Sheet (2)
JUL 30 1998

ENGINEERING DATA TRANSMITTAL

Page 1 of 1
1. EDT 622237

2. To: (Receiving Organization) Distribution		3. From: (Originating Organization) TWRS Projects/SST Retrieval		4. Related EDT No.: n/a	
5. Proj./Prog./Dept./Div.: D299/ W-320 TWRS/TCPN # D2MA1		6. Design Authority/ Design Agent/Cog. Engr.: JW Bailey, NHC		7. Purchase Order No.: n/a	
8. Originator Remarks: For approval and release of a new supporting document. This document has been generated to ensure retrievability of the Project W-320 "Piping Calculations, Vol. 9".				9. Equip./Component No.: n/a	
				10. System/Bldg./Facility: 241-C-106	
11. Receiver Remarks: 11A. Design Baseline Document? ☒ Yes ☐ No				12. Major Assm. Dwg. No.: n/a	
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				14. Required Response Date:	

15. DATA TRANSMITTED					(F)	(G)	(H)	(I)
(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	HNF-2479	-	0	Project W-320, 241-C-106 Sluicing, Piping Calculations, Vol. 9	NA			-

16. KEY					
Approval Designator (F)		Reason for Transmittal (G)		Disposition (H) & (I)	
E, S, Q, D or N/A (see WHC-CM-3-5, Sec. 12.7)		1. Approval 2. Release 3. Information	4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)	1. Approved 2. Approved w/comment 3. Disapproved w/comment	4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged

17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)											
(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN
2	1	Design Authority	JW Bailey	7/24/98	S2-48						
		Design Agent	M.C. Davenport	7/25/98							
2	1	Cog. Eng.	AE Graves	7/25/98	S2-48						
2	1	Cog. Mgr	JW Bailey	7/24/98	S2-48						
		QA									
		Safety									
		Env.									

18. M.C. Davenport Signature of EDT Originator 3/24/98 7/25/98		19. Authorized Representative Date for Receiving Organization		20. JW Bailey Signature of Cognizant Manager 3/24/98 7/25/98		21. DOE APPROVAL (if required) Ctrl. No. ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments	
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BD-7400-172-2 (05/96) GEF097

BD-7400-172-1

Project W-320, 241-C-106 Sluicing Piping Calculations, Vol. 9

John W. Bailey

Numatec Hanford Co., Richland, WA 99352

U.S. Department of Energy Contract DE-AC09-96RL13200

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Total Pages: 347

Key Words: W-320, Sluicing, Tank 241-C-106, Tank 241-AY-102, WRSS, calculations, piping.

Abstract: This supporting document has been prepared to make the FDNW calculations for Project W-320, readily retrievable.

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Release Approval

7/30/98
Date

Approved for Public Release

Project W-320, 241-C-106 Sluicing Piping Calculations, Vol. 9

TABLE OF CONTENTS

Calc. No.	Title	Page
W320-27-049	Sizing of HVAC Duct Flushing System	A-i
W320-27-050	Portable Exhauster Installation Analysis	B-i
W320-27-051	Jumper Flushing Supply Head Analysis	C-i
W320-27-053	New Supernate Jumper Analysis	D-i
W320-27-054	System Curves for Portable Exhauster Installation	E-i
W320-27-055	Nozzle Plate & Encasement Plate Analysis	F-i

W320-27-049

Sizing of HVAC Duct Flushing System

This sheet shows the status and description of the attached Design Analysis sheets.

Discipline: Mechanical

WO/Job No.: W-320

Calculation No.: W-320-27-049

Project No. & Name: W-320, WASTE RETRIEVAL for TANK 241-C-106.

Calculation Item: Sizing of HVAC Duct Flushing System

These calculations apply to:

Dwg. No.: H-2-818470 Sh. 1, and 2.

Rev. No. 1

Dwg. No.: H-2-818470 Sh. 5

Rev. No. 0

Other (Study, CDR):N/A

Rev. No. N/A

The status of these calculations is:

☐ Preliminary Calculations

☒ Final Calculations

☐ Check Calculations (On Calculation Dated)

☐ Void Calculation (Reason Voided)

Incorporated in Final Drawings?

☒ Yes ☐ No

This calculation verified by independent "check" calculations?

