cdot 10^4 \cdot ft \cdot \frac{lbf}{ft}$$

Since Mt is below the capacity (Mct = 80,900), the case of increased water depth on both sides of the center island is acceptable. Although there are some approximations in the calculation approach, no credit is taken for the structural brace and the above calculations appear to be sufficient to demonstrate structural adequacy.

APPENDIX B2

EMPTY CHUTE, 16.25 FT WATER DEPTH

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K-EAST BASIN CHUTE CENTER ISLAND SEISMIC CALCULATIONS

CALCULATION OBJECTIVE:

Evaluate the structural adequacy of the K-East Basin center island for the existing structural brace support. Assume that the chute has drained, due to seismic damage, and that an aftershock equal to the full design basis earthquake (DBE) occurs (.2g DBE, Ref.: SDC-4.1, Rev. 12). The evaluation begins with a simple cantilever beam scoping calculation and concludes with a more detailed 3D calculation, using the ANSYS computer code.

DESCRIPTION OF PROBLEM PARAMETERS:

Note: See WHC-SD-NR-DA-013 for geometry details. A listing of pertinent geometry parameters, used in the calculations, follows below:

$h = 16.25 \cdot ft$	Maximum water height, 16 ft - 3 in.
$a = 0.2$	DBE peak ground accel. magnitude
$lb = 68.5 \cdot ft$	Basin north/south interior width
$hw = 20.75 \cdot ft$	Height of center island
$twt = 5.5 \cdot ft$	Center island thickness for top 15 ft, 9 in.
$twb = 5.75 \cdot ft$	Center island thickness for bottom 5 ft.
$fy = 40000 \cdot \frac{lbf}{in^2}$	Rebar yield strength (Ref.: Spec. HW-4739)
$fc = 3000 \cdot \frac{lbf}{in^2}$	Concrete nominal design strength (Spec. HW-4740)
$As = 0.293 \cdot in^2$	Rebar area per foot (#6 @ 18")
$\gamma c = 150 \cdot \frac{lbf}{ft^3}$	Concrete unit weight
$\gamma w = 62.4 \cdot \frac{lbf}{ft^3}$	Water unit weight

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CENTER ISLAND FUNDAMENTAL FREQUENCY CALCULATIONS

An initial estimate of the center island fundamental frequency can be obtained by considering a one foot wide, 20.75 ft. long cantilever beam of constant thickness (66 in.):

$E := 150^{1.5} \cdot 33 \cdot \sqrt{3000}$ ACI, Para. 8.5.1

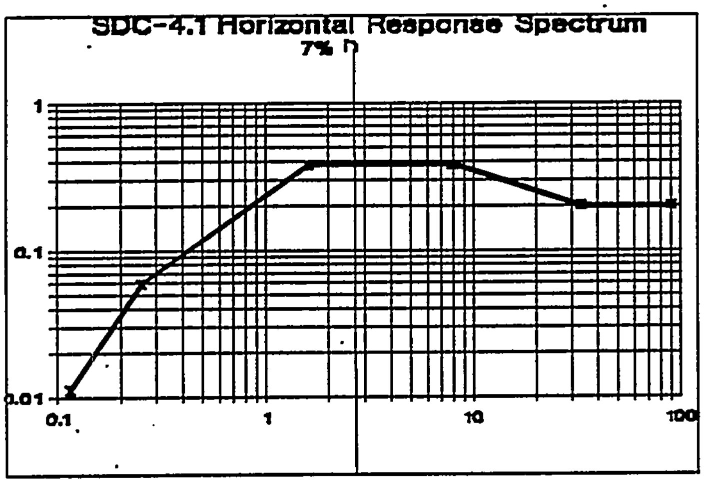
$I := \dfrac{12 \cdot 66^3}{12}$ $I = 2.875 \cdot 10^5$ $l := 12 \cdot 20.75$

$w := 5.5 \cdot \dfrac{150}{12}$ $w = 68.75$

$fn := 0.56 \cdot \sqrt{\dfrac{386.4 \cdot E \cdot I}{w \cdot l^4}}$ Ref.: Standard Handbook for Mech. Engrs., 7th Ed., p.5-101, Eq. (38)

$fn = 20.922$ Fund. frequency, hz (no added mass from water)

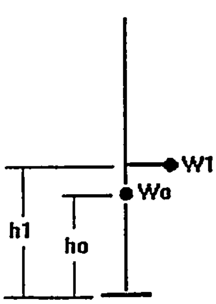
A more precise calculation including the impulsive water mass and the existing seismic support, using an ANSYS model described later, predicted a fundamental frequency of 30 hz. From Fig. 3 of SDC-4.1, Rev. 12 (shown below), 7% damping, an amplification of 5% over the peak ground acceleration of was obtained for a frequency of 30 hz.



Note: Shown ground surface response spectra is conservative relative to basin floor spectra predicted in Winkel & Kanjilal, 1991, *105-KE/105-KW Irradiated Fuel Storage Basins Seismic Qualification*, Westinghouse Hanford Co., Richland, WA.

$as := 1.05 \cdot a$

$as = 0.21$



Hydrodynamic Forces:

The impulsive and convective weight magnitudes (Wo and W1) and effective heights (ho and h1), shown on the sketch on the left, are calculated below.

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$$Wb = \frac{\gamma w \cdot lb \cdot h}{2}$$

Half of weight of the basin water in lbs. per foot. Half of the water weight is applied to the divider wall per Fig. 5.9(c) of ASCE Manual No. 58, "Structural Analysis and Design of Nuclear Plant Facilities".

$$Wb = 3.473 \cdot 10^{4} \cdot \frac{lbf}{ft}$$

Impulsive Component:

$$L = \frac{lb}{2} \qquad L = 34.25 \cdot ft$$

$$Wo = \frac{\tanh\left[\sqrt{3} \cdot \left(\frac{L}{h}\right)\right]}{\sqrt{3} \cdot \left(\frac{L}{h}\right)} \cdot Wb$$

$$Wo = 9.5 \cdot 10^{3} \cdot \frac{lbf}{ft}$$

Impulsive weight applied to divider wall

$$ho = (0.4) \cdot h \qquad ho = 6.5 \cdot ft$$

Effective ht. = 0.4h, Ref.: ASCE, "Guidelines for the Seismic Design of Oil and Gas Pipeline Systems, Table 7.1.

$$Mbo = Wo \cdot ho \cdot as$$

$$Mbo = 1.297 \cdot 10^{4} \cdot lbf \cdot \frac{ft}{ft}$$

Base moment due to impulsive pressure

DESIGN CALCULATION

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Convective Component:

$$W1 := 0.527 \cdot \frac{L}{h} \cdot \tanh\left(1.58 \cdot \frac{h}{L}\right) \cdot Wb$$

$W1 = 2.449 \cdot 10^{4} \cdot \frac{lbf}{ft}$ Convective weight

$$h1 := \left[1 - \frac{\cosh\left(1.58 \cdot \frac{h}{L}\right) - 1}{1.58 \cdot \frac{h}{L} \cdot \sinh\left(1.58 \cdot \frac{h}{L}\right)}\right] \cdot h$$

$h1 = 8.485 \cdot ft$

$$\omega := \sqrt{1.58 \cdot \frac{32.2 \cdot \frac{ft}{sec^2}}{L} \cdot \tanh\left(1.58 \cdot \frac{h}{L}\right)}$$

$\omega = 0.971 \cdot sec^{-1}$

$T := 2 \cdot \frac{\pi}{\omega}$ $T = 6.47 \cdot sec$

$f := \frac{\omega}{2 \cdot \pi}$ $f = 0.155 \cdot sec^{-1}$ Convective mass nat. frequency

$ac := .038$ From SDC-4.1, 0.5% damping. See Appendix B1, p. 6

$Mb1 := W1 \cdot h1 \cdot ac$

$Mb1 = 7.898 \cdot 10^{3} \cdot ft \cdot \frac{lbf}{ft}$ Convective mass base moment

BASE MOMENT DUE TO WALL SEISMIC INERTIA:

$W := twt \cdot \gamma c \cdot hw$ $W = 1.712 \cdot 10^{4} \cdot \frac{lbf}{ft}$

$Mbi := W \cdot \frac{hw}{2} \cdot as$ $Mbi = 3.73 \cdot 10^{4} \cdot ft \cdot \frac{lbf}{ft}$

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BASE MOMENT DUE TO WALL PRESSURE:

$$Mbp := \gamma w \cdot \frac{(h)^3}{6} \qquad Mbp = 4.463 \cdot 10^4 \cdot ft \cdot \frac{lbf}{ft}$$

LOAD CONTRIBUTION FROM ISOLATION DOORS:

The isolation door openings are 3 ft., 2 in. in width. Assuming half of the static and dynamic loading imposed on the 2475 lb (Ref. field measurement), 18 foot high isolation doors are carried by the center island, the additional moment contribution is

$$Mbd := 3.17 \cdot ft \cdot \left[Mbp + \sqrt{(Mb1)^2 + (Mbo)^2} \right] + 2475 \cdot lbf \cdot as \cdot 9 \cdot ft$$

$$Mbd = 1.943 \cdot 10^5 \cdot ft \cdot lbf$$

Assuming the isolation door edge loads are carried by the entire divider wall (see ACI 349, Para. 14.2.4), the additional base moment per foot, dMg, is calculated:

$$dMbd := \frac{Mbd}{42.17 \cdot ft} \qquad dMbd = 4.607 \cdot 10^3 \cdot ft \cdot \frac{lbf}{ft}$$

COMBINED SEISMIC BASE MOMENT:

The total seismic base moment consists of the hydrodynamic base moments, the inertial base moment, the static pressure moment, and the isolation door loading. To account for phase differences between the convective and impulsive/inertia modes, a root-sum-square combination was utilized:

$$M_t := \sqrt{(Mb1)^2 + (Mbo + Mbi)^2} + Mbp + dMbd$$

$$M_t = 1.001 \cdot 10^5 \cdot ft \cdot \frac{lbf}{ft}$$

Note that during normal operations the center island is subjected to deadweight column loads which would reduce the base moment. However, during a seismic event, the column reactions are not predicted to maintain a downward reaction on the divider wall, and were not included.

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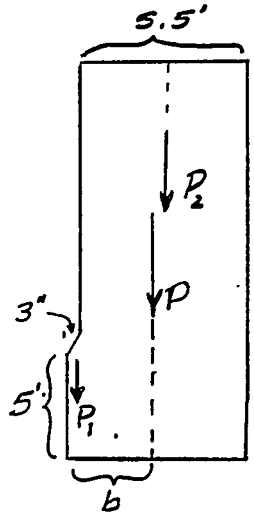
CENTER ISLAND BASE MOMENT CAPACITY

Dead Weight Load (Per foot, including 0.13g seismic uplift):



$a_v := 0.13$

$P_1 := \frac{3}{12} \cdot ft \cdot 5 \cdot ft \cdot 1 \cdot ft \cdot \gamma c \cdot (1 - a_v)$ $P_1 = 163.125 \cdot lbf$

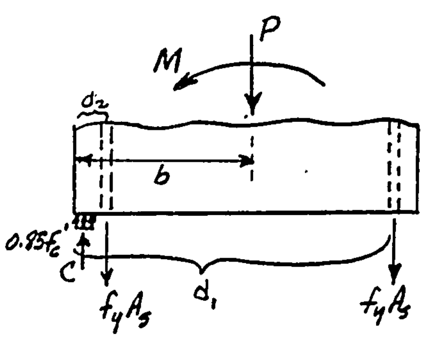
$P_2 := 5.5 \cdot ft \cdot 20.75 \cdot ft \cdot 1 \cdot ft \cdot \gamma c \cdot (1 - a_v)$ $P_2 = 1.489 \cdot 10^4 \cdot lbf$

$P := P_1 + P_2$ $P = 1.506 \cdot 10^4 \cdot lbf$

$b := \frac{P_1 \cdot 1.5 \cdot in + P_2 \cdot 36 \cdot in}{P}$ $b = 35.626 \cdot in$

Ref. Dwg. H-1-21071

Moment Capacity Calculation:

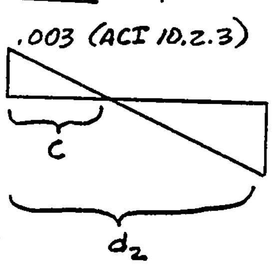


$d_1 := 69 \cdot in - \frac{0.75 \cdot in}{2} - 2.75 \cdot in$ $d_1 = 65.875 \cdot in$

$d_2 := 5.75 \cdot in + \frac{0.75 \cdot in}{2}$ $d_2 = 6.125 \cdot in$

$a := \frac{2 \cdot fy \cdot As + P}{0.85 \cdot fc \cdot 12 \cdot in}$ $a = 1.258 \cdot in$

Strain:



Verify compression side steel yields in tension:

$\beta_1 := 0.85$ ACI, Para. 10.2.7.3

$c := \frac{a}{\beta_1}$ $c = 1.48 \cdot in$ ACI, Para. 10.2.7.1

$\varepsilon_{s2} := 0.003 \cdot \left(\frac{d_2 - c}{c}\right)$ $\varepsilon_{s2} = 0.009 \cdot \frac{in}{in}$

$\varepsilon_y := \frac{40000}{29 \cdot 10^6}$ $\varepsilon_y = 0.001 \cdot \frac{in}{in}$ Rebar $\varepsilon > \varepsilon y$ (yields)

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Taking moments about the center of concrete compression zone:

$$M_n = fy \cdot As \cdot \left(d_1 - \frac{a}{2} + d_2 - \frac{a}{2}\right) + P \cdot \left(b - \frac{a}{2}\right)$$

$$M_n = 1.13 \cdot 10^5 \cdot ft \cdot lbf$$

Strength reduction factor:

$$A_g = 69 \cdot in \cdot 12 \cdot in \qquad A_g = 828 \cdot in^2$$

$$\phi = 0.9 - \frac{P}{0.1 \cdot fc \cdot A_g} \cdot 0.2$$ ACI, Para. 9.3.2.2

$$\phi = 0.888$$

Center Island Base Moment Capacity:

$$M_{cap} = \phi \cdot M_n$$

$$M_{cap} = 1.003 \cdot 10^5 \cdot ft \cdot lbf$$

Demand/capacity discussion follows shear calculations

CENTER ISLAND BASE SHEAR CAPACITY:

Shear strength per ACI-349, Section 11.3:

$$b_w = 12 \cdot \frac{in}{ft}$$

$$V_c = 2 \cdot \left(1 + \frac{15060}{2000 \cdot 828}\right) \cdot \sqrt{3000 \cdot \frac{lbf}{in^2}} \cdot b_w \cdot d$$ ACI-349, Eq. 11-4

$$\phi V_c = 0.85 \cdot V_c$$

$$\phi V_c = 7.512 \cdot 10^4 \cdot \frac{lbf}{ft}$$

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Shear-Friction strength of base construction joint per ACI-349, Section 11.7:

$\phi := 0.85$ — Shear strength reduction factor

$\mu := 1.0$ — Friction coef., surface "rough" per Dwg. # H-1-21071

$dw := \gamma c \cdot 20.75 \cdot ft \cdot (5.5 \cdot ft) \cdot 0.87$

$dw = 1.489 \cdot 10^4 \cdot \frac{lbf}{ft}$ — Dead wt./ft, less seismic uplift of 0.13g (net compression load, increased thickness near base conservatively ignored)

$A_{vf} := \frac{12}{18} \cdot 0.44 \cdot 2 \cdot \frac{in^2}{ft}$ — Compression plus tension steel. See ACI, para. 11.7.7 commentary

$V_n = (A_{vf} \cdot fy + dw) \cdot \mu \cdot \phi$

$V_n = 3.261 \cdot 10^4 \cdot \frac{lbf}{ft}$ — Shear-Friction capacity (controls shear capacity of center island)

Center Island Factored Loads:

Base Shear:

$$V_{un} := \left(1.4 \cdot \gamma w \cdot \frac{h^2}{2}\right) \cdot \left(1 + \frac{3.17}{42}\right)$$

Factored base shear, normal cond., including isol. door edge load (distributed over length of center island)

$$V_{un} = 1.24 \cdot 10^4 \cdot \frac{lbf}{ft}$$

$$V_{us} := \left[\sqrt{(Wo \cdot as)^2 + (W1 \cdot as)^2} + \gamma w \cdot \frac{h^2}{2}\right] \cdot \left(1 + \frac{3.17}{42}\right) + W \cdot as + \frac{2475 \cdot lbf}{42 \cdot ft} \cdot as$$

$V_{us} = 1.84 \cdot 10^4 \cdot \frac{lbf}{ft}$ — Seismic base shear demand controls over normal cond., Vus < Vn = 32,600 lb/ft - OK

Base Moment:

$$M_n := 1.4 \cdot Mbp \cdot \left(1 + \frac{3.17}{42}\right)$$

$M_n = 6.719 \cdot 10^4 \cdot ft \cdot \frac{lbf}{ft}$ — Factored Normal Cond. base moment, including isol. door contribution

$$M_s = M_t$$

$$M_s = 1.001 \cdot 10^5 \cdot ft \cdot \frac{lbf}{ft}$$ Seismic demand (controls over normal condition loading)

Since Ms is close to the capacity (Mct = 100,300), the contribution from the structural brace (see dwg. # H-1-34900) was evaluated. The structural brace has a tensile capacity of 29,000 lb (Appendix B3), which results in the following resisting moment (elevation 18.25 ft):

$$Mbs = \frac{29000 \cdot lbf \cdot 18.25 \cdot ft}{42.17 \cdot ft} \qquad Mbs = 1.255 \cdot 10^4 \cdot ft \cdot \frac{lbf}{ft}$$

At capacity, the structural brace reduces the seismic demand to:

$$V_{un} = V_{un} - \frac{29000 \cdot lbf}{42.17 \cdot ft} \qquad V_{un} = 1.172 \cdot 10^4 \cdot \frac{lbf}{ft}$$ Normal Base Shear

$$V_{us} = V_{us} - \frac{29000 \cdot lbf}{42.17 \cdot ft} \qquad V_{us} = 1.771 \cdot 10^4 \cdot \frac{lbf}{ft}$$ Seismic Base Shear

$$M_n = M_n - Mbs \qquad M_n = 5.464 \cdot 10^4 \cdot ft \cdot \frac{lbf}{ft}$$ Normal Base Moment

$$M_s = M_s - Mbs \qquad M_s = 8.757 \cdot 10^4 \cdot ft \cdot \frac{lbf}{ft}$$ Seismic Base Moment

Thus, the shear capacity (32,600) and the moment capacity (100,300) are not exceeded. Although, ACI 349, Para. 14.2.4, does provide some rationale for ignoring variations along the length of the center island, a more detailed analysis was performed as a check on the beam calculations and provide a better understanding of the center island response. A 3D finite element shell model was constructed as described below.

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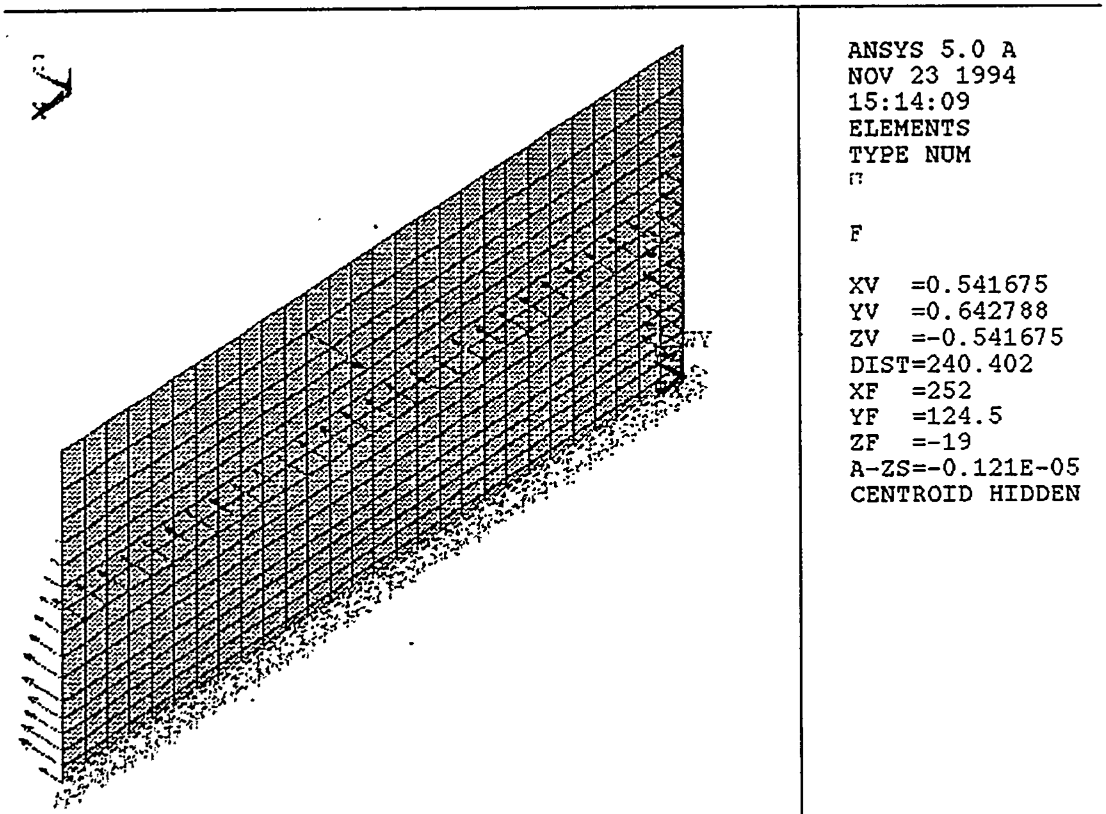
ANSYS MODEL DESCRIPTION/RESULTS

Using SHELL63 elements from ANSYS 5.0A, a finite element model of the divider wall was developed as shown below.



CENTER ISLAND FINITE ELEMENT MODEL

Note the fixed boundary conditions along the bottom of the model. Also shown are the convective fluid dynamic forces, the isolation door edge forces, and the support brace force. The large arrow on the coordinate axes indicates the direction (acceleration in opposite direction) of the lateral inertia loading. Not shown is the static water pressure loading and the impulsive masses.

DESIGN CALCULATION

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ANSYS Model Loading

- Pressure loading: 0 psi @ 195", 7.042 psi @ base

- Seismic inertia loading of 0.21g (applied as ACEL loading to C. Island & impulsive masses)

- Impulsive mass weight of 9500 lb/ft at a height of 6.5 ft (78 in.)

- Convective force of 24,490x0.03 = 735 lb/ft @ ht. = 8.49' (102", conserv. applied @ 111"). Conservatively assumed to be in phase with center island & impulsive mass inertia loading

- Overturning resisting force of 29,000 lb (anchor bolt allowable pullout load) – Ref App B-3

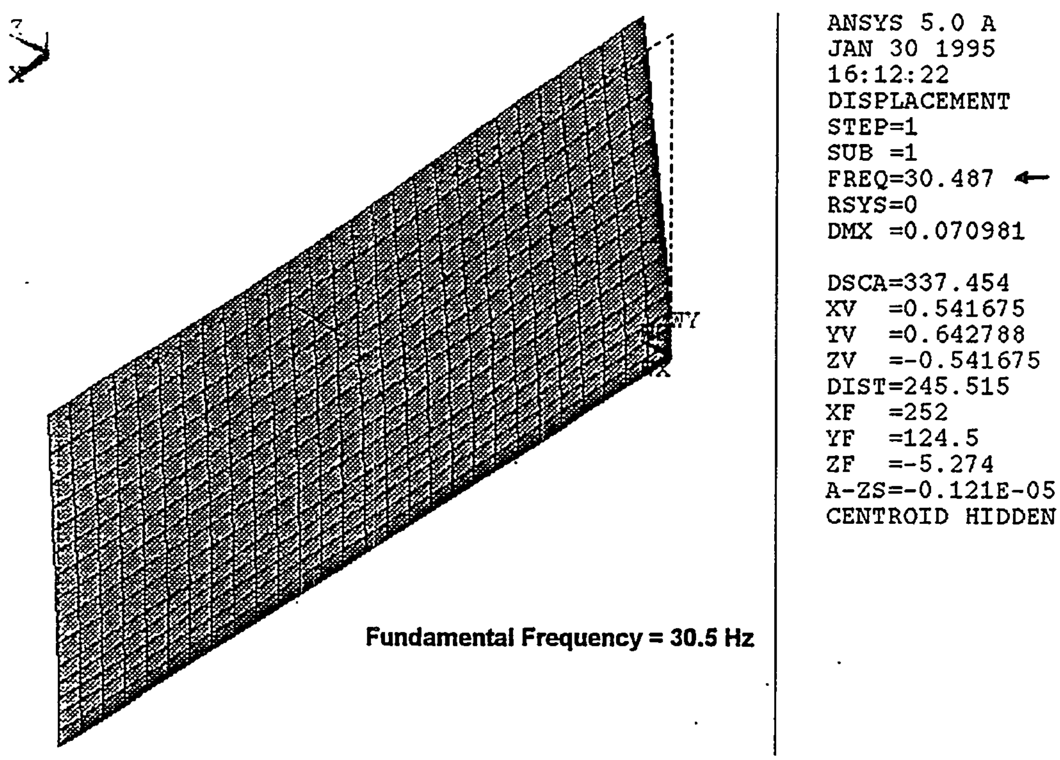
- Edge loading from isolation door:

  - Isolation door inertia loading: (2200/2)x0.23 = 253 lb @ 9 ft on each end (conserv. applied @ 111 in.)

  - Half of isolation door static pressure loading applied along edge of center island model

  - Half of isolation door hydrodynamic loading (Impulsive mass: 9500 x 1.6 = 15,200 lb mass @ height of 6.5 ft. Convective force of 735 x 1.6 = 1176 lb @ 8.49 ft)

Modal Analysis Results (Truss element support @ structural brace location):



Fundamental Frequency = 30.5 Hz

DESIGN CALCULATION

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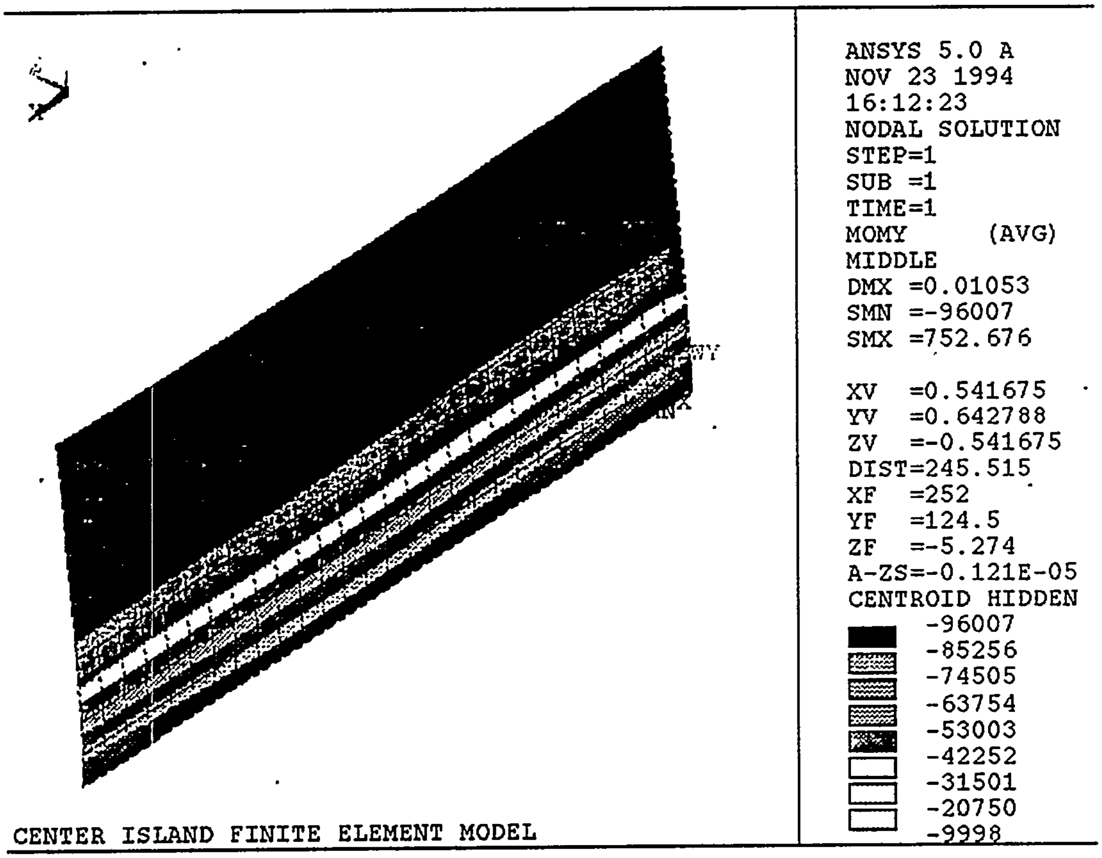
ANSYS Results

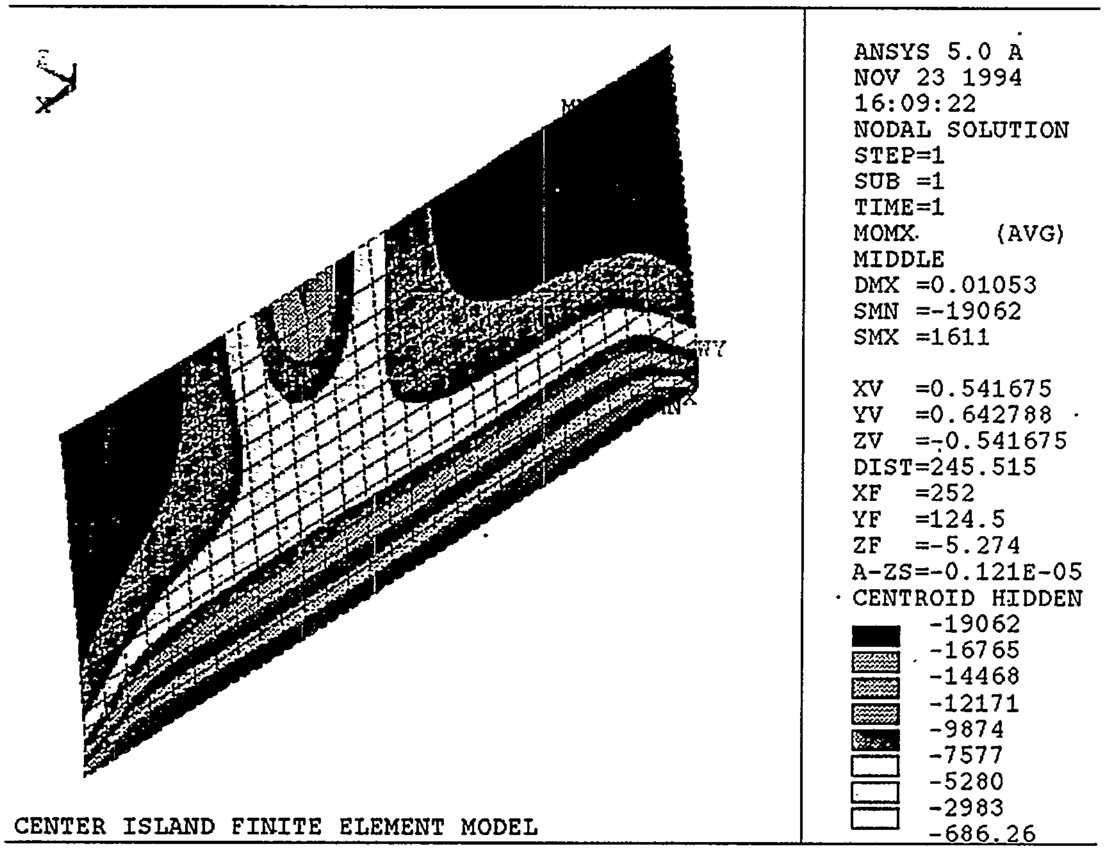
Y Moment Results (moment about a horizontal axis)



Note that a maximum moment of 96,000 ft-lbs/ft was predicted at the west end of the center island. This local moment is very close to the capacity of 100,300. However, there is extra rebar at the ends of the center island, resulting in an increased capacity near the ends. This additional capacity is addressed below.

