2
SEP 16 1994 **21** ENGINEERING DATA TRANSMITTAL

Page 1 of 1
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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 Transmittal	Originator Disposition	Receiver Disposition
1.	H-2-821382	1	0	Riser 3A Spray Wand Adapter	QS	1,2	1	/
2.	H-2-821383	1	0	Riser Adapter Lifting Yoke	QS	1,2	1	/
3.	WHC-SD-WM-DA-169		0	Design Analysis	QS	1,2	1	1

16. KEY					
Approval Designator (F)		Reason for Transmittal (G)		Disposition (H) & (I)	
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		2. Release	5. Post-Review	2. Approved w/comment	5. Reviewed w/comment
		3. Information	6. Dist. (Receipt Acknow. Required)	3. Disapproved w/comment	6. Receipt acknowledged

(G)	(H)	17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)								(G)	(H)
Reason	Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(J) Name	(K) Signature	(L) Date	(M) MSIN	Reason	Disp.
1	1	Cog.Eng. S. W. Shaw	<i>[Signature]</i>	9/16/94	H5-70	DV: J. P. Hauptman	<i>[Signature]</i>	9/15/94	S2-03	1	1
1	1	Cog. Mgr. R. E. Russell	<i>[Signature]</i>	9/16/94	H5-70	DV: R. E. Mendoza	<i>[Signature]</i>	9/15/94	P1-51	1	1
1	1	QA M. L. McElroy	<i>[Signature]</i>	9-15-94	H61-57	DV: J. J. O'Conner	<i>[Signature]</i>	9/14/94	H4-099	1	1
1	1	Safety G. E. McPherson	<i>[Signature]</i>	9-15-94	T4-10	DV: J. P. Strehlow	<i>[Signature]</i>	9/14/94	H5-68	1	1
		Env.		9-15-94		M. J. Ostrom	<i>[Signature]</i>	9/14/94	H5-68	3	
1	1	DV: J. R. Biggs	<i>[Signature]</i>	9/16/94	H4-01	CENTRAL FILES (2)		18-04			
1	1	DV: M. S. Harris	<i>[Signature]</i>	9/16/94	S2-54	OSTI (2)		18-04			
Note: DV-Design Verification											

18. <i>[Signature]</i> S. W. Shaw Signature of EDT Originator	9/16/94 Date	19. <i>[Signature]</i> Carl Horne Authorized Representative for Receiving Organization	9/16/94 Date	20. <i>[Signature]</i> R. E. Russell Cognizant Manager	9/16/94 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-169, REV. 0

Document Title: Design Analysis Supporting 101-SY Riser 3A Spraywand Adapter and Lifting Yoke Design

Release Date: 9/16/94

* * * * *

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

APPROVED FOR PUBLIC RELEASE

* * * * *

WHC Information Release Administration Specialist:

N. L. Solis N.L. SOLIS
(Signature)

9/16/94
(Date)

SUPPORTING DOCUMENT		1. Total Pages 41
2. Title Design Analysis Supporting 101-SY Riser 3A Spraywand Adapter and Lifting Yoke Design		3. Number WHC-SD-WM-DA-169
5. Key Words Adapter, Lifting, Yoke, Spraywand, 101-SY APPROVED FOR PUBLIC RELEASE		4. Rev No. 0
6. Author Name: S. W. Shaw Signature Organization/Charge Code 8D320/N2B6f		
7. Abstract <i>9/16/94 D. Solis</i> This document contains the results of stress and radiological analysis performed in support of the Riser 3A Spraywand Adapter and Lifting Yoke.		
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 (21) BY WHC DATE SEP 16 1994 <i>Sta. 21</i> </div>
9. Impact Level Q, S		

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED *878*

**DESIGN ANALYSIS SUPPORTING 101-SY
RISER 3A SPRAYWAND ADAPTER
AND LIFTING YOKE DESIGN**

**WHC-SD-WM-DA-169
REV 0
September 12, 1994**

by

**S. W. Shaw
Mechanical Engineering**

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1.0 INTRODUCTION

To facilitate the decontamination of mixing pumps installed in riser 12A of double shell waste tank 241-SY-101, it was determined that installation of a spraywand (H-2-817857) in riser 3A would be desirable. This document is to record the results of analysis performed in support of the spraywand riser adapter (H-2-821382) and lifting yoke (H-2-821383) designs.

2.0 BACKGROUND

Considerations pertinent to a spraywand installation in riser 3A included establishing spraywand elevation in the pump pit, provision of shielding to minimize radiation exposure to workers in the vicinity, and a methodology for installation which was well defined.

3.0 RESULTS

3.1 RADIOLOGICAL

The results of shielding analysis performed to determine dose rates in the vicinity of the riser adapter are shown in Attachment A.

3.2 STRESS

The results of stress analysis supporting the design of the riser adapter and lifting yoke are shown in Attachment B.

