DISTRIBUTION SHEET

To C. E. Hanson	From J. P. Strehlow TWRS/ESS	Page 1 of 1
Project Title/Work Order Multiport Riser Installation on Tank 241SY101/N2BJ9		Date 09/12/94
		EDT No. 604606
		ECN No. N/A

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
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ENGINEERING DATA TRANSMITTAL

Page 1 of 1

1. EDT 604606

To: (Receiving Organization) Special Projects C. E. Hanson		3. From: (Originating Organization) TWRS/ESS J. P. Strehlow		4. Related EDT No.: 604607	
5. Proj./Prog./Dept./Div.: Waste Management		6. Cog. Engr.: J. P. Strehlow		7. Purchase Order No.: N/A	
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(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	Approval Designator	Reason for Trans- mittal	Orig- inator Dispo- sition	Receiv- er Dispo- sition
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16. KEY											
Approval Designator (F)		Reason for Transmittal (G)				Disposition (H) & (I)					
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1	1	Cog. Eng. JP Strehlow	<i>JP Strehlow</i>	9/15/94	H5-68						
1	1	Cog. Mgr. RK Brown	<i>RK Brown</i>	9/15/94	H5-68						
1	1	QA ML McElroy	<i>M. L. McElroy</i>	9/15/94	H5-57						
1	1	Safety (SL) Krogsrud	<i>L.S. Krogsrud</i>	9/15/94	R3-08						
		Env.									
1	1	DR Precechtel	<i>DR Precechtel</i>	9/15/94	N1-21						

18. <i>JP Strehlow per Telecom</i> J. P. Strehlow 9/15/94 Signature of EDT Originator		19. <i>C. E. Hanson</i> C. E. Hanson 9/15/94 Authorized Representative Date for Receiving Organization		20. <i>9-15-94</i> F. K. Brown 9-15-94 Significant Manager Date		21. DOE APPROVAL (if required) Ctrl. No. ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments	
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RELEASE AUTHORIZATION

Document Number: WHC-SD-WM-DA-161, Rev. 0

Document Title: Structural Analysis of Multiport Riser 5A
Installation on Tank 241SY101.

Release Date: 9/15/94

* * * * *

This document was reviewed following the
procedures described in WHC-CM-3-4 and is:

APPROVED FOR PUBLIC RELEASE

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SUPPORTING DOCUMENT

1. Total Pages

379

2. Title Structural Analysis of Multiport Riser 5A Installation on Tank 241SY101	3. Number WHC-SD-WM-DA-161	4. Rev No. 0
5. Key Words Multiport Tanks Riser 5A Structural Analysis 241SY101 APPROVED FOR PUBLIC RELEASE <i>U. Burkland 9/15/94</i>	6. Author Name: ADVENT Engineering Services, Inc./J. P. Strehlow <i>J. P. Strehlow for 9/15/94</i> Signature Organization/Charge Code 8D220/N2BJ9	
7. Abstract This supporting document provides the structural analysis of record of the multiport riser that will be installed on tank 241SY101.		
8. PURPOSE AND USE OF DOCUMENT - This document was prepared for use within the U.S. Department of Energy and its contractors. It is to be used only to perform, direct, or integrate work under U.S. Department of Energy contracts. This document is not approved for public release until reviewed. PATENT STATUS - This document copy, since it is transmitted in advance of patent clearance, is made available in confidence solely for use in performance of work under contracts with the U.S. Department of Energy. This document is not to be published nor its contents otherwise disseminated or used for purposes other than specified above before patent approval for such release or use has been secured, upon request, from the Patent Counsel, U.S. Department of Energy Field Office, Richland, WA. DISCLAIMER - This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, nor any of their contractors, subcontractors or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or any third party's use or the results of such use of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.	10. RELEASE STAMP <div style="border: 1px solid black; padding: 5px; text-align: center;">OFFICIAL RELEASE BY WHC DATE SEP 16 1994 35 Station 21</div>	
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STRUCTURAL ANALYSIS OF MULTIPOINT RISER 5A
ON TANK 241SY101

ADVENT CALCULATION 94003.1.1

Attachment 1 - Structural design specification for multipoint riser on tank
241SY101.

INDEPENDENT REVIEW

Document Reviewed ADVENT Calculation 94003.1.1

Author ADVENT/Strehlow Report No. WHC-SD-WM-DA-161 EDT No. 604606
and Associates, Engineers Rev. 0

The subject document has been reviewed by the undersigned. The reviewer reviewed and verified the following items as applicable [EP.4.1].

- Engineering Specification
- Design Input
- Basic Assumption
- Approach/Design Methodology
- Related Information
- Conclusion/Result Interpretation

URS/John A. Blume & Associates, Engineers
Reviewer

9/94
Date

See Appendix H

TRADEMARKS

The following trademark is used in this report.

ANSYS is a trademark of Swanson Analysis Systems, Inc.,
Houston, Pennsylvania

DESIGN VERIFICATION METHOD

The need for design verification has been reviewed with the method selected as indicated below:

See Appendix H

Independent Review

Alternative Calculations

Qualification Testing

Formal Design Review

Cognizant Project/Design Manager

SD # WHC-SD-WM-DA-161

ECN # 604606

DWG(S) # N/A

CALCULATION COVER SHEET

WHC-SO-WM-DA-161
REV. 0

PROJECT SY-101 H ₂ Mitigation	JOB NO. 94003	FILE NO. 94003.1.1			
CLIENT Westinghouse Hanford Company	CLIENT CALC. NO. N/A	NO. OF SHEETS 196* + Appendices A, B, C, D, E, F, G, H, I, and J			
SUBJECT Structural Analysis of Multiport Riser 5A					
PURPOSE See Sheet Nos. 1-1 through 1-4 and I-4					
SOURCES OF DATA & REFERENCES See Sheet Nos. 2-1 through 2-5, I-2 and I-3					
PURPOSE FOR REVISION Reconciliation. Added Sheet No. iv, 7-80a, 7-80b and Appendices I and J. Revised Sheet Nos: i, ii, 3-1, 4-1, 4-2, 4-3, 5-2, 5-3, 5-5, 5-20, 5-21, 6-1, 7-2 through 7-6, 7-12, 7-13, 7-17, 7-30, 7-32, 7-34, 7-36, 7-38, 7-40, 7-42b, 7-43, 7-44, 7-45, 7-47, 7-51, 7-52, 7-56, 7-63, 7-65, 7-67, 7-69, 7-71, 7-73, 7-88, 8-2, 8-4, 8-6, 8-9 and 8-11.					
Originators	Reviewers	Design Verified by	Date	Approved By	Date
P. Jagadish	R. Mistry	R. SALIGA	9/14/94	R. SALIGA	9/14/94
R. Mistry	P. Jagadish				
	N. Moisidis	Revision No. 1	Project Distribution Project File Westinghouse Hanford Company		
	W. Huang				
		Supersedes Calc. No.			
		94003.1.1 Rev. 0			

* Including calculation cover sheet, Table of contents (i, ii, iii & iv) and Sheet nos. 7-42a, 7-42b, 7-80a and 7-80b.

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	9-14-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	9/14/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	i	Rev. No.	1

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Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	9-14-94
Subject	Structural Analysis of Multiport Riser SA	Reviewed By:	<i>[Signature]</i>	Date	9/14/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
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Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	6-6-94
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Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	1-3-94
Subject	Structural Analysis of Multiport Riser SA	Reviewed By:	<i>[Signature]</i>	Date	9/3/94
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Client Calc. No.		Sheet No.	iv	Rev. No.	1

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APPENDIX J Reconciliation Design Input: Copy of CC Mail and ECNs
(18 Sheets)

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-16-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Ravi Ming</i>	Date	5/16/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	1-1	Rev. No.	0

1.0 INTRODUCTION

The Tank 101-SY multiport riser assembly in the 241-SY-101 waste tank will replace the existing 42 inch riser with four smaller ports. Each smaller port can be used independently to access the tank interior with equipment and instruments needed to mitigate the concentration of hydrogen in the tank. This document provides a design report on the structural evaluation of the multiport riser assembly as well as its anchorage.

The multiport riser assembly is a steel structure installed directly above the 42 inch riser and sealed at the existing riser flange. The assembly is structurally supported by the concrete pad placed around the 42 inch riser. The multiport riser assembly will provide two 8-inch penetrations, one 12-inch penetration and one 24-inch penetration. Each penetration will have a shielding plate. These penetrations will be used to insert equipment such as a sonic probe into the tank.

A schematic drawing of the SY-101 tank with the multiport riser assembly in place is shown in Figure 1.1.

SDC-4.1 (Reference 2.1.2) provides four safety classifications (Safety Class 1 through 4) of structures, systems and components. These safety classes can be correlated respectively to the High Hazard, Moderate Hazard, Low Hazard/Important and General Use usage categories defined in the 1990 version of UCRL-15910 (Reference 2.1.4) for non-reactor facilities. In the 1992 draft version of UCRL-15910, these descriptive classifications have been modified, in reverse order, to Performance Categories 1 through 4. Safety Class 1 structures, systems and components are those that perform a function required for nuclear criticality safety or whose failure might result in a significant release of radioactive, hazardous, or toxic materials as defined by DOE Order 6430.1A, Division 13 (Reference 2.1.3), as it relates to non-reactor nuclear facilities.

In addition to normal loads, non-reactor Safety Class 1 structures, systems and components are to withstand the effects of extreme environmental loads including Design Basis Earthquake (DBE), Design Basis Wind (DBW), Design Basis Flood, Volcanic Eruptions and other abnormal loads considered on a case by case basis. Non-reactor Safety Class 2, 3 and 4 structures, systems and components are those that are not Safety Class 1 and are respectively specified as onsite safety related, occupational safety related and non-safety related items. The 241-SY-101 tank is

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Handwritten Signature</i>	Date	5-16-96
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Handwritten Signature</i>	Date	11/1/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
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considered as a non-reactor Safety Class 1 structure. The multiport riser assembly is considered as a non-reactor Safety Class 2 structure since it serves to contain the radioactive and toxic materials under normal operating conditions. However, the pressure relief doors provided on the assembly are considered as Safety Class 1 structures.

Section 0111-99.0.4 of Reference 2.1.3 states "the adequacy of systems, components, and structures to withstand a seismic event shall be verified by a dynamic analysis, except where it can be demonstrated that the use of a simplified approach, such as a static load method, component testing, or a combination of testing and analysis provides assurance of adequate seismic design. The ratio of vertical-to-horizontal acceleration shall be two-thirds, unless site-specific data justify the use of a different ratio". Therefore, the multiport riser assembly is evaluated using dynamic analysis for DBE loads. A response spectrum method of structural analysis is performed for this purpose.

Section 0111-99.0.8 of Reference 2.1.3 also states "Concrete structures and structural members for safety class concrete structures shall meet the design and construction requirements of ACI 349 for new construction or original (or equivalent) codes for existing construction providing the margin of safety of the overall facility is maintained. Safety class steel structures shall meet the design, fabrication, and erection requirements of ANSI/AISC N690 for new construction or original (or equivalent) codes for existing construction providing the margin of safety of the overall facility is maintained". For the concrete footing, the structural evaluation shall be based on ACI 349-90 (Reference 2.1.5) requirements. For the multiport riser assembly, the structural evaluation shall be based on ANSI/AISC N690-84 (Reference 2.1.6) requirements.

Section 0111-2.4.1 of Reference 2.1.3 states "The structural frame and exterior components of all buildings, signs, tanks, towers, and other exposed structures shall be designed to resist pressures due to wind assumed to act from any direction. Partial wind loading shall be considered if it produces a more severe effect". The wind load on the multiport riser is considered as negligible and therefore is not included as one of the design-basis loads in the design and analysis of the multiport riser assembly. In addition, the design-basis ashfall and snow loads are also considered as negligible and therefore are not included in the design and analysis of the multiport riser assembly.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Alvin Williams</i>	Date	5-16-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Ravi Nair</i>	Date	5/16/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
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Additional design requirements that are factored into the structural evaluation of the multiport riser assembly include:

- No loads transferred to the tank dome penetration riser 5A.
- Pump and tank contents will not be expelled from the tank if there is a hydrogen burn event.

To meet the additional requirements identified above, the multiport riser assembly is evaluated against the beyond-design-basis loads resulting from a postulated hydrogen burn event. Beyond-design-basis loads include a displacement time history of the dome while moving in the upward direction during the burn event and an internal pressure time history at the top of the 42 inch riser. A time-history analysis of the multiport riser assembly is performed to address these beyond-design-basis loads. The stress evaluation of the various structural components in the multiport riser assembly for beyond-design-basis loads is based on the criteria provided for the faulted condition in Reference 2.1.25.

In order to minimize the reanalysis of the multiport riser assembly during the design phase of the new equipment to be installed in the tank through the multiport riser, a margin analysis is performed that will provide a stress equation to calculate a set of reactions allowed on each port from the new equipment. The stress equation is developed for unit loads and unit moments applied at ports in different combinations. The intent of this stress equation is to provide the stresses in the multiport riser due to additional loads from new equipment analysis without coupling the multiport riser and the new equipment into one model. Decoupling the equipment from the multiport riser will save significant amount of time and labor cost in the analysis of the equipment.

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-18-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Ravi Murti</i>	Date	5/18/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
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FIGURE 1.1: Schematic of SY-101 Tank and the Multiport Riser # 5A Assembly.

(See Sheet 1 of 3, Dwg. H-2-821100, Rev. A)

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System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	2 - 1	Rev. No.	0

2.0 REFERENCES

2.1 Criteria Documents, Codes, Regulatory Requirements and Technical References

- 2.1.1 McWethy, L. M., et al., "Tank 101-SY Multiport Riser Assembly Functional Design Criteria," Document No. WHC-SD-WM-FDC-027, Rev. 0, Westinghouse Hanford Company.
- 2.1.2 "Standard Architectural-Civil Design Criteria," Document No. SDC-4.1, Hanford Plant Standards, Rev. 11. Department of Energy, Richland, Washington.
- 2.1.3 "General Design Criteria," United States Department of Energy, DOE Order No. 6430.1A.
- 2.1.4 Kennedy, Robert P., et al., "Design and Evaluation Guidelines for Department of Energy Facilities Subjected to Natural Phenomena Hazards," UCRL-15910, June 1990.
- 2.1.5 "Code Requirements for Nuclear Safety Related Concrete Structures (ACI 349-90)," American Concrete Institute.
- 2.1.6 "Nuclear Facilities - Steel Safety Related Structures for Design Fabrication and Erection," ANSI/AISC N690-1984.
- 2.1.7 "Minimum Design Loads for Buildings and Other Structures," ASCE Standard, ASCE 7-88 (Formerly ANSI A58.1), American Society of Civil Engineers, 1990.
- 2.1.8 "Boiler and Pressure Vessel Code," Section VIII, Division 2, Appendix 5, American Society of Mechanical Engineers, 1992.
- 2.1.9 "Preparation of Design Analysis Reports, ASME Design Reports, and ASME Load Capacity Data Sheets," Standard Engineering Practices, Document No. WHC-CM-6-1, EP-1.11, Rev. 3, Westinghouse Hanford Company, Richland, Washington.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By: <i>[Signature]</i>	Date	5-31-94
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- 2.1.10 "Supporting Documents," Standard Engineering Practices, Document No. WHC-CM-6-1, EP-1.12, Rev. 7, Westinghouse Hanford Company, Richland, Washington.
- 2.1.11 "Engineering Document Change Control," Standard Engineering Practices, Document No. WHC-CM-6-1, EP-2.2, Rev. 6, Westinghouse Hanford Company, Richland, Washington.
- 2.1.12 "Design Verification Requirements," Standard Engineering Practices, Document No. WHC-CM-6-1, EP-4.1, Rev. 4, Westinghouse Hanford Company, Richland, Washington.
- 2.1.13 Newmark, N.M., and Hall, W.J., "Development of Criteria for Seismic Review of Selected Nuclear Power Plants," U.S. Nuclear Regulatory Commission Regulatory Report, NUREG/CR-0098, May, 1978.
- 2.1.14 Not Used.
- 2.1.15 "Structural Integrity Evaluation of Double Shell Waste Tank 241-SY-101 Under Postulated Hydrogen Burn," Document No. WHC-SD-WM-TI-465, Addendum C, Rev. 0, 1991.
- 2.1.16 Federal Highway Administration, DOT 49, Code of Federal Regulations 393.100.
- 2.1.17 "Combining Modal Responses and Spatial Components in Seismic Response Analysis," USNRC Regulatory Guide 1.92, February, 1976.
- 2.1.18 "Standard Architectural-Civil Design Criteria - Design and Installation of Expansion Anchors," Document No. SDC-4.2, Hanford Plant Standards, Rev. 0, Department of Energy, Richland, Washington.
- 2.1.19 "Manual of Steel Construction," American Institute of Steel Construction, 9th Edition.
- 2.1.20 Foundation Engineering Handbook, Hsai-Yang Fang, Second edition, Van Nostrand Reinhold, New York.

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Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-3-94
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2.1.21 ADVENT Engineering Services, "Structural Design Specification for the Multiport Riser in Tank 241-SY-101", February 1994, Document No. WHC-SD-WM-RD-043, Rev. 0.

2.1.22 ANSYS Reference Manual, Version 4.4, Swanson Analysis Systems, Inc.

2.1.23 NAVCO Piping Datalog, Edition No. 10 (Rev. June 1, 1974).

2.1.24 DRILLCO Maxi-Bolt Anchoring System, Drillco Devices, Ltd.

2.1.25 ASME Boiler and Pressure Vessel Code, Section III, Appendix F, 1989.

Calculation Sheet

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2.2 Design Input Documents

- 2.2.1 Westinghouse Hanford Company Drawing Number H-2-821100, Rev. B, Sheet 1 of 3, Multi-Port Riser Installation Tank 241-SY-101.
- 2.2.2 Westinghouse Hanford Company Drawing Number H-2-821100, Rev. B, Sheet 2 of 3, Multi-Port Riser Installation Tank 241-SY-101.
- 2.2.3 Westinghouse Hanford Company Drawing Number H-2-821100, Rev. A, Sheet 3 of 3, Multi-Port Riser Installation Tank 241-SY-101.
- 2.2.4 Westinghouse Hanford Company Drawing Number H-2-821101, Rev. B, Sheet 1 of 7, 42" Multi-Port Adapter Riser Assembly.
- 2.2.5 Westinghouse Hanford Company Drawing Number H-2-821101, Rev. A, Sheet 2 of 7, 42" Multi-Port Adapter Riser Assembly.
- 2.2.6 Westinghouse Hanford Company Drawing Number H-2-821101, Rev. B, Sheet 3 of 7, 42" Multi-Port Adapter Riser Assembly.
- 2.2.7 Westinghouse Hanford Company Drawing Number H-2-821101, Rev. B, Sheet 4 of 7, 42" Multi-Port Adapter Riser Assembly.
- 2.2.8 Westinghouse Hanford Company Drawing Number H-2-821101, Rev. B, Sheet 5 of 7, 42" Multi-Port Adapter Riser Assembly.
- 2.2.9 Westinghouse Hanford Company Drawing Number H-2-821101, Rev. B, Sheet 6 of 7, 42" Multi-Port Adapter Riser Assembly.
- 2.2.10 Westinghouse Hanford Company Drawing Number H-2-821101, Rev. A, Sheet 7 of 7, 42" Multi-Port Adapter Riser Assembly.
- 2.2.11 Westinghouse Hanford Company Drawing Number H-2-821095, Rev. B, Sheet of 1, Multi-Port Riser Supports and Base Plates.
- 2.2.12 Facsimile from Edward Rodriguez (Los Alamos National Laboratory) to Ravi Baliga (ADVENT), 2-9-94, ADVENT Project No. 94003, File No. 5.0, Log No. 2, "Displacements and Acceleration P-T History for SY-101 Dome".

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2.2.13 Facsimile from Edward Rodriguez (Los Alamos National Laboratory) to Ravi Baliga (ADVENT), 2-15-94, ADVENT Project No. 94003, File No. 5.0, Log No. 3, "Pressure P-T History".

2.2.14 Communication Report dated 4-20-94, "WHC - MPR 5A Analysis", Telecon between Cameron Thomas (Westinghouse Hanford Company) and Ravi Mistry (ADVENT), ADVENT Project File 94003, File No. 2.7, Log. No. T2.

2.2.15 Communication Report dated 4-25-94, "WHC - MPR 5A Analysis", Telecon between John Strehlow (Westinghouse Hanford Company) and Ravi Baliga (ADVENT), ADVENT Project File 94003, File No. 2.7, Log. No. T3

2.2.16 Communication Report dated 3-11-94, "WHC - MPR 5A Analysis", Telecon between Don Precechtel (Westinghouse Hanford Company) and Ravi Baliga (ADVENT), ADVENT Project File 94003, File No. 2.7, Log. No. T1.

2.2.17 Not Used.

2.2.18 John A. Blume & Associates, Engineers, "Analysis of Underground Waste Storage Tanks 241-SY at Hanford, Washington", prepared for Atlantic Richfield Company, Richland, Washington, ARH-R-172, October 1974.

2.2.19 Westinghouse Hanford Company Drawing Number H-2-140051, Rev.1, Sheet 1 of 1, Tank 101-SY HMT Test Chamber Concrete Support Structure.

2.2.20 Ebasco Services Inc., Design Calculations For Test Chamber, Strong Back, and Support Structure, Calculation No. WHC/92-25 CALC-CE-005, 9/30/92, ADVENT Project No. 94003, File No. 5, Log No.4.

2.2.21 Suyama, R. M., 1994, Standard Design Criteria Deviation Request (external letter 9455268 to R. M. Hiegel, DOE-RL, dated August 4), Westinghouse Hanford Company, Richland, Washington. ADVENT Project No. 94003, File No. 5.0, Log No. 11.

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3.0 NOTES AND ASSUMPTIONS

1. Prying force in the anchor bolts for the Beyond Design Basis loading conditions is conservatively taken as 50% of the loads calculated in the analysis, and is added to the calculated loads to derive the total demand force in the anchor bolts.
2. The MPR footing pad is of normal weight concrete with weight density of 150 pcf (Ref. 2.2.19).
3. Wherever the base metal capacities are smaller than the weld capacities, base metal capacities are used for welded connection qualification, though it is not a requirement to be considered per Reference 2.1.19.

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System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
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4.0 SUMMARY OF RESULTS, CONCLUSIONS, AND REQUIREMENTS

4.1 Summary of Results

The MPR 5A assembly was modelled and analyzed for Design Basis loads consisting of dead loads and design basis earthquake, and Beyond Design Basis loads resulting from the hydrogen burn event. Stresses in the structural elements of the MPR assembly and the connections (bolts, anchor bolts, and welds) were calculated. These results are summarized in Section 7. Additional results are summarized below.

- The maximum relative displacement in the vertical direction between the base of the MPR assembly and the existing 42" riser was calculated to be as follows:
 - 0.009 in. for the Normal Loads.
 - 0.010 in. for the Extreme Loads.
 - 0.210 in. for the Beyond Design Basis Loads.
- The translational reaction forces at each of the four ports of the MPR assembly were calculated to be as follows :

LOAD	NORMAL						EXTREME					
Port ID	F _X	F _Y	F _Z	M _X	M _Y	M _Z	F _X	F _Y	F _Z	M _X	M _Y	M _Z
20"	0	0	1273	12	0	0	336	386	1664	3325	526	2060
12"	0	0	6959	43	0	0	2375	2254	8241	3198	733	2182
3" (N)	0	0	1008	8	39	0	302	321	1324	1061	526	700
3" (S)	0	0	1008	8	39	0	293	324	1318	1141	97	301

Units: Lbs. and inch.

Calculation Sheet

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- Translational and rotational stiffness in the three orthogonal directions were calculated to be as follows:

Port ID	Translational Stiffness (lbs/in.)			Rotational Stiffness (Lb-in./radian)		
	K _x	K _y	K _z	K _{xx}	K _{yy}	K _{zz}
20"	2.916E+08	4.634E+10	2.960E+10	2.005E+12	2.357E+12	1.285E+09
12"	1.819E+08	1.858E+10	3.140E+10	6.664E+11	7.869E+10	2.698E+09
8" North	5.336E+08	1.895E+08	7.922E+09	7.106E+10	6.165E+10	2.714E+09
8" South	5.438E+08	1.867E+08	1.559E+10	7.703E+10	5.633E+10	2.714E+09

- A margin analysis was performed to determine stress margins in members and connections after allowing for dead loads, earthquake loads, and beyond design basis loads. Results of the margin analysis are summarized in Section 8. Procedures on the use of margin values to evaluate and accept loads from equipment to be installed in future are also given in Section 8.

4.2 Conclusions

A review of the results of MPR analysis indicates that the MPR assembly configuration, as shown on Westinghouse drawings, References 2.2.1 through 2.2.11, qualifies per acceptance criteria of Reference 2.1.21 and Reference 2.2.21, without any need for modifications, for the following loading conditions:

- Normal Load Case consisting of Dead Loads (MPR and Equipments weighing 1000 lbs each at 20" port and two 8" ports, and 5180 lbs at 12" port)
- Extreme Load Case consisting of Dead Loads (MPR and Equipment) and Design Basis Earthquake Loads which include 0.2 PGA spectra in the two orthogonal horizontal directions and 0.134 (2/3 of 0.2) PGA spectrum in the vertical direction.
- Beyond Design Basis Load Case consisting of displacement and pressure time histories resulting from the hydrogen burn event.

9-2-94
9/3/94
[Signature]

Calculation Sheet

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The existing 15'x15'x3' concrete footing pad, supporting the MPR assembly, also qualifies for the aforesaid design loads, based on our review of the footing original design performed by EBASCO.

4.3 Requirements

1. The gasket separating the 42" riser and the MPR assembly shall be designed to accommodate the minimum relative vertical displacement of $\frac{1}{4}$ inch, between the 42" riser and the base of MPR assembly, to prevent any load transfer and structural interaction between the two components.
2. The anchor bolts should be installed with a minimum concrete edge distance of 20.5 in. and bolt center-to-center spacing of 20 in.
3. Nominal tensile strength of weld metal for all the welded connections of the MPR assembly shall not be less than 70 ksi.
4. The multiport riser design requires that the 42-in dome penetration riser of the 241-SY-101 tank is isolated from the concrete pad and the multiport riser (MPR) assembly. This requirement assures that there is no direct load transfer from the MPR assembly and the concrete pad to the 42-in riser.
5. To perform decoupled analysis of equipment to be suspended from the MPR ports, three translational and three rotational stiffness for each MPR port, summarized in Section 4.1, shall be used to model the boundary conditions at the port support.

Note that it is the responsibility of the engineer analyzing the "TO BE" installed equipment to justify that the MPR assembly can be decoupled from the "TO BE" installed equipment. The decoupling criteria provided in Section 3.1.7 of the ASCE 4-86 document may be followed. If decoupling is not justifiable the MPR assembly should be included in the analysis of the "TO BE" installed equipment.

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Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5/31/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
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5.0 MODEL DEVELOPMENT

Separate finite element models of the "Multiport Riser 5A" are developed for the design basis (DB) and the beyond design basis (BDB) loading conditions. The DB model is used to qualify the MPR for dead load and dead load plus seismic loads. The BDB model is used to qualify the MPR for the hydrogen burn loads consisting of displacement and pressure loads. Because of the nature of the loads, the BDB model accounts for the soil-structure interaction effects.

The MPR assembly is modelled using PREP7 pre-processor module of ANSYS general purpose finite element software (Ref. 2.1.22). Most of the finite element mesh is generated using the Solid modelling option in ANSYS.

Three dimensional shell elements (ANSYS STIF63), with membrane and bending stiffness option (default), are used to model the various plate members (hardware) of MPR and Support sub assembly. Three dimensional generalized mass elements (ANSYS STIF 21) without rotary inertia option (KEYOPT (3) = 2) are used to model soil and foundation mass. Single degree of freedom longitudinal spring (UZ DOF) is used to model the soil spring stiffness in the vertical direction. As mentioned above, the soil springs are used only for the BDB model.

The material type and the corresponding yield and tensile stresses are listed in Table 5.1. The material densities are adjusted where necessary to account for equipment and other mass. Those calculations are shown in Section 5.1.

The various parts of the MPR are modelled using different REAL constants which are listed in Table 5.2 and shown in Figures 5.1 through 5.6. Soil spring constant and concentrated masses (representing soil stiffness and soil/foundation mass) calculations are shown in Section 5.2.

The radial stiffener vertical flange (REAL 4) and the support sub assembly gusset plate flange (REAL 23) are connected using six bolts per support (Ref. 2.2.2). This connection is modelled by defining Linear constraint equations between REAL 4 elements and REAL 23 element nodes using ANSYS CPINTF command. The REAL 23 element nodes represent the actual bolted connection location.

Geometry and KEY POINTS (KP) of the model is shown on sheet nos. 5-15 through 5-23. The ANSYS plots are shown on sheet 5-24 through 5-40.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-31-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Ravi Mung</i>	Date	7/31/94
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Boundary conditions for Design Basis (DB) analysis:

The base plate (REAL 21) of support sub assembly is anchored to the concrete footing using four anchors per base plate. The nodes corresponding to the anchors at base plate (node nos. 1690, 1706, 1710, 1742, 1821, 1837, 1841, 1873, 1952, 1968, 1972 & 2004) are restrained in the two horizontal and the vertical directions (UX, UY and UZ degrees of freedom).

Boundary conditions for Beyond Design Basis (BDB) analysis:

The ANSYS model is extended to account for the mass of concrete footing, and mass and stiffness of soil. The soil stiffness is modelled using uniaxial spring elements (ANSYS STIF14) at twelve locations corresponding to the anchor points. One end of the spring element is connected to base plate and the other end is coupled to a common node point (node # 5001) in the vertical direction (UZ degree of freedom). The mass of the concrete footing and half of the mass of the soil column are equally lumped at twelve (12) nodes of the three base plates (REAL 21) corresponding to twelve (12) anchor locations. The remaining half of the soil mass is applied at the bottom of the spring elements (node # 5001). The nodes corresponding to the anchors at the base plates are restrained in the two horizontal directions (UX and UY degrees of freedom). The lumped mass and soil stiffness calculations are shown in Section 6.2.2 and the values are also listed in Section 5.2.

5.1 Material Properties

Modulus of elasticity of steel, $E = 29E+06$ psi.

Weight Density of steel = 490 pcf. = $0.000734 \text{ lb-sec}^2/\text{in}^4$.

Total weight of the MPR = 6591 lbs. *9-2-94 with 9/2/94* Ref. 2.2.16

Mass density used in the ANSYS analysis = $8.33816E-04 \text{ lb-sec}^2/\text{in}^4$ MAT 1

Total mass of MPR (Element type 1) = 17.7784

(See file MPR5A-DL.OUT, ADVENT file C94003.1.1.A)

Therefore, the weight of MPR = $17.7784 \times 386.4 = 6870 \text{ lbs} > 6591 \text{ lbs.}$, O.K.

* CHANGED TO 8690 LBS. (SEE SHEET NO. I-4) *9-2-94 with 9/2/94*

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-18-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5/18/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	5-3	Rev. No.	1

27.5" ϕ Flange for 20" Riser

Thickness, $t = 1.6875"$
Outer Dia., $d_o = 27.5"$
Inner Dia., $d_i = 18.969"$

Weight of Flange, 20" 150#, RF, WN (19" Bore) = 180 lbs. Ref. 2.1.23
Additional weight at 20" port = 1000 lbs. Ref. 2.2.16
(The additional weight accounts for the weight of the camera to be installed in the 20" Riser).

$$\text{Total volume of flange modelled} = t (d_o^2 - d_i^2) \pi / 4 = 525.408 \text{ in}^3$$

$$\text{Mass density} = (180 + 1000) / (525.408 \times 386.4) = 5.8123\text{E-}03 \text{ lb-sec}^2/\text{in}^4 \dots \text{MAT 2}$$

19" ϕ Flange for 12" Riser Thickness, $t = 1.25"$

Outer Dia., $d_o = 19"$
Inner Dia., $d_i = 12.063"$

Weight of Flange, 12" 150#, RF, WN (11.75" Bore) = 80 lbs. Ref. 2.1.23
Additional weight at 12" port (Sonic probe weight) = 7000 lbs. * Ref. 2.2.16
(The additional weight accounts for the weight of the sonic probe to be installed in the 12" Riser).

$$\text{Total volume of flange modelled} = t (d_o^2 - d_i^2) \pi / 4 = 211.551 \text{ in}^3$$

$$\text{Mass density} = (80 + 7000) / (211.551 \times 386.4) = 86.613\text{E-}03 \text{ lb-sec}^2/\text{in}^4 \dots \text{MAT 3}$$

13.5" ϕ Flange for 8" Riser Thickness, $t = 1.125"$

Outer Dia., $d_o = 13.5"$
Inner Dia., $d_i = 8.125"$

Weight of Flange, 20" 150#, RF, WN (19" Bore) = 39 lbs. Ref. 2.1.23
Additional weight = 1000 lbs. Ref. 2.2.16
(The additional weight accounts for the weight of the instrument to be installed in the 8" Riser).

* REDUCED TO 5180 LBS. (SEE SHEET NO. I-19) *[Handwritten note: 9-2-94 with 9 1/2 / 34]*

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	6-13-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
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$$\text{Total volume of flange modelled} = t (d_o^2 - d_i^2) \pi / 4 = 102.702 \text{ in}^3$$

$$\text{Mass density} = (39 + 1000) / (102.702 \times 386.4) = 26.812\text{E-}03 \text{ lb-sec}^2/\text{in}^4 \dots \text{MAT 4}$$

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	9-13-94
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System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	5-5	Rev. No.	1

TABLE 5.1

ANSYS REAL #	PART # ¹	COMPONENT DESCRIPTION	Yield Stress	Tensile Stress
1	35	Bottom Triangular Plate	30 ksi. (ASTM A240 304 SST)	75 ksi. (ASTM A240 304 SST)
2	34	Bottom Plate of Pressure Relief Vent (PRV)		
3	35	Side Plate of PRV & Diagonal Stiffener Plate between Top Shield Plate and Bottom Triangular Plate		
4	34	Vertical Flange of Radial Vertical Stiffener		
5	37	Top Shield Plate		
6	34	Top Plate of PRV		
7	22	Pressure Relief Door of PRV		
8	34	Radial Vertical Stiffener		
9	34	Horizontal Flange for Radial Vert. Stiffener		
10	41	20" Riser (Pipe, 20" SCH XS 19.00" ID)	30 ksi.	75 ksi.
11	40	12" Riser (Pipe, 12" SCH XS 11.75" ID)	(ASTM A312 304 SST)	(ASTM A312 304 SST)
12	39	3" Riser (Pipe, 3" SCH 30)		
13	50	Flange, 20" 150#, RF, WN (19" Bore)	30 ksi.	75 ksi.
14	49	Flange, 12" 150#, RF, WN (11.75" Bore)	(ASTM A182 304 SST)	(ASTM A182 304 SST)
15	48	Flange, 8" 150#, RF, WN (7.62" Bore)		
20	32	42" Dia. Riser	25 ksi. ³	70 ksi. ³
21	3 ²	Base Plate of Support Sub Assembly	36 ksi.	58 ksi.
22	6 ²	Gusset Plate of Support Sub Assembly	(ASTM A-36 CS)	(ASTM A-36 CS)
23	6 ²	Inside Flange for Gusset Plate		
24	6 ²	Outside Flange for Gusset Plate		

- 1 See DWG. H-2-821101, Sht 1 of 7, Rev. A
2 See DWG. H-2-821095, Sht 1 of 1, Rev. A
3 ASTM A240 304L SST

Note: (Ref. 2.2.15)

S_y = 49.3 ksi. S_u = 86.5 ksi (1/2" PL)
S_y = 39.679 ksi. S_u = 91.751 ksi (3/4" PL)

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5-30-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	5-6	Rev. No.	0

5.2 Member (REAL) Properties

Table 5.2 (Sheet 5-7) lists different REAL properties used in the modelling and analysis of the different components of the Multiport riser. For all members, with exception of the 1/2" and 3/4" thick plates, the yield stress and the ultimate tensile stress are taken as specified by the respective ASTM designations. For the 1/2" and 3/4" thick plates, actual values of the yield and ultimate tensile stresses, provided by Westinghouse (Reference 2.2.15) are used for the qualification of these components.

For the components not mentioned in Table 5.2, their properties are listed below.

REAL 41 (ANSYS STIF14)

Soil stiffness in the vertical direction = 153461 kip/ft. (See Section. 6.2.2)

Twelve uniaxial (UZ) springs are used to model this property.

Spring stiffness = $(153461/12) = 12788.417 \text{ k/ft.} = 1.0657\text{E}+06 \text{ lb/in.}$

REAL 42 (ANSYS STIF21)

Weight of concrete footing = 96921 lbs. (See Section. 6.2.2)

Weight of tributary soil = 142150 lbs.

Footing weight + half of soil weight = $96921 + 142150/2 = 167996 \text{ lbs.}$

This mass is applied at twelve node points (Node nos. 1690, 1706, 1710, 1742, 1821, 1837, 1841, 1873, 1952, 1968, 1972 and 2004) corresponding to top of twelve soil springs.

Concentrated mass per node = $167996/(12 \times 386.4) = 36.231 \text{ lb-sec}^2/\text{in.}$

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-26-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5-27-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	5-7	Rev. No.	0

TABLE 5.2

ANSYS REAL #	PART # ¹	COMPONENT DESCRIPTION	THICKNESS (inches)
1	35	Bottom Triangular Plate	0.75
2	34	Bottom Plate of Pressure Relief Vent (PRV)	0.50
3	35	Side Plate of PRV & Diagonal Stiffener Plate between Top Shield Plate and Bottom Triangular Plate	0.75 / 0.625 ³
4	34	Vertical Flange of Radial Vertical Stiffener	0.50
5	37	Top Shield Plate	3.00
6	34	Top Plate of PRV	0.50
7	22	Pressure Relief Door of PRV	0.12
8	34	Radial Vertical Stiffener	0.50
9	34	Horizontal Flange for Radial Vertical Stiffener (REAL 8)	0.50
10	41	20" Riser (Pipe, 20" SCH XS 19.00" ID)	0.50
11	40	12" Riser (Pipe, 12" SCH XS 11.75" ID)	0.50
12	39	8" Riser (Pipe, 8" SCH 80)	0.50
13	50	Flange, 20" 150#, RF, WN (19" Bore)	1.6875
14	49	Flange, 12" 150#, RF, WN (11.75" Bore)	1.25
15	48	Flange, 8" 150#, RF, WN (7.62" Bore)	1.125
20	32	42" Dia. Riser	0.25
21	3 ²	Base Plate of Support Sub Assembly	1.25
22	6 ²	Gusset Plate of Support Sub Assembly	0.625
23	6 ²	Inside Flange for Gusset Plate	0.625
24	6 ²	Outside Flange for Gusset Plate	0.625

¹ See DWG. H-2-821101, Sheet 1 of 7, Rev. A

² See DWG. H-2-821095, Sht 1 of 1, Rev. A

³ Thickness used in the analyses

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	7/1/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
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Figure 5.1

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5-30-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	5-9	Rev. No.	0

Figure 5.2

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Handwritten signature</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Handwritten signature</i>	Date	5/31/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	5-10	Rev. No.	0

Figure 5.3

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5-30-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	5-11	Rev. No.	0

Figure 5.4

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:		Date	
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	5-12	Rev. No.	0

Figure 5.5

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date:	5-31-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	5-13	Rev. No.	0

Figure 5.6

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5/31/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	5-14	Rev. No.	0

REAL 43 (ANSYS STIF21)

Half of soil column mass = $142150 / (2 \times 386.4) = 183.942 \text{ lb-sec}^2/\text{in}^4$

This mass is applied at node no. 5001. Note that the node 5001 is coupled to the bottom of spring element nodes (total twelve nodes) in UZ direction.

5.3 Geometric Properties and ANSYS Model

The geometric properties, KEY POINTS for ANSYS Solid modelling and ANSYS plots are shown on sheet nos. 5-15 through 5-40.

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-6-94
Subject	Structural Analysis of Multiport Riser 5A and 5B	Reviewed By:	<i>[Signature]</i>	Date	5-9-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	5-15	Rev. No.	0

KEY POINTS FOR ANSYS SOLID MODELLING

● KEY POINTS ($Z = 0.0$)

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-7-94
Subject	Structural Analysis of Multiport Riser 5A and 5B	Reviewed By:	<i>Ravi Mung</i>	Date	5/16/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	5-17	Rev. No.	0

KEY POINTS FOR ANSYS SOLID MODELLING

- KEY POINTS ($Z = 24.625''$)

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-19-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5-10-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	5-18	Rev. No.	0

KEY POINTS @ EL. Z = 24.625"

Project	Westinghouse Hanford Company	Prepared By: <i>W. W. W.</i>	Date: 5-9-94
Subject	Structural Analysis of Multiport Riser SA and SB	Reviewed By: <i>W. W. W.</i>	Date: 5-9-94
System	SY-101 H ₂ Mitigation Project	Job No. 94003	File No. 94003.1.1
Client Calc. No.	Sheet No. 5-19	Rev. No.	0

KEY POINTS FOR ANSYS SOLID MODELLING

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Handwritten signature</i>	Date	4-1-94
Subject	Structural Analysis of Multiport Riser 5A and 5B	Reviewed By:	<i>Handwritten signature</i>	Date	5/16/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	5-20	Rev. No.	8 1

($\Xi = -10.375"$)

KEY POINTS FOR ANSYS SOLID MODELLING

* Y-COORDINATE CHANGED (SEE SHEET NOS. 5-21 & I-4)
ALSO SEE ADVENT FILE NOS. C94003.1.1 W THROUGH Ξ)

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	4-9-94
Subject	Structural Analysis of Multiport Riser 5A and 5B	Reviewed By:	<i>[Signature]</i>	Date	5/16/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	5-21	Rev. No.	<i>[Signature]</i>

KEY POINTS FOR ANSYS SOLID MODELLING

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-16-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Ravi Nigam</i>	Date	5/16/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	5-22	Rev. No.	0

KEY POINTS FOR ANSYS SOLID MODELLING

SUPPORT SUB ASSEMBLY STIFFENERS:

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-16-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Raw Ming</i>	Date	5-16-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	5-23	Rev. No.	0

KEY POINTS FOR ANSYS SOLID MODELLING

SUPPORT SUB ASSEMBLY BASE PLATES

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>all my work</i>	Date	5-31-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Paul</i>	Date	5/31/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	5-24	Rev. No.	0

1

ANSYS 4.4A
MAY 18 1994
14:34:09
PLOT NO. 1
PREP7 ELEMENTS
REAL NUM

XU =1
YU =1
ZU =1
*DIST=73
*XF =10.582
*YF =6.454
*ZF =13.677
UUP =Z
YRT0=1.195
PRECISE HIDDEN

MULTI-PORT RISER # 5A: TIME HISTORY ANALYSIS (CASE 1)

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-31-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5-31-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	5-25	Rev. No.	0

1

MULTI-PORT RISER # 5A: TIME HISTORY ANALYSIS (CASE 1)

ANSYS 4.4A
MAY 18 1994
14:34:37
PLOT NO. 2
PREP7 ELEMENTS
REAL NUM

XU =1
YU =1
ZU =1
*DIST=73
*XF =10.582
*YF =6.454
*ZF =13.677
UUP =Z
YRT0=1.195
PRECISE HIDDEN

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-16-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Ravi Ming</i>	Date	5-16-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	5-26	Rev. No.	0

3" THICK TOP
SHIELD PLATE
(REAL 5)

ANSYS 4.40
MAR 16 1994
11:55:19
PREP7 ELEMENTS
TYPE NUM
ZU = 1
DIST=35.143
VP = -0.4181
ZF = 36.125
PRECISE HIDDEN
REAL 5

ANSYS 4.40
MAR 17 1994
14:26:59
PREP7 ELEMENTS
TYPE NUM
ZU = 1
DIST=40
VP = -1.618
ZF = 30.497123
ZF = 37.197
VXTOL=1.155

SELECTED NODES @ EL. Z = 24.625"

ANSYS 4.40
MAR 17 1994
14:29:40
PREP7 ELEMENTS
TYPE NUM
ZU = 1
DIST=45.954
VP = -0.298273
VP = -1.167
ZF = 34.625
VXTOL=1.155

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-16-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5/16/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	5-27	Rev. No.	0

ANSYS 4.4A
MAR 17 1994
11:56:33
PREP7 ELEMENTS
TYPE NUM
ZU =1
WDIST=38
WXP =0.562513
WYP =-0.771139
WZF =7.188
YRTO=1.195

30TOM TRIANGUAR PLATE

ANSYS 4.4A
MAR 17 1994
15:49:10
PREP7 ELEMENTS
TYPE NUM
XU =-1
YU =1
ZU =1
WDIST=38
WXP =-1.24
WYP =0.777455
WZF =-3.489
UUP =2
YRTO=1.195

REAL 20

42" Ø RISER

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Handwritten Signature</i>	Date	5-16-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Handwritten Signature</i>	Date	5/16/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	5-28	Rev. No.	0

INTERSECTION OF BOTTOM TRIANGULAR R & VENT BOTTOM R

Project	Westinghouse Hanford Company	Prepared By:	<i>Handwritten signature</i>	Date	5-16-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Handwritten signature</i>	Date	5-16-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	5-24	Rev. No.	0

ANEYS 4.48
MAR 17 1994
14:03:21
PREP7 ELEMENTS
TYPE NUM
YU =1
ZU =1
NDIST=27
WXP =33.995
WYP =3.111
WZF =5.077
UUP =2
VNTOL=1.195

ANEYS 4.48
MAR 17 1994
13:59:39
PREP7 ELEMENTS
TYPE NUM
YU =1
ZU =1
NDIST=36.974
WXP =-35.366
WYP =29.765
WZF =-4.423
UUP =2
VNTOL=1.195

ANEYS 4.48
MAR 17 1994
14:04:52
PREP7 ELEMENTS
TYPE NUM
YU =-1
ZU =-1
NDIST=25.381
WXP =19.206
WYP =-12.401
WZF =-4.18
UUP =2
VNTOL=1.195

PRESSURE RELIEF PANEL & TOP R OF VENT

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Handwritten signature</i>	Date	5-16-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Handwritten signature</i>	Date	5-16-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	5-30	Rev. No.	0

RADIAL VERTICAL STIFFENER & FLANGES.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Henry W. W.</i>	Date	5-16-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Ravi N. N.</i>	Date	5/16/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	5-31	Rev. No.	0

ANEYS 4.40
MAR 17 1994
12:13:27
PREP7 ELEMENTS
TYPE MIM
XU =1
YU =1.4
ZU =1.2
NOIST=28
WVF =-18.33
WVF =24.311
WVF =8.342044
UUP =2
YXTO=1.195

ANEYS 4.40
MAR 17 1994
12:08:33
PREP7 ELEMENTS
TYPE MIM
XU =-1
YU =-1
ZU =1
NOIST=28
WVF =-8.663
WVF =-1.376
WVF =-3.881
UUP =2
YXTO=1.195

ANEYS 4.40
MAR 17 1994
14:22:53
PREP7 ELEMENTS
TYPE MIM
XU =-1
YU =1
ZU =1.2
NOIST=31
WVF =10.879
WVF =-14.853
WVF =14.72
UUP =2
YXTO=1.195

SIDE R OF PRESSURE RELIEF VENT & DIAGONAL
VERTICAL STIFFENERS

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Almy</i>	Date	5-6-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Ravi</i>	Date	5/16/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	5-32	Rev. No.	0

```
AMEYS 4.48  
MAM 17 1994  
13:14:28  
PREP7 ELEMENTS  
TYPE MAIN  
  
ZU =1  
WDIST=7.395  
WVF =8.14944  
WVF =32.236  
WVF =7.188  
YNTOL=1.195
```

```

ANSYS 4.4A
MAR 17 1994
15:09:48
PREP7 ELEMENTS
TYPE NUM

TV =1
MOIST=8.276
WVF =-27.577
WVF =-15.174
WZF =7.188
YATO=1.195

```

```

AMEYE 4.48
MAR 17 1994
14:53:39
PREP? ELEMENTS
TYPE NUM

ZU =1
WDIST=9
WZF =29.654
WVF =13.574
WZF =24.623
YRTOM1.195

```

X SEE NEXT SHEET

INTERSECTION OF "TOP SHIELD PL" & RADIAL STIFFENER FLANGE

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-16-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Ravi M. [Signature]</i>	Date	5/16/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	5-33	Rev. No.	0

ANEYS 4.40
MAR 17 1994
15:17:02
PREP7 ELEMENTS
TYPE MIN
ZU = 1
NOIST=27.393
WVF = 20.34944
WVF = 22.226
WZF = 27.188
VXTOL=1.193

ANEYS 4.40
MAR 17 1994
15:12:37
PREP7 ELEMENTS
TYPE MIN
ZU = 1
NOIST=28.876
WVF = 2-27.577
WVF = 2-15.174
WZF = 27.188
VXTOL=1.193

ANEYS 4.40
MAR 17 1994
15:02:04
PREP7 ELEMENTS
TYPE MIN
ZU = 1
NOIST=9
WVF = 29.654
WVF = 2-15.574
WZF = 24.625
VXTOL=1.193

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>W. W. W. W.</i>	Date	5-16-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>R. W. W. W.</i>	Date	5/16/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	5-34	Rev. No.	0

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Wm Wm</i>	Date	5-16-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Ravi Mung</i>	Date	5/16/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	5-35	Rev. No.	0

SUPPORT SUB
ASSEMBLY BASE R

1764	1758	1753	1752	1751	1789	1788
1762	1742	1745	1744	1743	1786	1784
1763	1746	1749	1748	1747	1787	1785
1768	1734	1737	1736	1735	1782	1780
1761	1738	1741	1740	1739	1783	1781
1758	1726	1729	1728	1727	1698	1696
1759	1730	1733	1732	1731	1699	1697
1756	1718	1721	1720	1719	1694	1692
1757	1722	1725	1724	1723	1695	1693
1754	1710	1713	1712	1711	1690	1689
1755	1714	1717	1716	1715	1691	1688

MULTI-PORT RISER # 5A : RESPONSE SPECTRUM ANALYSIS

ANSYS 4.4a
APR 12 1994
18:27:59
PREP7 ELEMENTS
TYPE NUM
ZV =1
*DIST=17
*XF =-8.833642
*YF =-68.618
*ZF =18.625
*MCC=98
*RTO=1.195

REAL 21 NODES
WEST

1895	1881	1884	1883	1882	1848	1839
1893	1873	1876	1875	1874	1847	1835
1894	1877	1880	1879	1878	1848	1836
1891	1865	1868	1867	1866	1833	1831
1892	1869	1872	1871	1870	1834	1832
1889	1857	1860	1859	1858	1829	1827
1890	1861	1864	1863	1862	1830	1828
1887	1849	1852	1851	1850	1825	1823
1888	1853	1856	1855	1854	1826	1824
1885	1841	1844	1843	1842	1821	1820
1886	1845	1848	1847	1846	1822	1819

MULTI-PORT RISER # 5A : RESPONSE SPECTRUM ANALYSIS

ANSYS 4.4a
APR 12 1994
18:28:54
PREP7 ELEMENTS
TYPE NUM
ZV =1
*DIST=17.419
*XF =-33.361
*YF =-30.331
*ZF =18.625
*MCC=38
*RTO=1.195

REAL 21 NODES
(SOUTH)

1958	1952	1977	1978	1979	1976	2017
1951	1952	1973	1974	1975	1972	2016
1955	1957	1985	1986	1987	1984	2019
1954	1956	1981	1982	1983	1980	2018
1959	1961	1993	1994	1995	1992	2021
1958	1960	1989	1990	1991	1988	2020
1963	1965	2001	2002	2003	2000	2023
1962	1964	1997	1998	1999	1996	2022
1967	1969	2007	2008	2009	2006	2025
1966	1968	2005	2006	2007	2004	2024
1970	1971	2013	2014	2015	2012	2026

MULTI-PORT RISER # 5A : RESPONSE SPECTRUM ANALYSIS

ANSYS 4.4a
APR 12 1994
18:23:38
PREP7 ELEMENTS
TYPE NUM
ZV =1
*DIST=17.67
*XF =-32.73
*YF =-30.33
*ZF =18.625
*MCC=38
*RTO=1.195

REAL 21 NODES
(NORTH)

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>John T. [Signature]</i>	Date	5-16-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Ravi [Signature]</i>	Date	5/16/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	5-36	Rev. No.	0

SUPPORT SUB ASSEMBLY BASE PLATE ELEMENTS

1481	1441	1448	1439	1438	1481
1488	1437	1435	1433	1431	1488
1449	1436	1434	1432	1430	1399
1448	1429	1427	1425	1423	1398
1447	1428	1426	1424	1422	1397
1446	1427	1425	1423	1421	1396
1445	1426	1424	1422	1420	1395
1444	1425	1423	1421	1419	1394
1443	1424	1422	1420	1418	1393
1442	1423	1421	1419	1417	1392

MULTI-PORT RISER # 5A : RESPONSE SPECTRUM ANALYSIS

ANSYS 4.4A
APR 12 1994
18:29:25
PREP7 ELEMENTS
ELEM NUM
ZU = 1
*DIST=17
*XF = 50.83662
*YF = 50.618
*ZF = 18.625
*MCE=38
*RTD=1.193
REAL 21 ELEMENTS
(WEST)

1688	1618	1619	1620	1621	1658
1689	1622	1624	1626	1628	1659
1610	1623	1625	1627	1629	1660
1611	1630	1632	1634	1636	1661
1612	1631	1633	1635	1637	1662
1613	1638	1640	1642	1644	1663
1614	1639	1641	1643	1645	1664
1615	1646	1648	1650	1652	1665
1616	1647	1649	1651	1653	1666
1617	1654	1655	1656	1657	1667

MULTI-PORT RISER # 5A : RESPONSE SPECTRUM ANALYSIS

ANSYS 4.4A
APR 12 1994
18:31:19
PREP7 ELEMENTS
ELEM NUM
ZU = 1
*DIST=17
*XF = 50.818
*YF = 50.662
*ZF = 18.625
*MCE=38
*RTD=1.193
REAL 21 ELEMENTS
(NORTH)

1589	1549	1548	1547	1546	1589
1588	1545	1543	1541	1539	1588
1557	1544	1542	1540	1538	1587
1556	1537	1535	1533	1531	1586
1555	1536	1534	1532	1530	1585
1554	1535	1533	1531	1529	1584
1553	1534	1532	1530	1528	1583
1552	1533	1531	1529	1527	1582
1551	1532	1530	1528	1526	1581
1550	1531	1529	1527	1525	1580

MULTI-PORT RISER # 5A : RESPONSE SPECTRUM ANALYSIS

ANSYS 4.4A
APR 12 1994
18:36:37
PREP7 ELEMENTS
ELEM NUM
ZU = 1
*DIST=17
*XF = 50.843
*YF = 50.669
*ZF = 18.625
*MCE=38
*RTD=1.193
REAL 21 ELEMENTS
(SOUTH)

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-16-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5/16/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	5-37	Rev. No.	0

SUPPORT SUB ASSEMBLY VERTICAL STIFFENER

ANSYS 4.4a
APR 12 1994
18:08:37
POST1 ELEMENTS
TYPE NUM
XU =1
YU =-1
ZU =1
*DIST=28.963
*XT =-0.397451
*YT =-61.694
*ZF =4.293
VUP =2
VINT=1.193

REAL 22 NODES
(WEST)

ANSYS 4.4a
APR 12 1994
17:51:28
POST1 ELEMENTS
TYPE NUM
XU =1
YU =0.25
ZU =1
*DIST=18.947
*XT =-39.882
*YT =-34.916
*ZF =-3.711
VUP =2

REAL 22 NODES
(NORTH)

ANSYS 4.4a
APR 12 1994
18:17:05
POST1 ELEMENTS
TYPE NUM
XU =1
YU =2
ZU =1.5
*DIST=21.878
*XT =-36.184
*YT =-2.893
*ZF =-29.737
VUP =2
VINT=1.193

REAL 22 NODES
(SOUTH)

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-16-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5/16/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	5-38	Rev. No.	0

SUPPORT SUB ASSEMBLY (NEW) OUTER FLANGE

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-16-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5/16/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	5-39	Rev. No.	0

* BOLTED CONNECTION
LOCATION (TYP.)

SUPPORT SUB ASSEMBLY INNER FLANGE

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-16-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5/16/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	5-40	Rev. No.	0

ONEVE 4.48
APR 9 1994
16:58:41
PREP7 ELEMENTS
ELEM NUM
YU =1
NDIST=14.216
WVF =20.946082
WZF =12.7
WZF =11.642
WUP =2
YNT0=1.195
REAL & ELEMENTS
(WEST)

ONEVE 4.48
APR 9 1994
16:58:12
PREP7 ELEMENTS
ELEM NUM
YU =1
YU =1
YU =1
NDIST=14.206
WVF =-14.353
WVF =-4.357
WZF =-42.122
WUP =2
YNT0=1.195
REAL & ELEMENTS
(SOUTH)

ONEVE 4.48
APR 9 1994
16:56:16
PREP7 ELEMENTS
ELEM NUM
YU =-1
YU =1
YU =1
NDIST=14.378
WVF =-14.322
WVF =-4.211
WZF =-42.226
WUP =2
YNT0=1.195
REAL & ELEMENTS
(NORTH)

VERTICAL FLANGE FOR RADIAL VERTICAL STIFFENER.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	9-13-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>W G</i>	Date	9/13/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	6-1	Rev. No.	1

6.0 STRUCTURAL ANALYSIS

6.1 Design Basis (DB) Analysis

The DB analysis was performed for dead loads and seismic loads which are described below.

6.1.1 Dead Load

Dead load of the multiport riser assembly includes total weight of the individual components in the entire assembly plus the dead load of equipment such as sonic probe, etc, to be installed in the port at a later date. The dead load of the multiport riser is adjusted to obtain a total weight of 6591* lbs. (Ref. 2.2.16). The densities of multiport riser flanges are adjusted, per Ref. 2.2.16, to account for its own weight plus the weight of the equipment as below:

Equipment in 20" port	=	1000 lbs.
Equipment in 12" port	=	7000** lbs.
Equipment in two 8" ports	=	1000 lbs. each

6.1.2 Seismic Load

Section 3.2 of Reference 2.1.21 requires use of the Design Basis Earthquake (DBE) response spectrum curves for a 0.12g ZPA to determine the loads on Safety Class 2 structures such as the multiport riser hardware and the concrete footing. As directed by WHC the free field response spectra is used in the analyses. However, the analysis reported herein is performed using the Design Basis Earthquake (DBE) response spectrum curve (5% damping); provided in Reference [2.1.2], for a 0.2g ZPA in two horizontal directions and 0.134g ZPA (2/3 of 0.2) in the vertical direction. The use of higher than required levels of earthquake motions will provide additional margin of safety that may compensate for expected dynamic amplification of the free field motion in vertical direction due to dynamic response of the roof of the tank. In future this analysis should be reviewed for its accuracy when the actual dynamic amplification factor is available.

* Increased to 8690 lbs. (see Sheet no. I-4)

** Reduced to 5180 lbs. (see Sheet no. I-19)

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Handwritten signature</i>	Date	6-3-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Handwritten signature</i>	Date	6/4/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	6-2	Rev. No.	0

Control points for the 0.2g horizontal response spectrum are given below.