(1) Drawing H-1-21054 & H-1-21071 (2) Doc. No. ______ (3) Page 8 of 28
(4) Building 105-KE, 105-KW (5) Rev. ______ (6) Job No. ______
(7) Subject K-Basin Chute Wall Seismic Evaluation, Water on Basin Side Only
(8) Originator B. V. Winkel BVW Date 2-14-95
(9) Checker S. K. Kanjilal SK Kanjilal Date 2-21-95

X Moment Results (moment about a vertical axis):



Note that a maximum x moment of about 19,000 ft-lbs/ft is predicted. As shown below, there is adequate horizontal rebar for this seismic demand.

(1) Drawing H-1-21054 & H-1-21071 (2) Doc. No. ______ (3) Page 14 of 20
(4) Building 105-KE (5) Rev. ______ (6) Job No. ______
(7) Subject KE-Basin Center Island Seismic Evaluation, Water on Basin Side Only
(8) Originator B. V. Winkel BVW Date 2-14-95
(9) Checker L. J. Julyk LJJ Date 2/15/95

HORIZONTAL STEEL MOMENT CAPACITY

The 105-KE seismic support reaction introduces moments about a vertical axis. Per dwg. H1-21071, #6 horizontal rebar @ 18 in. was placed on both faces of the center island. The capacity is similar to the vertical steel capacity with no dead weight loading. Ignoring the compression steel:

$$A_s := 0.293 \cdot in^2 \qquad fy = 4 \cdot 10^4 \cdot \frac{lbf}{in^2}$$

$$d := 69 \cdot in - 2.75 \cdot in - \frac{0.75 \cdot in}{2} \qquad d = 65.875 \cdot in$$

$$a := \frac{fy \cdot As}{0.85 \cdot fc \cdot 12 \cdot in}$$

$$a = 0.383 \cdot in$$

$$M_n := fy \cdot As \cdot \left(d - \frac{a}{2}\right)$$

$$M_n = 6.415 \cdot 10^4 \cdot ft \cdot lbf$$ Nominal bending strength per ft

$$\phi := 0.9$$

$$M_{cap} := \phi \cdot M_n$$

$$M_{cap} = 5.774 \cdot 10^4 \cdot ft \cdot lbf$$

Thus, the horizontal rebar moment capacity exceeds the predicted maximum of 19,000 ft-lbf/ft shown on the previous page.

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(4) Building 105-KE (5) Rev. ______ (6) Job No. ______
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(9) Checker S. K. Kanjilal SK Kanjilal Date 2-21-95

Since the horizontal and vertical rebar are the same (#6 @ 18 in.), the moments about a horizontal axis are critical (Y Moment @ base). As indicated above, a peak demand of 96,000 ft-lbs/ft occurs at the west end of the base of the center island. For a capacity of 100,300, the resulting safety margin is

$$MS := \frac{100300}{96000} - 1$$

$$MS = 0.045$$

This near zero safety margin can be increased by accounting for the extra rebar near the ends of the center island. From Dwg. # H-1-21054, there is rebar on the ends of the center island at approximately the same spacing as the north and south faces. The additional moment capacity from this end rebar is addressed below. It is also noted that from ACI 349, Para. 14.2.4, that an effective horizontal length of four times the wall thickness could be used, which would significantly reduce the peak moment.

$$As1 := 0.44 \cdot in^2 \qquad d1 := d - 18 \cdot in \qquad d1 = 48.625 \cdot in$$

$$As2 := 0.44 \cdot in^2 \qquad d2 := d1 - 18 \cdot in \qquad d2 = 30.625 \cdot in$$

$$As := As1 + As2$$

$$\phi := 0.9$$

$$a := \frac{As \cdot fy}{0.85 \cdot fc \cdot 12 \cdot in} \qquad a = 1.15 \cdot in$$

$$dMc := \left[As1 \cdot fy \cdot \left(d1 - \frac{a}{2} \right) + As2 \cdot fy \cdot \left(d2 - \frac{a}{2} \right) \right] \cdot \frac{\phi}{12 \cdot in}$$

$$dMc = 1.031 \cdot 10^5 \cdot ft \cdot \frac{lbf}{ft} \qquad Mct = 9.693 \cdot 10^4 \cdot ft \cdot \frac{lbf}{ft}$$

Spreading this additional end capacity over the full width of the wall:

$$Mct := 100300 \cdot ft \cdot \frac{lbf}{ft} + dMc \cdot \frac{1.5}{42.17}$$

$$Mct = 1.04 \cdot 10^5 \cdot ft \cdot \frac{lbf}{ft}$$

Note from p. 8, that by taking credit for the end rebar, the capacity, Mct, exceeds the demand, Ms, without the seismic brace. This finding was utilized in evaluating the K West brace options. A more detailed evaluation of the local effects of the end rebar for K East follows.

(1) Drawing H-1-21054 & H-1-21071 (2) Doc. No. ______ (3) Page 16 of 20
(4) Building 105-KE (5) Rev. ______ (6) Job No. ______
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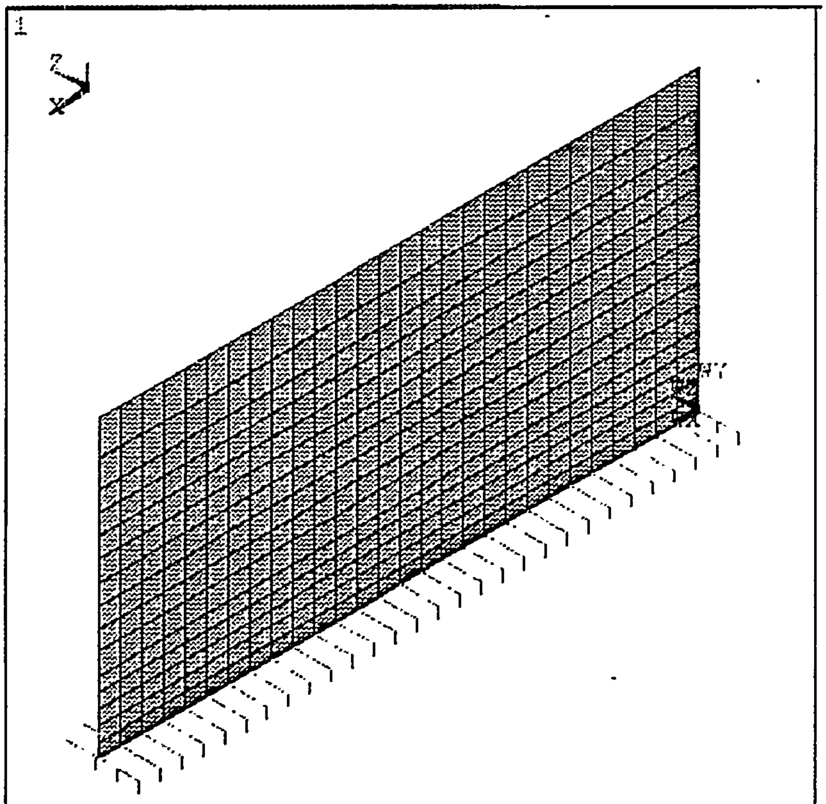
CENTER ISLAND REBAR MODEL

To more accurately determine the influence of the extra rebar at the ends of the center island, the ANSYS center island model was modified to include the rebar as shown below.



CENTER ISLAND MODEL, INDIVIDUAL REBAR MODELLING

Note that each rebar on the tensile side is modelled (every 18 inches), including the first two rebar on the ends. Rigid links (beam elements) are used to connect the rebar (LINK 8, 3D spar) to the center island shell elements. One of the more difficult modelling details, is the selection of an "effective length" for the rebar. When rebar, at a joint, is loaded in tension, its effective length increases with load, due to bond slip, which begins at the joint. The effective length increases until the rebar reaches its yield strength. This effective length concept is illustrated on the following page. This concept was utilized in a B Plant analysis (Rpt. No. WHC-SD-WM-SA-005). At yield, the effective length can be expressed as ld:

$A_s := 0.44 \cdot in^{(2)}$ $\quad f_y := 40000 \cdot \frac{lbf}{in^2}$ $\quad c_s := \pi \cdot 0.75 \cdot in$ $\quad u := 14 \cdot \frac{\sqrt{lbf}}{in} \cdot \sqrt{fc}$

$l_d := \frac{A_s \cdot f_y}{c_s \cdot u}$ $\quad l_d = 9.741 \cdot in$ Effective length, #6 rebar, at yield (used for ANSYS model, as approximate effective length)

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(4) Building 105-KE (5) Rev. ______ (6) Job No. ______
(7) Subject KE-Basin Chute Wall Seismic Evaluation, Water on Basin Side Only
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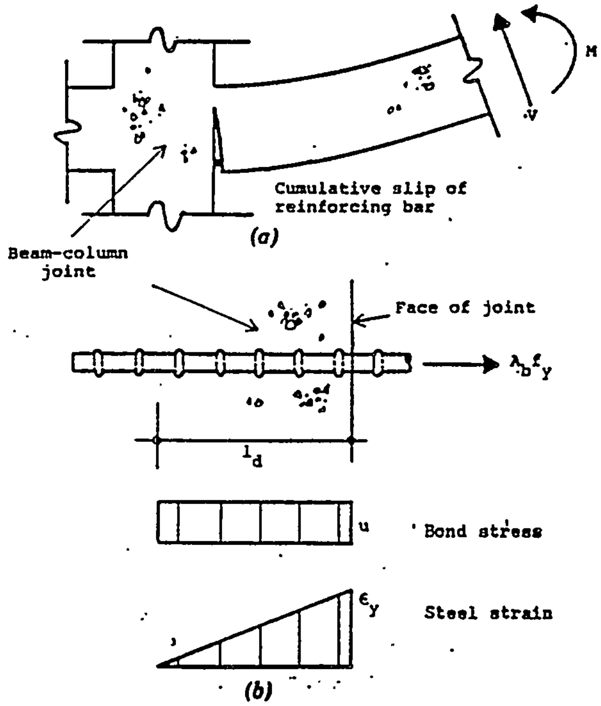
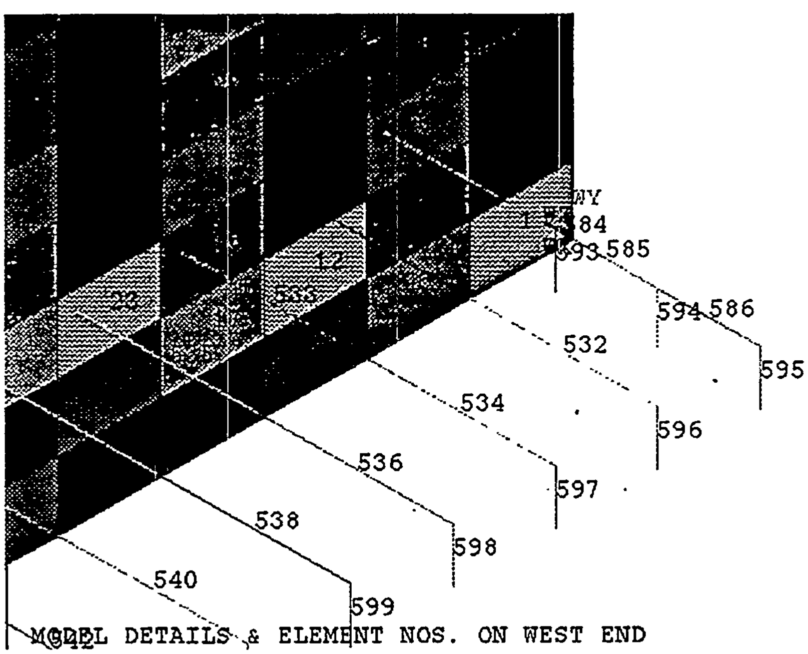
(9) Checker S. K. Kanjilal SKanjilal Date 2-21-95

Joint Stiffness Due to Rebar Bond Slip:



This center island/rebar model was subjected to the normal plus seismic loading described above. The maximum rebar stresses occurred in the rebar near the west end:



MODEL DETAILS & ELEMENT NOS. ON WEST END

The ANSYS center island/rebar model rebar stress and strain results are listed below:

591	0.00000E+00	0.00000E+00	0.00000E+00
592	0.00000E+00	0.00000E+00	0.00000E+00
593	13388.	0.46167E-03	0.00000E+00
594	21453.	0.73975E-03	0.00000E+00
595	29492.	0.10170E-02	0.00000E+00
596	30703.	0.10587E-02	0.00000E+00
597	30927.	0.10665E-02	0.00000E+00
598	31035.	0.10702E-02	0.00000E+00
599	31068.	0.10713E-02	0.00000E+00
600	31064.	0.10712E-02	0.00000E+00
601	31036.	0.10702E-02	0.00000E+00
602	30994.	0.10688E-02	0.00000E+00

***** POST1 ELEMENT TABLE LISTING *****

STAT ELEM	CURRENT RSTRS	CURRENT RSTRN	CURRENT RPSTRN
603	30942.	0.10670E-02	0.00000E+00
604	30884.	0.10650E-02	0.00000E+00
[illegible]	[illegible]	[illegible]	[illegible]

Note that a maximum rebar stress of 31,068 psi occurred in Ele. 599. Using 90% of the minimum yield as the allowable rebar stress for a seismic event (ACI strength reduction factor of 0.9), the allowable stress is 36,000 psi. The corresponding margin of safety is

$$MS := \frac{36000}{31068} - 1$$

$$MS = 0.159$$

Thus, there is sufficient rebar to carry the center island loading with water on one side during a design basis earthquake.

(1) Drawing H-1-21054 & H-1-21071 (2) Doc. No. (3) Page 19 of 28
(4) Building 105-KE (5) Rev. (6) Job No.
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(9) Checker S. K. Kanjilal SKKanjilal Date 7-21-95

As a final check on the adequacy of the center island rebar, consider development length requirements and primary tension steel requirements for bracket/corbel designs (combined moment and shear).

ACI Para. 12.2.2 development length:

$$l_{db} = \frac{0.04 \cdot A_s \cdot f_y}{\sqrt{fc \cdot lbf}}$$

$$l_{db} = 12.853 \cdot in$$

Dwg. No. H-1-21071 does not specify the actual length of the center island base dowels, but the dowels appear to extend down to the level of the bottom rebar of the floor. Thus, the actual development length should be at least 20 in., which is well above the required 12.85 in.

In addition to meeting the flexural steel requirement, Para. 11.9.3.5 requires that at least 2/3 of the required shear-friction steel be on the tensile side. From above,

$$A_{vf} = 0.587 \cdot \frac{(in)^2}{ft}$$ Available rebar steel area

$$V_n = 3.261 \cdot 10^4 \cdot \frac{lbf}{ft}$$ Shear-friction capacity

$$V_{us} = 1.841 \cdot 10^4 \cdot \frac{lbf}{ft}$$ Seismic shear demand

Required Avf:

$$A_{vf} = \frac{18410}{32610} \cdot A_{vf}$$

$$A_{vf} = 0.331 \cdot \frac{in^2}{ft}$$

$$\frac{2}{3} \cdot A_{vf} = 0.221 \cdot \frac{in^2}{ft}$$

The available primary tensile steel is (12/18)x0.44 = 0.29 sq. in./ft, which exceeds the required value of 0.221 (requirement met).

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(4) Building 105-KE (5) Rev. ________ (6) Job No. ________
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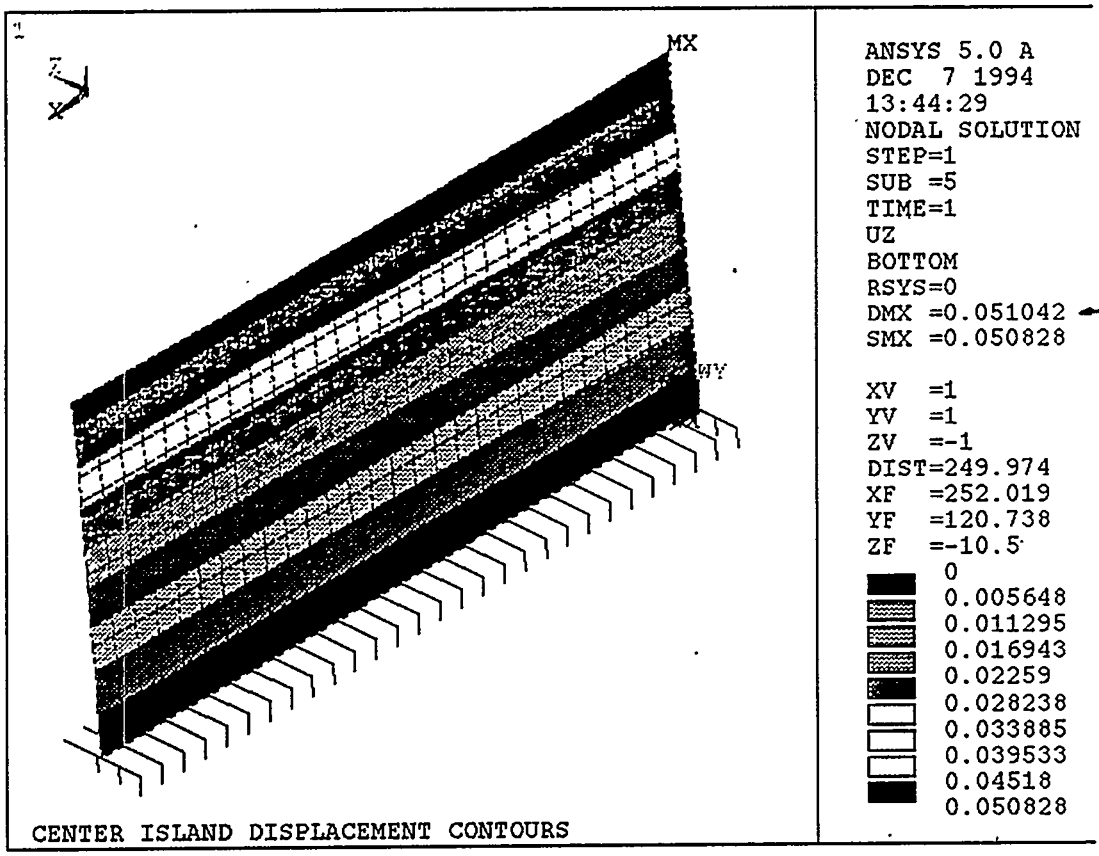
ANCHOR BOLT PULLOUT CONCERN

The above calculations show that the center island has sufficient capacity for a design basis earthquake event with the anchor bolts loaded to their allowable level. The peak load actually picked up by the anchor bolts is very sensitive to the actual stiffness (force/deflection) properties of the support bracket. If there is no play in the bolted joints and anchor bolts, the support bracket allowable load could be exceeded before the cantilevered wall picks up its share of the load. The above center island/rebar ANSYS model provides a feel for the amount of deformation required for the cantilever wall to pick up the load. The predicted displacement contours are shown below:



CENTER ISLAND DISPLACEMENT CONTOURS

Note that a maximum displacement of 0.051 in. was predicted for the very stiff center island. Tests on 3/4-in. anchor bolts (Ref.: NUREG/CR-2999) indicate that displacements ranging from 0.25 in. to over 1.0 in. were achieved before reaching the anchor bolt capacities. Ignoring any displacements in the support bracket bolted joint, a displacement of at least 0.50 in. (0.25 in. on each end) would be necessary before exceeding the anchor bolt capacity. Therefore, it would require an order of magnitude increase in the predicted center island displacement for the anchor bolts to fail.

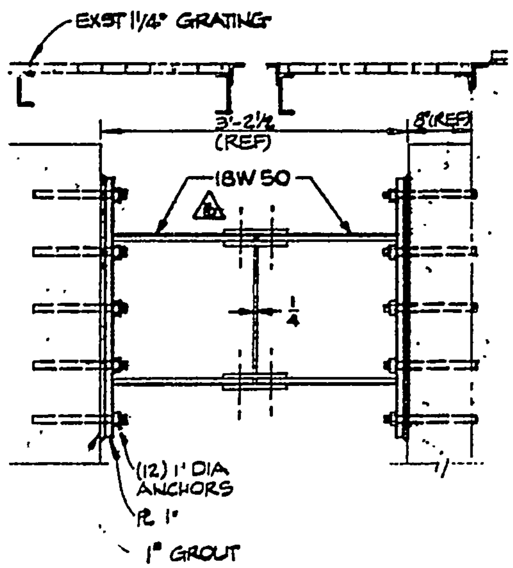
APPENDIX B3

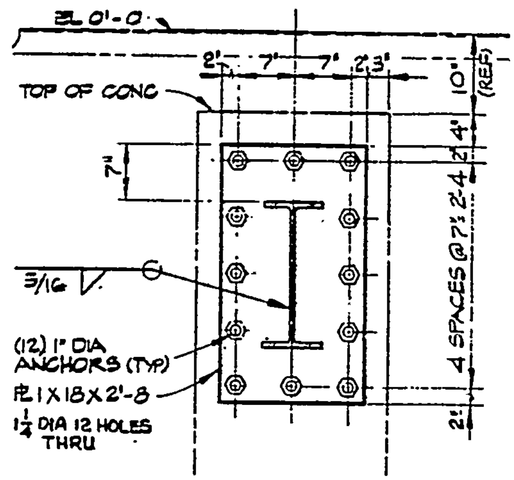
105-KE SUPPORT BRACE

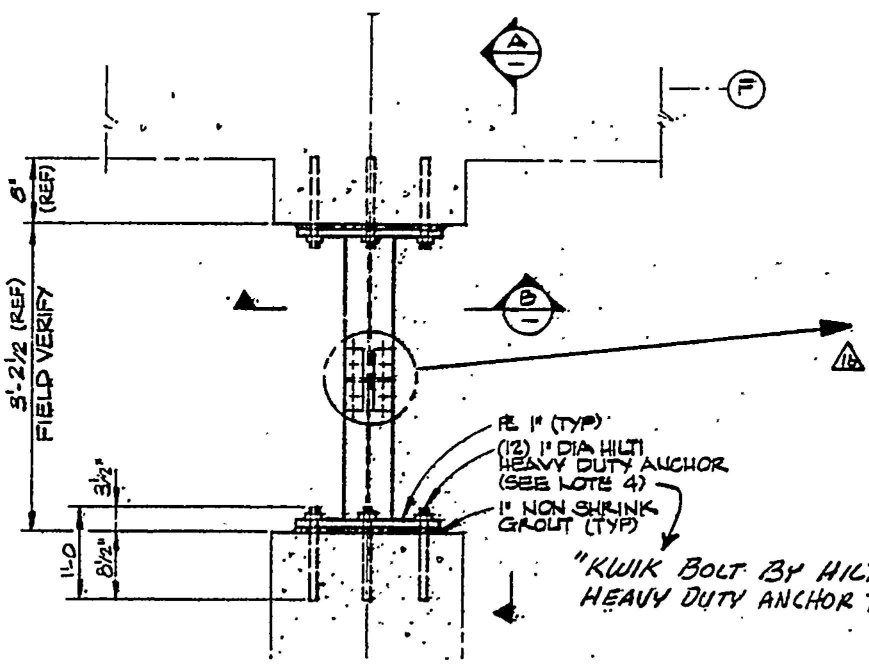
(1) Drawing H-1-21054 & H-1-34900 (2) Doc. No. ________ (3) Page 1 of 7
(4) Building 105-KE, 105-KW (5) Rev. ________ (6) Job No. ________
(7) Subject 105-KE Struct. Brace Cap. (8) Originator B. V. Winkel BVW Date 2/14/95
(9) Checker L. J. Julyk Date 2/15/95

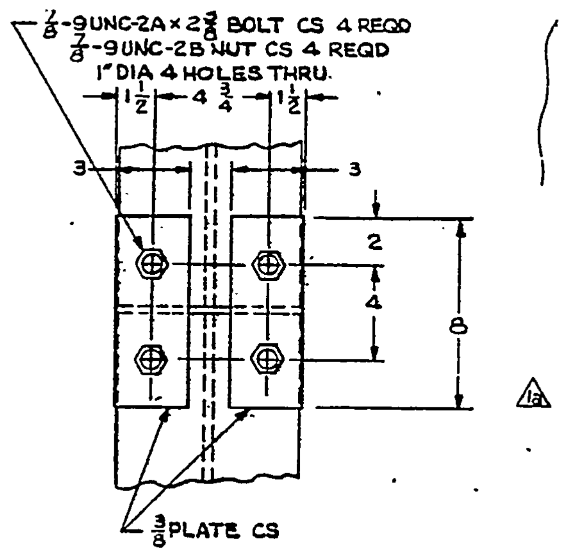
105-KE SUPPORT BRACE CALCULATIONS

Geometry (Dwg.: H-1-34900)









"KWIK BOLT BY HILTI
HEAVY DUTY ANCHOR TYP HVA" (ADHESIVE TYPE)

SCALE: 1/4

(1) Drawing H-1-21054 & H-1-34900 (2) Doc. No. ________ (3) Page 2 of 7
(4) Building 105-KE, 105-KW (5) Rev. ________ (6) Job No. ________
(7) Subject 105-KE Struct. Brace Cap. (8) Originator B. V. Winkel BVW Date 2/14/95
(9) Checker L. J. Julyk LJJ Date 2/15/95

ICBO Report on HILTI HVA Type Anchors:

International Conference of Building Officials

EVALUATION REPORT

Report No. 4016
September, 1984

Filing Category: FASTENERS—Concrete and Masonry Anchors

HILTI HVA ADHESIVE CONCRETE ANCHORS
HILTI FASTENING SYSTEMS, INC.
POST OFFICE BOX 45400
TULSA, OKLAHOMA 74145

I. **Subject:** Hilti HVA Adhesive Concrete Anchors.

II. **Description:** The Hilti concrete anchors are stud-type adhesive anchors for use in regular-weight concrete having a minimum compressive strength of 2000 psi or structural lightweight concrete having a minimum compressive strength of 3000 psi. The anchors consist of a threaded rod of zinc-plated SAE 1018 steel, a nut, washer and sealed glass tube containing an unsaturated polyester resin. Inside the tube of resin there is a smaller tube containing quartz sand which has been coated with a hardening agent. The threaded rod is identified as "HAS" and the tube of resin as "HBP." The anchor is available in ⅜-, ½-, ⅝-, ¾-, ⅞- and 1-inch threaded rod sizes.

values are tabulated in Table No. III. Allowable load values are influenced by the environment in which the anchor is used. The allowable values given in Tables Nos. III and IV must be adjusted in accordance with Figure No. 1 when the anchors are installed in locations where the concrete temperature may exceed 68°F.

Identification: The anchors are identified in the field by labels on the packaging indicating the manufacturer's name, product name and the anchor size. The HBP cartridges are marked individually as to size and the threaded rod has an "H" stamped on top.

III. **Evidence Submitted:** Descriptive data, results of tension and shear tests and results of dynamic tests.

TABLE NO. III
ALLOWABLE TENSION AND SHEAR VALUES IN STONE AGGREGATE CONCRETE[1 2 4 5 7] (Pounds)

ANCHOR DESIGNATION	MINIMUM EMBEDMENT (Inches)	f'_c = 2000 psi		f'_c = 3500 psi	
		Tension[3 6]	Shear	Tension[3 6]	Shear
HVA ⅜	3½	1130	1000	1210	1000
HVA ½	4¼	2065	1945	2460	1945
HVA ⅝	5	2865	2810	3900	2810
HVA ¾	6⅝	4335	3925	5110	3925
HVA ⅞	6⅝	4335	5770	6760	5770
HVA 1	8¼	6775	6800	8400	6800

[1]The tabulated tensile and shear values are for anchors installed in stone aggregate concrete having the minimum designated ultimate compressive strength at time of installation.

[2]The HVA anchor experiences a reduction in tensile and shear capacity with increased concrete temperature. The load factors noted in Figure No. 1 must be applied to the values noted in the above table when the anchors are installed in locations where the concrete temperature may exceed 68°F.

[3]The allowable tension capacities shown reflect the higher short-term test values obtained reduced by 25 percent to account for the long-term load-carrying capabilities characteristic of adhesive anchors, therefore, the allowable values noted above do not have to be reduced for long-term loading conditions.

[4]The allowable load values may be increased 33⅓ percent for duration of loading, such as seismic or wind.

[5]Spacing of the HVA anchors shall be in accordance with the requirements noted in Table No. II.

[6]The anchors cannot be used to resist tension forces in overhead or wall installations, since the anchor values for this loading condition are affected by elevated temperature conditions.

[7]Special inspection in accordance with Section 306 (a) 12 of the code must be provided for all anchor installations.

From Table No. III, Short Duration Loading (Seismic), 4000 psi concrete, ICBO Allow. Tension:

$$P_{nom} = \frac{4}{3} \cdot \frac{4000}{3500} \cdot 8400 \cdot lbf \qquad P_{nom} = 1.28 \cdot 10^4 \cdot lbf$$

(1) Drawing H-1-21054 & H-1-34900 (2) Doc. No. ______ (3) Page 3 of 7
(4) Building 105-KE, 105-KW (5) Rev. ______ (6) Job No. ______
(7) Subject 105-KE Struct. Brace Cap. (8) Originator B. V. Winkel BVW Date 2/1/95
(9) Checker L. J. Julyk LJJ Date 2/15/95

Allowable Working Load Per HILTI Quality and Service Manual:

HVA Adhesive Anchor System

Specification Table

Description	Hole Diameter (in.)	Min. Hole Depth (in.)	Max. thickness of object fastened (in.)	Drill Bit	Allowable Working Loads[1] 4000 psi concrete Tension (lbs)	Shear (lbs)	Maximum Tightening Torque (ft*lbs)	Wrench Size[1] (in.)
HAS 38-518	15/32	3½	1	TE-C 15/32-6	1,500	1,000	18	9/16
HAS 12-612	9/16	4¼	1½	TE-C 9/16-6	2,800	2,000	35	¾
HAS 58-758	11/16	5	1¾	TE-C 11/16-12	4,500	3,000	80	15/16
HAS 34-958	⅞	6⅝	2	TE-C ⅞-10	6,600	4,800	160	1⅛
HAS 78-10 HDG	1	6⅝	2¼	TE-F 1-13	8,500	6,300	200	1 7/16
HAS 1-12	1⅛	8¼	2½	TE-F 1⅛-17	12,100	7,600	330	1½
HAS 114-16	1½	12	2¾	TE-G 1½-17	19,300	13,000	550	1⅞

1. Based on standard rod material.
Also stocked: High strength steel rods, stainless steel (304) rods. Available thru special order; stainless steel (316) rods, HFA internally threaded anchors.