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ATTACHMENT A

RADIOLOGICAL ANALYSIS

Westinghouse
Hanford Company

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Page A-2

Internal
Memo

From: Radiation Physics and Shielding
Phone: 376-1889 H0-35
Date: August 17, 1994
Subject: DOSE RATE CALCULATIONS IN THE VICINITY OF THE SPRAY WAND IN
TANK 101-SY

8D530-KEH-94-001

To: S. W. Shaw H5-70

cc: J. Greenborg H0-35
R. A. Schwarz H0-35
KEH File/LB

- References:
1. L. L. Carter, *Certification of MCNP Version 4A for the WHC Computer Platforms*, ECN-186710, SD-MP-SWD-30001, Rev. 6, January 1994.
 2. Memo, Brit E. Hey to T. R. Benegas, *Dose Rate Calculations in Vicinity of Waste Tank 101-SY Mixer Pump and Shield Plug*, dated September 1, 1992.
 3. Memo, R. A. Schwarz and K. E. Hillesland to D. R. Precechtel, *Dose Rate Calculations for Installing a Multi-Port Riser on Tank SY-101*, dated February 24, 1994.
 4. Israel O. Laurant, *Validation of ISOSHLD-PC on the IBM PC (PS-2/AT/XT)*. EDT-109878, WHC-SD-SQA-CSWD-303, Rev. 0, 0, February 1990.

1.0 SUMMARY

Dose Rates have been calculated in the vicinity of a spray wand placed in tank 101-SY using MCNP (Reference 1). Figure 1 is a contour plot showing dose rates in the pump pit. The dose rate at the top of the shielding assembly is about 200 mrem/hr. Notice that the model dose not include the spray wand, drill rod washer, and 12 in. flange. The model also uses plugs in the 42 in. and 4 in. risers inside the pump pit to simplify the analysis, since the focus is the 12 in. riser.

2.0 GEOMETRY

The model was developed from a previous MCNP model created by Brit Hey (Reference 2). The spray wand shielding was placed on the 12 in. riser inside the pump pit. The shield consisted of a 3 in. cover plate, and an axial shield. The axial shield is made from filling the annulus between 6 in. schedule 40 and 14 in. schedule 40 pipe with steel shot. The top of the

S. W. Shaw
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August 17, 1994

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shielding assembly is 65.55 in. above the bottom of the pump pit. The steel was modeled as 7.8 g/cc iron, and the steel shot as 4.68 g/cc iron. For simplicity, the 42 in. and 6 in. risers were modeled with concrete plugs in place.

The top of the supernate was put at 400 in. above the bottom of the tank. The composition of the supernate was also taken from a previous MCNP model (Reference 2), but with a density of 1.55 g/cc. The density for the supernate was based on a homogeneous mixture with sludge (Reference 3).

3.0 SOURCE

The source consisted of a 160 cm radius, 60 cm deep cylinder at the top of 101-SY's supernate and centered beneath the 12 in. riser. A $1.277\text{E}+14$ Bq ($1.764\text{E}+7$ Bq/cc) source at an energy of .662 MeV was used (Reference 3 - "homogenized source"). The choice of .662 MeV is based on the assumption that Cs-137/Ba-137m is the dominant source for photons.

4.0 MCNP OPTIMIZATION

The source was split into three radial and three axial sections for a total of nine cells in order to bias towards the top and center of the source. A DXTRAN sphere was placed at the bottom of the 12 in. riser.

5.0 RESULTS

Figure 1 is a contour plot showing dose rates in the pump pit. The dose rate at the top of the shielding assembly is about 200 mrem/hr due to streaming directly up through the 6 in. pipe. To the sides, dose rates are generally less than 1 mrem/hr. Near the 3 in. plates, dose rates are as high as 12 mrem/hr.

The dose rates in the pit are based on the assumption that the 42 in. and 4 in. risers have their concrete plugs in place. Because the model concentrated on streaming through the 12 in. riser, dose rates due to penetration of the 4 in. plug are good to within an order of magnitude (20 to 40 percent variance), and dose rates due to penetration of the 42 in. plug are unreliable to the sides (50+ percent variance). Any additional dose rates in the pump pit from different configurations for these risers are additive to those reported here.

6.0 VERIFICATION

A second MCNP run was made with a surface tally at the top of the shielding assembly. This result was compared to an ISO-PC (Ver 1.9) (Reference 4) run.

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7.0 ARCHIVAL FILES

The archival files are stored on a 3.5 in. disk labelled "Karl Hillesland - 7/94" under the directory wand. The files include the following:

wand.mem	This document in WP5.1 format
ihey	Original MCNP input file developed by Brit Hey (Reference 2)
iwand	MCNP input file with field of point detectors
wand.in	PC-ISO 1.9 input file
maketal.new2.c	C-program for creating tallies
tal.dat	Input file used by maketal.new2.c
readerr.new.c	C-program for translating mctal file to format used by PV-WAVE
mctal	mctal file developed in running MCNPH with iwand as the input file.
dose.pro	PV-WAVE 4.2 program for creating contour plot of dose rate
error.pro	PV-WAVE 4.2 program for creating contour plot of variance

Karl E. Hillesland, Rotational Engineer
Radiation Physics and Shielding

Reviewed by:

Randy A. Schwarz, Advanced Scientist
Radiation Physics and Shielding

Concurrence:

Jess Greenborg, Manager
Radiation Physics and Shielding

sam

Attachments

Figure 1. Spray Wand Installation

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ATTACHMENT B
STRESS ANALYSIS

Westinghouse
Hanford Company

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Internal
Memo

From: Mechanical Engineering
Phone: 376-3244 H5-70
Date: July 26, 1994
Subject: STRUCTURAL ANALYSIS OF RISER 3A SPRAY WAND ADAPTER

To: S. W. Shaw H5-70
cc: DAK-File/LB

References: DOE-RL, 1993, *Hanford Site Hoisting and Rigging Manual*, DOE-RL 92-36, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Pytel, A., and F. L. Singer, 1987, *Strength of Materials*, Fourth Edition, Harper and Row, Publishers, New York, New York.