FREQUENCY	ACCELERATION (g)
0.10	0.010
0.25	0.065
1.64	0.420
8.00	0.420
33.00	0.200
100.00	0.200

MPR Fundamental Frequencies:

Eigenvalue analysis of the DB model resulted in three modes under 33 hz. They are:

Mode #	Frequency (Hz.)
1	24.13
2	24.41
3	30.17

Modes 1 and 2 are the horizontal modes in X (N-S) and Y (E-W) directions, and mode 3 is the vertical mode.

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-16-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5/16/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	6-3	Rev. No.	0

6.1.3 Load Combinations and ANSYS Post Processing

ANSYS "POST1" post processor combines the modal results of the response spectrum analysis using the "Grouping Method" as specified in NRC Regulatory guide 1.92 (Reference 2.1.17), then combines the directional responses using the SRSS method. The response due to Dead load is combined with the seismic results in the following two load cases: D+S and D-S. The envelope of these load cases is used to evaluate the members and connections for Extreme Load conditions.

The multiport riser structure (with exception to 8", 12" & 20" risers) is symmetric about 120°. Some of the members and connections are oriented in an angle to cartesian global coordinate system. Therefore, three separate post processing were performed to obtain the nodal forces (ANSYS NFORCE) in the direction parallel/perpendicular to plane of the members.

Following is a summary of analyses and post processing input/out files:

Analysis type:	Input File	Output File	ADVENT File No.
Static (KAN 0) Load Step 1: 1.0 g in X-dir. Load Step 2: 1.0 g in Y-dir. Load Step 3: 1.0 g in Z-dir. (Note Z is vertical)	MPR5A-DL.INP	MPR5A-DL.OUT ANSYS generated file "FILE12.DAT" is renamed as "DL.12".	C94003.1.1.A
Response Spectrum (KAN 2) Load Step 1: Dummy Load Step 2: X-dir. Load Step 3: Y-dir. Load Step 4: Z-dir.	MPR5A-EQ.INP	MPR5A-EQ.OUT ANSYS generated file "FILE12.DAT" is renamed as "EQ.12".	C94003.1.1.B

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-16-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5/16/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	6-4	Rev. No.	0

Analysis type:	Input File	Output File	ADVENT File No.
Post Processing (POST 1)	MPR5A-DB.P1I	MPR5A-DB.P1O	C94003.1.1.C
Load Case 1: Gravity loads (D)	MPR5A-DB.P2I	MPR5A-DB.P2O	C94003.1.1.D
Load Case 2: D+Seismic	MPR5A-DB.P3I	MPR5A-DB.P2O	C94003.1.1.E
Load Case 3: D-Seismic			
Load Case 6: Envelope of Load Cases 2 and 3			

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-31-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5-11-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	6-5	Rev. No.	0

6.2 Beyond Design Basis (BDB) Analysis

6.2.1 Hydrogen Burn Loads

The hydrogen burn loads consist of: 1) Transient pressure loads, and 2) Transient displacement loads.

The displacement time history is applied at boundary node (# 5001; See sheet 5-14). The pressure time history is applied by selecting the control point between linear pressure loads. The pressure is applied on all the interior surfaces of the MPR including the pressure relief vent. Both time histories were provided to ADVENT by Los Alamos National Laboratory (LANL) Safety Analysis Group. The pressure loading option is not available in ANSYS linear transient dynamic analysis (KAN 5). Therefore, the pressure is converted into nodal forces which are applied at corresponding nodes. Note that the degree of freedom at a node point where the forces are to be applied needs to be declared as master degree of freedom (MDOF) in ANSYS Linear Transient Dynamic analysis. The calculation of nodal forces from pressure at various node points for different components of the MPR are shown in Tables 6.2.1 to 6.2.9.

Two linear transient dynamic analyses were performed for the following loading conditions:

- CASE 1: Assumes that two pressure relief doors are opened simultaneously and the third one is closed. Therefore the pressure is applied on only one pressure relief door (East pressure relief door in this case).
- CASE 2: Similar to CASE 1. Assumes that East pressure relief door and any one of the remaining two doors are opened simultaneously while the third one is closed. Since the structure is symmetric about East-West, the response due to North pressure relief door being closed and other two open simultaneously is similar to South pressure relief door being closed and other two open simultaneously. Therefore, the pressure is applied on North pressure relief door only.

Note that no structural damping is considered in the linear transient dynamic analysis, which is conservative.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	Ravi 11/21/94	Date	6/4/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	[Signature]	Date	6-6-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	6-6	Rev. No.	0

6.2.1.1 Transient Pressure Loads

The transient pressure loads were provided by the Los Alamos National Laboratory (Reference 2.2.13) in the form of a pressure time history as shown in Appendix A. Thirteen control points were selected for input to the MPR mathematical model. The following are the values of time versus pressure for these control points.

Time, sec.	Pressure, psi
0.00000	0.0000
0.01796	0.8795
0.16701	0.8775
0.31701	0.8754
0.39201	0.8744
0.46201	1.9732
0.61201	9.1196
0.72671	30.3786
0.86425	48.2430
1.01925	46.0928
1.16425	42.8923
1.31925	39.5379
1.37370	38.4141

Pressure was applied on the interior exposed areas of the various components of the MPR assembly. These areas include the following :

- Top Shield Plate
- Bottom Triangular Plate
- Vertical Stiffeners
- Bottom Plates of Pressure Relief Vent
- Top Plates of Pressure Relief Vent
- Pressure Relief Door
- Side Plates of Pressure Relief Vent

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	Ramirez	Date	6/4/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	[Signature]	Date	6-6-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	6-7	Rev. No.	0

For each of the above components, the exposed area was calculated. Total pressure for each time point was then calculated for each area. This total pressure was then distributed to key node points of each exposed area.

Following are the calculations for the exposed areas of aforesaid components of the MPR assembly.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>R. M. M.</i>	Date	6/4/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	6-6-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	6-8	Rev. No.	0

Top Shield Plate :

Exposed Area = Area of the Hexagonal part of the Top Shield Plate
 + Areas of the three Segments of the Top Shield Plate
 - Areas of Circular openings of the 8" North & South Risers,
 the 12" Riser, and the 20" Riser

⊗ ID based on Schedule 80_{pipe} specification.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	Kenn M. King	Date	2-11-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	[Signature]	Date	6-6-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	6-9	Rev. No.	0

$$\begin{aligned} \text{Area of Hexagon} &= [(33.3968 + 63.8968)/2] \times 26.413775 \\ &+ [(30.5 + 63.8968)/2] \times 28.922425 \\ &= 2,650 \text{ in.}^2 \end{aligned}$$

$$\begin{aligned} \text{Area of Segment} &= (\pi) \times (33^2) \times [(2 \times \sin(15.25/33))/360] \\ &- (1/2) \times (33-3.375) \times 30.5 \\ &= 71.359 \text{ in.}^2 \end{aligned}$$

33" RADIUS
(TOP SHIELD PLATE)

$$\begin{aligned} \text{Area of 8" Risers} &= (\pi/4) \times (7.625^2) \\ &= 45.66 \text{ in.}^2 \end{aligned}$$

$$\begin{aligned} \text{Area of 12" Riser} &= (\pi/4) \times (11.376^2) \\ &= 101.64 \text{ in.}^2 \end{aligned}$$

$$\begin{aligned} \text{Area of 20" Riser} &= (\pi/4) \times (17.938^2) \\ &= 252.72 \text{ in.}^2 \end{aligned}$$

$$\begin{aligned} \text{Exposed Area} &= 2,650 + 3 \times 71.359 - 45.66 - 101.64 - 252.27 \\ &= 2,464.06 \text{ in.}^2 \text{ USE } 2,470 \text{ in.}^2 \end{aligned}$$

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>R. M. M. M.</i>	Date	6/4/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	6-6-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	6-10	Rev. No.	0

Bottom Triangular Plate :

$$\begin{aligned}
 \text{Exposed Area} &= \text{Area of Hexagon} + 3 \times \text{Area of Rectangles} \\
 &\quad - \text{Area of 42" Riser opening} \\
 &= 2650 + 3 \times 30.5 \times 1.88 - (\pi/4) \times (42^2) \\
 &= 1,436.8 \text{ in.}^2
 \end{aligned}$$

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Ravi Mung</i>	Date	6/4/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>H. W. Smith</i>	Date	6-6-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	6-11	Rev. No.	0

Vertical Stiffeners :

$$\begin{aligned}
 \text{Exposed Area} &= 33.3968 \times 24. \\
 &= 801.5 \text{ in.}^2
 \end{aligned}$$

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Ran Dwyer</i>	Date	6/4/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>A. W. H. H.</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	6-12	Rev. No.	0

Following sketch applies to the top plate, bottom plate, side plate and pressure relief door of the pressure relief vent (PRV).

Top Plates of Pressure Relief Vent :

$$\begin{aligned}
 \text{Exposed Area} &= [(9.735 + 6)/2] \times 30. \\
 &= 236 \text{ in.}^2
 \end{aligned}$$

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By: <i>R. M. J.</i>	Date	6/4/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By: <i>[Signature]</i>	Date	6-6-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No. 94003.1.1
Client Calc. No.		Sheet No.	6-13	Rev. No. 0

Bottom Plates of Pressure Relief Vent : (Refer to the sketch on previous page)

$$\begin{aligned}\text{Exposed Area} &= 9. \times 30. \\ &= 270 \text{ in.}^2\end{aligned}$$

Pressure Relief Door : (Refer to the sketch on previous page)

$$\begin{aligned}\text{Exposed Area} &= 24. \times 30. \\ &= 720 \text{ in.}^2\end{aligned}$$

Side Plates of Pressure Relief Vent : (Refer to the sketch on previous page)

$$\begin{aligned}\text{Exposed Area} &= 10.9138 \times 24. \\ &= 261.9 \text{ in.}^2\end{aligned}$$

Areas calculated above were used to calculate total pressure, and subsequently, pressure per node. Tables 6.1 through 6.9 give the time versus pressure control point values, total force for a given component, and force per node.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Ram Singh</i>	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Alvin</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	6-14	Rev. No.	0

TABLE 6.1 : PRESSURE FORCES ON TOP SHIELD PLATE

PRESSURE T/H*		Total Force Shield Plate (lbs)	Force per Node (=22) (lbs)
Time (sec)	Pressure (psi)		
0.00000	0	0.0	0.0
0.01796	0.8795	2172.4	98.7
0.16701	0.8775	2167.4	98.5
0.31701	0.8754	2162.2	98.3
0.39201	0.8744	2159.8	98.2
0.46201	1.9732	4873.8	221.5
0.61201	9.1196	22525.4	1023.9
0.72671	30.3786	75035.1	3410.7
0.86425	48.2430	119160.2	5416.4
1.01925	46.0928	113849.2	5175.0
1.16425	42.8923	105944.0	4815.6
1.31925	39.5379	97658.6	4439.0
1.37370	38.4141	94882.8	4312.9

Shield Plate Area = 2470 in.²

• Reference 2.1.13

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Rui Ming</i>	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Anthony M. ...</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	6-15	Rev. No.	0

**TABLE 6.2 : TOTAL PRESSURE FORCES ON
PRESSURE RELIEF VENT TOP (PRVT) &
PRESSURE RELIEF DOOR (PRD)**

Time (sec)	PRESSURE T/H* Pressure (psi)	Total Force PRVT (lbs)	Force per Node (=3) (lbs)	Total Force PRD (lbs)	Force per Node (=6) (lbs)
0.00000	0	0.0	0.0	0.0	0.0
0.01796	0.8795	207.6	69.2	633.2	105.5
0.16701	0.8775	207.1	69.0	631.8	105.3
0.31701	0.8754	206.6	68.9	630.3	105.0
0.39201	0.8744	206.4	68.8	629.6	104.9
0.46201	1.9732	465.7	155.2	1420.7	236.8
0.61201	9.1196	2152.5	717.5	6566.1	1094.4
0.72671	30.3786	7170.1	2390.0	21872.6	3645.4
0.86425	48.2430	11386.6	3795.5	34735.0	5789.2
1.01925	46.0928	10879.1	3626.4	33186.8	5531.1
1.16425	42.8923	10123.7	3374.6	30882.5	5147.1
1.31925	39.5379	9331.9	3110.6	28467.3	4744.5
1.37370	38.4141	9066.7	3022.2	27658.2	4609.7

PRVT Area $[(9.735+6)/2] \times 30 = 236.0 \text{ in.}^2$

PRD Area = $30 \times 24 = 720 \text{ in.}^2$

• Reference 2.1.13

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Ravi Singh</i>	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	6-16	Rev. No.	0

TABLE 6.3 : PRESSURE FORCES ON INDIVIDUAL PRVT AND PRD

Force per Node (=6) (lbs)	East PRD		South PRD		North PRD	
	(N = 688, 683, 873, 686, 684, 871)		(N = 310, 305, 495, 308, 306, 493)		(N = 1066, 112, 117, 1064, 113, 115)	
	Fx (lbs)	Fy (lbs)	Fx (lbs)	Fy (lbs)	Fx (lbs)	Fy (lbs)
0.0	0	0.0	0.0	0.0	0.0	0.0
105.5	0	-105.5	-91.4	52.8	91.4	52.8
105.3	0	-105.3	-91.2	52.7	91.2	52.7
105.0	0	-105.0	-91.0	52.5	91.0	52.5
104.9	0	-104.9	-90.9	52.5	90.9	52.5
236.8	0	-236.8	-205.1	118.4	205.1	118.4
1094.4	0	-1094.4	-947.7	547.2	947.7	547.2
3645.4	0	-3645.4	-3157.0	1822.7	3157.0	1822.7
5789.2	0	-5789.2	-5013.6	2894.6	5013.6	2894.6
5531.1	0	-5531.1	-4790.1	2765.6	4790.1	2765.6
5147.1	0	-5147.1	-4457.5	2573.5	4457.5	2573.5
4744.5	0	-4744.5	-4108.9	2372.3	4108.9	2372.3
4609.7	0	-4609.7	-3992.1	2304.8	3992.1	2304.8

N : NODE NOS.

Project	Westinghouse Hanford Company	Prepared By:	<i>Ravi Mung</i>	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Alvin White</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	6-17	Rev. No.	0

**TABLE 6.4 : TOTAL PRESSURE FORCES ON
VERTICAL STIFFENERS (VS) &
PRESSURE RELIEF VENT SIDE PLATES (PRVSP)**

PRESSURE T/H*		VS		PRVSP	
Time (sec)	Pressure (psi)	Total Force	Force per Node (=8)	Total Force	Force per Node (=2)
		TF (lbs)	Fvs (lbs)	TF (lbs)	Fprvsp (lbs)
0.00000	0	0.0	0.0	0.0	0.0
0.01796	0.8795	704.9	88.1	230.4	115.2
0.16701	0.8775	703.3	87.9	229.8	114.9
0.31701	0.8754	701.7	87.7	229.3	114.6
0.39201	0.8744	700.9	87.6	229.0	114.5
0.46201	1.9732	1581.6	197.7	516.8	258.4
0.61201	9.1196	7309.6	913.7	2388.7	1194.4
0.72671	30.3786	24349.2	3043.6	7957.1	3978.6
0.86425	48.2430	38667.9	4833.5	12636.3	6318.2
1.01925	46.0928	36944.4	4618.1	12073.1	6036.6
1.16425	42.8923	34379.2	4297.4	11234.8	5617.4
1.31925	39.5379	31690.5	3961.3	10356.2	5178.1
1.37370	38.4141	30789.8	3848.7	10061.9	5030.9

Total Force, TF = Pressure x Area

Force per node, F = TF / N where N = number of nodes

SP Area = 33.3968 x 24 = 801.5 in.²

PRVSP Area = 10.9138 x 24 = 261.9 in.²

* Reference : 2.1.13

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Law Ming</i>	Date	6/9/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	6-18	Rev. No.	0

**TABLE 6.5 : PRESSURE FORCES ON
INDIVIDUAL VERTICAL STIFFENERS**

Force per Node (=8)	West VS (N = 79 to 82, 272 to 275)		South VS (N = 457 to 460, 650 to 653)		North VS (N = 835 to 838, 1028 to 1031)	
	F _x = F*Cos90 (lbs)	F _y = F*Sin90 (lbs)	F _x = F*Cos30 (lbs)	F _y = F*Sin30 (lbs)	F _x = F*Cos30 (lbs)	F _y = F*Sin30 (lbs)
0.0	0	0.0	0.0	0.0	0.0	0.0
88.1	0	88.1	-76.3	-44.1	76.3	-44.1
87.9	0	87.9	-76.1	-44.0	76.1	-44.0
87.7	0	87.7	-76.0	-43.9	76.0	-43.9
87.6	0	87.6	-75.9	-43.8	75.9	-43.8
197.7	0	197.7	-171.2	-98.8	171.2	-98.8
913.7	0	913.7	-791.3	-456.8	791.3	-456.8
3043.6	0	3043.6	-2635.9	-1521.8	2635.9	-1521.8
4833.5	0	4833.5	-4185.9	-2416.7	4185.9	-2416.7
4618.1	0	4618.1	-3999.4	-2309.0	3999.4	-2309.0
4297.4	0	4297.4	-3721.7	-2148.7	3721.7	-2148.7
3961.3	0	3961.3	-3430.6	-1980.7	3430.6	-1980.7
3848.7	0	3848.7	-3333.1	-1924.4	3333.1	-1924.4

N: NODE NOS.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Rui Ming</i>	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	6-19	Rev. No.	0

TABLE 6.6 : PRESSURE FORCES ON EAST PRVSP

Force per Node (=2)	EAST PRVSP			
	North Plate (N = 262, 263)		South Plate (N = 69, 70)	
	Fx = F*Cos90 (lbs)	Fy = F*Sin90 (lbs)	Fx = F*Cos90 (lbs)	Fy = F*Sin90 (lbs)
Fprvsp=F				
			</	

N: NODE NOS.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	Ran Mig	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	[Signature]	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	6-20	Rev. No.	0

**TABLE 6.7 : PRESSURE FORCES ON
SOUTHWEST PRVSP**

Force per Node (=2)	SOUTHWEST PRVSP			
	West Side Plate (N = 447, 448)		East Side Plate (N = 640, 641)	
Fprvsp=F (lbs)	Fx = F*Cos60 (lbs)	Fy = F*Sin60 (lbs)	Fx = F*Cos60 (lbs)	Fy = F*Sin60 (lbs)
0.0	0.0	0.0	0.0	0.0
115.2	57.6	99.8	-57.6	-99.8
114.9	57.5	99.5	-57.5	-99.5
114.6	57.3	99.3	-57.3	-99.3
114.5	57.3	99.2	-57.3	-99.2
258.4	129.2	223.8	-129.2	-223.8
1194.4	597.2	1034.3	-597.2	-1034.3
3978.6	1989.3	3445.5	-1989.3	-3445.5
6318.2	3159.1	5471.7	-3159.1	-5471.7
6036.6	3018.3	5227.8	-3018.3	-5227.8
5617.4	2808.7	4864.8	-2808.7	-4864.8
5178.1	2589.1	4484.4	-2589.1	-4484.4
5030.9	2515.5	4356.9	-2515.5	-4356.9

N: NODE NOS.

Project	Westinghouse Hanford Company	Prepared By:	<i>Ran King</i>	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>W. W. W.</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	6-21	Rev. No.	0

TABLE 6.8 : PRESSURE FORCES ON
NORTHWEST PRVSP

Force per Node (=2)	NORTHWEST PRVSP			
	West Side Plate (N = 1018, 1019)		East Side Plate (N = 825, 826)	
	Fx =	Fy =	Fx =	Fy =
	F*Cos60 (lbs)	F*Sin60 (lbs)	F*Cos60 (lbs)	F*Sin60 (lbs)
	0.0	0.0	0.0	0.0
	115.2	-57.6	99.8	57.6
	114.9	-57.5	99.5	57.5
	114.6	-57.3	99.3	57.3
	114.5	-57.3	99.2	57.3
	258.4	-129.2	223.8	129.2
	1194.4	-597.2	1034.3	597.2
	3978.6	-1989.3	3445.5	1989.3
	6318.2	-3159.1	5471.7	3159.1
	6036.6	-3018.3	5227.8	3018.3
	5617.4	-2808.7	4864.8	2808.7
	5178.1	-2589.1	4484.4	2589.1
	5030.9	-2515.5	4356.9	2515.5

N: NODE NOS.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	Rui Ming	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	Anthony	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	6-22	Rev. No.	0

**TABLE 6.9 : TOTAL PRESSURE FORCES ON
PRESSURE RELIEF VENT BOTTOM (PRVB) &
TRIANGULAR PLATE (TP)**

PRESSURE T/H*		PRVB		TP	
Time	Pressure	Total Force	Force per Node (=3)	Total Force	Force per Node (=12)
(sec)	(psi)	TF (lbs)	Fz (lbs)	TF (lbs)	Fz (lbs)
0.00000	0	0.0	0.0	0.0	0.0
0.01796	0.8795	237.5	-79.2	1263.7	-105.3
0.16701	0.8775	236.9	-79.0	1260.8	-105.1
0.31701	0.8754	236.4	-78.8	1257.8	-104.8
0.39201	0.8744	236.1	-78.7	1256.3	-104.7
0.46201	1.9732	532.8	-177.6	2835.1	-236.3
0.61201	9.1196	2462.3	-820.8	13103.0	-1091.9
0.72671	30.3786	8202.2	-2734.1	43648.0	-3637.3
0.86425	48.2430	13025.6	-4341.9	69315.5	-5776.3
1.01925	46.0928	12445.1	-4148.4	66226.1	-5518.8
1.16425	42.8923	11580.9	-3860.3	61627.7	-5135.6
1.31925	39.5379	10675.2	-3558.4	56808.1	-4734.0
1.37370	38.4141	10371.8	-3457.3	55193.4	-4599.5

Total Force, TF = Pressure x Area

Force per node, F = TF / N where N = number of nodes

PRVB Area = 270.0 in.²

TP Area = 1436.8 in.²

* Reference : 2.1.13

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	Ravi Mung	Date	5/16/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	[Signature]	Date	5-16-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	6-23	Rev. No.	0

6.2.1.2 Transient Displacement Loads

The vertical displacement time history, shown in Appendix B, was provided by the Los Alamos National Laboratory (Reference 2.2.12). This time history is digitized at time intervals of 0.005 second and has a maximum displacement of 13.2 in. at time 1.22 second. It was applied at boundary node point 5001 of the MPR mathematical model.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By: <i>Ravi Singh</i>	Date: <i>5-16-94</i>
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By: <i>[Signature]</i>	Date: <i>5-16-94</i>
System	SY-101 H ₂ Mitigation Project	Job No. 94003	File No. 94003.1.1
Client Calc. No.		Sheet No. 6-24	Rev. No. 0

6.2.2 SOIL SPRING CONSTANT & SOIL/FOUNDATION MASS

6.2.2.1 Soil Spring Constant :

The vertical soil spring constant was calculated based on the method given in Reference 2.1.20 (Chapter 15 - Foundation Vibrations, George Gazetas).

Table 15.3 in Reference 2.1.20 gives the stiffness, K_z , for surface foundations on homogeneous stratum over bedrock.

$$K_z = \frac{2GL}{1-\nu} \left[0.73 + 1.54 \left(\frac{B}{L} \right)^{3/4} \right] \left(1 + \frac{\frac{B}{H}}{0.5 + \frac{B}{L}} \right)$$

where G = Soil shear modulus
 L = one-half of length of footing
 B = one-half of width of footing
 H = Height of soil column

Table 6.2.10 in this report gives the values for various heights of soil column under the footing. The soil height of 6 ft was used in the analysis as it represents average soil height between the base of the footing and top of the tank. The soil shear modulus was taken as 1966.7 ksf from Reference 2.2.18. Based on the 6-ft height, the soil spring constant was calculated to be 153,461 kips per foot.

There are a total of 12 anchor bolts, four at each base plate. The soil spring constant for the entire foundation was divided by 12 to model the soil spring constant at each anchor bolt location.

$$\begin{aligned} \text{Therefore, spring constant at each anchor} &= (153461 \times 1000 / 12) / 12 \\ &= 1.0657E+6 \text{ lb/in.} \end{aligned}$$

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Rain</i>	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	6-25	Rev. No.	0

6.2.2.2 Soil/Foundation Mass :

The foundation mass represents the full mass of the concrete footing and half the mass of the soil column. Concrete is assumed to be normal weight with a density of 150 pcf. Soil density is taken from Reference 2.2.18.

Refer to Figure on next page.

$$\begin{aligned}
 \text{Net area of the concrete footing} &= \text{Area of the concrete footing} - \text{Area of 42" riser opening} \\
 &= (15 \times 15) - (\pi/4) \times ((42/12)^2) \\
 &= 225 - 9.621 \\
 &= 215.379 \text{ ft}^2
 \end{aligned}$$

$$\begin{aligned}
 \text{Mass of the concrete footing} &= (215.379) \times 3 \times 150 / 386.4 \\
 &= 250.83 \text{ lb-sec}^2/\text{in.}
 \end{aligned}$$

$$\begin{aligned}
 \text{Mass per anchor} &= 250.83 / 12 \\
 &= 20.903 \text{ lb-sec}^2/\text{in.}
 \end{aligned}$$

Net area of the concrete footing also represents net area of the soil column below the footing. Therefore,

$$\begin{aligned}
 \text{Mass of the soil column} &= \text{Area} \times \text{Soil Column Height} \times \text{Soil Density} / 386.4 \\
 &= 215.379 \times 5.5 \times (120/386.4) \\
 &= 367.883 \text{ lb-sec}^2/\text{in.}
 \end{aligned}$$

Half of the soil mass is lumped at top of the spring and the other half at its bottom. Therefore, soil mass at the 12 anchors = $367.883 / 2 = 183.948 \text{ lb-sec}^2/\text{in.}$

$$\begin{aligned}
 \text{Mass per anchor} &= (183.948) / (12) \\
 &= 15.329 \text{ lb-sec}^2/\text{in.}
 \end{aligned}$$

$$\text{Total Mass per anchor} = 20.903 + 15.329 = 36.232 \text{ lb-sec}^2/\text{in.}$$

Project	Westinghouse Hanford Co.	Prepared By:	Ravi Mung	Date	5/16/94
Subject	Structural Analysis of MPR 5A	Reviewed By:	[Signature]	Date	5-16-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	6-26	Rev. No.	0

CONCRETE FOOTING & SOIL COLUMN DETAILS

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	Ravi Mung	Date	6/4/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	[Signature]	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	6 - 27	Rev. No.	0

TABLE 6.10 : VERTICAL SOIL SPRING CONSTANT FOR MPR 5A

Soil Shear Modulus G (ksf)	One-Half Footing Length L (ft)	One-Half Footing Width B (ft)	Soil Height H (ft)	(1)	(2)	(3)	Vertical Soil Stiffness Kz (klf)
							(1)*(2)*(3)
1966.7	7.5	7.5	3.0	2.7	2.3	36875	223217
1966.7	7.5	7.5	4.0	2.3	2.3	36875	188339
1966.7	7.5	7.5	5.0	2.0	2.3	36875	167413
1966.7	7.5	7.5	6.0	1.8	2.3	36875	153461
1966.7	7.5	7.5	7.0	1.7	2.3	36875	143496
1966.7	7.5	7.5	8.0	1.6	2.3	36875	136023

$$(1) = [1 + (B / H) / (0.5 + (B / L))]$$

$$(2) = [0.73 + (1.54 \times (B / L) ^ 0.75)]$$

$$(3) = (2 \times G \times L) / (1 - \nu) \quad \text{where } \nu = \text{Soil Poisson's Ratio} = 0.2$$

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-16-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Ravi Mung</i>	Date	5/17/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	6 - 2 8	Rev. No.	0

6.2.3 Load Combinations and ANSYS Post Processing

"POST1" post processor was used to obtain the stresses in members, and forces in anchors and connections (bolts & welds). "POST26" post processor was used to obtain the response (relative displacements at bottom of 42" riser, etc.) time history. The POST1 post processor computer run was made to compare the response at all integration time points to obtain an enveloped load case. Three separate runs were made to get the forces (ANSYS NFORCE) in element oriented direction as discussed in Section 6.1.3.

Following is a summary of analyses & post processing I/O files:

Analysis type:	Input File	Output File	ADVENT File No.
Linear Transient Dynamic (KAN 5) CASE 1	MPR5A-1.INP	MPR5A-1.OUT	C94003.1.1.F
Post Processing (POST 1)	MPR5A-1.P1I	MPR5A-1.P1O	C94003.1.1.G
Load Case 10: Max. of all time points	MPR5A-1.P2I	MPR5A-1.P2O	C94003.1.1.H
Load Case 9: Min. of all time points	MPR5A-1.P3I	MPR5A-1.P3O	C94003.1.1.I
Load Case 8: Absolute maximum of Load Cases 9 and 10		MPR5A-1.7A *	
		MPR5A-1.7B *	
		MPR5A-1.7C *	
Post Processing (POST 26)	MPR5A-26.P1I	MPR5A-26.P1O	C94003.1.1.J
Post Processing (Post 1)	MPR5A-1A.P1I	MPR5A-1A.P1O	C94003.1.1.K
Linear Transient Dynamic (KAN 5) CASE 2	MPR5A-2.INP	MPR5A-2.OUT	C94003.1.1.L
Post Processing (POST 1)	MPR5A-2.P1I	MPR5A-2.P1O	C94003.1.1.M
Load Case 10: Max. of all time points	MPR5A-2.P2I	MPR5A-2.P2O	C94003.1.1.N
Load Case 9: Min. of all time points	MPR5A-2.P3I	MPR5A-2.P3O	C94003.1.1.O
Load Case 8: Absolute maximum of Load Case 9 and 10		MPR5A-2.7A *	
		MPR5A-2.7B *	
		MPR5A-2.7C *	
Post Processing (POST 26)	MPR5A-26.P2I	MPR5A-26.P2O	C94003.1.1.P
Post Processing (Post 1)	MPR5A-2A.P1I	MPR5A-2A.P1O	C94003.1.1.Q

* Re-named ANSYS post data "FILE07.DAT" files

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	6-6-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	6/6/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-1	Rev. No.	0

7.0 STRUCTURAL EVALUATION

The demand member stresses, Principal stresses (SG1T, SG2T, SG3T, SG1T, SG2T, & SG3T) and Equivalent stresses (SGET & SGEB), at top and bottom surfaces of the shell elements are obtained in ANSYS POST1 post-processing.

The welds are evaluated by considering the nodal average force, *ANSYS NFORCE*: *FX, FY, FZ and in-plane moment (MX or MY or MZ)*, and the weld properties used to calculate the forces in the weld (f_w) are based on corresponding tributary nodal spacing.

ANSYS NFORCE (nodal average force) is used to obtain the demand forces (FX, FY, and FZ) for bolts at node points which represent the connection.

The reaction forces are used to obtain the demand forces in anchor bolts due to DB loads and *ANSYS NFORCE* is used to obtain the demand force in anchor bolts due to BDB loads.

7.1 Design Basis (DB)

Design basis structural evaluation is performed per Section 7.1 of Reference 2.1.21 for Normal Loads (D: Gravity loads) and Extreme Loads (D±S: Gravity ± Seismic). The member evaluation is shown on sheet nos. 7-2 and 7-3. The anchor bolts evaluation is shown on sheet nos. 7-4 through 7-6. The bolted connection evaluation is shown on sheet nos. 7-7 through 7-11. The weld capacity calculations are shown on sheet nos. 7-12 thru 7-22. The weld property calculations are shown on sheet nos. 7-23 thru 7-28. The welded connection evaluation is shown on sheet nos. 7-29 thru 7-41. Maximum displacement anywhere in the Multiport riser and relative displacement at the bottom of 42" riser are shown on sheet no. 7-42. Concrete footing evaluation is shown on sheet no. 7-42a. Hand calculation to qualify the lifting lug is shown on sheet no. 7-42b and Port covers and its bolts are shown on sheet nos. 7-87 thru 7-88.

7.1.1 Evaluation of Members

Demand members stresses, which include membrane and bending stresses, allowable member stresses and stress ratios are shown on Tables 7.1 and 7.2.

Project	Westinghouse Hanford Company	Prepared By:	<i>Allen-Hay</i>	Date	6-3-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Ron Nung</i>	Date	6/4/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-2	Rev. No.	8-1

Table 7.1: STRESSES IN VARIOUS MPR # 5A COMPONENTS

Load Case : Dead Load (D) -- Normal Load Case

REAL #	Component (REAL) Description	Part No.*	Element No.	Demand*** Stress, psi	Allowable** Stress, psi	Stress Ratio
1	Bottom Triangular Plate	35 (1)	774	679	22,500	0.030
2	Bottom Plate of Pressure Relief Vent (PRV)	34 (1)	43	233	22,500	0.010
3	Side Plate of PRV & Diagonal Stiffener Plate between Top Shield Plate (REAL 5) and Bottom Triangular Plate (REAL 1)	35 (1)	222	951	22,500	0.042
4	Vertical Flange of Radial Vertical Stiffener	34 (1)	224	685	22,500	0.030
5	Top Shield Plate	37 (1)	972	1,381	22,500	0.061
6	Top Plate of PRV	34 (1)	851	305	22,500	0.014
7	Pressure Relief Door of PRV	22 (1)	N/A	N/A	N/A	N/A
8	Radial Vertical Stiffener	34 (1)	147	2,038	22,500	0.091
9	Horizontal Flange of Radial Vertical Stiffener	34 (1)	66	1,286	22,500	0.057
10	20" Riser	41 (1)	1016	746	22,500	0.033
11	12" Riser	40 (1)	1327	1,474	22,500	0.066
12	8" Riser	39 (1)	1297	453	22,500	0.020
13	27.5" Dia. Flange for 20" Riser	50 (1)	1121	231	22,500	0.010
14	19" Dia. Flange for 12" Riser	49 (1)	1387	1,438	22,500	0.064
15	13.5" Dia. Flange for 8" Riser	48 (1)	1370	311	22,500	0.014
20	42" Dia. Riser	32 (1)	904	517	18,750	0.028
21	Base Plate @ Anchorage	3 (2)	1449	3,284	27,000	0.122
22	Gusset Plate @ Anchorage	6 (2)	1463	1,016	27,000	0.038
23	Gusset Plate Flange @ Anchorage	6 (2)	1481	2,311	27,000	0.086
24	New Gusset Plate Flange @ Anchorage	6 (2)	1721	3,182	27,000	0.118

- * (1) - Ref. Drawing No. H-2-821101, Rev. B, Sheet 1 of 7.
- ** Allowable Stress = 0.75 x Material Yield Stress
- *** Includes Membrane and Bending (Load Case 1 - ADVENT File : C94003.1.1 C)

▼ REVISED (SEE SHEET NO. I-10) *9-2-94*
WHL 9/2/94

Project	Westinghouse Hanford Company	Prepared By:	<i>John W. West</i>	Date	6-3-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Ron Ming</i>	Date	6/4/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-3	Rev. No.	8 1

TABLE 7.2 : STRESSES IN VARIOUS MPR # 5A COMPONENTS

Load Case : Dead Load (D) + Seismic Load (DBE) -- Extreme Load Case

REAL #	Component (REAL) Description	Part No.*	Element No.	Demand*** Stress, psi	Allowable** Stress, psi	Stress Ratio
1	Bottom Triangular Plate	35 (1)	194	1,154	36,000	0.032
2	Bottom Plate of Pressure Relief Vent (PRV)	34 (1)	204	532	36,000	0.015
3	Side Plate of PRV & Diagonal Stiffener Plate between Top Shield Plate (REAL 5) and Bottom Triangular Plate (REAL 1)	35 (1)	62	1,267	36,000	0.035
4	Vertical Flange of Radial Vertical Stiffener	34 (1)	63	1,593	36,000	0.044
5	Top Shield Plate	37 (1)	1207	2,774	36,000	0.077
6	Top Plate of PRV	34 (1)	386	500	36,000	0.014
7	Pressure Relief Door of PRV	22 (1)	N/A	N/A	N/A	N/A
8	Radial Vertical Stiffener	34 (1)	147	2,859	36,000	0.079
9	Horizontal Flange of Radial Vertical Stiffener	34 (1)	66	1,910	36,000	0.053
10	20" Riser	41 (1)	1032	1,161	36,000	0.032
11	12" Riser	40 (1)	1348	2,349	36,000	0.065
12	8" Riser	39 (1)	1082	883	36,000	0.025
13	27.5" Dia. Flange for 20" Riser	50 (1)	1359	284	36,000	0.008
14	19" Dia. Flange for 12" Riser	49 (1)	1388	2,030	36,000	0.056
15	13.5" Dia. Flange for 8" Riser	48 (1)	1128	443	36,000	0.012
20	42" Dia. Riser	32 (1)	905	702	30,000	0.023
21	Base Plate @ Anchorage	3 (2)	1449	5,204	43,200	0.120
22	Gusset Plate @ Anchorage	6 (2)	1463	1,773	43,200	0.041
23	Gusset Plate Flange @ Anchorage	6 (2)	1476	3,737	43,200	0.087
24	New Gusset Plate Flange @ Anchorage	6 (2)	1721	5,568	43,200	0.129

* (1) - Ref. Drawing No. H-2-821101, Rev. B, Sheet 1 of 7.

(2) - Ref. Drawing No. H-2-821095, Rev. B, Sheet

** Allowable Stress = 1.6 x 0.75 x Material Yield Stress

*** Includes Membrane and Bending (Load Case 6 - ADVENT File : C94003.1.1 C)

▼ REVISED (SEE SHEET NO. I-10) *W. 9-2-94*
W. 9/2/94

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	6-3-94
Subject	Structural Analysis of Multiport Riser SA	Reviewed By:	<i>Ravi Mig</i>	Date	6/4/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-4	Rev. No.	81

7.1.2 Evaluation of Anchor Bolts

(REF. 2.2.21)

[Signature] 9-2-94
wnt 9/2/94

Embedment and spacing requirement for DRILLCO MAXI-BOLTS per Table II-A, Ref.2.1.24 are:

Part No.	:	MB-1250-30-23
Anchor Diameter	:	1¼ inch.
Embedment depth	:	23 inch.
C/C center spacing	:	12 inch. (F _c = 4000 psi, Ref. 2.2.19)
Min. edge distance	:	20.5 inch. To be checked by WHC

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-15-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5-15-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-5	Rev. No.	01

Allowable Working Design Loads per Table I, Ref. 2.1.24:

Tension, $F_a = 50.014$ Kips.
Shear, $V_a = 25.979$ Kips. (Case 1)

$$\text{STRESS RATIO} = (T/F_a) + (V/V_a) \leq 1.0$$

Where, Demand TENSION (lbs), $T = 1.5^* (FZ)$ (* Prying factor)
Demand SHEAR (lbs.), $V = (FX^2 + FY^2)^{1/2}$

NORMAL LOADS (D) - REACTION FORCE (See Load Case 1, file "MPR5A-DB.P10", ADVENT file C94003.1.1.C)						
NODE #	FX (Lbs.)	FY (Lbs.)	FZ (Lbs.)	SHEAR (Lbs.)	TENSION (Lbs.)	STRESS RATIO
1690	-65	-606	1498	610	0	0.023
1706	65	-606	1498	610	0	0.023
1710	1061	-633	1882	1236	0	0.048
1742	-1061	-633	1882	1236	0	0.048
1821	467	251	1146	530	0	0.020
1837	386	408	1062	562	0	0.022
1841	60	1030	1465	1031	0	0.040
1873	877	-449	1454	985	0	0.038
1952	-386	408	1062	562	0	0.022
1968	-467	251	1146	530	0	0.020
1972	-877	-449	1454	985	0	0.038
2004	-60	1030	1465	1031	0	0.040

REVISED (SEE SHEET NOS. I-6 AND I-7)
4-2-94 WnH 9/2/94

Note: Positive reaction force (+FZ) is compression.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-15-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5-15-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-6	Rev. No.	81

Factored Design Loads per Table I, Ref. 2.1.24:

Tension, $F_u = 85.024$ Kips.
Shear, $V_u = 44.165$ Kips. (Case 1)

$$\text{STRESS RATIO} = (T/F_u) + (V/V_u) \leq 1.0$$

Where, Demand TENSION (lbs), $T = 1.5^* (FZ)$ (* Prying factor)
Demand SHEAR (lbs.), $V = (FX^2 + FY^2)^{1/2}$

EXTREME LOADS (D ± DBE) - REACTION FORCE (See Load Case 6, file "MPR5A-DB.P10", ADVENT file C94003.1.1.C)						
NODE #	FX (Lbs.)	FY (Lbs.)	FZ (Lbs.)	SHEAR ¹ (Lbs.)	TENSION (Lbs.)	STRESS RATIO ²
1690	398	943	1815	1024	0	0.023
1706	397	944	1813	1024	0	0.023
1710	1441	969	2448	1736	0	0.039
1742	1441	969	2481	1737	0	0.039
1821	859	441	1409	966	0	0.022
1837	630	820	1244	1034	0	0.023
1841	178	1615	2129	1625	0	0.037
1873	1403	632	2117	1539	0	0.035
1952	633	824	1249	1039	0	0.024
1968	864	441	1409	970	0	0.022
1972	1408	629	2103	1542	0	0.035
2004	181	1618	2128	1628	0	0.037

REVISED (SEE SHEET NOS. I-6 AND I-7)
H6/2/94
AUM
H6-2-94

Note: Positive reaction force (+FZ) is compression.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	6-4-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	6/6/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-7	Rev. No.	0

7.1.3 Evaluation of Bolted Connections

(Between Vertical Flange for Radial stiffener (REAL 4) and Gusset Plate Flange @ anchorage (REAL 23) of Support Sub Assembly)

This connection is modelled in ANSYS by defining "Linear constraint equations between REAL 4 elements and REAL 23 element nodes at bolts location (ANSYS CPINTF command). The forces at bolt locations are obtained in ANSYS postprocessing (POST1) using NFORCE command. Note that the NFORCE command lists the nodal average force at (selected) nodes of selected elements in global coordinates.

Bolts: 1 1/4" Dia. ASTM A-325 (Area, A = 1.227 in²)

Allowables: Tension = 54.0 kips. Ref. 2.1.19
Shear = 25.8 kips. (Single shear)

$F_t = 55 - 1.8 f_v \leq 44$ ksi. Section Q1.6.3, Ref. 2.1.6

Where, f_v is demand shear in ksi.

STRESS RATIO = SHEAR/25800 ≤ 1.0 (for Normal Loads)
 ≤ 1.4 (for Extreme Loads)

STRESS RATIO* = TENSION/54000 ≤ 1.0 (for Normal Loads)
 ≤ 1.6 (for Extreme Loads)

(Where, 1.4 and 1.6 are stress limit coefficient for shear and tension due to Extreme loads per Table Q1.5.7.1, Ref. 2.1.6)

Note: The positive numbers reported in the following tables under TENSION column represent tension in bolts, while negative numbers represent compression.

* If $F_t = 44$ ksi.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-31-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5-31-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-8	Rev. No.	0

NORMAL LOADS (D)						
(See Load Case 1, file "MPR5A-DB.P10", ADVENT file C94003.1.1.C)						
NODE #	FX (Lbs)	FY (Lbs)	FZ (Lbs)	SHEAR (Lbs)	TENSION (Lbs)	STRESS RATIO ¹
1808	94	-581	1559	1561	-581	0.061
1809	-13	-109	1093	1093	-109	0.042
1810	-51	-550	527	530	-550	0.021
1816	-94	-581	1559	1561	-581	0.061
1817	13	-109	1093	1093	-109	0.042
1818	51	-550	527	530	-550	0.021
SHEAR = (FX ² + FZ ²) ^{1/2} TENSION = FY						
1939	516	487	990	1004	690	0.039
1940	79	-9	763	764	64	0.030
1941	303	133	367	368	329	0.014
1947	548	415	1396	1399	682	0.054
1948	69	12	831	831	65	0.032
1949	275	202	378	380	339	0.015
SHEAR = (FZ ² + (FX COS 60 - FY COS 30) ²) ^{1/2} TENSION = (FX COS 30 + FY COS 60)						
2070	-548	415	1396	1399	-682	0.054
2071	-69	12	831	831	-65	0.032
2072	-275	202	378	380	-339	0.015
2078	-516	487	990	1004	-690	0.039
2079	-79	-9	763	764	-64	0.030
2080	-303	133	367	368	-329	0.014
SHEAR = (FZ ² + (FX COS 60 + FY COS 30) ²) ^{1/2} TENSION = (FX COS 30 - FY COS 60)						

1 STRESS RATIO = SHEAR/25800 ≤ 1.0

Note: Units - Lbs.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-31-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5-13-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-9	Rev. No.	0

EXTREME LOADS (D+DBE)						
(See Load Case 2, file "MPR5A-DB.P10", ADVENT file C94003.1.1.C)						
NODE #	FX	FY	FZ	SHEAR	TENSION	STRESS RATIO ¹
1808	599	62	2500	2570	62	0.100
1809	163	-63	1694	1702	-63	0.066
1810	37	-466	735	736	-466	0.029
1816	409	63	2500	2534	63	0.098
1817	188	-63	1694	1704	-63	0.066
1818	130	-466	736	747	-466	0.029
SHEAR = $(FX^2 + FZ^2)^{1/2}$				TENSION = FY		
1939	1164	1006	1592	1618	1511	0.063
1940	158	116	1213	1213	195	0.047
1941	363	189	520	521	409	0.020
1947	1167	997	2159	2178	1509	0.084
1948	167	140	1298	1299	214	0.050
1949	338	286	534	540	436	0.021
SHEAR = $(FZ^2 + (FX \cos 60 - FY \cos 30)^2)^{1/2}$				TENSION = $(FX \cos 30 + FY \cos 60)$		
2070	73	999	2163	2343	-436	0.091
2071	27	137	1301	1307	-45	0.051
2072	-197	273	542	560	-307	0.022
2078	133	1006	1596	1851	-388	0.072
2079	17	129	1253	1259	-50	0.049
2080	-223	228	537	543	-307	0.021
SHEAR = $(FZ^2 + (FX \cos 60 + FY \cos 30)^2)^{1/2}$				TENSION = $(FX \cos 30 - FY \cos 60)$		

1 STRESS RATIO = SHEAR/25800 ≤ 1.4

Note: Units - Lbs.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-31-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5-10-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-10	Rev. No.	0

EXTREME LOADS (D-DBE)						
(See Load Case 3, file "MPR5A-DB.P10", ADVENT file C94003.1.1.C)						
NODE #	FX	FY	FZ	SHEAR	TENSION	STRESS RATIO ¹
1808	-410	-1224	617	741	-1224	0.029
1809	-188	-156	492	527	-156	0.020
1810	-139	-633	319	348	-633	0.013
1816	-598	-1225	617	859	-1225	0.033
1817	-163	-156	493	519	-156	0.020
1818	-27	-633	318	319	-633	0.012
SHEAR = $(FX^2 + FZ^2)^{1/2}$				TENSION = FY		
1939	-133	-32	389	391	-131	0.015
1940	1	-133	313	334	-66	0.013
1941	243	76	213	220	249	0.009
1947	-71	-167	634	643	-145	0.025
1948	-29	-117	363	374	-83	0.014
1949	212	117	223	223	242	0.009
SHEAR = $(FZ^2 + (FX \cos 60 - FY \cos 30)^2)^{1/2}$				TENSION = $(FX \cos 30 + FY \cos 60)$		
2070	-1168	-168	630	964	-928	0.037
2071	-165	-114	361	404	-86	0.016
2072	-353	130	214	224	-371	0.009
2078	-1165	-31	385	721	-993	0.028
2079	-175	-146	273	347	-79	0.013
2080	-383	37	196	253	-350	0.010
SHEAR = $(FZ^2 + (FX \cos 60 + FY \cos 30)^2)^{1/2}$				TENSION = $(FX \cos 30 - FY \cos 60)$		

1 STRESS RATIO = SHEAR/25800 ≤ 1.4

Note: Units - Lbs.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	6-3-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	6/4/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-11	Rev. No.	0

Check tension for Normal loads

Enveloped SHEAR = 1561 Lbs. (See sheet 7-8)
Enveloped TENSION = 690 Lbs. (See sheet 7-8)

$$F_t = 55 - 1.8 (1.561/1.227) = 52.71 \text{ ksi} > 44 \text{ ksi.} \therefore F_t = 44 \text{ ksi}$$

$$\text{Stress ratio} = (690/54000) = 0.013 < 1.0.$$

(Tension is not governing)

Check tension for Extreme Loads

Enveloped SHEAR = 2570 Lbs.
Enveloped TENSION = 1511 Lbs.

$$F_t = 55 - 1.8 (2.57/1.227) = 51.23 \text{ ksi} > 44 \text{ ksi.} \therefore F_t = 44 \text{ ksi}$$

$$\text{Stress ratio} = (1511/54000) = 0.028 < 1.6$$

(Tension is not governing)

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-26-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5/27/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-13	Rev. No.	81

Connection between REAL 1 & REAL 3 (TYP. @ 3 Places)

See Sheet 5, Dwg. H-2-821101

Weld Type: Complete-Penetration Groove weld

Connection between REAL 1 & REAL 4 (TYP. @ 3 Places)

See Sheet 5, Dwg. H-2-821101

Weld Type: 3/8" FILLET on one side and 3/16" BEVEL on the other side.

~~Allowable:~~

~~$$\begin{aligned} \text{Fillet weld} &= 0.3 \times 70 \times 0.707 \times 3/8 = 5.568 \text{ kip/in.} \\ \text{Bevel weld} &= 0.3 \times 70 \times (3/16) = 3.938 \text{ kip/in.} \end{aligned}$$~~

~~$$\text{Total} = 9.505 \text{ kip/in.}$$~~

~~$$\text{Base Metal} = 0.4 \times 30 \times (0.5") = 6.0 \text{ kip/in.}$$~~

~~$$(* 0.1875 + 0.375 = 0.5625 > 0.5, \therefore \text{Use, } 0.5")$$~~

SEE SHEET NO. 7-30a

(Governs)

[Signature]
9-13-94
WVH 9/13/94

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	6-3-94
Subject	Structural Analysis of Multiport Riser SA	Reviewed By:	<i>[Signature]</i>	Date	6/4/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-12	Rev. No.	8/1

7.1.4 Evaluation of Welded Connections

7.1.4.1 Allowable Weld Capacity

~~ASSUMED: Included angle at root of partial penetration groove weld = 60°.
(Effective throat thickness = Depth of chamfer, Table J2.1, Ref. 2.1.19)~~

*1-13-1
with 7/12*

Connection between REAL 1 & REAL 20

See Sheet 6, Dwg. H-2-821101

Weld Type: Two concentric circles of 1/4" FILLET weld 1" apart.

Allowable: Based on 1/8" fillet weld (Conservative)

$$\text{Fillet weld} = 0.3 \times 70 \times 0.707 \times (2 \times 1/8) = 3.712 \text{ kip/in.}$$

$$\text{Base Metal} = 0.4 \times 25 \times (0.25) = 2.5 \text{ kip/in.} \quad (\text{Governs})$$

Connection between REAL 1 & REAL 2 (TYP. @ 3 Places)

See Sheet 6, Dwg. H-2-821101

Weld Type: 3/16" FILLET on one side and BEVEL on both sides.

REVISED.
SEE SHEET NOS.
I-4 & I-14)
AL 4-2-94
with 7/12/94

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	2/3/97
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-14	Rev. No.	0

Connection between REAL 1 & REAL 8 (TYP. @ 3 Places)

See Sheet 3, Dwg. H-2-821101

Weld Type: 3/8" FILLET on both sides.

Allowable:

$$\text{Fillet weld} = 0.3 \times 70 \times 0.707 \times (0.5") = 7.424 \text{ kip/in.}$$

$$\text{Base Metal} = 0.4 \times 30 \times (0.5") = 6.0 \text{ kip/in.} \quad (\text{Governs})$$

$$(* 0.375 + 0.375 = 0.75 > 0.5, \therefore \text{Use, } 0.5")$$

Connection between REAL 2 & REAL 3 (TYP. @ 6 Places)

See Sheet 5, Dwg. H-2-821101

Weld Type: Complete-Penetration Groove weld

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5/31/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-15	Rev. No.	0

Connection between REAL 3 & REAL 5 (TYP. @ 3 Places)

See Sheet 4, Dwg. H-2-821101

Weld Type: Complete-Penetration Groove weld

Connection between REAL 3 & REAL 6 (TYP. @ 6 Places)

See Sheet 4, Dwg. H-2-821101

Weld Type: Complete-Penetration Groove weld

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-15-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5-15-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-16	Rev. No.	0

Connection between REAL 3 & REAL 8 (TYP. @ 3 Places)

See Sheet 5, Dwg. H-2-821101

Weld Type: 3/8" FILLET on both sides.

Allowable:

$$\text{Fillet weld} = 0.3 \times 70 \times 0.707 \times (0.5") = 7.424 \text{ kip/in.}$$

$$\text{Base Metal} = 0.4 \times 30 \times (0.5") = 6.0 \text{ kip/in.} \quad (\text{Governs})$$

$$(* 0.375 + 0.375 = 0.75 > 0.5, \therefore \text{Use, } 0.5")$$

Connection between REAL 4 & REAL 8 (TYP. @ 3 Places)

See Sheet 5, Dwg. H-2-821101

Weld Type: 3/8" FILLET on both sides.

Allowable:

$$\text{Fillet weld} = 0.3 \times 70 \times 0.707 \times (0.5") = 7.424 \text{ kip/in.}$$

$$\text{Base Metal} = 0.4 \times 30 \times (0.5") = 6.0 \text{ kip/in.} \quad (\text{Governs})$$

$$(* 0.375 + 0.375 = 0.75 > 0.5, \therefore \text{Use, } 0.5")$$

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5-17-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-17	Rev. No.	2 1

Connection between REAL 4 & REAL 9 (TYP. @ 3 Places)

See Sheet 4, Dwg. H-2-821101

Weld Type: 3/8" FILLET on one side and 3/16" BEVEL on the other side.

Allowable:

$$\text{Fillet weld} = 0.3 \times 70 \times 0.707 \times 3/8 = 5.568 \text{ kip/in.}$$

$$\text{Bevel weld} = 0.3 \times 70 \times (3/16) = 3.938 \text{ kip/in.}$$

$$\text{Total} = 9.505 \text{ kip/in.}$$

$$\text{Base Metal} = 0.4 \times 30 \times (0.5") = 6.0 \text{ kip/in.} \quad (\text{Governs})$$

$$(* 0.1875 + 0.375 = 0.5625 > 0.5, \therefore \text{Use, } 0.5")$$

See Sheet NO. 7-80 a and 7-80 b

Connection between REAL 5 & REAL 6 (TYP. @ 3 Places)

See Sheet 6, Dwg. H-2-821101

Weld Type: 5/16" FILLET on one side and BEVEL on both sides.

REVISED
(SEE SHEET NO. I-4 & I-16)

[Signature] 9-13-94

with 9/13/94

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5-31-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-18	Rev. No.	0

Connection between REAL 5 & REAL 8 (TYP. @ 3 Places)

See Sheet 3, Dwg. H-2-821101

Weld Type: 3/8" FILLET on both sides.

Allowable:

$$\text{Fillet weld} = 0.3 \times 70 \times 0.707 \times (0.5") = 7.424 \text{ kip/in.}$$

$$\text{Base Metal} = 0.4 \times 30 \times (0.5") = 6.0 \text{ kip/in.} \quad (\text{Governs})$$

$$(* 0.375 + 0.375 = 0.75 > 0.5, \therefore \text{Use, } 0.5")$$

Connection between REAL 5 & REAL 9 (TYP. @ 3 Places)

See Sheet 6, Dwg. H-2-821101

Weld Type: 1/4" FILLET on one side and BEVEL on both sides.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5/31/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-19	Rev. No.	0

Connection between REAL 5 & REAL 10 (TYP. @ 1 Places)

See Sheet 3, Dwg. H-2-821101 (Section L-L)

Weld Type: 7/16" FILLET on both sides.

Allowable: Based on 3/8" fillet weld on both sides (Conservative)

$$\text{Fillet weld} = 0.3 \times 70 \times 0.707 \times (2 \times 3/8) = 11.135 \text{ kip/in.}$$

$$\text{Base Metal} = 0.4 \times 30 \times (2 \times 3/8) = 9.0 \text{ kip/in.} \quad (\text{Governs})$$

Connection between REAL 5 & REAL 11 (TYP. @ 1 Places)

See Sheet 3, Dwg. H-2-821101 (Section L-L)

Weld Type: 7/16" FILLET on both sides.

Allowable: Based on 3/8" fillet weld on both sides (Conservative)

$$\text{Fillet weld} = 0.3 \times 70 \times 0.707 \times (2 \times 3/8) = 11.135 \text{ kip/in.}$$

$$\text{Base Metal} = 0.4 \times 30 \times (2 \times 3/8) = 9.0 \text{ kip/in.} \quad (\text{Governs})$$

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5-31-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-20	Rev. No.	0

Connection between REAL 5 & REAL 12 (TYP. @ 2 Places)

See Sheet 3, Dwg. H-2-821101 (Section L-L)

Weld Type: 7/16" FILLET on both sides.

Allowable: Based on 3/8" fillet weld on both sides (Conservative)

$$\text{Fillet weld} = 0.3 \times 70 \times 0.707 \times (2 \times 3/8) = 11.135 \text{ kip/in.}$$

$$\text{Base Metal} = 0.4 \times 30 \times (2 \times 3/8) = 9.0 \text{ kip/in.} \quad (\text{Governs})$$

Connection between REAL 8 & REAL 9 (TYP. @ 3 Places)

See Sheet 3, Dwg. H-2-821101 (View G-G)

Weld Type: 3/8" FILLET on both sides.

Allowable:

$$\text{Fillet weld} = 0.3 \times 70 \times 0.707 \times (0.5") = 7.424 \text{ kip/in.}$$

$$\text{Base Metal} = 0.4 \times 30 \times (0.5") = 6.0 \text{ kip/in.} \quad (\text{Governs})$$

$$(* 0.375 + 0.375 = 0.75 > 0.5, \therefore \text{Use, } 0.5")$$

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5/30/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-21	Rev. No.	0

Connection between REAL 10 & REAL 13 (TYP. @ 1 Places) Connection between REAL 11 & REAL 14 (TYP. @ 1 Places) Connection between REAL 12 & REAL 15 (TYP. @ 2 Places)

See Sheet 6, Dwg. H-2-821101

Weld Type: Complete-Penetration Groove weld.

Connection between REAL 21 & REAL 22 (TYP. @ 3 Places)

See Sheet 1 of 1, Dwg. H-2-821095, Rev. B.

Weld Type: 5/16" FILLET on both side.

Allowable: Based on 1/4" Fillet weld on both sides (Conservative)

$$\begin{array}{llll} \text{Fillet weld} & = & 0.3 \times 70 \times 0.707 \times (2 \times 1/4) & = 7.424 \text{ kip/in.} \\ \text{Base Metal} & = & 0.4 \times 36 \times (2 \times 1/4) & = 7.2 \text{ kip/in.} \quad (\text{Governs}) \end{array}$$

Connection between REAL 21 & REAL 23 (TYP. @ 3 Places)

See Sheet 1 of 1, Dwg. H-2-821095, Rev. B.

Weld Type: Complete-Penetration Groove weld

Connection between REAL 22 & REAL 23 (TYP. @ 3 Places)

See Sheet 1 of 1, Dwg. H-2-821095, Rev. B.