Note that for a 1-in. bolt, the "allowable working load", in tension, for a 4000 psi concrete is 8500 lb. Since this value is less than the ICBO value of 12,800 lb, it was consevatively used for the anchor bolt capacity calculations which follow.

DESIGN CALCULATION WHC-SD-SNF-DA-005, Rev. 0

(1) Drawing H-1-21054 & H-1-34900 (2) Doc. No. ________ (3) Page 4 of 7
(4) Building 105-KE, 105-KW (5) Rev. ________ (6) Job No. ________
(7) Subject 105-KE Struct. Brace Cap. (8) Originator B. V. Winkel BVW Date 2/14/95
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Anchor Bolt Capacity

Ref.: "Guidelines for Assessing the Seismic Adequacy of Safety Class 3 and 4 Equipment at the Hanford Site", WHC-SE-GN-DGS-30006, Section 8.0 (Note: Section 8.0 applies to SC 1/2 anchors). The pullout capacity is defined as

Pall = PnomxRTpxRLpxRSpxREpxRFpxRRpxRCp

where,
Pall = allowable pullout capacity
Pnom = nominal pullout capacity
RCp = reduction factor for concrete cracking
RTp = reduction factor for anchor bolt type
RLp = reduction factor for embedment length
RSp = reduction factor for closely spaced anchors
REp = reduction factor for near edge anchors
RCp = reduction factor for securing anchors with essential relays

Per Dwg. H-1-34900, there are 12, 1" bolts, HILTI heavy duty type HVA with 8" embedment.

$S := 7.0$	Anchor bolt spacing, in.
$D := 1.0$	Bolt diameter, in.
$E := 5.0$	Edge distance, in.
$f_c := 3000$	Concrete 28-day strength, psi
$P_{nom} := 8500$	Allow. working load per HILTI manual, 4000 psi concr.
$RC_p := 1.0$	No visible cracking per visual inspection
$RT_p := 1.0$	Anchor Bolt type known: HILTI
$RL_p := 1.0$	HILTI manual reqd. embedment = 6.5" < 8.0"
$RS_p := \frac{S}{10 \cdot D}$	
$RE_p := \frac{E}{10 \cdot D}$	
$RF_p := \frac{f_c}{4000}$	
$RR_p := 1.0$	No reduction (no essential relays)

$$P_{all} := P_{nom} \cdot RT_p \cdot RL_p \cdot RS_p \cdot RE_p \cdot RF_p \cdot RR_p \cdot RC_p$$

$P_{all} = 2.231 \cdot 10^3$ Allow. pullout load per bolt (side bolts only, top & bottom bolts have larger edge distances

(1) Drawing H-1-21054 & H-1-21071 (2) Doc. No. ________ (3) Page 5 of 7
(4) Building 105-KE Basin (5) Rev. ________ (6) Job No. ________
(7) Subject Cen. Island Structural Brace (8) Originator B. V. Winkel BVW Date 2/14/95
(9) Checker L. J. Julyk LJJ Date 2/15/95

Top Bolt:

$E = 6$

$RE_p := \frac{E}{10 \cdot D}$

$P_{all} := P_{nom} \cdot RT_p \cdot RL_p \cdot RS_p \cdot RE_p \cdot RF_p \cdot RR_p \cdot RC_p$

$P_{all} = 2.678 \cdot 10^3$ Side bolt allowable pullout load, lb

Bottom Bolt:

$E = 12$

Since E > 10D, the reduction factor is one:

$RE_p := 1.0$

$P_{all} = P_{nom} \cdot RT_p \cdot RL_p \cdot RS_p \cdot RE_p \cdot RF_p \cdot RR_p \cdot RC_p$

$P_{all} = 4.463 \cdot 10^3$ Side bolt allowable pullout load, lb

Anchor Bolt Total Capacity

$P_{total} := 10 \cdot 2231 + 2678 + 4463$

$P_{total} = 2.945 \cdot 10^4$ Total anchorage allowable load, lbs.

(1) Drawing H-1-21054 & H-1-21071 (2) Doc. No. ________ (3) Page 6 of 7
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(9) Checker L. J. Julyk Date 2/15/95

Beam Capacity

Beam size: 18W50, material: A36, DBE allow. stress = 0.6xSyx1.7 = 36,700 psi per AISC N690

$A_b := 14.7 \cdot in^2$

$P_{allow} := A_b \cdot 36700 \cdot \frac{lbf}{in^2}$

$P_{allow} = 5.395 \cdot 10^5 \cdot lbf$ Beam allow. load

Splice Bolts Capacity

Bolt size: 7/8", hole size: 1" (oversize, >d+1/16), material: A325 (from marking observed during visual inspection)

$A := .6013 \cdot in^2$

$F_v := 15000 \cdot 1.4 \cdot \frac{lbf}{in^2}$ Allow. shear stress per AISC N-690

$F_b := F_v \cdot A \cdot 2$

$F_b = 2.525 \cdot 10^4 \cdot lbf$ Allowable force/bolt (double shear)

$F_{btot} := 4 \cdot F_b$

$F_{btot} = 1.01 \cdot 10^5 \cdot lbf$ Bolt connection capacity, lb

Splice Plate Capacity

Plate size: 8"x3"x3/8", A36 steel

$A_p := 3 \cdot \frac{3}{8} - 1 \cdot \frac{3}{8}$ Single plate tensile area, sq. in.

$F_t := 0.6 \cdot 36000 \cdot 1.7$ Allow. tensile stress per AISC N690

(1) Drawing H-1-21054 & H-1-21071 (2) Doc. No.. (3) Page 7 of 7
(4) Building 105-KE Basin (5) Rev. (6) Job No.
(7) Subject Cen. Island Structural Brace (8) Originator B. V. Winkel BVW Date 2/14/95
(9) Checker L. J. Julyk Date 2/15/95

$F_p := A_p \cdot F_t$

$F_p = 2.754 \cdot 10^4$ Allow. load per plate, lb

$F_{ptot} := 4 \cdot F_p$

$F_{ptot} = 1.102 \cdot 10^5$ Splice plate capacity, lb

Anchor Plate Capacity

Use approximate, simply supported beam analysis, ignoring contribution of top and bottom center bolts. Assume 14" (distance between vertical bolt lines) simply supported beam with load at center. Plate dimensions: 18"x32"x1", material: A36.

$I := \frac{32 \cdot 1^3}{12}$

$F_{ballow} := 0.66 \cdot 36000 \cdot 1.7$ Allow. bending stress per AISC N690

$F_{cap} := F_{ballow} \cdot \frac{I}{0.5} \cdot \frac{2}{7}$

$F_{cap} = 6.155 \cdot 10^4$ Plate capacity, lb

Fillet Weld Capacity (5/16 weld, full beam circumference)

$l := 2 \cdot 18 + 4 \cdot 7.125$ Weld length, in

$F_{allow} := 0.4 \cdot 36000 \cdot 1.4$ Allow. shear stress per AISC N690

$F_{cap} := F_{allow} \cdot l \cdot \frac{5}{16} \cdot .707$

$F_{cap} = 2.873 \cdot 10^5$ Capacity of fillet weld, lb

Note that the capacity of the center island structural brace is limited by the anchor bolts, resulting in a structural brace allowable load of 29,000 lbs.

APPENDIX B4

105-KW SUPPORT BRACE

(1) Drawing H-1-21071 & H-1-34853 (2) Doc. No. ______ (3) Page 1 of 3
(4) Building 105-KW (5) Rev. ______ (6) Job No. ______
(7) Subject KW-Basin Center Island Seismic Evaluation, Water on Basin Side Only
(8) Originator B. V. Winkel BW Date 2/14/95
(9) Checker L. J. Julyk LJJ Date 2/15/95

K-WEST CENTER ISLAND SUPPORT BRACE CALCULATIONS

Input Parameters:

Note: For simplicity, determine support capacity by ignoring the angle bracing between the channels. Also, conservatively assume ends are pinned for both rotational axes. Allowables per AISC N-690 for "abnormal extreme" load category (per 105-KE analysis, seismic event controls)

$A := 3.09 \cdot in^2$

$E := 29 \cdot 10^6 \cdot \frac{lbf}{in^2}$

$F_y := 36000 \cdot \frac{lbf}{in^2}$

$l := 84 \cdot in$

$r := 0.529 \cdot in$ — C6x10.5 channel (dwg. H-1-34853) weak axis

$K := 1.0$ — Pinned ends (conservative)

$\frac{K \cdot l}{r} = 158.79$

$C_c := \sqrt{\frac{2 \cdot \pi^2 \cdot E}{F_y}}$

$C_c = 126.099$ — Kl/r > Cc, Eq. (Q1.5-2) controls

$$F_a := \frac{12 \cdot \pi^2 \cdot E}{23 \cdot \left(K \cdot \frac{l}{r}\right)^2}$$

$$F_a = 5.922 \cdot 10^3 \cdot \frac{lbf}{in^2}$$

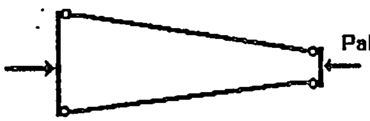
Check tensile allowable:

$Ft_{allow} := 0.6 \cdot F_y$ $\quad Ft_{allow} = 2.16 \cdot 10^4 \cdot \frac{lbf}{in^2}$ — Compression controls

$P_{allow} := F_a \cdot A \cdot 2 \cdot 1.7$ — Stress limit coef. = 1.7 (per AISC N-690, seismic loading)

$P_{allow} = 6.222 \cdot 10^4 \cdot lbf$ — Channel beams allowable load

(1) Drawing H-1-21071 & H-1-34853 (2) Doc. No. ______ (3) Page 2 of 5
(4) Building 105-KW (5) Rev. ______ (6) Job No. ______
(7) Subject KW-Basin Center Island Seismic Evaluation, Water on Basin Side Only
(8) Originator B. V. Winkel BVW Date 2/14/95
(9) Checker L. J. Julyk LJJ Date 2/15/95



Note that channel beams are not parallel to the axial load. The reduction in Pallow due to this deviation follows.

$$\alpha := \operatorname{atan}\left(\frac{3.5}{83.5}\right)$$

Slope is 3.5" over 83.5"

$$\alpha = 0.042$$

$$\cos(\alpha) = 0.999$$

Thus, the effect of the deviation from parallel is negligible.

Anchor Bolts

Per Dwg. H-1-34853, 1" diameter HILTI Super Kwik bolts with 8-1/2" embedment were specified for the support brace anchorage (9 bolts each end). Per Table No. II of the "HILTI Architects and Engineers Anchor and Fastener Design Manual", the allowable load in tension for 3000 psi concrete is 4265 lb if no "special inspection" was performed. Since the drawing did not specify a special inspection, the 4265 lb allowable was used. Applies only to tensile loading. When chute is empty (critical case), loading is compression.

$$P_{allow} := 9 \cdot 4265 \cdot \mathrm{lbf}$$

No knockdown factors (spacing & edge distance > 10D)

$$P_{allow} = 3.839 \cdot 10^{4} \cdot \mathrm{lbf}$$

Anchor bolts allowable (tension loading, non-critical load case)

End Pin Bolts

From Appendix B2, the center island base moment due to pressure (empty chute) is approximately equal to the total seismic base moment. Thus, the critical support brace loading is compressive and shear pullout at a bolt hole is not a feasible failure mode. Only the bolt shear failure mode is considered. Either A307 or A36, 1-3/4" eye bolts are specified for the smaller end of the braces (A307 also specified for larger end). Using the lower allowable (A307), the allowable shear stress is 10 ksi. The allowable shear load for double shear is

$$P_{allow} := \frac{2 \cdot 10000 \cdot \frac{\mathrm{lbf}}{\mathrm{in}^2} \cdot \pi \cdot (1.75 \cdot \mathrm{in})^2}{4} \cdot 1.4$$

Stress lim. coef. = 1.4 for shear (N690, Table Q1.5.7.1, footnote g)

$$P_{allow} = 6.735 \cdot 10^{4} \cdot \mathrm{lbf}$$

End pin allowable

(1) Drawing H-1-21071 & H-1-34853 (2) Doc. No. (3) Page 3 of 3
(4) Building 105-KW (5) Rev. (6) Job No.
(7) Subject KW-Basin Center Island Seismic Evaluation, Water on Basin Side Only
(8) Originator B. V. Winkel Date 2/14/95
(9) Checker L. J. Julyk Date 2/15/95

Beam-to-Tube Connector Plate

Connector plate on smaller end is smaller (7"x3/4" cross-section, A36 steel)

$$P_{allow} := 7 \cdot in \cdot 0.75 \cdot in \cdot 0.6 \cdot 36000 \cdot \frac{lbf}{in^2} \cdot 1.7$$

$$P_{allow} = 1.928 \cdot 10^5 \cdot lbf$$

End Tubes

North end tube shorter (t = 0.375", A563 steel, grade not specified, assume grades MT 1010 to 1020 per ASTM spec. para. 6.1, min. yield = 25 ksi) Applies to tensile loading.

$$P_{allow} := 2 \cdot 7 \cdot in \cdot 0.375 \cdot in \cdot 0.6 \cdot 25000 \cdot \frac{lbf}{in^2} \cdot 1.7$$

$$P_{allow} = 1.339 \cdot 10^5 \cdot lbf$$

Welds

Critical welds are the two 6-1/4"x5/16" fillet welds connecting the side plates to the end plate on the smaller end:

$$P_{allow} := 2 \cdot 6.25 \cdot in \cdot \frac{5}{16} \cdot in \cdot 0.707 \cdot 0.4 \cdot 36000 \cdot \frac{lbf}{in^2} \cdot 1.4$$

$$P_{allow} = 5.568 \cdot 10^4 \cdot lbf$$

Conclusion

Note that the side-plate-to-end-plate fillet welds are the limiting components that determine the capacity of the support braces. Since there are three braces supporting the center island, the total support capacity is 3x55,700 = 167,100 lb. In the 105-KE evaluation, a support of 29,000 lb was found to be sufficient for the center island. Therefore, the existing 105-KW support braces are adequate in their current configuration for a full 0.2g aftershock. However, since there is some concern that the braces may be damaged due to reactor building rocking during a DBE, the case of an empty drain chute aftershock, with no center island support, was also evaluated. See Section 5.2.2 of report text.

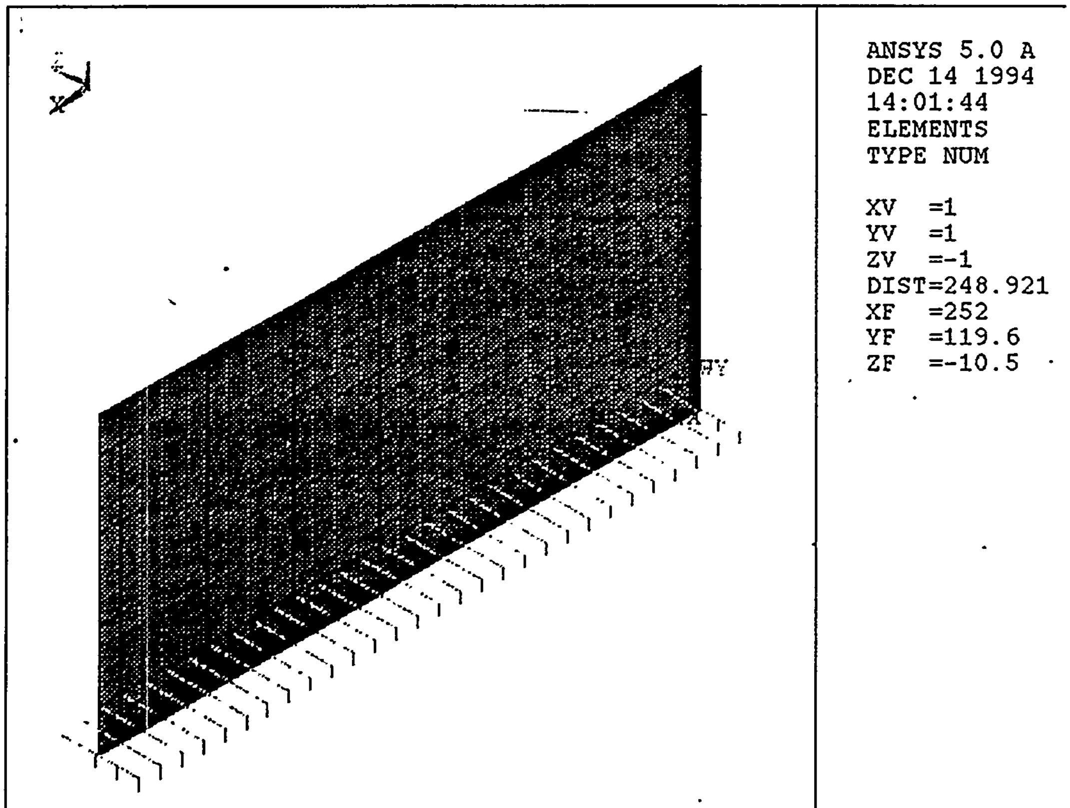
APPENDIX B5

INELASTIC ANALYSIS OF CENTER ISLAND

(1) Drawing H-1-21071 & H-1-34853 (2) Doc. No. ________ (3) Page 1 of 7
(4) Building 105-KW (5) Rev. ________ (6) Job No. ________
(7) Subject KW-Basin Center Island Seismic Evaluation, Water on Basin Side Only
(8) Originator B. V. Winkel BVW Date 2-14-95
(9) Checker L. J. Julyk LJJ Date 2/15/95

INELASTIC ANALYSIS OF CENTER ISLAND

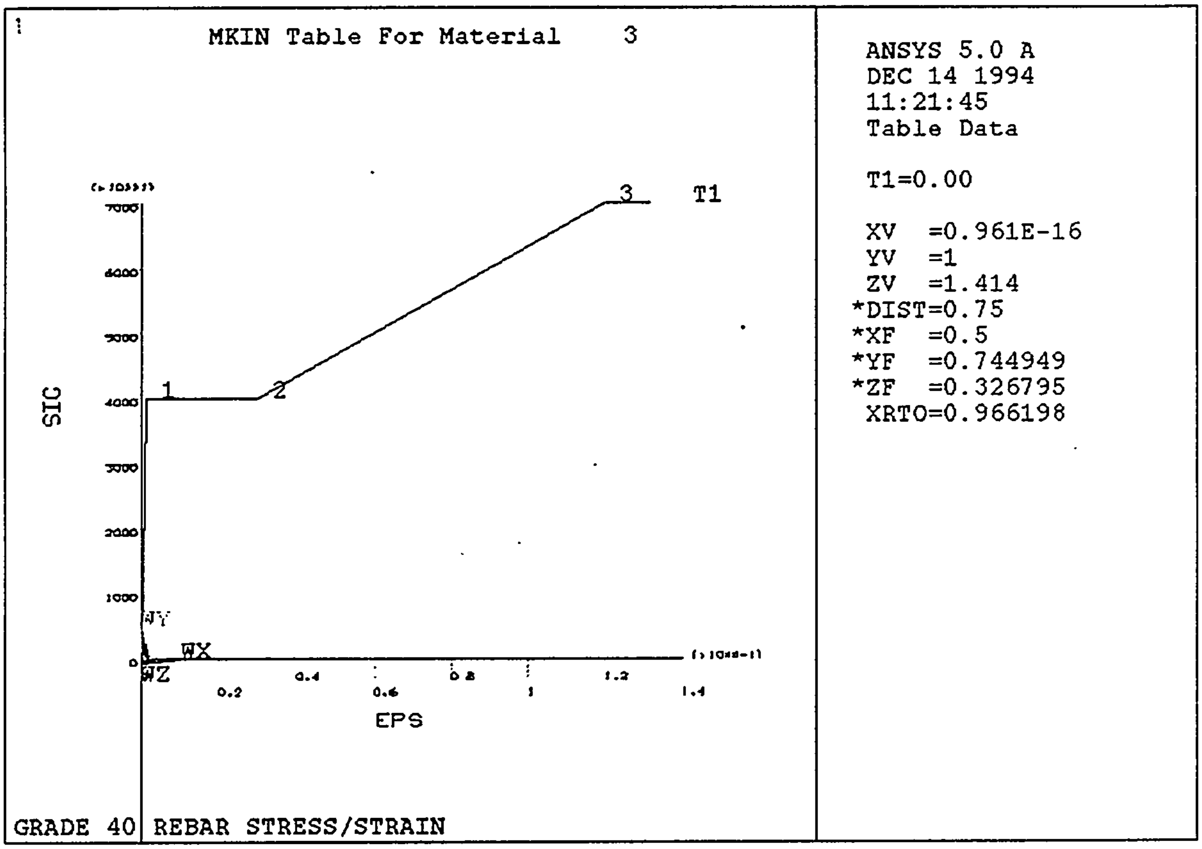
For a low probability event, such as a Design Basis Earthquake (DBE), Section III of the ASME Code, Appendix F, allows a "plastic instability" analysis. Per Para. F-1324.4, the allowable loading is 70% of the plastic instability load. Using the center island/rebar model used in the 105-KE analysis, shown below, an inelastic analysis was performed.



105-KW CENTER ISLAND ELASTIC/PLASTIC MODEL

(1) Drawing H-1-21071 & H-1-34853 (2) Doc. No. ______ (3) Page 2 of 7
(4) Building 105-KW (5) Rev. ______ (6) Job No. ______
(7) Subject KW-Basin Center Island Seismic Evaluation, Water on Basin Side Only
(8) Originator B. V. Winkel BVW Date 2-14-95
(9) Checker L. J. Julyk LJJ Date 2/15/95

Each rebar on the tensile side (north side) of the center island was modelled using the ANSYS LINK8 element, which has plasticity capability. The Grade 40 rebar was assumed to have a yield strength of the minimum value of 40 ksi, as shown below. Also note that a 3% plateau was assumed beyond yield, which is typical of the Grade 40 rebar. Ultimate stress/strain values of 70 ksi and 12%, respectively were assumed (Ref.: Park, R. and Paulay, T., Reinforced Concrete Structures, Chapter 2, "Stress-Strain Relationships for Concrete and Steel", Wiley and Sons, New York, 1975.



To demonstrate that the center island does not exceed 70% of the plastic instability load, the DBE load case was increased by a factor of 1.4, i.e. 1/0.7, and the elastic/plastic response was obtained. The results of the inelastic analysis follow below.

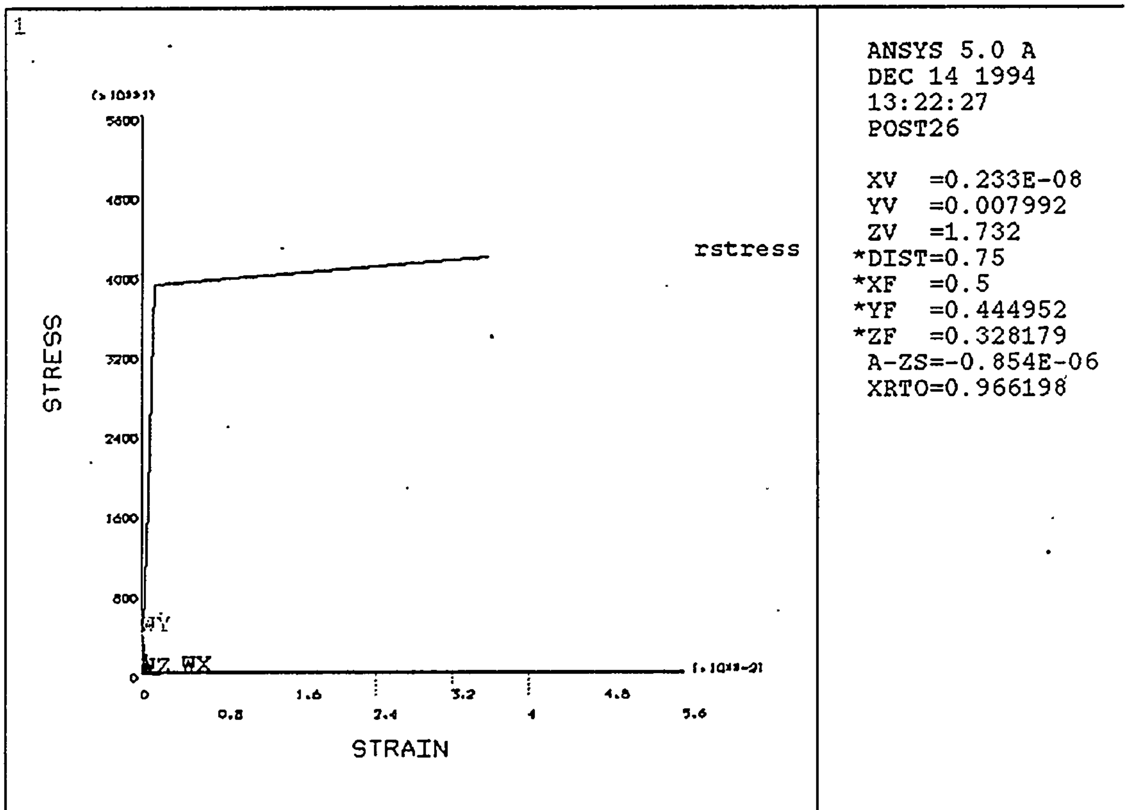
(1) Drawing H-1-21071 & H-1-34853 (2) Doc. No. ________ (3) Page 3 of 7
(4) Building 105-KW (5) Rev. ________ (6) Job No. ________
(7) Subject KW-Basin Center Island Seismic Evaluation, Water on Basin Side Only
(8) Originator B. V. Winkel BW Date 2-14-95
(9) Checker L. J. Julyk LJJ Date 2/15/95

The end-of-loading stress/strain results for the 140% loading are listed below for the more highly strained rebar elements. Note that elements 608 through 610 have the highest stress/strain values. These elements are in the middle of the north face. Note also that a maximum strain of 3.6% was predicted.

STAT ELEM	CURRENT RSTRESS	CURRENT STRAIN
603	41953.	0.35772E-01
604	41954.	0.35774E-01
605	41954.	0.35775E-01
606	41955.	0.35776E-01
607	41955.	0.35776E-01
608	41955.	0.35777E-01
609	41955.	0.35777E-01
610	41955.	0.35777E-01
611	41955.	0.35776E-01
612	41955.	0.35776E-01
613	41954.	0.35775E-01
614	41954.	0.35774E-01
615	41953.	0.35772E-01
616	41953.	0.35770E-01
617	41952.	0.35767E-01
618	41951.	0.35764E-01
619	41949.	0.35759E-01
620	41946.	0.35751E-01
621	41943.	0.35740E-01
622	41937.	0.35722E-01
623	40025.	0.16200E-01
624	40029.	0.25922E-01
625	41910.	0.35643E-01

(1) Drawing H-1-21071 & H-1-34853 (2) Doc. No. ______ (3) Page 4 of 7
(4) Building 105-KW (5) Rev. ______ (6) Job No. ______
(7) Subject KW-Basin Center Island Seismic Evaluation, Water on Basin Side Only
(8) Originator B. V. Winkel BVW Date 2-14-95
(9) Checker L. J. Julyk LJJ Date 2/15/95

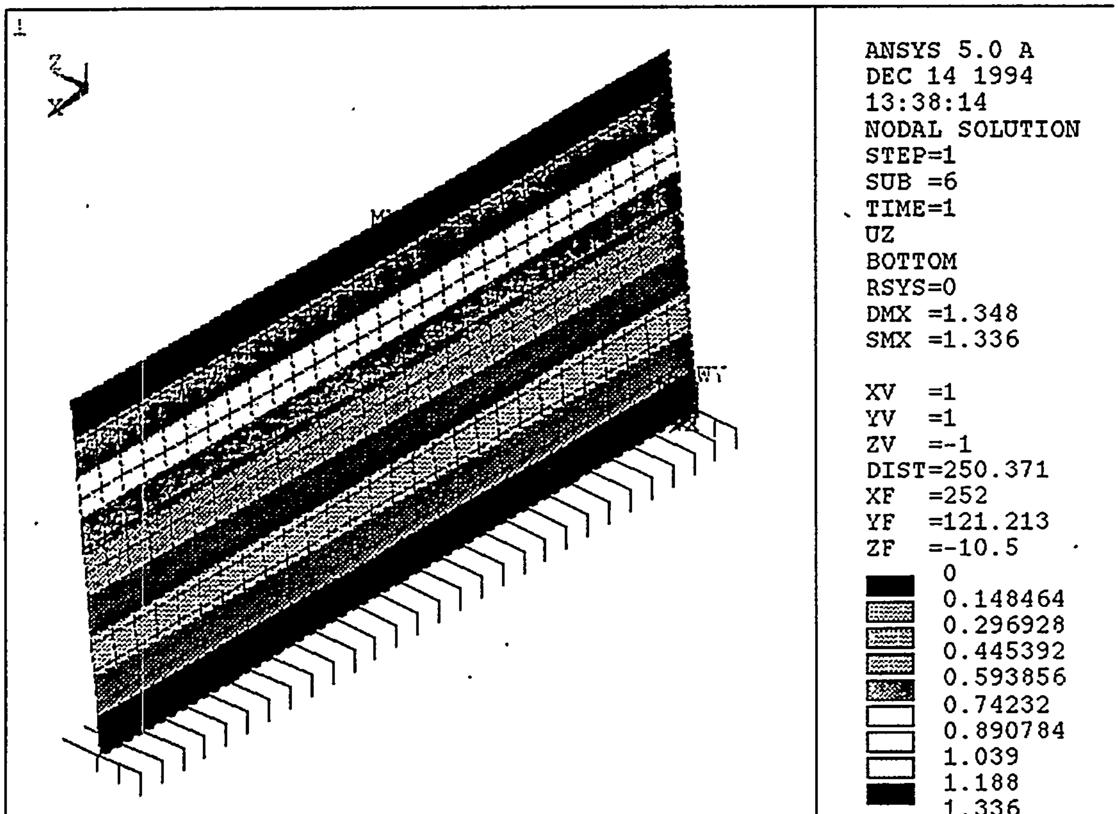
The element 609 stress/strain response is shown below. The maximum stress and strain values of 42 ksi and 3.6% are well below the plastic instability values of 70 ksi and 12%. Therefore, the DBE load case does not exceed the ASME requirement of 0.7 times the plastic instability loading.