☐ Yes ☒ No

Original and Revised Calculation Approvals:

	Rev. 0 Signature/Date	Rev. 1 Signature/Date	Rev. 2 Signature/Date
Originator	11/04/97		
Checked by	4/6/97		
Approved by	4/8/98		
Checked Against Approved Vendor Data	4.11.98		

INDEX

Design Analysis
Page No.

Description

I, ii	Calculation Identification and Index
iii	Calculation Cross Index
1	Objectives, Design Inputs and Calculation
2	Conclusion
Appendix A	Technical Data

HNF-2479, Rev. 0
Page A-2

[illegible]

IEL

2.

Calc. No.: W-320-27-049

Revision: 0

Page No.: 1 of 2

DESIGN ANALYSIS

poration

WO/Job No.: W-320

TRIEVAL For TANK 241-C-106.

Date: 11/04/97

By: N. J. Juplo

Flushing System

Checked: 11/6/97

By: J. L. Egan

ss Building

Revised:

By:

f this calculation is to determine the size and capacity of the HVAC duct (10"VT-1010-system.

TS:

Document, Project W-320, Tank 241-C-106 Sluicing, Project Rebaselining Change Scope, HNF-SD-W320-DB-001, Rev. 0.

VS

sed for the calculation of the flushing system is only based on the full flushing coverage face of the HVAC duct. The effectiveness and frequency of flushing to remove ds that accumulate on the interior walls of the duct (thus reducing radiological dose e outside surface of the duct) will be determined by field measurements, radiological rm by farm HPs.

ANALYSIS

tion.

hing system raw water supply pressure is 60 psig.

size = 10"

Ref. 1.

shing supply line = 1" (1" RAW-601-M5) located in the Process Bldg. Ref. 2.

ES

I-320 Drawing # H-2-818470, Sh. 1, Rev. 1.

I-320 Drawing # H-2-818481, Sh. 2, Rev. 1.

chnical Paper # 410, Flow of Fluids.

pray Nozzles, Systems and Accessories.

N:

the reasonable liquid flow rate for the existing 1" supply line:

ne Technical Paper # 410, Flow of Fluids:

Ref. 3, page B-14.

DESIGN ANALYSIS

Numatec Hanford Corporation

WO/Job No.: W-320

W-320, WASTE RETRIEVAL For TANK 241-C-106.
Sizing of HVAC Duct Flushing System

Date: 11/04/97

By: N. J. Juplo

Checked: 11/1/97

By: *D. L. Evans*

on: C-Tank Farm/Process Building

Revised:

By:

A 1" diameter pipe with a reasonable velocity of 5.57 ft/sec. (pressure drop of 6.36 psi/100 ft of pipe), has a discharge of 15 gpm.

From Lechler Spray Nozzles, Systems and Accessories:

A 1/4" spray nozzle, full cone, 90 degree spray at 60 psi pressure will deliver 0.64 gpm (max. 0.8 gpm at 100 psi pressure).

By inspection, the 1/4" spray nozzle at 60 psi pressure will effectively cover the inner surface of the 10" duct up to a distance of at least 4 feet from the nozzle.

Per the HVAC duct Drawing (Ref. 1), 8 nozzles at approx. 2'-8" centers will effectively flush the HVAC duct (conservative overlapping spray). With 8 spray nozzles, the maximum total flushing flow requirement of the nozzles is 6.4 gpm (at 100 psi pressure), which is well within the raw water supply availability of 15 gpm.

The flush system header is a 1/2" diameter pipe and is only approximately 20 feet long. At 6.4 maximum gpm the fluid velocity is 6.75 ft/sec. (reasonable) and the pressure drop is about 17 psi/100 ft. of pipe. The total pressure drop of the 1/2" pipe should not be a significant factor to affect the flushing system, to fully cover the inner surface of the HVAC duct to be flushed.

4.0. CONCLUSIONS:

Based on the above analysis, a flushing system consisting of eight (8) 1/4" spray nozzles with a maximum flow rate of 0.8 gpm each at 100 psi pressure, will meet the flushing requirement for the 10" HVAC duct 10"VT-1010-M5. In addition, an existing 1" line located in the Process Building can be utilized and can handle the flushing requirement.