Weld Type: 3/8" FILLET on both sides.

$$\begin{array}{llll} \text{Allowable: Fillet weld} & = & 0.3 \times 70 \times 0.707 \times (0.5^*) & = 7.424 \text{ kip/in.} \\ \text{Base Metal} & = & 0.4 \times 36 \times (0.5^*) & = 7.2 \text{ kip/in.} \quad (\text{Governs}) \end{array}$$

(* 0.375 + 0.375 = 0.75" > 0.5", ∴ Use, 0.5")

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>dlw msh</i>	Date	5-30-96
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Lawrence</i>	Date	5/31/96
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-22	Rev. No.	0

Connection between REAL 21 & REAL 24 (TYP. @ 3 Places)

See Sheet 1 of 1, Dwg. H-2-821095, Rev. B.

Weld Type: Complete-Penetration Groove weld

Connection between REAL 22 & REAL 24 (TYP. @ 3 Places)

See Sheet 1 of 1, Dwg. H-2-821095, Rev. B.

Weld Type: Complete-Penetration Groove weld

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	6-3-94
Subject	Structural Analysis of Multiport Riser SA	Reviewed By:	<i>[Signature]</i>	Date	6/4/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-23	Rev. No.	0

7.1.4.2 Calculation of Weld Properties

Connection between REAL 1 & REAL 4 (TYP. @ 3 Places)

Distance between Key points 17 and 18 = 3.5" (1 segment)

Corresponding weld length = 3.25"

Min. tributary length of weld, $L_w = 3.25/2 = 1.625"$

Section modulus, $S = 6.5 \times 0.5 = 3.25 \text{ in}^3/\text{in}$

Connection between REAL 1 & REAL 8 (TYP. @ 3 Places)

Distance between Key points 17 and 15 = 6.7" (1 segment)

Distance between Key points 15 and 14 = 13.3" (3 Segments)

Distance between Key points 14 and 11 = 5.75" (1 segment) ← *Governs*

Tributary length of weld, $L_w = 5.75/2 = 2.875"$

Section modulus, $S = 25 \times 0.5 = 12.5 \text{ in}^3/\text{in}$

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser SA	Reviewed By:	<i>[Signature]</i>	Date	5-31-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-24	Rev. No.	0

Connection between REAL 3 & REAL 8 (TYP. @ 3 Places)

Distance between Key points 11 and 41 = 24.625" (3 Segments)

Corresponding weld length = 24"

Tributary length of weld, L_w = $24/3$ = 8" (for interior nodes)
 = $24/6 + 5.5/2$ = 6.75" (for exterior nodes)

Section modulus, S = 24×0.5 = 12 in³/in

Connection between REAL 4 & REAL 8 (TYP. @ 3 Places)

Distance between Key points 17 and 47 = 24.625" (3 Segments)

Corresponding weld length = 24"

Min. tributary length of weld, L_w = $24/6$ = 4"

Section modulus, S = 24×0.5 = 12 in³/in

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	2/21/97
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-25	Rev. No.	0

Connection between REAL 4 & REAL 9 (TYP. @ 3 Places)

Distance between Key points 47 and 48 = 3.5" (1 segment)

Corresponding weld length = 3.25"

Min. tributary length of weld, $L_w = 3.25/2 = 1.625"$

Section modulus, $S = 6.5 \times 0.5 = 3.25 \text{ in}^3/\text{in}$

Connection between REAL 5 & REAL 8 (TYP. @ 3 Places)

Distance between Key points 41 and 44 = 5.75" (1 segment)

Corresponding weld length = 5.5"

Min. tributary length of weld, $L_w = 5.5/2 = 2.75"$

Section modulus, $S = 5.5 \times 0.5 = 2.75 \text{ in}^3/\text{in}$

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5-30-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-26	Rev. No.	0

Connection between REAL 5 & REAL 10 (TYP. @ 1 Places)

Weld: Two concentric circles of 7/16" Fillet weld, 2" apart
(Sec. L-L, Sheet 3, Dwg. H-2-821101)

$$\text{Length of weld, } L_w = \pi D = \pi \times 18.969 = 59.6 \text{ in}$$

$$\text{Section modulus, } S = bd = (\pi D)d = 59.6 \times 2 = 119.2 \text{ in}^3/\text{in.}$$

$$\text{Tributary } L_w = 59.6/26 = 2.292 \text{ in.} \quad (\text{Where 26 is the no. of nodes})$$

$$\text{Tributary } S = 119.2/26 = 4.584 \text{ in}^3/\text{in.}$$

Connection between REAL 5 & REAL 11 (TYP. @ 1 Places)

Weld: Two concentric circles of 7/16" Fillet weld, 2" apart
(Sec. L-L, Sheet 3, Dwg. H-2-821101)

$$\text{Length of weld, } L_w = \pi D = \pi \times 12.063 = 37.9 \text{ in}$$

$$\text{Section modulus, } S = bd = (\pi D)d = 37.9 \times 2 = 75.8 \text{ in}^3/\text{in.}$$

$$\text{Tributary } L_w = 37.9/20 = 1.895 \text{ in.} \quad (\text{Where, 20 is the no. of nodes})$$

$$\text{Tributary } S = 75.8/20 = 3.79 \text{ in}^3/\text{in.}$$

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5/31/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-27	Rev. No.	0

Connection between REAL 5 & REAL 12 (TYP. @ 2 Places)

Weld: Two concentric circles of 7/16" Fillet weld, 2" apart
(Sec. L-L, Sheet 3, Dwg. H-2-821101)

$$\text{Length of weld, } L_w = \pi D = \pi \times 8.125 = 25.525 \text{ in}$$

$$\text{Section modulus, } S = bd = (\pi D)d = 25.525 \times 2 = 51.051 \text{ in}^3/\text{in.}$$

$$\text{Tributary } L_w = 25.525/16 = 1.595 \text{ in.} \quad (\text{Where 16 is the no of nodes})$$

$$\text{Tributary } S = 51.051/16 = 3.191 \text{ in}^3/\text{in.}$$

Connection between REAL 8 & REAL 9 (TYP. @ 3 Places)

Distance between Key points 44 and 45 = 13.3" (3 Segments) ← *Governs*

Distance between Key points 45 and 47 = 5.5" (1 segment)

$$\text{Min. tributary length of weld, } L_w = 13.3/6 = 2.217"$$

$$\text{Section modulus, } S = 19.5 \times 0.5 = 9.75 \text{ in}^3/\text{in}$$

Connection between REAL 21 & REAL 22 (TYP. @ 3 Places)

Distance between Key points 714 and 724 = 17.05" (4 segments)

Corresponding weld length = 17.05 - 0.25 = 16.8"

$$\text{Minimum tributary length of weld, } L_w = 16.8/8 = 2.1"$$

$$\text{Section modulus, } S = 16.8 \times 0.5 = 8.4 \text{ in}^3/\text{in (Cons.)}$$

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5-31-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-28	Rev. No.	0

Connection between REAL 22 & REAL 23 (TYP. @ 3 Places)

Distance between Key points 714 and 744 = 10.375" (Elem. size = 5.1875")

Distance between Key points 744 and 774 = 24.625"

(Outer elem. size = 3" & inner elem. size = 9")

Minimum tributary length of weld, $L_w = 3/2 = 1.5"$

Section modulus, $S = 35 \times 0.5 = 17.5 \text{ in}^3/\text{in (Cons.)}$

Connection between REAL 1 & REAL 20

Weld: Two concentric circles of 1/4" Fillet weld
(Sheet 6, Dwg. H-2-821101)

Length of weld, $L_w = \pi D = \pi \times 41.25 = 129.59 \text{ in}$

Section modulus, $S = bd = (\pi D)d = 129.59 \times 1 = 129.59 \text{ in}^3/\text{in.}$

Tributary $L_w = 129.6/36 = 3.6 \text{ in.}$ (Where 36 is the no of nodes)

Tributary $S = 129.6/36 = 3.6 \text{ in}^3/\text{in.}$

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	6-3-94
Subject	Structural Analysis of Multiport Riser SA	Reviewed By:	<i>Ravi Mig</i>	Date	6/4/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-24	Rev. No.	0

7.1.4.3 Weld Evaluation

The nodal average force (*ANSYS NFORCE*) is printed based on each welded connection in post processing. First, the elements and nodes of one of the plates being connected are selected as a *group*. Then the nodes along the welded connection are re-selected from that group as a *sub-group* and the *NFORCE* is printed.

The multiport riser has members and connections at 120° symmetry. Therefore, three separate post-processing are performed by rotating the global coordinates to coincide with the members/elements local axis.

Enveloped forces (FX, FY, FZ) are obtained from each *sub-group* of nodes and listed in the Table below. The absolute summation of in-plane moments (MX or MY or MZ) is obtained from the sub-group of nodes and listed in the table below, with an exception to welded connection of all risers. For welded connection of risers, enveloped nodal in-plane moments are listed in the table. Then the forces in the weld are calculated using the minimum tributary length of weld (L_w) and full section modulus (S) or tributary section modulus (S_n), as applicable. The weld properties (L_w , S or S_n) and DB weld capacity (F_w) calculations are shown on sheet nos. 7-12 thru 7-28. Demand force in the weld (depends of the orientation of the weld):

$$\begin{aligned} f_w &= [(FX/L_w + 2*\Sigma M/S)^2 + (FY/L_w)^2 + (FZ/L_w)^2]^{1/2} \quad \text{OR} \\ &= [(FX/L_w)^2 + (FY/L_w + 2*\Sigma M/S)^2 + (FZ/L_w)^2]^{1/2} \quad \text{OR} \\ &= [(FX/L_w)^2 + (FY/L_w)^2 + (FZ/L_w + 2*\Sigma M/S)^2]^{1/2} \end{aligned}$$

Demand force in weld (for 8", 12" and 20" risers at the intersection of Top shield plate and for 42" riser at the intersection of bottom triangular plate):

$$f_w = [(FX/L_w + 2*M/S_n)^2 + (FY/L_w)^2 + (FZ/L_w)^2]^{1/2}$$

Where, M = SRSS of MX and MY

$$\text{STRESS RATIO (S.R.)} = f_w/F_w \leq 1.0 \quad (\text{Normal Load: D})$$

$$= f_w/F_w \leq 1.4 \quad (\text{Extreme Load: D} \pm S)$$

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-30	Rev. No.	0-1

NORMAL LOADS - D (lbs)									
Connection between:	FX	FY	FZ	ΣM	L _{PR}	S	f _{PR}	F _{PR}	S.R
See Load Case 1, file: MPR5A-DB.PIO, ADVENT file C94003.1.1.C									
REAL 1 & REAL 2 (WEST)	266	108	4	52					
REAL 1 & REAL 3 (WEST)	203	106	864	312					
REAL 1 & REAL 4 (WEST)	27	18	438	32					
REAL 1 & REAL 8 (WEST)	0	1410	1333	0					
REAL 2 & REAL 3 (S of E PRV)	266	108	8	24					
REAL 2 & REAL 3 (N of E PRV)	266	108	8	24					
REAL 2 & REAL 7 (EAST)	8	0	8	2					
REAL 3 & REAL 5 (WEST)	272	95	1836	1813					
REAL 3 & REAL 6 (N of E PRV)	6	24	21	3					
REAL 3 & REAL 6 (S of E PRV)	6	24	21	3					
REAL 3 & REAL 7 (S of E PRV)	5	0	12	0					
REAL 3 & REAL 7 (N of E PRV)	5	0	12	0					
REAL 3 & REAL 8 (WEST)	0	2127	3462	0					
REAL 4 & REAL 8 (WEST)	0	289	1143	0					
REAL 4 & REAL 9 (WEST)	65	23	458	74					
REAL 5 & REAL 6 (EAST)	18	24	16	323					
REAL 5 & REAL 8 (WEST)	0	2787	2935	0					
REAL 5 & REAL 9 (WEST)	500	1218	42	236					
REAL 6 & REAL 7 (WEST)	6	0	11	1					

* Re-evaluated (See Sheet Nos. I-14 and I-15)
 ** Re-evaluated (See Sheet Nos. I-16, I-17 and I-18)

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	7-1-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-31	Rev. No.	0

NORMAL LOADS - D (Lbs)										
Connection between:	FX	FY	FZ	EM	L _w	S	f _w	F _w	S.R	
REAL 8 & REAL 9 (WEST)	0	1218	89	0	2.217	9.75	551	6000	0.092	
REAL 21 & REAL 22 (WEST)	0	959	532	0	2.1	8.40	522	7200	0.073	
REAL 21 & REAL 23 (WEST)	1088	12	2654	148	Complete-penetration groove weld, ∴ O.K.					
REAL 22 & REAL 23 (WEST)	0	1038	1450	0	1.5	17.50	1189	7200	0.165	
REAL 21 & 24, and REAL 22 & 24 (WEST)	1582	13	3189	0	Complete-penetration groove weld, ∴ O.K.					
				SRSS of MX & MY		S _n				
REAL 5 & REAL 10	133	103	567	124	2.292	4.584	275	9000	0.031	
REAL 5 & REAL 11	126	138	691	79	1.895	3.79	387	9000	0.043	
REAL 5 & REAL 12 (NORTH)	134	142	368	31	1.585	3.17	270	9000	0.030	
REAL 5 & REAL 12 (SOUTH)	134	142	368	31	1.585	3.17	270	9000	0.030	
REAL 10 & REAL 13	67	78	74	56	Complete-penetration groove weld, ∴ O.K.					
REAL 11 & REAL 14	100	69	394	261						
REAL 12 & REAL 15 (NORTH)	13	14	84	29						
REAL 12 & REAL 15 (SOUTH)	13	14	84	29						
REAL 1 & REAL 20	88	108	14	30	3.622	3.622	51	2500	0.020	

Project:	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date:	5-30-94
Subject:	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date:	5-30-94
System:	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-32	Rev. No.	8 1

NORMAL LOADS - D (lbs)									
Connection between:	FX	FY	FZ	ΣM	L _W	S	t _W	F _W	S.R
See Load Case 1, file: MPR5A-DB.P20, ADVENT file C94003.1.1.D									
REAL 1 & REAL 2 (SOUTH)	364	228	4	72	(Fillet & two side Bevel weld, :: O.K. *)				
REAL 1 & REAL 3 (NORTH)	409	65	714	374	Complete-penetration groove weld, :: O.K.				
REAL 1 & REAL 4 (NORTH)	37	19	390	61	(1.625	3.25	279	6000	0.046
REAL 1 & REAL 8 (NORTH)	1	977	983	8	2.875	12.50	483	6000	0.080
REAL 2 & REAL 3 (E of S PRV)	130	228	9	37	Complete-penetration groove weld, :: O.K.				
REAL 2 & REAL 3 (W of S PRV)	364	138	9	14	Complete-penetration groove weld, :: O.K.				
REAL 2 & REAL 7 (SOUTH)	125	0	67	3	N/A				
REAL 3 & REAL 5 (NORTH)	419	103	1198	1560	Complete-penetration groove weld, :: O.K.				
REAL 3 & REAL 6 (W of S PRV)	32	31	20	1	Complete-penetration groove weld, :: O.K.				
REAL 3 & REAL 6 (E of S PRV)	41	127	22	21	Complete-penetration groove weld, :: O.K.				
REAL 3 & REAL 7 (W of S PRV)	6	29	136	0	N/A				
REAL 3 & REAL 7 (E of S PRV)	11	45	154	0	N/A				
REAL 3 & REAL 8 (NORTH)	1	1658	2793	2	4	12.00	812	6000	0.135
REAL 4 & REAL 8 (NORTH)	37	295	862	4	4	12.00	228	6000	0.038
REAL 4 & REAL 9 (NORTH)	46	16	351	43	1.625	3.25	244	6000	0.041
REAL 5 & REAL 6 (SOUTH)	132	143	22	119	(Fillet & two side Bevel weld, :: O.K. **)				
REAL 5 & REAL 8 (NORTH)	1	2067	2657	1	2.75	2.75	1225	6000	0.204
REAL 5 & REAL 9 (NORTH)	354	889	36	205	Fillet & two side Bevel weld, :: O.K.				
REAL 6 & REAL 7 (SOUTH)	96	0	79	3	N/A				

* Re-evaluated (See Sheet Nos. I-14 and I-15)
 ** Re-evaluated (See Sheet Nos. I-16, I-17 and I-18)

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5-30-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-33	Rev. No.	0

NORMAL LOADS - D (Lbs)									
Connection between:	FX	FY	FZ	ΣM	L _w	S	f _w	F _w	S.R
REAL 8 & REAL 9 (NORTH)	23	889	77	4	2.217	9.75	403	6000	0.067
REAL 21 & REAL 22 (NORTH)	1	785	390	16	2.1	8.40	419	7200	0.058
REAL 21 & REAL 23 (NORTH)	855	8	2069	95	Complete-penetration groove weld, ∴ O.K.				
REAL 22 & REAL 23 (NORTH)	3	1235	978	15	1.5	17.50	1052	7200	0.146
REAL 21 & 24, and REAL 22 & 24 (NORTH)	1217	10	2455	6	Complete-penetration groove weld, ∴ O.K.				

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:		Date	
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-34	Rev. No.	8 1

NORMAL LOADS - D (lbs)

Connection between:	FX	FY	FZ	ΣM	L _{wp}	S	f _{wp}	F _{wp}	S.R
See Load Case 1, file: MPR5A-DBP30, ADVENT file C94003.1.1.E									
REAL 1 & REAL 2 (NORTH)	364	228	4	72	(Fillet & two side Bevel weld, :: O.K.)*				
REAL 1 & REAL 3 (SOUTH)	409	65	714	374	Complete-penetration groove weld, :: O.K.				
REAL 1 & REAL 4 (SOUTH)	37	19	390	61	1.625	3.25	279	6000	0.046
REAL 1 & REAL 8 (SOUTH)	1	977	983	8	2.875	12.50	483	6000	0.080
REAL 2 & REAL 3 (W of N PRV)	364	138	9	14	Complete-penetration groove weld, :: O.K.				
REAL 2 & REAL 3 (E of N PRV)	130	228	9	37	N/A				
REAL 2 & REAL 7 (NORTH)	125	0	67	3	N/A				
REAL 3 & REAL 5 (SOUTH)	419	103	1198	1560	Complete-penetration groove weld, :: O.K.				
REAL 3 & REAL 6 (W of N PRV)	32	31	20	1	Complete-penetration groove weld, :: O.K.				
REAL 3 & REAL 6 (E of N PRV)	41	127	22	21	N/A				
REAL 3 & REAL 7 (W of N PRV)	33	0	136	0	N/A				
REAL 3 & REAL 7 (E of N PRV)	59	0	154	0	N/A				
REAL 3 & REAL 8 (SOUTH)	1	1658	2793	2	4	12.00	812	6000	0.135
REAL 4 & REAL 8 (SOUTH)	37	295	862	4	4	12.00	228	6000	0.038
REAL 4 & REAL 9 (SOUTH)	46	16	351	43	1.625	3.25	244	6000	0.041
REAL 5 & REAL 6 (NORTH)	132	143	22	119	(Fillet & two side Bevel weld, :: O.K.)*				
REAL 5 & REAL 8 (SOUTH)	1	2067	2657	1	2.75	2.75	1225	6000	0.204
REAL 5 & REAL 9 (SOUTH)	354	889	36	205	Fillet & two side Bevel weld, :: O.K.				
REAL 6 & REAL 7 (NORTH)	96	0	79	3	N/A				

A see sheet no. 7-80a

AA see sheet no. 7-80a & b

Re-evaluated (See Sheet Nos. I-14 and I-15)

Re-evaluated (See Sheet Nos. I-16, I-17 and I-18)

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Ravi Minj</i>	Date	5/31/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-35	Rev. No.	0

NORMAL LOADS - D (Lbs)									
Connection between:	FX	FY	FZ	ΣM	L _w	S	f _{wp}	F _w	S.R
REAL 8 & REAL 9 (SOUTH)	23	889	77	4	2.217	9.75	403	6000	0.067
REAL 21 & REAL 22 (SOUTH)	1	785	390	16	2.1	8.40	419	7200	0.058
REAL 21 & REAL 23 (SOUTH)	855	8	2069	95	Complete-penetration groove weld, ∴ O.K.				
REAL 22 & REAL 23 (SOUTH)	3	1235	978	15	1.5	17.50	1052	7200	0.146
REAL 21 & 24, and REAL 22 & 24 (SOUTH)	1217	10	2455	6	Complete-penetration groove weld, ∴ O.K.				

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	11/1/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-36	Rev. No.	8 1

EXTREME LOADS: D+S (lbs)

Connection between:	FX	FY	FZ	ΣM	L _{PP}	S	f _{PP}	F _{PP}	SR
See Load Case 6, file: MPR5A-DB.P10, ADVENT file C94003.1.1.C									
REAL 1 & REAL 2 (WEST)	407	207	8	76	(Fillet & two side Bevel weld, ± O.K. *)				
REAL 1 & REAL 3 (WEST)	626	215	1047	394	Complete-penetration groove weld, ± O.K.				
REAL 1 & REAL 4 (WEST)	759	35	647	122	1.625	3.25	665	6000	0.111
REAL 1 & REAL 8 (WEST)	3	1717	2545	24	2.875	12.50	1071	6000	0.179
REAL 2 & REAL 3 (S of E PRV)	399	207	9	33	Complete-penetration groove weld, ± O.K.				
REAL 2 & REAL 3 (N of E PRV)	399	207	9	33	Complete-penetration groove weld, ± O.K.				
REAL 2 & REAL 7 (EAST)	80	0	104	7	N/A				
REAL 3 & REAL 5 (WEST)	972	141	2278	2154	Complete-penetration groove weld, ± O.K.				
REAL 3 & REAL 6 (N of E PRV)	29	104	30	26	Complete-penetration groove weld, ± O.K.				
REAL 3 & REAL 6 (S of E PRV)	29	103	30	26	Complete-penetration groove weld, ± O.K.				
REAL 3 & REAL 7 (S of E PRV)	65	0	107	3	N/A				
REAL 3 & REAL 7 (N of E PRV)	65	0	108	3	N/A				
REAL 3 & REAL 8 (WEST)	2	2887	4038	25	4	12.00	1243	6000	0.207
REAL 4 & REAL 8 (WEST)	759	522	1637	2680	4	12.00	733	6000	0.122
REAL 4 & REAL 9 (WEST)	297	29	663	94	1.625	3.25	501	6000	0.083
REAL 5 & REAL 6 (EAST)	109	78	21	441	(Fillet & two side Bevel weld, ± O.K. *)				
REAL 5 & REAL 8 (WEST)	2	3434	3957	8	2.75	2.75	1910	6000	0.318
REAL 5 & REAL 9 (WEST)	615	1538	50	284	Fillet & two side Bevel weld, ± O.K.				
REAL 6 & REAL 7 (WEST)	68	0	101	6	N/A				

▲ See Sheet 7-80 a
 ▲ See Sheet 7-80 a d-b

Re-evaluated (See Sheet Nos. I-14 and I-15)
 Re-evaluated (See Sheet Nos. I-16, I-17 and I-18)

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5/31/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-37	Rev. No.	0

EXTREME LOADS : D±S (Lbs)									
Connection between:	FX	FY	FZ	ΣM	L _w	S	f _w	F _w	S.R
REAL 8 & REAL 9 (WEST)	1115	3948	108	144	2.217	9.75	1852	6000	0.309
REAL 21 & REAL 22 (WEST)	13	1333	1425	112	2.1	8.40	949	7200	0.132
REAL 21 & REAL 23 (WEST)	1421	20	3422	204	Complete-penetration groove weld, ∴ O.K.				
REAL 22 & REAL 23 (WEST)	16	2206	1681	141	1.5	17.50	1862	7200	0.259
REAL 21 & 24, and REAL 22 & 24 (WEST)	4058	32	4178	126	Complete-penetration groove weld, ∴ O.K.				
				SRSS of MX & MY		S _n			
REAL 5 & REAL 10	210	450	762	169	2.292	4.584	420	9000	0.047
REAL 5 & REAL 11	572	839	1511	136	1.895	3.79	986	9000	0.110
REAL 5 & REAL 12 (NORTH)	417	491	602	44	1.585	3.17	570	9000	0.063
REAL 5 & REAL 12 (SOUTH)	416	489	596	45	1.585	3.17	567	9000	0.063
REAL 10 & REAL 13	613	574	369	66	Complete-penetration groove weld, ∴ O.K.				
REAL 11 & REAL 14	770	761	1209	312					
REAL 12 & REAL 15 (NORTH)	315	229	378	33					
REAL 12 & REAL 15 (SOUTH)	261	206	399	33					
REAL 1 & REAL 20	246	507	45	34	3.622	3.622	165	2500	0.066

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5-31-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-38	Rev. No.	8

EXTREME LOADS : D±S (Lbs)

See Load Case 6, file: MPR5A-DB.P20, ADVENT file C94003.1.1.D

Connection between:	FX	FY	FZ	ΣM	I _{xy}	S	f _{xy}	F _{xy}	S.R
REAL 1 & REAL 2 (SOUTH)	627	304	9	-126					
REAL 1 & REAL 3 (NORTH)	842	290	956	-479					
REAL 1 & REAL 4 (NORTH)	574	16	584	-158					
REAL 1 & REAL 8 (NORTH)	1112	642	2056	16					
REAL 2 & REAL 3 (E of S PRV)	445	54	11	25					
REAL 2 & REAL 3 (W of S PRV)	586	304	10	14					
REAL 2 & REAL 7 (SOUTH)	206	0	300	-8					
REAL 3 & REAL 5 (NORTH)	667	324	1660	-2050					
REAL 3 & REAL 6 (W of S PRV)	77	93	34	21					
REAL 3 & REAL 6 (E of S PRV)	256	84	39	12					
REAL 3 & REAL 7 (W of S PRV)	159	87	288	7					
REAL 3 & REAL 7 (E of S PRV)	194	116	304	6					
REAL 3 & REAL 8 (NORTH)	2279	1317	3700	24					
REAL 4 & REAL 8 (NORTH)	574	284	1224	2512					
REAL 4 & REAL 9 (NORTH)	250	12	517	-60					
REAL 5 & REAL 6 (SOUTH)	270	84	28	-452					
REAL 5 & REAL 8 (NORTH)	2413	1395	3686	5					
REAL 5 & REAL 9 (NORTH)	1063	1042	48	-270					
REAL 6 & REAL 7 (SOUTH)	186	0	274	-8					

Fillet & two side Bevel weld, ± O.K. *

Complete-penetration groove weld, ± O.K.

1.625 3.25 440 6000 0.073

2.875 12.50 845 6000 0.141

Complete-penetration groove weld, ± O.K.

N/A

Complete-penetration groove weld, ± O.K.

Complete-penetration groove weld, ± O.K.

N/A

N/A

4 12.00 1136 6000 0.189

4 12.00 595 6000 0.099

1.625 3.25 321 6000 0.053

Fillet & two side Bevel weld, ± O.K. *

2.75 2.75 1683 6000 0.281

Fillet & two side Bevel weld, ± O.K.

N/A

* Re-evaluated (See Sheet Nos. I-14 and I-15)

** Re-evaluated (See Sheet Nos. I-16, I-17 and I-18)

A SEE SHEET 7-800A

A SEE SHEET 7-800A & Y

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5/31/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-39	Rev. No.	0

EXTREME LOADS : D±S (Lbs)									
Connection between:	FX	FY	FZ	ΣM	L _W	S	f _W	F _W	S.R.
REAL 8 & REAL 9 (NORTH)	2609	1598	104	23	2.217	9.75	1381	6003	0.230
REAL 21 & REAL 22 (NORTH)	1062	615	1284	43	2.1	8.40	853	7200	0.119
REAL 21 & REAL 23 (NORTH)	1125	14	2700	-150	Complete-penetration groove weld, ∴ O.K.				
REAL 22 & REAL 23 (NORTH)	2216	1273	1324	100	1.5	17.50	1924	7200	0.267
REAL 21 & 24, and REAL 22 & 24 (NORTH)	3490	13	3527	113	Complete-penetration groove weld, ∴ O.K.				

Project	Westinghouse Hanford Company	REV. 0	Prepared By:	<i>W. W. W.</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser 5A		Reviewed By:	<i>W. W. W.</i>	Date	5/3/94
System	SY-101 H ₂ Mitigation Project		Job No.	94003	File No.	94003.1.1
Client Calc. No.			Sheet No.	7-40	Rev. No.	8 1

EXTREME LOADS : D±S (Lbs)

See Load Case 6, file: MPR5A-DB.P30, ADVENT file: C94003.1.1.E

Connection between:	FX	FY	FZ	ΣM	I _W	S	f _W	F _W	S.R
REAL 1 & REAL 2 (NORTH)	259	659	9	41					
REAL 1 & REAL 3 (SOUTH)	415	726	951	223					
REAL 1 & REAL 4 (SOUTH)	285	496	582	79					
REAL 1 & REAL 8 (SOUTH)	1	1281	2053	-35					
REAL 2 & REAL 3 (W of N PRV)	30	659	10	-28					
REAL 2 & REAL 3 (E of N PRV)	259	364	11	-47					
REAL 2 & REAL 7 (NORTH)	103	179	301	4					
REAL 3 & REAL 5 (SOUTH)	357	665	1662	986					
REAL 3 & REAL 6 (W of N PRV)	48	114	34	-104					
REAL 3 & REAL 6 (E of N PRV)	61	261	39	-115					
REAL 3 & REAL 7 (W of N PRV)	85	147	268	4					
REAL 3 & REAL 7 (E of N PRV)	88	153	288	4					
REAL 3 & REAL 8 (SOUTH)	1	2628	3694	25					
REAL 4 & REAL 8 (SOUTH)	257	615	1220	2464					
REAL 4 & REAL 9 (SOUTH)	126	214	515	29					
REAL 5 & REAL 6 (NORTH)	137	253	28	220					
REAL 5 & REAL 8 (SOUTH)	1	2781	3684	-10					
REAL 5 & REAL 9 (SOUTH)	474	1253	48	135					
REAL 6 & REAL 7 (NORTH)	93	162	275	4					

▲ see sheet 7-80a
 ▲ see sheet 7-80a & b
 * Re-evaluated (See Sheet Nos. I-14 and I-15)
 ** Re-evaluated (See Sheet Nos. I-16, I-17 and I-18) 9/13/94

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5/31/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-41	Rev. No.	0

EXTREME LOADS : D+S (Lbs)									
Connection between:	FX	FY	FZ	ΣM	L _{ip}	S	f _{ip}	F _{ip}	S.R
REAL 8 & REAL 9 (SOUTH)	79	3046	104	-318	2.217	9.75	1375	6000	0.229
REAL 21 & REAL 22 (SOUTH)	4	1218	1278	-87	2.1	8.40	826	7200	0.115
REAL 21 & REAL 23 (SOUTH)	564	974	2703	75	Complete-penetration groove weld, ∴ O.K.				
REAL 22 & REAL 23 (SOUTH)	6	2554	1324	110	1.5	17.50	1929	7200	0.268
REAL 21 & 24, and REAL 22 & 24 (SOUTH)	1743	3017	3541	113	Complete-penetration groove weld, ∴ O.K.				

Calculation Sheet

Project	Westinghouse Hanford Company		Prepared By:	<i>Henry D. Smith</i>	Date	6-3-94
Subject	Structural Analysis of Multiport Riser 5A		Reviewed By:	<i>Ravi M. Singh</i>	Date	6/4/94
System	SY-101 H ₂ Mitigation Project		Job No.	94003	File No.	94003.1.1
Client Calc. No.			Sheet No.	7-42	Rev. No.	0

7.1.5 Summary of Displacements

SUMMARY OF MAXIMUM VERTICAL (Z) DISPLACEMENT ANYWHERE DUE TO NORMAL (D) AND EXTREME (D ± DBE) LOADS

LOADS	MAX. DISPLACEMENT (in)
Normal (DL)	0.01499 @ Node # 1395 ^a
Extreme (DL ± Seismic)	0.01774 @ Node # 1395 ^b

Node no. 1395 is located at 12" riser flange (see sheet no. 7-82)

SUMMARY OF RELATIVE VERTICAL (Z) DISPLACEMENT AT BOTTOM OF 42" RISER DUE TO NORMAL (D) AND EXTREME (D ± DBE) LOADS

LOADS	NODE NO.	VERTICAL DISPLACEMENT (UZ) (in.)
NORMAL	180	-0.00890 ^a
	550	-0.00761 ^a
	743	-0.00716 ^a
	1123	-0.00761 ^a
EXTREME	180	-0.01010 ^b
	550	-0.00862 ^b
	743	-0.00812 ^b
	1123	-0.00863 ^b

See sheet no. 7-82 for the location of node nos. 180, 550, 743 and 1123.

^a See Load Case 1, file MPR5A-DB.P10, ADVENT computer file C94003.1.1.C

^b See Load Case 6, file MPR5A-DB.P10, ADVENT computer file C94003.1.1.C

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Ravi Nzing</i>	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>W. H. H. H.</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-42 a	Rev. No.	0

7.1.6 Evaluation of Concrete Footing :

The 15 ft x 15 ft x 3 ft thick existing concrete footing that will support the proposed MPR assembly was originally designed by Ebasco Services Incorporated (Reference 2.2.20) for the purposes of supporting the Test Chamber. ADVENT performed a cursory review of the referenced document. Following is a summary of critical design parameters of the original design.

Dead Weight of Test Chamber	= 38.5 kips
Vertical Seismic Acceleration	= 0.37g
Horizontal Seismic Acceleration for overturning	= 0.20g
Vertical Height for Overturning	= 7 ft

Two of these critical parameters, dead weight of the structure and vertical height for overturning, of the MPR assembly are 16.87 kips and @ 4 ft 10 in. (to top of 8" Riser), respectively. These parameters are considerably smaller than those used in the original design of the footing by EBASCO. Based on this comparison, we believe that the footing is adequately designed to resist the postulated design loads.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	6-3-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Rainier</i>	Date	6/4/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-42 b	Rev. No.	81

7.1.7 Analysis and Evaluation of Lifting Lugs

(See DWG. H-2-821101, Rev. B, Sheet 3)

Part # 34: 1/2" thick ASTM A240 304 SST Plate (See DWG. H-2-821101, Sheet 1)

Yield stress, $F_y = 30$ Ksi Ultimate tensile stress, $F_{ut} = 75$ ksiAllowable tensile stress, $F_t = 0.45 F_y = 13.5$ ksi

Section D3.1, Ref. 2.1.19

Allowable shear stress, $F_v = 0.40 F_y = 12.0$ ksi

Section F4, Ref. 2.1.19

Total weight of Multiport Riser = ~~6591 lbs~~ ~~7.0 kips~~ 8.69 KIPS. (SHEET NO. I-4)

Assume that the total weight is distributed equally to all three lugs and the direction of force is vertical (Conservative). DLF of 2.0 shall be used to account for dynamic impact per SDC 4.2 (Ref. 2.1.18) criteria.

Tensile stress, $f_t = (DLF \times 7/3) / A_e = 1.56$ ksi. ($A_e = 2 \times 0.5 \times (6-3) = 3 \text{ in}^2$)

Shear stress, $f_v = (DLF \times 7/3) / (0.5 \times 1.5) = 6.22$ ksi. (Cons.)

Stress ratio = $1.56/13.5 = 0.116$ 0.143

= $6.22/12 = 0.519$ (Governs) < 1.0, O.K.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	9-13-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	9/13/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-43	Rev. No.	1

7.2 Beyond Design Basis (BDB)

Beyond Design basis structural evaluation is performed per Section 7.2 of Reference 2.1.21. The member evaluation is shown on sheet nos. 7-44 and 7-45. The anchor bolts evaluation is shown on sheet nos. 7-46 and 7-47. The bolted connection evaluation is shown on sheet nos. 7-48 thru 7-50. The BDB weld capacity calculations are shown on sheet nos. 7-51 thru 7-61. The weld property calculations are shown on sheet nos. 7-23 thru 7-28. The welded connection evaluation is shown on sheet nos. 7-62 thru 7-80. Maximum displacement anywhere in the Multiport riser and also at the bottom of 42" riser are shown on sheet no. 7-81. Concrete footing evaluation is shown on sheet no. 7-83. Verification of linear transient dynamic analysis results calculations are shown on sheet nos. 7-84 thru 7-86.

7.2.1 Evaluation of Members

Demand members stresses, which include membrane and bending stresses, allowable member stresses and stress ratios are shown on Tables 7.3 and 7.4.

As per Section 7.2 of Reference 2.1.21, Beyond-Design-Basis Acceptance Criteria, the multiport riser shall not become a projectile and the tank contents shall not be expelled from the tank. Therefore, the multiport riser members are evaluated based on the following allowables:

Allowable Stress	= 0.7 x Ultimate tensile stress	(for stainless steel)
Allowable Stress	= 1.0 x Ultimate tensile stress	(for carbon steel)

Project:	Westinghouse Hanford Company	Prepared By:	<i>W. J. H. H.</i>	Date	9-13-94
Subject:	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>W. J. H. H.</i>	Date	9/13/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-45	Rev. No.	1

Table 7.4 : STRESSES IN VARIOUS MPR # 5A COMPONENTS

Load Case : Beyond-Design-Basis -- Case 2 : North-West Vent Closed -- Other Two Open

REAL #	Component (REAL) Description	Part No.*	Element No.	Demand**** Stress, psi	Allowable** Stress, psi	Stress Ratio
1	Bottom Triangular Plate	35 (1)	309	24,630	52,500	0.469
2	Bottom Plate of Pressure Relief Vent (PRV)	34 (1)	809	44,420	52,500	0.846
3	Side Plate of PRV & Diagonal Stiffener Plate between Top Shield Plate (REAL 5) and Bottom Triangular Plate (REAL 1)	35 (1)	817	41,253	52,500	0.786
4	Vertical Flange of Radial Vertical Stiffener	34 (1)	223	10,653	52,500	0.203
5	Top Shield Plate	37 (1)	1187	19,655	52,500	0.374
6	Top Plate of PRV	34 (1)	77	49,115	52,500	0.936
7	Pressure Relief Door of PRV	22 (1)	N/A	N/A	N/A	N/A
8	Radial Vertical Stiffener	34 (1)	147	24,476	52,500	0.466
9	Horizontal Flange of Radial Vertical Stiffener	34 (1)	226	15,028	52,500	0.286
10	20" Riser	41 (1)	1016	9,667	52,500	0.184
11	12" Riser	40 (1)	1085	11,591	52,500	0.221
12	8" Riser	39 (1)	1302	18,292	52,500	0.348
13	27.5" Dia. Flange for 20" Riser	50 (1)	1365	1,481	52,500	0.028
14	19" Dia. Flange for 12" Riser	49 (1)	1382	4,515	52,500	0.086
15	13.5" Dia. Flange for 8" Riser	48 (1)	1378	5,327	52,500	0.101
20	42" Dia. Riser	32 (1)	294	30,051	49,000	0.613
21	Base Plate @ Anchorage***	3 (2)	1395	35,312	58,000	0.609
22	Gusset Plate @ Anchorage***	6 (2)	1459	11,145	58,000	0.192
23	Gusset Plate Flange @ Anchorage***	6 (2)	1476	27,194	58,000	0.469
24	New Gusset Plate Flange @ Anchorage	6 (2)	1721	32,581	58,000	0.562

* (1) - Ref. Drawing No. H-2-821101, Rev. B, Sht 1 of 7.

(2) - Ref. Drawing No. H-2-821095, Rev. B, Sht 1

** Allowable Stress = 0.70 x Ultimate Stress for Stainless Steel (Real # 1 thru 20)

= 1.00 x Ultimate Stress for Carbon Steel (Real # 21 thru 24)

**** Includes Membrane and Bending (Load Case 8 - ADVENT File : C94003.1.1 M)

Project:	Westinghouse Hanford Company	Prepared By:	<i>W. H. H.</i>	Date	9-13-94
Subject:	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>W. H. H.</i>	Date	9/13/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-44	Rev. No.	1

Table 7.3 : STRESSES IN VARIOUS MPR # 5A COMPONENTS

Load Case : Beyond-Design-Basis -- Case 1 : East Vent Closed -- Other Two Open

REAL #	Component (REAL) Description	Part No.*	Element No.	Demand**** Stress, psi	Allowable** Stress, psi	Stress Ratio
1	Bottom Triangular Plate	35 (1)	164	23,739	52,500	0.452
2	Bottom Plate of Pressure Relief Vent (PRV)	34 (1)	649	45,241	52,500	0.862
3	Side Plate of PRV & Diagonal Stiffener Plate between Top Shield Plate (REAL 5) and Bottom Triangular Plate (REAL 1)	35 (1)	512	23,879	52,500	0.455
4	Vertical Flange of Radial Vertical Stiffener	34 (1)	63	13,784	52,500	0.263
5	Top Shield Plate	37 (1)	972	26,425	52,500	0.503
6	Top Plate of PRV	34 (1)	543	48,266	52,500	0.919
7	Pressure Relief Door of PRV	22 (1)	N/A	N/A	N/A	N/A
8	Radial Vertical Stiffener	34 (1)	147	29,452	52,500	0.561
9	Horizontal Flange of Radial Vertical Stiffener	34 (1)	226	15,117	52,500	0.288
10	20" Riser	41 (1)	1032	12,436	52,500	0.237
11	12" Riser	40 (1)	1085	19,431	52,500	0.370
12	8" Riser	39 (1)	1302	22,944	52,500	0.437
13	27.5" Dia. Flange for 20" Riser	50 (1)	1127	2,140	52,500	0.041
14	19" Dia. Flange for 12" Riser	49 (1)	1144	5,673	52,500	0.108
15	13.5" Dia. Flange for 8" Riser	48 (1)	1140	4,318	52,500	0.082
20	42" Dia. Riser	32 (1)	904	29,410	49,000	0.600
21	Base Plate @ Anchorage	3 (2)	1444	40,124 ▼	58,000	0.692 ▼
22	Gusset Plate @ Anchorage	6 (2)	1459	12,997	58,000	0.224
23	Gusset Plate Flange @ Anchorage	6 (2)	1492	29,895	58,000	0.515
24	New Gusset Plate Flange @ Anchorage	6 (2)	1716	40,808	58,000	0.704

* (1) - Ref. Drawing No. H-2-821101, Rev. B, Sht 1 of 7.

(2) - Ref. Drawing No. H-2-821095, Rev. B, Sht 1

** Allowable Stress = 0.70 x Ultimate Stress for Stainless Steel (Real # 1 thru 20)

= 1.00 x Ultimate Stress for Carbon Steel (Real # 21 thru 24)

**** Includes Membrane and Bending (Load Case 8 - ADVENT File : C94003.1.1 G)

▼ REVISED (SEE SHEET NO. I-10)

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	6-3-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	6/4/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-46	Rev. No.	81

7.2.2 Evaluation of Anchor Bolts

(REF. 2.2.21)

[Signature] 9-2-94
WHT 9/2/94

Embedment and spacing requirement for DRILLCO MAXI-BOLTS per Table II-A, Ref.2.1.24 are:

Part No. : MB-1250-30-23
Anchor Diameter : 1¼ inch.
Embedment depth : 23 inch.
C/C center spacing : 12 inch. ($f_c = 4000$ psi, Ref. 2.2.19)
Min. edge distance : 20.5 inch. To be checked by WHC

Factored Design Loads per Table I, Ref. 2.1.24:

Tension, $F_u = 85.024$ Kips.
Shear, $V_u = 44.165$ Kips. (Case 1)

$$\text{STRESS RATIO} = (T/F_u) + (V/V_u) \leq 1.0$$

Where,

Demand TENSION (lbs), $T = 1.5^* (FZ)$ (* Prying factor)

Demand SHEAR (lbs.), $V = (FX^2 + FY^2)^{1/2}$

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-15-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5-15-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-47	Rev. No.	81

ELEM. #	FX	FY	SHEAR	FZ	TENSION	STRESS RATIO
CASE-1 (See File MPR5A-1. P10, ADVENT file C94003.1.1.G)						
1690	5325	12720	13790	16350	24525	0.601
1706	5386	12720	13813	16280	24420	0.600
1710	15100	12460	19577	24420	36630	0.874
1742	15090	12440	19557	24420	36630	0.874
1821	5170	6028	7941	10610	15915	0.367
1837	4543	10140	11111	13380	20070	0.488
1841	2551	12080	12346	13570	20355	0.519
1873	8403	4268	9425	12390	18585	0.432
1952	4520	10080	11047	13330	19995	0.485
1968	5138	5877	7806	10550	15825	0.363
1972	8378	4267	9402	12350	18525	0.431
2004	2561	11990	12260	13450	20175	0.515
CASE-2 (See File MPR5A-2. P10, ADVENT file C94003.1.1.M)						
1690	6607	9594	11649	17100	25650	0.565
1706	5664	8995	10630	16040	24060	0.524
1710	11500	8456	14274	19650	29475	0.670
1742	12320	9534	15578	20160	30240	0.708
1821	7864	2745	8329	10240	15360	0.369
1837	5898	6120	8499	11710	17565	0.399
1841	2596	12450	12718	16840	25260	0.585
1873	11910	5313	13041	16990	25485	0.595
1952	4525	4733	6548	10050	15075	0.326
1968	6683	4297	7945	11030	16545	0.374
1972	6885	3716	7824	11650	17475	0.383
2004	1919	7987	8214	11470	17205	0.388

REVISED: SEE SHEET NOS. I-6 & I-7
H/L 1/16 PM 4-6-94
9-2-94 WMD 9/2/94

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	6-3-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	6/4/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-48	Rev. No.	0

7.2.3 Evaluation of Bolted Connections

(Between Vertical Flange for Radial stiffener (REAL 4) and Gusset Plate Flange @ anchorage (REAL 23) of Support Sub Assembly)

The forces at bolt locations are obtained in ANSYS postprocessing (POST1) using *NFORCE* command. Note that the *NFORCE* command lists the nodal average force at (selected) nodes of the selected elements in global coordinates. The forces in the bolts at North and South support are printed by rotating the nodal coordinates, such that the rotated Y-axis is parallel to the axis of the bolts (i.e., FY is axial force and FX/FZ is the shear for the bolts).

Bolts: 1 1/4" Dia. ASTM A-325

Allowables: Tension = 54.0 kips. Ref. 2.1.19
Shear = 25.8 kips. (Single shear)

$F_t = 55 - 1.8 f_v \leq 44 \text{ ksi.}$ Section Q1.6.3, Ref. 2.1.6

Where, f_v is demand shear in ksi.

STRESS RATIO = Tension/(F_t , A) ≤ 1.6 (Area, A = 1.227 in²)
STRESS RATIO = Shear/25800 ≤ 1.4

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>H. W. W.</i>	Date	6-4-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>R. J. M.</i>	Date	2/4/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-49	Rev. No.	0

BEYOND DESIGN BASIS (BDB) LOADS: CASE-1							
Node No.	FX (Lbs.)	FY (Lbs.)	FZ (Lbs.)	Shear (FX ² +FZ ²) ^{1/2} (Lbs.)	Tension FY (Lbs.)	STRESS RATIO	
						Tension	Shear
See Load Case 9 & 10, file "MPR5A-1.P1O", ADVENT file C94003.1.1.G							
1808	5327	23360	19073	19803	23360	0.734	0.768
1809	3701	2249	14072	14551	2249	0.054	0.564
1810	1541	6349	5954	6151	6349	0.118	0.238
1816	5363	23366	19480	20205	23366	0.751	0.783
1817	3751	2249	14298	14782	2249	0.055	0.573
1818	1525	6358	5978	6169	6358	0.118	0.239
See Load Case 9 & 10, file "MPR5A-1.P2O", ADVENT file C94003.1.1.H							
1939	14110	8125	17260	22293	8125	0.297	0.864
1940	2782	586	11620	11948	586	0.013	0.463
1941	4305	2480	5231	6775	2480	0.046	0.263
1947	15570	6158	15320	21843	6158	0.219	0.847
1948	2723	611	11550	11867	611	0.013	0.460
1949	4585	2133	5133	6883	2133	0.040	0.267
See Load Case 9 & 10, file "MPR5A-1.P3O", ADVENT file C94003.1.1.I							
2070	4785	13020	17220	17872	13020	0.369	0.693
2071	1359	3144	11720	11799	3144	0.068	0.457
2072	1680	3570	4681	4973	3570	0.066	0.193
2078	3535	14380	17820	18167	14380	0.413	0.704
2079	1396	3104	10670	10761	3104	0.065	0.417
2080	1236	3695	4625	4787	3695	0.068	0.186

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-15-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5-15-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-50	Rev. No.	0

BEYOND DESIGN BASIS (BDB) LOADS: CASE-2

Node No.	FX	FY	FZ	Shear (FX ² +FZ ²) ^½	Tension FY	STRESS RATIO	
	(Lbs.)	(Lbs.)	(Lbs.)	(Lbs.)	(Lbs.)	Tension	Shear
See Load Case 9 & 10, file "MPR5A-2.P1O", ADVENT file C94003.1.1.M							
1808	9531	14135	22955	24855	14135	0.621	0.963
1809	4202	1687	17157	17664	1687	0.047	0.685
1810	2364	5654	7034	7421	5654	0.105	0.288
1816	9314	14046	24269	25995	14046	0.679	1.008
1817	4532	1899	16991	17585	1899	0.053	0.682
1818	2202	5990	7055	7391	5990	0.111	0.286
See Load Case 9 & 10, file "MPR5A-2.P2O", ADVENT file C94003.1.1.N							
1939	16990	2751	21430	27348	2751	0.151	1.060
1940	3936	1336	12600	13200	1336	0.031	0.512
1941	5075	2828	5591	7551	2828	0.052	0.293
1947	18000	3451	24150	30120	3451	0.260	1.167
1948	3928	1137	11660	12304	1137	0.025	0.477
1949	5101	2028	5500	7501	2028	0.038	0.291
See Load Case 9 & 10, file "MPR5A-2.P3O", ADVENT file C94003.1.1.O							
2070	11300	12750	23880	26419	12750	0.640	1.024
2071	2180	3754	11430	11636	3754	0.081	0.451
2072	2265	4545	5511	5958	4545	0.084	0.231
2078	10310	11780	21240	23610	11780	0.471	0.915
2079	2221	3844	12530	12725	3844	0.086	0.493
2080	2008	4941	5623	5971	4941	0.092	0.231

REV. 0

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	6-3-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Ravi Ming</i>	Date	6/4/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-51	Rev. No.	81

7.2.4 Evaluation of Welded Connection

7.2.4.1 Beyond Design Basis (BDB) Weld Allowables

BDB weld allowable are :

(Ref. 2.1.25)

Weld (tension and shear) = $0.42 \times$ tensile strength of weld

Base metal (tension and shear) = $0.42 \times$ Ultimate tensile strength of plate

~~ASSUMED. Included angle at root of partial penetration groove weld = 60° .
(Effective throat thickness = Depth of chamfer, Table J2.1, Ref. 2.1.19)~~

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Connection between REAL 1 & REAL 20

See Sheet 6, Dwg. H-2-821101, Rev. B

Weld Type: Two concentric circles of $1/4"$ FILLET weld 1" apart.

Allowable: Based on $1/8"$ fillet weld (Conservative)

Fillet weld = $0.42 \times 70 \times 0.707 \times (2 \times 1/8) = 5.196 \text{ kip/in.}$ (Governs)

Base Metal = $0.42 \times 70 \times (1/4) = 7.35 \text{ kip/in.}$

Connection between REAL 1 & REAL 2 (TYP. @ 3 Places)

See Sheet 6, Dwg. H-2-821101, Rev. B

Weld Type: $3/16"$ FILLET on one side and BEVEL on both sides.

REVISED
SEE SHEET
NBS. I-4 & I-14.
WMB 9-2-94
WMB 9/2/94

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-31-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	6-1-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-52	Rev. No.	01

Connection between REAL 1 & REAL 3 (TYP. @ 3 Places)

See Sheet 5, Dwg. H-2-821101, Rev. B

Weld Type: Complete-Penetration Groove Weld.

Connection between REAL 1 & REAL 4 (TYP. @ 3 Places)

See Sheet 5, Dwg. H-2-821101, Rev. B

Weld Type: 3/8" FILLET on one side and 3/16" BEVEL on the other side.

~~Allowable:~~

~~|		
Fillet weld	= 0.42x70x0.707x3/8	= 7.795 kip/in.
Bevel weld	= 0.42x70x(3/16)	= 5.513 kip/in.
Total		= 13.307 kip/in.
Base Metal	= 0.42x75x(0.5")	= 15.75 kip/in. |~~

(Governs)

(* 0.1875 + 0.375 = 0.5625 > 0.5, ∴ Use, 0.5")

SEE SHEET NO. 7-80 a

[Handwritten notes]
9-13-94
with
9/13/94

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	6-4-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	2/4/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-53	Rev. No.	0

Connection between REAL 1 & REAL 8 (TYP. @ 3 Places)

See Sheet 3, Dwg. H-2-821101, Rev.B

Weld Type: 3/8" FILLET on both sides.

Allowable:

$$\text{Fillet weld} = 0.42 \times 70 \times 0.707 \times (0.5") = 10.393 \text{ kip/in. (Governs)}$$

$$\text{Base Metal} = 0.42 \times 75 \times (0.5") = 15.75 \text{ kip/in.}$$

$$(* 0.375 + 0.375 = 0.75 > 0.5, \therefore \text{Use, } 0.5")$$

Connection between REAL 2 & REAL 3 (TYP. @ 6 Places)

See Sheet 5, Dwg. H-2-821101, Rev. B

Weld Type: Complete-Penetration Groove Weld.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-31-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	7-1-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-54	Rev. No.	0

Connection between REAL 3 & REAL 5 (TYP. @ 3 Places)

See Sheet 4, Dwg. H-2-821101, Rev. B

Weld Type: Complete-Penetration Groove Weld.

Connection between REAL 3 & REAL 6 (TYP. @ 6 Places)

See Sheet 4, Dwg. H-2-821101, Rev. B

Weld Type: Complete-Penetration Groove Weld.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-31-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5-31-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-55	Rev. No.	0

Connection between REAL 3 & REAL 8 (TYP. @ 3 Places)

See Sheet 5, Dwg. H-2-821101, Rev. B

Weld Type: 3/8" FILLET on both sides.

Allowable:

$$\text{Fillet weld} = 0.42 \times 70 \times 0.707 \times (0.5") = 10.393 \text{ kip/in. (Governs)}$$

$$\text{Base Metal} = 0.42 \times 75 \times (0.5") = 15.75 \text{ kip/in.}$$

$$(* 0.375 + 0.375 = 0.75 > 0.5, \therefore \text{Use, } 0.5")$$

Connection between REAL 4 & REAL 8 (TYP. @ 3 Places)

See Sheet 5, Dwg. H-2-821101, Rev. B

Weld Type: 3/8" FILLET on both sides.

Allowable:

$$\text{Fillet weld} = 0.42 \times 70 \times 0.707 \times (0.5") = 10.393 \text{ kip/in. (Governs)}$$

$$\text{Base Metal} = 0.42 \times 75 \times (0.5") = 15.75 \text{ kip/in.}$$

$$(* 0.375 + 0.375 = 0.75 > 0.5, \therefore \text{Use, } 0.5")$$

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-31-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	7-13-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-56	Rev. No.	1

Connection between REAL 4 & REAL 9 (TYP. @ 3 Places)

See Sheet 4, Dwg. H-2-821101, Rev. B

Weld Type: 3/8" FILLET on one side and 3/16" BEVEL on the other side.

Allowable:

Fillet weld = $0.42 \times 70 \times 0.707 \times 3/8$ = 7.795 kip/in.

Bevel weld = $0.42 \times 70 \times (3/16)$ = 5.513 kip/in.

Total = 13.307 kip/in. (Governs)

Base Metal = $0.42 \times 75 \times (0.5)$ = 15.75 kip/in.

(* $0.1875 + 0.375 = 0.5625 > 0.5$, $\therefore$ Use, 0.5")

See Sheet No. 7-80a and 7-80b

Connection between REAL 5 & REAL 6 (TYP. @ 3 Places)

See Sheet 6, Dwg. H-2-821101, Rev. B

Weld Type: 5/16" FILLET on one side and BEVEL on both sides.

REVISED

SEE SHEET NOS. I-7 & I-16

A. 9-13-94

with 9/13/94

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-31-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	12/1/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-57	Rev. No.	0

Connection between REAL 5 & REAL 8 (TYP. @ 3 Places)

See Sheet 3, Dwg. H-2-821101, Rev. B

Weld Type: 3/8" FILLET on both sides.

Allowable:

$$\text{Fillet weld} = 0.42 \times 70 \times 0.707 \times (0.5^*) = 10.393 \text{ kip/in. (Governs)}$$

$$\text{Base Metal} = 0.42 \times 30 \times (0.5^*) = 15.75 \text{ kip/in.}$$

$$(* 0.375 + 0.375 = 0.75 > 0.5, \therefore \text{Use, } 0.5")$$

Connection between REAL 5 & REAL 9 (TYP. @ 3 Places)

See Sheet 6, Dwg. H-2-821101, Rev. B

Weld Type: 1/4" FILLET on one side and BEVEL on both sides.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-31-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5/1/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-58	Rev. No.	0

Connection between REAL 5 & REAL 10 (TYP. @ 1 Places)

See Sheet 3, Dwg. H-2-821101 (Section L-L), Rev. B

Weld Type: 7/16" FILLET on both sides.

Allowable: Based on 3/8" fillet weld on both sides (Conservative)

$$\text{Fillet weld} = 0.42 \times 70 \times 0.707 \times (2 \times 3/8) = 15.589 \text{ kip/in.} \quad (\text{Governs})$$

$$\text{Base Metal} = 0.42 \times 75 \times (2 \times 3/8) = 23.625 \text{ kip/in.}$$

Connection between REAL 5 & REAL 11 (TYP. @ 1 Places)

See Sheet 3, Dwg. H-2-821101 (Section L-L), Rev. B

Weld Type: 7/16" FILLET on both sides.

Allowable: Based on 3/8" fillet weld on both sides (Conservative)

$$\text{Fillet weld} = 0.42 \times 70 \times 0.707 \times (2 \times 3/8) = 15.589 \text{ kip/in.} \quad (\text{Governs})$$

$$\text{Base Metal} = 0.42 \times 75 \times (2 \times 3/8) = 23.625 \text{ kip/in.}$$

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-31-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	7/31/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-59	Rev. No.	0

Connection between REAL 5 & REAL 12 (TYP. @ 2 Places)

See Sheet 3, Dwg. H-2-821101 (Section L-L), Rev. B

Weld Type: 7/16" FILLET on both sides.

Allowable: Based on 3/8" fillet weld on both sides (Conservative)

$$\text{Fillet weld} = 0.42 \times 70 \times 0.707 \times (2 \times 3/8) = 15.589 \text{ kip/in.} \quad (\text{Governs})$$

$$\text{Base Metal} = 0.42 \times 75 \times (2 \times 3/8) = 23.625 \text{ kip/in.}$$

Connection between REAL 8 & REAL 9 (TYP. @ 3 Places)

See Sheet 3, Dwg. H-2-821101 (View G-G), Rev. B

Weld Type: 3/8" FILLET on both sides.

Allowable:

$$\text{Fillet weld} = 0.42 \times 70 \times 0.707 \times (0.5") = 10.393 \text{ kip/in.} \quad (\text{Governs})$$

$$\text{Base Metal} = 0.42 \times 75 \times (0.5") = 15.75 \text{ kip/in.}$$

$$(* 0.375 + 0.375 = 0.75 > 0.5, \therefore \text{Use, } 0.5")$$

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-31-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5-1-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-60	Rev. No.	0

Connection between REAL 10 & REAL 13 (TYP. @ 1 Places) Connection between REAL 11 & REAL 14 (TYP. @ 1 Places) Connection between REAL 12 & REAL 15 (TYP. @ 2 Places)

See Sheet 6, Dwg. H-2-821101, Rev. B

Weld Type: **Complete-Penetration Groove Weld.**

Connection between REAL 21 & REAL 22 (TYP. @ 3 Places)

See Sheet 1 of 1, Dwg. H-2-821095, Rev. B

Weld Type: **5/16" FILLET** on both side.