WHC, 1994a, *Riser 3A Spray Wand Adapter*, drawing H-2-821382, Westinghouse Hanford Company, Richland, Washington.

WHC, 1994b, *Riser Adapter Lifting Yoke*, drawing H-2-821383, Westinghouse Hanford Company, Richland, Washington.

The riser 3A spray wand adapter (drawing H-2-821382) and lifting yoke (drawing H-2-821383) were structurally analyzed for lifting and found acceptable per criteria given in the *Hanford Site Hoisting and Rigging Manual*. The rigging manual states that maximum stress shall not exceed one-third of the minimum yield strength of the material.

The weight of the spray wand adapter is estimated at 3,382 lbf including the shield cap. This weight is an upper bound to the actual weight, which will be significantly less. The shield cap weighs considerably more than the drill rod washer, so it was included in the weight estimate instead of the washer. The steel shot cavity was assumed solid, conservatively increasing the estimated weight of the adapter.

For design purposes, the weight of the adapter was assumed to be 3,500 lbf. A dynamic load factor (DLF) of 2.0 was assumed for conservatism. The structural analysis focused principally on the lifting lugs of the adapter and spreader bar (lifting yoke). The lugs were analyzed for tensile and bending failure, shear tear out, and adequacy of connecting welds. The critical welds of the adapter assembly also were evaluated and found acceptable.

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July 26, 1994

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All questions regarding the attached analysis should be directed to
D. A. Koehler at 376-3244.

D. A. Koehler, Engineer
Mechanical Engineering

\kph

Attachment

Riser 3A Spray Wand Adapter Stress Analysis

July 1994

Prepared By:

D. A. Koehler
D. A. Koehler, Engineer
Mechanical Engineering

7/26/94
Date

Reviewed By:

S. M. Miller
S. M. Miller, Engineer
Equipment Stress Analysis

7/26/94
Date

Approved By:

R. E. Russell
R. E. Russell, Manager
Mechanical Engineering

7/27/94
Date

WESTINGHOUSE HANFORD COMPANY
for the
U.S. Department of Energy
Richland Field Office (RL)

INDEPENDENT REVIEW

Document Reviewed Riser 3A Spray Wand Adapter Stress AnalysisAuthor D.A. Koehler Document No. _____ EDT No. _____

The subject document has been reviewed by the undersigned. The reviewer reviewed and verified the following items as applicable [EP.4.1, Rev. 3].

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

Reviewer

7/27/94
Date

CHECKLIST FOR INDEPENDENT REVIEW

WHC-SD-WM-DA-169

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Document Reviewed Riser 3A Spray Wand Adapter Stress AnalysisAuthor D.A. Koehler

Document No. _____

Yes No N/A

☒	☐	☐	Problem completely defined.
☒	☐	☐	Necessary assumptions explicitly stated and supported.
☐	☐	☒	Computer codes and data files documented.
☒	☐	☐	Data used in calculations explicitly stated in document.
☒	☐	☐	Data checked for consistency with original source information as applicable.
☒	☐	☐	Mathematical derivations checked including dimensional consistency of results.
☐	☐	☒	Models appropriate and used within range of validity or use outside range of established validity justified.
☒	☐	☐	Hand calculations checked for errors.
☐	☐	☒	Code run streams correct and consistent with analysis documentation.
☐	☐	☒	Code output consistent with input and with results reported in analysis documentation.
☒	☐	☐	Acceptability limits on analytical results applicable and supported. Limits checked against sources.
☒	☐	☐	Safety margins consistent with good engineering practices.
☒	☐	☐	Conclusions consistent with analytical results and applicable limits.
☒	☐	☐	Results and conclusions address all points required in the problem statement.

MANDATORY

Software QA Log Number N/A

Scott M. Will
Reviewer

7/26/94
Date

DESIGN CALCULATION

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- (1) Drawing H-2-821382 (2) Doc. No. _____ (3) Page 1 of 10
 (4) Building 241-SY-101 (5) Rev. _____ (6) Job No. _____
 (7) Subject Riser 3A Spray Wand Adapter Stress Analysis
 (8) Originator DA Koehler & D. Kellu Date 7/25/94
 (9) Checker S. M. Miller A. W. Miller Date 7/26/94

(10)

Weight of Spray Wand Adapter (Riser Adapter)

The following calculations conservatively estimate the weight of the spray wand adapter. Each component of the spray wand adapter is calculated separately, jointly producing an upper bound to the total weight.

Density of steel, $\rho_s = 490 \text{ lbf/ft}^3 = 0.2836 \text{ lbf/in}^3$ (Pytel 1987)

Cover, PN 4 : Plate 35 Dia x 3 thk ASTM A36 CS

$$W_1 = \rho_s (3 \text{ in.}) \left[\frac{\pi}{4} (35^2 - 6.75^2 - 2(3)^2) \right]$$

$$= 776 \text{ lbf.}$$

Inner Pipe, PN 8 : Pipe 6 Dia Schd 40
ASTM A53

$$W_2 = 18.97 \text{ lbf/ft} (1 \text{ ft}/12 \text{ in.}) (6.75 \text{ in.})$$

$$= 107 \text{ lbf.}$$

Outer Pipe, PN 7 : Pipe 14 Dia Schd 40 ASTM A53

The 12x14 Reducer will be included in the weight of the outer pipe.