Appendix A

FULL CONE

AXIAL FULL CONE WALL MOUNT NOZZLES

HNF-2479, Rev. 0
Page A-7

1/4" TO 1/2" NPT (M)

Inlet	Dimensions Inches		Approx. Weight (oz.)
	A	B	
1/4"	1.179	9/16	2
3/8"	1.260	11/16	3
1/2"	2.38	7/8	3.7

Full Cone Wall Mount Nozzles

Lechler axial wall mount full cone nozzles mirror our popular 460 series and offer the same outstanding performance. All the advantages of this design are available in the wall mount

configuration which allows mounting through the side of a pipe, vessel or container.

This configuration uses a male NPT thread on both ends of the nozzle, both the same size.

Product Codes for Ordering				Nozzle Inlet/Mounting Thread Male NPT x Male NPT	Orifice Diam. (In.)	Flow Rate (Gallons Per Minute)							Spray Width @ 40 psi			
Nozzle Type	Material Code					20 psi	25 bar	40 psi	60 psi	80 psi	100 psi	10' 50'	12' 60'	15' 75'	20' 100'	
	ES	ES	0													
Spray Angle	16	17	30	1/4 x 1/4	3/8 x 3/8	1/2 x 1/2										
60°																
480.404	○	○	○	BC/BC		.051	0.23	1.00	0.30	0.35	0.40	0.43				
480.444	○	○	○	BC/BC		.053	0.28	1.25	0.38	0.44	0.50	0.54				
480.484	○	○	○	BC/BC		.057	0.36	1.60	0.48	0.57	0.63	0.69				
480.504	○	○	○	BC/BC		.059	0.41	1.80	0.54	0.64	0.71	0.78				
480.524	○	○	○	BC/BC		.066	0.46	2.00	0.60	0.71	0.79	0.87				
480.564	○	○	○	BC/BC		.074	0.57	2.50	0.75	0.88	0.99	1.08				
480.604	○	○	○	BC/BC		.084	0.72	3.15	0.95	1.11	1.25	1.37				
480.644	○	○	○	BE/BE		.094	0.91	4.00	1.20	1.41	1.59	1.73				
480.684	○	○	○	BE/BE		.100	1.14	5.00	1.50	1.77	1.98	2.17				
480.704	○	○	○	BE/BE		.106	1.27	5.60	1.68	1.98	2.22	2.43				
480.724	○	○	○	BE/BE		.112	1.43	6.30	1.89	2.23	2.45	2.73				
480.764	○	○	○	BE/BE		.116	1.62	8.00	2.40	2.83	3.17	3.47				
480.784	○	○	○	BE/BE		.126	2.05	9.00	2.70	3.18	3.57	3.90				
480.804	○	○	○	BE/BE		.133	2.28	10.0	3.00	3.53	3.96	4.33				
480.844	○	○	○	BG/BG		.149	2.85	12.5	3.75	4.42	4.95	5.42				
480.884	○	○	○	BG/BG		.169	3.64	16.0	4.81	5.65	6.34	6.93				
90°	120°												H=10° 90°	H=20° 120°	H=10° 120°	H=20° 120°
480.406	480.408	○	○	BC/BC		.047	0.23	1.00	0.30	0.35	0.40	0.43				
480.446	480.448	○	○	BC/BC		.051	0.28	1.25	0.38	0.44	0.50	0.54				
480.486	480.488	○	○	BC/BC		.053	0.36	1.60	0.48	0.57	0.63	0.69				
480.506	480.508	○	○	BC/BC		.057	0.41	1.80	0.54	0.64	0.71	0.78				
480.526	480.528	○	○	BC/BC		.059	0.46	2.00	0.60	0.71	0.79	0.87				
480.566	480.568	○	○	BC/BC		.066	0.57	2.50	0.75	0.88	0.99	1.08				
480.606	480.608	○	○	BC/BC		.074	0.72	3.15	0.95	1.11	1.25	1.37				
480.646	480.648	○	○	BC/BC		.084	0.91	4.00	1.20	1.41	1.59	1.73				
480.686	480.688	○	○	BC/BC		.094	1.14	5.00	1.50	1.77	1.98	2.17				
480.706	480.708	○	○	BC/BC		.100	1.27	5.60	1.68	1.98	2.22	2.43				
480.726	480.728	○	○	BC/BC		.106	1.43	6.30	1.89	2.23	2.45	2.73				
480.746	480.748	○	○	BE/BE		.112	1.62	7.10	2.13	2.51	2.81	3.08				
480.766	480.768	○	○	BE/BE		.141	1.82	8.00	2.40	2.83	3.17	3.47				
480.786	480.788	○	○	BE/BE		.145	2.05	9.00	2.70	3.18	3.57	3.90				
480.806	480.808	○	○	BE/BE		.159	2.28	10.0	3.00	3.53	3.96	4.33				
480.846		○	○	BE/BE		.163	2.85	12.5	3.75	4.42	4.95	5.42				
480.886		○	○	BG/BG		.185	3.64	16.0	4.81	5.65	6.34	6.93				
480.926		○	○	BG/BG		.204	4.55	20.0	6.01	7.07	7.93	8.61				
480.966		○	○	BG/BG		.228	5.69	25.0	7.51	8.83	9.91	10.8				
480.006		○	○	BG/BG		.252	7.17	31.5	9.46	11.1	12.4	13.6				