Allowable: *Based on 1/4" fillet weld on both sides (Conservative)*

$$\begin{aligned} \text{Fillet weld} &= 0.42 \times 70 \times 0.707 \times (2 \times 1/4) = 10.393 \text{ kip/in.} & (\text{Governs}) \\ \text{Base Metal} &= 0.42 \times 75 \times (2 \times 1/4) = 15.75 \text{ kip/in.} \end{aligned}$$

Connection between REAL 21 & REAL 23 (TYP. @ 3 Places)

See Sheet 1 of 1, Dwg. H-2-821095, Rev. B

Weld Type: **Complete-Penetration Groove Weld.**

Connection between REAL 22 & REAL 23 (TYP. @ 3 Places)

See Sheet 1 of 1, Dwg. H-2-821095, Rev. B

Weld Type: **3/8" FILLET** on both sides.

$$\begin{aligned} \text{Allowable: Fillet weld} &= 0.42 \times 70 \times 0.707 \times (0.5") = 10.393 \text{ kip/in.} & (\text{Governs}) \\ \text{Base Metal} &= 0.42 \times 75 \times (0.5") = 15.75 \text{ kip/in.} \end{aligned}$$

$$(* 0.375 + 0.375 = 0.75" > 0.5", \therefore \text{Use, } 0.5")$$

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-31-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Ravi May</i>	Date	5-11-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-61	Rev. No.	0

Connection between REAL 21 & REAL 24 (TYP. @ 3 Places)

See Sheet 1 of 1, Dwg. H-2-821095, Rev. B

Weld Type: Complete-Penetration Groove Weld.

Connection between REAL 22 & REAL 24 (TYP. @ 3 Places)

See Sheet 1 of 1, Dwg. H-2-821095, Rev. B

Weld Type: Complete-Penetration Groove Weld.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	6-3-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Ravi Mij</i>	Date	6/4/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-62	Rev. No.	0

7.2.4.2 Weld Evaluation

The nodal average force (*ANSYS NFORCE*) is printed based on each welded connection in post processing. First, the elements and nodes of one of the plates being connected are selected as a *group*. Then the nodes along the welded connection are re-selected from that group as a *sub-group* and the *NFORCE* is printed.

The multiport riser has members and connections at 120° symmetry. Therefore, three separate post-processing are performed by rotating the global coordinates to coincide with the members/elements local axis.

Enveloped forces (FX, FY, FZ) are obtained from each *sub-group* of nodes and listed in the Table below. The absolute summation of in-plane moments (MX or MY or MZ) is obtained from the sub-group of nodes and listed in the table below, with an exception to welded connection of all risers. For welded connection of risers, enveloped nodal in-plane moments are listed in the table. Then the forces in the weld are calculated using the minimum tributary length of weld (L_w) and full section modulus (S) or tributary section modulus (S_n), as applicable. The weld properties (L_w , S or S_n) and BDB weld capacity (F_w) calculations are shown on sheet nos. 7-23 through 7-28 and 7-51 through 7-61, respectively.

Demand force in the weld (depends on the orientation of the weld):

$$\begin{aligned}
 f_w &= [(FX/L_w + 2*EM/S)^2 + (FY/L_w)^2 + (FZ/L_w)^2]^{1/2} \quad \text{OR} \\
 &= [(FX/L_w)^2 + (FY/L_w + 2*EM/S)^2 + (FZ/L_w)^2]^{1/2} \quad \text{OR} \\
 &= [(FX/L_w)^2 + (FY/L_w)^2 + (FZ/L_w + 2*EM/S)^2]^{1/2}
 \end{aligned}$$

Demand force in weld (for 8", 12" and 20" risers at the intersection of Top shield plate and for 42" riser at the intersection of bottom triangular plate):

$$f_w = [(FX/L_w + 2*M/S_n)^2 + (FY/L_w)^2 + (FZ/L_w)^2]^{1/2}$$

Where, M = SRSS of MX and MY

$$\text{STRESS RATIO (S.R.)} = f_w/F_w \leq 1.0$$

Project	Westinghouse Hanford Company	REV. 0	Prepared By:	<i>[Signature]</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser 5A		Reviewed By:	<i>[Signature]</i>	Date	5/31/94
System	SY-101 H ₂ Mitigation Project		Job No.	94003	File No.	94003.1.1
Client Calc. No.			Sheet No.	7-63	Rev. No.	8 1

BEYOND DESIGN BASIS - CASE 1

See Load Case 8, file: MPR5A-1.P10, ADVENT file C94003.1.1.G

Connection between:	FX	FY	FZ	ΣM	L _{WP}	S	f _{WP}	F _{WP}	S.R
REAL 1 & REAL 2 (WEST)	8268	7629	1101	12801	Fillet & two side Bevel weld, ∴ O.K.*				
REAL 1 & REAL 3 (WEST)	9895	4225	14710	73784	Complete-penetration groove weld, ∴ O.K.				
REAL 1 & REAL 4 (WEST)	6521	603	5378	3149	1.625	3.25	(6616)	13307	0.497
REAL 1 & REAL 8 (WEST)	4	15674	23949	71	2.875	12.50	9965	10393	0.959
REAL 2 & REAL 3 (S of E PRV)	7804	7598	1136	5193	Complete-penetration groove weld, ∴ O.K.				
REAL 2 & REAL 3 (N of E PRV)	7834	7629	1137	5202					
REAL 2 & REAL 7 (EAST)	4578	4423	3892	66737	N/A				
REAL 3 & REAL 5 (WEST)	10248	3407	24627	57668	Complete-penetration groove weld, ∴ O.K.				
REAL 3 & REAL 6 (N of E PRV)	2359	4886	754	1341					
REAL 3 & REAL 6 (S of E PRV)	2362	4859	754	1341	Complete-penetration groove weld, ∴ O.K.				
REAL 3 & REAL 7 (S of E PRV)	3590	5633	3599	43819					
REAL 3 & REAL 7 (N of E PRV)	3591	5633	3539	43819	N/A				
REAL 3 & REAL 8 (WEST)	5	35341	49304	36	6.75	12.00	8990	10393	0.865
REAL 4 & REAL 8 (WEST)	6521	8617	13746	35625	4	12.00	8941	10393	0.860
REAL 4 & REAL 9 (WEST)	3122	237	6107	902	1.625	3.25	(4724)	13307	0.355
REAL 5 & REAL 6 (EAST)	1670	4452	2568	20620	Fillet & two side Bevel weld, ∴ O.K.*				
REAL 5 & REAL 8 (WEST)	1	38792	57988	6	2.75	2.75	25373	10393	2.441
REAL 5 & REAL 9 (WEST)	5646	13562	698	4060	Fillet & two side Bevel weld, ∴ O.K.				
REAL 6 & REAL 7 (WEST)	2574	4402	5402	66523	N/A				

1 See sheet no. 7-80

* Re-evaluated (See Sheet Nos. I-14 and I-15)

** Re-evaluated (See Sheet Nos. I-16, I-17 and I-18)

▲ See sheet 7-80a

▲▲ See sheet 7-80a & b

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5-17-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-64	Rev. No.	0

BEYOND DESIGN BASIS - CASE 1										
Connection between:	FX	FY	FZ	ΣM	L _w	S	f _w	F _w	S.R.	
REAL 8 & REAL 9 (WEST)	9991	35276	1648	2318	2.217	9.75	16582	10393	1.596 ¹	
REAL 21 & REAL 22 (WEST)	5	15061	15224	45	2.1	8.40	10205	10393	0.982	
REAL 21 & REAL 23 (WEST)	12041	282	29396	2406	Complete-penetration groove weld, ∴ O.K.					
REAL 22 & REAL 23 (WEST)	7	43095	19918	63	1.5	17.50	31657	10393	3.046 ²	
				SRSS of MX & MY		S _n				
REAL 5 & REAL 10	3498	5876	8674	1720	2.292	4.584	5107	15589	0.328	
REAL 5 & REAL 11	7540	5769	12545	1677	1.895	3.79	8761	15589	0.562	
REAL 5 & REAL 12 (NORTH)	11575	9810	20370	989	1.585	3.17	16319	15589	1.047 ³	
REAL 5 & REAL 12 (SOUTH)	11402	9722	20408	989	1.585	3.17	16264	15589	1.043 ³	
REAL 10 & REAL 13	8143	8210	4167	353	Complete-penetration groove weld, ∴ O.K.					
REAL 11 & REAL 14	5804	6400	12315	337						
REAL 12 & REAL 15 (NORTH)	7818	16213	19188	134						
REAL 12 & REAL 15 (SOUTH)	7682	16014	18886	126						
REAL 1 & REAL 20	4081	8100	2520	2320	3.622	3.622	3359	5196	0.646	

1 See Sheet Nos. 7-75 & 7-76

2 See Sheet Nos. 7-77 & 7-78

3 See Sheet Nos. 7-79

Project	Westinghouse Hanford Company	REV. 0	Prepared By:	<i>[Signature]</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser 5A		Reviewed By:	<i>[Signature]</i>	Date	5-31-94
System	SY-101 H ₂ Mitigation Project		Job No.	94003	File No.	94003.1.1
Client Calc. No.			Sheet No.	7-65	Rev. No.	8 1

BEYOND DESIGN BASIS - CASE 1

See Load Case 8, file: MPR5A-1.P20, ADVENT file C94003.1.1.H

Connection between:	FX	FY	FZ	ΣM	L _W	S	I _W	P _W	S.R
REAL 1 & REAL 2 (SOUTH)	9385	3790	1377	-18814	Fillet & two side Bevel weld, ∴ O.K. *				
REAL 1 & REAL 3 (NORTH)	13888	6457	15637	-78280	Complete-penetration groove weld, ∴ O.K.				
REAL 1 & REAL 4 (NORTH)	5683	276	6444	-1712	1.625	3.25	(4554)	13307	0.342
REAL 1 & REAL 8 (NORTH)	10329	5900	17027	478	2.875	12.50	7287	10393	0.701
REAL 2 & REAL 3 (E of S PRV)	9385	3790	1640	3263	Complete-penetration groove weld, ∴ O.K.				
REAL 2 & REAL 3 (W of S PRV)	5779	3036	1763	2125	Complete-penetration groove weld, ∴ O.K.				
REAL 2 & REAL 7 (SOUTH)	2420	20	3629	-1247	N/A				
REAL 3 & REAL 5 (NORTH)	10734	4531	23859	-58045	Complete-penetration groove weld, ∴ O.K.				
REAL 3 & REAL 6 (W of S PRV)	2582	1403	767	420	Complete-penetration groove weld, ∴ O.K.				
REAL 3 & REAL 6 (E of S PRV)	2863	980	639	297	Complete-penetration groove weld, ∴ O.K.				
REAL 3 & REAL 7 (W of S PRV)	3440	683	6908	1312	N/A				
REAL 3 & REAL 7 (E of S PRV)	5273	677	3570	1560	N/A				
REAL 3 & REAL 8 (NORTH)	22911	13236	31171	669	6.75	12.00	6094	10393	0.586
REAL 4 & REAL 8 (NORTH)	5683	3190	13537	21476	4	12.00	5712	10393	0.550
REAL 4 & REAL 9 (NORTH)	2879	200	6812	-746	1.625	3.25	(4134)	13307	0.311
REAL 5 & REAL 6 (SOUTH)	2822	1018	2120	-13089	Fillet & two side Bevel weld, ∴ O.K. *				
REAL 5 & REAL 8 (NORTH)	21606	12479	39946	48	2.75	2.75	17156	10393	1.651
REAL 5 & REAL 9 (NORTH)	13607	7248	457	-2688	Fillet & two side Bevel weld, ∴ O.K.				
REAL 6 & REAL 7 (SOUTH)	2653	16	4241	-939	N/A				

1 See sheet no. 7-80

* Re-evaluated (See Sheet Nos. 1-14 and 1-15)

** Re-evaluated (See Sheet Nos. 1-16, 1-17 and 1-18)

▲ See Sheet 7-80a

▲ See Sheet 7-80a & b

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser SA	Reviewed By:	<i>Ravi Nij</i>	Date	13/1/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-66	Rev. No.	0

BEYOND DESIGN BASIS - CASE 1									
Connection between:	FX	FY	FZ	ΣM	L _w	S	f _w	F _w	S.R
REAL 8 & REAL 9 (NORTH)	27610	16167	1004	342	2.217	9.75	14441	10393	1.390 ¹
REAL 21 & REAL 22 (NORTH)	7077	4184	8382	1041	2.1	8.40	5770	10393	0.555
REAL 21 & REAL 23 (NORTH)	10967	177	26003	-1879	Complete-penetration groove weld, ∴ O.K.				
REAL 22 & REAL 23 (NORTH)	19993	11258	12036	3022	1.5	17.50	17426	10393	1.677 ²

1 See Sheet Nos. 7-75 & 7-76

2 See Sheet Nos. 7-77 & 7-78

Project	Westinghouse Hanford Company	REV. 0	Prepared By:	<i>W. J. ...</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser 5A		Reviewed By:		Date	
System	SY-101 H ₂ Mitigation Project		Job No.	94003	File No.	94003.1.1
Client Calc. No.			Sheet No.	7-67	Rev. No.	8 1

BEYOND DESIGN BASIS - CASE 1

See Load Case 8, file: MPR5A-1.P30, ADVENT file 094003.1.1.1

Connection between:	FX	FY	FZ	ΣM	L _{wp}	S	f _{wp}	F _{wp}	S.R
REAL 1 & REAL 2 (NORTH)	7850	6418	1379	5126	(Fillet & two side Bevel weld, :: O.K. ✱)				
REAL 1 & REAL 3 (SOUTH)	12525	10677	15517	38863	Complete-penetration groove weld, :: O.K.				
REAL 1 & REAL 4 (SOUTH)	2745	5068	6523	843	1.625	3.25	5756	13307	0.433
REAL 1 & REAL 8 (SOUTH)	56	11994	17129	-972	2.875	12.50	7146	10393	0.688
REAL 2 & REAL 3 (W of N PRV)	749	6391	1774	-5762	Complete-penetration groove weld, :: O.K.				
REAL 2 & REAL 3 (E of N PRV)	7850	6141	1650	-5112	N/A				
REAL 2 & REAL 7 (NORTH)	1208	2084	3610	443	Complete-penetration groove weld, :: O.K.				
REAL 3 & REAL 5 (SOUTH)	9053	8168	23766	29170	Complete-penetration groove weld, :: O.K.				
REAL 3 & REAL 6 (W of N PRV)	904	2893	758	-1589	Complete-penetration groove weld, :: O.K.				
REAL 3 & REAL 6 (E of N PRV)	1361	2542	641	-1572	N/A				
REAL 3 & REAL 7 (W of N PRV)	1678	2962	2518	311	N/A				
REAL 3 & REAL 7 (E of N PRV)	2562	4403	3357	530	N/A				
REAL 3 & REAL 8 (SOUTH)	39	26543	31308	668	6.75	12.00	6153	10393	0.592
REAL 4 & REAL 8 (SOUTH)	2745	5953	13758	21450	4	12.00	6159	10393	0.593
REAL 4 & REAL 9 (SOUTH)	1403	2488	6732	375	1.625	3.25	4714	13307	0.354
REAL 5 & REAL 6 (NORTH)	1917	2811	2123	6205	(Fillet & two side Bevel weld, :: O.K. ✱)				
REAL 5 & REAL 8 (SOUTH)	12	25122	40015	-107	2.75	2.75	17115	10393	1.647
REAL 5 & REAL 9 (SOUTH)	4882	13071	459	1341	Fillet & two side Bevel weld, :: O.K.				
REAL 6 & REAL 7 (NORTH)	1271	2216	4140	301	N/A				

1 See sheet no. 7-80

* Re-evaluated (See Sheet Nos. I-14 and I-15)

** Re-evaluated (See Sheet Nos. I-16, I-17 and I-18)

▲ SEE SHEET 7-80 a

▲▲ SEE SHEET 7-80 a & b

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5-31-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-68	Rev. No.	0

BEYOND DESIGN BASIS - CASE 1									
Connection between:	FX	FY	FZ	ΣM	L _w	S	f _w	F _w	S.R
REAL 6 & REAL 7 (NORTH)	1271	2216	4140	301	N/A				
REAL 8 & REAL 9 (SOUTH)	2223	27262	1099	-3500	2.217	9.75	12340	10393	1.187 ¹
REAL 21 & REAL 22 (SOUTH)	132	8269	8442	-2105	2.1	8.40	5281	10393	0.508
REAL 21 & REAL 23 (SOUTH)	5486	9570	26144	929	Complete-penetration groove weld, ∴ O.K.				
REAL 22 & REAL 23 (SOUTH)	250	22795	12074	3072	1.5	17.50	17509	10393	1.685 ²

- 1 See Sheet Nos. 7-75 & 7-76
- 2 See Sheet Nos. 7-77 & 7-78

Project:	Westinghouse Hanford Company	REV. 0	Prepared By:	<i>[Signature]</i>	Date	5-30-94
Subject:	Structural Analysis of Multiport Riser 5A		Reviewed By:	<i>[Signature]</i>	Date	10/10/94
System:	SY-101 H ₂ Mitigation Project		Job No.	94003	File No.	94003.1.1
Client Calc. No.			Sheet No.	7-64	Rev. No.	8

BEYOND DESIGN BASIS - CASE 2

See Load Case 8, file: MPR5A-2.PIO, ADV/ENT file C94003.1.1.M

Connection between:	FX	FY	FZ	ΣM	L _{WP}	S	f _{WP}	F _{WP}	S.R
REAL 1 & REAL 2 (WEST)	7033	4695	1236	14686	(Fillet & two side Bevel weld, ∴ O.K. ✕)				
REAL 1 & REAL 3 (WEST)	11607	6677	16201	71517					
REAL 1 & REAL 4 (WEST)	6348	381	5749	1785	1.625	3.25	6067	13307	0.456 ▲
REAL 1 & REAL 8 (WEST)	69	15190	23409	736	2.875	12.50	9805	10393	0.943
REAL 2 & REAL 3 (S of E PRV)	5900	4687	1914	7044	Complete-penetration groove weld, ∴ O.K.				
REAL 2 & REAL 3 (N of E PRV)	4930	3939	1918	7111					
REAL 2 & REAL 7 (EAST)	1560	81	2582	1389	N/A				
REAL 3 & REAL 5 (WEST)	9762	4717	23444	53346					
REAL 3 & REAL 6 (N of E PRV)	2617	5203	932	1716	Complete-penetration groove weld, ∴ O.K.				
REAL 3 & REAL 6 (S of E PRV)	2872	4346	903	1818					
REAL 3 & REAL 7 (S of E PRV)	1316	68	2588	546	N/A				
REAL 3 & REAL 7 (N of E PRV)	1666	67	2708	545					
REAL 3 & REAL 8 (WEST)	70	31309	41627	862	6.75	12.00	7804	10393	0.751
REAL 4 & REAL 8 (WEST)	6348	5573	13996	26333	4	12.00	6942	10393	0.668
REAL 4 & REAL 9 (WEST)	2866	257	6703	814	1.625	3.25	4953	13307	0.372 ▲
REAL 5 & REAL 6 (EAST)	2341	3866	1925	14397	(Fillet & two side Bevel weld, ∴ O.K. ✕)				
REAL 5 & REAL 8 (WEST)	21	34548	47970	112					
REAL 5 & REAL 9 (WEST)	5664	13316	566	3274	2.75	2.75	21563	10393	2.075'
REAL 6 & REAL 7 (WEST)	992	70	1642	1016	Fillet & two side Bevel weld, ∴ O.K.				

1 See sheet no. 7-80

• Re-evaluated (See Sheet Nos. I-14 and I-15)

• Re-evaluated (See Sheet Nos. I-16, I-17 and I-18)

▲ SEE SHEET 7-80 a

▲ SEE SHEET 7-80 a & b

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5-31-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-70	Rev. No.	0

BEYOND DESIGN BASIS - CASE 2

Connection between:	FX	FY	FZ	ΣM	L _{ip}	S	f _{ip}	F _{ip}	S.R
REAL 8 & REAL 9 (WEST)	9837	34524	1328	1909	2.217	9.75	16222	10393	1.561 ¹
REAL 21 & REAL 22 (WEST)	187	11409	11796	1333	2.1	8.40	8046	10393	0.774
REAL 21 & REAL 23 (WEST)	12818	230	31096	1884	Complete-penetration groove weld, ∴ O.K.				
REAL 22 & REAL 23 (WEST)	211	25476	15004	1929	1.5	17.50	19901	10393	1.915 ²
				SRSS of MX & MY & MY		S _n			
REAL 5 & REAL 10	3112	4189	6879	1729	2.292	4.584	4100	15589	0.263
REAL 5 & REAL 11	4403	5372	10379	1154	1.895	3.79	6829	15589	0.438
REAL 5 & REAL 12 (NORTH)	6942	6624	12338	643	1.585	3.17	10048	15589	0.645
REAL 5 & REAL 12 (SOUTH)	7468	10663	14832	725	1.585	3.17	12631	15589	0.810
REAL 10 & REAL 13	5507	5645	3435	264	Complete-penetration groove weld, ∴ O.K.				
REAL 11 & REAL 14	5032	5863	13004	241					
REAL 12 & REAL 15 (NORTH)	3646	3863	7067	101					
REAL 12 & REAL 15 (SOUTH)	7358	6866	13238	190					
REAL 1 & REAL 20	5608	5544	2574	2378	3.622	3.622	3322	5196	0.639

1 See Sheet Nos. 7-75 & 7-76

2 See Sheet Nos. 7-77 & 7-78

Project	Westinghouse Hanford Company	REV. 0	Prepared By: <i>Antony</i>	Date	5-30-94
Subject	Structural Analysis of Multipoint Riser 5A		Reviewed By: <i>Antony</i>	Date	5-30-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-1	Rev. No.	2

BEYOND DESIGN BASIS - CASE 2

See Load Case 8, file: MPR5A-2.P20, ADV/ENT file C94003.1.1.N

Connection between:	FX	FY	FZ	ΣM	L _{wp}	S	f _{wp}	F _{wp}	S.R
REAL 1 & REAL 2 (SOUTH)	7586	4527	1392	-19335	Fillet & two side Bevel weld, ± O.K. *				
REAL 1 & REAL 3 (NORTH)	9686	4902	15248	-77452	Complete-penetration groove weld, ± O.K.				
REAL 1 & REAL 4 (NORTH)	4260	163	4448	-1564	1.625	3.25	3167	13307	0.238
REAL 1 & REAL 8 (NORTH)	8626	4968	15528	412	2.875	12.50	6471	10393	0.623
REAL 2 & REAL 3 (E of S PRV)	4358	702	1685	3295	Complete-penetration groove weld, ± O.K.				
REAL 2 & REAL 3 (W of S PRV)	7586	4527	1821	2286					
REAL 2 & REAL 7 (SOUTH)	2698	6	4144	-593	N/A				
REAL 3 & REAL 5 (NORTH)	9950	4882	24058	-59146	Complete-penetration groove weld, ± O.K.				
REAL 3 & REAL 6 (W of S PRV)	3121	1789	824	365	Complete-penetration groove weld, ± O.K.				
REAL 3 & REAL 6 (E of S PRV)	2984	778	633	260					
REAL 3 & REAL 7 (W of S PRV)	3780	963	7364	1088	N/A				
REAL 3 & REAL 7 (E of S PRV)	5407	827	3953	1318					
REAL 3 & REAL 8 (NORTH)	22254	12822	31307	1081	6.75	12.00	6059	10393	0.583
REAL 4 & REAL 8 (NORTH)	4502	1033	10088	16211	4	12.00	4048	10393	0.390
REAL 4 & REAL 9 (NORTH)	2044	156	4760	-633	1.625	3.25	2836	13307	0.213
REAL 5 & REAL 6 (SOUTH)	4644	1780	2744	-21846	Fillet & two side Bevel weld, ± O.K. *				
REAL 5 & REAL 8 (NORTH)	21095	12169	37975	58	2.75	2.75	16440	10393	1.582
REAL 5 & REAL 9 (NORTH)	7465	7341	483	-2801	Fillet & two side Bevel weld, ± O.K.				
REAL 6 & REAL 7 (SOUTH)	2749	4	3274	-157	N/A				

1 See sheet no. 7-80

* Re-evaluated (See Sheet Nos. I-14 and I-15)

** Re-evaluated (See Sheet Nos. I-16, I-17 and I-18)

▲ SEE SHEET 7-80a

▲▲ SEE SHEET 7-80a 4.1

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5-11-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-72	Rev. No.	0

BEYOND DESIGN BASIS - CASE 2

Connection between:	FX	FY	FZ	ΣM	L _W	S	f _W	F _W	S.R.
REAL 8 & REAL 9 (NORTH)	27610	16167	1004	314	2.217	9.75	14441	10393	1.389 ¹
REAL 21 & REAL 22 (NORTH)	5408	3074	6698	763	2.1	8.40	4488	10393	0.432
REAL 21 & REAL 23 (NORTH)	8711	108	20838	-1782	Complete-penetration groove weld, ∴ O.K.				
REAL 22 & REAL 23 (NORTH)	16228	9447	9630	2442	1.5	17.50	14196	10393	1.366 ²

- 1 See Sheet Nos. 7-75 & 7-76
- 2 See Sheet Nos. 7-77 & 7-78

Project:	Westinghouse Hanford Company	REV. 0	Prepared By:	<i>[Signature]</i>	Date	5-30-94
Subject:	Structural Analysis of Multiport Riser 5A		Reviewed By:	<i>[Signature]</i>	Date	5-31-94
System:	SY-101 H ₂ Mitigation Project		Job No.	94003	File No.	94003.1.1
Client Calc. No.			Sheet No.	7-73	Rev. No.	81

BEYOND DESIGN BASIS - CASE 2

See Load Case 8, file: MPR5A-2.F30, ADVENT file 04003.1.1.0

Connection between:	FX	FY	FZ	ΣM	L _W	S	f _W	F _W	S.R
REAL 1 & REAL 2 (NORTH)	5014	9262	1158	4595	(Fillet & two side Bevel weld, ∴ O.K. ✕)				
REAL 1 & REAL 3 (SOUTH)	8457	8228	14500	40552	Complete-penetration groove weld, ∴ O.K.				
REAL 1 & REAL 4 (SOUTH)	2237	3842	4298	958	1.625	3.25	4236	13307	0.318
REAL 1 & REAL 8 (SOUTH)	7	11798	16717	-434	2.875	12.50	7060	10393	0.679
REAL 2 & REAL 3 (W of N PRV)	1297	9262	1209	-4790	Complete-penetration groove weld, ∴ O.K.				
REAL 2 & REAL 3 (E of N PRV)	5014	5151	1212	-4311	N/A				
REAL 2 & REAL 7 (NORTH)	1123	4988	4679	33145	Complete-penetration groove weld, ∴ O.K.				
REAL 3 & REAL 5 (SOUTH)	8496	8192	22958	31250	Complete-penetration groove weld, ∴ O.K.				
REAL 3 & REAL 6 (W of N PRV)	753	3264	928	-3583	Complete-penetration groove weld, ∴ O.K.				
REAL 3 & REAL 6 (E of N PRV)	1750	3629	1042	-3971	N/A				
REAL 3 & REAL 7 (W of N PRV)	842	6338	3069	44356	N/A				
REAL 3 & REAL 7 (E of N PRV)	534	6314	2324	44255	N/A				
REAL 3 & REAL 8 (SOUTH)	8	28714	39178	438	6.75	12.00	7240	10393	0.697
REAL 4 & REAL 8 (SOUTH)	2237	5713	10562	21870	4	12.00	5747	10393	0.553
REAL 4 & REAL 9 (SOUTH)	1251	2225	5398	358	1.625	3.25	3875	13307	0.291
REAL 5 & REAL 6 (NORTH)	1211	2608	2143	6550	(Fillet & two side Bevel weld, ∴ O.K. ✕)				
REAL 5 & REAL 8 (SOUTH)	7	29686	47432	-80	2.75	2.75	20298	10393	1.953
REAL 5 & REAL 9 (SOUTH)	4614	11188	532	1526	Fillet & two side Bevel weld, ∴ O.K.				
REAL 6 & REAL 7 (NORTH)	1241	4943	6320	33554	N/A				

1 See sheet no. 7-80

Re-evaluated (See Sheet Nos. I-14 and I-15)
 Re-evaluated (See Sheet Nos. I-16, I-17 and I-18)

See Sheet 7-80 a
 See Sheet 7-80 a & b

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	10/1/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-74	Rev. No.	0

BEYOND DESIGN BASIS - CASE 2

Connection between:	FX	FY	FZ	ΣM	L _w	S	f _w	F _w	S.R.
REAL 8 & REAL 9 (SOUTH)	366	29133	1248	-3826	2.217	9.75	13144	10393	1.265 ¹
REAL 21 & REAL 22 (SOUTH)	22	9965	10511	-1169	2.1	8.40	6698	10393	0.644
REAL 21 & REAL 23 (SOUTH)	4608	7983	22412	820	Complete-penetration groove weld, ∆ O.K.				
REAL 22 & REAL 23 (SOUTH)	22	26451	13629	1709	1.5	17.50	20011	10393	1.925 ²

1 See Sheet Nos. 7-75 & 7-76

2 See Sheet Nos. 7-77 & 7-78

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-30-96
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	6-1-96
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-75	Rev. No.	0

Welded connection between members REAL 8 & REAL 9:

Stresses due to BDB CASE 1 govern. Enveloped nodal average forces (ANSYS NFORCE) for BDB CASE 1 from REAL 8 element nodes at the interface of members REAL 8 and REAL 9 are:

Note: • Units are in lbs. and inches.

- $SRSS = (FX^2 + FY^2 + FZ^2)^{1/2}$
- $f_w = SRSS/L_w$
- Nodes 74, 830 and 472 are located at the intersection of REAL 3, REAL 5 and REAL 8. The forces from these nodes are considered with weld evaluation of connection between REAL 3 and REAL 8.

Node #	FX	FY	FZ	MX	MY	MZ	SRSS	L _w	f _w
WEST (Load Case 8, file name: MPR5A-1.P10, ADVENT file C94003.1.1.G)									
86	3003	6363	97	332	180	0	7037	2.75	2559
93	3419	14693	223	319	276	1	15087	4.967	3037
95	9991	35276	1648	2067	1536	0	36701	4.433	8279
96	3263	22245	447	381	192	0	22488	4.433	5073
SOUTH (Load Case 8, file name: MPR5A-1.P20, ADVENT file C94003.1.1.H)									
842	-5094	2484	74	-311	54	0	5668	2.75	2061
849	-13032	6891	230	-286	54	1	14744	4.967	2968
851	-27610	16167	1004	-1358	183	2	32010	4.433	7221
852	-18095	10408	370	-280	47	1	20878	4.433	4710

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5-30-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-76	Rev. No.	0

Node #	FX	FY	FZ	MX	MY	MZ	SRSS	L _w	f _w
NORTH (Load Case 8, file name: MPR5A-1.P3O, ADVENT file C94003.1.1.I)									
464	386	-5760	72	109	-291	0	5774	2.75	2100
471	1543	-12529	224	116	-353	1	12626	4.967	2542
473	2223	-27262	1099	574	-1407	1	27375	4.433	6175
474	764	-18290	339	118	-247	1	18309	4.433	4130

Governing, $f_w = 8279$ lbs/in. (see last page)

Conservatively add the forces due to in-plane moment, MY

Enveloped $\Sigma MY = 291 + 353 + 1407 + 247 = 2298$ lb-in.

Section modulus, $S_y = 19.5 \times 0.5 = 9.75$ in³/in.

Total force in weld, $f_w = 8279 + 2 \times (2298 / 9.75) = 8750$ lbs/in.

Stress ratio = $8750 / 10393 = 0.842 < 1.0$, O.K.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-20-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	6/21/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-77	Rev. No.	0

Welded connection between members REAL 22 & REAL 23:

Stresses due to BDB CASE 1 governs. Enveloped nodal average forces (ANSYS NFORCE) for BDB CASE 1 from REAL 22 element nodes at the interface of members REAL 22 and REAL 23 are:

- Note: • All units are in lbs and inches.
• $SRSS = (FX^2 + FY^2 + FZ^2)^{1/2}$ lbs.
• $f_w = SRSS/L_w$ lbs/in.

Node #	FX	FY	FZ	MX	MY	MZ	SRSS	L _w	f _w
WEST (Load Case 8, file name: MPR5A-1.P10, ADVENT file C94003.1.1.G)									
1698	1	4795	6094	1	3	1	7754	2.594	2990
1767	3	9536	14449	4	9	12	17312	4.094	4229
1771	4	7346	10925	2	2	6	13165	5.188	2538
1779	1	511	516	0	0	1	726	1.500	484
1783	7	43095	19918	5	13	22	47475	6.000	7913
1784	3	20690	14971	11	1	9	25539	9.000	2838
1785	1	12329	9500	3	0	12	15565	6.000	2594
SOUTH (Load Case 8, file name: MPR5A-1.P10, ADVENT file C94003.1.1.H)									
1960	-2068	1095	3122	-132	76	24	3902	2.594	1504
2029	-4245	2299	9763	-427	246	554	10892	4.094	2661
2033	-4100	2094	7959	-173	100	443	9195	5.188	1772
2041	-256	124	497	0	0	52	573	1.500	382
2045	-19993	11258	12036	-604	352	937	25910	6.000	4318
2046	-9770	5778	11879	-61	34	439	16429	9.000	1825
2047	-8553	4979	7909	-11	5	573	12669	6.000	2111

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	11/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-78	Rev. No.	0

Node #	FX	FY	FZ	MX	MY	MZ	SRSS	L _w	f _w
NORTH (Load Case 8, file name: MPR5A-1.P1O, ADVENT file C94003.1.1.I)									
1829	86	-2311	3117	0	-153	24	3882	2.594	1496
1898	133	-4810	9767	0	-496	564	10888	4.094	2660
1902	238	-4521	7925	0	-201	443	9127	5.188	1759
1910	20	-286	487	0	0	53	566	1.500	377
1914	250	-22795	12074	-3	-705	968	25796	6.000	4299
1915	-121	-11305	11888	1	-70	442	16405	9.000	1823
1916	-36	-9921	7891	1	-12	578	12677	6.000	2113

Governing, $f_w = 7913$ lbs/in. (see last page)

Conservatively add the forces due to in-plane moment, MZ
Enveloped $\Sigma MZ = 24 + 564 + 443 + 53 + 968 + 442 + 578 = 3072$ lb-in.

Section modulus, $S_z = 35 \times 0.5 = 17.5$ in³/in.
Total force in weld, $f_w = 7913 + 2 \times (3072 / 17.5) = 8264$ lbs/in. (Conservative)

Stress ratio = $8264 / 10393 = 0.795 < 1.0$, O.K.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	6-3-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	6/4/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-79	Rev. No.	0

Welded connection between members REAL 21 & REAL 24, and REAL 22 & REAL 24:

Complete-Penetration Groove weld per sheet 1 of 1, Dwg. H-2-821095, Rev. B.

Therefore, O.K.

Connection between members REAL 5 (Top Shield Plate) and REAL 12 (8" Risers):

Weld Type: 7/16" Fillet weld on both sides (See Sheet 3, Dwg. H-2-821101, Rev. B)

Note that the weld capacity, used to calculate the stress ratio of these connections on sheet 7-64, was based on 3/8" Fillet weld on both sides, which is conservative.

Allowables for 7/16" Fillet weld:

$$\text{Fillet weld} = 0.42 \times 70 \times 0.707 \times (2 \times 7/16) = 18.188 \text{ kip/in.} \quad (\text{Governs})$$

$$\text{Base Metal} = 0.42 \times 75 \times (2 \times 7/16) = 27.563 \text{ kip/in.}$$

$$\text{Force in weld, } f_w = 16319 \text{ lbs/in. (See sheet 7-64)}$$

$$\text{Stress ratio} = 16.319/18.188 = 0.897 < 1.0, \text{ O.K.}$$

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-30-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	1/10/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-80	Rev. No.	0

Welded connection between members REAL 5 & REAL 8:

The stress ratio reported in the above table is based on a conservative tributary weld length (L_w). The reported demand forces are at node nos. 74 & 94 (West), 452 & 472 (South) and 830 & 850 (North). Nodes 74, 472 & 830 are located at the intersection of REAL 3, REAL 5 and REAL 8 members. Nodes 94, 472 and 850 are located at the intersection of REAL 5, REAL 8 and REAL 9 members.

Enveloped nodal average force (ANSYS NFORCE) from Load Case 9 and 10, files "MPR5A-1A.P10" (ADVENT file no. C94003.1.1.K) and "MPR5A-2A.P10" (ADVENT file no. C94003.1.1.Q) are:

(Forces due to in-plane moment are small and are ignored here)

Tension = Negative FZ = -21889 lbs. (Node 94)

Shear = $(FX^2 + FY^2)^{1/2}$
 = $(21^2 + 38792^2)^{1/2}$ = 38792 lbs. (governs) (Node 94)
 = $(25707^2 + 14847^2)^{1/2}$ = 29686 lbs. (Node 472)
 = $((21610^2 + 12471^2)^{1/2})$ = 24950 lbs. (Node 850)

Length of weld, $L_w = 2.75 + (13.3/6) = 4.967$ in.

Force in weld, $f_w = (21889^2 + 38792^2)^{1/2} / 4.967 = 8968$ lbs/in.

Beyond design basis weld allowable: 3/8" Fillet weld on both sides.

$F_w = 0.42 \times 70 \times 0.707 \times (0.5") = 10.393$ kips/in. (governs)
 = $0.42 \times 75 \times (0.5") = 15.75$ kips/in.

Stress ratio = $8968 / 10393 = 0.863 < 1.0$, O.K.

Therefore, the subject welded connection is acceptable.

* $2 \times 3/8 = 3/4" > \text{Plate thickness of } 1/2". \therefore \text{Use } 0.5"$

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	9-13-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>W H D</i>	Date	9/15/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-80 a	Rev. No.	1

Welded connection between REAL 1 and REAL 4

Design Basis (DB) loads

Allowable weld capacity:

Fillet weld	= $0.3 \times 70 \times 0.707 \times 3/8$	= 5.568 kip/in.
Base Metal	= $0.4 \times 30 \times 0.375$	= 4.5 kip/in. (Governs)

Demand force in weld for Normal (D) loads	= 290 lb/in	(Sheet 7-30)
Demand force in weld for Extreme (D) loads	= 665 lb/in	(Sheet 7-36)

Stress ratio for Normal loads	= $290/4500$	= 0.064 < 1.0, O.K.
Stress ratio for Extreme loads	= $665/4500$	= 0.148 < 1.4, O.K.

Beyond Design Basis (BDB) loads

Allowable weld capacity:

Fillet weld	= $0.42 \times 70 \times 0.707 \times 3/8$	= 7.795 kip/in. (Governs)
Base Metal	= $0.42 \times 70 \times 0.375$	= 11.025 kip/in.

Demand force in weld for BDB loads	= 6616 lb/in	(Sheet 7-63)
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Stress ratio for BDB loads	= $6616/7795$	= 0.849 < 1.0, O.K.
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Welded connection between REAL 4 and REAL 9

Design Basis (DB) loads

Allowable weld capacity:

Fillet weld	= $0.3 \times 70 \times 0.707 \times 3/8$	= 5.568 kip/in.
Base Metal	= $0.4 \times 30 \times 0.375$	= 4.5 kip/in. (Governs)

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	9-13-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	9/13/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-80 b	Rev. No.	1

Demand force in weld for Normal (D) loads = 330 lb/in (Sheet 7-30)
 Demand force in weld for Extreme (D) loads = 501 lb/in (Sheet 7-36)

Stress ratio for Normal loads = $330/4500 = 0.073 < 1.0$, O.K.
 Stress ratio for Extreme loads = $501/4500 = 0.111 < 1.4$, O.K.

Beyond Design Basis (BDB) loads

Allowable weld capacity:

Fillet weld = $0.42 \times 70 \times 0.707 \times 3/8 = 7.795 \text{ kip/in.}$ (Governs)
 Base Metal = $0.42 \times 70 \times 0.375 = 11.025 \text{ kip/in.}$

Demand force in weld for BDB loads = 4953 lb/in (Sheet 7-69)

Stress ratio for BDB loads = $4953/7795 = 0.635 < 1.0$, O.K.

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	6-3-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	6/4/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-81	Rev. No.	0

7.2.5 Summary of Relative Displacements

SUMMARY OF RELATIVE VERTICAL (Z) DISPLACEMENT AT BOTTOM OF 42" RISER DUE TO BEYOND DESIGN BASIS (BDB) LOADS

BDB CASE NO.	NODE NO.	VERTICAL DISPLACEMENT (UZ) (in.)	
		Downwards	Upwards
1 ^a	180	-0.09541	0.1492
	550	-0.07422	0.1726
	743	-0.06405	0.1913
	1123	-0.07416	0.1726
2 ^b	180	-0.09794	0.1491
	550	-0.07173	0.1865
	743	-0.05470	0.2073
	1123	-0.07648	0.1542

See sheet no. 7-82 for the location of node nos. 180, 550, 743 and 1123.

^a See file "MPR5A-26.P1O", ADVENT computer file C94003.1.1.J

^b See file "MPR5A-26.P2O", ADVENT computer file C94003.1.1.P

42" ϕ RISER (REAL 20)

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Rui Ming</i>	Date	6/3/97
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>H. W. W. W.</i>	Date	6-4-97
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-83	Rev. No.	0

7.2.6 Evaluation of Concrete Footing :

The original design of the footing, by EBASCO (Reference 2.2.20), includes loads resulting from the hydrogen burn analysis, particularly the vertical seismic acceleration which was taken as equal to 0.37g in the original design. We, therefore, believe that the footing has adequate capacity to resist the BDB loads.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	5-6-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	6/6/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-84	Rev. No.	0

7.2.7 Verification of Linear Transient Dynamic Analysis Results:

As discussed in Section 6.2, the analysis of the MPR for the Beyond Design Basis (BDB) load case was performed by applying two time histories, Displacement and Pressure, simultaneously in ANSYS KAN 5 analysis. In ANSYS program, the load increment in a time history can be done either by a step function or by a ramp function depending on the type of time history. In our case, the both time histories are of ramp type and accordingly the ramp option is selected in the ANSYS program to apply the pressure and displacement time histories. The displacement time history was defined at all given time points and the pressure time history was defined at thirteen control points as explained in Section 6.2.1.1. The thirteen control points were selected to minimize the calculation of nodal forces resulting from the pressure time history at all given time points. In the ANSYS program even though it was expected to apply the time history as a ramp function, when two time histories with different number of control points were applied, the time history with less number of control points was applied as a step function. This discrepancy in the program resulted in applying the pressure time history in un-conservative manner on the left side of the peak (ascending gradient) and in conservative manner on right side of the peak (descending gradient).

To evaluate the impact, a test run was made to verify the response of the structure due to BDB loads. The displacement and pressure time histories were applied as two separate time histories in two separate linear transient dynamic analyses. The enveloped stresses due to responses from these two analyses were combined by absolute sum and compared to the enveloped stresses obtained from the combined pressure and displacement (CP&D) time history analysis. The responses were combined absolutely because of the ANSYS File 12 size limitations. It should be noted that a significant level of conservatism exists in combining the stresses absolutely.

Figure 7.1 shows the input pressure time history used in the CP&D analysis against the input pressure time history considered in the test run. Table 7.5 shows the member stresses due to transient displacement load, transient pressure load, and combined transient displacement and pressure loads. Based on this comparison, it is concluded that the results reported herein, which are based on the CP&D time history analysis, are conservative.

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	6-6-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	6/6/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-85	Rev. No.	0

TRANSIENT PRESSURE TIME HISTORY

CP&D Vs TEST RUN

FIGURE 7.1

Net Pressure =
(Tank Pressure - Atmospheric Pressure)

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	6-6-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	6/6/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-86	Rev. No.	0

Table 7.5: Demand Member Stresses (Psi.)				
REAL No.	S_d	S_p	$S_d + S_p$	S_{p+d}
1	19800	4056	23856	23739
2	25668	1476	27144	45241
3	16793	6397	23190	23879
4	5690	6536	12226	13784
5	6213	8338	14551	26425
6	30382	1755	32137	48266
8	11971	13853	25824	29452
9	5468	8510	13978	15117
10	3159	4484	7643	12436
11	2352	5737	8089	19431
12	2571	4713	7284	22944
13	374	864	1238	2140
14	551	2476	3027	5673
15	287	784	1071	4318
20	24993	2828	27821	29410
21	12742	22650	35392	40124
22	5413	6800	12213	12997
23	13092	15274	28366	29895
24	13063	22131	35194	40808

S_d Demand member stress due to transient displacement load only.
(See file MPR5A-1D.P1O, ADVENT file C94003.1.1 T)

S_p Demand member stress due to transient pressure load only.
(See file MPR5A-1D.P1O, ADVENT file C94003.1.1 U)

S_{p+d} Demand member stress due to simultaneously applied transient pressure and transient displacement loads (See sheet 7-44).

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	Ravi Mijj	Date	6/6/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	W. H. H. H.	Date	6-6-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-87	Rev. No.	0

7.2.7 Evaluation of Port Covers and Their Bolted Connections :

The MPR covers are part of the shield plug assembly (References 2.2.4 and 2.2.10) which consists of a 150#, RF blind flange, connected to the 3"-thick plug plate by means of a 6"-dia. tubing with a lifting lug at the top of the blind flange. The plug plate diameter is equal to the inside diameter of the port so that when the plug is in place, there is no venting of gases. A review of the details of this assembly indicates that the most critical loading for the entire assembly is the pressure loads coming from the tank (BDB Load Case), and the most critical component of the assembly is the bolts which undergo tension resulting from the pressure loads. We, therefore, evaluated the bolts for the pressure loading. The pressure was applied as a static load and the dynamic load factor (DLF) was taken as 2 (per Reference 2.1.2) to calculate the demand pressure loads for each port cover. Our evaluation of these demand pressure loads indicates that the bolts have very large capacity to resist the tension resulting from the pressure loads.

Table 7.6 summarizes the calculations and results of the bolt evaluation.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	Ravi M. Singh	Date	6/6/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	W. H. H. H.	Date	6-6-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	7-88	Rev. No.	81

**TABLE 7.6 : EVALUATION OF BOLTED FLANGE CONNECTIONS
OF MULTIPORT RISER COVERS**

BOLT CAPACITY						
Component Description	# of Bolts (1)	Bolt Dia. (in.)	Allowable Tension per Bolt (2) (lbs)	Total Bolt Tension Capacity (3) (lbs)		
8" Blind Flange, 150# RF (8" Risers)	8	0.750	19,400	155,200		
12" Blind Flange, 150# RF (12" Riser)	12	0.875	26,500	318,000		
20" Blind Flange, 150# RF (20" Riser)	20	1.125	43,700	874,000		
1) Per References 2.2.4 and 2.2.5. 2) Per Reference 2.1.19 : Table I-A, pg 4-3, A325 Bolts. * 3) Total Bolt Tension Capacity = # of Bolts x Area of Each Bolt x Allowable Tension per Bolt						
BOLT EVALUATION						
Component Description	Inside Dia. (in.)	Area (in.^2)	Demand Pressure (psi)	Demand Pressure Load, D (lbs)	Bolt Tension Capa.,C (lbs)	Ratio D/C
8" Blind Flange, 150# RF (8" Risers)	7.38	42.78	48.243	4,127	155,200	0.027 *
12" Blind Flange, 150# RF (12" Riser)	11.50	103.87	48.243	10,022	318,000	0.032
20" Blind Flange, 150# RF (20" Riser)	18.75	276.12	48.243	26,641	874,000	0.030
Demand Pressure = Max. Pressure - A = 48.243 psi = 62.943 - 14.700 = 48.243 psi Demand Pressure Load, D = Area x Demand Pressure x DLF(=2)						

* CHANGED TO ASTM A-307. (SEE SHEET NOS. I-4 & I-19)

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	<i>5-31-94</i>
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	<i>5-31-94</i>
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	2-1	Rev. No.	0

8 MARGIN ANALYSIS FOR EQUIPMENT LOADS

8.1 DB Model

Based on the Design Basis analysis, available stress margins for Normal and Extreme loads were calculated for structural members and connections (bolts, anchors, and welds) of the MPR assembly. These margins are available to resist loads resulting from equipment and instruments TO BE installed into the tank and supported by the 8", 12", and 20" risers. Maximum demand stress anywhere in the MPR structural component or connection is calculated by applying an unit force of 1 kip or unit moment of 1 kip-inch at the top of each riser in the three orthogonal directions. A total of 24 static load cases are considered as follows :

- (1) Unit Force Fx on 8" Riser / North
- (2) Unit Force Fy on 8" Riser / North
- (3) Unit Force Fz on 8" Riser / North
- (4) Unit Moment Mx on 8" Riser / North
- (5) Unit Moment My on 8" Riser / North
- (6) Unit Moment Mz on 8" Riser / North
- (7) Unit Force Fx on 8" Riser / South
- (8) Unit Force Fy on 8" Riser / South
- (9) Unit Force Fz on 8" Riser / South
- (10) Unit Moment Mx on 8" Riser / South
- (11) Unit Moment My on 8" Riser / South
- (12) Unit Moment Mz on 8" Riser / South
- (13) Unit Force Fx on 12" Riser
- (14) Unit Force Fy on 12" Riser
- (15) Unit Force Fz on 12" Riser
- (16) Unit Moment Mx on 12" Riser
- (17) Unit Moment My on 12" Riser
- (18) Unit Moment Mz on 12" Riser
- (19) Unit Force Fx on 20" Riser
- (20) Unit Force Fy on 20" Riser
- (21) Unit Force Fz on 20" Riser
- (22) Unit Moment Mx on 20" Riser
- (23) Unit Moment My on 20" Riser
- (24) Unit Moment Mz on 20" Riser

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>R. M. [signature]</i>	Date	6/4/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[signature]</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	8-2	Rev. No.	81

Results of the 24 static analyses are given in Table 8.1 for margins in structural members of the MPR assembly. Based on these unit load stresses, the following equation is developed to determine the allowable reaction forces and/or moments.

DEMAND MEMBER STRESS (due to reaction force and (or) moments) =

$$[(Ax880 + Bx867 + Cx220 279 + Dx44 + Ex45 + Fx39) + (Gx880 + Hx867 + Ix220 279 + Jx44 + Kx45 + Lx39) + (Mx345 + Nx356 415 + Ox237 301 + Px23 + Qx23 + Rx17) + (Sx343 436 + Tx328 398 + Ux192 244 + Vx13 + Wx14 + Xx7)]$$

DEMAND MEMBER STRESS	$\leq 19,216$	for Normal loads (SHEAR)
	$\leq 30,432$	for Extreme loads
	≤ 20462	for Normal loads (TENSION)

Where the coefficients,

A	Fx (kips)	@ 8" Riser (North);	M	Fx (kips)	@ 12" Riser
B	Fy (kips)	@ 8" Riser (North);	N	Fy (kips)	@ 12" Riser
C	Fz (kips)	@ 8" Riser (North);	O	Fz (kips)	@ 12" Riser
D	Mx (kip-in.)	@ 8" Riser (North);	P	Mx (kip-in.)	@ 12" Riser
E	My (kip-in.)	@ 8" Riser (North);	Q	My (kip-in.)	@ 12" Riser
F	Mz (kip-in.)	@ 8" Riser (North);	R	Mz (kip-in.)	@ 12" Riser
G	Fx (kips)	@ 8" Riser (South);	S	Fx (kips)	@ 20" Riser
H	Fy (kips)	@ 8" Riser (South);	T	Fy (kips)	@ 20" Riser
I	Fz (kips)	@ 8" Riser (South);	U	Fz (kips)	@ 20" Riser
J	Mx (kip-in.)	@ 8" Riser (South);	V	Mx (kip-in.)	@ 20" Riser
K	My (kip-in.)	@ 8" Riser (South);	W	My (kip-in.)	@ 20" Riser
L	Mz (kip-in.)	@ 8" Riser (South);	X	Mz (kip-in.)	@ 20" Riser

Example: Say that only the 12" riser is to be loaded. If reaction forces (Fx and Fy) are found to be 5.0 kips in each of the two horizontal directions, then coefficients "M" and "N" represent the value of 5 kips each. If no moments are applied, the above equation results the following demand stress value.

$$\begin{aligned} \text{DEMAND MEMBER STRESS} &= Mx345 + Nx356 415 \\ &= 5x345 + 5x356 = 3505 \text{ psi} < 19216 \text{ psi. } \therefore \text{OK.} \end{aligned}$$

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Ravi Mung</i>	Date	6/4/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Henry White</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	8 - 3	Rev. No.	0

Because the unit load stresses given in the table represent the absolute maximum stress anywhere in the MPR, this approach is conservative.

In addition to calculating member margins, the margins in the bolts, anchor bolts, and welded connections were calculated using similar approach. Tables 8.2 through 8.4 provide the available margins, and stress ratios in bolts, anchors bolts, and welds, respectively, for the DB model.

When determining the allowable reactions, margins must be calculated for both the members and the connections to ensure that the proposed reactions do not cause overstress in the members and in the connections.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	Ravi N. Singh	Date	6/1/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	[Signature]	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	8-4	Rev. No.	81

**TABLE 8.1 : AVAILABLE STRESS MARGINS IN MPR 5A MEMBERS
(DB Model)**

AVAILABLE STRESS MARGINS IN MEMBERS AFTER (D) & (DBE) LOADS			
Load	Demand Stress (1)	Allowable Stress	Available Stress
D	3,284	22,500	19,216 ▼
D + DBE	5,568	36,000	30,432

UNIT LOAD STRESS SUMMARY (See File : MPRPM11.OUT ; ADVENT File No. : C94003.1.1.AB)				
Load Type and Load Direction	Unit Loads Applied at Top Center of			
	8" Riser/North	8" Riser/South	12" Riser	20" Riser
	Maximum Stress anywhere in MPR			
Fx*	880	880	345	343
Fy*	867	867	356	328 ▼
Fz*	220	220	237	192
Mx**	44	44	23	13
My**	45	45	23	14
Mz**	39	39	17	7

* Unit Load = 1 kip

** Unit Moment = 1 kip-in.

(D) Allowable Stress = $0.75 \cdot F_y$ = $0.75 \cdot 30,000$ = 22,500 psi
 (D+DBE) Allowable Stress = $1.6 \cdot 0.75 \cdot F_y$ = $1.6 \cdot 0.75 \cdot 30,000$ = 36,000 psi

(1) Refer to Sheet Nos. 7-2 (Table 7.1) and 7-3 (Table 7.2).

NOTE : Refer to Sheet Nos. 8-1 through 8-3 for the procedure that describes how to calculate the allowable reaction loads resulting from sonic probes or other equipment suspended from the risers.

▼ REVISED IN TABLE I-3 (SEE SHEET NO. I-12) 4-2-94 wnt a/2/94

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	Ravi M. Singh	Date	6/7/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	H. M. Singh	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	2 - 5	Rev. No.	0

**TABLE 8.2 : AVAILABLE STRESS MARGINS IN MPR 5A BOLTS
(DB Model)**

Note : Stress Ratios based on 1 1/4 in. A325 Bolts.

AVAILABLE STRESS MARGINS IN MPR BOLTS AFTER (D) & (DBE) LOADS				
Load	Demand Stress Ratio (1)	Allowable Stress Ratio (2)	Available Stress Ratio	
D	0.061	1.000	0.939	
D + DBE	0.100	1.400	1.300	
UNIT LOAD STRESS RATIO SUMMARY (See Appendix D)				
Load Type and Load Direction	Unit Loads Applied at Top Center of			
	8" Riser/North	8" Riser/South	12" Riser	20" Riser
	Maximum Stress Ratio - Bolts (3)			
Fx*	0.008	0.008	0.011	0.010
Fy*	0.012	0.012	0.009	0.009
Fz*	0.005	0.005	0.005	0.004
Mx**	0.000	0.000	0.000	0.000
My**	0.000	0.000	0.000	0.000
Mz**	0.000	0.000	0.000	0.000

* Unit Load = 1 kip

** Unit Moment = 1 kip-in.

(1) Refer to Sheet Nos. 7-7 through 7-11.

(2) Shear governs.

(3) Zero values indicate insignificantly small ratios.

NOTE : Refer to Sheet Nos. 8-1 through 8-3 for the procedure that describes how to calculate the allowable reaction loads resulting from sonic probes or other equipment suspended from the risers.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>R. M. L. J.</i>	Date	6/4/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	8-6	Rev. No.	81

**TABLE 8.3 : AVAILABLE STRESS MARGINS IN MPR 5A ANCHOR BOLTS
(DB Model)**

Note : Stress Ratios based on 1 1/4 in. Maxi Bolts.

AVAILABLE STRESS MARGINS IN MPR ANCHOR BOLTS AFTER (D) & (DBE) LOADS			
Load	Demand Stress Ratio (1)	Allowable Stress Ratio (2)	Available Stress Ratio
D	0.048	1.000	0.952
D + DBE	0.066	1.700	1.634

UNIT LOAD STRESS RATIO SUMMARY (See Appendix E)				
Load Type and Load Direction	Unit Loads Applied at Top Center of			
	8" Riser/North	8" Riser/South	12" Riser	20" Riser
	Maximum Stress Ratio - Anchors (3)			
Fx*	0.013	0.013	0.012	0.012
Fy*	0.009	0.009	0.008	0.007
Fz*	0.007	0.007	0.007	0.006
Mx**	0.000	0.000	0.000	0.000
My**	0.000	0.000	0.000	0.000
Mz**	0.000	0.000	0.000	0.000

* Unit Load = 1 kip

** Unit Moment = 1 kip-in.

(1) Refer to Sheet Nos. 7-4 through 7-6.

(2) Per Reference 2.1.24

(3) Zero values indicate insignificantly small ratios.

NOTE : Refer to Sheet Nos. 8-1 through 8-3 for the procedure that describes how to calculate the allowable reaction loads resulting from sonic probes or other equipment suspended from the risers.

REVISED IN TABLE I-1 (SEE SHEET NO. I-8) | 9-2-94 unit 9/2/94

Project	Westinghouse Hanford Company	Prepared By:	<i>Ran mly</i>	Date	6/4/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	8-7	Rev. No.	0

**TABLE 8.4 : AVAILABLE STRESS MARGINS IN MPR 5A WELDS
(DB Model)**

AVAILABLE STRESS MARGINS IN MPR WELDS AFTER (D) & (DBE) LOADS				
Load	Demand Stress Ratio (1)	Allowable Stress Ratio	Available Stress Ratio	
D	0.245	1.000	0.755	
D + DBE	0.318	1.400	1.082	
UNIT LOAD STRESS RATIO SUMMARY (See Appendix F)				
Load Type and Load Direction	Unit Loads Applied at Top Center of			
	8" Riser/North	8" Riser/South	12" Riser	20" Riser
	Maximum Stress Ratio - Welds (2)			
Fx*	0.056	0.056	0.017	0.009
Fy*	0.064	0.064	0.020	0.011
Fz*	0.014	0.014	0.012	0.012
Mx**	0.003	0.003	0.001	0.000
My**	0.002	0.002	0.001	0.001
Mz**	0.002	0.002	0.001	0.000

* Unit Load = 1 kip

** Unit Moment = 1 kip-in.

(1) Refer to Sheet Nos. 7-29 through 7-41.