$$W_3 = 63.44 \text{ lbf/ft} (1 \text{ ft}/12 \text{ in.}) (63.25 \text{ in.})$$

$$= 334 \text{ lbf.}$$

DESIGN CALCULATION

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- (1) Drawing H-2-82/1382 (2) Doc. No. _____ of 10
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 (8) Originator DA Koehler Date 7/25/94
 (9) Checker S. M. MILLER Date 7/26/94

(10)

Steel Shot, PN 9 : #8 Shot

To be conservative, the cavity formed by the inner and outer pipe will be assumed solid.

$$W_4 = \rho_s (63.25 \text{ in.}) \left[\frac{\pi}{4} (13.124^2 - 6.625^2) \right] \text{ in}^2$$

$$= 1,808 \text{ lbf.}$$

Flange, PN 6 : 12 Dia Blind 150 Class

$$W_5 = \rho_s (1.5 \text{ in.}) \left[\frac{\pi}{4} (19^2 - 6.75^2) \right] \text{ in}^2$$

$$= 105 \text{ lbf.}$$

6 FLANGE, MODIFIED

Lifting Lugs, PN 5 : Plate 1/2 Hk
ASTM A36 CS

Approximate weight by assuming a rectangle.

$$W_6 = \rho_s (0.5 \text{ in.}) (6 \text{ in.} \times 4 \text{ in.}) (2)$$

$$= 7 \text{ lbf.}$$

5 LIFT LUG
SCALE: 1/4

DESIGN CALCULATION

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(1) Drawing H-2-821382 (2) Doc. No. _____
 (4) Building 241-SV-101 (5) Rev. _____ (6) Job No. _____
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 (8) Originator DA Koehler L.A. Koehler Date 7/25/94
 (9) Checker S. M. Miller L. H. Miller Date 7/26/94

(10)

Shield Cap, PN 2: Plate $\phi 19 \times 3$ thk ASTM A36 CS
 w/ Bail, plate 1 thk ASTM A36 CS

$$\begin{aligned} W_7 &= p_s (3 \text{ in.} \times \pi/4 \times 19^2 \text{ in}^2) + p_s (1 \text{ in.} \times 3 \text{ in.} \times 4.5 \text{ in.}) \\ &= 241 + 4 \\ &= 245 \text{ lbf.} \end{aligned}$$

Total weight of spray wand adapter assembly, $W_T = \sum_{i=1}^7 W_i$

$$W_T = 3,382 \text{ lbf.}$$

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 (8) Originator DA Koehler Date 7/25/94
 (9) Checker S.M. Miller Date 7/26/94

(10)

Lifting Analysis

The spray wand adapter will be installed using a spreader bar (H-2-821383) and the two lugs on the adapter.

The estimated weight of the adapter is approximately 3,382 lbf. For design purposes, the total weight of the adapter will be assumed to be 3,500 lbf.

Assume a dynamic load factor (DLF) of 2.0 on all lifts.

Allowable Stress

Allowable tensile stress, $F_t = \frac{1}{3} S_y$ (DOE-RL 92-36 1993)

Allowable shear stress, $F_s = \frac{1}{3} S_y$

For ASTM A36 CS,

$$F_t = \frac{1}{3} (36,000) = 12,000 \text{ lbf/in}^2$$

$$F_s = \frac{1}{3} (18,000) = 6,000 \text{ lbf/in}^2$$

- (1) Drawing H-2-821382 (2) Doc. No. _____
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 (9) Checker S.M. MILLER Date 7/26/94

(10)

Lifting Lugs, PN 5 : plate $\frac{1}{2}$ thick

5 LIFT LUG
SCALE: 1/4

Moment at pt A,

$$M_A = (3,500 \text{ lbf} \times 4 \text{ in.}) \\ = 14,000 \text{ lbf-in.}$$

Moment of inertia at pt. A,

$$I_A = \frac{1}{12} (\frac{1}{2} \text{ in.} \times 6 \text{ in.})^3 \\ = 9.0 \text{ in}^4$$

Bending stress at pt. A,

$$f_{bA} = \frac{M_A C}{I_A} = \frac{(14,000 \text{ lbf-in.} \times 3 \text{ in.})}{9.0 \text{ in}^4} = 4,667 \text{ lbf/in}^2$$

$$f_{bA} < F_t \rightarrow \text{OK}$$

Weld fixing lug to 14-in. pipe. Assume weld made with E60XX electrode. Ultimate strength of weldment is 60,000 lbf/in², slightly higher than ASTM A36 CS. Use same allowable stresses as A36.

Minimum failure area of weld,

$$A_w = 2(6 \text{ in.} \times \frac{5}{16} \text{ in.} \times \frac{1}{12}) = 2.65 \text{ in}^2$$

Moment of inertia of weld,

$$I_w = \frac{1}{12} (2 \times \frac{5}{16} \text{ in.} \times \frac{1}{12}) (6 \text{ in.})^3 = 8.0 \text{ in}^4$$

DESIGN CALCULATION

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- (1) Drawing H-4-821382 (2) Doc. No. _____ of 10
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 (8) Originator DA Koehler / D Koehler Date 7/25/94
 (9) Checker S.M. Miller / S.M. Miller Date 7/26/94

(10)

Bending stress at weld,

$$f_{bw} = \frac{(14,000 \text{ lbf-in} \times 3 \text{ in.})}{8.0 \text{ in}^3} = 5,250 \text{ lbf/in}^2$$

$$f_{bw} < F_t \rightarrow \text{OK}$$

Shear failure at hole.