ELEM. 609 STRESS/STRAIN

(1) Drawing H-1-21071 & H-1-34853 (2) Doc. No. ______ (3) Page 5 of 7
(4) Building 105-KW (5) Rev. ______ (6) Job No. ______
(7) Subject KW-Basin Center Island Seismic Evaluation, Water on Basin Side Only
(8) Originator B. V. Winkel BW Date 2-14-95
(9) Checker L. J. Julyk Date 2/15/95

The displacement contours are illustrated below. Note that a maximum displacement of 1.3 in. was predicted for the 140% load case.



DEFORMATION CONTOURS, 140% LOADING

As shown in the load history below, most of the plasticity occurs in the last 10% of the 1.4 load case. At 0.7 of this 1.4 load case, the deflection is small (about .05 in.). Thus, even though the DBE load case, without support braces, exceeds ACI 349 allowables, the predicted DBE deformations are small.

TIME	288 UZ u288
0.10000	0.691030E-02
0.20000	0.138206E-01
0.40000	0.276412E-01
0.80000	0.552824E-01
0.90000	0.621927E-01
1.0000	1.33617

(1) Drawing H-1-21071 & H-1-34853 (2) Doc. No. (3) Page 6 of 7
(4) Building 105-KW (5) Rev. (6) Job No.
(7) Subject KW-Basin Center Island Seismic Evaluation, Water on Basin Side Only
(8) Originator B. V. Winkel BW Date 2-14-95
(9) Checker L. J. Julyk LJJ. Date 2/15/95

Check shear failure instability:

Since tensile steel has yielded, assume only compressive steel is available for shear capacity.

$fy := 40000 \cdot \frac{lbf}{in^2}$ Rebar yield strength

$dw := 1.489 \cdot 10^4 \cdot \frac{lbf}{ft}$ Dead wt./ft of the center island

$\mu := 1.0$ Friction coef.

$A_{vf} := \frac{12}{18} \cdot 0.44 \cdot \frac{in^2}{ft}$ Compression steel area/ft

$V_n := (A_{vf} fy + dw) \cdot \mu$ Shear capacity

$V_n = 2.662 \cdot 10^4 \cdot \frac{lbf}{ft}$

$0.7 \cdot V_n = 1.864 \cdot 10^4 \cdot \frac{lbf}{ft}$ 0.7 of shear capacity

$V_{us} := 1.841 \cdot 10^4 \cdot \frac{lbf}{ft}$ Shear demand, DBE load condition does not exceed 70% of capacity. Thus, shear instability not predicted.

Note: Shear safety margin could be increased by taking credit for the compressive component of the base moment (>Avf x fy):

$V_n := (2 \cdot A_{vf} fy + dw) \cdot \mu$

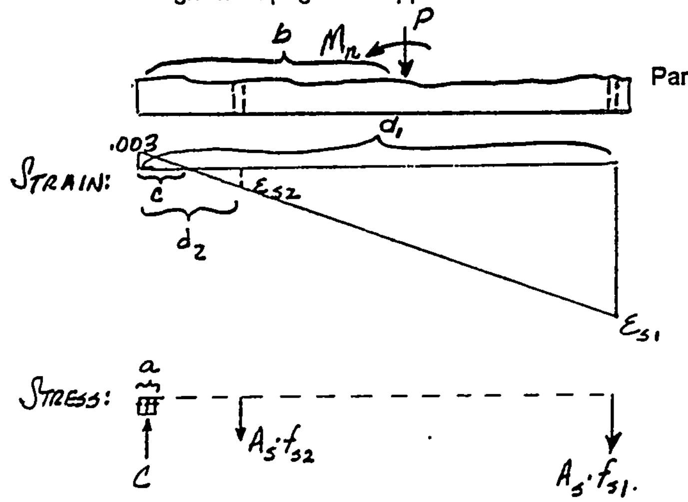
$V_n = 3.836 \cdot 10^4 \cdot \frac{lbf}{ft}$

$MS := \frac{V_n}{V_{us}} - 1$

$MS = 1.083$

(1) Drawing H-1-21071 & H-1-34853 (2) Doc. No. (3) Page 7 of 7
(4) Building 105-KW (5) Rev. (6) Job No.
(7) Subject KW-Basin Center Island Seismic Evaluation, Water on Basin Side Only
(8) Originator B. V. Winkel BW Date 2-14-95
(9) Checker L. J. Julyk LJ Date 2/15/95

The above inelastic analysis assumes that the center island ultimate failure mode is bending about the base. Considering rebar stresses beyond the yield stress, increases the possibility of a shear/friction failure. Once the concrete reaches ultimate strain, the associated powder/rubble at the location of thecrushing concrete will reduce the friction coefficient, and a shear/friction failure may occur. Thus, a reasonable ultimate capacity of the center island can be obtained by accounting for strain hardening in the rebar steel, but not allowing the concrete strains to exceed the ACI code ultimate of 0.003 in/in. An estimate of the crush initiation moment can be obtained by extending the capacity calculations given on page 6 of Appendix B-2.



Parameters from p. 6 of Appendix B-2:

$P := 1.506 \cdot 10^4 \cdot lbf$ $\qquad A_s = 0.293 \cdot in^2$

$b := 35.626 \cdot in$ $\qquad f_y = 40000 \cdot \frac{lbf}{in^2}$

$d_1 = 65.875 \cdot in$

$d_2 = 6.125 \cdot in$

$c := 1.48 \cdot in$

$a := 1.258 \cdot in$

$\varepsilon_{s2} = .009 \cdot \frac{in}{in}$

Solving for the strain in the tensile-side rebar:

$$\varepsilon_{s1} := \frac{d_1 - c}{c} \cdot 0.003 \qquad \varepsilon_{s1} = 0.131 \cdot \frac{in}{in}$$

From p. 2 of this appendix, a rebar strain of 0.13 results in a stress of about 70 ksi (minimum ultimate stress). For the compression-side steel, the strain is 0.009 in/in, which from p. 2, gives a stress of about 40 ksi (min. yield stress). Thus the moment associated with crush initiation can be conservatively calculated as:

$$M_n := f_y \cdot A_s \cdot \left(d_2 - \frac{a}{2}\right) + 70000 \cdot \frac{lbf}{in^2} \cdot A_s \cdot \left(d_1 - \frac{a}{2}\right) + P \cdot \left(b - \frac{a}{2}\right)$$

$$M_n = 1.608 \cdot 10^5 \cdot ft \cdot lbf \qquad 0.7 \cdot M_n = 1.126 \cdot 10^5 \cdot ft \cdot lbf$$

From p. 9 of Appendix B-2, the seismic demand is 100,100 ft-lbf, which is less.than the 0.7 ultimate capacity calculated above. Thus, using beam calculations and defining the "plastic instability" load as the onset of concrete crushing, the ASME III, Appendix F criterion is met.

APPENDIX B6

ANSYS MODEL LISTING

Software Application Report

SOFTWARE APPLICATION

ANSYS 5.0A
WHC-SD-SQA-CSWD-30014, Rev. 0 (Design verification report)

HARDWARE CONFIGURATION

MODEL: SGI3, Building ETC2

EDT/DOCUMENT NO.

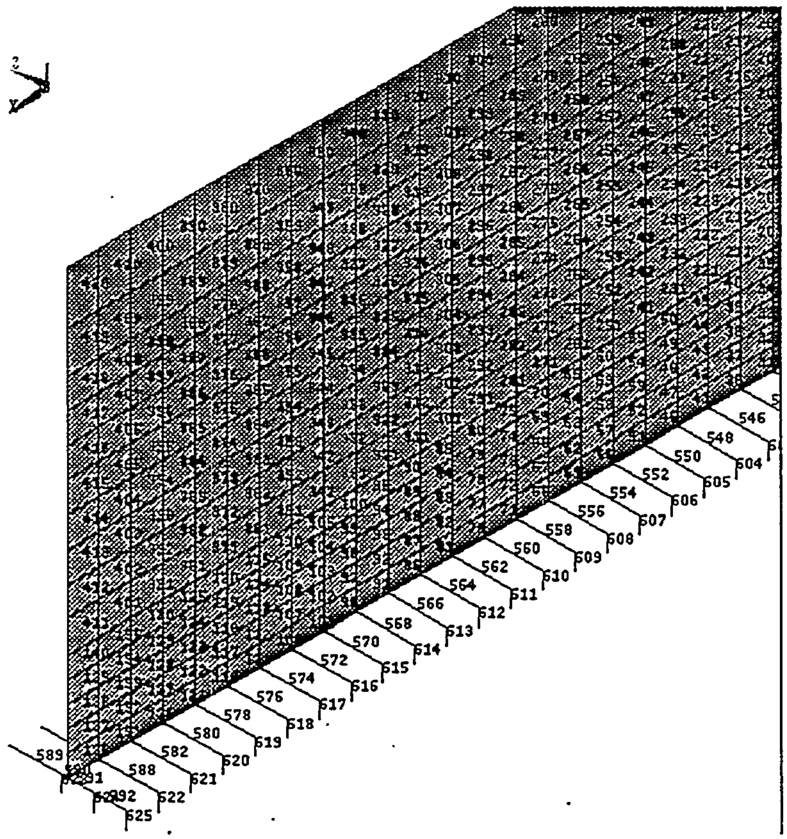
EDT 140087
WHC-SD-SNF-DA-005

DISCUSSION:

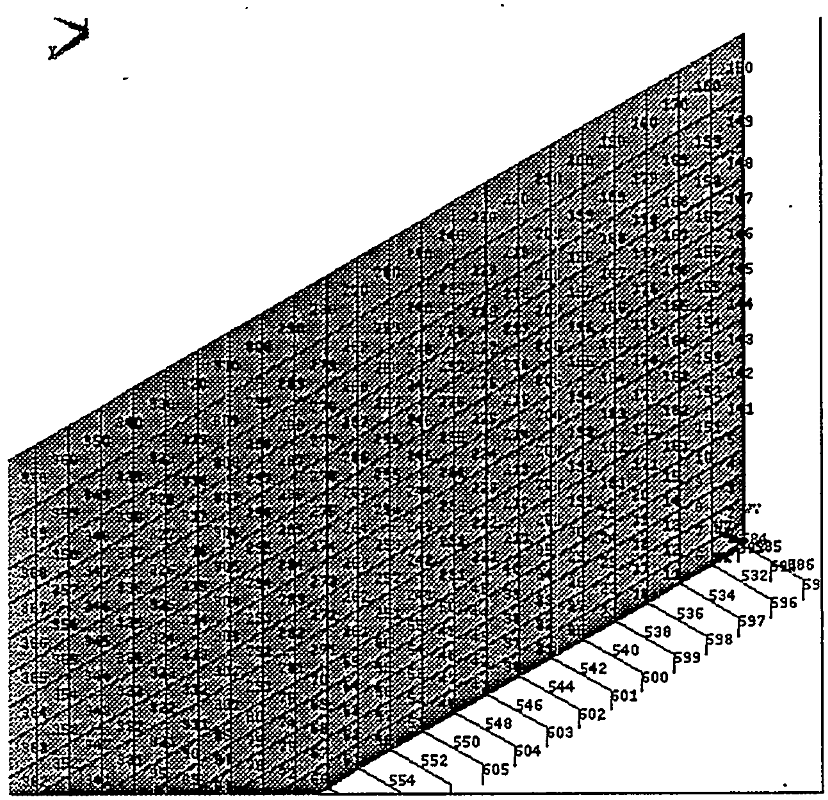
Element types used: SHELL63, MASS21, LINK8, BEAM4

The ANSYS analysis performed on the K Basin center island is not critical, since the structural adequacy was established from the hand/Mathcad calculations. The ANSYS calculations confirmed/strengthed the hand calculations.

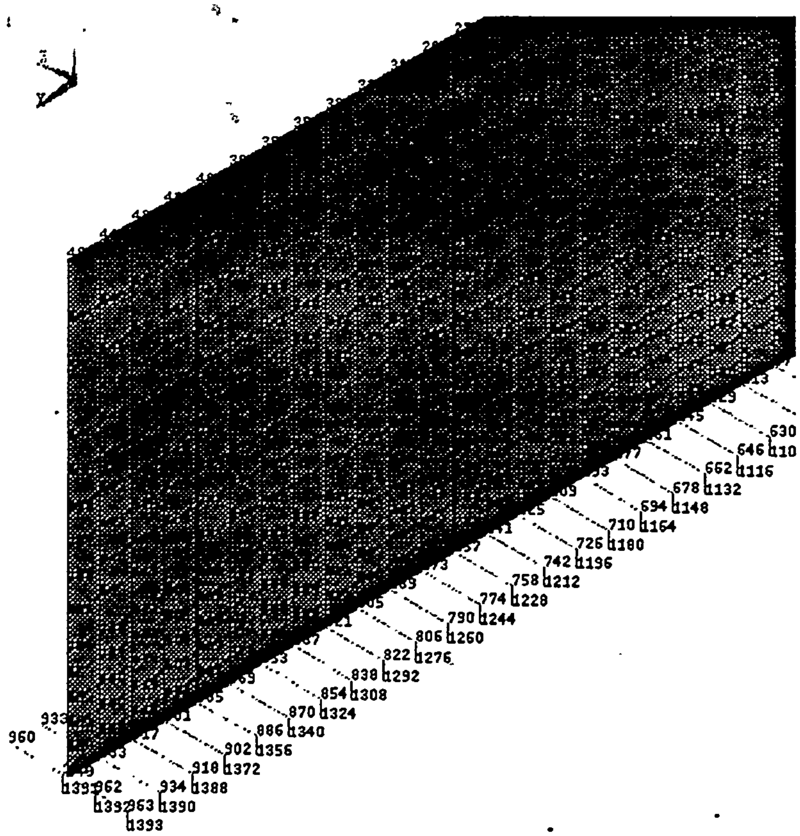
Element Numbers:



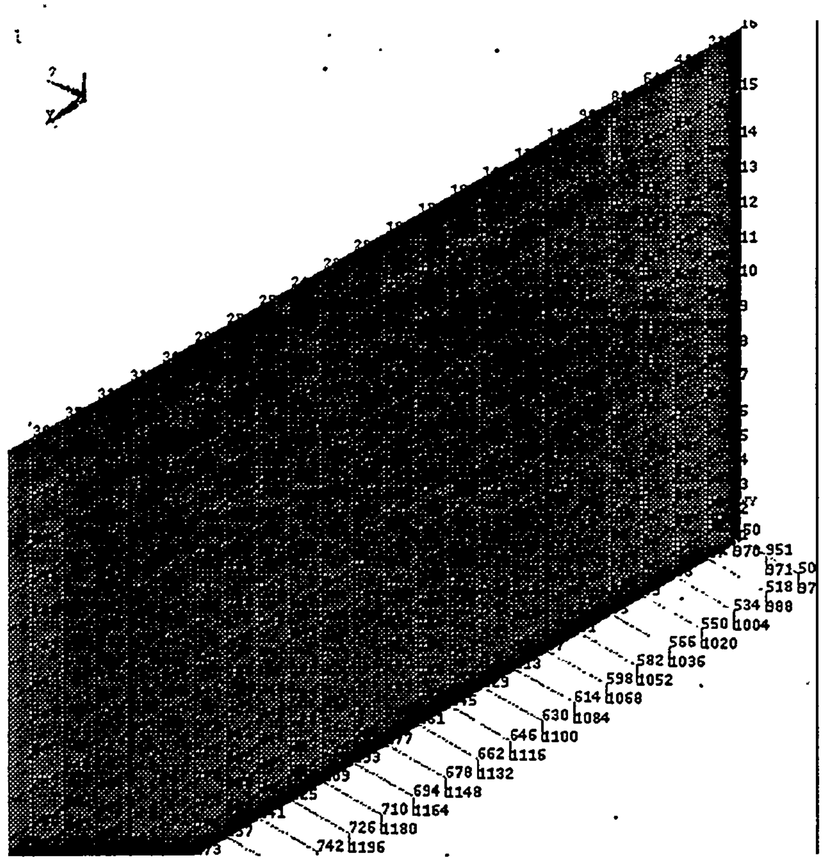
East End



West End



East End of Center Island



West End of Center Island

```
ANSYS MODEL LISTING USING CDWRITE OPTION (INELASTIC MODEL)

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ET, 3, 8
ET, 4, 4
ET, 5, 39
KEYOP, 5, 3, 2
ET, 6, 39
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N,R5.0,LOC,  55, 54.0000000   , 78.0000000   ,
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BETAD, 0.000000000E+00
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PRED,ON  ,,OFF
ERESX,DEFA
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D, 1180,ROTY, 0.000000000E+00, 0.000000000E+00
D, 1180,ROTZ, 0.000000000E+00, 0.000000000E+00
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D, 1196,UY , 0.000000000E+00, 0.000000000E+00
D, 1196,UZ , 0.000000000E+00, 0.000000000E+00
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D, 1196,ROTY, 0.000000000E+00, 0.000000000E+00
D, 1196,ROTZ, 0.000000000E+00, 0.000000000E+00
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D, 1212,UY , 0.000000000E+00, 0.000000000E+00
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D, 1212,ROTY, 0.000000000E+00, 0.000000000E+00
D, 1212,ROTZ, 0.000000000E+00, 0.000000000E+00
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D, 1228,UZ , 0.000000000E+00, 0.000000000E+00
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D, 1228,ROTY, 0.000000000E+00, 0.000000000E+00
D, 1228,ROTZ, 0.000000000E+00, 0.000000000E+00
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D, 1244,UY , 0.000000000E+00, 0.000000000E+00
D, 1244,UZ , 0.000000000E+00, 0.000000000E+00
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D, 1244,ROTY, 0.000000000E+00, 0.000000000E+00
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D, 1292,ROTY, 0.000000000E+00, 0.000000000E+00
D, 1292,ROTZ, 0.000000000E+00, 0.000000000E+00
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D, 1372,ROTZ, 0.000000000E+00, 0.000000000E+00
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D, 1391,ROTY, 0.000000000E+00, 0.000000000E+00
D, 1391,ROTZ, 0.000000000E+00, 0.000000000E+00
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D, 1392,ROTY, 0.000000000E+00, 0.000000000E+00
D, 1392,ROTZ, 0.000000000E+00, 0.000000000E+00
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SFE,   1,  1,PRES,1,R5.0
 7.07560000   7.07560000   6.64240000   6.64240000
SFE,   1,  1,PRES,2,R5.0
 0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE,   2,  1,PRES,1,R5.0
 6.64240000   6.64240000   6.20920000   6.20920000
SFE,   2,  1,PRES,2,R5.0
 0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE,   3,  1,PRES,1,R5.0
 6.20920000   6.20920000   5.77600000   5.77600000
SFE,   3,  1,PRES,2,R5.0
 0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE,   4,  1,PRES,1,R5.0
 5.77600000   5.77600000   5.34280000   5.34280000
SFE,   4,  1,PRES,2,R5.0
 0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE,   5,  1,PRES,1,R5.0
 5.34280000   5.34280000   4.90960000   4.90960000
SFE,   5,  1,PRES,2,R5.0
 0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE,   6,  1,PRES,1,R5.0
 7.07560000   7.07560000   6.64240000   6.64240000
SFE,   6,  1,PRES,2,R5.0
 0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE,   7,  1,PRES,1,R5.0
 6.64240000   6.64240000   6.20920000   6.20920000
SFE,   7,  1,PRES,2,R5.0
 0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE,   8,  1,PRES,1,R5.0
 6.20920000   6.20920000   5.77600000   5.77600000
SFE,   8,  1,PRES,2,R5.0
 0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE,   9,  1,PRES,1,R5.0
 5.77600000   5.77600000   5.34280000   5.34280000
SFE,   9,  1,PRES,2,R5.0
 0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE,  10,  1,PRES,1,R5.0
 5.34280000   5.34280000   4.90960000   4.90960000
SFE,  10,  1,PRES,2,R5.0
 0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE,  11,  1,PRES,1,R5.0
 7.07560000   7.07560000   6.64240000   6.64240000
SFE,  11,  1,PRES,2,R5.0
 0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE,  12,  1,PRES,1,R5.0
 6.64240000   6.64240000   6.20920000   6.20920000
SFE,  12,  1,PRES,2,R5.0
 0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE,  13,  1,PRES,1,R5.0
 6.20920000   6.20920000   5.77600000   5.77600000
SFE,  13,  1,PRES,2,R5.0
 0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE,  14,  1,PRES,1,R5.0
 5.77600000   5.77600000   5.34280000   5.34280000
SFE,  14,  1,PRES,2,R5.0
 0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE,  15,  1,PRES,1,R5.0
 5.34280000   5.34280000   4.90960000   4.90960000
SFE,  15,  1,PRES,2,R5.0
 0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE,  16,  1,PRES,1,R5.0
 7.07560000   7.07560000   6.64240000   6.64240000
SFE,  16,  1,PRES,2,R5.0
 0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE,  17,  1,PRES,1,R5.0
 6.64240000   6.64240000   6.20920000   6.20920000
SFE,  17,  1,PRES,2,R5.0
 0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE,  18,  1,PRES,1,R5.0
 6.20920000   6.20920000   5.77600000   5.77600000
SFE,  18,  1,PRES,2,R5.0
 0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE,  19,  1,PRES,1,R5.0
 5.77600000   5.77600000   5.34280000   5.34280000
SFE,  19,  1,PRES,2,R5.0
 0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE,  20,  1,PRES,1,R5.0
 5.34280000   5.34280000   4.90960000   4.90960000
SFE,  20,  1,PRES,2,R5.0
 0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE,  21,  1,PRES,1,R5.0
 7.07560000   7.07560000   6.64240000   6.64240000
SFE,  21,  1,PRES,2,R5.0
 0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE,  22,  1,PRES,1,R5.0
 6.64240000   6.64240000   6.20920000   6.20920000
SFE,  22,  1,PRES,2,R5.0
 0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE,  23,  1,PRES,1,R5.0
 6.20920000   6.20920000   5.77600000   5.77600000
SFE,  23,  1,PRES,2,R5.0
 0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE,  24,  1,PRES,1,R5.0
 5.77600000   5.77600000   5.34280000   5.34280000
SFE,  24,  1,PRES,2,R5.0
 0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE,  25,  1,PRES,1,R5.0
 5.34280000   5.34280000   4.90960000   4.90960000
SFE,  25,  1,PRES,2,R5.0
 0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE,  26,  1,PRES,1,R5.0
 7.07560000   7.07560000   6.64240000   6.64240000
SFE,  26,  1,PRES,2,R5.0
 0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE,  27,  1,PRES,1,R5.0
 6.64240000   6.64240000   6.20920000   6.20920000
SFE,  27,  1,PRES,2,R5.0
 0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE,  28,  1,PRES,1,R5.0
 6.20920000   6.20920000   5.77600000   5.77600000
SFE,  28,  1,PRES,2,R5.0
 0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE,  29,  1,PRES,1,R5.0
 5.77600000   5.77600000   5.34280000   5.34280000
SFE,  29,  1,PRES,2,R5.0
 0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE,  30,  1,PRES,1,R5.0
 5.34280000   5.34280000   4.90960000   4.90960000
SFE,  30,  1,PRES,2,R5.0
 0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE,  31,  1,PRES,1,R5.0
 7.07560000   7.07560000   6.64240000   6.64240000
SFE,  31,  1,PRES,2,R5.0
 0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE,  32,  1,PRES,1,R5.0
 6.64240000   6.64240000   6.20920000   6.20920000
SFE,  32,  1,PRES,2,R5.0
 0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE,  33,  1,PRES,1,R5.0
 6.20920000   6.20920000   5.77600000   5.77600000
SFE,  33,  1,PRES,2,R5.0
 0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE,  34,  1,PRES,1,R5.0
 5.77600000   5.77600000   5.34280000   5.34280000
SFE,  34,  1,PRES,2,R5.0
 0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE,  35,  1,PRES,1,R5.0
 5.34280000   5.34280000   4.90960000   4.90960000
SFE,  35,  1,PRES,2,R5.0
 0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE,  36,  1,PRES,1,R5.0
 7.07560000   7.07560000   6.64240000   6.64240000
SFE,  36,  1,PRES,2,R5.0
 0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE,  37,  1,PRES,1,R5.0
 6.64240000   6.64240000   6.20920000   6.20920000
SFE,  37,  1,PRES,2,R5.0
 0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE,  38,  1,PRES,1,R5.0
 6.20920000   6.20920000   5.77600000   5.77600000
SFE,  38,  1,PRES,2,R5.0
 0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE,  39,  1,PRES,1,R5.0
 5.77600000   5.77600000   5.34280000   5.34280000
SFE,  39,  1,PRES,2,R5.0
 0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE,  40,  1,PRES,1,R5.0
 5.34280000   5.34280000   4.90960000   4.90960000
SFE,  40,  1,PRES,2,R5.0
 0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE,  41,  1,PRES,1,R5.0
 7.07560000   7.07560000   6.64240000   6.64240000
SFE,  41,  1,PRES,2,R5.0
 0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE,  42,  1,PRES,1,R5.0
 6.64240000   6.64240000   6.20920000   6.20920000
SFE,  42,  1,PRES,2,R5.0
 0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE,  43,  1,PRES,1,R5.0
 6.20920000   6.20920000   5.77600000   5.77600000
SFE,  43,  1,PRES,2,R5.0
 0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE,  44,  1,PRES,1,R5.0
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5.77600000 5.77600000 5.34280000 5.34280000
SFE, 44, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 45, 1,PRES,1,R5.0
5.34280000 5.34280000 4.90960000 4.90960000
SFE, 45, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 46, 1,PRES,1,R5 0
7.07560000 7.07560000 6.64240000 6.64240000
SFE, 46, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 47, 1,PRES,1,R5.0
6.64240000 6.64240000 6.20920000 6.20920000
SFE, 47, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 48, 1,PRES,1,R5.0
6.20920000 6.20920000 5.77600000 5.77600000
SFE, 48, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 49, 1,PRES,1,R5 0
5.77600000 5.77600000 5.34280000 5.34280000
SFE, 49, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 50, 1,PRES,1,R5 0
5.34280000 5.34280000 4.90960000 4.90960000
SFE, 50, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 51, 1,PRES,1,R5 0
7.07560000 7.07560000 6.64240000 6.64240000
SFE, 51, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 52, 1,PRES,1,R5 0
6.64240000 6.64240000 6.20920000 6.20920000
SFE, 52, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 53, 1,PRES,1,R5 0
6.20920000 6.20920000 5.77600000 5.77600000
SFE, 53, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 54, 1,PRES,1,R5.0
5.77600000 5.77600000 5.34280000 5.34280000
SFE, 54, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 55, 1,PRES,1,R5 0
5.34280000 5.34280000 4.90960000 4.90960000
SFE, 55, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 56, 1,PRES,1,R5 0
7.07560000 7.07560000 6.64240000 6.64240000
SFE, 56, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 57, 1,PRES,1,R5 0
6.64240000 6.64240000 6.20920000 6.20920000
SFE, 57, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 58, 1,PRES,1,R5 0
6.20920000 6.20920000 5.77600000 5.77600000
SFE, 58, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 59, 1,PRES,1,R5 0
5.77600000 5.77600000 5.34280000 5.34280000
SFE, 59, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 60, 1,PRES,1,R5 0
5.34280000 5.34280000 4.90960000 4.90960000
SFE, 60, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 61, 1,PRES,1,R5 0
7.07560000 7.07560000 6.64240000 6.64240000
SFE, 61, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 62, 1,PRES,1,R5 0
6.64240000 6.64240000 6.20920000 6.20920000
SFE, 62, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 63, 1,PRES,1,R5 0
6.20920000 6.20920000 5.77600000 5.77600000
SFE, 63, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 64, 1,PRES,1,R5 0
5.77600000 5.77600000 5.34280000 5.34280000
SFE, 64, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 65, 1,PRES,1,R5 0
5.34280000 5.34280000 4.90960000 4.90960000
SFE, 65, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 66, 1,PRES,1,R5 0
7.07560000 7.07560000 6.64240000 6.64240000
SFE, 66, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 67, 1,PRES,1,R5 0
6.64240000 6.64240000 6.20920000 6.20920000
SFE, 67, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 68, 1,PRES,1,R5 0
6.20920000 6.20920000 5.77600000 5.77600000
SFE, 68, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 69, 1,PRES,1,R5 0
5.77600000 5.77600000 5.34280000 5.34280000
SFE, 69, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 70, 1,PRES,1,R5 0
5.34280000 5.34280000 4.90960000 4.90960000
SFE, 70, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 71, 1,PRES,1,R5 0
7.07560000 7.07560000 6.64240000 6.64240000
SFE, 71, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 72, 1,PRES,1,R5 0
6.64240000 6.64240000 6.20920000 6.20920000
SFE, 72, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 73, 1,PRES,1,R5 0
6.20920000 6.20920000 5.77600000 5.77600000
SFE, 73, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 74, 1,PRES,1,R5 0
5.77600000 5.77600000 5.34280000 5.34280000
SFE, 74, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 75, 1,PRES,1,R5 0
5.34280000 5.34280000 4.90960000 4.90960000
SFE, 75, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 76, 1,PRES,1,R5 0
7.07560000 7.07560000 6.64240000 6.64240000
SFE, 76, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 77, 1,PRES,1,R5 0
6.64240000 6.64240000 6.20920000 6.20920000
SFE 77, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 78, 1,PRES,1,R5 0
6.20920000 6.20920000 5.77600000 5.77600000
SFE, 78, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 79, 1,PRES,1,R5 0
5.77600000 5.77600000 5.34280000 5.34280000
SFE, 79, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 80, 1,PRES,1,R5 0
5.34280000 5.34280000 4.90960000 4.90960000
SFE, 80, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 81, 1,PRES,1,R5 0
7.07560000 7.07560000 6.64240000 6.64240000
SFE, 81, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 82, 1,PRES,1,R5.0
6.64240000 6.64240000 6.20920000 6.20920000
SFE, 82, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 83, 1,PRES,1,R5 0
6.20920000 6.20920000 5.77600000 5.77600000
SFE, 83, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 84, 1,PRES,1,R5 0
5.77600000 5.77600000 5.34280000 5.34280000
SFE, 84, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 85, 1,PRES,1,R5 0
5.34280000 5.34280000 4.90960000 4.90960000
SFE, 85, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 86, 1,PRES,1,R5 0
7.07560000 7.07560000 6.64240000 6.64240000
SFE, 86, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 87, 1,PRES,1,R5 0
6.64240000 6.64240000 6.20920000 6.20920000
SFE, 87, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 88, 1,PRES,1,R5 0
6.20920000 6.20920000 5.77600000 5.77600000
SFE, 88, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 89, 1,PRES,1,R5.0
5.77600000 5.77600000 5.34280000 5.34280000
SFE, 89, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 90, 1,PRES,1,R5 0
5.34280000 5.34280000 4.90960000 4.90960000
SFE, 90, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 91, 1,PRES,1,R5 0
7.07560000 7.07560000 6.64240000 6.64240000
SFE, 91, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 92, 1,PRES,1,R5 0
6.64240000 6.64240000 6.20920000 6.20920000
SFE, 92, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 93, 1,PRES,1,R5 0
6.20920000 6.20920000 5.77600000 5.77600000
SFE, 93, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 94, 1,PRES,1,R5 0
5.77600000 5.77600000 5.34280000 5.34280000
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SFE,  94,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  95,  1,PRES,1,R5.0
 5.34280000   5.34280000   4.90960000   4.90960000
SFE,  95,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  96,  1,PRES,1,R5.0
 7.07560000   7.07560000   6.64240000   6.64240000
SFE,  96,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  97,  1,PRES,1,R5.0
 6.64240000   6.64240000   6.20920000   6.20920000
SFE,  97,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  98,  1,PRES,1,R5.0
 6.20920000   6.20920000   5.77600000   5.77600000
SFE,  98,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  99,  1,PRES,1,R5.0
 5.77600000   5.77600000   5.34280000   5.34280000
SFE,  99,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  100,  1,PRES,1,R5.0
 5.34280000   5.34280000   4.90960000   4.90960000
SFE,  100,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  101,  1,PRES,1,R5.0
 7.07560000   7.07560000   6.64240000   6.64240000
SFE,  101,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  102,  1,PRES,1,R5.0
 6.64240000   6.64240000   6.20920000   6.20920000
SFE,  102,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  103,  1,PRES,1,R5.0
 6.20920000   6.20920000   5.77600000   5.77600000
SFE,  103,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  104,  1,PRES,1,R5.0
 5.77600000   5.77600000   5.34280000   5.34280000
SFE,  104,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  105,  1,PRES,1,R5.0
 5.34280000   5.34280000   4.90960000   4.90960000
SFE,  105,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  106,  1,PRES,1,R5.0
 7.07560000   7.07560000   6.64240000   6.64240000
SFE,  106,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  107,  1,PRES,1,R5.0
 6.64240000   6.64240000   6.20920000   6.20920000
SFE,  107,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  108,  1,PRES,1,R5.0
 6.20920000   6.20920000   5.77600000   5.77600000
SFE,  108,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  109,  1,PRES,1,R5.0
 5.77600000   5.77600000   5.34280000   5.34280000
SFE,  109,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  110,  1,PRES,1,R5.0
 5.34280000   5.34280000   4.90960000   4.90960000
SFE,  110,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  111,  1,PRES,1,R5.0
 7.07560000   7.07560000   6.64240000   6.64240000
SFE,  111,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  112,  1,PRES,1,R5.0
 6.64240000   6.64240000   6.20920000   6.20920000
SFE,  112,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  113,  1,PRES,1,R5.0
 6.20920000   6.20920000   5.77600000   5.77600000
SFE,  113,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  114,  1,PRES,1,R5.0
 5.77600000   5.77600000   5.34280000   5.34280000
SFE,  114,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  115,  1,PRES,1,R5.0
 5.34280000   5.34280000   4.90960000   4.90960000
SFE,  115,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  116,  1,PRES,1,R5.0
 7.07560000   7.07560000   6.64240000   6.64240000
SFE,  116,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  117,  1,PRES,1,R5.0
 6.64240000   6.64240000   6.20920000   6.20920000
SFE,  117,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  118,  1,PRES,1,R5.0
 6.20920000   6.20920000   5.77600000   5.77600000
SFE,  118,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  119,  1,PRES,1,R5.0
 5.77600000   5.77600000   5.34280000   5.34280000
SFE,  119,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  120,  1,PRES,1,R5.0
 5.34280000   5.34280000   4.90960000   4.90960000
SFE,  120,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  121,  1,PRES,1,R5.0
 7.07560000   7.07560000   6.64240000   6.64240000
SFE,  121,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  122,  1,PRES,1,R5.0
 6.64240000   6.64240000   6.20920000   6.20920000
SFE,  122,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  123,  1,PRES,1,R5.0
 6.20920000   6.20920000   5.77600000   5.77600000
SFE,  123,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  124,  1,PRES,1,R5.0
 5.77600000   5.77600000   5.34280000   5.34280000
SFE,  124,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  125,  1,PRES,1,R5.0
 5.34280000   5.34280000   4.90960000   4.90960000
SFE,  125,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  126,  1,PRES,1,R5.0
 7.07560000   7.07560000   6.64240000   6.64240000
SFE,  126,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  127,  1,PRES,1,R5.0
 6.64240000   6.64240000   6.20920000   6.20920000
SFE,  127,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  128,  1,PRES,1,R5.0
 6.20920000   6.20920000   5.77600000   5.77600000
SFE,  128,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  129,  1,PRES,1,R5.0
 5.77600000   5.77600000   5.34280000   5.34280000
SFE,  129,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  130,  1,PRES,1,R5.0
 5.34280000   5.34280000   4.90960000   4.90960000
SFE,  130,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  131,  1,PRES,1,R5.0
 7.07560000   7.07560000   6.64240000   6.64240000
SFE,  131,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  132,  1,PRES,1,R5.0
 6.64240000   6.64240000   6.20920000   6.20920000
SFE,  132,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  133,  1,PRES,1,R5.0
 6.20920000   6.20920000   5.77600000   5.77600000
SFE,  133,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  134,  1,PRES,1,R5.0
 5.77600000   5.77600000   5.34280000   5.34280000
SFE,  134,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  135,  1,PRES,1,R5.0
 5.34280000   5.34280000   4.90960000   4.90960000
SFE,  135,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  136,  1,PRES,1,R5.0
 7.07560000   7.07560000   6.64240000   6.64240000
SFE,  136,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  137,  1,PRES,1,R5.0
 6.64240000   6.64240000   6.20920000   6.20920000
SFE,  137,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  138,  1,PRES,1,R5.0
 6.20920000   6.20920000   5.77600000   5.77600000
SFE,  138,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  139,  1,PRES,1,R5.0
 5.77600000   5.77600000   5.34280000   5.34280000
SFE,  139,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  140,  1,PRES,1,R5.0
 5.34280000   5.34280000   4.90960000   4.90960000
SFE,  140,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  141,  1,PRES,1,R5.0
 4.90960000   4.90960000   4.29590000   4.29590000
SFE,  141,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  142,  1,PRES,1,R5.0
 4.29590000   4.29590000   3.68220000   3.68220000
SFE,  142,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  143,  1,PRES,1,R5.0
 3.68220000   3.68220000   3.06850000   3.06850000
SFE,  143,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  144,  1,PRES,1,R5.0
 3.06850000   3.06850000   2.45480000   2.45480000
SFE,  144,  1,PRES,2,R5.0
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0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 145, 1,PRES,1,R5.0
 2.45480000   2.45480000   1.84110000   1.84110000
SFE, 145, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 146, 1,PRES,1,R5.0
 1.84110000   1.84110000   1.22740000   1.22740000
SFE, 146, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 147, 1,PRES,1,R5.0
 1.22740000   1.22740000   0.613700000  0.613700000
SFE, 147, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 148, 1,PRES,1,R5.0
 0.613700000  0.613700000  0.000000000E+00 0.000000000E+00
SFE, 148, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 151, 1,PRES,1,R5.0
 4.90960000  -4.90960000   4.29590000   4.29590000
SFE, 151, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 152, 1,PRES,1,R5.0
 4.29590000   4.29590000   3.68220000   3.68220000
SFE, 152, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 153, 1,PRES,1,R5.0
 3.68220000   3.68220000   3.06850000   3.06850000
SFE, 153, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 154, 1,PRES,1,R5.0
 3.06850000   3.06850000   2.45480000   2.45480000
SFE, 154, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 155, 1,PRES,1,R5.0
 2.45480000   2.45480000   1.84110000   1.84110000
SFE, 155, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 156, 1,PRES,1,R5.0
 1.84110000   1.84110000   1.22740000   1.22740000
SFE, 156, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 157, 1,PRES,1,R5.0
 1.22740000   1.22740000   0.613700000  0.613700000
SFE, 157, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 158, 1,PRES,1,R5.0
 0.613700000  0.613700000  0.000000000E+00 0.000000000E+00
SFE, 158, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 161, 1,PRES,1,R5.0
 4.90960000   4.90960000   4.29590000   4.29590000
SFE, 161, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 162, 1,PRES,1,R5.0
 4.29590000   4.29590000   3.68220000   3.68220000
SFE, 162, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 163, 1,PRES,1,R5.0
 3.68220000   3.68220000   3.06850000   3.06850000
SFE, 163, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 164, 1,PRES,1,R5.0
 3.06850000   3.06850000   2.45480000   2.45480000
SFE, 164, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 165, 1,PRES,1,R5.0
 2.45480000   2.45480000   1.84110000   1.84110000
SFE, 165, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 166, 1,PRES,1,R5.0
 1.84110000   1.84110000   1.22740000   1.22740000
SFE, 166, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 167, 1,PRES,1,R5.0
 1.22740000   1.22740000   0.613700000  0.613700000
SFE, 167, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 168, 1,PRES,1,R5.0
 0.613700000  0.613700000  0.000000000E+00 0.000000000E+00
SFE, 168, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 171, 1,PRES,1,R5.0
 4.90960000   4.90960000   4.29590000   4.29590000
SFE, 171, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 172, 1,PRES,1,R5.0
 4.29590000   4.29590000   3.68220000   3.68220000
SFE, 172, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 173, 1,PRES,1,R5.0
 3.68220000   3.68220000   3.06850000   3.06850000
SFE, 173, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 174, 1,PRES,1,R5.0
 3.06850000   3.06850000   2.45480000   2.45480000
SFE, 174, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 175, 1,PRES,1,R5.0
 2.45480000   2.45480000   1.84110000   1.84110000
SFE, 175, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 176, 1,PRES,1,R5.0
 1.84110000   1.84110000   1.22740000   1.22740000
SFE, 176, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 177, 1,PRES,1,R5.0
 1.22740000   1.22740000   0.613700000  0.613700000
SFE, 177, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 178, 1,PRES,1,R5.0
 0.613700000  0.613700000  0.000000000E+00 0.000000000E+00
SFE, 178, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 181, 1,PRES,1,R5.0
 4.90960000   4.90960000   4.29590000   4.29590000
SFE, 181, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 182, 1,PRES,1,R5.0
 4.29590000   4.29590000   3.68220000   3.68220000
SFE, 182, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 183, 1,PRES,1,R5.0
 3.68220000   3.68220000   3.06850000   3.06850000
SFE, 183, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 184, 1,PRES,1,R5.0
 3.06850000   3.06850000   2.45480000   2.45480000
SFE, 184, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 185, 1,PRES,1,R5.0
 2.45480000   2.45480000   1.84110000   1.84110000
SFE, 185, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 186, 1,PRES,1,R5.0
 1.84110000   1.84110000   1.22740000   1.22740000
SFE, 186, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 187, 1,PRES,1,R5.0
 1.22740000   1.22740000   0.613700000  0.613700000
SFE, 187, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 188, 1,PRES,1,R5.0
 0.613700000  0.613700000  0.000000000E+00 0.000000000E+00
SFE, 188, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 191, 1,PRES,1,R5.0
 4.90960000   4.90960000   4.29590000   4.29590000
SFE, 191, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 192, 1,PRES,1,R5.0
 4.29590000   4.29590000   3.68220000   3.68220000
SFE, 192, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 193, 1,PRES,1,R5.0
 3.68220000   3.68220000   3.06850000   3.06850000
SFE, 193, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 194, 1,PRES,1,R5.0
 3.06850000   3.06850000   2.45480000   2.45480000
SFE, 194, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 195, 1,PRES,1,R5.0
 2.45480000   2.45480000   1.84110000   1.84110000
SFE, 195, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 196, 1,PRES,1,R5.0
 1.84110000   1.84110000   1.22740000   1.22740000
SFE, 196, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 197, 1,PRES,1,R5.0
 1.22740000   1.22740000   0.613700000  0.613700000
SFE, 197, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 198, 1,PRES,1,R5.0
 0.613700000  0.613700000  0.000000000E+00 0.000000000E+00
SFE, 198, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 201, 1,PRES,1,R5.0
 4.90960000   4.90960000   4.29590000   4.29590000
SFE, 201, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 202, 1,PRES,1,R5.0
 4.29590000   4.29590000   3.68220000   3.68220000
SFE, 202, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 203, 1,PRES,1,R5.0
 3.68220000   3.68220000   3.06850000   3.06850000
SFE, 203, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 204, 1,PRES,1,R5.0
 3.06850000   3.06850000   2.45480000   2.45480000
SFE, 204, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 205, 1,PRES,1,R5.0
 2.45480000   2.45480000   1.84110000   1.84110000
SFE, 205, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 206, 1,PRES,1,R5.0
 1.84110000   1.84110000   1.22740000   1.22740000
SFE, 206, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
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SFE, 207, 1,PRES,1,R5.0
1.22740000 1.22740000 0.613700000 0.613700000
SFE, 207, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 208, 1,PRES,1,R5.0
0.613700000 0.613700000 0.000000000E+00 0.000000000E+00
SFE, 208, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 211, 1,PRES,1,R5.0
4.90960000 4.90960000 4.29590000 4.29590000
SFE, 211, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 212, 1,PRES,1,R5.0
4.29590000 4.29590000 3.68220000 3.68220000
SFE, 212, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 213, 1,PRES,1,R5.0
3.68220000 3.68220000 3.06850000 3.06850000
SFE, 213, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 214, 1,PRES,1,R5.0
3.06850000 3.06850000 2.45480000 2.45480000
SFE, 214, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 215, 1,PRES,1,R5.0
2.45480000 2.45480000 1.84110000 1.84110000
SFE, 215, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 216, 1,PRES,1,R5.0
1.84110000 1.84110000 1.22740000 1.22740000
SFE, 216, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 217, 1,PRES,1,R5.0
1.22740000 1.22740000 0.613700000 0.613700000
SFE, 217, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 218, 1,PRES,1,R5.0
0.613700000 0.613700000 0.000000000E+00 0.000000000E+00
SFE, 218, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 221, 1,PRES,1,R5.0
4.90960000 4.90960000 4.29590000 4.29590000
SFE, 221, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 222, 1,PRES,1,R5.0
4.29590000 4.29590000 3.68220000 3.68220000
SFE, 222, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 223, 1,PRES,1,R5.0
3.68220000 3.68220000 3.06850000 3.06850000
SFE, 223, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 224, 1,PRES,1,R5.0
3.06850000 3.06850000 2.45480000 2.45480000
SFE, 224, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 225, 1,PRES,1,R5.0
2.45480000 2.45480000 1.84110000 1.84110000
SFE, 225, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 226, 1,PRES,1,R5.0
1.84110000 1.84110000 1.22740000 1.22740000
SFE, 226, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 227, 1,PRES,1,R5.0
1.22740000 1.22740000 0.613700000 0.613700000
SFE, 227, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 228, 1,PRES,1,R5.0
0.613700000 0.613700000 0.000000000E+00 0.000000000E+00
SFE, 228, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 231, 1,PRES,1,R5.0
4.90960000 4.90960000 4.29590000 4.29590000
SFE, 231, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 232, 1,PRES,1,R5.0
4.29590000 4.29590000 3.68220000 3.68220000
SFE, 232, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 233, 1,PRES,1,R5.0
3.68220000 3.68220000 3.06850000 3.06850000
SFE, 233, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 234, 1,PRES,1,R5.0
3.06850000 3.06850000 2.45480000 2.45480000
SFE, 234, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 235, 1,PRES,1,R5.0
2.45480000 2.45480000 1.84110000 1.84110000
SFE, 235, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 236, 1,PRES,1,R5.0
1.84110000 1.84110000 1.22740000 1.22740000
SFE, 236, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 237, 1,PRES,1,R5.0
1.22740000 1.22740000 0.613700000 0.613700000
SFE, 237, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 238, 1,PRES,1,R5.0
0.613700000 0.613700000 0.000000000E+00 0.000000000E+00
SFE, 238, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 241, 1,PRES,1,R5.0
4.90960000 4.90960000 4.29590000 4.29590000
SFE, 241, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 242, 1,PRES,1,R5.0
4.29590000 4.29590000 3.68220000 3.68220000
SFE, 242, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 243, 1,PRES,1,R5.0
3.68220000 3.68220000 3.06850000 3.06850000
SFE, 243, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 244, 1,PRES,1,R5.0
3.06850000 3.06850000 2.45480000 2.45480000
SFE, 244, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 245, 1,PRES,1,R5.0
2.45480000 2.45480000 1.84110000 1.84110000
SFE, 245, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 246, 1,PRES,1,R5.0
1.84110000 1.84110000 1.22740000 1.22740000
SFE, 246, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 247, 1,PRES,1,R5.0
1.22740000 1.22740000 0.613700000 0.613700000
SFE, 247, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 248, 1,PRES,1,R5.0
0.613700000 0.613700000 0.000000000E+00 0.000000000E+00
SFE, 248, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 251, 1,PRES,1,R5.0
4.90960000 4.90960000 4.29590000 4.29590000
SFE, 251, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 252, 1,PRES,1,R5.0
4.29590000 4.29590000 3.68220000 3.68220000
SFE, 252, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 253, 1,PRES,1,R5.0
3.68220000 3.68220000 3.06850000 3.06850000
SFE, 253, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 254, 1,PRES,1,R5.0
3.06850000 3.06850000 2.45480000 2.45480000
SFE, 254, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 255, 1,PRES,1,R5.0
2.45480000 2.45480000 1.84110000 1.84110000
SFE, 255, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 256, 1,PRES,1,R5.0
1.84110000 1.84110000 1.22740000 1.22740000
SFE, 256, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 257, 1,PRES,1,R5.0
1.22740000 1.22740000 0.613700000 0.613700000
SFE, 257, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 258, 1,PRES,1,R5.0
0.613700000 0.613700000 0.000000000E+00 0.000000000E+00
SFE, 258, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 261, 1,PRES,1,R5.0
4.90960000 4.90960000 4.29590000 4.29590000
SFE, 261, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 262, 1,PRES,1,R5.0
4.29590000 4.29590000 3.68220000 3.68220000
SFE, 262, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 263, 1,PRES,1,R5.0
3.68220000 3.68220000 3.06850000 3.06850000
SFE, 263, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 264, 1,PRES,1,R5.0
3.06850000 3.06850000 2.45480000 2.45480000
SFE, 264, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 265, 1,PRES,1,R5.0
2.45480000 2.45480000 1.84110000 1.84110000
SFE, 265, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 266, 1,PRES,1,R5.0
1.84110000 1.84110000 1.22740000 1.22740000
SFE, 266, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 268, 1,PRES,1,R5.0
0.613700000 0.613700000 0.000000000E+00 0.000000000E+00
SFE, 268, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 271, 1,PRES,1,R5.0
4.90960000 4.90960000 4.29590000 4.29590000
SFE, 271, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 272, 1,PRES,1,R5.0
```

```
4.29590000     4.29590000     3.68220000     3.68220000
SFE,  272,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  273,  1,PRES,1,R5.0
3.68220000     3.68220000     3.06850000     3.06850000
SFE,  273,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  274,  1,PRES,1,R5.0
3.06850000     3.06850000     2.45480000     2.45480000
SFE,  274,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  275,  1,PRES,1,R5.0
2.45480000     2.45480000     1.84110000     1.84110000
SFE,  275,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  276,  1,PRES,1,R5.0
1.84110000     1.84110000     1.22740000     1.22740000
SFE,  276,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  277,  1,PRES,1,R5.0
1.22740000     1.22740000     0.613700000    0.613700000
SFE,  277,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  278,  1,PRES,1,R5.0
0.613700000    0.613700000    0.000000000E+00  0.000000000E+00
SFE,  278,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  281,  1,PRES,1,R5.0
4.90960000     4.90960000     4.29590000     4.29590000
SFE,  281,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  282,  1,PRES,1,R5.0
4.29590000     4.29590000     3.68220000     3.68220000
SFE,  282,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  283,  1,PRES,1,R5.0
3.68220000     3.68220000     3.06850000     3.06850000
SFE,  283,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  .284,  1,PRES,1,R5.0
3.06850000     3.06850000     2.45480000     2.45480000
SFE,  284,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  285,  1,PRES,1,R5.0
2.45480000     2.45480000     1.84110000     1.84110000
SFE,  285,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  286,  1,PRES,1,R5.0
1.84110000     1.84110000     1.22740000     1.22740000
SFE,  286,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  287,  1,PRES,1,R5.0
1.22740000     1.22740000     0.613700000    0.613700000
SFE,  287,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  288,  1,PRES,1,R5.0
0.613700000    0.613700000    0.000000000E+00  0.000000000E+00
SFE,  288,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  291,  1,PRES,1,R5.0
4.90960000     4.90960000     4.29590000     4.29590000
SFE,  291,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  292,  1,PRES,1,R5.0
4.29590000     4.29590000     3.68220000     3.68220000
SFE,  292,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  293,  1,PRES,1,R5.0
3.68220000     3.68220000     3.06850000     3.06850000
SFE,  293,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  294,  1,PRES,1,R5.0
3.06850000     3.06850000     2.45480000     2.45480000
SFE,  294,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  295,  1,PRES,1,R5.0
2.45480000     2.45480000     1.84110000     1.84110000
SFE,  295,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  296,  1,PRES,1,R5.0
1.84110000     1.84110000     1.22740000     1.22740000
SFE,  296,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  297,  1,PRES,1,R5.0
1.22740000     1.22740000     0.613700000    0.613700000
SFE,  297,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  298,  1,PRES,1,R5.0
0.613700000    0.613700000    0.000000000E+00  0.000000000E+00
SFE,  298,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  301,  1,PRES,1,R5.0
4.90960000     4.90960000     4.29590000     4.29590000
SFE,  301,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  302,  1,PRES,1,R5.0
4.29590000     4.29590000     3.68220000     3.68220000
SFE,  302,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  303,  1,PRES,1,R5.0
3.68220000     3.68220000     3.06850000     3.06850000
SFE,  303,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  304,  1,PRES,1,R5.0
3.06850000     3.06850000     2.45480000     2.45480000
SFE,  304,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  305,  1,PRES,1,R5.0
2.45480000     2.45480000     1.84110000     1.84110000
SFE,  305,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  306,  1,PRES,1,R5.0
1.84110000     1.84110000     1.22740000     1.22740000
SFE,  306,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  307,  1,PRES,1,R5.0
1.22740000     1.22740000     0.613700000    0.613700000
SFE,  307,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  308,  1,PRES,1,R5.0
0.613700000    0.613700000    0.000000000E+00  0.000000000E+00
SFE,  308,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  311,  1,PRES,1,R5.0