(2) Zero values indicate insignificantly small ratios.

NOTE : Refer to Sheet Nos. 8-1 through 8-3 for the procedure that describes how to calculate the allowable reaction loads resulting from sonic probes or other equipment suspended from the risers.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	6-4-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	6/4/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	8-8	Rev. No.	0

8.2 BDB Model

The BDB model is similar to the DB model except that the soil structure interaction is considered in the vertical direction. The same results, derived for the DB model, are used for the BDB model, which is conservative. The only difference is the allowable margin value. Tables 8.5 through 8.8 give a summary of calculated and available margins for the members, bolts, anchor bolts, and welds of the BDB model.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Kari M. King</i>	Date	6/4/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	8-9	Rev. No.	81

**TABLE 8.5 : AVAILABLE STRESS MARGINS IN MPR 5A MEMBERS
(BDB Model)**

AVAILABLE STRESS MARGINS IN MPR MEMBERS				
		Available (1)		
		Stress, psi		
		49,000		
UNIT LOAD STRESS SUMMARY				
(See File : MPRPM11.OUT ; ADVENT File No. : C94003.1.1 AB)				
Load Type and Load Direction	Unit Loads Applied at Top Center of			
	8" Riser/North	8" Riser/South	12" Riser	20" Riser
	Maximum Stress anywhere in MPR			
Fx*	880	880	345	343
Fy*	867	867	356	328
Fz*	220	220	237	192
Mx**	44	44	23	13
My**	45	45	23	14
Mz**	39	39	17	7

* Unit Load = 1 kip

** Unit Moment = 1 kip-in.

(1) Allowable Stress = $0.70 \times \text{Ultimate Stress} = 0.70 \times 70000 = 49,000$ psi

NOTE : Refer to Sheet Nos. 8-1 through 8-3 for the procedure that describes how to calculate the allowable reaction loads resulting from sonic probes or other equipment suspended from the risers.

▼ REVISED IN TABLE I-4 (SEE SHEET NO. I-13)

4-2-94
Wm H
9/2/94

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Ravi Nigam</i>	Date	6/4/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Henry Smith</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	8-10	Rev. No.	0

**TABLE 8.6 : AVAILABLE STRESS MARGINS IN MPR 5A BOLTS
(BDB Model)**

Note : Stress Ratios based on 1 1/4 in. A325 Bolts.

AVAILABLE STRESS MARGINS IN MPR BOLTS				
		Available(1) Stress Ratio		
		1.400		
UNIT LOAD STRESS RATIO SUMMARY (See Appendix D)				
Load Type and Load Direction	Unit Loads Applied at Top Center of			
	8" Riser/North	8" Riser/South	12" Riser	20" Riser
	Maximum Stress Ratio - Bolts (2)			
Fx*	0.008	0.008	0.011	0.010
Fy*	0.012	0.012	0.009	0.009
Fz*	0.005	0.005	0.005	0.004
Mx**	0.000	0.000	0.000	0.000
My**	0.000	0.000	0.000	0.000
Mz**	0.000	0.000	0.000	0.000

* Unit Load = 1 kip

** Unit Moment = 1 kip-in.

(1) Shear governs.

(2) Zero values indicate insignificantly small ratios.

NOTE : Refer to Sheet Nos. 8-1 through 8-3 for the procedure that describes how to calculate the allowable reaction loads resulting from sonic probes or other equipment suspended from the risers.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	Ravi Mijar	Date	6/4/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	[Signature]	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	8-11	Rev. No.	81

**TABLE 8.7 : AVAILABLE STRESS MARGINS IN MPR 5A ANCHOR BOLTS
(BDB Model)**

Note : Stress Ratios based on 1 1/4 in. Maxi Bolts.

AVAILABLE STRESS MARGINS IN MPR ANCHOR BOLTS				
		Available (1)		
		Stress Ratio		
		1.700		
UNIT LOAD STRESS RATIO SUMMARY (See Appendix E)				
Load Type and Load Direction	Unit Loads Applied at Top Center of			
	8" Riser/North	8" Riser/South	12" Riser	20" Riser
	Maximum Stress Ratio - Anchors (2)			
Fx*	0.013	0.013	0.012	0.012
Fy*	0.009	0.009	0.008	0.007
Fz*	0.007	0.007	0.007	0.006
Mx**	0.000	0.000	0.000	0.000
My**	0.000	0.000	0.000	0.000
Mz**	0.000	0.000	0.000	0.000

* Unit Load = 1 kip

** Unit Moment = 1 kip-in.

(1) Per Reference 2.1.4

(2) Zero values indicate insignificantly small ratios.

NOTE : Refer to Sheet Nos. 8-1 through 8-3 for the procedure that describes how to calculate the allowable reaction loads resulting from sonic probes or other equipment suspended from the risers.

▼ REVISED IN TABLE I-2 (SEE SHEET NO. I-9) [Signature] 9-2-94
wmb
9/2/94

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Ravi Mitt</i>	Date	6/4/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	8-12	Rev. No.	0

**TABLE 8.8 : AVAILABLE STRESS MARGINS IN MPR 5A WELDS
(BDB Model)**

AVAILABLE STRESS MARGINS IN MPR WELDS				
Available Stress Ratio (Based on Ratio of BDB Weld capacity and DB Weld Capacity) (= 10393/6000)***				
		1.732		
UNIT LOAD STRESS RATIO SUMMARY (See Appendix F)				
Load Type and Load Direction	Unit Loads Applied at Top Center of			
	8" Riser/North	8" Riser/South	12" Riser	20" Riser
	Maximum Stress Ratio - Welds (1)			
Fx*	0.056	0.056	0.017	0.009
Fy*	0.064	0.064	0.020	0.011
Fz*	0.014	0.014	0.012	0.012
Mx**	0.003	0.003	0.001	0.000
My**	0.002	0.002	0.001	0.001
Mz**	0.002	0.002	0.001	0.000

* Unit Load = 1 kip

** Unit Moment = 1 kip-in.

*** Min. (BDB Weld Capacity/Normal Weld Capacity) per Sections 7.1.4.2 and 7.2.4.2

(1) Zero values indicate insignificantly small ratios.

NOTE : Refer to Sheet Nos. 8-1 through 8-3 for the procedure that describes how to calculate the allowable reaction loads resulting from sonic probes or other equipment suspended from the risers.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	Rain May	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	[Signature]	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	8-13	Rev. No.	0

LOG OF COMPUTER INPUT/OUTPUT FILES FOR MARGIN ANALYSIS

Input/Output File Name	ADVENT File Name	File Contents Description
MPRSM11.INP	C94003.1.1.AA	Static analysis for unit forces/moments (FILE12.DAT used for POST analyses)
MPRSM11.OUT	C94003.1.1.AB	Post analysis for member stresses
MPRPM11.INP	C94003.1.1.AC	Post analysis for bolts/anchor bolts stresses
MPRPM11.OUT	C94003.1.1.AD	Post analysis for weld forces / Fx / 8" Riser North
MPRPAB11.INP		Post analysis for weld forces / Fy / 8" Riser North
MPRPAB11.OUT		Post analysis for weld forces / Fz / 8" Riser North
MPRPW1.INP		Post analysis for weld forces / Mx / 8" Riser North
MPRPW1.OUT		Post analysis for weld forces / My / 8" Riser North
		Post analysis for weld forces / Mz / 8" Riser North
		Post analysis for weld forces / Fx / 8" Riser South
		Post analysis for weld forces / Fy / 8" Riser South
		Post analysis for weld forces / Fz / 8" Riser South
		Post analysis for weld forces / Mx / 8" Riser South
		Post analysis for weld forces / My / 8" Riser South
		Post analysis for weld forces / Mz / 8" Riser South
		Post analysis for weld forces / Mx / 12" Riser
		Post analysis for weld forces / Fy / 12" Riser
		Post analysis for weld forces / Fz / 12" Riser
		Post analysis for weld forces / Mx / 12" Riser
		Post analysis for weld forces / My / 12" Riser
		Post analysis for weld forces / Mz / 12" Riser
		Post analysis for weld forces / Fx / 20" Riser
		Post analysis for weld forces / Fy / 20" Riser
		Post analysis for weld forces / Fz / 20" Riser
		Post analysis for weld forces / Mx / 20" Riser
		Post analysis for weld forces / My / 20" Riser
		Post analysis for weld forces / Mz / 20" Riser
		Post analysis for weld forces / R1 to R20 / All Risers

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By: <i>Ran N. Ling</i>	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By: <i>W. H. H. H.</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No. 94003.1.1
Client Calc. No.		Sheet No.	8-14	Rev. No. 0

8.3 Translational and Rotational Stiffnesses of MPR Ports :

Translational and rotational stiffnesses in the three orthogonal directions are calculated for each of the four MPR ports (8" Riser/North, 8" Riser/South, 12" Riser, and 20" Riser) for use in the qualification of equipment (such as the sonic probe, etc.) to be suspended from the top of the riser ports.

From the unit load margin analyses, displacements and rotations were obtained at node points where unit loads were applied. Stiffnesses were calculated by dividing the applied unit load (force or moment) by the corresponding displacement or rotation at the point of application of load. Table 8.9 provides the stiffness calculations.

To perform a decoupled analysis of the equipment to be suspended from the port, the six corresponding stiffness values, given in Table 8.9, for each port may be used to model the boundary conditions.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	K. M. King	Date	6/7/94
Subject	Structural Analysis of Multiport Riser SA	Reviewed By:	[Signature]	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	8-15	Rev. No.	0

TABLE 8.9 : TRANSLATIONAL AND ROTATIONAL STIFFNESSES FOR MULTIPORT RISERS

Port ID	Node #	Direction	Unit Force (lbs)	Calculated Displacement (in.)	Translational Stiffness (lb/in.)	Unit Moment (lb-in.)	Calculated Rotation (rad.)	Rotational Stiffness (lb-in./rad.)
8" Riser (North)	5081	X	1000	1.874E-06	5.336E+08	1000	1.407E-08	7.106E+10
		Y	1000	5.278E-06	1.895E+08	1000	1.622E-08	6.165E+10
		Z	1000	1.262E-07	7.922E+09	1000	3.684E-07	2.714E+09
8" Riser (South)	5082	X	1000	1.839E-06	5.438E+08	1000	1.298E-08	7.703E+10
		Y	1000	5.355E-06	1.867E+08	1000	1.775E-08	5.633E+10
		Z	1000	6.415E-08	1.559E+10	1000	3.684E-07	2.714E+09
12" Riser	5012	X	1000	5.496E-06	1.819E+08	1000	1.501E-09	6.664E+11
		Y	1000	5.381E-08	1.858E+10	1000	1.271E-08	7.869E+10
		Z	1000	3.185E-08	3.140E+10	1000	3.707E-07	2.698E+09
20" Riser	5020	X	1000	3.430E-06	2.916E+08	1000	4.988E-10	2.005E+12
		Y	1000	2.158E-08	4.634E+10	1000	4.242E-10	2.357E+12
		Z	1000	3.379E-08	2.960E+10	1000	7.780E-07	1.285E+09

NOTE : Calculated displacements and rotations from File : MPRPAB11.OUT; ADVENT File No. C94003.1.1.AC.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	6-4-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	6/4/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	3-16	Rev. No.	0

8.4 Translational Reaction Forces At Top of MPR Ports

Reaction forces at different ports were obtained as the summation of nodal average force (*ANSYS NFORCE*) from the riser nodes at the intersection of the riser's flange and riser. Since the signs are lost during modal combination, the summation of nodal average forces is obtained based on mode by mode basis and the total seismic response is calculated manually as shown below:

$$\text{Total Seismic response, } E = \left[\begin{aligned} &\{(X1+X2)^2 + X3^2 + (0.2xDX)^2\} + \\ &\{(Y1+Y2)^2 + Y3^2 + (0.2xDY)^2\} + \\ &\{(Z1+Z2)^2 + Z3^2 + (0.134xDZ)^2\} \end{aligned} \right]^{1/2}$$

Where,

X1, X2 & X3: Seismic response in X direction due to Modes 1, 2 & 3.
Y1, Y2 & Y3: Seismic response in Y direction due to Modes 1, 2 & 3.
Z1, Z2 & Z3: Seismic response in Z direction due to Modes 1, 2 & 3.
DX, DY & DZ : 1.0 g Static response in X, Y and Z directions.

FX, FY & FZ: Translational reaction force (lbs) in X, Y and Z directions.
MX, MY & MZ: Translational reaction moment (lb-in.) about X, Y and Z directions.

Note: Modes 1 and 2 are closely spaced (within 10%).

Per Section 6.3 of Reference 2.1.21, "Grouping Method" is used.

See file MPR5A-DB.P4I, ADVENT file no. C94003.1.1.V for *ANSYS NFORCE* which are listed in tables below.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Handwritten Signature</i>	Date	6-3-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Handwritten Signature</i>	Date	6/4/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	8-17	Rev. No.	0

	X1	X2	X3	Y1	Y2	Y3	Z1	Z2	Z3	DX	DY	DZ	E	D+E
20" RISER PORT														
FX	218	0	0	-3	-12	7	0	-2	-16	1273	0	0	336	336
FY	-15	2	0	0	276	27	0	55	-61	0	1273	0	386	386
FZ	-3	2	-1	0	247	-102	0	49	226	0	0	1273	392	1664
MX	-25	21	-7	0	2316	-954	0	459	2117	0	579	12	3314	3325
MY	-4	3	-1	0	359	-148	0	71	328	579	0	0	526	526
MZ	-2022	-3	-1	24	-290	-109	3	-58	243	12	0	0	2060	2060
12" RISER PORT														
FX	-1925	0	0	23	-37	-2	3	-7	4	6959	0	0	2375	2375
FY	24	-16	0	0	-1736	-42	0	-344	93	0	6959	0	2254	2254
FZ	29	-3	3	0	-316	338	0	-63	-750	0	0	6959	1281	8241
MX	-225	-7	10	3	-773	1252	0	-153	-2778	0	0	43	3155	3198
MY	-713	1	0	8	155	24	1	31	-54	0	0	0	733	733
MZ	379	19	1	-5	2094	103	-1	415	-228	43	0	0	2182	2182
8" RISER PORT (North)														
FX	-184	-1	0	2	-94	36	0	-19	-80	1008	0	0	302	302
FY	-38	-2	-1	0	-182	-67	0	-36	148	0	1008	0	321	321
FZ	51	-1	1	-1	-76	111	0	-15	-246	0	0	1008	316	1324
MX	-189	3	-3	2	281	-409	0	56	907	0	0	8	1053	1061
MY	-88	1	-1	1	130	-189	0	26	420	0	0	39	487	526
MZ	-580	-3	1	7	-349	69	1	-69	-154	8	39	0	700	700

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	6-3-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	6/4/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	8-18	Rev. No.	0

8" RISER PORT (South)														
--	X1	X2	X3	Y1	Y2	Y3	Z1	Z2	Z3	DX	DY	DZ	E	D+E
FX	-187	1	0	2	77	-25	0	15	55	1008	0	0	293	293
FY	48	-2	-1	-1	-180	-69	0	-36	154	0	1008	0	324	324
FZ	-57	-1	1	1	-62	109	0	-12	-243	0	0	1008	310	1318
MX	232	2	-3	-3	250	-444	0	50	984	0	0	8	1133	1141
MY	12	0	0	0	13	-22	0	2	50	0	0	39	57	97
MZ	-691	3	0	8	380	-47	1	75	103	8	39	0	801	801

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>R. M. King</i>	Date	5/16/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	5-16-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	A-1	Rev. No.	0

APPENDIX A
TANK PRESSURE TIME HISTORY
(10 Sheets)

Los Alamos

NATIONAL LABORATORY

Technology & Safety Assessment Division
TSA-6, Engineering & Safety Analysis, MS K557
Los Alamos, New Mexico 87545

facsimile ADVENT

Project No. 94003
File No. 5.0
Log No. 3

FAX NUMBER
(505) 665-2897

VERIFICATION
(505) 667-6231

TO: RAVI BELEGA
ADVENT ENGINEERING
FAX # (510) 743-0414

FROM: E. RODRIGUEZ

Number of pages, including the cover sheet: 9

Date transmitted: 2/15/94

Verified: [Signature]

Approval: [Signature]

Cy: CRM-4, MS A150

MESSAGE: RAVI - HERE'S THE DATA YOU NEED FOR
THE MPP ANALYSIS. CALL ME WHEN YOU
RECEIVE IT.

- Ed -

Sheet No. A-2

JIMS/TRAC PRESSURE-TIME HISTORY
ORIGINAL 1.25"MEB BURN (13,100 cu ft)
CORRECTED FOR VOLUMETRIC EXPANSION

V

TIME	APPLIED PRESSURE	CORRECTED TANK PRESSURE
0.00000000,	14.7000,	14.7000
0.00006000,	15.5798,	15.5584
0.00012250,	15.5798,	15.5584
0.00068049,	15.5798,	15.5584
0.00167147,	15.5798,	15.5583
0.00278633,	15.5797,	15.5582
0.00402506,	15.5797,	15.5581
0.00541863,	15.5797,	15.5579
0.00696704,	15.5797,	15.5578
0.00870900,	15.5797,	15.5575
0.01064451,	15.5796,	15.5572
0.01282196,	15.5796,	15.5569
0.01524136,	15.5796,	15.5565
0.01796317,	15.5795,	15.5559
0.02098741,	15.5795,	15.5553
0.02438968,	15.5794,	15.5546
0.02816998,	15.5794,	15.5539
0.03242281,	15.5793,	15.5530
0.03714819,	15.5793,	15.5522
0.04201087,	15.5792,	15.5517
0.04701087,	15.5791,	15.5515
0.05201087,	15.5791,	15.5516
0.05701087,	15.5790,	15.5519
0.06201087,	15.5789,	15.5526
0.06701087,	15.5789,	15.5532
0.07201087,	15.5788,	15.5539
0.07701087,	15.5787,	15.5548
0.08201087,	15.5786,	15.5555
0.08701087,	15.5786,	15.5560
0.09201087,	15.5785,	15.5562
0.09701087,	15.5784,	15.5561
0.10201087,	15.5784,	15.5559
0.10701087,	15.5783,	15.5554
0.11201087,	15.5782,	15.5548
0.11701087,	15.5782,	15.5541
0.12201087,	15.5781,	15.5533
0.12701087,	15.5780,	15.5526
0.13201087,	15.5780,	15.5520
0.13701087,	15.5779,	15.5516
0.14201087,	15.5778,	15.5514
0.14701087,	15.5777,	15.5513
0.15201087,	15.5777,	15.5514
0.15701087,	15.5776,	15.5515
0.16201087,	15.5775,	15.5518
0.16701087,	15.5775,	15.5522
0.17201087,	15.5774,	15.5527
0.17701087,	15.5773,	15.5530
0.18201087,	15.5773,	15.5532
0.18701087,	15.5772,	15.5534
0.19201087,	15.5771,	15.5535
0.19701087,	15.5771,	15.5535
0.20201087,	15.5770,	15.5535
0.20701087,	15.5769,	15.5534
0.21201087,	15.5769,	15.5531
0.21701087,	15.5768,	15.5527

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0.22201087.	15.5767.	15.5524
0.22701087.	15.5766.	15.5520
0.23201087.	15.5766.	15.5517
0.23701087.	15.5765.	15.5514
0.24201087.	15.5764.	15.5510
0.24701087.	15.5764.	15.5507
0.25201087.	15.5763.	15.5506
0.25701087.	15.5762.	15.5506
0.26201087.	15.5762.	15.5506
0.26701087.	15.5761.	15.5506
0.27201087.	15.5760.	15.5507
0.27701087.	15.5760.	15.5508
0.28201087.	15.5759.	15.5510
0.28701087.	15.5758.	15.5513
0.29201087.	15.5758.	15.5516
0.29701087.	15.5757.	15.5517
0.30201087.	15.5756.	15.5518
0.30701087.	15.5755.	15.5518
0.31201087.	15.5755.	15.5518
0.31701087.	15.5754.	15.5517
0.32201087.	15.5753.	15.5515
0.32701087.	15.5753.	15.5511
0.33201087.	15.5752.	15.5506
0.33701087.	15.5751.	15.5502
0.34201087.	15.5751.	15.5498
0.34701087.	15.5750.	15.5496
0.35201087.	15.5749.	15.5494
0.35701087.	15.5749.	15.5492
0.36201087.	15.5748.	15.5492
0.36701087.	15.5747.	15.5492
0.37201087.	15.5746.	15.5493
0.37701087.	15.5746.	15.5496
0.38201087.	15.5745.	15.5498
0.38701087.	15.5744.	15.5501
0.39201087.	15.5744.	15.5502
0.39701087.	15.5743.	15.5503
0.40201087.	15.5742.	15.5504
0.40701087.	15.5742.	15.5504
0.41201087.	15.5741.	15.5503
0.41701087.	15.5740.	15.5500
0.42201087.	16.4130.	16.3869
0.42701087.	16.3830.	16.3561
0.43201087.	16.4565.	16.4284
0.43701087.	16.4654.	16.4360
0.44201087.	16.4875.	16.4567
0.44701087.	16.5194.	16.4874
0.45201087.	16.5373.	16.5042
0.45701087.	16.5407.	16.5069
0.46201087.	16.6732.	16.6388
0.46701087.	16.6972.	16.6631
0.47201087.	16.8416.	16.8076
0.47701087.	16.8589.	16.8253
0.48201087.	16.8762.	16.8432
0.48701087.	16.8821.	16.8498
0.49201087.	17.3120.	17.2794
0.49701087.	17.5691.	17.5364
0.50201087.	18.0651.	18.0312
0.50701087.	18.5991.	18.5630

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0.51201087.	19.0046.	18.9656
0.51701087.	19.0660.	19.0241
0.52201087.	19.2435.	19.1981
0.52701087.	19.2997.	19.2507
0.53201087.	19.6832.	19.6297
0.53701087.	20.0270.	19.9692
0.54201087.	20.2090.	20.1478
0.54701087.	20.2730.	20.2094
0.55201087.	20.5821.	20.5165
0.55701087.	20.7951.	20.7285
0.56201087.	21.0561.	20.9888
0.56701087.	21.2820.	21.2146
0.57201087.	21.4056.	21.3387
0.57701087.	22.0359.	21.9680
0.58201087.	22.3729.	22.3045
0.58701087.	22.6558.	22.5867
0.59201087.	22.7006.	22.6305
0.59701087.	22.7332.	22.6614
0.60201087.	23.1408.	23.0654
0.60701087.	23.2548.	23.1764
0.61201087.	23.8196.	23.7364
0.61701087.	24.9149.	24.8244
0.62201087.	25.4622.	25.3655
0.62701087.	26.1984.	26.0938
0.63201087.	26.8791.	26.7658
0.63701087.	27.0524.	26.9321
0.64201087.	27.4913.	27.3626
0.64701087.	27.9399.	27.8027
0.65201087.	28.3073.	28.1622
0.65701087.	29.2843.	29.1288
0.66201087.	29.4829.	29.3214
0.66701087.	30.0581.	29.8893
0.67076087.	30.4166.	30.2432
0.67357337.	31.1945.	31.0149
0.67708900.	32.4480.	32.2590
0.68148353.	33.8958.	33.6942
0.68514564.	35.6090.	35.3925
0.68789222.	35.8509.	35.6279
0.69094398.	36.5356.	36.3020
0.69437721.	36.9714.	36.7263
0.69819190.	37.3813.	37.1221
0.70248344.	37.7368.	37.4609
0.70725181.	38.1213.	37.8250
0.71160549.	38.8441.	38.5257
0.71160550.	38.8441.	38.5257
0.71280832.	39.5345.	39.2059
0.71521398.	40.0647.	39.7219
0.71761963.	40.5015.	40.1452
0.72032599.	41.4690.	41.0932
0.72333306.	42.9279.	42.5264
0.72671601.	45.0786.	44.6416
0.73047485.	47.0867.	46.6104
0.73470354.	47.8099.	47.3006
0.73940208.	49.1757.	48.6206
0.74425136.	50.2198.	49.6173
0.74925136.	50.9737.	50.3236
0.75425136.	51.3182.	50.6255
0.75925136.	52.5185.	51.7718

0.76425136,	53.4735.	52.6747
0.76925136,	55.3580,	54.4925
0.77425136,	55.7228,	54.8125
0.77925136,	55.9039,	54.9537
0.78425136,	56.0495,	55.0565
0.78925136,	56.5603,	55.5210
0.79425136,	56.6057,	55.5285
0.79925136,	56.5987,	55.4850
0.80425136,	56.8843,	55.7290
0.80925136,	58.2203,	57.0012
0.81425136,	58.8585,	57.5867
0.81925136,	59.3248,	57.9994
0.82425136,	59.4183,	58.0430
0.82925136,	59.9522,	58.5130
0.83425136,	60.3047,	58.8001
0.83925136,	60.5093,	58.9388
0.84425136,	60.7876,	59.1453
0.84925136,	61.0722,	59.3533
0.85425136,	62.0224,	60.2038
0.85925136,	62.5579,	60.6449
0.86425136,	62.9430, ← PEAK	60.9344
0.86925136,	62.9407,	60.8435
0.87425136,	62.9229,	60.7326
0.87925136,	62.8294,	60.5451
0.88425136,	62.8397,	60.4542
0.88925136,	62.7272,	60.2415
0.89425136,	62.6210,	60.0327
0.89925136,	63.1698,	60.4492
0.90425136,	63.0500,	60.2216
0.90925136,	62.9589,	60.0198
0.91425136,	62.8682,	59.8169
0.91925136,	63.0196,	59.8437
0.92425136,	62.9031,	59.6147
0.92925136,	62.7797,	59.3783
0.93425136,	62.6512,	59.1368
0.93925136,	62.5279,	58.9000
0.94425136,	62.4113,	58.6696
0.94925136,	62.2948,	58.4398
0.95425136,	62.1797,	58.2127
0.95925136,	62.0680,	57.9912
0.96425136,	62.1081,	57.9141
0.96925136,	61.9883,	57.6896
0.97425136,	61.8635,	57.4635
0.97925136,	61.7395,	57.2414
0.98425136,	61.6193,	57.0256
0.98925136,	61.5028,	56.8162
0.99425136,	61.3840,	56.6078
0.99925136,	61.2622,	56.3997
1.00425136,	61.1428,	56.1971
1.00925136,	61.0268,	56.0015
1.01425136,	60.9109,	55.8096
1.01925136,	60.7928,	55.6192
1.02425136,	60.8477,	55.5910
1.02925136,	60.7179,	55.3967
1.03425136,	60.5962,	55.2135
1.03925136,	60.4782,	55.0374
1.04425136,	60.3610,	54.8654
1.04925136,	60.2422,	54.6955

1.05425136,	60.1235,	54.5288
1.05925136,	60.0062,	54.3663
1.06425136,	59.8891,	54.2064
1.06925136,	59.7713,	54.0476
1.07425136,	59.6530,	53.8895
1.07925136,	59.5353,	53.7326
1.08425136,	59.4187,	53.5771
1.08925136,	59.3032,	53.4230
1.09425136,	59.1876,	53.2693
1.09925136,	59.0719,	53.1156
1.10425136,	58.9565,	52.9621
1.10925136,	58.8415,	52.8087
1.11425136,	58.7267,	52.6550
1.11925136,	58.6117,	52.5008
1.12425136,	58.4969,	52.3464
1.12925136,	58.3825,	52.1924
1.13425136,	58.2690,	52.0394
1.13925136,	58.1558,	51.8874
1.14425136,	58.0428,	51.7369
1.14925136,	57.9298,	51.5878
1.15425136,	57.8171,	51.4405
1.15925136,	57.7047,	51.2951
1.16425136,	57.5923,	51.1514
1.16925136,	57.4801,	51.0097
1.17425136,	57.3682,	50.8705
1.17925136,	57.2568,	50.7343
1.18425136,	57.1458,	50.6011
1.18925136,	57.0350,	50.4709
1.19425136,	56.9245,	50.3436
1.19925136,	56.8142,	50.2191
1.20425136,	56.7040,	50.0971
1.20925136,	56.5939,	49.9776
1.21425136,	56.4842,	49.8603
1.21925136,	56.3746,	49.7453
1.22425136,	56.2654,	49.6327
1.22925136,	56.1565,	49.5222
1.23425136,	56.0481,	49.4139
1.23925136,	55.9396,	49.3069
1.24425136,	55.8316,	49.2013
1.24925136,	55.7236,	49.0967
1.25425136,	55.6159,	48.9936
1.25925136,	55.5084,	48.8919
1.26425136,	55.4011,	48.7921
1.26925136,	55.2941,	48.6944
1.27425136,	55.1874,	48.5993
1.27925136,	55.0810,	48.5067
1.28425136,	54.9749,	48.4166
1.28925136,	54.8689,	48.3282
1.29425136,	54.7632,	48.2412
1.29925136,	54.6576,	48.1551
1.30425136,	54.5524,	48.0694
1.30925136,	54.4472,	47.9833
1.31425136,	54.3424,	47.8965
1.31925136,	54.2379,	47.8089
1.32425136,	54.1335,	47.7203
1.32925136,	54.0296,	47.6310
1.33425136,	53.9257,	47.5408
1.33925136,	53.8222,	47.4500

1.34425136.	53.7188,	47.3588
1.34925136,	53.6156,	47.2676
1.35425136,	53.5127,	47.1766
1.35925136.	53.4100,	47.0862
1.36425136,	53.3076,	46.9963
1.36925136, —————	53.2054,	46.9069
1.37237636,	53.1417,	46.8513
1.37320196,	53.1248,	46.8366
1.37352793,	53.1182,	46.8308
1.37373166.	53.1141,	46.8272

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Ran m</i>	Date	5/16/74
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>HW</i>	Date	5-16-74
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	B-1	Rev. No.	0

APPENDIX B

TANK DOME DISPLACEMENT TIME HISTORY

(12 Sheets)

Los Alamos
NATIONAL LABORATORY

facsimile

Technology & Safety Assessment Division
TSA-6, Engineering & Safety Analysis, MS K557
Los Alamos, New Mexico 87545

ADVENT	
Project No.	94003
File No.	5.0
Log No.	2

FAX NUMBER
(505) 665-2897

VERIFICATION
(505) 667-6231

TO: JOHN STRELOW (WHC)
FAX # (509) 376-7382

AND

RAVI BELEGA (ADVENT)
FAX # (510) 743-0414

FROM: EDWARD RODRIGUEZ LANL

Number of pages, including the cover sheet: 11

Date transmitted: 2/9/94

Verified: [Signature]

Approval: EAR

Cy: CRM-4, MS A150

MESSAGE:

HERE ARE THE DISPLACEMENTS
& ACCELERATIONS OF THE 101-SX
DOME AT 20 FT RADII FOR THE
"OLD" P-T HISTORY.

Sheet No. B-2

**DOMES DISPLACEMENT-TIME HISTORY
 LOCATION @ 20 FT RADIUS
 ORIGINAL 1.25*MEB CASE
 HLW TANK 101-SY**

TIME	DISPLACEMENT
0.42201	-0.099000
0.42701	-0.099000
0.43201	-0.099000
0.43701	-0.098000
0.44201	-0.095000
0.44701	-0.092000
0.45201	-0.089000
0.45701	-0.086000
0.46201	-0.082000
0.46701	-0.079000
0.47201	-0.076000
0.47701	-0.075000
0.48201	-0.075000
0.48701	-0.075000
0.49201	-0.075000
0.49701	-0.074000
0.50201	-0.074000
0.50701	-0.072000
0.51201	-0.069000
0.51701	-0.064000
0.52201	-0.059000
0.52701	-0.055000
0.53201	-0.051000
0.53701	-0.048000
0.54201	-0.044000
0.54701	-0.040000
0.55201	-0.037000
0.55701	-0.034000
0.56201	-0.032000
0.56701	-0.029000
0.57201	-0.025000
0.57701	-0.021000
0.58201	-0.017000
0.58701	-0.013000
0.59201	-0.0090000
0.59701	-0.0040000
0.60201	0.0015000
0.60701	0.0050000
0.61201	0.0073000
0.61701	0.0086000
0.62201	0.0098000
0.62701	0.011000
0.63201	0.013600
0.63701	0.017300
0.64201	0.023000
0.64701	0.032000
0.65201	0.044000
0.65701	0.058000
0.66201	0.072000
0.66701	0.087500
0.67076	0.10200

Sheet No. B-4

0.67357	0.10950
0.67709	0.11800
0.68148	0.12900
0.68515	0.14400
0.68789	0.15300
0.69094	0.16400
0.69438	0.17700
0.69819	0.19500
0.70248	0.21700
0.70725	0.24700
0.71161	0.28100
0.71161	0.29600
0.71281	0.29600
0.71521	0.31540
0.71762	0.33560
0.72033	0.35700
0.72333	0.38400
0.72672	0.41300
0.73048	0.45200
0.73470	0.49400
0.73940	0.55200
0.74425	0.61600
0.74925	0.69200
0.75425	0.77500
0.75925	0.86500
0.76425	0.96050
0.76925	1.0590
0.77425	1.1580
0.77925	1.2570
0.78425	1.3540
0.78925	1.4470
0.79425	1.5350
0.79925	1.6170
0.80425	1.6920 -
0.80925	1.7590
0.81425	1.8190
0.81925	1.8760
0.82425	1.9330
0.82925	1.9920
0.83425	2.0520
0.83925	2.1160
0.84425	2.1860
0.84925	2.2620
0.85425	2.3470
0.85925	2.4410
0.86425	2.5440
0.86925	2.6580
0.87425	2.7810
0.87925	2.9130
0.88425	3.0510
0.88925	3.1920
0.89425	3.3340
0.89925	3.4770
0.90425	3.6200

Sheet No. B-5

0.90925	3.7620
0.91425	3.9040
0.91925	4.0440
0.92425	4.1830
0.92925	4.3210
0.93425	4.4620
0.93925	4.6050
0.94425	4.7510
0.94925	4.9000
0.95425	5.0530
0.95925	5.2120
0.96425	5.3770
0.96925	5.5500
0.97425	5.7290
0.97925	5.9150
0.98425	6.1030
0.98925	6.2910
0.99425	6.4770
0.99925	6.6590
1.0043	6.8370
1.0093	7.0100
1.0143	7.1770
1.0193	7.3380
1.0243	7.4910
1.0293	7.6370
1.0343	7.7740
1.0393	7.9040
1.0443	8.0290
1.0493	8.1530
1.0543	8.2780
1.0593	8.4080
1.0643	8.5420
1.0693	8.6800
1.0743	8.8230
1.0793	8.9700
1.0843	9.1240
1.0893	9.2850
1.0943	9.4540
1.0993	9.6300
1.1043	9.8120
1.1093	9.9960
1.1143	10.180
1.1193	10.360
1.1243	10.540
1.1293	10.710
1.1343	10.880
1.1393	11.040
1.1443	11.190
1.1493	11.340
1.1543	11.480
1.1593	11.610
1.1643	11.740
1.1693	11.850
1.1743	11.970

Sheet No. B-6

1.1793	12.070
1.1843	12.180
1.1893	12.280
1.1943	12.380
1.1993	12.470
1.2043	12.570
1.2093	12.660
1.2143	12.740
1.2193	12.820
1.2243	12.890
1.2293	12.960
1.2343	13.020
1.2393	13.070
1.2443	13.120
1.2493	13.150
1.2543	13.180
1.2593	13.190
1.2643	13.200
1.2693	13.190
1.2743	13.180
1.2793	13.170
1.2843	13.150
1.2893	13.130
1.2943	13.110
1.2993	13.090
1.3043	13.070
1.3093	13.040
1.3143	13.010
1.3193	12.980
1.3243	12.960
1.3293	12.940
1.3343	12.930
1.3393	12.930
1.3443	12.940
1.3493	12.950
1.3543	12.960
1.3593	12.980
1.3643	13.000
1.3693	13.010
1.3724	13.030
1.3732	13.030
1.3735	13.030
1.3737	13.030

DOME ACCELERATION VS TIME HISTORY
LOCATION @ 20 FT RADIUS
ORIGINAL 1.25*MEB BURN CASE
ILW TANK 101-SY

TIME	ACCELERATION
0.42201	11.190
0.42701	24.450
0.43201	48.520
0.43701	50.630
0.44201	22.530
0.44701	4.9000
0.45201	9.9900
0.45701	12.520
0.46201	-9.2700
0.46701	-44.400
0.47201	-60.500
0.47701	-40.100
0.48201	0.87000
0.48701	16.470
0.49201	9.6300
0.49701	-6.0500
0.50201	34.900
0.50701	34.900
0.51201	63.180
0.51701	24.270
0.52201	-30.830
0.52701	-45.600
0.53201	-8.2000
0.53701	29.400
0.54201	6.4000
0.54701	-33.600
0.55201	-49.700
0.55701	6.0900
0.56201	50.810
0.56701	50.350
0.57201	-3.0400
0.57701	-33.870
0.58201	-2.6300
0.58701	35.260
0.59201	43.100
0.59701	-5.4100
0.60201	-53.560
0.60701	-66.310
0.61201	-47.260
0.61701	-0.16500
0.62201	11.000
0.62701	32.800
0.63201	42.340
0.63701	80.570
0.64201	131.40
0.64701	139.10
0.65201	95.670
0.65701	32.360
0.66201	-15.370
0.66701	-1.7800
0.67076	-13.300

0.67357	2.7500
0.67709	-49.200
0.68148	21.390
0.68515	169.10
0.68789	91.330
0.69094	125.90
0.69438	217.00
0.69819	138.30
0.70248	314.60
0.70725	35.170
0.71161	215.60
0.71161	146.00
0.71281	141.80
0.71521	155.80
0.71762	236.20
0.72033	19.210
0.72333	212.50
0.72672	172.70
0.73048	273.60
0.73470	234.00
0.73940	332.50
0.74425	290.00
0.74925	281.10
0.75425	314.70
0.75925	177.20
0.76425	161.80
0.76925	31.970
0.77425	-29.190
0.77925	-71.830
0.78425	-150.80
0.78925	-172.30
0.79425	-274.90
0.79925	-283.50
0.80425	-321.50
0.80925	-278.50
0.81425	-175.60
0.81925	18.970
0.82425	137.20
0.82925	-31.640
0.83425	151.10
0.83925	284.20
0.84425	210.00
0.84925	357.80
0.85425	364.30
0.85925	380.00
0.86425	441.20
0.86925	365.20
0.87425	395.20
0.87925	232.90
0.88425	89.420
0.88925	72.030
0.89425	-6.0600
0.89925	34.300
0.90425	-7.7000

Sheet No. B-10

0.90925	-55.600
0.91425	-48.000
0.91925	-66.300
0.92425	-58.300
0.92925	98.820
0.93425	156.40
0.93925	64.470
0.94425	133.20
0.94925	151.80
0.95425	208.50
0.95925	299.40
0.96425	293.10
0.96925	286.20
0.97425	223.00
0.97925	161.80
0.98425	8.0500
0.98925	-141.40
0.99425	-153.10
0.99925	-148.20
1.0043	-183.20
1.0093	-254.00
1.0143	-259.80
1.0193	-282.10
1.0243	-318.50
1.0293	-316.60
1.0343	-322.30
1.0393	-235.60
1.0443	-63.800
1.0493	90.200
1.0543	179.00
1.0593	189.70
1.0643	169.80
1.0693	160.20
1.0743	183.90
1.0793	244.20
1.0843	301.30
1.0893	333.00
1.0943	307.50
1.0993	222.50
1.1043	117.70
1.1093	8.5700
1.1143	-95.400
1.1193	-176.00
1.1243	-218.60
1.1293	-261.30
1.1343	-276.80
1.1393	-245.40
1.1443	-241.90
1.1493	-281.00
1.1543	-305.20
1.1593	-288.00
1.1643	-273.00
1.1693	-246.20
1.1743	-186.40

Sheet No. B-11

1.1793	-133.50
1.1843	-126.80
1.1893	-129.80
1.1943	-104.90
1.1993	-102.30
1.2043	-124.70
1.2093	-180.50
1.2143	-254.10
1.2193	-270.50
1.2243	-248.30
1.2293	-223.60
1.2343	-239.60
1.2393	-299.00
1.2443	-359.30
1.2493	-427.10
1.2543	-480.10
1.2593	-462.10
1.2643	-342.50
1.2693	-187.60
1.2743	-135.60
1.2793	-144.20
1.2843	-108.00
1.2893	-85.520
1.2943	-68.800
1.2993	-39.210
1.3043	-74.050
1.3093	-104.40
1.3143	-26.900
1.3193	146.50
1.3243	283.90
1.3293	354.00
1.3343	323.00
1.3393	276.10
1.3443	269.30
1.3493	139.90
1.3543	59.130
1.3593	-26.400
1.3643	-20.260
1.3693	-8.5200
1.3724	-93.980
1.3732	-117.50
1.3735	-131.80
1.3737	-141.60

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	Ravi N. Singh	Date	5/16/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	ADW/TW	Date	5-16-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	C-1	Rev. No.	0

APPENDIX C COMMUNICATION REPORTS

(4 Sheets)

ADVENTProject No. 94003File No. 2.7Log No. 71**COMMUNICATION
REPORT**

Company Westinghouse Hanford Company	Telecon ✓	Conference Report
Project MPR 5A Analysis	Job No.: 94003	Date: 3/11/94
Subject MPR & Equipment Weights	Time: 10:30 a.m.	Place: San Ramon
Participants Ravi Baliga	Of: ADVENT	
Don Precechtel	Of: WHC	
	Of:	
	Of:	

Item	Comments	Required Action By
	<p>Don gave the following weights to be used in the MPR analysis:</p> <p>Total weight of the MPR = 6591 lbs.</p> <p>Total weight of the Camera in the 20" port = 1000 lbs. (Actual weight is 980 lbs)</p> <p>Total weights of the equipment in the 8" ports = 1000 lbs each</p> <p>Total weight of the sonic probe in the 12" port = 7000 lbs</p>	

Signed: RL

Page 1 of 1

Distribution: D. Precechtel, J. Strehlow, R. Baliga, R. Mistry, P. Jagadish, Project File

Sheet No. C-2

WHC-SD-WM-DA-161

ADVENT

Project No. 94003

File No. 2.7

Log No. TS

COMMUNICATION REPORT

Company Westinghouse Hanford Company		Telecon ☒	Conference Report
Project MPR 5A Analysis		Job No.: 94003	
		Date: 4/20/94	
Subject Weld Detail for Connection Between Support Subassembly (Part #10) and Base Plate (Part #6)		Time: Noon	
		Place: San Ramon	
Participants Ravi Mistry		Of: ADVENT	
Cameron Thomas		Of: WHC	
		Of:	
		Of:	

Item	Comments	Required Action By
	<p>WHC Drawing H-2-821095, which provides support details of the MPR assembly, does not have information on weld detail between the support subassembly (consisting of a tee member) and the 4-hole base plate. I called Cam who provided the following information:</p> <ul style="list-style-type: none"> - Subject weld is 1/4" fillet weld all around the tee member to the base plate. 	

Signed: Ravi Mistry

Page 1 of 1

Distribution: R. Mistry, P. Jagadish, Project File

Sheet No. C-3

ADVENT	
Project No.	94003
File No.	2.7
Doc No.	T3

REV 0

COMMUNICATION REPORT

Company Westinghouse Hanford Company	Telecon ☒	Conference Report
Project MPR 5A Analysis	Job No.: 94003	Date: 4/25/94
Subject Material Properties	Time: 2:00 p.m.	Place: San Ramon
Participants Ravi Baliga	Of: ADVENT	
John Strehlow	Of: WHC	
	Of:	
	Of:	

Item	Comments	Required Action By
	<p>John gave the following material properties for 1/2" and 3/4" plates from their CMTR reports to be used in the stress evaluation of the multiport riser.</p> <p>1/2" plates: $F_y = 49.8$ ksi $F_u = 86.5$ ksi</p> <p>3/4" plates: $F_y = 39.679$ ksi $F_u = 91.751$ ksi</p>	

Signed:

Page 1 of 1

Distribution: J. Strehlow, R. Baliga, R. Mistry, P. Jagadish, Project File

Sheet No. C-4

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Ramming</i>	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>W. H. Smith</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	D-1	Rev. No.	0

APPENDIX D

CALCULATION OF UNIT LOAD STRESS RATIOS IN THE
MPR 5A BOLTS FOR THE MARGIN ANALYSIS

(26 Sheets)

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Rui Ming</i>	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	D-2	Rev. No.	0

MARGIN ANALYSIS

Stress Ratio Calculations for Bolted Connections

Bolt Specifications : 1 1/4" A-325

Allowable Tension : 54,000 lbs

Allowable Shear : 25,800 lbs

Refer to Section 7.1.3 on procedures to calculate stress ratios given in the following tables.

Refer to File MPRPAB11.OUT -- ADVENT File C94003.1.1 AC for values of Demand Forces given in the following tables.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Ran Ming</i>	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	D-3	Rev. No.	0

Unit Force Fx - 8" Riser North :

Load Step 2

Node #	Demand Forces			Shear Tension		Stress Ratio	
	Fx (lbs)	Fy (lbs)	Fz (lbs)	(lbs)	(lbs)	Tension	Shear
1808	-130	1	162	208	1	0.000	0.008
1809	35	0	30	46	0	0.000	0.002
1810	-3	-8	4	5	8	0.000	0.000
1816	-131	13	-169	214	13	0.000	0.008
1817	34	-1	-28	44	1	0.000	0.002
1818	-3	0	-1	3	0	0.000	0.000
1939	-191	-64	-162	167	-197	-0.004	0.006
1940	-2	-8	-89	89	-6	0.000	0.003
1941	-18	-7	-35	35	-19	0.000	0.001
1947	-180	-80	-88	90	-196	-0.004	0.004
1948	0	-12	-76	77	-6	0.000	0.003
1949	-14	-10	-34	34	-17	0.000	0.001
2070	-176	79	93	95	-192	-0.004	0.004
2071	0	12	77	78	-6	0.000	0.003
2072	-14	10	35	35	-17	0.000	0.001
2078	-188	63	157	162	-194	-0.004	0.006
2079	-2	7	89	89	-5	0.000	0.003
2080	-17	6	35	35	-18	0.000	0.001

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	Rai miz	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	W. W. W.	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	D-4	Rev. No.	0

Unit Force Fy - 8" Riser North :

Load Step 3

Node #	Demand Forces			Shear Tension		Stress Ratio	
	Fx (lbs)	Fy (lbs)	Fz (lbs)	Fvd (lbs)	Ftd (lbs)	Tension	Shear
1808	50	-225	60	78	225	0.004	0.003
1809	-20	-6	80	82	6	0.000	0.003
1810	-2	-15	37	37	15	0.000	0.001
1816	74	-232	234	245	232	0.004	0.010
1817	-14	-6	110	111	6	0.000	0.004
1818	4	-20	41	41	20	0.000	0.002
1939	-85	-78	-38	46	-113	-0.002	0.002
1940	-7	6	-42	43	-3	0.000	0.002
1941	-9	-5	-20	20	-10	0.000	0.001
1947	-80	-87	-104	110	-113	-0.002	0.004
1948	-6	4	-54	54	-3	0.000	0.002
1949	-8	-8	-20	20	-11	0.000	0.001
2070	30	-202	-276	319	127	0.002	0.012
2071	22	33	-82	91	3	0.000	0.004
2072	7	-9	-21	21	11	0.000	0.001
2078	23	-184	122	192	112	0.002	0.007
2079	24	36	-12	45	3	0.000	0.002
2080	-1	-2	-15	15	0	0.000	0.001

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	Ran Mig	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	W. W. W.	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	D-5	Rev. No.	0

Unit Force Fz - 8" Riser North :

Load Step 4

Node #	Demand Forces			Shear Tension		Stress Ratio	
	Fx (lbs)	Fy (lbs)	Fz (lbs)	Fvd (lbs)	Ftd (lbs)	Tension	Shear
1808	-27	38	-59	65	38	0.001	0.003
1809	7	7	-62	62	7	0.000	0.002
1810	3	33	-32	32	33	0.001	0.001
1816	-16	36	-132	133	36	0.001	0.005
1817	5	7	-74	74	7	0.000	0.003
1818	-3	35	-34	34	35	0.001	0.001
1939	-51	-22	-52	52	-55	-0.001	0.002
1940	0	0	-26	26	0	0.000	0.001
1941	-1	1	-10	10	0	0.000	0.000
1947	-49	-27	-41	41	-56	-0.001	0.002
1948	1	-2	-24	24	0	0.000	0.001
1949	1	-1	-9	9	0	0.000	0.000
2070	24	-26	-138	138	34	0.001	0.005
2071	9	0	-82	82	8	0.000	0.003
2072	33	-23	-39	39	40	0.001	0.002
2078	18	-39	-77	81	35	0.001	0.003
2079	10	1	-72	72	8	0.000	0.003
2080	36	-16	-37	37	39	0.001	0.001

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	Ran Ming	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	Anthony White	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	D-6	Rev. No.	0

Unit Moment Mx - 8" Riser North :

Load Step 5

Node #	Demand Forces			Shear Tension		Stress Ratio	
	Fx (lbs)	Fy (lbs)	Fz (lbs)	Fvd (lbs)	Ftd (lbs)	Tension	Shear
1808	0	-1	-2	2	1	0.000	0.000
1809	0	0	-2	2	0	0.000	0.000
1810	0	1	-1	1	1	0.000	0.000
1816	0	-1	-3	3	1	0.000	0.000
1817	0	0	-2	2	0	0.000	0.000
1818	0	1	-1	1	1	0.000	0.000
					0		
1939	0	-1	3	3	-1	0.000	0.000
1940	0	0	1	1	0	0.000	0.000
1941	1	0	1	1	1	0.000	0.000
1947	0	-1	-1	1	-1	0.000	0.000
1948	0	0	1	1	0	0.000	0.000
1949	1	0	1	1	1	0.000	0.000
2070	-1	-1	-1	2	0	0.000	0.000
2071	0	0	1	1	0	0.000	0.000
2072	0	0	0	0	0	0.000	0.000
2078	0	-1	3	3	1	0.000	0.000
2079	0	0	1	1	0	0.000	0.000
2080	-1	0	1	1	-1	0.000	0.000

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Ran Mif</i>	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>W. M. Mif</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	D-7	Rev. No.	0

Unit Moment My - 8" Riser North :

Load Step 6

Node #	Demand Forces			Shear Tension		Stress Ratio	
	Fx (lbs)	Fy (lbs)	Fz (lbs)	Fvd (lbs)	Ftd (lbs)	Tension	Shear
1808	1	0	3	3	0	0.000	0.000
1809	0	0	0	0	0	0.000	0.000
1810	0	0	0	0	0	0.000	0.000
1816	1	0	2	2	0	0.000	0.000
1817	0	0	0	0	0	0.000	0.000
1818	0	0	0	0	0	0.000	0.000
					0		
1939	1	-1	-1	2	0	0.000	0.000
1940	0	0	-2	2	0	0.000	0.000
1941	-1	-1	-1	1	-1	0.000	0.000
1947	1	0	-3	3	1	0.000	0.000
1948	0	0	-2	2	0	0.000	0.000
1949	-1	-1	-1	1	-1	0.000	0.000
2070	1	0	3	3	1	0.000	0.000
2071	0	0	2	2	0	0.000	0.000
2072	-1	1	1	1	-1	0.000	0.000
2078	1	1	1	2	0	0.000	0.000
2079	0	0	2	2	0	0.000	0.000
2080	-1	1	1	1	-1	0.000	0.000

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Rm. May</i>	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>John W. May</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	D-8	Rev. No.	0

Unit Moment Mz - 8" Riser North :

Load Step 7

Node #	Demand Forces			Shear Tension		Stress Ratio	
	Fx (lbs)	Fy (lbs)	Fz (lbs)	Fvd (lbs)	Ftd (lbs)	Tension	Shear
1808	4	0	-6	7	0	0.000	0.000
1809	-1	0	-1	1	0	0.000	0.000
1810	0	0	0	0	0	0.000	0.000
1816	4	0	6	7	0	0.000	0.000
1817	-1	0	1	1	0	0.000	0.000
1818	0	0	0	0	0	0.000	0.000
1939	-2	4	-6	7	0	0.000	0.000
1940	1	-1	-1	2	0	0.000	0.000
1941	0	0	0	0	0	0.000	0.000
1947	-2	4	6	7	0	0.000	0.000
1948	1	-1	1	2	0	0.000	0.000
1949	0	0	0	0	0	0.000	0.000
2070	-2	-4	-6	7	0	0.000	0.000
2071	1	1	-1	2	0	0.000	0.000
2072	0	0	0	0	0	0.000	0.000
2078	-2	-4	-6	7	0	0.000	0.000
2079	1	1	1	2	0	0.000	0.000
2080	0	0	0	0	0	0.000	0.000

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	Ravi Mig	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	H. W. Smith	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	D-9	Rev. No.	0

Unit Force Fx - 8" Riser South :

Load Step 8

Node #	Demand Forces			Shear Tension		Stress Ratio	
	Fx (lbs)	Fy (lbs)	Fz (lbs)	Fvd (lbs)	Ftd (lbs)	Tension	Shear
1808	-131	-13	169	214	13	0.000	0.008
1809	34	1	28	44	1	0.000	0.002
1810	-3	0	1	3	0	0.000	0.000
1816	-130	-1	-162	208	1	0.000	0.008
1817	35	0	30	46	0	0.000	0.002
1818	-3	8	-4	5	8	0.000	0.000
1939	-188	-62	-157	162	-194	-0.004	0.006
1940	-2	-7	-89	89	-5	0.000	0.003
1941	-17	-6	-35	35	-18	0.000	0.001
1947	-176	-78	-93	95	-191	-0.004	0.004
1948	0	-12	-77	78	-6	0.000	0.003
1949	-14	-10	-35	35	-17	0.000	0.001
2070	-180	80	88	90	-196	-0.004	0.004
2071	0	12	76	77	-6	0.000	0.003
2072	-14	9	34	34	-17	0.000	0.001
2078	-191	64	162	167	-197	-0.004	0.006
2079	-2	8	89	89	-6	0.000	0.003
2080	-18	7	35	35	-19	0.000	0.001

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Ravi Singh</i>	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Henry Wilson</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	D-10	Rev. No.	0

Unit Force Fy - 8" Riser South :

Load Step 9

Node #	Demand Forces			Shear Tension		Stress Ratio	
	Fx (lbs)	Fy (lbs)	Fz (lbs)	Fvd (lbs)	Ftd (lbs)	Tension	Shear
1808	-74	-232	234	245	232	0.004	0.010
1809	14	-6	110	111	6	0.000	0.004
1810	-4	-20	41	41	20	0.000	0.002
1816	-50	-225	59	77	225	0.004	0.003
1817	20	-6	80	82	6	0.000	0.003
1818	2	-15	37	37	15	0.000	0.001
1939	-23	-184	122	192	-112	-0.002	0.007
1940	-24	36	-12	45	-3	0.000	0.002
1941	1	-2	-15	15	0	0.000	0.001
1947	-30	-202	-276	319	-127	-0.002	0.012
1948	-22	33	-82	91	-3	0.000	0.004
1949	-7	-9	-21	21	-11	0.000	0.001
2070	80	-87	-105	111	113	0.002	0.004
2071	6	4	-54	54	3	0.000	0.002
2072	8	-8	-20	20	11	0.000	0.001
2078	85	-77	-38	45	112	0.002	0.002
2079	7	6	-42	43	3	0.000	0.002
2080	9	5	-20	22	5	0.000	0.001

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	Ravi Mijar	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	John W. Mijar	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	D-11	Rev. No.	0

Unit Force Fz - 8" Riser South :

Load Step 10

Node #	Demand Forces			Shear Tension		Stress Ratio	
	Fx (lbs)	Fy (lbs)	Fz (lbs)	Fvd (lbs)	Ftd (lbs)	Tension	Shear
1808	16	36	-132	133	36	0.001	0.005
1809	-5	7	-74	74	7	0.000	0.003
1810	3	35	-34	34	35	0.001	0.001
1816	27	38	-59	65	38	0.001	0.003
1817	-7	7	-62	62	7	0.000	0.002
1818	-3	33	-32	32	33	0.001	0.001
1939	-18	-39	-77	81	-35	-0.001	0.003
1940	-10	1	-72	72	-8	0.000	0.003
1941	-36	-16	-37	37	-39	-0.001	0.001
1947	-24	-26	-138	138	-34	-0.001	0.005
1948	-9	0	-82	82	-8	0.000	0.003
1949	-33	-23	-39	39	-40	-0.001	0.002
2070	49	-27	-41	41	56	0.001	0.002
2071	-1	-2	-24	24	0	0.000	0.001
2072	-1	-1	-9	9	0	0.000	0.000
2078	51	-22	-52	52	55	0.001	0.002
2079	0	0	-26	26	0	0.000	0.001
2080	1	1	-10	10	0	0.000	0.000

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Rev. Mij</i>	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>John W. W.</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	D-12	Rev. No.	0

Unit Moment Mx - 8" Riser South :

Load Step 11

Node #	Demand Forces			Shear Tension		Stress Ratio	
	Fx (lbs)	Fy (lbs)	Fz (lbs)	Fvd (lbs)	Ftd (lbs)	Tension	Shear
1808	0	-1	-3	3	1	0.000	0.000
1809	0	0	-2	2	0	0.000	0.000
1810	0	1	-1	1	1	0.000	0.000
1816	0	-1	-2	2	1	0.000	0.000
1817	0	0	-2	2	0	0.000	0.000
1818	0	1	-1	1	1	0.000	0.000
1939	0	-1	3	3	-1	0.000	0.000
1940	0	0	1	1	0	0.000	0.000
1941	1	0	1	1	1	0.000	0.000
1947	1	-1	-1	2	0	0.000	0.000
1948	0	0	1	1	0	0.000	0.000
1949	0	0	0	0	0	0.000	0.000
2070	0	-1	-1	1	1	0.000	0.000
2071	0	0	1	1	0	0.000	0.000
2072	-1	0	1	1	-1	0.000	0.000
2078	0	-1	3	3	1	0.000	0.000
2079	0	0	1	1	0	0.000	0.000
2080	-1	0	1	1	-1	0.000	0.000

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	Ravi Mung	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	W. W. W.	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	D-13	Rev. No.	0

Unit Moment My - 8" Riser South :

Load Step 12

Node #	Demand Forces			Shear Tension		Stress Ratio	
	Fx (lbs)	Fy (lbs)	Fz (lbs)	Fvd (lbs)	Ftd (lbs)	Tension	Shear
1808	1	0	-2	2	0	0.000	0.000
1809	0	0	0	0	0	0.000	0.000
1810	0	0	0	0	0	0.000	0.000
1816	1	0	3	3	0	0.000	0.000
1817	0	0	0	0	0	0.000	0.000
1818	0	0	0	0	0	0.000	0.000
1939	1	-1	-1	2	0	0.000	0.000
1940	0	0	-2	2	0	0.000	0.000
1941	-1	-1	-1	1	-1	0.000	0.000
1947	1	0	-3	3	1	0.000	0.000
1948	0	0	-2	2	0	0.000	0.000
1949	-1	-1	-1	1	-1	0.000	0.000
2070	1	0	3	3	1	0.000	0.000
2071	0	0	2	2	0	0.000	0.000
2072	-1	1	1	1	-1	0.000	0.000
2078	1	1	1	2	0	0.000	0.000
2079	0	0	2	2	0	0.000	0.000
2080	-1	1	1	1	-1	0.000	0.000