Shear area (conservative),

$$A_s = 2(1.5 - 0.563)(0.5) \text{ in}^2 \\ = 0.937 \text{ in}^2$$

Shear stress,

$$f_s = \frac{3,500 \text{ lbf}}{0.937 \text{ in}^2} = 3,735 \text{ lbf/in}^2 < F_s \rightarrow \text{OK}$$

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(10)

Assembly weldments

Weld between outer pipe and cover.

Minimum failure area ($\frac{1}{4}$ -in. fillet),

$$A_w = \pi (14 \text{ in.}) (\frac{1}{4} \text{ in.}) (\frac{1}{12})$$

$$= 7.8 \text{ in.}^2$$

Tensile stress at weld,

$$f_{tw} = (7,000 \text{ lbf}) / 7.8 \text{ in.}^2 = 897 \text{ lbf/in.}^2$$

$$f_{tw} < F_t \rightarrow \text{OK}$$

All other weldments in the adapter all not critical and are sized according to good welding practice.

- (1) Drawing H-2-821383 (2) Doc. No. _____ Page B-14 8 of 10
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 (7) Subject Riser 3A Spray Wand Adapter Stress Analysis
 (8) Originator DA Koehler DA Koehler Date 7/25/94
 (9) Checker S.M. MILLER S.M. Miller Date 7/26/94

(10)

Spreader Bar (lifting yoke)

Maximum bending moment,

$$M = (3,500 \text{ lbf} \times 11 \text{ in.}) = 38,500 \text{ lbf-in.}$$

Section modulus of
 S5 x 14.75 (AISC 1989),

$$S = 6.09 \text{ in}^3$$

Bending Stress in beam (ASTM A36 CS),

$$f_b = \frac{M}{S} = \frac{38,500 \text{ lbf-in.}}{6.09 \text{ in}^3} = 6,322 \text{ lbf/in}^2 < F_t \rightarrow \text{OK}$$

Top Lug, PN 4: Plate 3/4 thk

4 TOP LIFTING PLATE

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(10)

Shear failure area (conservative estimate),

$$A_s = 0.75 \text{ in. } (2) \left[1.5 - \frac{1}{2} \left(1\frac{1}{8} \right) \right] \text{ in.} = 1.407 \text{ in}^2$$

Shear stress,

$$f_s = \frac{7,000 \text{ lbf}}{1.407 \text{ in}^2} = 4,975 \text{ lbf/in}^2 < F_s \rightarrow \text{OK}$$

Tensile failure area,

$$A_t \approx A_s = 1.407 \text{ in}^2$$

Tensile stress,

$$f_t = \frac{7,000 \text{ lbf}}{1.407 \text{ in}^2} = 4,975 \text{ lbf/in}^2 < F_t \rightarrow \text{OK}$$

weld fastening top lug to spreader bar. Assumed constructed using E60XX electrode, $\sigma_{ult} = 60,000 \text{ lbf/in}^2$ weld is full penetration with a generous fillet producing a greater cross section than the base metal of the lug. Therefore, no weld analysis is required.

Bottom Lugs, PN5: Plate 1/2 thk

5 BOTTOM LIFT PLATE

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(9) Checker S. M. Miller Date 7/26/94

(10)

Shear failure area (conservative estimate),

$$A_s = 0.5 \text{ in.} (2) \left[1 \frac{1}{4} - \frac{1}{2} \left(\frac{7}{8} \right) \right] \text{ in.} = 0.813 \text{ in}^2$$

Shear stress,

$$f_s = \frac{3,500 \text{ lbf.}}{0.813 \text{ in}^2} = 4,308 \text{ lbf/in}^2 < F_s \rightarrow \text{OK}$$

Tensile failure area,

$$A_t = A_s = 0.813 \text{ in}^2$$

Tensile stress,

$$f_t = \frac{3,500 \text{ lbf.}}{0.813 \text{ in}^2} = 4,308 \text{ lbf/in}^2 < F_t \rightarrow \text{OK}$$

Weld fastening bottom lug to spreader bar. Assumed constructed using E60XX electrode. Weld is full penetration with a generous fillet producing a greater cross section than the base metal of the lug. Therefore, no weld analysis is required.

REVIEW COMMENT RECORD (RCR)

1. Date
August 5, 1994

3. Project No.
SY-101 Hydrogen
Mitigation

2. Review No.

4. Page
1 of 2

Document Number(s)/Title(s) Attached Sheet	6. Program/Project/ Building Number SY-101	7. Reviewer J. P. Strehlow	8. Organization/Group TWRS Engineering Support Services	9. Location/Phone ETC-1/ RM 280/ 376-5009
---	--	-------------------------------	---	--

Comment Submittal Approval: 10. Agreement with Indicated comment disposition(s) 11. CLOSED

Organization Manager (Optional)

Date

Reviewer/Point of Contact

Author/Originator

Date

Reviewer/Point of Contact

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	Drawing H-2-821383 - Test the yoke assembly at 1.5 times it's maximum capacity. Add a note to this drawing to cover this test.		Accept.	Closed
2	Drawing H-2-821383 - The shackles that will be used to connect the yoke to the spray adapter should be included on this drawing.		Accept.	Closed
3	Drawing H-2-821383 - The holes in the lifting plates need to be sized 1/16 in. larger than the pins that will be used or sized to the shackle manufacturer's recommendations.		Accept.	Closed
4	Drawing H-2-821382 - A full penetration weld can not be achieved with the connection weld called out for the top lift plate. To insure that this weld is full penetration, change the size for the bevel weld to 3/8 in., half the thickness of the 3/4 in. thick lifting plate.		Accept.	Closed
5	Drawings H-2-821382 and H-2-821383 - Add an NDE examination such as MT to the welds that connect the lifting lugs or lifting plates.		Accept.	Closed

