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Title/Desc:

ANALYSIS OF THE RETAINED GAS SAMPLE EXTRUDER
ASSEMBLY

SEP 1 1995

Sta. # 3 58

ENGINEERING DATA TRANSMITTAL

Page 1 of 1

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1	WHC-SD-WM-DA-200	NA	0	ANALYSIS OF THE RETAINED GAS SAMPLE (RGS) EXTRUDER ASSEMBLY	3QS	2 1 9-1-95	1	

16. KEY					
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1	1	Cog. Mgr. R. C. Knight		8-1-95	L6-38						
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1	1	Safety m.		8-1-95	S1-57						
		Env.									
1		AS Mngr. R. M. Boger		8-1-95	H5-57						
1	1	Indep. Review J. L. Julyk		12/1/95	E6-46						

18. <i>[Signature]</i> B. L. Coverdell Signature of EDT Originator Date 7-19-95		19. <i>[Signature]</i> C. G. Linschooten Authorized Representative for Receiving Organization Date 8-1-95		20. <i>[Signature]</i> R. C. Knight Cognizant Manager Date 8/3/95		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-200, REV 0

Document Title: Analysis of The Retained Gas Sample (RGS) Extruder Assembly

Release Date: 9/1/95

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

APPROVED FOR PUBLIC RELEASE

WHC Information Release Administration Specialist:

Kara M. Broz

9/1/95

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SUPPORTING DOCUMENT

1. Total Pages 28

2. Title

ANALYSIS OF THE RETAINED GAS SAMPLE (RGS)
EXTRUDER ASSEMBLY

3. Number

WHC-SD-WM-DA-200

4. Rev No.

0

5. Key Words

Extruder
Analysis
Retained
Gas
Sample

6. Author

Name: B. L. Coverdell

B L Coverdell
Signature

Organization/Charge Code AS/N2D2A

7. Abstract

In order for the Retained Gas Sample (RGS) Extruder Assembly to be safely used it was determined by the cognizant engineer that a stress analysis was necessary.

The use of the finite-element analysis (FEA) program COSMOS/M version 1.71 permitted a quick, easy, and detailed stress analysis of the RGS Extruder Assembly. The FEA model is a three dimensional model using the SHELL4T element type. From the results of the FEA, the cognizant engineer determined that the RGS Extruder would be rated at 10,000 lbf and load tested to 12,000 lbf. The respective input and output files for this model are EXTR02.GFM and EXTR02.OUT and can be found on the attached tape.

8. RELEASE STAMP

OFFICIAL RELEASE	58
BY WHC	
DATE SEP	1 1995
Sta #3	

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**ANALYSIS OF THE RETAINED GAS SAMPLE (RGS)
EXTRUDER ASSEMBLY**

July 10, 1995

PREPARED BY: B. L. Coverdell 7-21-95

B. L. Coverdell, Advanced Engineer
Analytical Services

REVIEWED BY: J. L. Julyk 7/27/95

J. L. Julyk, Engineer
Engineering and Technical Support Services

APPROVED BY: J. F. Thayer For R.M. Boger 7-31-95

R. M. Boger, Manager
Analytical Services

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

DESIGN VERIFICATION METHOD

The need for design verification has been reviewed with the method selected as indicated below:
(ESR / Work Plan # NA / _____).

- ☒ Independent Review
☐ Alternate Calculations
☐ Qualification Testing
☐ Formal Design Review

R. M. Boger For Rm Boger
Cognizant/Project/Design Manager

SD # WHC-SD-WM-DA-200

ECN # NA

DWG(S) # _____

CHECKLIST FOR INDEPENDENT REVIEW

Document Reviewed Analysis of the Retained Gas Sample Extruder Assembly

Author B. L. Coverdell

<u>Yes</u>	<u>No</u>	<u>N/A</u>	
[✓]	[]	[]	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. (SEE TAPE) <u>BLC</u> <u>9-1-95</u>
[✓]	[]	[]	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 BLC-95-20

I. L. Iuliyk
Reviewer

I. L. Iuliyk

7/27/95
Date

ENGINEERING ANALYSIS SOFTWARE REPORT FORM

July 10, 1995

DATE ANALYSIS PERFORMED

BLC-95-20

SOFTWARE LOG NUMBER

SOFTWARE APPLICATION: COSMOS/M ver 1.71.B. L. Coverdell

B. L. Coverdell, Analytical Services

ANALYST

7-21-95

DATE

J. F. Thayer for R. M. Boger

R. M. Boger, Analytical Services

MANAGER

7-31-95

DATE

DESCRIPTION OF ANALYSIS:

The use of the finite-element analysis (FEA) program COSMOS/M version 1.71 permitted a quick, easy, and detailed stress analysis of the RGS Extruder Assembly. The FEA model is a three dimensional model using the SHELL4T element type. The maximum loading was determined to be 10,000 lbf. The respective input and output files for this model are EXTR02.GFM and EXTR02.OUT and can be found on the attached tape.