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	Ravi Mij	Date	2/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	Anthony W. W.	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	D-14	Rev. No.	0

Unit Moment Mz - 8" Riser South :

Load Step 13

Node #	Demand Forces			Shear Tension		Stress Ratio	
	Fx (lbs)	Fy (lbs)	Fz (lbs)	Fvd (lbs)	Ftd (lbs)	Tension	Shear
1808	4	0	-6	7	0	0.000	0.000
1809	-1	0	-1	1	0	0.000	0.000
1810	0	0	0	0	0	0.000	0.000
1816	4	0	6	7	0	0.000	0.000
1817	-1	0	1	1	0	0.000	0.000
1818	0	0	0	0	0	0.000	0.000
1939	-2	4	-6	7	0	0.000	0.000
1940	1	-1	-1	2	0	0.000	0.000
1941	0	0	0	0	0	0.000	0.000
1947	-2	4	6	7	0	0.000	0.000
1948	1	-1	-1	2	0	0.000	0.000
1949	0	0	0	0	0	0.000	0.000
2070	-2	-4	-6	7	0	0.000	0.000
2071	1	1	-1	2	0	0.000	0.000
2072	0	0	0	0	0	0.000	0.000
2078	-2	-4	6	7	0	0.000	0.000
2079	1	1	1	2	0	0.000	0.000
2080	0	0	0	0	0	0.000	0.000

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	Ravi Mij	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	[Signature]	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	D-15	Rev. No.	0

Unit Force Fx - 12" Riser :

Load Step 14

Node #	Demand Forces			Shear Tension		Stress Ratio	
	Fx (lbs)	Fy (lbs)	Fz (lbs)	Fvd (lbs)	Ftd (lbs)	Tension	Shear
1808	-172	-8	222	281	8	0.000	0.011
1809	46	1	39	60	1	0.000	0.002
1810	-4	-6	4	6	6	0.000	0.000
1816	-172	8	-222	281	8	0.000	0.011
1817	46	-1	-39	60	1	0.000	0.002
1818	-4	6	-4	6	6	0.000	0.000
1939	-178	-89	-108	109	-199	-0.004	0.004
1940	-5	0	-71	71	-4	0.000	0.003
1941	-9	-3	-28	28	-9	0.000	0.001
1947	-168	-111	-117	118	-201	-0.004	0.005
1948	-2	-4	-73	73	-4	0.000	0.003
1949	-8	-7	-29	29	-10	0.000	0.001
2070	-168	111	117	118	-201	-0.004	0.005
2071	-2	4	73	73	-4	0.000	0.003
2072	-8	7	29	29	-10	0.000	0.001
2078	-178	89	108	109	-199	-0.004	0.004
2079	-5	0	72	72	-4	0.000	0.003
2080	-9	3	28	28	-9	0.000	0.001

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	Ravi Mig	Date	6/3/94
Subject	Structural Analysis of Multiport Riser SA	Reviewed By:	[Signature]	Date	6-6-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	D-16	Rev. No.	0

Unit Force Fy - 12" Riser :

Load Step 15

Node #	Demand Forces			Shear Tension		Stress Ratio	
	Fx (lbs)	Fy (lbs)	Fz (lbs)	Fvd (lbs)	Ftd (lbs)	Tension	Shear
1808	-14	-230	133	134	230	0.004	0.005
1809	-3	-5	83	83	5	0.000	0.003
1810	-2	-9	32	32	9	0.000	0.001
1816	14	-230	133	134	230	0.004	0.005
1817	3	-5	83	83	5	0.000	0.003
1818	2	-9	32	32	9	0.000	0.001
1939	-55	-139	63	112	-117	-0.002	0.004
1940	-16	24	-18	34	-2	0.000	0.001
1941	1	-1	-14	14	0	0.000	0.001
1947	-53	-155	-198	225	-123	-0.002	0.009
1948	-14	21	-64	69	-2	0.000	0.003
1949	-4	-6	-18	18	-6	0.000	0.001
2070	53	-155	-198	225	123	0.002	0.009
2071	14	21	-64	69	2	0.000	0.003
2072	4	-6	-18	18	6	0.000	0.001
2078	55	-139	64	113	117	0.002	0.004
2079	16	24	-18	34	2	0.000	0.001
2080	-1	-1	-14	14	0	0.000	0.001

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	Ravi Mung	Date	6/2/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	[Signature]	Date	6-6-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	D-17	Rev. No.	0

Unit Force Fz - 12" Riser :

Load Step 16

Node #	Demand Forces			Shear Tension		Stress Ratio	
	Fx (lbs)	Fy (lbs)	Fz (lbs)	Fvd (lbs)	Ftd (lbs)	Tension	Shear
1808	-9	33	-118	118	33	0.001	0.005
1809	1	9	-85	85	9	0.000	0.003
1810	4	45	-41	41	45	0.001	0.002
1816	9	33	-118	118	33	0.001	0.005
1817	-1	9	-85	85	9	0.000	0.003
1818	-4	45	-41	41	45	0.001	0.002
1939	-32	-40	-38	42	-48	-0.001	0.002
1940	-5	4	-38	38	-2	0.000	0.001
1941	-13	-5	-18	18	-14	0.000	0.001
1947	-32	-38	-95	96	-47	-0.001	0.004
1948	-5	2	-48	48	-3	0.000	0.002
1949	-13	-10	-20	20	-16	0.000	0.001
2070	32	-38	-95	96	47	0.001	0.004
2071	5	2	-48	48	3	0.000	0.002
2072	12	-9	-20	20	15	0.000	0.001
2078	32	-40	-38	42	48	0.001	0.002
2079	5	4	-38	38	2	0.000	0.001
2080	12	5	-18	21	8	0.000	0.001

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Ravi Mij</i>	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>W. H. H. H.</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	D-18	Rev. No.	0

Unit Moment Mx - 12" Riser :

Load Step 17

Node #	Demand Forces			Shear Tension		Stress Ratio	
	Fx (lbs)	Fy (lbs)	Fz (lbs)	Fvd (lbs)	Ftd (lbs)	Tension	Shear
1808	0	-1	-3	3	1	0.000	0.000
1809	0	0	-2	2	0	0.000	0.000
1810	0	1	-1	1	1	0.000	0.000
1816	0	-1	-3	3	1	0.000	0.000
1817	0	0	-2	2	0	0.000	0.000
1818	0	1	-1	1	1	0.000	0.000
1939	0	-1	3	3	-1	0.000	0.000
1940	0	0	1	1	0	0.000	0.000
1941	1	0	1	1	1	0.000	0.000
1947	1	-1	-1	2	0	0.000	0.000
1948	0	0	1	1	0	0.000	0.000
1949	1	0	0	1	1	0.000	0.000
2070	-1	-1	-1	2	0	0.000	0.000
2071	0	0	1	1	0	0.000	0.000
2072	-1	0	0	1	-1	0.000	0.000
2078	0	-1	3	3	1	0.000	0.000
2079	0	0	0	0	0	0.000	0.000
2080	-1	0	0	1	-1	0.000	0.000

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Ravi M. Singh</i>	Date	6/2/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	D-19	Rev. No.	0

Unit Moment My - 12" Riser :

Load Step 18

Node #	Demand Forces			Shear Tension		Stress Ratio	
	Fx	Fy	Fz	Fvd	Ftd	Tension	Shear
	(lbs)	(lbs)	(lbs)	(lbs)	(lbs)		
1808	2	0	-3	4	0	0.000	0.000
1809	0	0	0	0	0	0.000	0.000
1810	0	0	0	0	0	0.000	0.000
1816	2	0	3	4	0	0.000	0.000
1817	0	0	0	0	0	0.000	0.000
1818	0	0	0	0	0	0.000	0.000
1939	1	-1	-1	2	0	0.000	0.000
1940	0	0	-2	2	0	0.000	0.000
1941	-1	-1	-1	1	-1	0.000	0.000
1947	1	0	-3	3	1	0.000	0.000
1948	0	0	-2	2	0	0.000	0.000
1949	-1	-1	-1	1	-1	0.000	0.000
2070	1	0	3	3	1	0.000	0.000
2071	0	0	2	2	0	0.000	0.000
2072	-1	1	1	1	-1	0.000	0.000
2078	1	1	1	2	0	0.000	0.000
2079	0	0	2	2	0	0.000	0.000
2080	-1	1	1	1	-1	0.000	0.000

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	Ravi Mung	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	John W. Mung	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	D-20	Rev. No.	0

Unit Moment Mz - 12" Riser :

Load Step 19

Node #	Demand Forces			Shear Tension		Stress Ratio	
	Fx (lbs)	Fy (lbs)	Fz (lbs)	Fvd (lbs)	Ftd (lbs)	Tension	Shear
1808	4	0	-6	7	0	0.000	0.000
1809	-1	0	-1	1	0	0.000	0.000
1810	0	0	0	0	0	0.000	0.000
1816	4	0	6	7	0	0.000	0.000
1817	-1	0	1	1	0	0.000	0.000
1818	0	0	0	0	0	0.000	0.000
1939	-2	4	-6	7	0	0.000	0.000
1940	1	-1	-1	2	0	0.000	0.000
1941	0	0	0	0	0	0.000	0.000
1947	-2	4	6	7	0	0.000	0.000
1948	1	-1	1	2	0	0.000	0.000
1949	0	0	0	0	0	0.000	0.000
2070	-2	-4	-6	7	0	0.000	0.000
2071	1	1	-1	2	0	0.000	0.000
2072	0	0	0	0	0	0.000	0.000
2078	-2	-4	6	7	0	0.000	0.000
2079	1	1	1	2	0	0.000	0.000
2080	0	0	0	0	0	0.000	0.000

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	Ran N2y	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	[Signature]	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	D-21	Rev. No.	0

Unit Force Fx - 20" Riser :

Load Step 20

Node #	Demand Forces			Shear Tension		Stress Ratio	
	Fx (lbs)	Fy (lbs)	Fz (lbs)	Fvd (lbs)	Ftd (lbs)	Tension	Shear
1808	-84	-2	109	138	2	0.000	0.005
1809	22	0	19	29	0	0.000	0.001
1810	-2	-2	2	3	2	0.000	0.000
1816	-84	2	-109	138	2	0.000	0.005
1817	22	0	-19	29	0	0.000	0.001
1818	-2	2	-2	3	2	0.000	0.000
1939	-241	-5	-238	265	-211	-0.004	0.010
1940	11	-22	-85	88	-1	0.000	0.003
1941	-4	1	-24	24	-3	0.000	0.001
1947	-219	-26	33	93	-203	-0.004	0.004
1948	13	-27	-37	48	-2	0.000	0.002
1949	4	3	-20	20	5	0.000	0.001
2070	-219	25	-33	94	-202	-0.004	0.004
2071	13	27	37	48	-2	0.000	0.002
2072	4	-3	20	20	5	0.000	0.001
2078	-241	5	238	265	-211	-0.004	0.010
2079	11	22	85	88	-1	0.000	0.003
2080	-4	-2	24	24	-2	0.000	0.001

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Rw. mg</i>	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>H. H. H.</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	D - 2 2	Rev. No.	0

Unit Force Fy - 20" Riser :

Load Step 21

Node #	Demand Forces			Shear Tension		Stress Ratio	
	Fx (lbs)	Fy (lbs)	Fz (lbs)	Fvd (lbs)	Ftd (lbs)	Tension	Shear
1808	-16	-238	117	118	238	0.004	0.005
1809	-3	-3	71	71	3	0.000	0.003
1810	-1	-1	26	26	1	0.000	0.001
1816	16	-238	117	118	238	0.004	0.005
1817	3	-3	71	71	3	0.000	0.003
1818	1	-1	26	26	1	0.000	0.001
1939	-49	-143	82	129	-114	-0.002	0.005
1940	-17	25	-11	32	-2	0.000	0.001
1941	3	0	-11	11	3	0.000	0.000
1947	-47	-160	-197	228	-121	-0.002	0.009
1948	-15	23	-60	66	-1	0.000	0.003
1949	-2	-5	-16	16	-4	0.000	0.001
2070	47	-160	-197	228	121	0.002	0.009
2071	15	23	-60	66	1	0.000	0.003
2072	2	-5	-16	16	4	0.000	0.001
2078	49	-143	82	129	114	0.002	0.005
2079	17	25	-11	32	2	0.000	0.001
2080	-3	0	-11	11	-3	0.000	0.000

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Ravi Mig</i>	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Handwritten Signature</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	D-23	Rev. No.	0

Unit Force Fz - 20" Riser :

Load Step 22

Node #	Demand Forces			Shear Tension		Stress Ratio	
	Fx (lbs)	Fy (lbs)	Fz (lbs)	Fvd (lbs)	Ftd (lbs)	Tension	Shear
1808	0	50	-60	60	50	0.001	0.002
1809	1	2	-37	37	2	0.000	0.001
1810	2	10	-16	16	10	0.000	0.001
1816	0	50	-60	60	50	0.001	0.002
1817	-1	2	-37	37	2	0.000	0.001
1818	-2	10	-16	16	10	0.000	0.001
1939	-37	-13	-116	116	-39	-0.001	0.005
1940	-4	-5	-70	70	-6	0.000	0.003
1941	-29	-13	-32	32	-32	-0.001	0.001
1947	-43	-5	-74	76	-40	-0.001	0.003
1948	-3	-7	-63	63	-6	0.000	0.002
1949	-25	-18	-31	31	-31	-0.001	0.001
2070	43	-5	-74	76	40	0.001	0.003
2071	3	-7	-63	63	6	0.000	0.002
2072	25	-18	-31	31	31	0.001	0.001
2078	37	-13	-116	116	39	0.001	0.005
2079	4	-5	-70	70	6	0.000	0.003
2080	29	-13	-32	32	32	0.001	0.001

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	Ravi Mung	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	Alvin W. W.	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	D-24	Rev. No.	0

Unit Moment Mx - 20" Riser :

Load Step 23

Node #	Demand Forces			Shear Tension		Stress Ratio	
	Fx (lbs)	Fy (lbs)	Fz (lbs)	Fvd (lbs)	Ftd (lbs)	Tension	Shear
1808	0	-1	-2	2	1	0.000	0.000
1809	0	0	-2	2	0	0.000	0.000
1810	0	2	-1	1	2	0.000	0.000
1816	0	-1	-2	2	1	0.000	0.000
1817	0	0	-2	2	0	0.000	0.000
1818	0	2	-1	1	2	0.000	0.000
1939	0	-1	3	3	-1	0.000	0.000
1940	0	0	1	1	0	0.000	0.000
1941	1	0	1	1	1	0.000	0.000
1947	0	-2	-1	2	-1	0.000	0.000
1948	0	0	1	1	0	0.000	0.000
1949	1	0	1	1	1	0.000	0.000
2070	0	-2	-1	2	1	0.000	0.000
2071	0	0	1	1	0	0.000	0.000
2072	-1	0	1	1	-1	0.000	0.000
2078	0	-1	3	3	1	0.000	0.000
2079	0	0	1	1	0	0.000	0.000
2080	-1	0	1	1	-1	0.000	0.000

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Rain M. J.</i>	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	D-25	Rev. No.	0

Unit Moment My - 20" Riser :

Load Step 24

Node #	Demand Forces			Shear Tension		Stress Ratio	
	Fx (lbs)	Fy (lbs)	Fz (lbs)	Fvd (lbs)	Ftd (lbs)	Tension	Shear
1808	1	0	-2	2	0	0.000	0.000
1809	0	0	0	0	0	0.000	0.000
1810	0	0	0	0	0	0.000	0.000
1816	1	0	2	2	0	0.000	0.000
1817	0	0	0	0	0	0.000	0.000
1818	0	0	0	0	0	0.000	0.000
1939	1	-1	-1	2	0	0.000	0.000
1940	0	0	-2	2	0	0.000	0.000
1941	-1	-1	-1	1	-1	0.000	0.000
1947	1	0	-3	3	1	0.000	0.000
1948	0	0	-2	2	0	0.000	0.000
1949	-1	-1	-1	1	-1	0.000	0.000
2070	1	0	3	3	1	0.000	0.000
2071	0	0	2	2	0	0.000	0.000
2072	-1	1	1	1	-1	0.000	0.000
2078	1	1	1	2	0	0.000	0.000
2079	0	0	2	2	0	0.000	0.000
2080	-1	1	1	1	-1	0.000	0.000

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	Ravi Mij	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	[Signature]	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	D-26	Rev. No.	0

Unit Moment Mz - 20" Riser :

Load Step 25

Node #	Demand Forces			Shear Tension		Stress Ratio	
	Fx (lbs)	Fy (lbs)	Fz (lbs)	Fvd (lbs)	Ftd (lbs)	Tension	Shear
1808	4	0	-6	7	0	0.000	0.000
1809	-1	0	-1	1	0	0.000	0.000
1810	0	0	0	0	0	0.000	0.000
1816	4	0	6	7	0	0.000	0.000
1817	-1	0	1	1	0	0.000	0.000
1818	0	0	0	0	0	0.000	0.000
1939	-2	4	-6	7	0	0.000	0.000
1940	1	-1	-1	2	0	0.000	0.000
1941	0	0	0	0	0	0.000	0.000
1947	-2	4	6	7	0	0.000	0.000
1948	1	-1	1	2	0	0.000	0.000
1949	0	0	0	0	0	0.000	0.000
2070	-2	-4	-6	7	0	0.000	0.000
2071	1	1	-1	2	0	0.000	0.000
2072	0	0	0	0	0	0.000	0.000
2078	-2	-4	6	7	0	0.000	0.000
2079	1	1	1	2	0	0.000	0.000
2080	0	0	0	0	0	0.000	0.000

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Ran Mij</i>	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>H. W. Mij</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	E-1	Rev. No.	0

APPENDIX E

CALCULATION OF UNIT LOAD STRESS RATIOS IN THE MPR 5A ANCHOR BOLTS FOR THE MARGIN ANALYSIS

(14 Sheets)

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	Ravi Mung	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	[Signature]	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	E - 2	Rev. No.	0

Margin Analysis Stress Ratio Calculations for Anchor Bolts

Bolt Specifications : Part No. : MB-1250-30-23
(DRILLCO Maxi Bolt) Anchor Dia. : 1 1/4"
Allowable Tension, Fa : 50014 lbs
Allowable Shear, Va : 25979 lbs
Demand Tension, T : 1.5 x (FZ) lbs
Demand Shear, V : SQRT(FX^2 + FY^2) lbs

NOTE : Negative FZ represents Tension.

$$\text{STRESS RATIO} = (T/Fa + V/Va)$$

Refer to File MPRPAB11.OUT — ADVENT File : C94003.1.1 AC
for values of forces Fx, Fy, and Fz given in the tables below.

Dead Loads :

Load Step 1

Node #	Fx	Fy	Fz	Shear	Tension	Stress Ratio
1690	-65	-607	1498	610	0	0.023
1706	65	-607	1498	610	0	0.023
1710	1062	-634	1884	1237	0	0.048
1742	1062	-634	1884	1237	0	0.048
1821	467	251	1147	530	0	0.020
1837	386	408	1064	562	0	0.022
1841	60	1030	1466	1032	0	0.040
1873	878	-449	1455	986	0	0.038
1952	-386	408	1064	562	0	0.022
1968	-468	251	1147	531	0	0.020
1972	-878	-449	1455	986	0	0.038
2004	-60	1030	1466	1032	0	0.040

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	Ran mry-	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	Hank W. M.	Date	6-4-96
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	E-3	Rev. No.	0

Unit Force Fx - 8" Riser North :

Load Step 2

Node #	Fx	Fy	Fz	Shear	Tension	Stress Ratio
1690	-79	-4	-68	79	102	0.005
1706	-79	6	61	79	0	0.003
1710	-19	19	-8	27	12	0.001
1742	-20	-16	12	26	0	0.001
1821	-128	-3	-26	128	39	0.006
1837	-83	-76	-58	113	87	0.006
1841	-29	-161	-198	164	297	0.012
1873	-165	59	-202	175	303	0.013
1952	-82	74	64	110	0	0.004
1968	-126	3	28	126	0	0.005
1972	-162	-59	199	172	0	0.007
2004	-28	158	194	160	0	0.006

Unit Force Fy - 8" Riser North :

Load Step 3

Node #	Fx	Fy	Fz	Shear	Tension	Stress Ratio
1690	-12	-125	81	126	0	0.005
1706	85	-130	28	155	0	0.006
1710	156	-133	231	205	0	0.008
1742	-138	-117	222	181	0	0.007
1821	-58	-26	-41	64	62	0.004
1837	-35	-70	-6	78	9	0.003
1841	-18	-102	-118	104	177	0.008
1873	-86	31	-113	91	170	0.007
1952	2	-136	44	136	0	0.005
1968	16	-89	-105	90	158	0.007
1972	62	22	-100	66	150	0.006
2004	24	-125	-122	127	183	0.009

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Ran N. W.</i>	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>John W. W.</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	E-4	Rev. No.	0

Unit Force Fz - 8" Riser North :

Load Step 4

Node #	Fx	Fy	Fz	Shear	Tension	Stress Ratio
1690	-8	37	-93	38	140	0.004
1706	-17	39	-79	43	119	0.004
1710	-67	42	-112	79	168	0.006
1742	61	37	-110	71	165	0.006
1821	-29	-5	-31	29	47	0.002
1837	-21	-18	-34	28	51	0.002
1841	-8	-41	-48	42	72	0.003
1873	-41	14	-48	43	72	0.003
1952	28	-33	-94	43	141	0.004
1968	31	-25	-104	40	156	0.005
1972	69	39	-123	79	185	0.007
2004	2	-85	-124	85	186	0.007

Unit Moment Mx - 8" Riser North :

Load step 5

Node #	Fx	Fy	Fz	Shear	Tension	Stress Ratio
1690	0	0	-3	0	5	0.000
1706	0	0	-3	0	5	0.000
1710	-1	1	-3	1	5	0.000
1742	1	1	-3	1	5	0.000
1821	1	0	1	1	0	0.000
1837	1	-1	2	1	0	0.000
1841	0	1	1	1	0	0.000
1873	1	-1	2	1	0	0.000
1952	-1	-1	2	1	0	0.000
1968	-1	0	1	1	0	0.000
1972	-1	-1	1	1	0	0.000
2004	0	1	1	1	0	0.000

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Ran May</i>	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	E-5	Rev. No.	0

Unit Moment My - 8" Riser North :

Load Step 6

Node #	Fx	Fy	Fz	Shear	Tension	Stress Ratio
1690	1	0	0	1	0	0.000
1706	1	0	-1	1	2	0.000
1710	0	0	0	0	0	0.000
1742	0	0	0	0	0	0.000
1821	0	-1	-2	1	3	0.000
1837	0	-1	-2	1	3	0.000
1841	0	-2	-3	2	5	0.000
1873	-1	1	-3	1	5	0.000
1952	0	0	2	0	0	0.000
1968	0	1	2	1	0	0.000
1972	-1	-1	2	1	0	0.000
2004	0	1	3	1	0	0.000

Unit Moment Mz - 8" Riser North :

Load Step 7

Node #	Fx	Fy	Fz	Shear	Tension	Stress Ratio
1690	3	0	2	3	0	0.000
1706	3	0	-2	3	3	0.000
1710	1	-1	0	1	0	0.000
1742	1	1	0	1	0	0.000
1821	-1	2	2	2	0	0.000
1837	-1	2	-2	2	3	0.000
1841	0	1	0	1	0	0.000
1873	-1	0	0	1	0	0.000
1952	-1	-2	2	2	0	0.000
1968	-1	-2	-2	2	3	0.000
1972	-1	0	0	1	0	0.000
2004	0	-1	0	1	0	0.000

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	Ran Mig	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	dwight	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	E-6	Rev. No.	0

Unit Force Fx - 8" Riser South :

Load Step 8

Node #	Fx	Fy	Fz	Shear	Tension	Stress Ratio
1690	-79	-6	-61	79	92	0.005
1706	-79	4	68	79	0	0.003
1710	-20	16	-12	26	18	0.001
1742	-19	-19	8	27	0	0.001
1821	-126	-3	-29	126	44	0.006
1837	-82	-74	-64	110	96	0.006
1841	-28	-158	-194	160	291	0.012
1873	-162	59	-199	172	299	0.013
1952	-83	76	58	113	0	0.004
1968	-128	3	26	128	0	0.005
1972	-165	-59	202	175	0	0.007
2004	-29	161	198	164	0	0.006

Unit Force Fy - 8" Riser South :

Load Step 9

Node #	Fx	Fy	Fz	Shear	Tension	Stress Ratio
1690	-85	-130	28	155	0	0.006
1706	12	-125	81	126	0	0.005
1710	138	-117	222	181	0	0.007
1742	-156	-133	231	205	0	0.008
1821	-16	-89	-105	90	158	0.007
1837	-2	-136	44	136	0	0.005
1841	-24	-125	-122	127	183	0.009
1873	-62	22	-100	66	150	0.006
1952	35	-70	-6	78	9	0.003
1968	58	-26	-41	64	62	0.004
1972	86	31	-113	91	170	0.007
2004	18	-102	-118	104	177	0.008

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Ravi Mijar</i>	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	E-7	Rev. No.	0

Unit Force Fz - 8" Riser South :

Load Step 10

Node #	Fx	Fy	Fz	Shear	Tension	Stress Ratio
1690	17	39	-79	43	119	0.004
1706	8	37	-93	38	140	0.004
1710	-61	37	-110	71	165	0.006
1742	67	42	-112	79	168	0.006
1821	-31	-25	-104	40	156	0.005
1837	-28	-33	-94	43	141	0.004
1841	-2	-86	-124	86	186	0.007
1873	-69	39	-123	79	185	0.007
1952	21	-19	-34	28	51	0.002
1968	29	-5	-31	29	47	0.002
1972	41	14	-48	43	72	0.003
2004	8	-41	-48	42	72	0.003

Unit Moment Mx - 8" Riser South :

Load Step 11

Node #	Fx	Fy	Fz	Shear	Tension	Stress Ratio
1690	0	0	-3	0	5	0.000
1706	0	0	-3	0	5	0.000
1710	-1	1	-3	1	5	0.000
1742	1	1	-3	1	5	0.000
1821	1	0	1	1	0	0.000
1837	1	-1	2	1	0	0.000
1841	0	1	1	1	0	0.000
1873	1	-1	1	1	0	0.000
1952	-1	-1	2	1	0	0.000
1968	-1	0	1	1	0	0.000
1972	-1	-1	2	1	0	0.000
2004	0	1	1	1	0	0.000

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Ravi Mig</i>	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Anthony</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	E-8	Rev. No.	0

Unit Moment My - 8" Riser South :

Load Step 12

Node #	Fx	Fy	Fz	Shear	Tension	Stress Ratio
1690	1	0	1	1	0	0.000
1706	1	0	0	1	0	0.000
1710	0	0	0	0	0	0.000
1742	0	0	0	0	0	0.000
1821	0	-1	-2	1	3	0.000
1837	0	0	-2	0	3	0.000
1841	0	-1	-3	1	5	0.000
1873	-1	1	-2	1	3	0.000
1952	0	1	2	1	0	0.000
1968	0	1	2	1	0	0.000
1972	-1	-1	3	1	0	0.000
2004	0	2	3	2	0	0.000

Unit Moment Mz - 8" Riser South :

Load Step 13

Node #	Fx	Fy	Fz	Shear	Tension	Stress Ratio
1690	3	0	2	3	0	0.000
1706	3	0	-2	3	3	0.000
1710	1	-1	0	1	0	0.000
1742	1	1	0	1	0	0.000
1821	-1	2	2	2	0	0.000
1837	-1	2	-2	2	3	0.000
1841	0	1	0	1	0	0.000
1873	-1	0	0	1	0	0.000
1952	-1	-2	2	2	0	0.000
1968	-1	-2	-2	2	3	0.000
1972	-1	0	0	1	0	0.000
2004	0	-1	0	1	0	0.000

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Ravi Mung</i>	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	E-9	Rev. No.	0

Unit Force Fx - 12" Riser :

Load Step 14

Node #	Fx	Fy	Fz	Shear	Tension	Stress Ratio
1690	-104	-6	-84	104	126	0.007
1706	-104	6	84	104	0	0.004
1710	-26	23	-13	35	20	0.002
1742	-26	-23	13	35	0	0.001
1821	-115	-16	-28	116	42	0.005
1837	-72	-91	-32	116	48	0.005
1841	-31	-157	-183	160	275	0.012
1873	-152	52	-183	161	275	0.012
1952	-72	91	32	116	0	0.004
1968	-115	16	28	116	0	0.004
1972	-152	-52	183	161	0	0.006
2004	-31	158	183	161	0	0.006

Unit Force Fy - 12" Riser :

Load Step 15

Node #	Fx	Fy	Fz	Shear	Tension	Stress Ratio
1690	-49	-124	39	133	0	0.005
1706	49	-124	39	133	0	0.005
1710	138	-121	209	184	0	0.007
1742	-138	-121	209	184	0	0.007
1821	-34	-60	-68	69	102	0.005
1837	-15	-108	29	109	0	0.004
1841	-23	-111	-112	113	168	0.008
1873	-69	23	-97	73	146	0.006
1952	15	-108	29	109	0	0.004
1968	34	-60	-68	69	102	0.005
1972	69	23	-97	73	146	0.006
2004	23	-111	-112	113	168	0.008

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Ran Ming</i>	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Wally Hines</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	E-10	Rev. No.	0

Unit Force Fz - 12" Riser :

Load Step 16

Node #	Fx	Fy	Fz	Shear	Tension	Stress Ratio
1690	3	42	-110	42	165	0.005
1706	-3	42	-110	42	165	0.005
1710	-76	44	-134	88	201	0.007
1742	76	44	-134	88	201	0.007
1821	-25	-19	-60	31	90	0.003
1837	-20	-31	-48	37	72	0.003
1841	-6	-59	-75	59	113	0.005
1873	-48	22	-74	53	111	0.004
1952	20	-31	-48	37	72	0.003
1968	25	-19	-60	31	90	0.003
1972	48	22	-74	53	111	0.004
2004	6	-59	-75	59	113	0.005

Unit Moment Mx - 12" Riser :

Load Step 17

Node #	Fx	Fy	Fz	Shear	Tension	Stress Ratio
1690	0	0	-3	0	5	0.000
1706	0	0	-3	0	5	0.000
1710	-1	0	-3	1	5	0.000
1742	1	1	-3	1	5	0.000
1821	1	0	1	1	0	0.000
1837	1	-1	2	1	0	0.000
1841	0	1	1	1	0	0.000
1873	1	-1	1	1	0	0.000
1952	-1	-1	2	1	0	0.000
1968	-1	0	1	1	0	0.000
1972	-1	-1	1	1	0	0.000
2004	0	1	1	1	0	0.000

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Ravi M. Singh</i>	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	E-11	Rev. No.	0

Unit Moment My - 12" Riser :

Load Step 18

Node #	Fx	Fy	Fz	Shear	Tension	Stress Ratio
1690	1	0	0	1	0	0.000
1706	1	0	0	1	0	0.000
1710	0	0	0	0	0	0.000
1742	0	0	0	0	0	0.000
1821	0	-1	-3	1	4	0.000
1837	0	0	-2	0	3	0.000
1841	0	-2	-3	2	5	0.000
1873	-1	1	-3	1	5	0.000
1952	0	0	2	0	0	0.000
1968	0	1	2	1	0	0.000
1972	-1	-1	3	1	0	0.000
2004	0	2	3	2	0	0.000

Unit Moment Mz - 12" Riser :

Load Step 19

Node #	Fx	Fy	Fz	Shear	Tension	Stress Ratio
1690	3	0	2	3	0	0.000
1706	3	0	-2	3	3	0.000
1710	1	-1	0	1	0	0.000
1742	1	1	0	1	0	0.000
1821	-1	2	2	2	0	0.000
1837	-1	2	-2	2	3	0.000
1841	0	1	0	1	0	0.000
1873	-1	0	0	1	0	0.000
1952	-1	-2	2	2	0	0.000
1968	-1	-2	-2	2	3	0.000
1972	-1	0	0	1	0	0.000
2004	0	-1	0	1	0	0.000

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Ravi Mung</i>	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	E-12	Rev. No.	0

Unit Force Fx - 20" Riser :

Load Step 20

Node #	Fx	Fy	Fz	Shear	Tension	Stress Ratio
1690	-51	-3	-40	51	60	0.003
1706	-51	3	40	51	0	0.002
1710	-12	11	-6	16	9	0.001
1742	-12	-11	6	16	0	0.001
1821	-147	36	28	151	0	0.006
1837	-97	-36	-67	103	101	0.006
1841	-29	-129	-159	132	239	0.010
1873	-164	52	-173	172	260	0.012
1952	-97	36	67	103	0	0.004
1968	-147	-36	-28	151	42	0.007
1972	-164	-52	173	172	0	0.007
2004	-29	129	159	132	0	0.005

Unit Force Fy - 20" Riser :

Load Step 21

Node #	Fx	Fy	Fz	Shear	Tension	Stress Ratio
1690	-51	-122	20	132	0	0.005
1706	51	-122	20	132	0	0.005
1710	130	-119	193	176	0	0.007
1742	-130	-119	193	176	0	0.007
1821	-29	-62	-62	68	93	0.004
1837	-11	-110	41	111	0	0.004
1841	-23	-106	-104	108	156	0.007
1873	-63	20	-89	66	134	0.005
1952	11	-110	41	111	0	0.004
1968	29	-62	-62	68	93	0.004
1972	63	20	-89	66	134	0.005
2004	23	-107	-104	109	156	0.007

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	Ravi Mung	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	Henry White	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	E-13	Rev. No.	0

Unit Force Fz - 20" Riser :

Load Step 22

Node #	Fx	Fy	Fz	Shear	Tension	Stress Ratio
1690	7	31	-48	32	72	0.003
1706	-7	31	-48	32	72	0.003
1710	-42	31	-66	52	99	0.004
1742	42	31	-66	52	99	0.004
1821	-39	-9	-81	40	122	0.004
1837	-33	-17	-89	37	134	0.004
1841	-2	-72	-108	72	162	0.006
1873	-68	36	-109	77	164	0.006
1952	33	-17	-89	37	134	0.004
1968	39	-9	-81	40	122	0.004
1972	68	36	-109	77	164	0.006
2004	2	-72	-108	72	162	0.006

Unit Moment Mx - 20" Riser :

Load Step 23

Node #	Fx	Fy	Fz	Shear	Tension	Stress Ratio
1690	0	1	-3	1	5	0.000
1706	0	1	-3	1	5	0.000
1710	-1	1	-3	1	5	0.000
1742	1	1	-3	1	5	0.000
1821	1	0	1	1	0	0.000
1837	1	-1	2	1	0	0.000
1841	0	1	1	1	0	0.000
1873	1	-1	2	1	0	0.000
1952	-1	-1	2	1	0	0.000
1968	-1	0	1	1	0	0.000
1972	-1	-1	2	2	0	0.000
2004	0	1	1	1	0	0.000

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	Ravi Mig	Date	6/3/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	Alvin White	Date	6-4-96
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	E-14	Rev. No.	0

Unit Moment My - 20" Riser :

Load Step 24

Node #	Fx	Fy	Fz	Shear	Tension	Stress Ratio
1690	1	0	1	1	0	0.000
1706	1	0	-1	1	2	0.000
1710	0	0	0	0	0	0.000
1742	0	0	0	0	0	0.000
1821	0	-1	-3	1	5	0.000
1837	0	0	-2	0	3	0.000
1841	0	-1	-2	1	3	0.000
1873	-1	1	-2	1	3	0.000
1952	0	0	2	0	0	0.000
1968	0	1	3	1	0	0.000
1972	-1	-1	2	1	0	0.000
2004	0	1	2	1	0	0.000

Unit Moment Mz - 20" Riser :

Load step 25

Node #	Fx	Fy	Fz	Shear	Tension	Stress Ratio
1690	3	0	2	3	0	0.000
1706	3	0	-2	3	3	0.000
1710	1	-1	0	1	0	0.000
1742	1	1	0	1	0	0.000
1821	-1	2	2	2	0	0.000
1837	-1	2	-2	2	3	0.000
1841	0	1	0	1	0	0.000
1873	-1	0	0	1	0	0.000
1952	-1	-2	2	2	0	0.000
1968	-1	-2	-2	2	3	0.000
1972	-1	0	0	1	0	0.000
2004	0	-1	0	1	0	0.000

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Ravi Nigam</i>	Date	<i>6/3/94</i>
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Mark W. W.</i>	Date	<i>6-4-94</i>
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	<i>F-1</i>	Rev. No.	0

APPENDIX F

CALCULATION OF UNIT LOAD STRESS RATIOS IN THE MPR 5A WELDS FOR THE MARGIN ANALYSIS

(25 Sheets)

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Kari King</i>	Date	6/4/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Mike W. W.</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	F-2	Rev. No.	0

Stress Ratio Calculations for Welds

Load Step Description : Load Step 2 Unit Force Fx 8" Riser North

Source Output File ID : MPRPW1.OUT (See ADVENT File C94003.1.1 AD) .

- 1) Refer to Section 7.1.4.1 for Values of Fw; Section 7.1.4.2 for Values of Lw; and Section 7.1.4.3 on procedure to calculate fw.
- 3) Stress Ratio = fw / Fw

Connection Between	Fx (lbs)	Fy (lbs)	Fz (lbs)	Lw (in.)	fw (lb/in.)	Fw (lb/in.)	Stress Ratio
REAL 1 & REAL 4	38	10	48	1.625	38	6,000	0.006
REAL 1 & REAL 8	93	54	99	2.875	51	6,000	0.008
REAL 3 & REAL 8	155	89	296	6.750	51	6,000	0.009
REAL 4 & REAL 8	60	44	96	4.000	30	6,000	0.005
REAL 4 & REAL 9	17	3	39	1.625	26	6,000	0.004
REAL 5 & REAL 8	191	110	268	4.970	70	6,000	0.012
REAL 8 & REAL 9	96	80	8	2.217	56	6,000	0.009
REAL 21 & REAL 22	112	65	53	2.100	67	7,200	0.009
REAL 22 & REAL 23	310	178	101	1.500	248	7,200	0.034
REAL 5 & REAL 10	21	17	115	2.292	52	9,000	0.006
REAL 5 & REAL 11	16	16	75	1.895	41	9,000	0.005
REAL 5 & REAL 12 North	93	47	786	1.585	500	9,000	0.056
REAL 5 & REAL 12 South	12	9	34	1.585	23	9,000	0.003
REAL 1 & REAL 20	4	8	1	3.622	2	2,500	0.001

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	Ravi N. Singh	Date	6/4/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	[Signature]	Date	6-6-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	F-3	Rev. No.	0

Stress Ratio Calculations for Welds

Load Step Description : Load Step 3 Unit Force Fy 8" Riser North

Source Output File ID : MPRPW1.OUT (See ADVENT File C94003.1.1 AD)

- 1) Refer to Section 7.1.4.1 for Values of Fw; Section 7.1.4.2. for Values of Lw; and Section 7.1.4.3 on procedure to calculate fw.
- 2) Stress Ratio = fw / Fw

Connection Between	Fx (lbs)	Fy (lbs)	Fz (lbs)	Lw (in.)	fw (lb/in.)	Fw (lb/in.)	Stress Ratio
REAL 1 & REAL 4	25	38	79	1.625	56	6,000	0.009
REAL 1 & REAL 8	57	123	115	2.875	62	6,000	0.010
REAL 3 & REAL 8	97	147	224	6.750	42	6,000	0.007
REAL 4 & REAL 8	59	85	111	4.000	38	6,000	0.006
REAL 4 & REAL 9	10	19	44	1.625	30	6,000	0.005
REAL 5 & REAL 8	111	240	169	4.970	63	6,000	0.011
REAL 8 & REAL 9	121	34	5	2.217	57	6,000	0.009
REAL 21 & REAL 22	65	148	60	2.100	82	7,200	0.011
REAL 22 & REAL 23	184	414	115	1.500	312	7,200	0.043
REAL 5 & REAL 10	10	12	115	2.292	51	9,000	0.006
REAL 5 & REAL 11	19	24	109	1.895	60	9,000	0.007
REAL 5 & REAL 12 North	54	136	908	1.585	580	9,000	0.064
REAL 5 & REAL 12 South	14	14	31	1.585	23	9,000	0.003
REAL 1 & REAL 20	9	7	1	3.622	3	2,500	0.001

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	Ravi M. Singh	Date	6/4/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	[Signature]	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	1 - 4	Rev. No.	0

Stress Ratio Calculations for Welds

Load Step Description : Load Step 4 Unit Force Fz 8" Riser North

Source Output File ID : MPRPW1.OUT (See ADVENT File C94003.1.1 AD)

- 1) Refer to Section 7.1.4.1 for Values of Fw; Section 7.1.4.2 for Values of Lw; and Section 7.1.4.3 on procedure to calculate fw.
- 2) Stress Ratio = fw / Fw

Connection Between	Fx (lbs)	Fy (lbs)	Fz (lbs)	Lw (in.)	fw (lb/in.)	Fw (lb/in.)	Stress Ratio
REAL 1 & REAL 4	7	4	39	1.625	25	6,000	0.004
REAL 1 & REAL 8	88	89	93	2.875	54	6,000	0.009
REAL 3 & REAL 8	138	143	270	6.750	50	6,000	0.008
REAL 4 & REAL 8	18	18	81	4.000	21	6,000	0.004
REAL 4 & REAL 9	5	4	32	1.625	20	6,000	0.003
REAL 5 & REAL 8	174	180	249	4.970	71	6,000	0.012
REAL 8 & REAL 9	99	87	8	2.217	60	6,000	0.010
REAL 21 & REAL 22	55	59	34	2.100	42	7,200	0.006
REAL 22 & REAL 23	87	66	104	1.500	101	7,200	0.014
REAL 5 & REAL 10	12	21	93	2.292	42	9,000	0.005
REAL 5 & REAL 11	10	13	58	1.895	32	9,000	0.004
REAL 5 & REAL 12 North	17	20	95	1.585	62	9,000	0.007
REAL 5 & REAL 12 South	4	5	27	1.585	18	9,000	0.002
REAL 1 & REAL 20	12	11	1	3.622	5	2,500	0.002

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Lari M. J.</i>	Date	6/4/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>W. J. M.</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	F-5	Rev. No.	0

Stress Ratio Calculations for Welds

Load Step Description : Load Step 5 Unit Moment Mx 8" Riser North

Source Output File ID : MPRPW1.OUT (See ADVENT File C94003.1.1 AD)

- 1) Refer to Section 7.1.4.1 for Values of f_w ; Section 7.1.4.2 for Values of L_w ; and Section 7.1.4.3 on procedure to calculate f_w .
- 2) Stress Ratio = f_w / F_w

Connection Between	Fx (lbs)	Fy (lbs)	Fz (lbs)	Lw (in.)	f _w (lb/in.)	F _w (lb/in.)	Stress Ratio
REAL 1 & REAL 4	0	0	1	1.625	1	6,000	0.000
REAL 1 & REAL 8	1	3	2	2.875	1	6,000	0.000
REAL 3 & REAL 8	2	2	5	6.750	1	6,000	0.000
REAL 4 & REAL 8	0	1	2	4.000	1	6,000	0.000
REAL 4 & REAL 9	0	0	1	1.625	1	6,000	0.000
REAL 5 & REAL 8	2	5	5	4.970	1	6,000	0.000
REAL 8 & REAL 9	1	2	0	2.217	1	6,000	0.000
REAL 21 & REAL 22	1	1	1	2.100	1	7,200	0.000
REAL 22 & REAL 23	1	3	3	1.500	3	7,200	0.000
REAL 5 & REAL 10	0	1	6	2.292	3	9,000	0.000
REAL 5 & REAL 11	0	0	6	1.895	3	9,000	0.000
REAL 5 & REAL 12 North	6	6	39	1.585	25	9,000	0.003
REAL 5 & REAL 12 South	0	1	2	1.585	1	9,000	0.000
REAL 1 & REAL 20	0	1	0	3.622	0	2,500	0.000

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	Ravi M. Singh	Date	6/4/94
Subject	Structural Analysis of Multiport Riser SA	Reviewed By:	[Signature]	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	F-6	Rev. No.	0

Stress Ratio Calculations for Welds

Load Step Description : Load Step 6 Unit Moment My 8" Riser North

Source Output File ID : MPRPW1.OUT (See ADVENT File C94003.1.1 AD)

- 1) Refer to Section 7.1.4.1 for Values of Fw; Section 7.1.4.2 for Values of Lw; and Section 7.1.4.3 for Values of fw.
- 2) Stress Ratio = fw / Fw

Connection Between	Fx (lbs)	Fy (lbs)	Fz (lbs)	Lw (in.)	fw (lb/in.)	Fw (lb/in.)	Stress Ratio
REAL 1 & REAL 4	0	0	1	1.625	1	6,000	0.000
REAL 1 & REAL 8	2	1	2	2.875	1	6,000	0.000
REAL 3 & REAL 8	4	3	7	6.750	1	6,000	0.000
REAL 4 & REAL 8	0	0	2	4.000	1	6,000	0.000
REAL 4 & REAL 9	0	0	1	1.625	1	6,000	0.000
REAL 5 & REAL 8	4	3	13	4.970	3	6,000	0.000
REAL 8 & REAL 9	3	1	0	2.217	1	6,000	0.000
REAL 21 & REAL 22	1	1	1	2.100	1	7,200	0.000
REAL 22 & REAL 23	2	1	3	1.500	2	7,200	0.000
REAL 5 & REAL 10	1	1	6	2.292	3	9,000	0.000
REAL 5 & REAL 11	0	0	3	1.895	2	9,000	0.000
REAL 5 & REAL 12 North	6	5	34	1.585	22	9,000	0.002
REAL 5 & REAL 12 South	0	0	1	1.585	1	9,000	0.000
REAL 1 & REAL 20	1	0	0	3.622	0	2,500	0.000

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Ravi M. Singh</i>	Date	6/4/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>W. H. M. Singh</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	F-7	Rev. No.	0

Stress Ratio Calculations for Welds

Load Step Description : Load Step 7 Unit Moment Mz 8" Riser North

Source Output File ID : MPRPW1.OUT (See ADVENT File C94003.1.1 AD)

- 1) Refer to Section 7.1.4.1 for Values of Fw; Section 7.1.4.2 for Values of Lw; and Section 7.1.4.3 on procedure to calculate fw.
- 2) Stress Ratio = fw / Fw

Connection Between	Fx (lbs)	Fy (lbs)	Fz (lbs)	Lw (in.)	fw (lb/in.)	Fw (lb/in.)	Stress Ratio
REAL 1 & REAL 4	1	1	2	1.625	2	6,000	0.000
REAL 1 & REAL 8	0	0	0	2.875	0	6,000	0.000
REAL 3 & REAL 8	0	0	0	6.750	0	6,000	0.000
REAL 4 & REAL 8	1	1	0	4.000	0	6,000	0.000
REAL 4 & REAL 9	1	1	0	1.625	1	6,000	0.000
REAL 5 & REAL 8	0	0	0	4.970	0	6,000	0.000
REAL 8 & REAL 9	2	2	0	2.217	1	6,000	0.000
REAL 21 & REAL 22	0	0	0	2.100	0	7,200	0.000
REAL 22 & REAL 23	0	0	0	1.500	0	7,200	0.000
REAL 5 & REAL 10	1	1	0	2.292	1	9,000	0.000
REAL 5 & REAL 11	1	1	0	1.895	1	9,000	0.000
REAL 5 & REAL 12 North	19	18	0	1.585	17	9,000	0.002
REAL 5 & REAL 12 South	0	0	0	1.585	0	9,000	0.000
REAL 1 & REAL 20	0	0	0	3.622	0	2,500	0.000

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Ravi M. J.</i>	Date	6/4/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	F-8	Rev. No.	0

Stress Ratio Calculations for Welds

Load Step Description : Load Step 8 Unit Force Fx 8" Riser South

Source Output File ID : MPRPW1.OUT (See ADVENT File C94003.1.1 AD)

- 1) Refer to Section 7.1.4.1 for Values of Fw; Section 7.1.4.2 for Values of Lw; and Section 7.1.4.3 on procedure to calculate fw.
- 2) Stress Ratio = fw / Fw

Connection Between	Fx (lbs)	Fy (lbs)	Fz (lbs)	Lw (in.)	fw (lb/in.)	Fw (lb/in.)	Stress Ratio
REAL 1 & REAL 4	38	10	48	1.625	38	6,000	0.006
REAL 1 & REAL 8	93	54	99	2.875	51	6,000	0.008
REAL 3 & REAL 8	155	89	296	6.750	51	6,000	0.009
REAL 4 & REAL 8	60	44	96	4.000	30	6,000	0.005
REAL 4 & REAL 9	17	3	39	1.625	26	6,000	0.004
REAL 5 & REAL 8	191	110	268	4.970	70	6,000	0.012
REAL 8 & REAL 9	96	80	8	2.217	56	6,000	0.009
REAL 21 & REAL 22	112	65	53	2.100	67	7,200	0.009
REAL 22 & REAL 23	310	178	101	1.500	248	7,200	0.034
REAL 5 & REAL 10	21	17	115	2.292	52	9,000	0.006
REAL 5 & REAL 11	16	16	75	1.895	41	9,000	0.005
REAL 5 & REAL 12 North	93	47	786	1.585	500	9,000	0.056
REAL 5 & REAL 12 South	12	9	34	1.585	23	9,000	0.003
REAL 1 & REAL 20	4	8	1	3.622	2	2,500	0.001

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Ravi M. Singh</i>	Date	5/4/94
Subject	Structural Analysis of Multiport Riser 3A	Reviewed By:	<i>Henry M. Smith</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	F-9	Rev. No.	0

Stress Ratio Calculations for Welds

Load Step Description : Load Step 9 Unit Force Fy 8" Riser South

Source Output File ID : MPRPW1.OUT (See ADVENT File C94003.1.1 AD)

- 1) Refer to Section 7.1.4.1 for Values of Fw; Section 7.1.4.2 for Values of Lw; and Section 7.1.4.3 on procedure to calculate fw.
- 2) Stress Ratio = fw / Fw

Connection Between	Fx (lbs)	Fy (lbs)	Fz (lbs)	Lw (in.)	fw (lb/in.)	Fw (lb/in.)	Stress Ratio
REAL 1 & REAL 4	25	38	79	1.625	56	6,000	0.009
REAL 1 & REAL 8	57	123	115	2.875	62	6,000	0.010
REAL 3 & REAL 8	97	147	224	6.750	42	6,000	0.007
REAL 4 & REAL 8	59	85	111	4.000	38	6,000	0.006
REAL 4 & REAL 9	10	19	44	1.625	30	6,000	0.005
REAL 5 & REAL 8	111	240	169	4.970	63	6,000	0.011
REAL 8 & REAL 9	121	34	5	2.217	57	6,000	0.009
REAL 21 & REAL 22	65	148	60	2.100	82	7,200	0.011
REAL 22 & REAL 23	184	414	115	1.500	312	7,200	0.043
REAL 5 & REAL 10	10	12	115	2.292	51	9,000	0.006
REAL 5 & REAL 11	19	24	109	1.895	60	9,000	0.007
REAL 5 & REAL 12 North	54	136	908	1.585	580	9,000	0.064
REAL 5 & REAL 12 South	14	14	31	1.585	23	9,000	0.003
REAL 1 & REAL 20	9	7	1	3.622	3	2,500	0.001

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Ravi Nig</i>	Date	2/4/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Wally Shih</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	E-10	Rev. No.	0

Stress Ratio Calculations for Welds

Load Step Description : Load Step 10 Unit Force Fz 8" Riser South

Source Output File ID : MPRPW1.OUT (See ADVENT File C94003.1.1 AD)

- 1) Refer to Section 7.1.4.1 for Values of Fw; Section 7.1.4.2 for Values of Lw; and Section 7.1.4.3 on procedure to calculate fw.
- 2) Stress Ratio = fw / Fw

Connection Between	Fx (lbs)	Fy (lbs)	Fz (lbs)	Lw (in.)	fw (lb/in.)	Fw (lb/in.)	Stress Ratio
REAL 1 & REAL 4	7	4	39	1.625	25	6,000	0.004
REAL 1 & REAL 8	88	89	93	2.875	54	6,000	0.009
REAL 3 & REAL 8	138	143	270	6.750	50	6,000	0.008
REAL 4 & REAL 8	18	18	81	4.000	21	6,000	0.004
REAL 4 & REAL 9	5	4	32	1.625	20	6,000	0.003
REAL 5 & REAL 8	174	180	249	4.970	71	6,000	0.012
REAL 8 & REAL 9	99	87	8	2.217	60	6,000	0.010
REAL 21 & REAL 22	55	59	34	2.100	42	7,200	0.006
REAL 22 & REAL 23	87	66	104	1.500	101	7,200	0.014
REAL 5 & REAL 10	12	21	93	2.292	42	9,000	0.005
REAL 5 & REAL 11	10	13	58	1.895	32	9,000	0.004
REAL 5 & REAL 12 North	17	20	95	1.585	62	9,000	0.007
REAL 5 & REAL 12 South	4	5	27	1.585	18	9,000	0.002
REAL 1 & REAL 20	12	11	1	3.622	5	2,500	0.002

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	Ravi Mig	Date	6/4/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	John W. W.	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	F-11	Rev. No.	0

Stress Ratio Calculations for Welds

Load Step Description : Load Step 11 Unit Moment Mx 8" Riser South

Source Output File ID : MPRPW1.OUT (See ADVENT File C94003.1.1 AD)

- 1) Refer to Section 7.1.4.1 for Values of Fw; Section 7.1.4.2 for Values of Lw; and Section 7.1.4.3 on procedure to calculate fw.
- 2) Stress Ratio = fw / Fw

Connection Between	Fx (lbs)	Fy (lbs)	Fz (lbs)	Lw (in.)	fw (lb/in.)	Fw (lb/in.)	Stress Ratio
REAL 1 & REAL 4	0	0	1	1.625	1	6,000	0.000
REAL 1 & REAL 8	1	3	2	2.875	1	6,000	0.000
REAL 3 & REAL 8	2	2	5	6.750	1	6,000	0.000
REAL 4 & REAL 8	0	1	2	4.000	1	6,000	0.000
REAL 4 & REAL 9	0	0	1	1.625	1	6,000	0.000
REAL 5 & REAL 8	2	5	5	4.970	1	6,000	0.000
REAL 8 & REAL 9	1	2	0	2.217	1	6,000	0.000
REAL 21 & REAL 22	1	1	1	2.100	1	7,200	0.000
REAL 22 & REAL 23	1	3	3	1.500	3	7,200	0.000
REAL 5 & REAL 10	0	1	6	2.292	3	9,000	0.000
REAL 5 & REAL 11	0	0	6	1.895	3	9,000	0.000
REAL 5 & REAL 12 North	6	6	39	1.585	25	9,000	0.003
REAL 5 & REAL 12 South	0	1	2	1.585	1	9,000	0.000
REAL 1 & REAL 20	0	1	0	3.622	0	2,500	0.000

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Ravi N. Singh</i>	Date	6/4/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>John W. Smith</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	F-12	Rev. No.	0

Stress Ratio Calculations for Welds

Load Step Description : Load Step 12 Unit Moment My 8" Riser South

Source Output File ID : MPRPW1.OUT (See ADVENT File C94003.1.1 AD)

- 1) Refer to section 7.1.4.1 for Values of Fw; Section 7.1.4.2 for Values of Lw; and Section 7.1.4.3 on procedure to calculate fw.
- 2) Stress Ratio = fw / Fw

Connection Between	Fx (lbs)	Fy (lbs)	Fz (lbs)	Lw (in.)	fw (lb/in.)	Fw (lb/in.)	Stress Ratio
REAL 1 & REAL 4	0	0	1	1.625	1	6,000	0.000
REAL 1 & REAL 8	2	1	2	2.875	1	6,000	0.000
REAL 3 & REAL 8	4	3	7	6.750	1	6,000	0.000
REAL 4 & REAL 8	0	0	2	4.000	1	6,000	0.000
REAL 4 & REAL 9	0	0	1	1.625	1	6,000	0.000
REAL 5 & REAL 8	4	3	13	4.970	3	6,000	0.000
REAL 8 & REAL 9	3	1	0	2.217	1	6,000	0.000
REAL 21 & REAL 22	1	1	1	2.100	1	7,200	0.000
REAL 22 & REAL 23	2	1	3	1.500	2	7,200	0.000
REAL 5 & REAL 10	1	1	6	2.292	3	9,000	0.000
REAL 5 & REAL 11	0	0	3	1.895	2	9,000	0.000
REAL 5 & REAL 12 North	6	5	34	1.585	22	9,000	0.002
REAL 5 & REAL 12 South	0	0	1	1.585	1	9,000	0.000
REAL 1 & REAL 20	1	0	0	3.622	0	2,500	0.000

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Ravi N. Singh</i>	Date	6/4/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Henry M. Smith</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	F-13	Rev. No.	0

Stress Ratio Calculations for Welds

Load Step Description : Load Step 13 Unit Moment Mz 8" Riser South

Source Output File ID : MPRPW1.OUT (See ADVENT File C94003.1.1 AD)

- 1) Refer to Section 7.1.4.1 for Values of Fw; Section 7.1.4.2 for Values of Lw; and Section 7.1.4.3 on procedure to calculate fw.
- 2) Stress Ratio = fw / Fw

Connection Between	Fx (lbs)	Fy (lbs)	Fz (lbs)	Lw (in.)	fw (lb/in.)	Fw (lb/in.)	Stress Ratio
REAL 1 & REAL 4	1	1	2	1.625	2	6,000	0.000
REAL 1 & REAL 8	0	0	0	2.875	0	6,000	0.000
REAL 3 & REAL 8	0	0	0	6.750	0	6,000	0.000
REAL 4 & REAL 8	1	1	0	4.000	0	6,000	0.000
REAL 4 & REAL 9	1	1	0	1.625	1	6,000	0.000
REAL 5 & REAL 8	0	0	0	4.970	0	6,000	0.000
REAL 8 & REAL 9	2	2	0	2.217	1	6,000	0.000
REAL 21 & REAL 22	0	0	0	2.100	0	7,200	0.000
REAL 22 & REAL 23	0	0	0	1.500	0	7,200	0.000
REAL 5 & REAL 10	1	1	0	2.292	1	9,000	0.000
REAL 5 & REAL 11	1	1	0	1.895	1	9,000	0.000
REAL 5 & REAL 12 North	19	18	0	1.585	17	9,000	0.002
REAL 5 & REAL 12 South	0	0	0	1.585	0	9,000	0.000
REAL 1 & REAL 20	0	0	0	3.622	0	2,500	0.000

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Ravi Mij</i>	Date	6/4/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	F-14	Rev. No.	0

Stress Ratio Calculations for Welds

Load Step Description : Load Step 14 Unit Force Fx 12" Riser

Source Output File ID : MPRPW1.OUT (See ADVENT File C94003.1.1 AD)

- 1) Refer to Section 7.1.4.1 for Values for Fw; Section 7.1.4.2 for Values of Lw; and Section 7.1.4.3 on procedure to calculate fw.
- 2) Stress Ratio = fw / Fw