4.90960000     4.90960000     4.29590000     4.29590000
SFE,  311,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  312,  1,PRES,1,R5.0
4.29590000     4.29590000     3.68220000     3.68220000
SFE,  312,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  313,  1,PRES,1,R5.0
3.68220000     3.68220000     3.06850000     3.06850000
SFE   313,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  314,  1,PRES,1,R5.0
3.06850000     3.06850000     2.45480000     2.45480000
SFE,  314,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  315,  1,PRES,1,R5.0
2.45480000     2.45480000     1.84110000     1.84110000
SFE,  315,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  316,  1,PRES,1,R5.0
1.84110000     1.84110000     1.22740000     1.22740000
SFE,  316,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  317,  1,PRES,1,R5.0
1.22740000     1.22740000     0.613700000    0.613700000
SFE,  317,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  318,  1,PRES,1,R5.0
0.613700000    0.613700000    0.000000000E+00  0.000000000E+00
SFE,  318,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  321,  1,PRES,1,R5.0
4.90960000     4.90960000     4.29590000     4.29590000
SFE,  321,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  322,  1,PRES,1,R5.0
4.29590000     4.29590000     3.68220000     3.68220000
SFE,  322,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  323,  1,PRES,1,R5.0
3.68220000     3.68220000     3.06850000     3.06850000
SFE,  323,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  324,  1,PRES,1,R5.0
3.06850000     3.06850000     2.45480000     2.45480000
SFE,  324,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  325,  1,PRES,1,R5.0
2.45480000     2.45480000     1.84110000     1.84110000
SFE,  325,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  326,  1,PRES,1,R5.0
1.84110000     1.84110000     1.22740000     1.22740000
SFE,  326,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  327,  1,PRES,1,R5.0
1.22740000     1.22740000     0.613700000    0.613700000
SFE,  327,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  328,  1,PRES,1,R5.0
0.613700000    0.613700000    0.000000000E+00  0.000000000E+00
SFE,  328,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  331,  1,PRES,1,R5.0
4.90960000     4.90960000     4.29590000     4.29590000
SFE,  331,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  332,  1,PRES,1,R5.0
4.29590000     4.29590000     3.68220000     3.68220000
SFE,  332,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  333,  1,PRES,1,R5.0
3.68220000     3.68220000     3.06850000     3.06850000
SFE,  333,  1,PRES,2,R5.0
0.000000000E+00  0.000000000E+00  0.000000000E+00  0.000000000E+00
SFE,  334,  1,PRES,1,R5.0
3.06850000     3.06850000     2.45480000     2.45480000
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SFE, 334, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 335, 1,PRES,1,R5 0
2.45480000 2.45480000 1.84110000 1.84110000
SFE, 335, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 336, 1,PRES,1,R5 0
1.84110000 1.84110000 1.22740000 1.22740000
SFE, 336, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 337, 1,PRES,1,R5 0
1.22740000 1.22740000 0.613700000 0.613700000
SFE, 337, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 338, 1,PRES,1,R5 0
0.613700000 0.613700000 0.000000000E+00 0.000000000E+00
SFE, 338, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 341, 1,PRES,1,R5.0
4.90960000 4.90960000 4.29590000 4.29590000
SFE, 341, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 342, 1,PRES,1,R5.0
4.29590000 4.29590000 3.68220000 3.68220000
SFE, 342, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 343, 1,PRES,1,R5 0
3.68220000 3.68220000 3.06850000 3.06850000
SFE, 343, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 344, 1,PRES,1,R5.0
3.06850000 3.06850000 2.45480000 2.45480000
SFE, 344, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 345, 1,PRES,1,R5 0
2.45480000 2.45480000 1.84110000 1.84110000
SFE, 345, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 346, 1,PRES,1,R5 0
1.84110000 1.84110000 1.22740000 1.22740000
SFE, 346, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 347, 1,PRES,1,R5 0
1.22740000 1.22740000 0.613700000 0.613700000
SFE, 347, 1,PRES,2,R5.0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
SFE, 348, 1,PRES,1,R5.0
0.613700000 0.613700000 0.000000000E+00 0.000000000E+00
SFE, 348, 1,PRES,2,R5 0
0.000000000E+00 0.000000000E+00 0.000000000E+00 0.000000000E+00
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4.90960000 4.90960000 4.29590000 4.29590000
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APPENDIX C

MISCELLANEOUS
STRUCTURAL CALCULATIONS

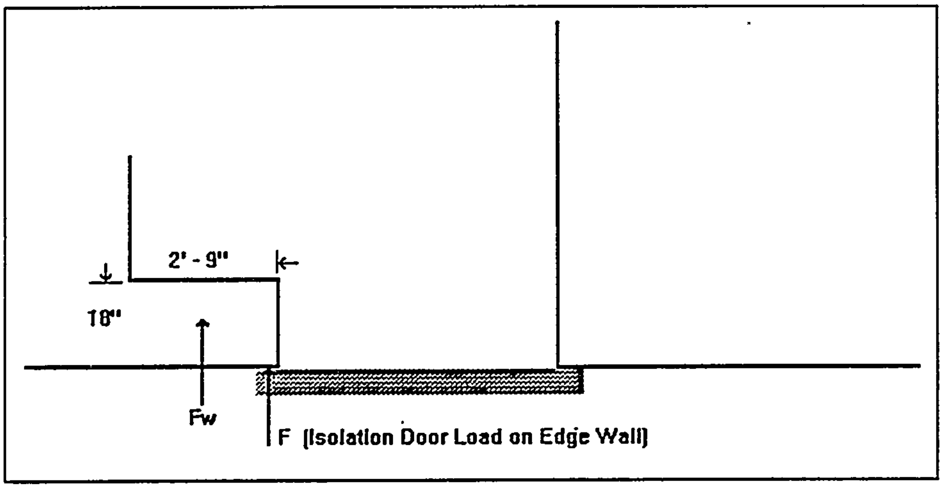
APPENDIX C1

ISOLATION BARRIER SUPPORT WALL CALCULATIONS

(1) Drawing H-1-21054 & H-1-21071 (2) Doc. No. ____ (3) Page 1 of 5
(4) Building 105-KE, 105-KW (5) Rev. ____ (6) Job No. ____
(7) Subject ISOL. DOOR EDGE WALL Originator B. V. Winkel BVW Date 2/14/95
(9) Checker L. J. Julyk LJJ Date 2/15/95

OBJECTIVE: Evaluate structural adequacy of the isolation door support walls. Since the east support wall is longer (2' - 9" vs 1' - 3"), only the east wall is addressed.

GEOMETRY:



Input Parameters:

$h = 18.0$	Conservatively assume water depth to top of door (18 ft)
$w = 2.75$	Support wall width, ft
$t = 1.5$	Wall thickness, ft
$\gamma = 62.4$	Water unit weight, pcf
$a := 0.24$	Inertia load for center island, 0.2g DBE response spectra
$w := 3.58$	Door width, ft
$Wt := 2475$	Closure door weight, lb (field measurement)

Edge Load Magnitude

(1) Normal Condition

max. water pressure load on bottom, water on basin side only

$F_s := \gamma \cdot h \cdot \frac{w}{2}$ Half of total load to edge wall

$F_s = 2.011 \cdot 10^3$ Max. static force (edge load from door, lb/ft)

(1) Drawing H-1-21054 & H-1-21071 (2) Doc. No. ________ (3) Page 2 of 5
(4) Building 105-KE, 105-KW (5) Rev. ________ (6) Job No. ________
(7) Subject ISOL. DOOR EDGE WALL Originator B. V. Winkel BVW Date 2/14/95
(9) Checker L. J. Julyk Date 2/15/95

$$Fw = \gamma \cdot h \cdot w$$

$Fw = 4.021 \cdot 10^{3}$ Max. static pressure force at bottom of wall, lb/ft (per foot height)

Using a dead load factor of 1.4 (liquid lateral pressure, ACI 349, Para. 9.2), the factored shear & moment values in the wall are determined:

$$V = 1.4 \cdot \left(F_s + Fw\right)$$

$V = 8.444 \cdot 10^{3}$ Normal cond. shear demand, lb/ft

$$M = 1.4 \cdot \left(F_s \cdot 2.75 + Fw \cdot \frac{w}{2}\right)$$

$M = 1.782 \cdot 10^{4}$ Normal cond. moment demand, lb-ft/ft

From WHC-SD-NR-SA-024, Table 9-2, the wall moment and shear capacities are 13,600 lb-ft/ft and 16,100 lb/ft, respectively (18" wall, hor. rebar: #5@ 12", including strength reduction factors). Thus, positive safety margins exist for both shear and moment. The min. safety margin is associated with the wall moment:

$$MS = \frac{16100}{M} - 1$$

$$MS = -0.096$$

(2) Normal Plus Seismic Loading

Seismic loading includes hydrodynamic pressure loading (basin side only) and the door inertial loading. From the attached DSI, the combined impulsive and convective hydrodynamic pressure is 246 psf. Thus the total edge load on the wall at the base of the door is:

$$F_d = 246 \cdot \frac{w}{2} + a \cdot \frac{Wt}{2 \cdot 18}$$

$F_d = 456.84$ Dynamic seismic force at bottom of door, lb/ft

$$F_t = F_s + F_d \qquad \frac{F_t}{\left(F_s\right)} = 1.227$$

$F_t = 2.467 \cdot 10^{3}$ Static plus dynamic edge load (lb/ft) on the wall at bottom of door

(1) Drawing H-1-21054 & H-1-21071 (2) Doc. No. ________ (3) Page 3 of 5
(4) Building 105-KE, 105-KW (5) Rev. ________ (6) Job No. ________
(7) Subject ISOL. DOOR EDGE WALL Originator B. V. Winkel BVW Date 2/14/95
(9) Checker L. J. Julyk Date 2/15/95

The dynamic wall load includes the inertial loading plus the dynamic pressure:

$Fw_d := 246 \cdot 1 + 150 \cdot 1 \cdot 0.2$ (150 lb/cu. ft concrete, rigid wall accel. = 0.2g)

$Fw_d = 759$ Dynamic wall load, lb/ft

$Fw_t := Fw_d + Fw$

$Fw_t = 3.848 \cdot 10^3$

The seismic shear and moment demand values (Load Factors = 1.0 per ACI 349, Sec. 9.2):

$V := F_t + Fw_t$

$V = 6.315 \cdot 10^3$

$M := (F_t) \cdot 2.75 + (Fw_t) \cdot \frac{1}{2}$

$M = 1.208 \cdot 10^4$

$MS := \frac{16100}{M} - 1$

$MS = 0.333$

Since the seismic condition margin of safety is greater than the normal condition margin, the normal loading condition controls and the minimum safety margin is +0.18, as calculated above. It is emphasized that the above calculations conservatively ignore the fact that the bottom of the wall cantilevers from the floor, as well as the adjacent wall, that is the stub wall is supported on the bottom as well as the one side. The contribution of this floor support was ignored for simplicity. Another conservatism is the fact that the lateral hydrostatic pressure decreases linearly with distance from the bottom of the wall to the liquid surface.

DON'T SAY IT --- *Write It!*

DATE: 5/18/94

TO: L. A. Rodgers H5-53

FROM: B. V. Winkel H5-57

Telephone: 376-5736

cc: M. R. Lindquist H5-57

SUBJECT: KBASIN CLOSURE GATE DESIGN LOADING

The design loading for the K Basin closure gates was generated as requested. The design load definitions and basis follow below. As indicated, both normal and seismic loadings are addressed. Normal loading is expected to control design, since AISC allows a 1/3 increase in allowables for seismic loading. Correspondingly, if ANSI/AISC N690 is used, a stress limit coefficient of 1.6 is allowed for an "extreme" load combination involving Ess.

Normal Loading

Other than dead weight and seal clamp loading, the only significant normal condition loading is hydrostatic pressure. Although the normal water level is near 16 ft., for design purposes, a water depth equal to the full height of the closure doors (18 ft.) was assumed. This results in a maximum pressure, at the base, of 62.4 x 18 = 1123 psf or 7.8 psi.

Seismic Loading

For a seismic event, two categories of loadings were considered, inertial and hydrodynamic pressures. Based upon an ANSYS model of the divider wall, including the impulsive hydrodynamic water mass, the fundamental frequency of the divider wall is 23.5 hz. From Figure 3 of SDC-4.1, Rev. 12, at 23 hz, 7% damping, a spectral value is 0.24 g's was obtained, which is the seismic inertial design load.

Using the ASCE Manual No. 58, Structural Analysis and Design of Nuclear Plant Facilities, Table 5.5, an impulsive mass of 11,640 lbs/ft was calculated for a water depth of 18 ft. The effective height of the mass is 0.4 x 18 = 7.2 ft. As recommended in ASCE 4-86, the weight of the impulsive mass should be spread over twice the effective height, when "local stresses are of interest". This results in a pressure of (11,640 x 0.24)/14.4 = 194 psf or 1.35 psi. An alternative impulsive pressure can be obtained from the base pressure equation on p. 265 of Guidelines for the Seismic Design of Oil and Gas Pipeline Systems:

$$p_i = 0.742\rho_l Ha = 0.742x62.4x18x0.24 = 200.0 \text{ psf} = 1.39 \text{ psi}.$$

The convective pressure component can be estimated by spreading the convective mass over "twice the distance from the top of the fluid to the center of the sloshing fluid mass" (ASCE 4-86):

$$p_c = 26{,}260x0.03/17 = 46.3 \text{ psf} = 0.32 \text{ psi}.$$

Thus, the combined impulsive and convective pressures are about 1.7 psi. The 0.24g inertial loading for a half-inch plate is equivalent to about 0.23 psi. One-third of the normal pressure is 7.8/3 = 2.6 psi, which is greater than 1.7 + 0.23 = 1.93 psi. Therefore, the normal operating condition loading controls.

Other Potential Off-Normal Loading Conditions

Table Q1.5.7.1 lists several different types of off-normal loadings and load combinations to be considered for nuclear facilities. The only potential loading brought to mind, by a review of this table, was the possibility of an impact load due to handling of fuel canisters, etc. Since canister/equipment handling is performed under water and is carefully controlled, these loads should be relatively small. Since the allowables for such an off-normal event is higher than for the normal operating condition, the normal condition would again be expected to control.

Wall Deformations

Questions have arisen relative to potential detrimental effects associated with deformations in the concrete walls at the closure gate seal locations. At the outside seals, away from the divider walls, the deformations would be negligible, since the wall segments are very short and attach to the chute side walls, which act as shear walls. The divider wall deformation predictions from an ANSYS analysis are attached. The attached deformation predictions are due to static water pressure plus seismic inertia. Seismic-induced sloshing loads are not included, but, since the sloshing frequency is very low, deformations due to sloshing are low. Note that the maximum deformation in the divider wall occurs at the top, and is equal to 0.013 inches (< 1/64 inch). The majority of this deformation is due to seismic inertial loading. I would be very surprised if this small deformation could significantly affect the closure walls. Depending on the seal flexibility, there may be a small possibility that some seal leakage could occur during an aftershock.

APPENDIX C2

SEISMIC-INDUCED SLIDING EVALUATIONS

Westinghouse Hanford Company **Internal Memo**

From: Facility Stress Analysis 8D420-BVW-94-009
Phone: 376-5736 H5-57
Date: November 21, 1994
Subject: CONCERN FOR DISCHARGE CHUTE HARDWARE SLIDING DURING AN EARTHQUAKE

To: T. R. Hull X3-76

cc: G. E. Conatore X3-75
T. J. Conrads H5-55
N. D. Ha H5-57
R. J. Kuhta X3-76
M. R. Lindquist H5-57 MRL
J. C. Wiborg B3-55
BVW File/LB

References:

1. Aslam, M., et al, 1975, *Sliding Response of Rigid Bodies to Earthquake Motions*, LBL-3868, UC-11, Lawrence Berkeley Laboratory, University of California, Berkeley, California.

2. Internal Memo, E. O. Weiner, to J. P. Strehlow, *Tank Slosh Displacements*, dated May 28, 1992. (Attached)

INTRODUCTION

This memo addresses the concern for earthquake-induced hardware movement in the discharge chute of the 105-KE Basin. The hardware of concern includes various equipment resting on the chute floor and the old isolation doors which are stored at the ends of the discharge chute. If hardware stored in the discharge chute moves during an earthquake, there is a potential for impact damage to the isolation door support bracket. A sketch of the discharge chute and current hardware locations is shown in Figure 1.

GENERAL DISCUSSION

The results of an analytical/experimental investigation of the issue of movement of unanchored equipment movements induced by earthquake motion is reported in (Aslam et al 1975). The Aslam report compares block sliding response predictions with actual responses from shake table data using several strong motion earthquake records, including the San Fernando Earthquake of 1971. Sliding displacements of 5 to 30 in. for friction coefficients of 0.30 to 0.10 were reported for the San Fernando earthquake motion (1.25 *g* maximum acceleration). A maximum sliding displacement of less than 2.0 in. was reported for a lesser earthquake (El Centro quake, maximum acceleration of 0.32 *g*, friction coefficient of 0.10).

Since the Hanford Site design basis earthquake has a maximum ground acceleration of 0.20 *g*'s, the 2.0 in. sliding associated with the El Centro earthquake should be conservative. For the underwater discharge chute location, the sliding could be enhanced due to hydraulic buoyancy and reduced friction coefficient. This sliding enhancement can be approximately accounted for by doubling the sliding prediction to 4.0 in.

Underwater sliding can also be increased by earthquake-induced horizontal movement of the water (sloshing). Horizontal sloshing magnitude is addressed in (Weiner 1992). As shown in the attached calculations, a maximum horizontal water movement of 16.7 in. was predicted (east/west direction). This maximum displacement occurs at the water surface and would be much less near the floor where most of the hardware is located. Sloshing-induced hardware movement should be essentially limited by the maximum water movement because the motion reverses with each half cycle. Combining the floor-movement-induced sliding with the sloshing-induced sliding gives a total displacement estimate of under two ft.

The above discussion assumes that equipment movement will be limited to sliding, i.e., no rocking or tipping. As discussed in (Aslam et al 1975), sliding is expected when the height/base-width ratio is less than the friction coefficient. Since none of the existing equipment height exceeds it's width, a friction factor in excess of one would be required, which is not reasonable, especially in water. There are exceptions to this conclusion discussed in the specific hardware discussions below.

SPECIFIC HARDWARE DISCUSSION

One exception to the height/width < 1.0 for the chute hardware is the old isolation doors parked at the ends of the chute as shown in Figure 1. However, tipping of the doors is prevented by cable stays which connect to the lifting eyes at the tops of doors. As shown in the attached calculations, the cable stays and lifting eyes are structurally adequate for the design basis earthquake loading. The only way the old isolation doors could damage the support brackets is to "pendulum out" a distance of over four ft. This unlikely pendulum action, should not exceed the maximum sliding prediction of two ft.

The closest hardware to the isolation door support brackets is the dump table, which is about 30 in. to the nearest point of the bracket. However, the two-ft high "stub wall" is between the dump table and the brackets and would prevent sliding in the direction of the brackets. Tipping of the dump table could occur, if the dump table center of gravity is well above the top of the stub wall. This will not occur, since the dump table center of gravity is less than two-ft high. The Fuel Segregation Canister Table is taller than its minimum width (32 in. high by 24 in. wide), but the center of gravity is below the top of the stub wall which will prevent tipping toward the support brackets.

T. R. Hull
Page 3
November 21, 1994

8D420-BVW-94-009

RECOMMENDATIONS

To prevent earthquake-induced damage to the isolation door support brackets, it is recommended that a hardware-free zone be established using a distance of four ft. This distance is well above the two ft maximum sliding predictions and allows for analysis uncertainties. For hardware, with height-to-width ratios greater than 1.0, the potential for tipping must be addressed to assure that the hardware cannot fall on the support brackets. If tipping is possible, adequate anchorage must be provided to prevent falling if the hardware height is greater than the distance to the isolation door support bracket. This criteria is met for the existing hardware shown in Figure 1.

B. V. Winkel

B. V. Winkel, Fellow Engineer
Facility Stress Analysis

rw

Attachment

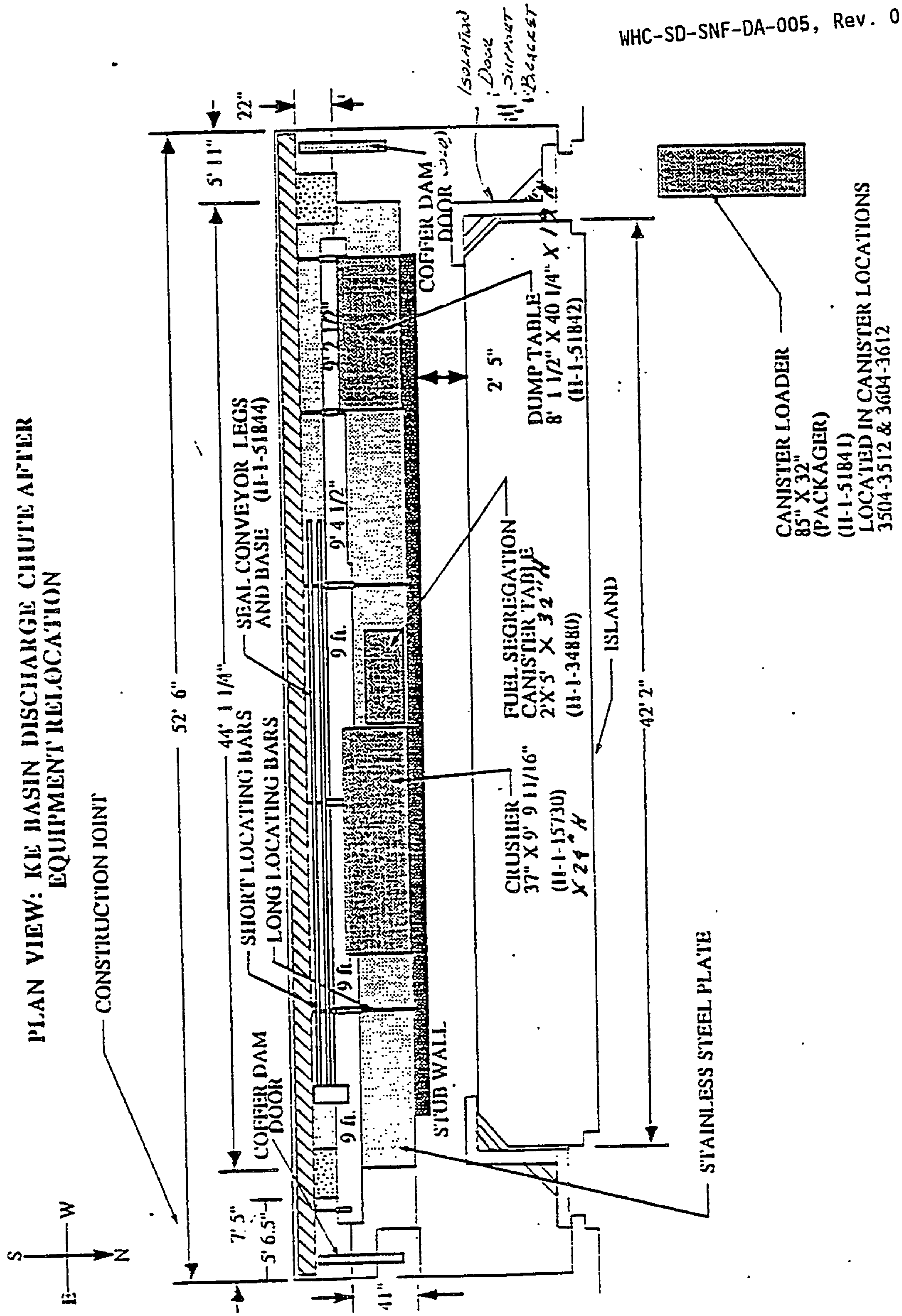


Figure 1. Discharge Chute Equipment Locations

ATTACHMENT

SUPPORTING CALCULATIONS

(1) Drawing H-1-21054 & H-1-21071 (2) Doc. No. ____ (3) Page ~~1 of~~ 4
(4) Building 105-KE, 105-KW (5) Rev. ____ (6) Job No. ____
(7) Subject Chute Seismic Sloshing (8) Originator B. V. Winkel Date 11-21-94
(9) Checker [illegible] Date 11/21/94

Reference: Structural Analysis and Design of Nuclear Plant Facilities, Section 5.4.6, ASCE Manual No. 58.

Input Parameters

$h = 16$ Water depth (KE & KW), ft.

$l = 26.25$ Half of water width in E/W direction, ft.

$g = 32.2$ Accel. of gravity, fps

$$\omega = \sqrt{\frac{1.58 \cdot g}{l} \cdot \tanh\left(1.58 \cdot \frac{h}{l}\right)} \qquad f = \frac{\omega}{2 \cdot \pi}$$

$\omega = 1.202$ $f = 0.191$ Chute sloshing frequency (cps)

$A1 = 1.0$ Displacement Amplitude, ft., from SDC-4.1 Response Spectra

$$\theta = 1.58 \cdot \frac{A1}{l} \cdot \tanh\left(1.58 \cdot \frac{h}{l}\right)$$

$$dmax = \frac{.527 \cdot l \cdot \coth\left(1.58 \cdot \frac{h}{l}\right)}{\left[\frac{g}{(\omega)^2 \cdot \theta \cdot l}\right] - 1}$$

$dmax = 1.036$ East/West slosh height, ft. (12.4 in.)

As shown in (Weiner 1992), the maximum horizontal displacement is of the same order of magnitude as the vertical displacement (slosh height). Following (Weiner 1992), the horizontal displacement is estimated on the next page.

(1) Drawing H-1-21054 & H-1-21071 (2) Doc. No. ______ (3) Page 2 of 4
(4) Building 105-KE, 105-KW (5) Rev. ______ (6) Job No. ______
(7) Subject Chute Seismic Sloshing (8) Originator B. V. Winkel Date 11-21-94
(9) Checker ______ Date 11-21-94

Parameters from Weiner analysis:

$kR = 1.84$ — 1st mode, round tank (approximate for rect. tank)

$J1 = 0.582$

$R = 1$ — Assume radius equals half of the chute width

$$hvratio = \frac{g \cdot \frac{kR}{R}}{2 \cdot \omega^2 \cdot J1}$$ See p. 7 of Weiner calcs.

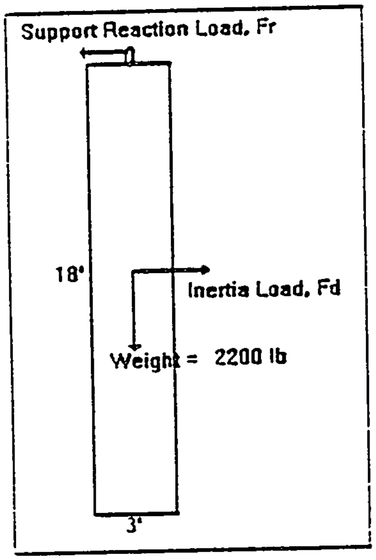
$hvratio = 1.342$ — Ratio of hor.-to-vertical max. displacement

$\delta hmax = hvratio \cdot dmax$

$\delta hmax = 1.39$ — Maximum hor. displ. in feet (16.7 in)

(1) Drawing H-1-21054 & H-1-21071 (2) Doc. No. ______ (3) Page 3 of 4
(4) Building 105-KE, 105-KW (5) Rev. ______ (6) Job No. ______
(7) Subject Iso. Door Anchorage (8) Originator B. V. Winkel Date 11-21-94
(9) Checker [illegible] Date 11-21-94

Old Isolation Door Geometry



North/South Direction Sliding:

Conservatively using the SDC-4.1 spectral peak of 0.42 g's (Safety Class 1 DBE, 5% damping):

$W := 2200$ Door Weight, lb, per L. Hyde, WHC (Old doors)

$Fd := 0.42 \cdot W$

$Fd = 924$

Conservatively assuming zero friction,

$Fr := Fd$ Max. cable stay reaction = 924 lb.

Note: A precise reaction load, which accounts for nonlinear rattling, fluid dynamics, etc., is very difficult to derive, but the above estimate is judged to be reasonably conservative.

The cable stay is anchored with four 3/4 in anchor bolts, which have an allowable pullout capacity of about 12,000 lb (3000 lb per bolt), which is well above the 924 lb max. reaction load. The cable is 3/8 in, which has a breaking strength in excess of 10,000 lb (Ref.: Wire Rope Eng. Handbook). Thus the cables and anchor bolts are structurally adequate to carry the DBE loading. The double 2X2 angles used in the anchor support are obviously also adequate for the 924 lb loading.

The lifting eye, at the top of the old isolation door, is constructed from A36, 1-in rod and has a max. inside height of 10 in. (Ref.: Dwg. H-1-42659). The eye is connected to the door by projecting through the top tubing and welded to the tube (seal weld at the bottom, and combined bevel and fillet weld at the top). Using the conservative reaction load of 924 lb, the bending stress in the weakest direction (east/west) is:

$M := \frac{Fr \cdot 10}{2}$ Moment per rod, in-lb

$I := \frac{\pi \cdot .5^4}{4}$ $c := 0.5$

$\sigma := M \cdot \frac{c}{I}$ $\sigma = 4.706 \cdot 10^4$ Lifting eye bending stress, psi

(1) Drawing H-1-21054 & H-1-21071 (2) Doc. No. ______ (3) Page 4 of 4
(4) Building 105-KE, 105-KW (5) Rev. ______ (6) Job No. ______
(7) Subject Iso. Door Anchorage (8) Originator B. V. Winkel Date 11-21-94
(9) Checker ______ Date 11-21-94

Since the minimum yield strength of A36 steel is 36,000 psi, yielding is predicted. Since A36 steel is very ductile, loads in excess of the yield stress can occur without function failure. Paragraph F-1323.2 of ASME Section III permits low probability loads (e.g. earthquake) up to 90% of the collapse/limit load. The plastic hinge shape factor for a rod is 1.7 which gives a lower bound limit load of 1.7 times the yield load:

$$P_l := \frac{1.7 \cdot 36000 \cdot I}{10 \cdot c}$$

$P_l = 600.83$ Lower bound collapse load per rod, lb

$$P_{allow} := 0.9 \cdot 2 \cdot P_l$$

$P_{allow} = 1.081 \cdot 10^3$ Allowable lifting eye load for seismic event, lb

Since the allowable load exceeds the estimated max. load of 924 lb., the margin of safety for the lifting eye is positive and the lifting eye is adequate for the design basis earthquake:

$$MS := \frac{P_{allow}}{924} - 1$$

$MS = 0.17$

Westinghouse Hanford Company — **Internal Memo**

From: Engineering Analysis
Phone: 6-3824 H5-53
Date: May 28, 1992
Subject: TANK SLOSH DISPLACEMENTS

To: J. P. Strehlow H5-56

cc: D. J. Green H5-53
L. J. Julyk H5-56
E. W. Pianka H5-56
J. B. Truitt H5-56
EOW File/LB

You requested that I firm up SY-101 horizontal fluid displacements in an SSE event for purposes of establishing loads the test chamber and pump designs. Previous displacements given to you (from the FY 91 SY-101 SSI analysis) were found to be too low, and the problem was associated with using too few master degrees-of-freedom in the fluid-structure model. Everyone please not that the existing SSI analysis is not affected, because slosh modes were shown to be non-contributing.

Analysis under separate cover gives an equivalent horizontal 9.8 in. fluid amplitude for the following conditions:

- The slosh frequency is 0.194 Hz
- The fluid amplitude is to be considered uniform from the primary liner springline to the bottom of the tank, and fluid forces are proportional to the square of the fluid velocity
- The cantilever is built in 5 ft above the soil surface. Equivalence is in terms of the bending moment at the built in end, i.e., the same bending moment is produced by the actual 18.6 in. surface amplitude which decays to 6.4 in. at the bottom of the tank.

The above applies for a probe location at the center of the tank and conservatively at any other location. The displacement amplitude can be reduced somewhat to 8.8 in. for a location halfway from the center to the wall.

J. P. Strehlow
Page 2
May 28, 1992

The solution method turns out to be rather simple: the slosh mode shape derived from the Blevins text are scaled by the sloth height provided by standard ASCE STD 4-86 formulas. The results were checked with ANSYS. I feel that this would have been an excellent technical task for a young engineer.

E.O.W.

E. O. Weiner, Fellow Engineer
Engineering Analysis

ggb

INDEPENDENT REVIEW

Document Reviewed Tank Slosh Displacements

Author Evan Weiner Report No. Memo to JPS 5/20/92 EDT No. ________

The subject document has been reviewed by the undersigned. The reviewer reviewed and verified the following items as applicable [EP.4.1, Rev. 3].

NA • Engineering Specification
✓ • Design Input
✓ • Basic Assumption
✓ • Approach/Design Methodology
✓ • Related Information
✓ • Conclusion/Result Interpretation

[signature] 5-27-92
Reviewer Date

CHECKLIST FOR CHECKING OF ANALYSIS/CALCULATIONS

Document Checked Tank Slosh Displacements
Author E O Weiner Report No. Memo to JNS 5-20-92 EDT No. ______

Yes	No	N/A	
[✓]	[ ]	[ ]	Problem adequately defined.
[✓]	[ ]	[ ]	Necessary assumptions stated and supported.
[✓]	[ ]	[ ]	Computer codes and data files documented.
[✓]	[ ]	[ ]	Data used in calculations stated in document.
[✓]	[ ]	[ ]	Data checked for consistency with original source information as applicable.
[✓]	[ ]	[ ]	Mathematical derivations checked including dimensional consistency of results.
[✓]	[ ]	[ ]	Models appropriate and used within range of validity or use outside range of established validity justified.
[✓]	[ ]	[ ]	Hand calculations checked for errors.
[~~✓~~] DW	[ ]	[✓]	Computer code run streams correct and consistent with analysis documentation. Computer code used only as a check of mode shape DW
[~~✓~~] DW	[ ]	[✓]	Computer code output consistent with input and with results reported in analysis documentation. Perhaps more numerical comparison on p. 4
[ ]	[ ]	[✓]	Acceptability limits on analytical results applicable and supported. Limits checked against sources.
[ ]	[ ]	[✓]	Safety margins consistent with good engineering practices.
[✓]	[ ]	[ ]	Conclusions consistent with analytical results and applicable limits.
[✓]	[ ]	[ ]	Results and conclusions address all points required in the problem statement.

I have checked the analysis/calculation and its complete and accurate to the best of my knowledge.

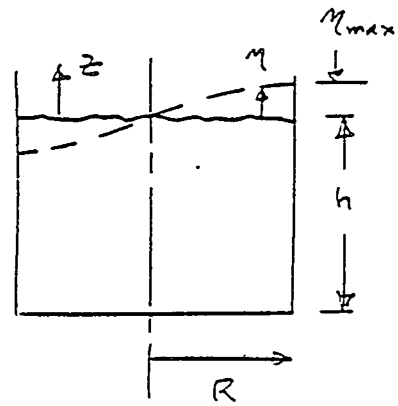
Dennis D Callen ____________ 5-27-92 ____________
Checker Date

Note: Any calculations, notes, or summaries generated as part of this review should be signed, dated, and attached to this checklist. Material should be labeled and recorded so that it is intelligible to a technically qualified third party.

(1) Drawing ______ (2) Doc. No. ______ (3) Page ~~1 of 12~~
(4) Building ______ (5) Rev. ______ (6) Job No. ______
(7) Subject Slosh modes
(8) Originator Ed Weiner Date 5/19/92
(9) Checker DA Wallace Date 5-28-92

(10)

Analysis is provided to determine slosh mode displacements in a circular tank during an SSE. The procedure is as follows



1. Use standard analysis (Haroun, ASO) for the slosh height η_{max} from the response spectrum
2. Determine the slosh mode (Blevins, 1979, section 13.5) for cos θ modes
3. Determine an equivalent displacement, assumed uniform wrt depth, that produces the same bending moment on a rigid cantilever suspended in the fluid from above.

Following Blevins, the slosh mode is described by a potential

$$\Phi = \frac{Ag}{\omega} \frac{\cosh k(h+z)}{\cosh kh} \tilde{\varphi} \sin(\omega t + \psi) \qquad (1)$$

$$\tilde{\varphi} = J_1(kr) \cos\theta \qquad (2)$$

where

A = constant

BD-6400-060.1 (12/87)

DESIGN CALCULATION

(1) Drawing ______ (2) Doc. No. ______ (3) Page ~~2 of 13~~
(4) Building ______ (5) Rev. ______ (6) Job No. ______
(7) Subject Slosh Model
(8) Originator EO Weiner Date 5/19/92
(9) Checker DA Wallace Date 5-28-92

(10) Blevins, Table 13-6

$Rk = R\omega/c = 1.841,\ 5.331,\ 8.536;\ J_1'(kR)=0$

g = accel. gravity.
ω = circular natural frequency
c = wave speed
t = time
J_1 = Bessels function, first kind

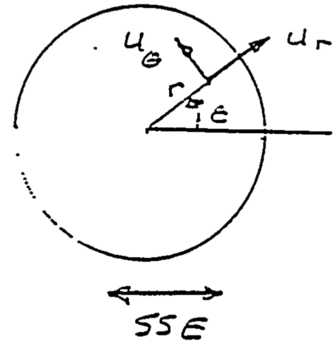
Note:

$$\omega^2 = gk \tanh kh \qquad (3)$$

$$\eta = -\frac{\partial \Phi}{\partial t} \qquad (4)$$

$$u_r = -\partial\Phi/\partial r \qquad u_\theta = -\frac{1}{r}\partial\Phi/\partial\theta \qquad (5)$$

where u_r and u_θ are the radial and tangential velocity components. Dropping the factors $\sin(\omega t+\varphi)$ and



$$f(z) \equiv \frac{\cosh k(h+z)}{\cosh kh},$$

the three displacement amplitude components are

$$\left.\begin{aligned}
\eta &= -\frac{1}{g}\frac{\partial\Phi}{\partial t} \sim A\,J_1(kr)\cos\theta \\
\delta_r &= \frac{u_r}{\omega} = \frac{Ag}{\omega^2}k\,J_1'(kr)\cos\theta \\
&= \frac{Ag}{\omega^2}k\left(J_0(kr) - \frac{J_1(kr)}{kr}\right)\cos\theta \\
\delta_\theta &= \frac{u_\theta}{\omega} = \frac{Ag}{\omega^2 r}J_1(kr)\sin\theta
\end{aligned}\right\} \qquad (6)$$

BD-6400-060.1 (12/87)

(1) Drawing ______ (2) Doc. No. ______ (3) Page 7 of 12
(4) Building ______ (5) Rev. ______ (6) Job No. ______
(7) Subject Slosh Mode
(8) Originator EO Weiner Date 5/19/92
(9) Checker D A Wallace Date 5-28-92

(10)

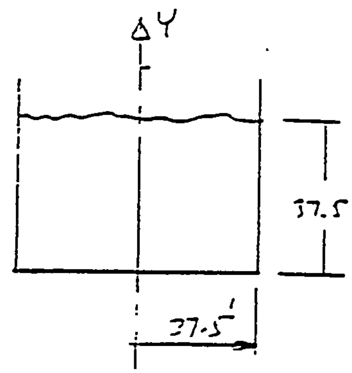
For the first slosh mode, (Haroun, 1980) gives

$$\eta_{max} = 0.837\ R\ S_a/g \qquad (7)$$

where S_a is the spectral acceleration at the natural frequency. Eqs (3) (6) + (7) provide enough information to determine the slosh mode, amplitude and frequency. Also, (Veletsos, 1992) shows higher mode constants for eq (7):

$$c_{c1}(1) = 0.837 \qquad c_{c2}(1) = 0.073 \qquad c_{c3}(1) = 0.028$$

The above formulation was checked with (ANSYS, 1989), using the 2% Newmark-Hall response spectrum in (SDC 4.1, 1989) Run 5/15/92 08:55 a. This run was carried out with all possible master degrees of freedom, because it was noticed that reduced masters gave low horizontal displacements.



Otherwise, the model follows the test model reported in (Giller, 1992, vol 2, p A39).

The first mode results: $f = .1948\ Hz$

$$\eta_R = 17.78'' = \eta_{max} \quad \text{Vertical displ}; \ r = R,\ z = 0$$

$$\delta_{r0} = 16.23'' \quad r\text{-displ},\ \theta = 0,\ r = 0,\ z = 0$$

BD-6400-060.1 (12/87)

(1) Drawing ______ (2) Doc. No. ______ (3) Page ~~4 of 17~~ 5

(4) Building ______ (5) Rev. ______ (6) Job No. ______

(7) Subject Slosh Mode

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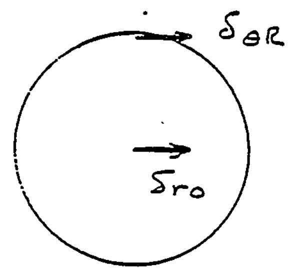
(9) Checker DA Wallace Date 5-28-92

(10)

$\delta_{\theta R} = 9.93''$ θ-displ, $\theta = \frac{\pi}{2}$, $r = R$, $z = 0$

$\delta_{rb} = 5.08''$ r-displ, $\theta = 0$, $r = 0$, $z = 0$

From eqs (3-7),



$$k^{-1} = \frac{R}{1.841} = \frac{37.5'}{1.841} = 20.37'$$

$$\omega^2 = \frac{32.17\ ^{1}/_{s^2}}{20.37'} \tanh\left(\frac{37.5'}{20.37'}\right)$$

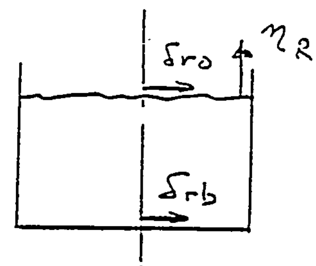
$$= 1.502\ s^{-2} \quad \omega = 1.225\ s^{-1}$$

$$f = .1950\ Hz$$

$$S_a = 0.0460\ g \quad (SDC4.1)$$

$$\eta_{max} = 0.837 \times 37.5' \times .0460 \times \frac{12'}{ft}$$

$$= 17.33''$$



Using $J_1(x) \approx x/2$ for $x \ll 1$, form ratios for other components in eq (6):

$$\left.\begin{aligned}
\frac{\delta_{ro}}{\eta_R} &= \frac{gk}{2\omega^2 J_1(kR)} = \frac{32.17\ ^{1}/_{s^2}/20.37'}{2 \times 1.502\ s^{-2} \times .582} = .903 \\
\frac{\delta_{\theta R}}{\delta_{ro}} &= \frac{J_1(kR)}{kR/2} = \frac{.582}{1.841/2} = .632 \\
\frac{\delta_{rb}}{\delta_{ro}} &= \frac{1}{\cosh kh} = \frac{1}{\cosh(37.5/20.37)} = .310
\end{aligned}\right\} \quad (7)$$

This compares with the ANSYS solution:

BD-6400-060.1 (12 87)

(1) Drawing ______ (2) Doc. No. ______ (3) Page 5 ~~of 10~~
(4) Building ______ (5) Rev. ______ (6) Job No. ______
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(10)

$$\eta_R = 17.78''$$

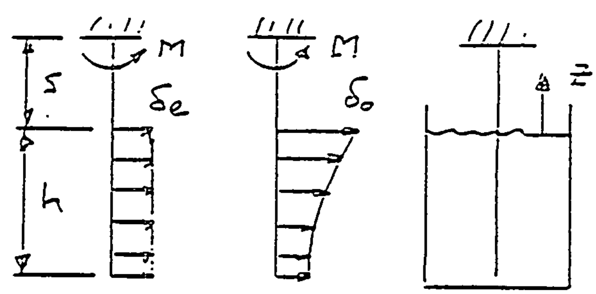
$$\frac{\delta_{ro}}{\eta_R} = \frac{16.23''}{17.78''} = 0.913$$

$$\frac{\delta_{\theta R}}{\delta_{ro}} = \frac{9.93''}{16.23''} = .612$$

$$\frac{\delta_{rb}}{\delta_{ro}} = \frac{5.08}{16.23} = .310$$

The agreement is satisfactory.

The remaining task provides an equivalent displacement δ_e so that a V^2-dep't drag force, uniform wrt z, produces the same bending moment as δ_o which is dep't on



$$f(z) = \frac{\cosh k(h+z)}{\cosh kh} \qquad (8)$$

Thus,

$$h\,\delta_e^2\,(s+h/2) = \delta_o^2 \int_{-h}^{0} (s-z)\, f^2(z)\, dz \qquad (9)$$

For SY-101, take the fluid level at the primary liner springline and the built-in end 5' above the soil surface (see dwg H-2-37772).

(1) Drawing ______ (2) Doc. No. ______ (3) Page 6 of 12
(4) Building ______ (5) Rev. ______ (6) Job No. ______
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(10)

$$h = 31.8' + 3.4' = 35.2'$$

$$S = 6.5' + 1.3' + 15' - 3.4' + 5 = 24.4'$$

soil concr. minor axis

$$R = 37.5'$$

$$kh = kR\frac{h}{R} = 1.841\frac{35.2}{37.5} = 1.727$$

Also, use 0.5% damping for the slosh mode per (DOE , 1992). The response is not available from SDC 4.1, so use 50 percentile displacement scaling of the 2% value in Table 29.1 of (Harris, 1976):

$$\frac{S_d|_{.5\%}}{S_d|_{2\%}} = \frac{1.97}{1.68} = 1.17$$

Then eqs(3-7) give

$$\omega^2 = \frac{1.84 \times 32.2}{37.5}\tanh\left(\frac{1.84 \times 35.2}{37.5}\right) = 1.485\ s^{-2}$$

$$\omega = 1.218\ s^{-1} \qquad f = .1938\ Hz$$

$$SDC\ 4.1:\quad S_a|_{2\%} \doteq .046\ g$$

$$S_a|_{.5\%} = 1.17 \times .046g = .0538g$$

$$\eta_{max} = .837\ R\ S_a/g = .837 \times 37.5' \times \frac{12''}{ft} \times .0538$$

4.2

$$= 20.3''$$

The hrzl displacement at the tank center is

(1) Drawing ____ (2) Doc. No. ____ (3) Page ~~7 of 12~~

(4) Building ____ (5) Rev. ____ (6) Job No. ____

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(10)

$$\frac{\delta_o}{\eta_{max}} = \frac{gk}{2\omega^2 J_1(kR)} = \frac{32.2'/s^2 \times 1.94/\overset{26.25'}{\cancel{37.5'}}}{2 \times \overset{1.46}{1.483}\, s^{-2} \times .582} = \overset{1.35}{.915}$$

$$\delta_o = .915\, \eta_{max} = \overset{1.35}{.915} \times \overset{14.2}{20.3''} = \overset{19.1''}{18.6''}$$

For eq (9)

$$\frac{1}{h}\int f^2(z)\,dz = \frac{1}{h}\int_{-h}^{0} \frac{\cosh^2 k(h+z)}{\cosh^2 kh}\,dz$$

$$= \frac{1}{kh\cosh^2 kh}\int_0^{kh} \cosh^2 x\,dx = \frac{\left[\sinh 2x + 2x\right]_0^{kh}}{4kh\cosh^2 kh}$$

$$= \frac{2kh + \sinh 2kh}{4kh\cosh^2 kh} = \frac{2 \times 1.727 + \sinh(2 \times 1.727)}{4 \times 1.727 \cosh^2(1.727)}$$

$$= .331$$

$$\frac{1}{h^2}\int_{-h}^{0} z\, f^2(z)\,dz = \frac{1}{h^2}\int_0^{kh}\left(\frac{x}{k} - h\right)\frac{\cosh^2 x}{\cosh^2 kh}\,\frac{dx}{k}$$

$$\int x\cosh^2 x\,dx = \int \frac{x}{2}(1 + \cosh 2x)\,dx$$

$$= \frac{1}{4}\left[x^2 + x\sinh 2x - \frac{1}{2}\cosh 2x\right]_0^{kh}$$

$$= \frac{1}{4}\left[k^2h^2 + kh\sinh 2kh - \frac{1}{2}(\cosh 2kh - 1)\right]$$

$$= 5.713$$

$$\therefore \quad \frac{1}{h^2}\int_{-h}^{0} z\, f^2(z)\,dz = \frac{5.713}{1.727^2\cosh^2 1.727} - .331 = -.103$$

& eq (9) is evaluated.

(1) Drawing ______ (2) Doc. No. ______ (3) Page ~~4 of 12~~
(4) Building ______ (5) Rev. ______ (6) Job No. ______
(7) Subject Slosh Mode
(8) Originator EO Weiner Date 5/20/92
(9) Checker DA Wallace Date 5-28-92

(10)

$$\frac{\delta_e^2}{\delta_0^2} \doteq \frac{1}{\frac{1}{2}+\frac{s}{h}} \int_{-h}^{0} \left(\frac{s}{h}-\frac{z}{h}\right) f^2(z)\,dz\ \frac{dz}{h} \qquad (9)$$

$$= \frac{1}{.5+\frac{24.4}{35.2}} \left(\frac{24.4}{35.2}\times .331 + .103\right) = .279$$

$$\delta_e = \sqrt{.279}\ f_0 = \sqrt{.279} \times 18.6'' = 9.8''$$

Check this result by integrating eq (9) numerically:

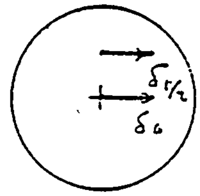
$-z/h$	$f(z)$	$s/h - z/h$
0	1	.693
.2	.730	.893
.4	.547	1.093
.6	.430	1.293
.8	.347	1.493
1.0	.345	1.693

with the trapezoidal rule: $\frac{1}{h}\int_{-h}^{0}\left(\frac{s}{h}-\frac{z}{h}\right) f^2(z)\,dz \doteq .334$

$$\therefore \quad \frac{\delta_e^2}{\delta_0^2} = \frac{.334}{.5+.693} = .280 \quad \underline{OK}$$

Some small decrease can be obtained for off-center locations; halfway at $r = R/2$ the δ_θ for $\theta = \pi/2$ gives

$$\frac{\delta_{1/2}}{\delta_0} = \frac{J_1(kr)/r}{\lim_{r\to 0}\left(J_1(kr)/r\right)} = \frac{2\,J_1(kr)}{kr}$$



BD-6400-060.1 (12/87)

(1) Drawing ________ (2) Doc. No. ________ (3) Page ~~9 of 12~~
(4) Building ________ (5) Rev. ________ (6) Job No. ________
(7) Subject Slosh Mode
(8) Originator EO Weiner Date 5/20/92
(9) Checker DW Wallace Date 5-28-92

(10)

$$\frac{\delta_{1/2}}{\delta_0} = \frac{2\ J_1\ (1.84/2)}{1.84/2} = \frac{2 \times .413}{.92} = .898$$

so the equivalent (uniform z-load) displacement

$$\delta_{e1/2} = 9.8'' \times .898 = 8.8''$$

DESIGN CALCULATION

(1) Drawing ______ (2) Doc. No. ______ (3) Page 10 of 10

(4) Building ______ (5) Rev. ______ (6) Job No. ______

(7) Subject Slosh Modes

(8) Originator EO Weiner Date 5/20/92

(9) Checker [illegible] Date 5-28-92

REFERENCES

ANSYS, 1989, G.J. DeSalvo and R.W. Gorman, "ANSYS Engineering Analysis System Users Manual", Rev 4.4, Swanson Analysis Systems, Inc., P.O. Box 65, Houston PA 15342, May 1, 1989.

AN''S, 1989, G.J. DeSalvo and R.W. Gorman, "ANSYS Engineering Analysis System Users Manual", Rev 4.4, Swanson Analysis Systems, Inc., P.O. Box 65, Houston PA 15342, May 1, 1989.

Bl vins, R.D., 1979, Formulas for Natural Frequency and Mode Shape, Van Nostrand.

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C ler, R.A. and E.O. Weiner, 1992, "Soil Structure Interaction Analysis for the Hanford Site 241-sy-101 Double-Shell Waste Storage Tanks", WHC-EP-0504, Westinghouse Hanford Company, Richland, Washington.

ris, C.M. and Crede, C.E., 1976, Shock and Vibration Handbook, 2nd ed, McGraw-Hill.

C-4.1, 1989, "Standard Arch-Civil Design Criteria, Design Loads for Facilities", Hanford Plant Standards, SDC-4.1, Rev 11 USDOE Richland Operations Office, Richland WA, May 16, 1989.

DESIGN CALCULATION

(1) Drawing ______ (2) Doc. No. ______ (3) Page 11 of 12

(4) Building ______ (5) Rev. ______ (6) Job No. ______

(7) Subject Slosh mode

(8) Originator EO Weiner Date 5/20/92

(9) Checker ______ Date ______

ANSYS INPUT - FOR CHECKING MODE SHAPES