J. L. JulykJ. L. Julyk, Engineering and Technical Support Services
REVIEWER7/21/95

DATE

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2.0 SUMMARY OF RESULTS	1
3.0 DISCUSSION	1
4.0 RESULTS AND CONCLUSIONS	2
5.0 REQUIREMENTS	2
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APPENDICES

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Appendix B	von Mises Stress Plot and Geometry Plot of RGS Extruder Assembly Finite-Element Model	B-1
Appendix C	Weld Analysis Calculations	C-1

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1.0 INTRODUCTION

In order for the Retained Gas Sample (RGS) Extruder Assembly to be safely used it was determined by the cognizant engineer that a structural analysis was necessary. The safety class assigned to this component is 3SQ.

2.0 SUMMARY OF RESULTS

The finite-element analysis (FEA) model EXTR02 determined that the maximum von Mises stress is 30,100 lbf/in² (see the stress plot in Appendix B) based on a 10,000 lbf load. The extruder assembly has been given a safety class of 3SQ, however, it is left up to the cognizant engineer to determine if the resulting stresses are within reasonable limits. It should be noted that the assembly was qualified by testing (WHC 1995). The calculations in Appendix C combined with the plot of von Mises stresses shows that all fillet welds are adequate. From the results of the FEA, the cognizant engineer determined that the RGS Extruder would be rated at 10,000 lbf and load tested to 12,500 lbf.

3.0 DISCUSSION

In order to sample the radioactive contents of waste storage tanks a device was designed to remotely remove a sample. This device is called the RGS Extractor. Due to the radioactive nature of the sample and the possibility that the sample could solidify in the extractor, it was determined that a mechanism was needed to remove the sample. This mechanism is the RGS Extruder Assembly (WHC 1994).

From experience it was determined that the loading to be applied to the RGS Extruder Assembly model is 10,000 lbf (Appendix A). Due to the low number of cycles, fatigue was not a consideration. The load imposed by the RGS Extractor was modeled by first placing a fixed boundary condition over the area which the extractor nut will contact and then placing forces around the hydraulic ram bolt holes the sum of which is 10,000 lbf (see plot 3 in Appendix B). The only true remaining boundary condition is in the Y-direction and it represents the reaction due to a table or stand that the assembly is placed upon, however, additional boundary conditions were necessary to ensure that the finite-element model was stable.

The results from the FEA model are shown as a von Mises stress plot in Appendix B. The FEA model was also interrogated to determine the maximum von Mises stress at the fillet welds. A plot of the maximum von Mises stress is shown in Appendix C. The maximum stress was then used in calculations to determine the adequacy of the fillet welds.

4.0 RESULTS AND CONCLUSIONS

The von Mises stress plot in Appendix B shows that the maximum stress due to the 10,000 lbf load on the RGS Extruder Assembly is 30,100 lbf/in². The maximum stress occurs in two locations; around the bolt holes and at the contact surface for the RGS Extractor. The high stress at both locations is due to stress concentrations in the FEA model. For this reason, the maximum stress in the RGS Extruder must be found by examining the FEA model at points away from these locations. Also, the hydraulic ram and the nut on the RGS Extractor were not modeled due to the complexity that they would add to the model. Both items would offer significant support to the extruder around the areas of highest stress. From the von Mises stress plot the cognizant engineer determined that the RGS Extruder Assembly would be rated for a maximum loading of 10,000 lbf and load tested to 12,500 lbf.

5.0 REQUIREMENTS

The only requirement that RGS Extruder Assembly must meet is that the force exerted by the hydraulic ram is not to exceed 10,000 lbf.

6.0 REFERENCES

- AISC, 1989, *Manual of Steel Construction*, ninth Edition, American Institute of Steel Construction, Chicago, Illinois.
- Blodgett, O. W., 1991, *Design of Welded Structures*, fourteenth printing, The James F. Lincoln Arc Welding Foundation, Cleveland, Ohio.
- SRAC, 1994, *COSMOS/M*, Version 1.71, Structural Research and Analysis Corporation, Santa Monica, California.
- WHC, 1994, *Retained Gas Sampling Extruder Assembly*, drawing H-2-85441, Westinghouse Hanford Company, Richland, Washington.
- WHC, 1995, *Acceptance Test Procedure for the Retained Gas Sample Extruder (H-2-85441)*, WHC-SD-WM-ATP-495 Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Appendix A

cc:Mail of RGS Extruder Assembly Loading Requirements

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Author: Brent J Webb at ~WHC163
Date: 9/27/94 12:41 PM
Priority: Normal
Subject: RGS EXTRACTOR & EXTRUDER

WHC-SD-WM-DA-200
Rev. 0

----- Message Contents -----

Chris,

We expected to see 10,000 lbf once or twice in the extruder lifetime. We expect to possibly 4 % at the 5000 lbf range, and 95% at 2000 lbf or less. This is based on previous SY-103 data.

Thanks... Brent

For the extractor design I need all the specifications of the bought items. Since the parts are already selected on the drawing somebody must have that information. It saves us time. Thanks.