Connection Between	Fx (lbs)	Fy (lbs)	Fz (lbs)	Lw (in.)	fw (lb/in.)	Fw (lb/in.)	Stress Ratio
REAL 1 & REAL 4	50	3	63	1.625	50	6,000	0.008
REAL 1 & REAL 8	85	49	87	2.875	46	6,000	0.008
REAL 3 & REAL 8	111	64	202	6.750	35	6,000	0.006
REAL 4 & REAL 8	64	37	86	4.000	28	6,000	0.005
REAL 4 & REAL 9	23	2	34	1.625	25	6,000	0.004
REAL 5 & REAL 8	161	93	145	4.970	47	6,000	0.008
REAL 8 & REAL 9	80	82	4	2.217	52	6,000	0.009
REAL 21 & REAL 22	106	62	52	2.100	64	7,200	0.009
REAL 22 & REAL 23 •	314	181	90	6.000	62	7,200	0.009
REAL 5 & REAL 10	22	24	125	2.292	56	9,000	0.006
REAL 5 & REAL 11	71	20	279	1.895	152	9,000	0.017
REAL 5 & REAL 12 North	11	11	24	1.585	18	9,000	0.002
REAL 5 & REAL 12 South	12	10	28	1.585	20	9,000	0.002
REAL 1 & REAL 20	7	8	0	3.622	3	2,500	0.001

* Lw @ node 2045

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Kari M. King</i>	Date	6/4/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	F-15	Rev. No.	0

Stress Ratio Calculations for Welds

Load Step Description : Load Step 15 Unit Force Fy 12" Riser

Source Output File ID : MPRPW1.OUT (See ADVENT File C94003.1.1 AD)

- 1) Refer to Section 7.1.4.1 for Values of Fw; Section 7.1.4.2 for Values of Lw; and Section 7.1.4.3 on procedure to calculate fw.
- 2) Stress Ratio = fw / Fw

Connection Between	Fx (lbs)	Fy (lbs)	Fz (lbs)	Lw (in.)	fw (lb/in.)	Fw (lb/in.)	Stress Ratio
REAL 1 & REAL 4	17	24	56	1.625	39	6,000	0.006
REAL 1 & REAL 8	51	114	52	2.875	47	6,000	0.008
REAL 3 & REAL 8	102	102	207	6.750	37	6,000	0.006
REAL 4 & REAL 8	52	85	98	4.000	35	6,000	0.006
REAL 4 & REAL 9	6	12	38	1.625	25	6,000	0.004
REAL 5 & REAL 8	105	188	251	4.970	67	6,000	0.011
REAL 8 & REAL 9	89	100	8	2.217	60	6,000	0.010
REAL 21 & REAL 22	62	141	60	2.100	79	7,200	0.011
REAL 22 & REAL 23 *	0	418	104	6.000	72	7,200	0.010
REAL 5 & REAL 10	15	7	78	2.292	35	9,000	0.004
REAL 5 & REAL 11	25	69	330	1.895	178	9,000	0.020
REAL 5 & REAL 12 North	4	7	54	1.585	34	9,000	0.004
REAL 5 & REAL 12 South	4	7	54	1.585	34	9,000	0.004
REAL 1 & REAL 20	4	4	0	3.622	2	2,500	0.001

* Lw @ node 1783

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Kari M. Lint</i>	Date	6/4/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	F-16	Rev. No.	0

Stress Ratio Calculations for Welds

Load Step Description : Load Step 16 Unit Force Fz 12" Riser

Source Output File ID : MPRPW1.OUT (See ADVENT File C94003.1.1 AD)

- 1) Refer to Section 7.1.4.1 for Values of Fw; Section 7.1.4.2 for Values of Lw; and Section 7.1.4.3 on procedure to calculate fw.
- 2) Stress Ratio = fw / Fw

Connection Between	Fx (lbs)	Fy (lbs)	Fz (lbs)	Lw (in.)	fw (lb/in.)	Fw (lb/in.)	Stress Ratio
REAL 1 & REAL 4	4	4	33	1.625	21	6,000	0.003
REAL 1 & REAL 8	46	115	103	2.875	56	6,000	0.009
REAL 3 & REAL 8	95	178	289	6.750	52	6,000	0.009
REAL 4 & REAL 8	19	21	89	4.000	23	6,000	0.004
REAL 4 & REAL 9	5	3	35	1.625	22	6,000	0.004
REAL 5 & REAL 8	104	220	265	4.970	72	6,000	0.012
REAL 8 & REAL 9	58	92	9	2.217	49	6,000	0.008
REAL 21 & REAL 22	38	68	38	2.100	41	7,200	0.006
REAL 22 & REAL 23	0	84	63	6.000	18	7,200	0.002
REAL 5 & REAL 10	10	5	71	2.292	31	9,000	0.003
REAL 5 & REAL 11	10	14	88	1.895	47	9,000	0.005
REAL 5 & REAL 12 North	11	12	29	1.585	21	9,000	0.002
REAL 5 & REAL 12 South	11	12	29	1.585	21	9,000	0.002
REAL 1 & REAL 20	6	9	1	3.622	3	2,500	0.001

* Lw @ node 1785

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Ravi M. J.</i>	Date	6/4/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	F-17	Rev. No.	0

Stress Ratio Calculations for Welds

Load Step Description : Load Step 17 Unit Moment Mx 12" Riser

Source Output File ID : MPRPW1.OUT (See ADVENT File C94003.1.1 AD)

- 1) Refer to Section 7.1.4.1 for Values of Fw; Section 7.1.4.2 for Values of Lw; and Section 7.1.4.3 on procedure to calculate fw.
- 2) Stress Ratio = fw / Fw

Connection Between	Fx (lbs)	Fy (lbs)	Fz (lbs)	Lw (in.)	fw (lb/in.)	Fw (lb/in.)	Stress Ratio
REAL 1 & REAL 4	0	0	1	1.625	1	6,000	0.000
REAL 1 & REAL 8	1	3	2	2.875	1	6,000	0.000
REAL 3 & REAL 8	3	2	8	6.750	1	6,000	0.000
REAL 4 & REAL 8	0	0	2	4.000	1	6,000	0.000
REAL 4 & REAL 9	0	0	1	1.625	1	6,000	0.000
REAL 5 & REAL 8	3	3	16	4.970	3	6,000	0.001
REAL 8 & REAL 9	1	3	0	2.217	1	6,000	0.000
REAL 21 & REAL 22	1	1	1	2.100	1	7,200	0.000
REAL 22 & REAL 23	1	3	3	1.500	3	7,200	0.000
REAL 5 & REAL 10	1	0	4	2.292	2	9,000	0.000
REAL 5 & REAL 11	2	2	19	1.895	10	9,000	0.001
REAL 5 & REAL 12 North	0	1	3	1.585	2	9,000	0.000
REAL 5 & REAL 12 South	0	1	3	1.585	2	9,000	0.000
REAL 1 & REAL 20	0	0	0	3.622	0	2,500	0.000

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Rui Ming</i>	Date	6/4/14
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Advent</i>	Date	6-4-14
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	F - 18	Rev. No.	0

Stress Ratio Calculations for Welds

Load Step Description : Load Step 18 Unit Moment My 12" Riser

Source Output File ID : MPRPW1.OUT (See ADVENT File C94003.1.1 AD)

- 1) Refer to Section 7.1.4.1 for Values of Fw; Section 7.1.4.2 for Values of Lw; and Section 7.1.4.3 on procedure to calculate fw.
- 2) Stress Ratio = fw / Fw

Connection Between	Fx (lbs)	Fy (lbs)	Fz (lbs)	Lw (in.)	fw (lb/in.)	Fw (lb/in.)	Stress Ratio
REAL 1 & REAL 4	0	0	1	1.625	1	6,000	0.000
REAL 1 & REAL 8	2	1	2	2.875	1	6,000	0.000
REAL 3 & REAL 8	2	1	4	6.750	1	6,000	0.000
REAL 4 & REAL 8	0	0	2	4.000	1	6,000	0.000
REAL 4 & REAL 9	0	0	1	1.625	1	6,000	0.000
REAL 5 & REAL 8	4	2	3	4.970	1	6,000	0.000
REAL 8 & REAL 9	3	1	0	2.217	1	6,000	0.000
REAL 21 & REAL 22	1	1	1	2.100	1	7,200	0.000
REAL 22 & REAL 23	2	1	3	1.500	2	7,200	0.000
REAL 5 & REAL 10	1	1	7	2.292	3	9,000	0.000
REAL 5 & REAL 11	2	2	16	1.895	9	9,000	0.001
REAL 5 & REAL 12 North	0	0	2	1.585	1	9,000	0.000
REAL 5 & REAL 12 South	0	0	2	1.585	1	9,000	0.000
REAL 1 & REAL 20	1	0	0	3.622	0	2,500	0.000

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	Ravi Mung	Date	6/4/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	Anthony M. W.	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	F-19	Rev. No.	0

Stress Ratio Calculations for Welds

Load Step Description : Load Step 19 Unit Moment Mz 12" Riser

Source Output File ID : MPRPW1.OUT (See ADVENT File C94003.1.1 AD)

- 1) Refer to Section 7.1.4.1 for Values of Fw; Section 7.1.4.2 for Values of Lw; and Section 7.1.4.3 on procedure to calculate fw.
- 2) Stress Ratio = fw / Fw

Connection Between	Fx (lbs)	Fy (lbs)	Fz (lbs)	Lw (in.)	fw (lb/in.)	Fw (lb/in.)	Stress Ratio
REAL 1 & REAL 4	1	1	2	1.625	2	6,000	0.000
REAL 1 & REAL 8	0	0	0	2.875	0	6,000	0.000
REAL 3 & REAL 8	0	0	0	6.750	0	6,000	0.000
REAL 4 & REAL 8	1	1	0	4.000	0	6,000	0.000
REAL 4 & REAL 9	1	1	0	1.625	1	6,000	0.000
REAL 5 & REAL 8	0	0	0	4.970	0	6,000	0.000
REAL 8 & REAL 9	2	2	0	2.217	1	6,000	0.000
REAL 21 & REAL 22	0	0	0	2.100	0	7,200	0.000
REAL 22 & REAL 23	0	0	0	1.500	0	7,200	0.000
REAL 5 & REAL 10	1	0	0	2.292	0	9,000	0.000
REAL 5 & REAL 11	9	9	0	1.895	7	9,000	0.001
REAL 5 & REAL 12 North	1	1	0	1.585	1	9,000	0.000
REAL 5 & REAL 12 South	1	1	0	1.585	1	9,000	0.000
REAL 1 & REAL 20	0	0	0	3.622	0	2,500	0.000

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	Ran Ming	Date	6/4/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	Henry W. W.	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	F-20	Rev. No.	0

Stress Ratio Calculations for Welds

Load Step Description : Load Step 20 Unit Force Fx 20" Riser

Source Output File ID : MPRPW1.OUT (See ADVENT-File C94003.1.1 AD)

- 1) Refer to Section 7.1.4.1 for Values of Fw; Section 7.1.4.2 for values of Lw; and Section 7.1.4.3 on procedure to calculate fw.
- 2) Stress Ratio = fw / Fw

Connection Between	Fx (lbs)	Fy (lbs)	Fz (lbs)	Lw (in.)	fw (lb/in.)	Fw (lb/in.)	Stress Ratio
REAL 1 & REAL 4	25	29	68	1.625	48	6,000	0.008
REAL 1 & REAL 8	80	46	76	2.875	42	6,000	0.007
REAL 3 & REAL 8	106	61	191	6.750	34	6,000	0.006
REAL 4 & REAL 8	51	61	77	4.000	28	6,000	0.005
REAL 4 & REAL 9	12	12	30	1.625	21	6,000	0.004
REAL 5 & REAL 8	141	81	149	4.970	44	6,000	0.007
REAL 8 & REAL 9	79	87	4	2.217	53	6,000	0.009
REAL 21 & REAL 22	100	59	52	2.100	61	7,200	0.008
REAL 22 & REAL 23	327	185	92	6.000	64	7,200	0.009
REAL 5 & REAL 10	59	30	115	2.292	58	9,000	0.006
REAL 5 & REAL 11	2	1	25	1.895	13	9,000	0.001
REAL 5 & REAL 12 North	5	2	16	1.585	11	9,000	0.001
REAL 5 & REAL 12 South	5	2	26	1.585	17	9,000	0.002
REAL 1 & REAL 20	6	6	0	3.622	2	2,500	0.001

• Lw @ node 2045

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	Kari Mij- Date 6/4/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	[Signature] Date 6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003 File No. 94003.1.1
Client Calc. No.		Sheet No.	F - 21 Rev. No. 0

Stress Ratio Calculations for Welds

Load Step Description : Load Step 21 Unit Force Fy 20" Riser

Source Output File ID : MPRPW1.OUT (See ADVENT File C94003.1.1 AD)

- 1) Refer to Section 7.1.4.1 for Values of Fw; Section 7.1.4.2 for values of Lw; and Section 7.1.4.3 on procedure to calculate fw.
- 2) Stress Ratio = fw / Fw

Connection Between	Fx (lbs)	Fy (lbs)	Fz (lbs)	Lw (in.)	fw (lb/in.)	Fw (lb/in.)	Stress Ratio
REAL 1 & REAL 4	18	26	56	1.625	40	6,000	0.007
REAL 1 & REAL 8	44	105	87	2.875	50	6,000	0.008
REAL 3 & REAL 8	40	143	242	6.750	42	6,000	0.007
REAL 4 & REAL 8	51	86	88	4.000	33	6,000	0.006
REAL 4 & REAL 9	7	13	35	1.625	23	6,000	0.004
REAL 5 & REAL 8	75	194	192	4.970	57	6,000	0.009
REAL 8 & REAL 9	91	76	6	2.217	54	6,000	0.009
REAL 21 & REAL 22	59	135	60	2.100	76	7,200	0.011
REAL 22 & REAL 23 •	0	431	92	6.000	73	7,200	0.010
REAL 5 & REAL 10	30	83	87	2.292	54	9,000	0.006
REAL 5 & REAL 11	11	12	9	1.895	10	9,000	0.001
REAL 5 & REAL 12 North	12	15	32	1.585	24	9,000	0.003
REAL 5 & REAL 12 South	12	15	31	1.585	23	9,000	0.003
REAL 1 & REAL 20	4	6	0	3.622	2	2,500	0.001

* Lw @ node 1783

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Rui Ming</i>	Date	6/4/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	F-22	Rev. No.	0

Stress Ratio Calculations for Welds

Load Step Description : Load Step 22 Unit Force Fz 20" Riser

Source Output File ID : MPRPW1.OUT (See ADVENT File C94003.1.1 AD)

- 1) Refer to Section 7.1.4.1 for Values of Fw; Section 7.1.4.2 for Values of Lw; and Section 7.1.4.3 on procedure to calculate fw.
- 2) Stress Ratio = fw / Fw

Connection Between	Fx (lbs)	Fy (lbs)	Fz (lbs)	Lw (in.)	fw (lb/in.)	Fw (lb/in.)	Stress Ratio
REAL 1 & REAL 4	2	4	32	1.625	20	6,000	0.003
REAL 1 & REAL 8	77	50	81	2.875	43	6,000	0.007
REAL 3 & REAL 8	136	104	273	6.750	48	6,000	0.008
REAL 4 & REAL 8	15	19	70	4.000	19	6,000	0.003
REAL 4 & REAL 9	2	4	28	1.625	17	6,000	0.003
REAL 5 & REAL 8	156	110	297	4.970	71	6,000	0.012
REAL 8 & REAL 9	62	65	9	2.217	41	6,000	0.007
REAL 21 & REAL 22	50	41	29	2.100	34	7,200	0.005
REAL 22 & REAL 23	0	91	41	6.000	17	7,200	0.002
REAL 5 & REAL 10	17	8	91	2.292	41	9,000	0.005
REAL 5 & REAL 11	6	4	28	1.895	15	9,000	0.002
REAL 5 & REAL 12 North	7	5	43	1.585	28	9,000	0.003
REAL 5 & REAL 12 South	7	5	43	1.585	28	9,000	0.003
REAL 1 & REAL 20	8	7	1	3.622	3	2,500	0.001

* Lw @ node 1783

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	Kari Ming	Date	6/4/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	[Signature]	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	F - 23	Rev. No.	0

Stress Ratio Calculations for Welds

Load Step Description : Load Step 23 Unit Moment Mx 20" Riser

Source Output File ID : MPRPW1.OUT (See ADVENT File C94003.1.1 AD)

- 1) Refer to Section 7.1.4.1 for Values of Fw; Section 7.1.4.2 for Values of Lw; and Section 7.1.4.3 on procedure to calculate fw.
- 2) Stress Ratio = fw / Fw

Connection Between	Fx (lbs)	Fy (lbs)	Fz (lbs)	Lw (in.)	fw (lb/in.)	Fw (lb/in.)	Stress Ratio
REAL 1 & REAL 4	0	0	1	1.625	1	6,000	0.000
REAL 1 & REAL 8	1	3	2	2.875	1	6,000	0.000
REAL 3 & REAL 8	0	5	8	6.750	1	6,000	0.000
REAL 4 & REAL 8	0	1	2	4.000	1	6,000	0.000
REAL 4 & REAL 9	0	0	1	1.625	1	6,000	0.000
REAL 5 & REAL 8	2	5	9	4.970	2	6,000	0.000
REAL 8 & REAL 9	2	2	0	2.217	1	6,000	0.000
REAL 21 & REAL 22	1	1	1	2.100	1	7,200	0.000
REAL 22 & REAL 23	1	3	3	1.500	3	7,200	0.000
REAL 5 & REAL 10	1	1	7	2.292	3	9,000	0.000
REAL 5 & REAL 11	0	0	1	1.895	1	9,000	0.000
REAL 5 & REAL 12 North	0	0	2	1.585	1	9,000	0.000
REAL 5 & REAL 12 South	0	0	2	1.585	1	9,000	0.000
REAL 1 & REAL 20	0	0	0	3.622	0	2,500	0.000

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>Ravi N. Singh</i>	Date	6/4/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>John W. Smith</i>	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	F-24	Rev. No.	0

Stress Ratio Calculations for Welds

Load Step Description : Load Step 24 Unit Moment My 20" Riser

Source Output File ID : MPRPW1.OUT

(See ADVENT File C94003.1.1 AD)

- 1) Refer to Section 7.1.4.1 for Values of Fw; Section 7.1.4.2 for Values of Lw; and Section 7.1.4.3 on procedure to calculate fw.
- 2) Stress Ratio = fw / Fw

Connection Between	Fx (lbs)	Fy (lbs)	Fz (lbs)	Lw (in.)	fw (lb/in.)	Fw (lb/in.)	Stress Ratio
REAL 1 & REAL 4	0	0	1	1.625	1	6,000	0.000
REAL 1 & REAL 8	2	1	2	2.875	1	6,000	0.000
REAL 3 & REAL 8	3	2	5	6.750	1	6,000	0.000
REAL 4 & REAL 8	0	0	2	4.000	1	6,000	0.000
REAL 4 & REAL 9	0	0	1	1.625	1	6,000	0.000
REAL 5 & REAL 8	4	2	5	4.970	1	6,000	0.000
REAL 8 & REAL 9	2	1	0	2.217	1	6,000	0.000
REAL 21 & REAL 22	1	1	1	2.100	1	7,200	0.000
REAL 22 & REAL 23	2	1	3	1.500	2	7,200	0.000
REAL 5 & REAL 10	1	1	11	2.292	5	9,000	0.001
REAL 5 & REAL 11	0	0	3	1.895	2	9,000	0.000
REAL 5 & REAL 12 North	0	0	2	1.585	1	9,000	0.000
REAL 5 & REAL 12 South	0	0	2	1.585	1	9,000	0.000
REAL 1 & REAL 20	0	0	0	3.622	0	2,500	0.000

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	Ravi Mij	Date	6/4/94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	[Signature]	Date	6-4-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	F-25	Rev. No.	0

Stress Ratio Calculations for Welds

Load Step Description : Load Step 25 Unit Moment Mz 20" Riser

Source Output File ID : MPRPW1.OUT (See ADVENT File C94003.1.1 AD)

- 1) Refer to Section 7.1.4.1 for Values of Fw; Section 7.1.4.2 for Values of Lw; and Section 7.1.4.3 on procedure to calculate fw.
- 2) Stress Ratio = fw / Fw

Connection Between	Fx (lbs)	Fy (lbs)	Fz (lbs)	Lw (in.)	fw (lb/in.)	Fw (lb/in.)	Stress Ratio
REAL 1 & REAL 4	1	1	2	1.625	2	6,000	0.000
REAL 1 & REAL 8	0	0	0	2.875	0	6,000	0.000
REAL 3 & REAL 8	0	0	0	6.750	0	6,000	0.000
REAL 4 & REAL 8	1	1	0	4.000	0	6,000	0.000
REAL 4 & REAL 9	1	1	0	1.625	1	6,000	0.000
REAL 5 & REAL 8	0	0	0	4.970	0	6,000	0.000
REAL 8 & REAL 9	2	2	0	2.217	1	6,000	0.000
REAL 21 & REAL 22	0	0	0	2.100	0	7,200	0.000
REAL 22 & REAL 23	0	0	0	1.500	0	7,200	0.000
REAL 5 & REAL 10	4	5	0	2.292	3	9,000	0.000
REAL 5 & REAL 11	0	0	0	1.895	0	9,000	0.000
REAL 5 & REAL 12 North	0	0	0	1.585	0	9,000	0.000
REAL 5 & REAL 12 South	0	0	0	1.585	0	9,000	0.000
REAL 1 & REAL 20	0	0	0	3.622	0	2,500	0.000

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	6-4-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>Ravi Mig</i>	Date	6/4/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	G-1	Rev. No.	0

APPENDIX G

MULTIPORT RISER ASESEMBLY WESTINGHOUSE DRAWINGS

(13 Sheets)

[illegible]

VIEW F-F CONT'D
SEE FIGURE 3 PLACES
SCALE 1/8"

⑩ PRESSURE RELIEF PANEL GASKET
Page 10

⑪ RISER FLANGE GASKET
NOTE 12

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	9-14-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	9/14/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	—	Rev. No.	1

APPENDIX H

(Total: 18 Sheets)

ADVENT Response to Steve Broken and Bahram Mosaddad (*URS*) - RCR. (8 Sheets)

ADVENT Response to John P. Strehlow (*WHC*) - RCR. (6 Sheets)

ADVENT Response to Bob White (*WHC*) - RCR. (1 Sheet)

ADVENT Response to M.L. Mcelroy (*WHC*) - RCR. (1 Sheet)

ADVENT Response to Omar Jaka (*WHC*) - RCR. (1 Sheet)

SEP 14 '94 04:42PM URS

WHC-SD-WM-DA-161
REV. 0

Pp. 40/47

Facsimile

URS

A PROFESSIONAL SERVICES ORGANIZATION

**URS CONSULTANTS
JOHN A. BLUME & ASSOCIATES, ENGINEERS**

**100 CALIFORNIA STREET, SUITE 500
SAN FRANCISCO, CA 94111-4529
PHONE: (415) 774-2700**

FAX: (415) 398-1804

Telecopy Transmission

Attention RAVI BALIGA
Firm ADVENT ENGINEERING
Location _____
FAX No 510-743-0414

From Marty Gurnee
Date 9/14/94
Job No. _____
No. of Pages (incl. this one) 7

Notes or Special Instructions:

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There is no handwriting or other markings on the paper.

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(415) 774-2700

Post-It™ brand fax transmittal memo 7671		# of pages > 7
To: Ravi Baliga	From: Andy Garofalo	
ADVENT	Co.	
	Phone #	
Fax # 510-743-0414	Fax #	

URS

A PROFESSIONAL SERVICES ORGANIZATION

URS CONSULTANTS, INC. JME & ASSOCIATES, ENGINEERS

100 CALIFORNIA STREET, SUITE 500
SAN FRANCISCO, CA 94111-4529
TEL: (415) 774-2700
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CHICAGO
SAN ANTONIO
MEMPHIS

Date: September 14, 1994

To: John Strehlow, MSIN H5-68
Westinghouse Hanford Company
P.O. Box 1970
Richland, WA 99352

Subject: Independent Review of Structural Analysis Report (Reference 3), prepared by ADVENT Engineering Services.

- References:
- 1) "WHC Statement of Work - Independent Review of Multiport Riser Structural Analysis," PO #384095, Task 002, Mod 1, Received 9/12/1994.
 - 2) "Structural Analysis of Multiport Riser 5A - Calculation," Draft Rev. 0, Prepared by ADVENT Engineers, Dated 5/18/1994.
 - 3) "Structural Analysis of Multiport Riser 5A - Calculation," Rev. 1, Prepared by ADVENT Engineers, Dated 9/3/1994.

cc: Ravi Baliga, ADVENT Engineering Services, with enclosures

Dear John:

We have completed our review of the subject documents per the statement of work contained in Reference 1. Specifically, the scope of our work is strictly limited to the following three items:

- 1) Review Reference 3 for the purpose of assessing ADVENT's response to and the resolution of URS/Blume's comments on Reference 2 submitted to WHC in March of 1994.
- 2) Review Appendix I of Reference 3 which includes ADVENT's reconciliation of differences between the WHC as-built drawings with the drawings used in the structural analysis of the riser.
- 3) Review ADVENT's response to and the resolution of URS/Blume's comments submitted under item 2.

Copies of the completed RCR forms are enclosed.

WHC-9-145rev.1a

URS

A PROFESSIONAL SERVICES ORGANIZATION

Per the attached letter, ADVENT Engineering has assured URS/Blume (and WHC) that there are no technical changes in Reference 3 that effect the qualification of the MPF that were not reviewed by URS/Blume in our review of Reference 2.

WPR

M. Blume 9/14/94

Very truly yours,

R. Martin Czarnecki
Senior Vice President

ADVENT

ENGINEERING SERVICES, INC.

September 14, 1994
94003-15

Marty Czarnecki
URS Consultants, Inc.
John A. Blume Associates, Engineers
100 California Street, Suite 500
San Francisco, CA 94111-4529

SUBJECT: *Westinghouse Hartford Company Purchase Order MTB-SWV-384096, Task Order No. 1 Modification 3 - Multiport Riser (MPR) Analysis Design Review.*

Dear Marty:

ADVENT has completed incorporating your review comments on the draft version of the Rev. 0 analysis of the MPR assembly. In addition, URS has raised 2 more questions during the review of the Rev. 1 analysis document. These questions are related to using the ultimate strength of 75 ksi for carbon steel (A36) in the evaluation of the carbon steel plates for the Beyond-Design-Basis loads and requiring a minimum of 60 degrees for the included angle at the root for the Bevel weld. To incorporate these comments and to delete these requirements from the calculation, ADVENT has revised the evaluation of the carbon steel plates using the ultimate strength of 58 ksi and also revised the weld evaluation. These revised sheets are included in Attachment A to this letter.

ADVENT understands that URS did not review the Rev. 0 analysis document of the MPR assembly. ADVENT would like to assure URS that the technical data that may affect the qualification of the MPR assembly did not change between Rev. 0 draft and the Rev.1 analyses documents of the MPR assembly.

If you have any questions please feel free to contact me at (510)743-7777.

Sincerely,

Ravi Baliga
Chief Executive Officer

RECEIVED
SEP 14 1994
URS CONSULTANTS

REVIEW COMMENT RECORD (RCR)

1. Date 5/23/1994	2. Review No.
3. Project No.	4. Page 1 of 2

5. Document Number(s)/Title(s) ADVENT Calculation No. 94003.1.1, Draft Rev. 0 Dated 5-18-94	6. Program/Project/ Building Number Tank 101-SY Hydrogen Mitigation Project	7. Reviewer Bahram Mosaddad	8. Organization/Group URS Consultants, Inc.	9. Location/Phone San Francisco (415) 774-2783
---	--	--------------------------------	--	--

17. Comment Submittal Approval:

10. Agreement with indicated comment disposition(s)

11. CLOSED

Organization Manager (Optional)

9/13/94
Date

Bahram Mosaddad 9/13/94
Reviewer/Point of Contact
Bahram Mosaddad

Date 9/14/94

Bahram Mosaddad
Reviewer/Point of Contact

Author/Originator

Author/Originator

12. Item	13. Comment(s)/Discrepancy(s) (Provide technical justification for the comment and detailed recommendation of the action required to correct/ resolve the discrepancy/problem indicated.)	14. If/Of Point	15. Disposition (Provide justification if NOT accepted.)	16. Status
----------	---	-----------------	--	------------

1	In DBE analysis of the MPR assembly the free field ground motion was used. The SY-101 tank should significantly modify the free field motion at the riser location in horizontal and vertical directions. Has an SSI analysis of the tank and surrounding soils been performed to verify or deny this effect?		An SSI analysis is not performed in the MPR analysis. Per SDC 4.1 free field spectra is used in the MPR analysis.	Closed BM 9-14-94
2	Has the adequacy of the existing 42 inch riser for DBE and BDB loads been investigated? Has the SSI effects been considered for evaluation of the 42 inch riser?		42" Riser is isolated from the MPR assembly and the concrete footing pad. Therefore, the 42" Riser is not evaluated in this report.	Closed BM 9-14-94
3	In the Hydrogen Burn Analysis how in the displacement time history applied to the model? Where is Node #5001?		Explained in Section 5.0, sheet no. 5-2 and 5-14.	Closed BM 9-14-94
4.	Has the relative displacement between the 42 inch riser and the MPR assembly been computed under BDB loads to check potential vertical impact between them? Can the environmental connection material between the 42 inch riser and MPR absorb the deformation demand due to the relative displacements?		Relative displacement is calculated (see ADVENT Calc. sheet no. 7-81, 94003.1.1, Rev. 1) and ADVENT has suggested that WMC shall design the gasket to accommodate the demand displacement of at least 1/4" to prevent the load transfer from the MPR to the 42" riser.	Closed BM 9-14-94

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SEP 14 '94 03:38PM U R S CONSULTANTS

REVIEW COMMENT RECORD (RCR)		1. Date 5/23/1994	2. Review No.
		3. Project No.	4. Page 2 of 2
12. Item	13. Comment(s)/Discrepancy(s) (Provide technical justification for the comment and detailed recommendation of the action required to correct/ resolve the discrepancy/problem indicated.)	14. Hold Point	15. Disposition (Provide justification if NOT accepted.)
5.	It appears that the 42 inch riser is structurally isolated from the concrete foundation. Is it true?		Yes (see Section 4.4, ADVENT Calc. 94003.1.1, Rev. 1).
6.	In the margin analysis for the future equipment loads why are the Vertical force, Fz, and the torsional moment, Mz, are excluded from unit load analyses.		ADVENT final analysis (Rev. 1) includes all three forces (Fx, Fy, Fz) and all three moments (Mx, My, Mz) in the unit load analysis.
7.	What is the justification for decoupled analysis of the "TO BE" installed equipment with the MPR assembly? What are the decoupling criteria?		The dynamic loads due to reactions of "TO BE" installed equipment on the MPR in future were not accurately known at the time of this evaluation. To account for impact of future equipment mass on the dynamic response of the MPR assembly representative equipment weights, provided by WHC, were included in the analytical models. Note that it is the responsibility of the engineer analyzing the "TO BE" installed equipment to justify that the MPR assembly can be decoupled from the "TO BE" installed equipment. The decoupling criteria provided in Section 3.1.7 of the ASCE 4-86 document may be followed. If decoupling is not justifiable, the MPR assembly should be included in the analysis of the "TO BE" installed equipment.

Closed
BM 9-14-94

Closed
BM 9-14-94

Closed
BM 9-14-94

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SEP 14 '94 04:44PM

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REV. 0

P. 46/47

REVIEW COMMENT RECORD (RCR)

REVIEW COMMENT RECORD (RCR)		1. Date 5/23/1994		2. Review No.	
		3. Project No.		4. Page 1 of 2	
5. Document Number(s)/Title(s) ADVENT Calculation No. 94003.1.1, Draft Rev. 0 Dated 5-18-94		6. Program/Project/ Building Number Tank 101-SY Hydrogen Mitigation Project		7. Reviewer Steve Brokken	
		8. Organization/Group URS Consultants, Inc.		9. Location/Phone San Francisco (415) 774-2783	
17. Comment Submittal Approval:		10. Agreement with indicated comment disposition(s) 9/13/94		11. CLOSED	
Organization Manager (Optional) Reviewer/Point of Contact		Date Steve Brokken		Reviewer/Point of Contact Date	
		Author/Originator		Author/Originator	
12. Item	13. Comment(s)/Discrepancy(s) (Provide technical justification for the comment and detailed recommendation of the action required to correct/resolve the discrepancy/problem indicated.)		14. Hold Point	15. Disposition (Provide justification if NOT accepted.)	
16. Status					
1	ADVENT Calculations specifically recommend modifications to Westinghouse MPR Assembly design to meet BDB. These modifications have not been incorporated to Westinghouse MPR Assy drawings. Update of Westinghouse MPR Assy dwgs required.			Westinghouse Rev. A and Rev. B drawings (Appendix G of ADVENT Calc. 94003.1.1, Rev. 0) reflect ADVENT recommended modifications in the ADVENT draft report. Closed SMB	
2	Westinghouse MPR Assy needs clarification, unable to identify some components on MPR dwgs, (e.g. - real 9). Recommend when MPR assy updated, that more information (weld symbols and component identification numbers) be added to dwgs. Exploded view of all components of assy would be helpful.			Westinghouse Rev. A and Rev. B drawings (Appendix G of ADVENT Calc. 94003.1.1, Rev. 0) identify all components and welds. Closed SMB	
3	Weld sizes do not conform to minimum recommendations of AWS D1.1, recommend minimum sizes of fillet and groove welds per AWS D1.1 be followed to minimize potential for weld cracking even though AWS D1.1 is not the governing weld criteria document.			Yes. Westinghouse Rev. A and Rev. B drawings (Appendix G of ADVENT Calc. 94003.1.1, Rev. 0) show weld sizes which meet the minimum size requirement criteria. Closed SMB	
4.	ADVENT calcs sheet 4-1 item 7: Reference to E70XX is incorrect, this is not a suitable designator for stainless welding electrodes. Recommend "E70XX" be removed.			Removed. Closed SMB	

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WHC-SD-WM-DA-161
REV. 0

P.47/47

<h1>REVIEW COMMENT RECORD (RCR)</h1>	1. Date 5/23/1994	2. Review No.
	3. Project No.	4. Page 2 of 2

12. Item	13. Comment(s)/Discrepancy(s) (Provide technical justification for the comment and detailed recommendation of the action required to correct/ resolve the discrepancy/problem indicated.)	14. Hold Point	15. Disposition (Provide justification if NOT accepted.)	16. Status
5.	Connection of real 21 to real 23: Westinghouse dwg H-2-821100 A sht 2, calcs refer to a full penetration weld (sht 7-60), drawings show 1/4" fillet. This is not noted as a recommended modification. This requires correction.		See Response to Comment 1.	Closed <i>[Signature]</i>
6.	Real 21 to Real 24, same as item 5.		See Response to Comment 1.	Closed <i>[Signature]</i>
7.	Real 22 to Real 24, same as item 5.		See Response to Comment 1.	Closed <i>[Signature]</i>
8.	Intentional modifications versus inconsistencies with Westinghouse MPR dwgs unclear.		See Response to Comment 1.	Closed <i>[Signature]</i>
307 9.	H-2-821101 A indicates torqued ASTM A307 fasteners - should these be A325 fasteners if pre-tension is required?		Changed by Westinghouse to A-325 bolts in Rev. B drawings (see WHC drawing H-2-821101, Rev. B, Sheet 1 of 7) and maintained the torque requirement. Later in the Rev. 0 drawing, these bolts are changed back to A307 bolts and the torque requirement was deleted.	Closed <i>[Signature]</i>

REVIEW COMMENT RECORD (RCR)

1. Date June 3, 1994	2. Review No. N/A
3. Project No.	4. Page 1 of 6

5. Document Number(s)/Title(s) ADVENT Calculation 94003.1:1 Structural Analysis of Multiport Riser 5A	6. Program/Project/ Building Number SY-101 H2 Mitigation	7. Reviewer J. P. Strehlow 7/15/94 J.P. Strehlow per Telcom	8. Organization/Group TWRS/ES	9. Location/Phone ETC-2/376-5009
---	---	---	----------------------------------	-------------------------------------

17. Comment Submittal Approval: _____ 11. CLOSED

10. Agreement with indicated comment disposition(s)
J.P. Strehlow per Telcom
J.P. Strehlow 7/15/94
Reviewer/Point of Contact Date

Organization Manager (Optional)

Date

Reviewer/Point of Contact
J.P. Strehlow per Telcom
J.P. Strehlow 7/15/94

WHC-SD-WM-DA-161
REV 0

12. Item	13. Comment(s)/Discrepancy(s) (Provide technical justification for the comment and detailed recommendation of the action required to correct/resolve the discrepancy/problem indicated.)	14. Hold Point	15. Disposition (Provide justification if NOT accepted.)	16. Status
1	The structural analysis is to be based on the most current revisions of the MPR drawings, Revision B on some drawings. Any recommendations shall be based on these drawings. Reference the current Revision for each drawing in Section 2.2.		ADVENT analysis reflects use of most current revisions of the MPR drawings as of 6/1/94. All drawings are referenced in Section 2.2.	J.P.S per Telcom
2	Reference 2.2.16 is a repeated number.		Corrected (Refer to Sheet No. 2-5).	J.P.S per Telcom
3	The call out for Reference 2.2.16 (first usage) may be incorrect. Don Prechechtel provided the estimated weight of the MPR and estimated loads on each riser, see Appendix C.		Corrected (Refer to Sheet No. 2-5).	J.P.S per Telcom

REVIEW COMMENT RECORD (RCR)

1. Date

June 3, 1994

2. Review No.

N/A

3. Project No.

4. Page

2 of 6

12. Item	13. Comment(s)/Discrepancy(s) (Provide technical justification for the comment and detailed recommendation of the action required to correct/resolve the discrepancy/problem indicated.)	14. Hold Point	15. Disposition (Provide justification if NOT accepted.)	16. Status
4	<p>In the list of assumptions, Section 3.0, make the following changes.</p> <ul style="list-style-type: none"> - Change the compressive strength of the concrete pad from an assumption to a reference. The strength is called out on drawing H-2-140051, Revision 1. Title "TANK 101-SY HMT TEST CHAMBER CONCRETE SUPPORT STRUCTURE" Sheet 1 of 1. - Provide a justifications for all assumptions. 		<ul style="list-style-type: none"> - Done, Included this Dwg as Ref. 2.2.19 - Assumptions justified (Refer to Sheet No. 3-1). 	<p>grs p...rc</p> <p>WHC-SD-WM-DA-161 REV 0</p>
5	Page 5-2, first para. Why is soil structure interaction effects not considered for DB analysis. Provide a justification.		Justified. See Sec. 6.1.2.	grs p...rc
6	Page 5-2, bottom of page. The weight you are comparing the model weight to should be 6591 lbs, not 6291 lbs.		Corrected (Refer to Sheet No. 5-2).	grs p...rc
7	Account for all of the DOF's at each port (24 total) in the unit load analyses performed to establish stress coefficients for the future load evaluation algorithms.		Done (Refer to Section 8, Sheet Nos. 8-1 through 8-12).	grs p...rc
8	There are several items in the tables in Section 7 that have margins over 1.0. Please explain.		Explained (Refer to Section 7).	grs p...rc
9	Section 6.2.2.2, provide references for the 120 lbs/ft ³ soil density and the 150 lbs/ft ³ concrete density. Use upper tier documents.		Reference/justification provided. Refer Section 3, Sheet 3-1, and Section 6, Sheet No. 6-25.	grs p...rc
10	Provided better identification of the tables in Section 7.		Added subsections 7.1.1 through 7.1.8 and 7.2.1 through 7.2.8.	grs p...rc

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REVIEW COMMENT RECORD (RCR)

1. Date June 3, 1994	2. Review No. N/A
3. Project No.	4. Page 3 of 6

12. Item	13. Comment(s)/Discrepancy(s) (Provide technical justification for the comment and detailed recommendation of the action required to correct/resolve the discrepancy/problem indicated.)	14. Hold Point	15. Disposition (Provide justification if NOT accepted.)	16. Status
11	Provided a Figure that identifies the ANSYS real numbers that are used through out the analysis as reference numbers.		Done. Refer to Section 5, Sheet Nos. 5-8 to 5-13, Figure Nos. 5.1 to 5.6.	<i>JRS, p. 10</i>
12	<p>In the conclusion section report include the following.</p> <ul style="list-style-type: none"> - Provide the relative movement (vertical) between MPR and existing riser for all design basis loads and the beyond design basis loads. Address the relative movement between the MPR and the existing riser and between the concrete pad and the existing riser in the horizontal direction. No loads are to be transferred to the riser. - Provide the transnational reaction forces at each port (from the assumed equipment weights) - Provide the translational and rotational stiffness at each port. - Provide an explanation of what the stress algorithms are and how, in general, they are to be used to evaluate and accept loads from equipment installed in the future. 		<ul style="list-style-type: none"> - Provided. Refer to Section 4.1, Sheet 4-1. - Provided. Refer to Section 4.1, Sheet 4-1. - Provided. Refer to Section 4.1, Sheet 4-2. - Included in paragraph 2 on Sheet 4-2 and explained in detail in Section 8.0 	<i>JRS, p. 10</i>

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REVIEW COMMENT RECORD (RCR)

1. Date June 3, 1994	2. Review No. N/A
3. Project No.	4. Page 4 of 6

12. Item	13. Comment(s)/Discrepancy(s) (Provide technical justification for the comment and detailed recommendation of the action required to correct/resolve the discrepancy/problem indicated.)	14. Hold Point	15. Disposition (Provide justification if NOT accepted.)	16. Status
311	Consider including an algorithm for the relative movement between the MPR and the riser, similar to the stress algorithm. There would need to be assumed maximum $\pm$ values for the approach to work. The maximum values would then need to be reported in the conclusion section.		<p>Governing loading condition for relative displacement between the MPR and the riser is the BDB load case where the maximum relative displacement is 0.21 in. We do not believe that the equipment reaction forces will cause relative displacement when added with DBE relative displacement of 0.01" to be higher than 0.21 in. Our opinion is based on the fact that the maximum relative displacement for the extreme load case ($D \pm DBE$) is only 0.01 in.</p> <p>Refer to Section 4-1 for summary of maximum relative displacement and Section 4-3 for recommendation on the gasket design.</p>	<p><i>Jrs, jcn</i> <i>TC</i></p> <p style="text-align: right;">WMC-SD-WM-DA-161 REV 0</p>

REVIEW COMMENT RECORD (RCR)

<div style="display: flex; justify-content: space-between; padding: 5px;"> <div>1. Date June 3, 1994</div> <div>2. Review No. N/A</div> </div> <div style="display: flex; justify-content: space-between; padding: 5px;"> <div>3. Project No.</div> <div>4. Page 5 of 6</div> </div>		<div style="display: flex; justify-content: space-between; padding: 5px;"> <div>15. Disposition (Provide justification if NOT accepted.)</div> <div>16. Status</div> </div>	
		<div style="display: flex;"> <div style="flex: 1; padding-right: 10px;"> <p>13. Comment(s)/Discrepancy(s) (Provide technical justification for the comment and detailed recommendation of the action required to correct/resolve the discrepancy/problem indicated.)</p> <p>Add a section for recommendations. This will include the following.</p> <ul style="list-style-type: none"> - Design changes that are needed, based on current drawings. - Items that must be either checked, verified, or reconciled when the as-built drawings are completed. - Requirements necessary to insure that no loads are transferred to the riser. - Procedure on how to perform structural analyses of equipment installed in the future. For example, with a decoupled analysis and apply the rotational stiffness for the port as support boundary conditions. <p>Address the structural capacity of the existing concrete pad for design basis and beyond design basis loads. This evaluation can probably utilize the results from the EBASO structural report for the pad to address most if not all of these loads.</p> </div> <div style="flex: 1; padding-left: 10px;"> <p>14. Hold Point</p> </div> </div>	

WHC-SD-WM-DA-161
REV 0

REVIEW COMMENT RECORD (RCR)

1. Date

June 3, 1994

2. Review No.

N/A

3. Project No.

4. Page

6 of 6

12. Item	13. Comment(s)/Discrepancy(s) (Provide technical justification for the comment and detailed recommendation of the action required to correct/resolve the discrepancy/problem indicated.)	14. Hold Point	15. Disposition (Provide justification if NOT accepted.)	16. Status
	Include an analysis of the lifting lugs on the MPR.		Included. Refer to Section 7.1.7, Sheet No. 7-42b.	JPS, p. TC
	Include an analysis of the covers for each port and their connection bolts.		Included. Refer to Section 7.2.8, Sheet Nos. 7-87 to 7-88.	JPS, p. TC
	Indicate what the plate stresses are, membrane or membrane plus bending.		Membrane plus bending. Refer to Section 7, Sheet No. 7-1 thru 7-3 and 7-44 to 7-45.	JPS, p. TC
	Provide the full call out for reference 2.1.14.		Done.	JPS, p. TC
	Provide more detail in the table of contents, i.e., include more subsections.		Done. Refer to TABLE OF CONTENTS, Sheet Nos. i to iii.	JPS, p. TC

WMC-SD-WM-DA-161
REV 0

REV 0

[345] From: bob_white@lumbre.ta52.lanl.gov at -SMTPlink 5/25/94 5:59AM (2958 bytes: 44 ln)

To: wo_miller@lumbre.ta52.lanl.gov at -SMTPlink

Receipt Requested

cc: John P Strehlow at -WHC240, Donald R Precechtel at -WHC76,
rick_johnson@lumbre.ta52.lanl.gov at -SMTPlink, kemal_p@lumbre.ta52.lanl.gov
at -SMTPlink, jack_edwards@lumbre.ta52.lanl.gov at -SMTPlink

Subject: MPR Discussions

----- Message Contents -----

Jack Lentsch, Don Precechtel, and John Strehlow and I had a discussion about the MPR SA. Since I am running a bit late for my meetings today, this note will be brief. The highlights are as follows:

- 1) They want to keep the safety classification the same and don't want to downgrade the classification as changing the SC at this time wouldn't buy them anything, as the procurement, contracts, etc., are in place.
- 2) They are definately going with a design that has clips instead of magnetic latches, but the design involves carbon steel clips (I worry about them rusting and letting go sooner). Maybe they need to be galvanized, painted, etc., and maybe we need some kind of a cleverly worded control on annual inspections. I will trust your judgement on this.
- 3) They have a problem with making the concrete anchors SC-1. If the anchors are SC-1, the welds should also be SC-1 (which they aren't), then it propagates. The way I see it, it is designed to stay in place in the event of a burn, and the SC designation becomes a paper and procurement problem that is best solved by making it SC-2. I don't think we need to consider the consequences of material being ejected from the MPR if the anchors and welds are not SC-1. I will trust your judgement on this.
- 4) There was a lot of discussion about settling and differential movement of the MPR relative to the riser due to frost heaves, settling, etc. With a 3/4-inch gasket, they are sure that the MPR won't load the riser due to settling, and I guess I agree. They talked about doing a survey so that any differential movement could be checked periodically with an annual survey, but they did not feel that the risk was great enough to require this. I will trust your judgement on this.
- 5) There was some discussion about wether or not we were requiring blast deflectors. I told them I didn't think so, but we did want some kind of protection for the MPR against somebody damaging it by backing a truck into it. I think Don is thinking about a safety cage.
- 6) I told them that to get the MPR out, we would need to get the words consistent with the design. Precechtel has a marked up copy of the SA, as does Strehlow, but they are still going through it. It looks like the best thing to do would be for you to plan on coming up here next week and spend a day figuring out what needs to be changed. I suggest you call Don and set up a time.
- 7) Don gave me the latest set of drawings - I will bring them into the office on Friday.

THESE COMMENTS ARE NOT APPLICABLE TO ADVENT
ANALYSIS. THEREFORE, NO RESPONSE IS PROVIDED TO THESE
COMMENTS BY ADVENT.

REVIEW	COMMENT	RECORD	(RCR)	1. Date	2. Review #
				5/19/94	94-143
				3. Project No.	4. Page
				N/A	1 of 1

5. Document Number(s)/Title(s)	6. Program/Project/ Building Number	7. Reviewer	8. Organization/Group	9. Location/Phone
MULTIPOINT RISER *DRAFT* STRUCTURAL ANALYSIS & SPECIFICATION'S	HYDROGEN MITIGATION/101- SY	M.L. MCELROY	TWRS PROGRAM QA	200E/M0234/373- 5588

17. Comment Submittal Approval:	10. Agreement with indicated comment disposition(s)	11. CLOSED
Organization Manager (Optional)	<u>9-15-94</u> Date <u>M.L. McElroy</u> Reviewer/Point of Contact	<u>9-15-94</u> Date <u>M.L. McElroy</u> Reviewer/Point of Contact
Author/Originator		Author/Originator

12. Item	13. Comment(s)/Discrepancy(s) (Provide technical justification for the comment and detailed recommendation of the action required to correct/resolve the discrepancy/problem indicated.)	14. Hold Point	15. Disposition (Provide justification if NOT accepted.)	16. Status
1.	Question--I noted that the analyses is only performed for riser 5A. Although similar, will riser 5B also have an analyses performed?		RISER 5B IS CANCELLED BY WHC	WHC-SD-MM-DA-161 REV 0 Close
2.	In the "analysis" & "specifications" a 24-inch penetration is listed. I believe that it should be a 20-inch. If so this will have to be changed. Also, how will this affect the analysis report?	MLM	NOT APPLICABLE TO ADVENT ANALYSIS	
3.	Sheet 1-2--the pressure relief doors are listed as a safety class 1, this may have to be changed if the safety class is changed as per the safety assessment.		NOT APPLICABLE TO ADVENT ANALYSIS	
	Riser 5A will have an existing concrete pad in place for the the MPR to rest on. How was the pad verified & accepted before credit was taken for it's use?	MLM	THE CONCRETE FOOTING DESIGN FROM EMBASCO IS USED AS A REFERENCE DOCUMENT.	

REVIEW	COMMENT	RECORD	(RCR)	1. Date May 25, 1994	2. Review No. 641-94
				3. Project No. SY-101 H2 Mitigation	4. Page 1 of 1

5. Document Number(s)/Title(s) 94003.1.1/ Structural Analysis of Multiport Riser 5A	6. Program/Project/ Building Number SY-101 H2 Mitigation	7. Reviewer Omar Jaka	8. Organization/Group Nuclear Safety/Waste Tank Safety Assurance	9. Location/Phone 2751E/B101/2-2322
--	--	--------------------------	---	--

17. Comment Submittal Approval:	10. Agreement with indicated comment disposition(s)	11. CLOSED
Organization Manager (Optional)	<u>9/15/94</u> Date <u>M. O. Jaka</u> Reviewer/Point of Contact <u>M.P. Kline for J.P. Sheehan</u> Author/Originator	<u>9/15/94</u> Date <u>M. O. Jaka</u> Reviewer/Point of Contact <u>M.P. Kline for J.P. Sheehan</u> Author/Originator

12. Item	13. Comment(s)/Discrepancy(s) (Provide technical justification for the comment and detailed recommendation of the action required to correct/resolve the discrepancy/problem indicated.)	14. Hold Point	15. Disposition (Provide justification if NOT accepted.)	16. Status
1.	Has the additional load due to Concrete pad and multiport riser been accounted for dome loading ?	OJ	DOME IS NOT CONNECTED TO THE MPR. NO DIRECT LOAD TRANSFER FROM MPR TO THE DOME	WHC-SD-WM-DA-161 REV 0 Revised Disposition Comments others At Bottom M. Kline 9/15/94
2.	Drawing H-2-821100 Rev.A Sheet 1, General Note 2: The anchor bolts are not classified or identified. Full detail of Concrete Anchor bolts need to be given on the drawing.	OJ	SEE ADVENT ANALYSIS 94003/1.1.	
3.	Concrete pad dimensions and concrete compressive strength are not called out on drawings	OJ	NOT APPLICABLE TO ADVENT	
4.	What kind of arrangement is done to make sure that load from concrete pad is not transferred to the riser ?	OJ	THE DISPLACEMENT FROM THE MPR ANALYSIS IS CHECKED AGAINST THE AVAILABLE GAP.	

Revised disposition to Comment #1
 Drawing H-2-37792 documents that the 42-in riser plug weighs 5286 lbf. The weight of the MPR as documented in the MPR structural report is 8690 lbf (p 59). This is net weight gain of approximately 3400 lbf. This change in inventory is being tracked in Rev 0B of Tank 241SY101 Dome Loading Control Document (WHC-SD-WM-TA-141) and is shown to be acceptable. *OK, closed*

Revised disposition to Comment #2
 The revision 0 of this drawing calls out the identification of the concrete anchor bolts as item #13 in the parts list. They are the Drillco Maxi-bolt (material ASTM A193, Qty 12). *OK, closed*

Revised disposition to Comment #3
 Drawing H-2-821100, Rev. 0, Sheet 1 identifies the concrete pad as an existing pad and refers to drawing H-2-140051 for details. *OK, closed*

Revised disposition to Comment #4
 The work plan for the installation of the MPR will address this issue. The riser will not support the MPR. Rather, during installation, jacks will be used to support the MPR. *OK, closed*

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	8-26-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	8/26/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	I-1	Rev. No.	/

APPENDIX I
RECONCILIATION
(20 Sheets)

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	8-26-94
Subject	Structural Analysis of Multiport Riser SA	Reviewed By:	<i>[Signature]</i>	Date	8/26/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	I-2	Rev. No.	1

MULTI PORT RISER (MPR) RECONCILIATION

This reconciliation is performed in consideration of the following drawings:

1. Westinghouse Hanford Company Drawing Number H-2-821095, Rev. 0, Sheet of 1, Multi-Port Riser Supports and Base Plates.
2. Westinghouse Hanford Company Drawing Number H-2-821100, Rev. 0, Sheet 1 of 3, Multi-Port Riser Installation Tank 241-SY-101.
3. Westinghouse Hanford Company Drawing Number H-2-821100, Rev. 0, Sheet 2 of 3, Multi-Port Riser Installation Tank 241-SY-101.
4. Westinghouse Hanford Company Drawing Number H-2-821100, Rev. 0, Sheet 3 of 3, Multi-Port Riser Installation Tank 241-SY-101.
5. Westinghouse Hanford Company Drawing Number H-2-821101, Rev. 0, Sheet 1 of 7, 42" Multi-Port Adapter Riser Assembly.
6. Westinghouse Hanford Company Drawing Number H-2-821101, Rev. 0, Sheet 2 of 7, 42" Multi-Port Adapter Riser Assembly.
7. Westinghouse Hanford Company Drawing Number H-2-821101, Rev. 0, Sheet 3 of 7, 42" Multi-Port Adapter Riser Assembly.
8. Westinghouse Hanford Company Drawing Number H-2-821101, Rev. 0, Sheet 4 of 7, 42" Multi-Port Adapter Riser Assembly.
9. Westinghouse Hanford Company Drawing Number H-2-821101, Rev. 0, Sheet 5 of 7, 42" Multi-Port Adapter Riser Assembly.
10. Westinghouse Hanford Company Drawing Number H-2-821101, Rev. 0, Sheet 6 of 7, 42" Multi-Port Adapter Riser Assembly.
11. Westinghouse Hanford Company Drawing Number H-2-821101, Rev. 0, Sheet 7 of 7, 42" Multi-Port Adapter Riser Assembly.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	9-2-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	9/2/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	I-3	Rev. No.	1

12. Copy of CC Mail from John P. Strehlow (WHC) to Ravi Baliga (ADVENT) on 9/2/94; ADVENT Project No. 94003, File No. 5.0, Log No. 10.
13. Fax Message (Engineering Change Notice: ECN 198612 dated 8/10/94) from John Strehlow (WHC) to Ravi Baliga and Jagadish (ADVENT), dated 8/18/94, ADVENT Project No. 94003, File No, 5.0, Log No.8.
14. Fax Message (Engineering Change Notices: ECN 602699 dated 8/19/94 and ECN 612809 dated 8/31/94) from John P. Strehlow (WHC) to Ravi Baliga (ADVENT), dated 9/1/94, ADVENT Project No. 94003, File No, 5.0, Log No.12.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	9-2-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	9/2/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	I-4	Rev. No.	1

Summary of Reconciliation

All the parts, connections, and material properties remain unchanged from that addressed in the previous analyses (ADVENT calculation file no. 94003.1.1, Rev.0) with the following exceptions:

1. The *edge distance* between the inner flange (Part # 6; REAL 23) and the base plate (Part # 5; REAL 21) was 6.0 in. (See Dwg. No. H-2-821095, Rev.0, Sheet 1 of 1).
2. The thickness of *diagonal stiffener* (Part No. 35; REAL 3) was 0.75 in. (See Dwg. No. H-2-821101, Rev.0, Sheet 1 of 7).
3. Welded connection between the *Bottom triangular plate* (Part # 35, REAL 1) and the *Bottom plate of pressure relief vent* (Part # 34, REAL 2) was 5/16" Bevel weld and 1/4" Fillet weld (See Dwg. No. H-2-821101, Rev.0, Sheet 6 of 7).
4. Welded connection between the *Top shield plate* (Part # 37, REAL 5) and the *Top plate of pressure relief vent* (Part # 34, REAL 6) was 5/16" Bevel weld and 5/16" Fillet weld (See Dwg. No. H-2-821101, Rev.0, Sheet 6 of 7).
5. The bolts (Part Nos. 59, 60 & 61, Dwg. No. H-2-821101, Rev 0, Sheet 1 of 7) were changed to type ASTM A307 in ECN 198612.
6. The total weight of the Multi Port Riser was increased to 8690 lbs. (See item 12, sheet I-3).
7. A Note (# 6) was added on Dwg. H-2-821095, Rev.0, sheet 1 of 1: "Field may reduce the anchor bolt spacing to 18-in. minimum to avoid rebar in concrete pad". This 18-in. minimum spacing requirement was changed to a fixed 20-in. spacing in ECN 602699.
8. Note # 3 on Dwg. No. H-2-821100, sheet 1, Rev.0 was deleted and replaced with a note: "Torque 1-1/4" A-325 bolts to 1550 +/- 50 ft-lbs." in ECN 612809.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	8-26-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	8/26/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	I-5	Rev. No.	/

- 1 As identified in the recommendations accompanying the previous analyses (Section 4.3, ADVENT calculation 94003.1.1, Rev.0), those analyses are based on the *edge distance*, between the inner flange (REAL 23, Part # 6) and the base plate (REAL 21, Part # 5), of 4.75 in. The Rev.0 drawing shows this *edge distance* as 6.0 in.

The increase in *edge distance* results in a redistribution of stresses in the base plate and a redistribution of forces in the anchor bolts. Consequently, it will affect the margins listed in Section 8.0 of ADVENT calc. 94003.1.1, Rev.0.

It is judged that the change in response due to shift in frequency is negligible. To account for the change in stiffness of the base plate assembly, a static analysis of DB model (file name MPR5A-DL.INP, ADVENT computer file C94003.1.1.A, Rev.0) is performed by applying the peak pressure loads and the responses (anchor bolt forces and support assembly stresses) are computed. Then the DB model is modified to represent the increase in *edge distance* and the static analysis for the same peak pressure loads are repeated. The percentage increase in the responses are calculated and the Rev.0 demand loads are factored to obtain new demand loads.