REVIEW COMMENT RECORD (RCR)

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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

Spray wand adapter stress analysis, page 5 - The evaluation of the lifting lug attachment weld should treat all fillet weld stresses as shear stresses. Also, the stress in the weld caused by the shear load needs to be included and combined with stress caused by the bending load. See "Design of Welded Structures," by Blodgett for details on an appropriate method. Using this method, and applying the assumed DLF of 2.0 that was used in the analysis, the stress in the connection weld will exceed the allowable value for shear stress. Therefore, a full penetration weld is recommended.

Accept.

Closed

7 Spray wand adapter stress analysis, page 8 - The stress in the 1/4 in. fillet weld should be compared to the shear stress allowable.

Accept.

Closed

8 Spray wand adapter stress analysis, page 8 - The stress analysis of the lifting yoke needs to be based on a load of 5,000 lbf, the maximum capacity shown on H-2-821383. The DLF of 2.0 would also need to be applied, bring the total load for the analysis to 10,000 lbf.

Accept.

Closed

9 Spray wand adapter stress analysis, page 9 and 10 - The shear stresses in the lifting plates will exceed the allowable value of 6,000 psi when a load of 5,000 lbf and a DLF of 2.0 are applied. Therefore, either use thicker material, increase the outside radius, or decrease the yoke capacity.

Accept.

Closed

Westinghouse
Hanford Company

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Page B-19

Internal
Memo

From: Mechanical Engineering
Phone: 376-3244 H5-70
Date: August 17, 1994
Subject: STRUCTURAL ANALYSIS OF RISER 3A SPRAY WAND ADAPTER (*Comments Incorporated*)

To: S. W. Shaw H5-70

cc: R. E. Russell H5-70
J. P. Strehlow H5-68
DAK-File/LB

References: AISC, 1989, *Allowable Stress Design*, American Institute of Steel Construction, Chicago, Illinois.

DOE-RL, 1993, *Hanford Site Hoisting and Rigging Manual*, DOE-RL 92-36, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Pytel, A., and F. L. Singer, 1987, *Strength of Materials*, Fourth Edition, Harper and Row, Publishers, New York, New York.

WHC, 1994a, *Riser 3A Spray Wand Adapter*, drawing H-2-821382, Westinghouse Hanford Company, Richland, Washington.

WHC, 1994b, *Riser Adapter Lifting Yoke*, drawing H-2-821383, Westinghouse Hanford Company, Richland, Washington.

Review comments from J. P. Strehlow were incorporated in the structural analysis of the riser 3A spray wand adapter. The attached structural analysis represents the revised version.

The riser 3A spray wand adapter (drawing H-2-821382) and lifting yoke (drawing H-2-821383) were structurally analyzed for lifting and found acceptable per criteria given in the *Hanford Site Hoisting and Rigging Manual*. The rigging manual states that maximum stress shall not exceed one-third of the minimum yield strength of the material.

The weight of the spray wand adapter is estimated at 3,385 lbf including the shield cap. This weight is an upper bound to the actual weight, which will be significantly less. The shield cap weighs considerably more than the drill rod washer, so it was included in the weight estimate instead of the washer. The steel shot cavity was assumed solid, conservatively increasing the estimated weight of the adapter.

S. W. Shaw
Page 2
August 17, 1994

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For design purposes, the weight of the adapter was assumed to be 3,500 lbf. A dynamic load factor (DLF) of 2.0 was assumed for conservatism. The structural analysis focused principally on the lifting lugs of the adapter and spreader bar (lifting yoke). The lugs were analyzed for tensile and bending failure, shear tear out, and adequacy of connecting welds. The critical welds of the adapter assembly also were evaluated and found acceptable.

All questions regarding the attached analysis should be directed to D. A. Koehler at 376-3244.

D. A. Koehler, Engineer
Mechanical Engineering

\kph

Attachment

INDEPENDENT REVIEW

Document Reviewed Riser 3A Spray Wand Adapter Stress Analysis

Author D.A. Koehler Document No. _____ EDT No. _____

The subject document has been reviewed by the undersigned. The reviewer reviewed and verified the following items as applicable [EP.4.1, Rev. 3].

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

Reviewer

7/27/94
Date

CHECKLIST FOR INDEPENDENT REVIEW

WHC-SD-WM-DA-169

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Document Reviewed Riser 3A Spray Wand Adapter Stress AnalysisAuthor D.A. Koehler

Document No. _____

Yes No N/A

☒	☐	☐	Problem completely defined.
☒	☐	☐	Necessary assumptions explicitly stated and supported.
☐	☐	☒	Computer codes and data files documented.
☒	☐	☐	Data used in calculations explicitly stated in document.
☒	☐	☐	Data checked for consistency with original source information as applicable.
☒	☐	☐	Mathematical derivations checked including dimensional consistency of results.
☐	☐	☒	Models appropriate and used within range of validity or use outside range of established validity justified.
☒	☐	☐	Hand calculations checked for errors.
☐	☐	☒	Code run streams correct and consistent with analysis documentation.
☐	☐	☒	Code output consistent with input and with results reported in analysis documentation.
☒	☐	☐	Acceptability limits on analytical results applicable and supported. Limits checked against sources.
☒	☐	☐	Safety margins consistent with good engineering practices.
☒	☐	☐	Conclusions consistent with analytical results and applicable limits.
☒	☐	☐	Results and conclusions address all points required in the problem statement.