```
/prep7
/title, Housner-Haroun Comparison, 37.5' x 37.5', full masters
kan,2
kay,1,0          * reduced
kay,2,400        * expand all modes
et,1,81
et,2,61
ex,1,.3e6        * bulk modulus
dens,1,93.5e-6   * lbf sec^2 / in^4, sp gr = 1
gxy,1,386        * g for k-slosh. See stif81
ex,2,30e6        * shell
nuxy,2,.3
dens,2,725e-6
r,1,.45          * shell thicknesses
n,1              * c/l nodes, origin at bottom
h=37.5           * ft input
n,10,,h
fill
dr=(37.5)/5.
ngen,6,10,1,10,1,dr      * remaining fluid nodes
ngen,2,10,51,60,1,0      * shell nodes, on top of last col fluid nodes
nscale,0,all,,,12,12,12 * ft to in
nlist,all
type,1 $ mat,1           * fluid elmts
e,1,11,12,2
egen,9,1,-1
egen,5,10,-9
type,2 $ mat,2 $ real,1 * shell elmts
e,61,62
egen,9,1,-1
elist,all
cp,1,ux,52,62            * fluid-struct coupling - radial only
rp9,1,,1,1
cplist,all
ce,1,0,1,uz,1,1,ux,1     * uz = -ux on centerline
rp10,1,,1,,,1
m,all,all                * all masters
mdele,1,uz,10            * remove eliminated dofs from masters
mdele,62,ux,70
mdele,61,rotz,70         * remove shell rotations
mdele,61,uy,69           * leave one axial shell master
iter
mode,1,1
freq,    0.10,  0.16,  0.26,  0.40,  0.60,  1.10,  1.73,  8.00, 12.00
freq,   20.00, 33.00, 100.00
sv, .02, 0.012, 0.031, 0.084, 0.129, 0.192, 0.351, 0.550, 0.550, 0.412
sv, .02, 0.286, 0.200, 0.200   * SDC 4.1 Rev 11 0.2g 2% damping
```

DESIGN CALCULATION

(1) Drawing ______ (2) Doc. No. ______ (3) Page 12 of 12
(4) Building ______ (5) Rev. ______ (6) Job No. ______
(7) Subject Slosh Mode
(8) Originator EO Werner Date 5/20/92
(9) Checker ______ Date ______