Summary of Computer Files:

Input file	Output file	
ANCHOR1.INP	ANCHOR1.OUT	Static (KAN 0) analysis of the DB model, with modifications to account for change in the <i>edge distance</i> , for peak pressure loads (pressure similar to BDB-1 case)
ANCHOR2.INP	ANCHOR2.OUT	Static (KAN 0) analysis of DB model for peak pressure loads (pressure similar to BDB-1 case)
ANCHOR1.PI	ANCHOR1.PO	Post processing corresponding to ANCHOR1.INP
ANCHOR2.PI	ANCHOR1.PO	Post processing corresponding to ANCHOR2.INP

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	9-1-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	9/1/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	I-6	Rev. No.	

Response of Anchor bolt forces:

Force, FZ, at node no. 1710/1742 = 10185 lbs. (from file ANCHOR1.PO)
 Force, FZ, at node no. 1710/1742 = 9782 lbs. (from file ANCHOR2.PO)

% increase in force, FZ, at node no. 1710/1742 = $(10185/9782) = 4.1\%$

(Note that the % increase in forces, FX and FY, are much smaller than 4.1%)

Response of Support assembly:

Max. stress at base plate (REAL 21) = 20630 psi (SG1T @ el. # 1444, see file ANCHOR1.PO)

SG1T at el.# 1444 = 16263 psi (see file ANCHOR2.PO)

% increase in stress, SG1T, at element # 1444 = $(20630/16263) \approx 27\%$

The anchor bolts and base plate are re-evaluated below and the margin calculations are revised accordingly.

Evaluation of Anchor Bolts:

The governing demand forces from the Rev.0 analyses are listed below:

LOAD TYPE	SHEAR (Lbs)	TENSION (Lbs)
Normal (D) (See Sheet No. 7-5)	1236	0
Extreme (D±S) (See Sheet No. 7-6)	1737	0
Normal (BDB) (See Sheet No. 7-47)	19557	36630

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	9-1-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	9/1/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	I-7	Rev. No.	1

Normal Loads (D):

($V_u = 25979$, Sheet 7-5)

$$\text{Demand shear} = 1236 \times 1.041 = 1287 \text{ lbs.}$$

$$\text{Stress ratio} = 1287 / V_u = 0.050 < 1.0, \text{ O.K.}$$

Extreme Loads (D $\pm$ S):

($V_u = 44165$, Sheet 7-6)

$$\text{Demand shear} = 1737 \times 1.041 = 1808 \text{ lbs.}$$

$$\text{Stress ratio} = 1808 / V_u = 0.040 < 1.0, \text{ O.K.}$$

Beyond Design Basis Loads (BDB):

$$T_u = 85024 \text{ lbs. and } V_u = 44165 \text{ lbs (Sheet no. 7-46)}$$

$$\text{Stress ratio} = 1.041 \times [36630/85024 + 19577/44165] = 0.910 < 1.0, \text{ O.K.}$$

Therefore, the anchor bolts are acceptable for Normal, Extreme and Beyond Design Basis loads.

Margin Analysis of Anchor Bolts:

Tables 8.3 and 8.7 (see sheet nos. 8-6 and 8-11) are revised by increasing the unit load stresses by 4.1%.

Note: TABLE I-1: Revised TABLE 8.3
TABLE I-2: Revised TABLE 8.7

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	9-1-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	9/1/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	I-8	Rev. No.	/

**TABLE I-1: AVAILABLE STRESS MARGINS IN MPR 5A ANCHOR BOLTS
(DB MODEL)**

AVAILABLE STRESS MARGINS IN MPR ANCHOR BOLTS AFTER (D) AND (DBE) LOADS			
Load	Demand Stress Ratio	Allowable Stress Ratio	Available Stress Ratio
D	0.050	1.000	0.950
D+DBE	0.068 (1.7x0.040)	1.700	1.632

UNIT LOAD STRESS RATIO SUMMARY (1.041 x Stress ratios from Table 8.3)				
Load Type and Load Direction	Unit Loads applied at Top Center of			
	8" Riser/North	8" Riser/South	12" Riser	20" Riser
	Maximum Stress Ratio - Anchors			
FX*	0.014	0.014	0.013	0.013
FY*	0.009	0.009	0.008	0.007
FZ*	0.007	0.007	0.007	0.006
MX**	0.000	0.000	0.000	0.000
MY**	0.000	0.000	0.000	0.000
MZ**	0.000	0.000	0.000	0.000

* Unit Load = 1 Kip

** Unit Moment = 1 kip-in.

Note: All the notes for Table 8.3 are still applicable here.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	9-1-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	9/1/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	I-9	Rev. No.	1

**TABLE I-2: AVAILABLE STRESS MARGINS IN MPR 5A ANCHOR BOLTS
(BDB MODEL)**

AVAILABLE STRESS MARGINS IN MPR ANCHOR BOLTS				
Available Stress Ratio				
1.7				
UNIT LOAD STRESS RATIO SUMMARY (1.041 x Stress ratios from Table 8.7)				
Load Type and Load Direction	Unit Loads applied at Top Center of			
	8" Riser/North	8" Riser/South	12" Riser	20" Riser
	Maximum Stress Ratio - Anchors			
FX*	0.014	0.014	0.013	0.013
FY*	0.009	0.009	0.008	0.007
FZ*	0.007	0.007	0.007	0.006
MX**	0.000	0.000	0.000	0.000
MY**	0.000	0.000	0.000	0.000
MZ**	0.000	0.000	0.000	0.000

* Unit Load = 1 Kip

** Unit Moment = 1 kip-in.

Note: All the notes for Table 8.7 are still applicable here.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	9-13-94
Subject	Structural Analysis of Multiport Riser SA	Reviewed By:	<i>[Signature]</i>	Date	9-13-94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	I-10	Rev. No.	1

Evaluation of Base Plate (REAL 21)

The base plate stresses are increased by 27%.

Normal Load (D):

$$\begin{aligned}\text{Revised Stress} &= 1.27 \times (3284 \text{ psi, sheet no. 7-2}) \\ &= 4171 \text{ psi}\end{aligned}$$

$$\text{Base plate allowable} = 0.4 F_y = 0.4 \times 36000 = 14400 \text{ psi.}$$

$$\begin{aligned}\text{Stress ratio} &= 4171/14400 & (F_y = 36000 \text{ psi, see Table 5.1}) \\ &= 0.290 < 1.0, \text{ O.K.}\end{aligned}$$

Extreme Load (D±S):

$$\begin{aligned}\text{Revised Stress} &= 1.27 \times (5204 \text{ psi, sheet no. 7-3}) \\ &= 6609 \text{ psi}\end{aligned}$$

$$\begin{aligned}\text{Stress ratio} &= 6609/(1.4 \times 14400) \\ &= 0.337 < 1.0, \text{ O.K.}\end{aligned}$$

Note: Since there is no tension in the anchors for Normal and Extreme loads, the stresses are judged to be shear stresses.

Beyond Design Basis Load (BDB):

$$\begin{aligned}\text{Revised Stress} &= 1.27 \times (40124 \text{ psi, sheet no. 7-44}) \\ &= 50957 \text{ psi}\end{aligned}$$

$$\begin{aligned}\text{Stress ratio} &= 50957/(58000 \text{ psi, sheet 7-44}) \\ &= 0.879 < 1.0, \text{ O.K.}\end{aligned}$$

Therefore, the base plate is acceptable for Normal, Extreme and Beyond Design Basis loads.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	9-1-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	9/1/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	I-11	Rev. No.	1

Margin Analysis of Members:

The available stresses listed in Table 8.1 and 8.5 are revised below and the unit load stresses are increased based on the following criteria:

- The unit load stresses are increased by 27%, if the reported unit load stresses are at the base plate (REAL 21; element nos. 1392 through 1667) and/or
- If the reported unit load stress is less than the 127% of the base plate stress obtained from the unit load analyses.

Note: TABLE I-3: Revised TABLE 8.1
TABLE I-4: Revised TABLE 8.5

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	9-1-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	9/1/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	I-12	Rev. No.	1

**TABLE I-3: AVAILABLE STRESS MARGINS IN MPR 5A MEMBERS
(DB MODEL)**

AVAILABLE STRESS MARGINS IN MEMBERS AFTER (D) AND (DBE) LOADS			
Load	Demand Stress ^c	Allowable Stress ^c	Available Stress
D	4,171 ^a 3,182 ^b	14,400 ^a 22,500 ^b	18,888 ^a 19,318 ^b
D+DBE	6,609 ^a 5,568 ^b	19,600 ^a 36,000 ^b	12,991 ^a 30,432 ^b

UNIT LOAD STRESS SUMMARY (See Table 8.1 and ADVENT File No. C94003.1.1.AB)				
Load Type and Load Direction	Unit Loads applied at Top Center of			
	8" Riser (North)	8" Riser (South)	12" Riser	20" Riser
	Maximum Stress Ratio - Anchors			
FX*	880	880	345	436 (1.27x343)
FY*	867	867	415 (1.27x327 @ cl.# 1444 = 415 > 356)	398 (1.27x313 @ cl.# 1444 = 398 > 328)
FZ*	279 (1.27x220)	279 (1.27x220)	301 (1.27x237)	244 (1.27x192)
MX**	44	44	23	13
MY**	45	45	23	14
MZ**	39	39	17	7

* Unit Load = 1 Kip

** Unit Moment = 1 kip-in.

a: Shear

b: Tension/Compression

c: See Sheet Nos. 7-2, 7-3 and I-10

Note: All the notes for Table 8.1 are still applicable here.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	7-1-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	7/1/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	I-13	Rev. No.	1

**TABLE I-4: AVAILABLE STRESS MARGINS IN MPR 5A MEMBERS
(BDB MODEL)**

AVAILABLE STRESS MARGINS IN MPR MEMBERS				
Available Stress (Psi)				
49000				
UNIT LOAD STRESS SUMMARY (See Table I-3)				
Load Type and Load Direction	Unit Loads applied at Top Center of			
	8" Riser (North)	8" Riser (South)	12" Riser	20" Riser
	Maximum Stress - Anchors			
FX*	880	880	345	436
FY*	867	867	415	398
FZ*	279	279	301	244
MX**	44	44	23	13
MY**	45	45	23	14
MZ**	39	39	17	7

* Unit Load = 1 Kip

** Unit Moment = 1 kip-in.

Note: All the notes for Table 8.5 are still applicable here.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	9-13-94
Subject	Structural Analysis of Multiport Riser 3A	Reviewed By:	<i>[Signature]</i>	Date	9/13/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	I-14	Rev. No.	1

- 2 The change in stress due to increase in plate thickness, Part # 34 (REAL 3), from 5/8" to 3/4" is judged to reduce the reported stress for this member in Tables 7.1, 7.2, 7.3 and 7.4. The change in the plate stiffness would result in redistribution of stresses. It is judged, that the impact of stress redistribution will have negligible effect on other parts of the Multiport Riser assembly. Therefore the conclusion stated in Section 4.2 will not be altered.

- 3 The welded connection between the *Bottom triangular plate* (Part # 35, REAL 1) and the *Bottom plate of pressure relief vent* (Part # 34, REAL 2) was 5/16" bevel weld and 1/4" fillet weld (See Dwg. No. H-2-821101, Rev.0, Sheet 6 of 7).

This connection was qualified in Rev.0 calculation as "two sided bevel weld and one sided fillet weld" (See sheet nos. 7-12, 7-30, 7-32, 7-34, 7-36, 7-38, 7-40, 7-63, 7-65, 7-67, 7-69, 7-71 & 7-73). Therefore the re-evaluation of the connection is performed below:

Weld Properties: (Typ. @ 3 places)

Length of weld = 30 "

Average tributary length of weld, $L_w = 30/7 \approx 4.0$ in.

Section modulus, $S = 30 \times 0.5 = 15$ in³/in.

Allowable Weld Capacity (F_w): (Typ. @ 3 places): 1/4 Fillet and 5/16" Bevel weld

Fillet weld = $0.3 \times 70 \times 0.707 \times (1/4) = 3.711$ kip/in.

Base metal = $0.4 \times 30 \times (1/4) = 3.0$ kip/in. ← *Governs* (Cons.)

Beyond Design Basis Weld Capacity (F_w): 1/4 Fillet and 5/16" Bevel weld

Fillet weld = $1.6 \times 3.711 = 5.938$ kip/in. ← *Governs*

Base metal = $1.6 \times 0.4 \times 70 \times (1/4) = 11.2$ kip/in. (* Ref. 2.1.6)

Note: No credit is taken for the capacity of Bevel weld because the Bevel weld does not meet the minimum weld throat thickness criteria per Ref. 2.1.19.

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	9-13-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	9/13/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	I-15	Rev. No.	1

WELDED CONNECTION BETWEEN REAL 1 AND REAL 2							
Location	FX	FY	FZ	EM	f_w^*	F_w	S.R.
NORMAL LOADS: (D)							
EAST	266	108	4	52	118	3000	0.040
SOUTH	364	228	4	72	177	3000	0.060
NORTH	364	228	4	72	177	3000	0.060
EXTREME LOAD: (D±S)							
EAST	407	207	8	76	187	4800 (=1.6x3000)	0.039
SOUTH	627	304	9	126	286	4800	0.060
NORTH	259	659	9	41	288	4800	0.060
Beyond Design Basis (CASE-1)							
EAST	8268	7629	1101	12801	5812	5938	0.979
SOUTH	9385	3790	1377	18814	5531	5938	0.931
NORTH	7850	6418	1379	5126	4553	5938	0.767
Beyond Design Basis (CASE-2)							
EAST	7033	4695	1236	14686	4783	5938	0.805
SOUTH	7586	4527	1392	19335	5365	5938	0.904
NORTH	5014	9262	1158	4595	4783	5938	0.805

Units: Lbs. and inches.

* See Sheet Nos. 7-29 and 7-62.

The stresses in these connections due to unit load analysis are negligible. Therefore, the margin analysis is unaffected from the change in the weld.

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	9-13-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	9/13/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	I-16	Rev. No.	1

- 4 Welded connection between the *Top shield plate* (Part # 37, REAL 5) and the *Top plate of pressure relief vent* (Part # 34, REAL 6) was 5/16" Bevel weld and 5/16" fillet weld (See Dwg. No. H-2-821101, Rev.0, Sheet 6 of 7).

This connection was qualified in Rev.0 calculation as "two sided bevel weld and on sided fillet weld" (See sheet nos. 7-12, 7-30, 7-32, 7-34, 7-36, 7-38, 7-40, 7-63, 7-65, 7-67, 7-69, 7-71 & 7-73). Therefore the re-evaluation of the connection is performed below:

Weld Properties: (Typ. @ 3 places)

$$\begin{aligned} \text{Arc length between key points 36 and 39} &= 33 \times 27.524^\circ \times \pi/180 \\ &= 15.853 \text{ in. (3 segments)} \end{aligned}$$

$$\text{Average tributary length of weld, } L_w = 31.7/6 = 2.642 \text{ in.}$$

$$\text{Total length of weld} = R \theta = 33 \times (2 \times \text{ASIN}(15/33) \times \pi/180) = 31"$$

$$\text{Section modulus, } S = 31 \times 0.5 = 15.5 \text{ in}^3/\text{in.}$$

Allowable Weld Capacity (F_w): (Typ. @ 3 places): 5/16 Fillet and 5/16" Bevel weld

Assumed: Min. Tensile strength of weld = 70 ksi.

$$\begin{aligned} \text{Fillet weld} &= 0.3 \times 70 \times 0.707 \times (5/16) = 4.6397 \text{ kip/in.} \\ \text{Base metal} &= 0.4 \times 30 \times (5/16) = 3.75 \text{ kip/in.} \leftarrow \text{Governs (Cons.)} \end{aligned}$$

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	9-13-94
Subject	Structural Analysis of Multiport Riser SA	Reviewed By:	<i>W G</i>	Date	9/13/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	I-17	Rev. No.	1

Beyond Design Basis Weld Capacity (F_w): 5/16 Fillet and 5/16" Bevel weld

Fillet & Bevel weld = 1.6×4.6397	= 7.424 kip/in. ← <i>Governs</i>
Base metal = $1.6 \times 0.3 \times 75 \times (5/16)$	= 11.25 kip/in. (* Ref. 2.1.6)

Note: No credit is taken for the capacity of Bevel weld because the Bevel weld does not meet the minimum weld throat thickness criteria per Ref. 2.1.19. --

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	9-13-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	9/13/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	I-18	Rev. No.	1

WELDED CONNECTION BETWEEN REAL 5 AND REAL 6							
Location	FX	FY	FZ	EM	f_w	F_w	S.R.
NORMAL LOADS: (D)							
EAST	18	24	16	323	52	3750	0.014
SOUTH	132	143	22	119	86	3750	0.023
NORTH	132	143	22	119	86	3750	0.023
EXTREME LOADS: (D±S)							
EAST	109	78	21	441	96	6000 (1.6x3750)	0.016
SOUTH	270	84	28	452	137	6000	0.023
NORTH	137	253	28	220	135	6000	0.023
Beyond Design Basis (CASE-1)							
EAST	1670	4452	2568	20620	4498	7424	0.606
SOUTH	2822	1018	2120	13089	2467	7424	0.332
NORTH	1917	2811	2123	6205	2156	7424	0.290
Beyond Design Basis (CASE-2)							
EAST	7033	4695	1236	14686	4559	7424	0.614
SOUTH	7586	4527	1392	19335	5122	7424	0.690
NORTH	5014	9262	1158	4595	4538	7424	0.611

Units: Lbs. and inches.

* See Sheet Nos. 7-29 and 7-62.

The stresses in these connections due to unit load analysis are negligible. Therefore, the margin analysis is unaffected from the change in the weld.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	9-2-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	9/2/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	I-19	Rev. No.	1

- 5 The bolts (Part Nos. 59, 60 & 61, Dwg. No. H-2-821101, Rev.1, Sheet 1 of 7) were changed to type ASTM A307 in ECN 198612.

These bolts are corresponding to the connection of the MPR port covers. They were evaluated in Section 7.2.7 using ASTM A325 bolts.

Therefore, the connection is re-evaluated here.

Demand pressure load (D)	= 4.127 kip	(@ 8" port)
	= 10.022 kip	(@ 12" port)
	= 26.641 kip	(@ 20" port)

Bolt capacity (C)	= 8 x 8.8" kip	= 70.4 kip	(Eight 3/4"φ A307 bolts)
	= 12 x 12.0" kip	= 144.0 kip	(Twelve 7/8"φ A307 bolts)
	= 20 x 19.9" kip	= 398.0 kip	(Twenty 1-1/4" A307 bolts)

* See Table I-A, Ref. 2.1.19

Stress ratio	= 4.127/70.4	= 0.059 < 1.0, O.K.
	= 10.022/144	= 0.070 < 1.0, O.K.
	= 26.641/398	= 0.067 < 1.0, O.K.

Therefore the bolts are acceptable for the pressure load.

6. The total weight of the Multi Port Riser (MPR) is increased to 8690 lbs (See item 12, Sheet I-3).

The Rev.0 analyses considered the weight of the MPR to be 6870 lbs. (see sheet 5-2).

Increase in weight of the MPR = 8690-6870 = 1820 lbs.

The increase in weight of the MPR will alter the dynamic response characteristics. To minimize the additional effort of re-analyses, the MPR assembly is considered qualified if the weight of the equipment to be installed in 12" port is reduced to (7000-1820) 5180 lbs.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	9-2-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	9/2/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	I-20	Rev. No.	1

7. A Note (# 6) was added on Dwg. H-2-821095, Rev.0, sheet 1 of 1: "Field may reduce the anchor bolt spacing to 18-in. minimum to avoid rebar in concrete pad". This 18-in. minimum spacing requirement was changed to a fixed 20-in. spacing in ECN 602699.

The analyses was based on the anchor bolt spacing of 20-in. Therefore, no further analysis/evaluation is required.

As discussed in the meeting, between Ravi Baliga (ADVENT) and Don Precechtel (WHC), any interference of the rebar in the concrete pad shall be cut without disturbing the integrity of the concrete in the "shear cone" region. Note that no rebar is required in the concrete pad to develop full tension and shear capacities of the anchor bolts.

8. Note # 3 on Dwg. No. H-2-821100, sheet 1, Rev.0 was deleted and replaced with a note: "Torque 1-1/4" A-325 bolts to 1550 +/- 50 ft-lbs." in ECN 612809.

The note was added per ANSI N690 (Ref. 2.1.6) requirement for A-325 bolts. The added note does not affect the conclusion of bolted connection evaluated using these bolts in Sections 7.1.3 and 7.2.3. Therefore, no further analysis/evaluation is required.

Calculation Sheet

Project	Westinghouse Hanford Company	Prepared By:	<i>[Signature]</i>	Date	9-2-94
Subject	Structural Analysis of Multiport Riser 5A	Reviewed By:	<i>[Signature]</i>	Date	9/2/94
System	SY-101 H ₂ Mitigation Project	Job No.	94003	File No.	94003.1.1
Client Calc. No.		Sheet No.	J-1	Rev. No.	1

APPENDIX J

Design Input: Copy of CC Mail and ECNs

(18 Sheets)

REV 0

[2] From: John P Strehlow at -WHC240 9/2/94 8:03AM (769 bytes: 16 ln)
 To: ^ADVENT Engineering Services at -DOE_HANFORD_1
 Subject: Attantion Ravi Baliga

----- Message Contents -----

Ravi,

Here are the final weights for the multiport riser. These were given to me by Don Precechtel on 8-31-94.

MPR assembly	7,490 lbf
Support legs (3)	1,200 lbf

Total	8,690 lbf

The weight of the MPR assembly does not include the three jack assemblies that will be used to install the multiport since they will not be part of the permanent installation.

John Strehlow

FAX MESSAGE

ADVENT	
Project I.o.	99003
File No.	5.0
Log No.	7

WESTINGHOUSE HANFORD COMPANY

MECHANICAL ENGINEERING

PO BOX 1970 MSIN H5-70

RICHLAND WA 99352

Date: 8/15/94Number of Pages including this one 7To: RAVI BALIGAFrom: JOHN STREHLWFax Number: (510) 743-0414

Fax Number: _____

Telephone: _____

Telephone: (509) 376-5009

Message:

I WILL SEND A BETTER COPY BY
OVERNIGHT MAIL.

We're Making Sure!

Westinghouse
Hanford CompanyInternal
Memo

From: TWRS Safety Programs Engineering Support
Phone: 376-3329 L6-37
Date: August 15, 1994
Subject: REBAR SURVEY OF RISER 5A CONCRETE SUPPORT STRUCTURE, TANK SY-101

To: J. P. Strehlow H5-68
cc: R. E. Mendoza R1-51
B. K. Schroeder H5-70
DRP-File/LB

This letter provides the results from the rebar survey on the concrete support structure for riser 5A, Tank SY-101. The data is included in the Survey Report provided by KEH, Attachment 1. This survey was conducted within a 3'-6" square area where the MPR support pads will be located (three locations). Some of this data was then transferred to a plan view of the multiport riser on the concrete support structure, Attachment 2. This superposition shows there will be some interference with the rebar during core drilling for the anchor bolts. The areas marked "solid" in the survey report (and not included in the plan view of Attachment 2) suggest a congested area where it may be impossible to avoid rebar during core drilling.

In a meeting held with Advent Engineering on Thursday afternoon, August 11, 1994, it was concluded that core drilling into rebar should not present a significant structural problem. Therefore, we are proceeding with core drilling and anchor bolt installation as shown in the plan view of Attachment 2.

The original request for the survey is attached for information (Attachment 3). If you have any questions or concerns on the above, please contact me on 376-3329.

D. R. Precechtel

\bks

Attachments 3

08/15/94 16:27
08/10/94 08:47

WHC-SD-WM-DA-1c:
REV 0

2003
JUG

Attachment 1, Pg 1 of 2

KAISER ENGINEERS HANFORD		SURVEY DATA REPORT		Request No. 944-346	
Project/W.O. No.		Title SY-101 RISER 5A CONCRETE SUPPORT STRUCTURE		File No. 2WSY-017	
KEH Job No. CR1469		Prepared By R.N. Taylor		Date 08/10/94	
				Reviewer <i>AM</i>	
				1	
DESCRIPTION OF WORK		ACCEPTABILITY (Within Plan Tolerance)		DISTRIBUTION	
Performed GPR concrete scan at Tank SY-101, riser 5A as shown on drawing.		Yes []		Survey File	
		No []		Field Project File	
		NA []		J.R. Ammerman	
		TBD by []			
		Requestor []			
SURVEY RESULTS AND COMMENTS					

SEE ATTACHMENT

Post-It® Fax Note 7671		Date 8-10	# of pages 2
To Don Price, H&L		From Vern Lonn	
Cc/Dect. 306E/274/300		Co. KEH Survey Dept.	
Phone # 376-3329		Phone # 372-1650	
Fax # 376-4945		Fax #

SCAN PLAN OF RISER 5A

SCALE: 1/2" = 1'

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Westinghouse
Hanford CompanyInternal
Memo

From: TWRS Safety Programs Engineering Support
Phone: 376-3329 (L6-37)
Date: July 25, 1994
Subject: LETTER OF INSTRUCTION FOR REBAR OF RISER 5A CONCRETE
SUPPORT STRUCTURE, TANK SY-101

LOI #MPR-1

To: M. S. Harris S2-54
cc: R. E. Mendoza R1-51
B. K. Schroeder H5-70
DRP/File/LB

WHC requests KEH to survey and locate the rebar in specified areas (see below) of the concrete support structure for Riser 5A of Tank SY-101 (LOI #MPR-1).

Background Information

The multiport riser (MPR) will be installed and mounted on the concrete support structure of Riser 5A. Part of the installation procedure for the MPR will be core drilling and installation of anchor bolts into the concrete support structure. The concern is: a) the possible interference of the rebar with the core drilling operation, and b) structural integrity of the concrete support structure if rebar is encountered during core drilling. It is preferred to avoid rebar during anchor bolt core drilling, if possible. Hence, a scan or survey of the concrete support structure to locate rebar in the selected areas is required.

Scope of Work

1. Survey the three (3) areas (3.5' x 3.5') shown on the attached figure (Scan Plan of Riser 5A) using ground-penetrating radar (GPR).
2. Provide a survey report indicating all rebar within these three areas.
3. Mark or otherwise indicate on the concrete support structure the location of all rebar indicated from the survey.

Construction drawings (H-2-140051 and H-2-140052) for Tank SY-101 concrete support structure are attached for information. These drawings provide the rebar configuration in the concrete support structure.

Cost

Work Order CR1469 is provided in the amount of \$2000 to perform the above scope of work.

M. S. Harris
Page 2
July 18, 1994

Schedule

This work, including the survey report, should be completed by August 1, 1994. It will be necessary to coordinate this effort with 200W tank farm personnel one week in advance of performing the work.

D. R. Precechtel

jkt

ADVENT	
Doc. No.	94003
I.O.	5.0
27 No.	8

FAX MESSAGE

WESTINGHOUSE HANFORD COMPANY

MECHANICAL ENGINEERING

PO BOX 1970 MSIN H5-70

RICHLAND WA 99352

Date: 8/18/94

Number of Pages including this one _____

To: RAVI BALIGA / AGADISH From: JOHN STREHLERFax Number: (510) 743-0414

Fax Number: _____

Telephone: _____

Telephone: (509) 376-5009

Message:

THIS ECN FORM IS PART OF THE OVERALL
AS-BUILT CONFIGURATION FOR THE MULTIPORT
RISER. I WILL SEND A COPY WHEN RELEASED.
YOU DON'T NEED TO INCLUDE A COPY OF THIS
IN THE REPORT, JUST REFERENCE IT.

We're Making Sure!

ENGINEERING CHANGE NOTICE

Page 1 of _____

1. ECN 198612

Proj.
ECN

2. ECN Category (mark one) Supplemental ☐ Direct Revision ☐ Change ECN ☒ Temporary ☐ Standby ☐ Supersedure ☐ Cancel/Void ☐	3. Originator's Name, Organization, MSIN, and Telephone No. B. K. Schroeder, 8D320, H5-70, 376-0518		4. Date 8/10/94
	5. Project Title/No./Work Order No. SY-101 Mitigation Project/N2BJ2	6. Bldg./Sys./Fac. No. 241-SY-101 Tank Farms	7. Approval Designator Q8 D8-6-94
	8. Document Numbers Changed by this ECN (Includes sheet no. and rev.) H-2-821100, Sheet 1, Rev 0 H-2-821101, Sheet 1, Rev 0 H-2-821101, Sheet 2, Rev 0	9. Related ECN No(s). N/A	10. Related PO No. 420947

11a. Modification Work ☐ Yes (fill out Blk. 11b) ☒ No (NA Blks. 11b, 11c, 11d)	11b. Work Package No. N/A QH	11c. Modification Work Complete N/A QH Cog. Engineer Signature & Date	11d. Restored to Original Condition (Temp. or Standby ECN only) N/A QH Cog. Engineer Signature & Date
---	---------------------------------	---	---

12. Description of Change

- Dwg No. H-2-821100, sheet 1, parts list item #16, should read: "BOLT, HVY HEX HD 1 1/4-7 UNC-2A X 3" LONG". (i.e., the bolts should be 3" long vice 2" long)
- Dwg No. H-2-821101, sheet 1, Item nos. 58, 59, 60, 61: Change ASTM 325 to "ASTM A307"
- Dwg No. H-2-821101, sheet 2, Item no. 15, PIN: Add an extension to the threaded end of the alignment pin as shown in the attached figure 1.

13a. Justification (mark one) As-Found ☐	Criteria Change ☐	Design Improvement ☐	Environmental ☐
Facilitate Const. ☐	Const. Error/Omission ☐	Design Error/Omission ☒	

13b. Justification Details

- The current 2" bolt is not long enough to engage the nut and a 3" bolt is required.
- ASTM A307 GR B bolts are a preferred choice for bolts that will be cycled (i.e., installed and removed periodically).
- The alignment pin is extended so as to engage the bolt hold pattern on the riser flange before the temporary studs and possible galling of the studs.

14. Distribution (include name, MSIN, and no. of copies) R. E. Bauer L6-37 C. E. Hanson H5-09 L. S. Krogsrud R3-08 M. L. McElroy S1-57 D. R. Precechtel L6-37 (3) B. K. Schroeder H5-70 G. F. Vargo, Jr. H5-09	RELEASE STAMP
---	---------------

REV 0

ENGINEERING CHANGE NOTICE				Page 2 of 3		1. ECM (use no. from pg. 1) 198612	
15. Design Verification Required [] Yes [X] No		16. Cost Impact <div style="display: flex; justify-content: space-between;"> <div> ENGINEERING Additional [] \$ Savings [] \$ N/A </div> <div> CONSTRUCTION Additional [] \$ Savings [] \$ N/A </div> </div>				17. Schedule Impact (days) Improvement [] Delay [] N/A	
18. Change Impact Review: Indicate the related documents (other than the engineering documents identified on Side 1) that will be affected by the change described in Block 12. Enter the affected document number in Block 19.							
SDO/DO	[]	Seismic/Stress Analysis	[]	Tank Calibration Manual	[]		
Functional Design Criteria	[]	Stress/Design Report	[X]	Health Physics Procedure	[]		
Operating Specification	[]	Interface Control Drawing	[]	Spares Multiple Unit Listing	[]		
Criticality Specification	[]	Calibration Procedure	[]	Test Procedures/Specification	[]		
Conceptual Design Report	[]	Installation Procedure	[]	Component Index	[]		
Equipment Spec.	[]	Maintenance Procedure	[]	ASME Coded Item	[]		
Const. Spec.	[]	Engineering Procedure	[]	Human Factor Consideration	[]		
Procurement Spec.	[]	Operating Instruction	[]	Computer Software	[]		
Vendor Information	[]	Operating Procedure	[]	Electric Circuit Schedule	[]		
OM Manual	[]	Operational Safety Requirement	[]	ICRS Procedure	[]		
FSAR/SAR	[]	IEFD Drawing	[]	Process Control Manual/Plan	[]		
Safety Equipment List	[]	Cell Arrangement Drawing	[]	Process Flow Chart	[]		
Radiation Work Permit	[]	Essential Material Specification	[]	Purchase Requisition	[X]		
Environmental Impact Statement	[]	Fac. Proc. Samp. Schedule	[]	Tickler File	[]		
Environmental Report	[]	Inspection Plan	[]		[]		
Environmental Permit	[]	Inventory Adjustment Request	[]		[]		
19. Other Affected Documents: (NOTE: Documents listed below will not be revised by this ECM.) Signatures below indicate that the signing organization has been notified of other affected documents listed below.							
Document Number/Revision		Document Number/Revision		Document Number/Revision			
N/A							
20. Approvals							
Signature		Date		Signature			
Date		Date		Date			
<u>OPERATIONS AND ENGINEERING</u>							
Cog. Eng. DR Precachtel		8-15-94		PE			
Cog. Mgr. CE Hanson		8/17/94		QA			
QA ML McElroy		8-16-94		Safety			
Safety LS Krogstad				Design			
DRP 8-15-94				Environ.			
Environ.				Other			
Other RE Bauer		8/16/94					
GF Vargo Jr.		8/16/94					
<u>DEPARTMENT OF ENERGY</u>							
Signature or a Control Number that tracks the Approval Signature							
<u>ADDITIONAL</u>							

FIGURE 1

15 PIN
SCALE: FULL

FAX MESSAGE

FROM: MECHANICAL ENGINEERING
MAILSTOP H5-70
WESTINGHOUSE HANFORD COMPANY
P.O. BOX 1970
RICHLAND, WA 99352

DATE: 9/1/94 Number of Pages 5
Including This One
TO: RAVI BALIGA FROM: JOHN STREHLER
FAX NUMBER: (509) 743-0414 FAX NUMBER: _____
TELEPHONE: _____ TELEPHONE: (509) 376-5009

MESSAGE:

We're Making Sure!

ENGINEERING CHANGE NOTICE

Page 1 of 2

1. ECN 602699

Proj.
ECN

2. ECN Category (mark one) Supplemental ☐ Direct Revision ☐ Change ECN ☒ Temporary ☐ Standby ☐ Supersedeure ☐ Cancel/Void ☐	3. Originator's Name, Organization, MSIN, and Telephone No. B. K. Schroeder, 80320, H5-70, 376-0518		4. Date 8/19/94
	5. Project Title/No./Work Order No. SY-101 Mitigation Project/N2BJ2	6. Bldg./Sys./Fac. No. 241-SY-101 Tank	7. Approval Designator Q
	8. Document Numbers Changed by this ECN (includes sheet no. and rev.) H-2-821101, shts 1 & 3, Rev 0 H-2-821095, Rev 0	9. Related ECN No(s). N/A	10. Related PO No. N/A
11a. Modification Work ☐ Yes (fill out Blk. 11b) ☒ No (NA Blks. 11b, 11c, 11d)	11b. Work Package No. N/A	11c. Modification Work Complete N/A	11d. Restored to Original Condition (Temp. or Standby ECN only) N/A
12. Description of Change 1. Dwg H-2-821101, Sheet 1: (a) add item no. 55: plug, 1/2 NPT, 304 SST and (b) change item no. 67: Cat No. 6412, Insulation, foam 1" thick. 2. Dwg H-2-821101, Sheet 3, Section M-M: add P/N 55. 3. Dwg H-2-821095: (a) Section E-7, delete "SEE NOTE 6" and (b) under GENERAL NOTES, delete note 6 and corresponding text.			
13a. Justification (mark one) Criteria Change ☐ Design Improvement ☐ Environmental ☐ As-Found ☐ Facilitate Const. ☐ Const. Error/Omission ☐ Design Error/Omission ☒			
13b. Justification Details 1. Plug was inadvertently omitted. Insulation was changed from 3/4" to 1" to conform with analysis and procurement. 2. Plug was inadvertently omitted. 3. The 20" spacing for MAXI bolts is the preferred dimension and the option is no longer required.			
14. Distribution (include name, MSIN, and no. of copies) <i>* ADVANCE COPIES</i> R. E. Bauer L6-37 STA. 1 SS-5T C. E. Hanson H5-09 2 SS-61 L. S. Krogsrud R3-08 3 SS-65 M. L. McElroy S1-57 4 RL-27 D. R. Precechtel L6-37 (3) 5 TK-30 B. K. Schroeder H5-70 6 T2-03 G. F. Vargo, Jr. H5-09 16 SS-00 20 TY-00			RELEASE STAMP OFFICIAL RELEASE (21) BY WHC DATE SEP 02 1994 Sta. 21

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1. ECM (use no. from pg. 1)

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Page 1 of 2

1. ECN 612809

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2. ECN Category (mark one) Supplemental ☐ Direct Revision ☐ Change ECN ☒ Temporary ☐ Standby ☐ Supersedeure ☐ Cancel/Void ☐	3. Originator's Name, Organization, MSIN, and Telephone No.		4. Date
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	8. Document Numbers Changed by this ECN (Includes sheet no. and rev.)	9. Related ECN No(s).	10. Related PO No.
	H-2-821100, Sheet 1, Rev 0	N/A	N/A

11a. Modification Work	11b. Work Package No.	11c. Modification Work Complete	11d. Restored to Original Condition (Temp. or Standby ECN only)
☐ Yes (fill out Blk. 11b)		N/A	N/A
☒ No (NA Blks. 11b, 11c, 11d)		Cog. Engineer Signature & Date	Cog. Engineer Signature & Date

12. Description of Change

1. Dwg No. H-2-821100, sheet 1, Notes: Delete the text in note #3 and replace with the following: "Torque 1-1/4" A-325 bolts to 1550 +/- 50 ft-lbs."

13a. Justification (mark one)	Criteria Change ☐	Design Improvement ☐	Environmental ☐
As-Found ☐	Facilitate Const. ☐	Const. Error/Omission ☐	Design Error/Omission ☒

13b. Justification Details

1. ANSI N690 requires A-325 bolts to be torqued to 70-75% of tensile strength.

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WHC-SD-WM-DA-161
REV 0
ATTACHMENT 1

STRUCTURAL DESIGN SPECIFICATION
FOR
THE MULTIPORT RISER
ON TANK 241SY101

WHC-SD-WM-DA-161
Rev. 0

STRUCTURAL DESIGN SPECIFICATION
FOR
THE MULTI-PORT RISER
ON TANK 241SY101

August, 1994

Prepared By

J.P. Strehlow
Westinghouse Hanford Co.

R. Baliga
ADVENT Engineering Services, Inc.

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**STRUCTURAL DESIGN SPECIFICATION
FOR
THE MULTIPORT RISER
ON TANK 241SY101**

1.0 INTRODUCTION

This document establishes the requirements and guidelines for performing the structural analysis of the multiport riser (MPR) and its supporting structure. This document is a supplement to the functional design criteria WHC-SD-WM-FDC-027 (Reference 8.1), which provides the functional and design requirements necessary to design, analyze, fabricate, test, and install the MPR on waste tank 241SY101. This structural design specification addresses the scope of the structural analysis, the loading, and the load cases that are to be analyzed and establishes the acceptance criteria for evaluating the results of the structural analysis.

The MPR assembly will be installed over riser 5A on tank 241SY101, a 42-in. tank riser. The purpose of the MPR is to replace the single large riser opening with four smaller ports. Each port can be used independently to install equipment or instruments as needed to conduct tank operations. The MPR will also provide pressure relief capability for the tank.

1.1 Scope

The scope of this document includes the following:

- Identification of the design requirements applicable to the MPR design from the Hanford Plant Standard, SDC-4.1 (Reference 8.2), U.S. Department of Energy Order No. 6430.1A (Reference 8.3) and UCRL-15910 (Reference 8.4) documents
- Definition of the various design-basis, beyond-design-basis, transportation, and normal installation loads to be considered in the structural evaluation of the MPR and the effect that the MPR will have on its supporting structure
- Definition of the loads and load combinations
- Provision of acceptance criteria to serve as the basis for qualification of the MPR and its supporting structure under design-basis and beyond-design-basis loads
- Provision of a method to evaluate and accept the application of future equipment loads on the MPR ports without reanalysis of the MPR and its support structure

1.2 Multiport Riser Structural Description

The MPR is a stainless steel structure installed directly above the 42-in. riser 5A and is sealed at the existing riser flange. The assembly is structurally supported by a concrete footing located around the 42-in. riser, but it is not connected to the riser. The MPR will provide two 8-in. ports, one 12-in. port, and one 20-in. port. Each port will have a shielding plate and blind flange. These ports will be used to install various types of equipment or instruments in the tank.

The configuration of the MPR is documented on drawing H-2-821101 and the installation is documented in drawing H-2-821100. A schematic of the multiport riser installed over the 42-in. tank riser 5A is shown in Figure 1.1.

1.3 Jurisdictional Boundary

This structural design specification covers the entire MPR assembly, as shown on the design drawings, including the concrete footing and the anchors that connect the MPR to the concrete footing. Equipment installed through a multiport riser ports and their connection bolts are not within the jurisdiction of this specification.

1.4 Definitions

Shall Consider:	Requires a referable assessment with discussion of rationale when an alternate method is selected.
Shall:	Denotes a requirement.
Must:	Denotes a requirement.
Should:	Denotes a recommendation.

2.0 GENERAL REQUIREMENTS

2.1 Design Requirements

SDC-4.1 (Reference 8.2) provides the criteria for establishing the design loads for facilities. These criteria are based on four safety classifications (Safety Class 1 through 4) for the structure, system, and component. The safety classes can be correlated respectively to the High-Hazard, Moderate-Hazard, Low-Hazard/Important and General-Use usage categories defined in the 1990 version of UCRL-15910 (Reference 8.4) for non-reactor facilities. In the 1992 draft version of UCRL-15910, these descriptive classifications have been modified, in reverse order, to Performance Categories 1 through 4. Safety Class 1 structures, systems, and components are those that perform a function required for nuclear criticality safety or whose failure might result in a significant release of radioactive, hazardous, or toxic materials as defined by DOE Order 6430.1A, Division 13, as it relates to non-reactor nuclear facilities.

In addition to normal loads, non-reactor Safety Class 1 structures, systems and components are to withstand the effects of extreme environmental loads including design basis earthquake (DBE), design basis wind (DBW), design basis flood, volcanic eruptions and other abnormal loads considered on a case by case basis. Non-reactor Safety Class 2, 3 and 4 structures, systems and components are those that are not Safety Class 1 and are respectively specified as onsite safety-related, occupational safety-related and non-safety-related items.

Tank 241SY101 is non-reactor Safety Class 1 structures; the risers on this tank are non-reactor Safety Class 2 structures. The MPR that will also be considered non-reactor Safety Class 2 components for the purpose of these structural analyses because the MPR will contain radioactive and toxic materials under normal operating conditions.

Section 0111-99.0.4 of Reference 8.3 states: "the adequacy of systems, components, and structures to withstand a seismic event shall be verified by a dynamic analysis, except where it can be demonstrated that the use of a simplified approach, such as a static load method, component testing, or a combination of testing and analysis provides assurance of adequate seismic design. The ratio of vertical-to-horizontal acceleration shall be two-thirds, unless site-specific data justify the use of a different ratio." Therefore, the MPR together with the tank and the other supporting structures shall be evaluated by dynamic analysis for DBE loads. A response spectrum method of structural analysis is an acceptable method of analysis for this purpose. Section 0111-99.0.8 of Reference 8.3 states that "Safety class structures and structural members shall be designed to resist the appropriate load combinations provided in UCRL-15910." Therefore, the load combinations provided in Section 6.0 of this document shall be based on UCRL-15910.

Section 0111-99.0.8 of Reference 8.3 also states "Safety class steel structures shall meet the design, fabrication, and erection requirements

of ANSI/AISC N690 for new construction or original (or equivalent) codes for existing construction providing the margin of safety of the overall facility is maintained". For the MPR, the structural evaluation shall be based on ANSI/AISC N690-84 (Reference 8.6) requirements.

Section 0111-2.4.1 of Reference 8.3 states that "The structural frame and exterior components of all buildings, signs, tanks, towers, and other exposed structures shall be designed to resist pressures due to wind assumed to act from any direction. Partial wind loading shall be considered if it produces a more severe effect." Therefore, wind load shall be included as one of the design-basis loads in the design and analysis of the MPR assembly. The wind-load calculations shall be in accordance with procedures in ASCE 7-88 (Reference 8.7) with the basic wind speed obtained from SDC-4.1. In addition to the DBW load, the design-basis ashfall and snow loads shall be included in the design and analysis of the MPR assembly.

Additional design requirements that shall be factored into the structural evaluation of the MPR and its supporting structure include the following:

- The MPR shall not transfer loads to the existing 42-in. riser 5A.
- The MPR shall not become a projectile and the tank contents shall not be expelled from the tank if there is a hydrogen burn inside the tank.
- Fatigue of the MPR shall be evaluated if the loads from installed equipment transmit cyclic loads to the MPR.
- All structural members designed to the requirements of this Structural Design Specification must be fabricated from a material that can be characterized in terms of the material designations found in the ASME Boiler and Pressure Vessel Code, Section VIII (Reference 8.8); ANSI/AISC N690; or a similar nationally recognized, widely accepted industry design standard. Where possible, lightweight, high-strength material shall be selected to minimize loads applied to the tank dome.

2.2 Future Equipment Loads

Future equipment may be installed through the MPR ports. To minimize the reanalysis of the MPR when this new equipment is installed, a margin analysis shall be performed. The results of this margin analysis will provide data for stress equations that can be used to determine whether the additional reaction loads from the new equipment can be tolerated without exceeding the specified design limits on stress for the MPR. This approach requires that the reaction loads from the new equipment be determined from a separate decouple analysis

The stress equations shall be developed by applying three unit forces and three unit moments individually at each port for each of orthogonal direction, i.e., a total of 24 unit load analyses. The maximum stress

within the MPR for each unit load will form the coefficients to the stress equations. When multiplied by the actual reaction loads for new equipment, the stress equation will give an upper-bound estimate of the maximum stress in the MPR. This upper bound estimate will be conservative, as the stress equation will combine the maximum stresses from any point within the MPR without regard for location.

To make the stress equations more effective and less conservative different equations may be developed for selected locations or components such as welds, bolts, and plates; these may be divided into different groups and a separate stress equation devised for each group. The final makeup of these groups shall be determined on the basis of the results of the analyses and evaluations of the MPR assembly at its current configuration.

The upper-bound maximum stress will be compared to the remaining available stress margin for the location or component to determine if the reaction loads from the new equipment are acceptable. These evaluations shall be performed for both normal and extreme load-combination categories.

The addition of equipment will alter the mass distribution and as a result the mode shapes and the natural frequencies of the MPR assembly will be different from those for the current configuration. To account for this effect, the mass (translational) corresponding to the following estimated equipment weights shall be applied at the top of each port, unless the actual equipment is included in the model:

20-in. port	1,000 lbf
12-in. port	7,000 lbf
8-in. ports	1,000 lbf (each)

The rotational mass or inertia of the equipment is not included with these applied masses because it is expected to have a second order effect on the frequency response of the MPR.

These estimated equipment masses will produce only the translational reaction forces at the top of each riser. Moment reactions from future installed equipment will be accounted for when the actual configuration of future equipment is defined and the loads from this equipment, determined from a separate decoupled DBE analysis, are evaluated as DBE loads on the MPR.

The following information shall be provided for use in decoupled analyses of equipment or instruments that may be installed in the MPR in the future.

- Report the reaction forces and moments created by the estimated equipment mass applied at the top of each port on the MPR. These reaction forces and moments shall be reported for both the normal and the extreme load combinations.
- The translational and rotational stiffnesses in the orthogonal directions at top of each port shall be provided.

2.3 Design Reports

All engineering reports documenting the satisfaction of this specification and the acceptance criteria shall be prepared in accordance with the requirements of WHC *Standard Engineering Practices*, EP-1.12 (Reference 8.9). All calculations supporting the engineering report shall be prepared in accordance with the requirements of WHC *Standard Engineering Practices*, EP-1.11 (Reference 8.10). Changes to engineering reports shall be performed in accordance with the requirements of WHC *Standard Engineering Practices* EP-2.2 (Reference 8.11). The design verification of engineering reports and the supporting documents shall be performed in accordance with the requirements of WHC *Standard Engineering Practices*, EP-4.1 (Reference 8.12). All engineering reports submitted to WHC Engineering shall be subjected to independent review. Submittal to WHC Cognizant Engineer shall include, in hard-copy form, all engineering reports, supporting documents, and computer output associated with the supporting documents. The submittal shall also include input run-streams of all computer models either in a 5.25-in. floppy diskette or in a 3.5-in. floppy diskette.

2.4 Conflicting Requirements

If requirements imposed by this Structural Design Specification conflict with requirements listed in another specification applicable to the MPR, the conflict shall be brought to the attention of the WHC Cognizant Engineer for resolution.

3.0 DESIGN-BASIS LOADS

3.1 Dead Load (D)

Dead load of the MPR assembly shall include the total weight of all individual components that form the MPR assembly and the weight of all equipment and instruments installed through the ports on the MPR. The weight of the installed equipment or instruments may either be the actual weight or the estimated equipment weight defined for the port.

3.2 Design-Basis Earthquake Load (DBE)

The DBE load shall be included as a design-basis extreme load. The response spectra curves provided in SDC 4.1 (Reference 8.2) shall be used to determine the DBE loads. The DBE response spectra curves for a 0.20 g zero-period acceleration shall be used to determine the loads on Safety Class 1 structures such as the pressure relief doors on the MPR assembly. The DBE response spectra curves for a 0.12 g zero-period acceleration shall be used to determine the loads on Safety Class 2 structures such as the MPR and the concrete footing. The required damping for the spectral curves shall be per UCRL-15910 criteria.

The DBE response spectra curves provided in SDC 4.1 are median centered U.S. Newmark-Hall Spectra (Reference 8.13); they do not include the effects of soil-structure interaction and structural amplification.

To account for possible amplification of the tank dome in the vertical direction, the vertical response spectra shall be increased by at least 50%. This increase may be accomplished by applying the horizontal response spectra as the vertical response spectra or by other suitable methods.

The mass of the installed equipment or instruments shall be accounted for in the DBE load either by adding the actual installed equipment instrument to the MPR model or by including the estimated equipment mass (translational) at the top of each port. The estimated equipment masses will produce only the translational reaction forces at the top of each riser. Moment reactions from future installed equipment will be accounted for when the actual configuration of future equipment is defined and the loads from this equipment, determined from a separate decoupled DBE analysis, are evaluated.

3.3 Design Basis Equipment Loads (EQ1, EQ2)

These loads are the reactions (forces and moments) transferred to the ports on the MPR from either external loads or internally generated loads developed by the equipment installed in the MPR. EQ1 is the equipment load for the normal load category and EQ2 is the equipment load for the extreme load category.

At present the size and configuration of any additional equipment to be installed in the ports are not known. Therefore, the reactions (forces and moments) that will be transferred to the MPR ports are not available. Evaluation of these loads shall be performed after the configuration of the equipment to be installed has been defined. This evaluation may be performed either by including the equipment in an analysis of the MPR or by separately evaluating and accepting the loads (forces and moments) that this equipment will transfer to the MPR. For this separate evaluation, the loads are obtained from a decoupled analysis of the equipment. This separate evaluation and acceptance of equipment loads shall be performed using the stress equations obtained from the margin analysis, as described in Section 2.2 of this Specification.

3.4 Design-Basis Wind Load (W)

The MPR installed over the 42-in. riser on the 241SY101 tank is exposed to environmental loads such as the DBW. However, the total height of the MPR is less than 4 ft. Therefore, the wind load on the projected surface of the MPR can be neglected.

3.5 Design-Basis Ashfall Load (A)

The design-basis ashfall load defined in SDC 4.1 will have a negligible effect on the MPR. Therefore, this load can be neglected.

3.6 Design-Basis Snow Load (SN)

The design-basis snow load defined in SDC 4.1 will have a negligible effect on the MPR. Therefore, it can be neglected.

3.7 Earth Pressure Load (H)

The concrete footing for the MPR extends approximately 3 feet below grade. At this depth the lateral earth pressure on this footing is considered negligible. Therefore, this load can be neglected.

4.0 BEYOND-DESIGN-BASIS LOADS

4.1 Hydrogen Burn Load (H2) (241SY101 tank only)

The waste in the 241SY101 tank generates hydrogen and nitrous oxide gases. The concentration of these gases inside the tank can reach flammability levels during episodic releases of these gases from the waste during a waste rollover. This situation creates the possibility of a hydrogen burn. This event is referred to as the maximum expected burp (MEB) burn accident. Several burn events have been evaluated, including a 1.25 MEB and a best-estimate MEB. For this analysis the transient pressure loadings and the tank dome displacement/acceleration time histories that correspond to the 1.25 MEB (Reference 8.15) shall be applied.

The hydrogen burn load shall include the actual mass of the equipment installed or to be installed in the MPR. To account for the potential effect of future installations of equipment or instruments that have not been defined, the mass that corresponds to the estimated equipment weight defined for each riser shall be included, if the addition of these masses creates a worse load case on the MPR during the hydrogen burn.

5.0 TRANSPORTATION AND NORMAL INSTALLATION LOADS

The party who installs the MPR shall evaluate the MPR assembly for the various transportation loads. The party who installs the MPR assembly shall be responsible for providing adequate support to the assembly during transportation to prevent physical damage to the component or operational impairment. Road shipment shock and vibration forces in accordance with Federal Highway Administration, DOT 49 Code of Federal Regulations (CFR) 393.100, are to be assumed during transportation (Reference 8.16).

The party who installs the MPR assembly shall be responsible for providing adequate rigging and support for the assembly to assure that the MPR assembly as well as the tank dome penetration riser over which the MPR is installed will not be damaged during normal installation. Installation procedures shall be provided to WHC Cognizant Engineer for review and comment in accordance with the schedule established by Project Management. The installation procedure shall contain a listing of all equipment to be used. The estimated total weight of all equipment and personnel to be located above the tank at any one time during the installation shall be included in the procedure. The estimated total weight shall be reported to Project Management.

Lifting lugs on the MPR and for the shielding plates installed on each port shall be evaluated for a dead weight load with a dynamic amplification load factor of 2.0 applied to the load. Stresses within the lifting lugs and their attachment welds shall satisfy the requirements of ANSI N690-1984 (Reference 8.6) for normal loads.

6.0 LOAD COMBINATIONS

6.1 Design-Basis Load Combination for the MPR Assembly

The following load combinations shall be used in evaluating the MPR assembly components.

Category	Load Combination	Stress Limit* Coefficient
Normal	$D + EQ1$	1.0
Extreme	$D + [DBE] + EQ2$	1.6

Where D = dead load
DBE = design-basis earthquake load
EQ1 = design-basis equipment load for normal load category
EQ2 = design-basis equipment load for extreme load category

* For items subject to the requirements of ANSI N690-1984.

6.2 Design-Basis Load Combination for Concrete Structures

The following load combinations shall be used in evaluating the reinforced concrete footing.

Category	Load Combination	Stress Limit* Coefficient
Normal	$1.4D + 1.7EQ1$	1.0
Extreme	$D + EQ2$	1.0

6.3 Modal and Directional Combination

A three-directional response spectrum analysis with DBE loading shall be performed to obtain structural response of the MPR assembly to the earthquake loading. The Grouping Method as stated in U.S. Nuclear Regulatory Commission's (NRC) Regulatory Guide 1.92 (Reference 8.17) or the complete quadratic combination (CQC) method shall be used to perform the modal combination. The responses for each of the three directions of seismic data shall be combined by the SRSS method. The missing mass effect shall be accounted for in the total response of the MPR assembly if the number of modes included in the analysis are not sufficient to insure that 90% or more of the total system response has been achieved.

6.4 Beyond-Design-Basis Load Combination

The stresses in the MPR and its supporting structure that are caused by the beyond-design-basis load need not be combined with those stresses in the MPR caused by design-basis loads.

6.5 Transportation Load Combination

The stresses in the MPR assembly due to transportation loads need not be combined with any other design-basis normal loads.

6.6 Normal Installation Load Combination

The stresses in the MPR assembly during normal installation need not be combined with any other design-basis normal loads.

7.0 EVALUATION AND ACCEPTANCE CRITERIA

7.1 Design-Basis Acceptance Criteria

The stresses in the multiport riser assembly and other supporting structures are developed by the external loadings imposed on the assembly. Therefore, these stresses are of a primary nature and they are not self-limiting. The primary stresses in the multiport riser assembly shall satisfy the requirements of ANSI N690 -1984 (Reference 8.6). The primary stresses in the concrete footing shall satisfy the requirements of ACI 349-90 (Reference 8.5). Any anchorage designed for design-basis loads shall meet the requirements of the Standard Design Criteria, SDC-4.2 (Reference 8.18).

Stress limit coefficients shall be applied to the stress allowables as shown in References 8.6 and 8.19. By Reference 8.6, the stress allowable after applying the stress limit coefficient shall not exceed 0.7 times F_u in axial tension nor 0.7 F_u times the ratio Z/S for tension plus bending. Here, F_u is the ultimate stress of the material, Z is the plastic section modulus of the member and S is the elastic section modulus of the member. Alternatively, for the extreme load case, the computed stress can reach the member plastic capacity which is computed as the shape factor times the material yield stress of the member.

Stress limit coefficients in shear for extreme and abnormal load conditions shall be limited to 1.4.

7.2 Beyond-Design-Basis Acceptance Criteria

The acceptance criteria applicable to the hydrogen burn event and other beyond-design-basis loadings is that the multiport riser shall not become a projectile and the tank contents shall not be expelled from the tank. Any anchorage designed for beyond-design-basis loads shall meet the requirements of the applicable ICBO evaluation report for the anchor. The stresses in the multiport riser assembly and other supporting structure due to hydrogen burn pressure loading need not be combined with those stresses in the system due to design-basis loads and other beyond-design-basis loads such as EQ3. However, the stresses due to the EQ3 loading shall be combined with the deadweight stresses in the multiport riser.

7.3 Fatigue Evaluation Criteria

The MPR assembly shall be evaluated for fatigue if the equipment installed on the MPR is capable of generating cyclic loads. The strain range for 10^6 cycles of operation shall be used in the endurance limit determination for materials that possess the fatigue characteristics of carbon steel; for austenitic steels, the strain range for 10^{11} cycles shall be used. The material endurance limit strain range is assumed to exist at the highest peak strain location. The combined effect of these

load cases shall be obtained by limiting the cumulative usage factor to 1.0 as described in Appendix 5 of ASME Code Section VIII, Division 2.

8.0 REFERENCES

- 8.1 McWethy, L. M., et al., "Tank 101-SY Multiport Riser Assembly Functional Design Criteria," Document No. WHC-SD-WM-FDC-027, Rev. 0, Westinghouse Hanford Company.
- 8.2 "Standard Architectural-Civil Design Criteria," Document No. SDC-4.1, Hanford Plant Standards, Rev. 11. Department of Energy, Richland, Washington.
- 8.3 "General Design Criteria," U.S. Department of Energy, DOE Order No. 6430.1A.
- 8.4 Robert P. Kennedy, et al., "Design and Evaluation Guidelines for Department of Energy Facilities Subjected to Natural Phenomena Hazards," UCRL-15910, June 1990.
- 8.5 "Code Requirements for Nuclear Safety Related Concrete Structures (ACI 349-90)," American Concrete Institute.
- 8.6 "Nuclear Facilities - Steel Safety Related Structures for Design Fabrication and Erection," ANSI/AISC N690-1984.
- 8.7 "Minimum Design Loads for Buildings and Other Structures," ASCE Standard, ASCE 7-88 (Formerly ANSI A58.1), American Society of Civil Engineers, 1990.
- 8.8 "Boiler and Pressure Vessel Code," Section VIII, Division 2, Appendix 5, American Society of Mechanical Engineers, 1992.
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