MANDATORY

Software QA Log Number N/A

Reviewer

7/26/94
Date

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 (8) Originator DA Koehler & D. Koehler Date 7/25/94
 (9) Checker S. M. Miller A. W. Miller Date 7/26/94

(10)

Weight of Spray Wand Adapter (Riser Adapter)

The following calculations conservatively estimate the weight of the spray wand adapter. Each component of the spray wand adapter is calculated separately, jointly producing an upper bound to the total weight.

Density of steel, $\rho_s = 490 \text{ lbf/ft}^3 = 0.2836 \text{ lbf/in}^3$ (Pytel 1987)

Cover, PN 4 : Plate 35 Dia x 3 Hk ASTM A36 CS

$$W_1 = \rho_s (3 \text{ in.}) \left[\frac{\pi}{4} (35^2 - 6.75^2 - 2(3)^2) \right]$$

$$= 776 \text{ lbf.}$$

Inner Pipe, PN 8 : Pipe 6 Dia Schd 40
ASTM A53

$$W_2 = 18.97 \text{ lbf/ft} (1 \text{ ft}/12 \text{ in.}) (6.75 \text{ in.})$$

$$= 107 \text{ lbf.}$$

Outer Pipe, PN 7 : Pipe 14 Dia Schd 40 ASTM A53
The 12x14 Reducer will be included in the weight of the outer pipe.

$$W_3 = 63.44 \text{ lbf/ft} (1 \text{ ft}/12 \text{ in.}) (63.25 \text{ in.})$$

$$= 334 \text{ lbf.}$$

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 (9) Checker S. M. MILLER K M Miller Date 7/26/94

(10)

Steel Shot, PN 9 : #8 Shot

To be conservative, the cavity formed by the inner and outer pipe will be assumed solid.

$$W_4 = p_s (63.25 \text{ in.}) \left[\frac{\pi}{4} (13.124^2 - 6.625^2) \right] \text{ in}^2$$

$$= 1,808 \text{ lbf.}$$

Flange, PN 6 : 12 Dia Blind 150 Class

$$W_5 = p_s (1.5 \text{ in.}) \left[\frac{\pi}{4} (19^2 - 6.75^2) \right] \text{ in}^2$$

$$= 105 \text{ lbf.}$$

⑥ FLANGE, MODIFIED

Lifting Lugs, PN 5 : Plate 3/4 thk
ASTM A36 CS

Approximate weight by assuming a rectangle.

$$W_6 = p_s (0.75 \text{ in.}) (6 \text{ in.} \times 4 \text{ in.}) (2)$$

$$= 10 \text{ lbf}$$

⑤ LIFT LUG
SCALE: 1/4

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 (9) Checker S. M. MILLER L. M. Miller Date 7/26/94

(10)

Shield Cap, PN 2: Plate $\phi 19 \times 3$ thk ASTM A36 CS
 w/ Bail, plate 1 thk ASTM A36 CS

$$\begin{aligned}
 W_7 &= \rho_s (3 \text{ in.}) (\pi/4) (19^2 \text{ in}^2) + \rho_s (1 \text{ in.}) (3 \text{ in.}) (4.5 \text{ in.}) \\
 &= 241 + 4 \\
 &= 245 \text{ lbf.}
 \end{aligned}$$

Total weight of spray wand adapter assembly, $W_T = \sum_{i=1}^7 W_i$

$$W_T = 3,385 \text{ lbf.}$$

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 (8) Originator DA Koehler DA Koehler Date 7/25/94
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(10)

Lifting Analysis

The spray wand adapter will be installed using a spreader bar (H-2-821383) and the two lugs on the adapter.

The estimated weight of the adapter is approximately 3,385 lbf. For design purposes, the total weight of the adapter will be assumed to be 3,500 lbf.

Assume a dynamic load factor (DLF) of 2.0 on all lifts.

Allowable Stress

Allowable tensile stress, $F_t = \frac{1}{3} S_y$ (DOE-RL 92-36 1993)

Allowable shear stress, $F_s = \frac{1}{3} S_y$

For ASTM A36 CS,

$$F_t = \frac{1}{3} (36,000) = 12,000 \text{ lbf/in}^2$$

$$F_s = \frac{1}{3} (18,000) = 6,000 \text{ lbf/in}^2$$

Allowable bending stress = Allowable tensile stress

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 (9) Checker J.M. Miller L.M. Miller Date 7/26/94

(10)

Lifting Lugs, PN 5: plate 3/4" thk, ASTM A36

Moment at A-A,

$$M_A = (3,500 \text{ lbf} \times 4 \text{ in.}) = 14,000 \text{ lbf-in.}$$

Moment of Inertia at A-A,

$$I_A = \frac{1}{12} (3/4 \text{ in.} \times 6 \text{ in.})^3 = 13.5 \text{ in}^4$$