```
svtyp, 2, 386       * scale Sa, units = in/sec**2
sed, 1, 0, -1       * excitation direction, see 2.25.4
d, 1,uy,,, 10       * no vertical fluid motion on centerline
d, 1,uy,,,51,10     * or tank bottom
d,61,ux,,,,,uy,uz   * shell bottom contact - no displ
d,51,ux             * cannot couple to ground
dlist
cgomga,1e-6
wsort,y,-1
stat
afwrite
finish
/input,27
finish
/post1
stress,sdmi,61,11       * stress - direct, meridional, at i-node
      ,sdti,61,12       * direct tangential
      ,sbmi,61,13       * bending
      ,sbti,61,14
      ,txzi,61,35       * shear force/len
      ,prs,81,1         * fluid pressure
*create,mac             * see 3.0.8.3
set,1,arg1              * modes 1-n are iters 1-n, screen out cir modes
*get,sdti,sdti,50       * test signif hoop membrane stress - impulse mode
stst=abs(sdti)
*if,stst,gt,100,:doit
*get,txzi,txzi,46       * test signif base shear - impulse mode
ttst=abs(txzi)
*if,ttst,gt,30,:doit
*get,uy,uy,30           * test signif vert fluid displ - slosh mode
utst=abs(uy)
*if,utst,gt,.3,:doit
*go,:dont
:doit
nrsel,node,10,60,10      * fluid surface
nasel,node,61,70         * shell
nasel,node,1,10          * c/l
prdisp
prrfor
ersel,type,2     * shell elmts
easel,elem,37,45 * fluid elmts by wall
prstrs,sdmi,sdti,sbmi,sbti,txzi,prs
:dont
*end
*use,mac,1
rp150,,1         * look at all modes expanded
finish
```

APPENDIX C3

SEISMIC SLOSH HEIGHT PREDICTIONS

Westinghouse Hanford Company **Internal Memo**

From: Facility Stress Analysis 8VW-8D420-94-010
Phone: 376-5736 H5-57
Date: December 7, 1994
Subject: K BASIN SLOSH HEIGHT PREDICTIONS

To: J. C. Wiborg B3-55

cc: W. A. Frier X3-74
L. L. Hyde H5-57
R. J. Kuhta X3-76
M. R. Lindquist H5-57 MRL
BVW File/LB

References: 1. BNL, 1993, K. Bandyopadhyay et al., *Seismic Design and Evaluation Guidelines for The Department of Energy High-Level Waste Storage Tanks and Appurtenances*, BNL 52361, U.S. Department of Energy, Brookhaven National Laboratories, Associated Universities, Inc., Upton, New York, New York.

2. ASCE 1980, *Structural Analysis and Design of Nuclear Plant Facilities*, ASCE Manual No. 58, American Society of Civil Engineers, New York, New York.

3. Veletsos, A. S., Private Communication (telephone) Between B. V. Winkel, Westinghouse Hanford Company, and A. S. Veletsos, Rice University, Houston, Texas, December 1, 1994.

INTRODUCTION

The K Basin normal operating water level is 4 ft, 9 in. below the top of the basin retaining walls. Due to this large freeboard, the concern for seismic-induced slosh heights exceeding this freeboard has not been considered to be a significant issue. This judgement had been confirmed by slosh height predictions which had not been formally documented. Since the issue of excessive sloshing was recently raised by K Basin readiness reviews, it became prudent to take a second look at the slosh height calculations. This memo documents the original calculations and also adds a second calculation, based upon more recent guidelines given in BNL 1993.

DISCUSSION

Slosh height predictions were originally made in 1991, using standard techniques common to the nuclear industry (ASCE 1980). This 1991 calculation is documented in page one of the attached calculations. As indicated, slosh heights of 10.2 in. in the north/south direction and

J. C. Wiborg
Page 3
December 7, 1994

BVW-8D420-94-010

14.7 in. in the east/west direction were predicted. Page two of the calculations provides a second independent calculation, using methodology from the more recent BNL 1993 document. The second independent calculation predicted slosh heights of 15.1 in. (north/south) and 19.3 in. (east/west).

The adequacy of the BNL 1993 methodology for the K Basin application was discussed with the author of the hydrodynamics section of the BNL 1993 report (Veletsos 1994). The specifics discussed included (1) the effect of surface waves (Rayleigh and Love) on the slosh height calculations, (2) the adequacy of the Hanford site Design Basis Earthquake response spectra for slosh predictions, and (3) the reasonableness of the magnitude of the K Basin slosh height predictions.

Veletsos stated that the seismic response spectra should be independent of the type of waves which generated the empirical ground motion data used in developing the spectra. However, since the site response spectra was developed primarily for evaluating structures, the accuracy of the spectra at the relatively low sloshing frequencies may be not as good as at frequencies more typical of nuclear-safety structures. I described the low frequency portion of our site spectra to him, and the values appeared to be reasonable to him. When I described the amount of freeboard at the K Basins, he expressed the opinion that the low frequency inaccuracies would not likely be large enough to increase the slosh heights to the level of the 4.75-ft freeboard.

It is noted that the slosh height predictions, discussed above, are for the basin proper, i.e. the pits and chute are not addressed. Since the slosh/freeboard margin for the basin is large, individual calculations for all of the pits and chute was judged to be unnecessary.

RECOMMENDATIONS

It is recommended that the slosh height predictions given by the BNL 1993 procedures (15.1-in. north/south, 19.3-in. east/west) be treated as our current best estimate of the K Basin slosh response. If slosh height input to design/operation decisions is needed, these predictions could be doubled to cover uncertainties.

B. V. Winkel, Fellow Engineer
Facility Stress Analysis

rw

Attachment

ATTACHMENT

MATHCAD CALCULATIONS

(1) Drawing H-1-21054 & H-1-21071 (2) Doc. No. ________ (3) Page ~~1 of 2~~
(4) Building 105-KE, 105-KW (5) Rev. ________ (6) Job No. ________
(7) Subject K-Basin Seismic Sloshing (8) Originator B. V. Winkel Date 12-5-94
(9) Checker L. L. Hyde Date 12-6-94

Reference: Structural Analysis and Design of Nuclear Plant Facilities, Section 5.4.6, ASCE Manual No. 58. (Originally used in 1991 slosh height estimates.)

Input Parameters

$i = 1..2$ — i = 1 is N/S direction, i = 2 is E/W direction

$h = 16$ — Water depth (KE & KW), ft.

$l_1 = 34.21$ — Half of water width in N/S direction, ft.

$l_2 = 20.15$ — Half of water width in E/W direction, ft.

$g = 32.2$ — Accel. of gravity, fps

$$\omega_i = \sqrt{\frac{1.58 \cdot g}{l_i} \cdot \tanh\left(1.58 \cdot \frac{h}{l_i}\right)} \qquad f_i = \frac{\omega_i}{2 \cdot \pi}$$ Sloshing frequency

ω_i	f_i	
0.967	0.154	N/S and E/W, respectively,
1.465	0.233	sloshing natural frequencies

$A1 = 1.0$ — Displacement Amplitude, ft., from SDC-4.1 Response Spectra, 0.5% damping

$$\theta_i = 1.58 \cdot \frac{A1}{l_i} \cdot \tanh\left(1.58 \cdot \frac{h}{l_i}\right)$$

$$dmax_i = \frac{.527 \cdot l_i \cdot \coth\left(1.58 \cdot \frac{h}{l_i}\right)}{\left(\frac{g}{\omega_i^{\,2} \cdot \theta_i \cdot l_i}\right) - 1}$$

$dmax_1 = 0.851$ — North/South slosh height, ft. (10.2 in.)

$dmax_2 = 1.227$ — East/West slosh height, ft. (14.7 in.)

(1) Drawing H-1-21054 & H-1-21071 (2) Doc. No. ______ (3) Page ~~2 of 3~~
(4) Building 105-KE, 105-KW (5) Rev. ______ (6) Job No. ______
(7) Subject K-Basin Seismic Sloshing (8) Originator B. V. Winkel Date 12-5-94
(9) Checker L. L. Hyde Date 12-6-94

Slosh height predictions using Eq. 4.51 from the TSEP Guidelines document (memo, Ref. 1):

$R_i = \frac{1.84}{1.58} \cdot l_i$ Cylindrical to rectangular tank conversion per ASCE Man. 58

$j = 1..3$

$\lambda_1 = 1.841$ $\lambda_2 = 5.331$ $\lambda_3 = 8.536$ Eq. (4.5)

$$fc_{i,j} = \frac{1}{2\cdot\pi}\cdot\sqrt{\lambda_j\cdot\frac{g}{R_i}\cdot\tanh\left(\lambda_j\cdot\frac{h}{R_i}\right)}$$

$fc_{1,j}$	$fc_{2,j}$
0.154	0.233
0.326	0.43
0.418	0.545

First three modes of N/S and E/W sloshing frequencies

$SA_{1,1} = .035$ $SA_{2,1} = .080$

$SA_{1,2} = 0.15$ $SA_{2,2} = 0.18$

$SA_{1,3} = 0.18$ $SA_{2,3} = 0.21$

Accelerations (g's) from Figure 7-7 of ECN 191290 (current K Basin foundation spectra, 0.5% damping)

$$hs_i = \sqrt{(0.837\cdot SA_{i,1})^2 + (0.073\cdot SA_{i,2})^2 + (0.028\cdot SA_{i,3})^2}\cdot R_i$$

Eq. (4.51), Note that SA values are already in g units resulting in removal of g from the demoninator of the eq.

hs_i
1.262
1.607

N/S (0.884 ft = 15.1 in.) and E/W (1.504 ft = 19.3 in.) slosh height predictions using Eq. (4.51) of the TSEP document

APPENDIX C4

HARDWARE DROP CALCULATIONS

Westinghouse
Hanford Company

Internal Memo

From: Facility Stress Analysis
Phone: 376-5736 H5-57
Date: November 10, 1994
Subject: K BASIN HARDWARE DROP CONCERNS

BVW-8D420-94-008

To: J. C. Wiborg 83-55

cc: W. W. Chen H5-57
W. A. Frier X3-74
R. J. Kuhta X3-76
M. R. Lindquist H5-57 MRL
BVW File/LB

References: 1. ASCE, 1980a, *Civil Engineering and Nuclear Power*, Vol. V: Report of the ASCE Committee on Impactive and Impulsive Loads, Second ASCE Conference on Civil Engineering and Nuclear Power, Knoxville, Tennessee.

2. ASCE, 1980b, *Structural Analysis and Design of Nuclear Plant Facilities*, ASCE Manual No. 58, American Society of Civil Engineers, New York, New York.

3. Bechtel, 1974, *Topical Report, Design of Structures for Impact*, BC-TOP-9A, Bechtel Corporation, San Francisco, California.

4. Winkel, B. V., 1994, *Isolatión Door Drop Concern*, Internal Memo No. BVW-8D420-94-007 to J. C. Wiborg, Westinghouse Hanford Company, Richland, Washington.

INTRODUCTION

Increased activities in hardware handling within and above the 105-KE and 105-KW Basins have raised concerns for a drop accident which could result in accidentally-dropped hardware punching through the basin floor producing an unacceptable leak rate. The purpose of this memo is to establish maximum allowable hardware handling heights in order to avoid an unacceptable hardware drop in the basins.

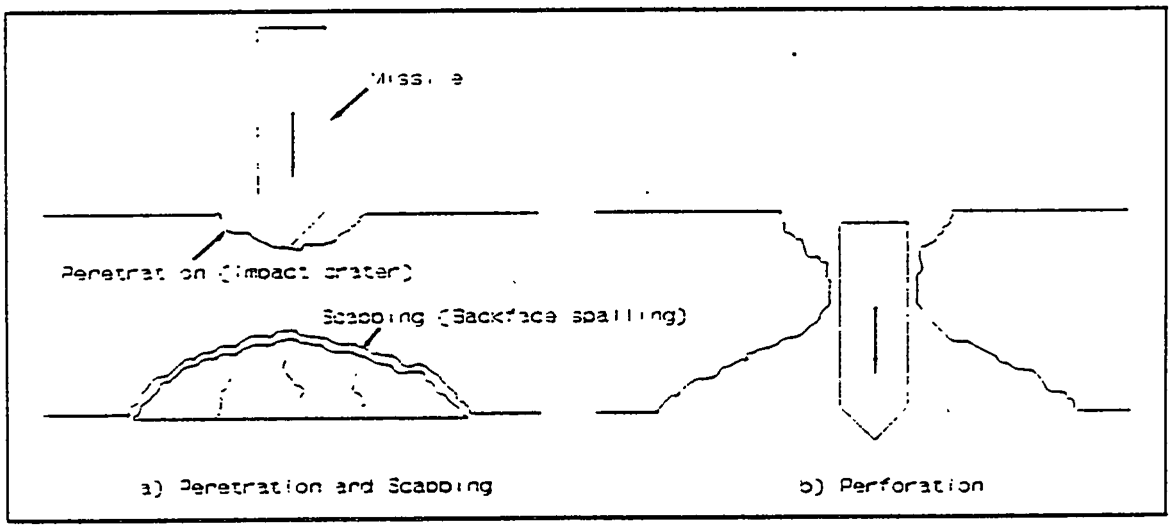
Accidental dropping of a basin isolation door was recently addressed in (Winkel 1994). The (Bechtel 1974), (ASCE 1980b), and (ASCE 1980a) references used in (Winkel 1994) were reviewed relative to the current more general drop concern. The (ASCE 1980b) and (ASCE 1980a) references are more current and comprehensive and were selected as the more appropriate guidelines for the current evaluation. The current methodology for predicting concrete slab damage due to missile impact utilizes empirical equations developed from relatively small missiles projected at high

J. C. Wiborg BVW-8D420-94-008
Page 2
November 10, 1994

velocities. The (ASCE 1980b) reference does include some limited low velocity test data (80 to 470 ft/sec). However, the maximum impact velocity considered in the current K Basin study is 44 ft/sec (30 foot drop height in air). Therefore, the attached impact damage calculations should be treated as approximate.

DISCUSSION

Concrete slab missile impact damage is generally grouped into three categories: "penetration", "scabbing", and "perforation". These terms are illustrated in Figure 1. If the impact surface penetration and backface scabbing are deep enough, full penetration or perforation will occur. Using the (ASCE 1980b) equations for predicting perforation thicknesses, the associated drop heights for a range of missile weights were determined.



The perforation equations are based upon cylindrically-shaped steel missiles with an impact direction normal to the cylinder axis. The impact area specified in the impact equations corresponds to the cylinder cross-sectional area. Establishing an equivalent area for a general missile shape is difficult, especially when considering the possibility of corner and edge drops. For simplicity and conservatism, a small impact area of 2.0 sq. in. was assumed for establishing the maximum allowable drop heights discussed below.

Perforation predictions for a range of missile weights and drop heights are shown in the Figure 2 solid curve. These predictions include the following conservatisms: (1) No velocity reduction due to drag forces or missile bouyancy were considered. (2) The missile impact surface was assumed to have a sharp nose. (3) No credit was taken for the soil support on the backface. (4) A 20% perforation thickness increase was conservatively included, as recommended by (ASCE 1980b). (5) A conservatively small impact area of 2.0 sq in was assumed. (6) Concrete floor penetration was based upon data for solid steel missiles.

To illustrate the application of the Figure 2 perforation curve, consider a missile weight of 5000 lbs. From the Figure 2 solid curve, a drop height in excess of 8.5 feet could result in a perforation/penetration of the basin floor.

It is noted that the above perforation predictions assume a local-type failure. For relatively large missiles, a general-type failure is possible. For the K Basin floor, a general-type failure would likely consist of cracks penetrating through the floor and radiating out from the point of impact. General-type floor failures are more difficult to predict and are location sensitive, i.e. dependent on where the drop occurs. Due to the relatively heavy reinforcing in the basin floor, such cracks are likely to be tight with an associated slow leak rate. The cracks should also be repairable. Thus, it was assumed that a general-type failure should not control the equipment height limits.

RECOMMENDATIONS

Note in Figure 2, that a "recommended drop height limit" curve is shown (dotted line curve). This curve represents a factor of one and one-half margin of safety on missile weight, to account for uncertainties in the penetration predictions for the K Basin low velocity ranges. It should provide an adequate margin for establishing safe operating limits when handling hardware above the basin floor. Following up on the above example, note that for a 5,000 lb missile, the drop height limit curve yields a height limit of 5.0 ft.

It is recommended that the drop height limit curve (dotted curve) shown in Figure 2 be used to establish administrative controls for hardware movement within the K Basins. That is, for a specific hardware weight, elevations above the drop height limit should be avoided. If for a specific hardware application this limit curve is found to be too restrictive, some relaxation may be possible by conservatively factoring in hydraulic resistance, by justifying a larger impact area, and/or by justifying a lesser safety factor. Impact areas in excess of the two square inches considered in Figure 2 are addressed in the attached calculations.

B. V. Winkel

B. V. Winkel, Fellow Engineer
Facility Stress Analysis

rw

Attachment

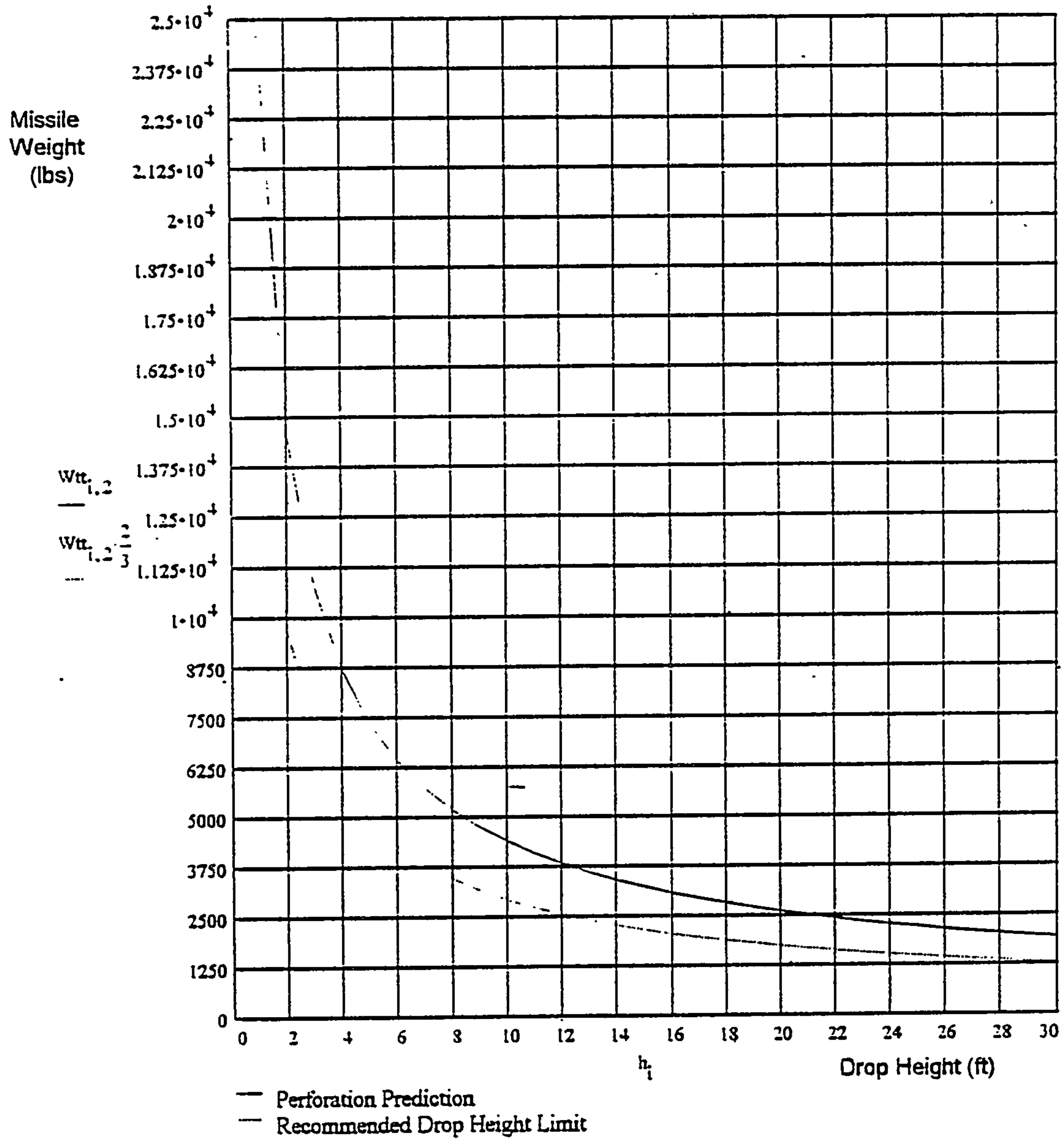


Figure 2 Missile perforation predictions and recommended drop height limits.

ATTACHMENT

MATHCAD CALCULATIONS

(1) Drawing H-1-21054 & H-1-21071 (2) Doc. No. ________ (3) Page ___of___
(4) Building 105-KE, 105-KW (5) Rev. ________ (6) Job No. ________
(7) Subject Drop Accident Limits Originator B. V. Winkel Date 11/9/94
(9) Checker [illegible] Date 11/10/94

References: (1) ASCE 1980, *Structural Analysis and Design of Nuclear Plant Facilities*, American Society of Civil Engineers, New York, New York. (2) ASCE 1980a, *Civil Engineering and Nuclear Power*, Vol. V: Report of the ASCE Committee on Impactive and Impulsive Loads, American Society of Civil Engineers, New York, New York.

Two "perforation" prediction equations were used, the NDRC equa. from Ref. 1 and the CEA-EDF formula from Ref. 2. Ref. 2 states that the CEA-EDF equa. is more accurate. Calcs. below check for conservatism comparison of the two, for the K Basin application.

Input Parameters:

$g = 32.2$ Accel. of gravity, ft/sec/sec

$fc = 3000$ Concrete Strength, psi (conservative 28-day minimum)

$v(h) = \sqrt{2 \cdot g \cdot h}$ Conservative Impact Velocity, fps (Ignores hydraulic effects)

$N = 1.14$ Conservatively assume "sharp nose" missile

$K = \dfrac{180}{\sqrt{fc}}$ Definition of K per Ref. 1

NDRC equation approach, Ref. 1:

$$xa(W,A,h) = \sqrt{4 \cdot K \cdot N \cdot W \cdot \sqrt{\frac{4 \cdot A}{\pi}} \cdot \left(\frac{\sqrt{2 \cdot g \cdot h}}{1000 \cdot \sqrt{\frac{4 \cdot A}{\pi}}}\right)^{1.8}}$$

Eq. 6.33a, Ref. 1, for x/d<2.0, using definition of d (d = sqrt(4A/pi)) as given on p. 335 of reference, where A is the "contact surface area" of the projectile.

$$xb(W,A,h) = K \cdot N \cdot W \cdot \left[\frac{\sqrt{2 \cdot g \cdot h}}{1000 \cdot \left(\sqrt{\frac{4 \cdot A}{\pi}}\right)}\right]^{1.8} - \sqrt{\frac{4 \cdot A}{\pi}}$$

Eq. 6.33b, for x/d>2.0

$$d(A) = \sqrt{\frac{4 \cdot A}{\pi}}$$

Effective projectile diameter, as recommended by Ref. 1

Select penetration, x, depending on x/d condition, as indicated above:

$$x(W,A,h) := \mathrm{if}\left(\frac{xa(W,A,h)}{d(A)} > 2.0, xb(W,A,h), xa(W,A,h)\right)$$

(1) Drawing H-1-21054 & H-1-21071 (2) Doc. No. ______ (3) Page ___ of ___
(4) Building 105-KE, 105-KW (5) Rev. ______ (6) Job No. ______
(7) Subject Drop Accident Limits Originator B. V. Winkel Date 11/8/94
(9) Checker [illegible] Date 11/10/94

Substituting the penetration, x, into Equa. 6.36, Ref. 1, and solving for the perforation, e:

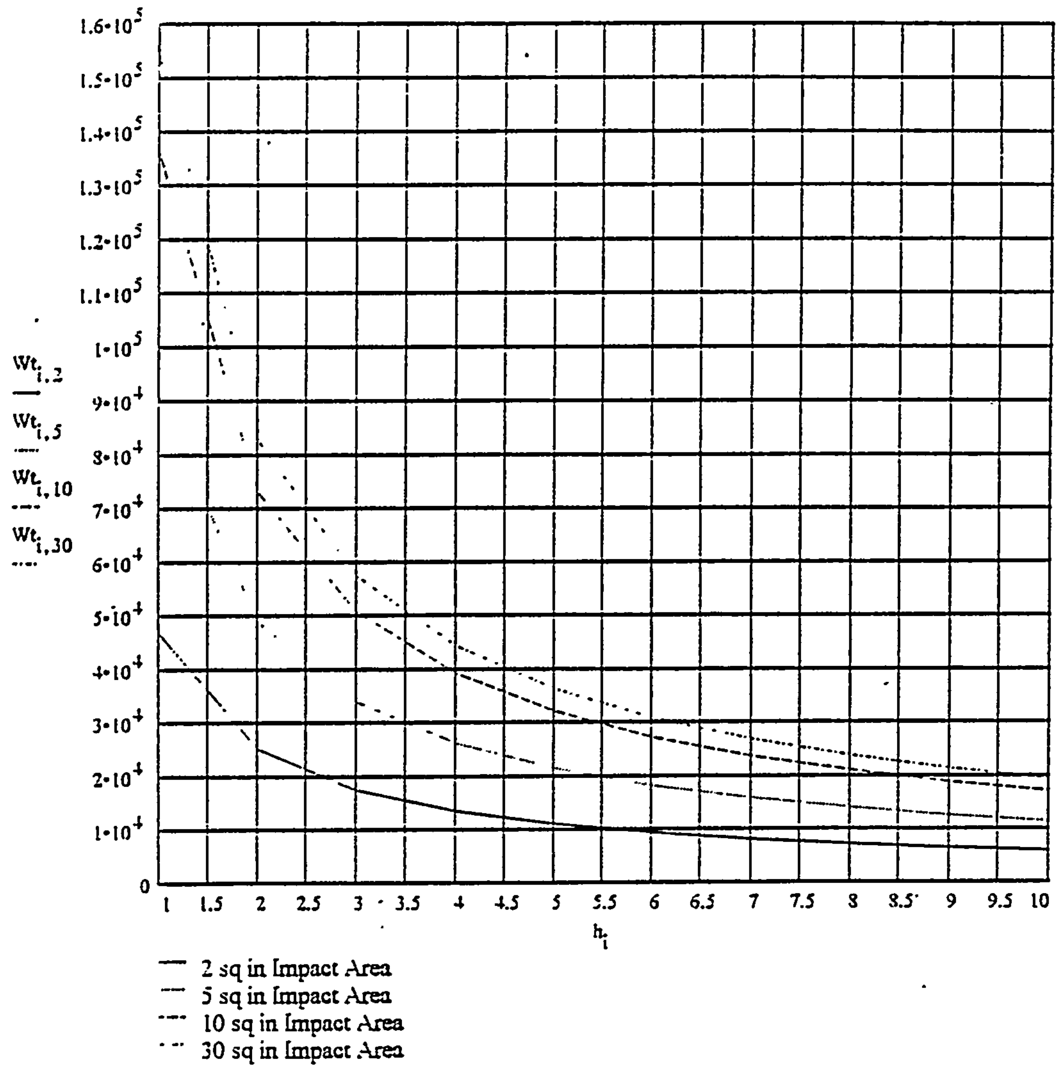
$$e(W,A,h) = 1.32\cdot\sqrt{\frac{4\cdot A}{\pi}} + 1.24\cdot x(W,A,h)$$

$W = 10000$ Initial seed to iterative solution to explicitly solve for W as a function of drop height, h, and Area, A.

$i = 1..10$ $j = 1..30$ Drop heights: 1' - 10', Areas: 1 - 30 sq. in.

$h_i = i$ $A_j = j$

$Wt_{i,j} = \mathrm{root}(e(W,A_j,h_i) - 20., W)$ Solving for zero roots of e - 20. A penetration of 20 in was used to provide a 20% thickness margin (1.2x20= 24 in) as recommended by Ref. 1.

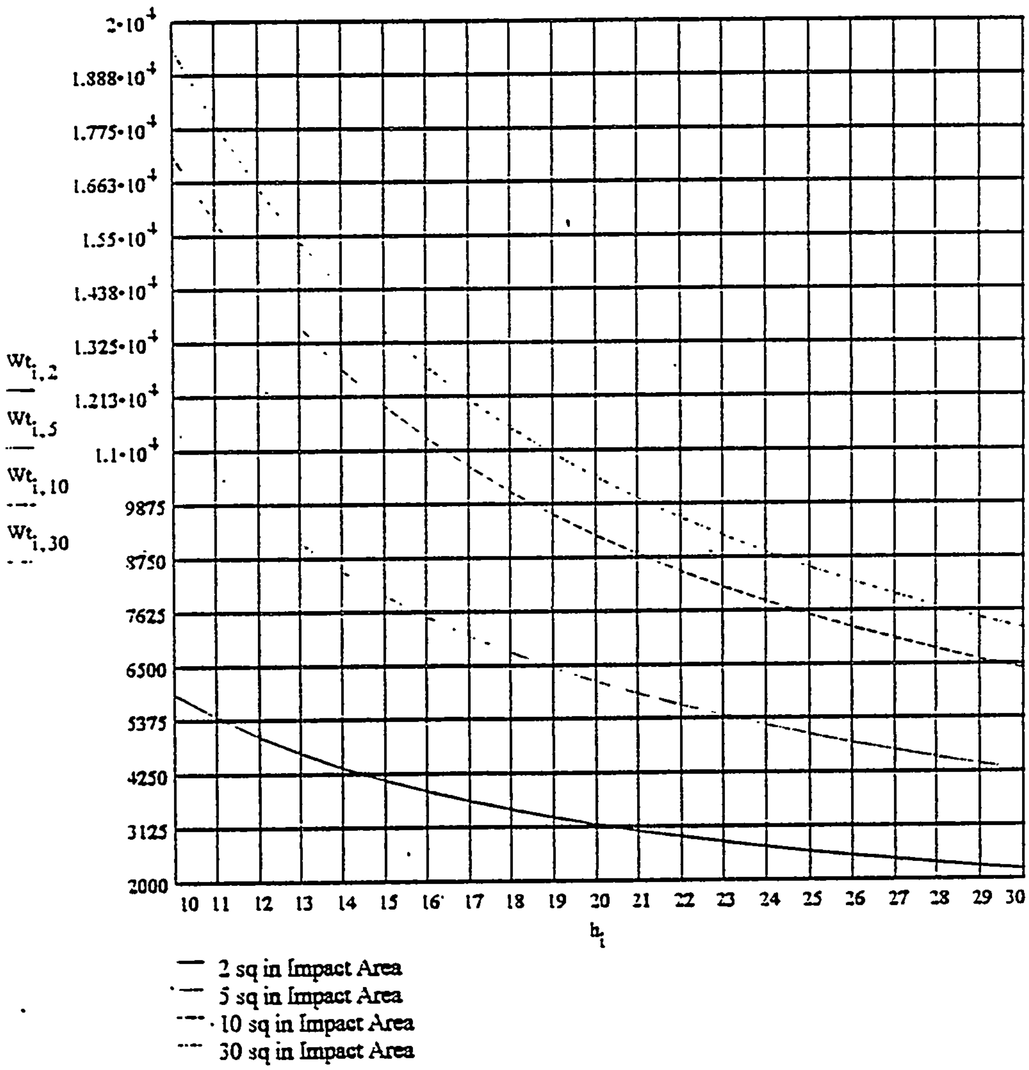


(1) Drawing H-1-21054 & H-1-21071 (2) Doc. No. ______ (3) Page ___of___
(4) Building 105-KE, 105-KW (5) Rev. ______ (6) Job No. ______
(7) Subject Drop Accident Limits Originator B. V. Winkel Date 11/9/94
(9) Checker [handwritten signature] Date 11/10/92

$i := 10..30$ $\quad j := 1..30$ $\quad$ Drop Height: 10' - 30', Area: 1 - 30 sq. in.

$h_i := i$ $\quad A_j := j$

$Wt_{i,j} := \mathrm{root}(e(W, A_j, h_i) - 20., W)$



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(9) Checker [signature] Date 11/10/94

CEA-EDF Formula (Reference 2)

$i = 1..30$

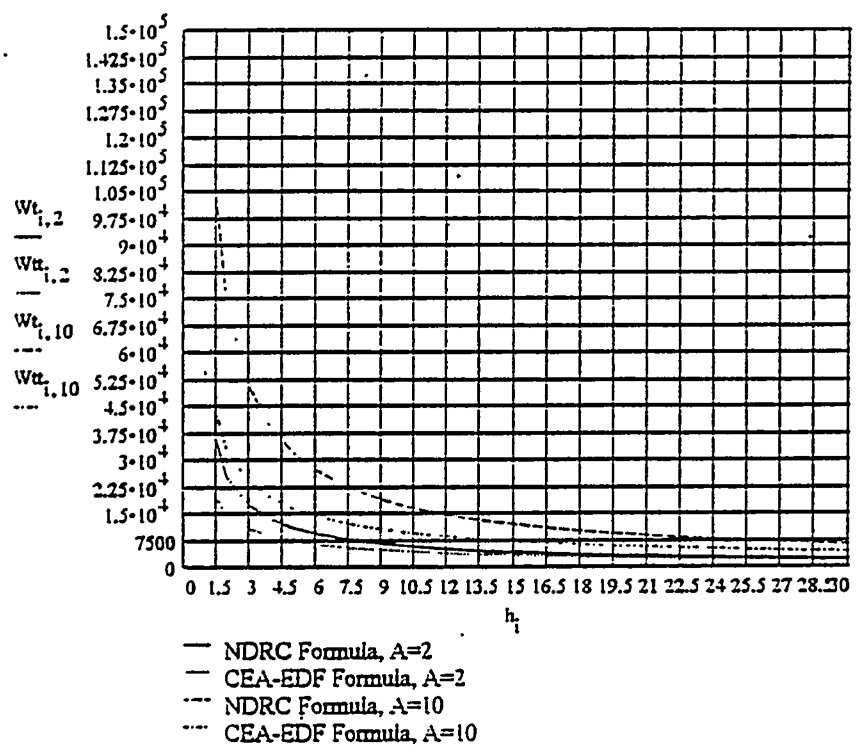
$$tp(W,A,h) = 0.765 \cdot fc^{-.375} \cdot \left(\frac{W}{\sqrt{4 \cdot \frac{A}{\pi}}}\right)^{.5} \cdot \left(\sqrt{2 \cdot g \cdot h}\right)^{0.75}$$

$W = 10000$

$h_i = i$

$Wtt_{i,j} = root(tp(W,A_j,h_i) - 22.5, W)$

22.5" thickness allows for 10% spread of data per Ref. 2



Note that the CEA-EDF Formula gives more conservative results for the range of parameters considered above.

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(9) Checker [illegible] Date 11/10/94

Matrix of permissible weights as a function of height, i, and impact area, j:

$$Wtt_{i,j} = Wtt_{i,j} \cdot \frac{2}{3}$$

$i = 1..5$

$Wtt_{i,2}$	$Wtt_{i,5}$	$Wtt_{i,10}$	$Wtt_{i,30}$
$1.641 \cdot 10^{4}$	$2.594 \cdot 10^{4}$	$3.669 \cdot 10^{4}$	$6.355 \cdot 10^{4}$
$9.757 \cdot 10^{3}$	$1.543 \cdot 10^{4}$	$2.182 \cdot 10^{4}$	$3.779 \cdot 10^{4}$
$7.199 \cdot 10^{3}$	$1.138 \cdot 10^{4}$	$1.61 \cdot 10^{4}$	$2.788 \cdot 10^{4}$
$5.802 \cdot 10^{3}$	$9.173 \cdot 10^{3}$	$1.297 \cdot 10^{4}$	$2.247 \cdot 10^{4}$
$4.908 \cdot 10^{3}$	$7.76 \cdot 10^{3}$	$1.097 \cdot 10^{4}$	$1.901 \cdot 10^{4}$

$i = 10, 15 .. 30$

$Wtt_{i,2}$	$Wtt_{i,5}$	$Wtt_{i,10}$	$Wtt_{i,30}$
$2.918 \cdot 10^{3}$	$4.614 \cdot 10^{3}$	$6.525 \cdot 10^{3}$	$1.13 \cdot 10^{4}$
$2.153 \cdot 10^{3}$	$3.404 \cdot 10^{3}$	$4.814 \cdot 10^{3}$	$8.338 \cdot 10^{3}$
$1.735 \cdot 10^{3}$	$2.743 \cdot 10^{3}$	$3.88 \cdot 10^{3}$	$6.72 \cdot 10^{3}$
$1.468 \cdot 10^{3} - 0.004i$	$2.321 \cdot 10^{3}$	$3.282 \cdot 10^{3}$	$5.684 \cdot 10^{3}$
$1.28 \cdot 10^{3} - 0.03i$	$2.024 \cdot 10^{3}$	$2.862 \cdot 10^{3}$	$4.958 \cdot 10^{3}$

Westinghouse Hanford Company

Internal Memo

From: Facility Stress Analysis
Phone: 376-5736 H5-57
Date: October 17, 1994
Subject: ISOLATION DOOR DROP CONCERN

BVW-8D420-94-007

To: J. C. Wiborg B3-55

cc: W. W. Chen H5-57
M. R. Lindquist H5-57 MRL
BVW File/LB

References: 1. Bechtel 1974, *Topical Report, Design of Structures for Impact*, BC-TOP-9A, Bechtel Corporation, San Francisco, California.

2. ASCE 1980, *Structural Analysis and Design of Nuclear Plant Facilities*, ASCE Manual No. 58, American Society of Civil Engineers, New York, New York.

INTRODUCTION

This memo addresses the consequences of a 2-ft drop of an isolation barrier door. The primary concern is that an isolation door could punch through the basin floor resulting in an unacceptable water leak through the opening.

The above references provide empirical equations for predicting missile penetrations through concrete slabs. The data base for the equations results from tests of cylindrical steel missiles with velocities up to 500 ft/sec. No lower bound velocities are stated, but it is likely that the minimum velocities are higher than the 11 ft/sec velocities associated with a 2-ft drop. Therefore, the results should be treated as approximate.

DISCUSSION

To account for the irregular geometry of the isolation door, an attempt was made to bound the problem by assuming a minimum contact area of 4 in^2 (edge/corner drop) and a maximum contact area of 182 in^2 (flat bottom drop). Calculations are attached. The results are summarized below.

A maximum crater depth of 2.4-in. was predicted for the worst-case contact area of 4 in^2, which is well below the 2-ft floor thickness. For the flat bottom drop, a maximum penetration of 1.1-in. was predicted.

In addition to penetrating the top surface, there is a potential for "scabbing" or "spalling" to occur on the underneath surface. Reference 1 estimates that scabbing will not occur for slab thicknesses greater than 22.6-in. However, in Reference 2, scabbing depths as great as 18.3-in. are predicted for a 2,426 lb missile (closure door weight) with a 4.0 in^2 footprint.

It is emphasized that the above worst case predictions are conservative, with the primary conservatism being the minimum size of the contact area of the isolation door missile. For very small penetrations, a small contact area is feasible for an edge/corner drop, but as the penetration magnitude increases, a corresponding increase in contact area would occur for the door missile. Also, the scabbing prediction is based upon tests involving concrete slabs with no soil on the back side. The soil backing should reduce the magnitude of the scabbing.

CONCLUSION

Ignoring these conservatisms, and using the worst case predictions, the worst combined penetration and scabbing is 2.4 + 18.3 = 20.7 in., which is less than the floor slab thickness of 24 in. Thus, it is concluded that a significant floor leak due to a 2-ft high isolation door drop is highly unlikely. It should be emphasized that the above predictions do not address floor cracking. However, if floor cracks should occur, the leakage rate should be small, and the cracks should be repairable.

B. Winkel

B. V. Winkel, Fellow Engineer
Facility Stress Analysis

rw

Attachment

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(7) Subject Isolation Door Drop Originator B. V. Winkel Date 10/15/94
(9) Checker [signature] Date 10/13/94

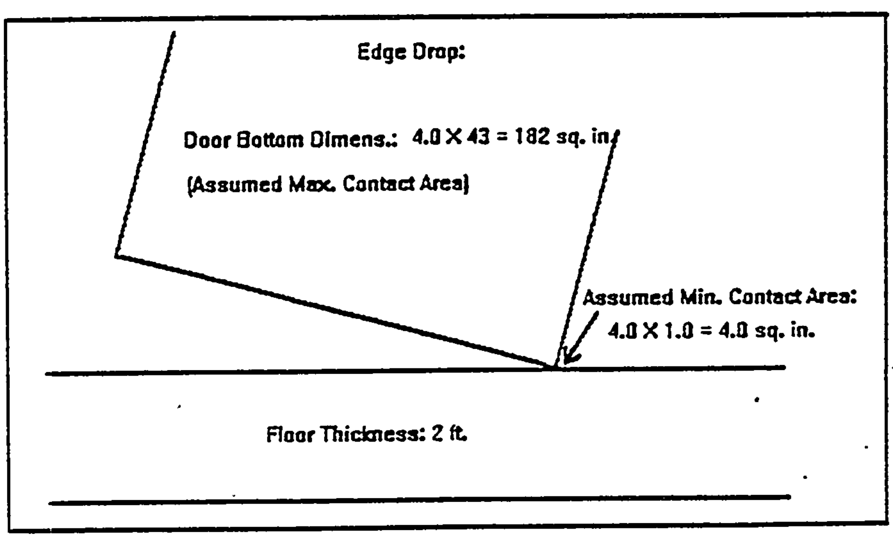
References: (1) Structural Analysis and Design of Nuclear Plant Facilities, Section 6.4.1.2, ASCE Manual No. 58. (2) Topical Report, Design of Structures for Impact, BC-TOP-9A, Bechtel Corp.

Input Parameters

$i = 1..2$	i=1 is upper bound solution, i=2 is lower bound solution
$W = 2426$	Closure door weight, lbs.
$h = 2$	Max. drop height, ft.
$g = 32.2$	Accel. of gravity, ft/sec^2
$A_1 = 4.0$	Assumed min. footprint area, sq. in.
$A_2 = 182$	Assumed max. footprint area, sq. in.
$D_i = \sqrt{\frac{4 \cdot A_i}{\pi}}$	Effective projectile diameter, in inches, for non-cylindrically shaped missiles per Ref. (1)
$fc = 3000$	Concrete design strength, psi
$t = 24$	Concrete floor thickness, in.

$v = \sqrt{2 \cdot g \cdot h}$

$v = 11.349$ Impact velocity, ft/sec



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Penetration Calculations

Note: "Penetration defined as "depth of crater formed at zone of impact" per Ref. (1).

Ref. (2), Section 2.1.1:

$$Kp = 0.0035$$

$$Ap_i = \frac{W}{\left(\frac{A_i}{144}\right)}$$

Missile weight divided by frontal area, psf

$$X_i = 12 \cdot Kp \cdot Ap_i \cdot \log\left(1 + \frac{v^2}{215000}\right)$$

Eq. (2-1), Ref. (2)

$$X1_i = \left[1 - e^{-4\left(\frac{t}{X_i} - 2\right)}\right] \cdot X_i$$

Eq. (2-2), Ref. (2)

$$X1 = \begin{pmatrix} 0.954 \\ 0.021 \end{pmatrix}$$

Upper and lower bound penetration predictions, in. per Ref. (2)

Ref. (1) penetration predictions:

$$N = 1.14$$

Conservatively assume "sharp nose" missile

$$K = \frac{180}{\sqrt{fc}}$$

$$x_i = \sqrt{4 \cdot K \cdot N \cdot W \cdot D_i \cdot \left(\frac{v}{1000 \cdot D_i}\right)^{1.8}}$$

Eq. 6.33a, Ref. 1, for x/D<2.0

$$x = \begin{pmatrix} 2.445 \\ 1.14 \end{pmatrix}$$

Ref. (1) penetration predictions, in.

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Perforation:

"Perforation" defined as "the thickness of a concrete element that will just be perforated by a missile" of weight, W, and diameter, D, per Ref. (2).

$$T_i = \frac{427}{\sqrt{fc}} \cdot \frac{W}{(D_i)^{1.8}} \cdot \left(\frac{v}{1000}\right)^{1.33}$$

Eq. (2-3), Ref. 2

$$T = \begin{pmatrix} 11.313 \\ 0.364 \end{pmatrix}$$

Upper and lower bound perforation thickness predictions

Scabbing:

"Scabbing" definition: "the peeling off (ejection) of material from the back face of the target". Ref. (2) states that scabbing is not initiated as long as the slab thickness is greater than twice the perforation thickness, T. Since twice the max. perforation (2 x 11.3 = 22.6 in.) is less than the floor thickness of 24 in., scabbing should not occur. However, Ref. (1) does not specify a threshold thickness for scabbing initiation. Therefore, the following scabbing predictions were made.

$$s1_i = \frac{15.5}{\sqrt{fc}} \cdot \left[\frac{W^{.4} \cdot v^{.5}}{(D_i)^{.2}}\right]$$

Eq. 6.40, Ref. 1, for solid steel missile

$$s2_i = \frac{5.42}{\sqrt{fc}} \cdot \left[\frac{W^{.4} \cdot v^{.65}}{(D_i)^{.2}}\right]$$

Eq. 6.41, Ref. 1, for steel pipe missile

$$s1 = \begin{pmatrix} 18.302 \\ 12.494 \end{pmatrix}$$

Solid steel missile scabbing predictions, in.

$$s2 = \begin{pmatrix} 9.213 \\ 6.29 \end{pmatrix}$$

Steel pipe missile scabbing predictions, in.