For the extruder design we need a usage schedule for the stress engineering. Like we expect xx% extrusions at 1000 lbs; yy% extrusions at 2000 lbs; zz% extrusions at 5000 lbs and ww% extrusions at 10,000 lbs.

The workplan specifies 3000 extrusions in 10 years. Is that what we are going to do or are going to do less extrusions in less/more time. If there is only one possibility in the life time that we hit 10,000 lbs or even once a year that is quit a difference. Please let me know.

Chris Linschooten

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Appendix B

von Mises Stress Plot and Geometry Plot of RGS Extruder Assembly Finite-Element Model

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Lin STRESS Lc=3

COSMOS/M

Version : V1.71

EXTR02

7-26-95

PLOT 1

COSMOS/M
Version : V1.71
EXTR02
7-26-95

PLOT 3

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Appendix C
Weld Analysis Calculations

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ICF KAISER

HANFORD COMPANY

DESIGN ANALYSIS

Calc. No. _____
Revision 0
Page No. 1 of

ent: Westinghouse Hanford Company
Subject: Retained Gas Sample (RGS) Weld Calculations
Location: 200 E /

WO/Job No. N2D2A
Date: 07/18/95
Checked: 7/28/95
Revised: _____

By: B. L. Coverdell
By: [Signature]
By: _____

PURPOSE:

The calculations below determine the adequacy of the fillet welds used to construct the Retained Gas Sample (RGS) Extruder Assembly.

ASSUMPTIONS:

- 1) The finite-element analysis model EXTR02 is an adequate representation of the RGS Extruder Assembly.

DESCRIPTION:

The fillet welds are analyzed by extracting the maximum von Mises stress from the linear elastic finite element model EXTR02. The von Mises stresses are extract at all of the seems to be welded, however, only the maximum stress is used in the weld calculations. The maximum von Mises stress is shown on the accompanying plot.

WELD CALCULATIONS:

The weld can be shown to be adequate by determining the maximum von Mises stress on the weld, calculating the actual linear weld force and comparing it to the allowable linear weld force. The maximum von Mises stress is shown in the attached figure. The maximum stress occurs at the connection of the bottom plate and the plate connecting the hydraulic ram.

$$\sigma_{\max} = 6893.3 \cdot \text{psi}$$

$$\sigma_{\max} = 6.893 \cdot 10^3 \cdot \text{psi}$$

Maximum von Mises stress on any of the welds (see plot 12.15)

$$t = 0.625 \cdot \text{in}$$

Thickness of the welded plate.

$$F_t = \sigma_{\max} \cdot t$$

$$F_t = 4308.3 \cdot \frac{\text{lbf}}{\text{in}}$$

Actual linear weld force.

$$w_a = 2 \cdot 0.25 \cdot \text{in}$$

Weld size from WHC 1994. All plates are welded on either side by 1/4" welds.

$$f_a = w_a \cdot .707 \cdot .3 \cdot 60000 \cdot \text{psi}$$

$$f_a = 6363 \cdot \frac{\text{lbf}}{\text{in}}$$

Allowable linear weld force per Blodgett 1991, Chapter 7 and AISC 1989.

$$\frac{f_a}{F_t} = 1.477$$

Since the true weld force is less than the allowable weld force, this weld is adequate to support the new load due to the tie down reconfiguration.

RESULTS AND CONCLUSIONS:

The weld calculations above show that all 1/4" fillet welds are adequate on the RGS Extruder Assembly.

REFERENCES:

- AISC, 1989, *Manual of Steel Construction*, ninth Edition, American Institute of Steel Construction, Chicago Illinois.
- Blodgett, 1991, *Design of Welded Structures*, 14th printing, The James F. Lincoln Arc Welding Foundation, Cleveland, Ohio.
- SRAC, 1993, *COSMOS/M*, Version 1.71, Structural Research and Analysis Corporation, Santa Monica, California.
- WHC, 1994, *Retained Gas Sample Extruder Assembly*, drawing H-2-85441 Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Line STRESS Lc=3

Von Mises

COSMOS/M

Version : V1.71

EXTR02

7-25-95

PLOT

PLOT 5

PLOT

L1n STRESS Lc=3

PLOT 7

Lin STRESS Lc=3

VON MISES
2.89E+04
2.53E+04
2.17E+04
1.81E+04
1.46E+04
1.10E+04
7.43E+03
3.88E+03
284.000

COSMOS/M
Version : V1.71
EXTR02
7-25-95

PLOT

PLOT 9

PLOT

Lin STRESS Lc-3

Von Mises

COSMOS/M

Version : V1.71

EXTR02

7-25-95

PLOT 11

PLOT

PLOT 13

Line STRESS Loc-3

Von Mises
3.01E+04
2.64E+04
2.28E+04
1.89E+04
1.51E+04
1.14E+04
7.62E+03
3.87E+03
115.0000

COSMOS/M
Version: V1.71
EXTR02
7-25-95

PLOT

PLOT 15

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