Bending stress at A-A,

$$f_{bA} = \frac{M_A C}{I_A} = \frac{(14,000 \text{ lbf})(3 \text{ in.})}{13.5 \text{ in}^4} = 3,111 \text{ lbf/in}^2$$

$$f_{bA} < F_t \rightarrow \text{OK}$$

Shear stress at B-B,

$$f_{sB} = \frac{3,500 \text{ lbf}}{2 (3/4 \times 1 3/32)} = 2,133 \text{ lbf/in}^2 < F_s \rightarrow \text{OK}$$

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 (8) Originator DA Koehler D. Koehler Date 7/25/94
 (9) Checker S. M. MILLER S. M. Miller Date 7/26/94

(10)

Weld fixing lug to 14-in. pipe. Assume weld made with E60XX electrode, $\sigma_u = 60,000 \text{ lbf/in}^2$. Ultimate strength of weld is slightly higher than base metal, ASTM A36, $\sigma_u = 58,000 \text{ lbf/in}^2$. Since weld is full penetration and weld failure area is equivalent to the base metal cross-section, no further weld analysis is necessary.

Shear failure at hole,

Shear failure area,

$$A_s = 2 \left(1\frac{1}{2} - \frac{1}{2} \left(\frac{13}{16} \right) \right) \left(\frac{3}{4} \right) \text{ in}^2$$

$$= 1.641 \text{ in}^2$$

(Conservative estimate)

Shear stress,

$$f_s = \frac{3,500 \text{ lbf.}}{1.641 \text{ in}^2} = 2,133 \text{ lbf/in}^2 < F_s \rightarrow \text{OK}$$

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(10)

Assembly Weldments

Critical weld: weld between outer pipe (PN 7) and cover (PN 4).

Minimum failure area of $\frac{1}{4}$ -in. fillet,

$$A_w = \pi (14 \text{ in.} \times \frac{1}{4} \text{ in.}) (\frac{1}{12})$$

$$= 7.8 \text{ in.}^2$$

Assume fillet weld fails in shear.

shear stress on weld,

$$f_{sw} = \frac{7000 \text{ lbf.}}{7.8 \text{ in.}^2} = 897 \text{ lbf/in.}^2$$

$$f_{sw} < F_s \rightarrow \text{OK}$$

All other welds in the adapter (excluding the lifting lug welds) are not critical and are sized according to good welding practice.

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 (8) Originator DA Koehler Date 7/25/94
 (9) Checker SM MILLER Date 7/26/94

(10)

Riser Adapter Lifting Yoke (Spreader Bar)

Maximum Capacity 5,000 lbf.

Maximum Bending Moment,

$$M = 5,000 \text{ lbf} (11 \text{ in.}) = 55,000 \text{ in-lbf}$$

Section Modulus of $S5 \times 14.75$,

$$S = 6.09 \text{ in}^3 \quad (\text{AISC 1989})$$

Bending Stress in Beam,

$$f_b = \frac{M}{S} = \frac{55,000 \text{ in-lbf}}{6.09 \text{ in}^3} = 9,031 \text{ lbf/in}^2 < F_t \rightarrow \text{OK}$$

Top Lug, PN4: Plate 1 thk

Shear failure area,

$$A_s = 1(2) \left[1\frac{1}{2} - \frac{1}{2} \left(1\frac{1}{16} \right) \right] \text{ in}^2 \\ = 1.938 \text{ in}^2$$

conservative estimate

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(10)

Shear Stress,

$$f_s = \frac{10,000 \text{ lbf}}{1.938 \text{ in}^2} = 5,161 \text{ lbf/in}^2 < F_s \rightarrow \text{OK}$$

Tensile failure area,

$$A_t \approx A_s = 1.938 \text{ in}^2$$

Tensile stress,

$$f_t = \frac{10,000 \text{ lbf}}{1.938 \text{ in}^2} = 5,161 \text{ lbf/in}^2 < F_t \rightarrow \text{OK}$$

Weld fixing top lug to spreader bar. Assume weld made with E60XX electrode, $G_u = 60,000 \text{ lbf/in}^2$. Ultimate strength of weld is slightly higher than base metal, ASTM A36, $G_u = 58,000 \text{ lbf/in}^2$. Since weld is full penetration and weld failure area is larger than the base metal cross-section, no further weld analysis is necessary.

Bottom Lugs, PN5: Plate $\frac{3}{4}$ thk

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(10)

Shear failure area,

$$A_s = \frac{3}{4} (2) \left[1 \frac{1}{4} - \frac{1}{2} \left(\frac{13}{16} \right) \right] \text{ in}^2 = 1.266 \text{ in}^2$$

conservative estimate

Shear stress,

$$f_s = \frac{5,000 \text{ lbf}}{1.266 \text{ in}^2} = 3,949 \text{ lbf/in}^2 < F_s \rightarrow \text{OK}$$

Tensile failure area,

$$A_t \approx A_s = 1.266 \text{ in}^2$$

Tensile stress,

$$f_t = \frac{5,000 \text{ lbf}}{1.266 \text{ in}^2} = 3,949 \text{ lbf/in}^2 < F_t \rightarrow \text{OK}$$

Weld fixing bottom lug to spreader bar. Assume weld made with E60XX electrode, $\sigma_u = 60,000 \text{ lbf/in}^2$. Ultimate strength of weld is slightly higher than base metal, ASTM A36, $\sigma_u = 58,000 \text{ lbf/in}^2$. Since weld is full penetration and weld failure area is larger than the base metal cross-section, no further weld analysis is necessary.