* Nozzles are manufactured to spray performance, not orifice diameter.

Ordering Information:

Type + Material Code + Connector No. = Order No.

480. 608 30 BC/BC 480. 608. 30. BC. BC

Material Code:

16 303 SS

17 316 SS

30 Brass

FULL CONE

VANELESS FULL CONE NOZZLES

1/4" TO 1" NPT (M)

HNF-2479, Rev. 0
Page A-8

Vaneless Tangential Full Cone Nozzles

Lechler's patented tangential full cone nozzles use no internal inserts or vanes. The unique design generates a precise, uniform spray distribution, for spray performance and reliability that's superior to conventional insert-dependent tangential full cone nozzles. Spray angles are extremely stable, regardless of pressure fluctuation.

Typical Applications:
Washing and cleaning
Cooling of gas or solid product
Surface spraying
Improvement of chemical reactions

Nozzle Inlet Conn. (NPT)	Dimensions in (in.)		H2	Approx. Weight (oz)
	L1	L2		
1/4	1.1	.79	.81	1.5
3/8	1.42	.98	1.04	3.75
1/2	1.91	1.32	1.52	8.87
3/4	2.30	1.52	2.24	—
1	3.00	1.91	2.60	—
1 1/4	1.10	.79	.63	—
3/8	1.42	.98	.91	—
1/2	1.95	1.32	1.50	—

* Mat. PVDF

The following sizes are available in molded PVDF:

Threaded Inlets			Integral Twist-Loc Base
422.406.5E.BC	422.606.5E.BE	422.888.5E.BE	422.406.5E.KB
422.408.5E.BC	422.646.5E.BE	422.896.5E.BE	422.528.5E.KB
422.448.5E.BC	422.728.5E.BE	422.926.5E.BG	422.606.5E.KB
422.486.5E.BC	422.806.5E.BE	422.966.5E.BG	422.608.5E.KB
422.488.5E.BC	422.846.5E.BE	422.968.5E.BG	
422.566.5E.BC	422.866.5E.BE	422.006.5E.BG	
422.568.5E.BC	422.886.5E.BE	422.128.5E.BK	

* See page 67.

Product Codes for Ordering										Free Pass. Diam. (in.)	Flow Rate (Gallons Per Minute)								Spray Width @ 40 p.s.i.			
Nozzle Type		Material Code		NPT Code				Flow Rate (Gallons Per Minute)								Spray Width @ 40 p.s.i.						
Spray Angle																						
30°	120°	16	17	3/4	1/4	3/8	1/2	3/4	1"	10 p.s.i.	20 p.s.i.	30 p.s.i.	40 p.s.i.	60 p.s.i.	80 p.s.i.	100 p.s.i.	150 p.s.i.	180 p.s.i.	210 p.s.i.	240 p.s.i.		
422.406	422.408	○	○	BC	—	—	—	—	—	.059	.1	.2	1.0	.3	.3	.4	.4					
422.446	422.448	○	○	BC	—	—	—	—	—	.065	.1	.2	1.2	.3	.4	.5	.6					
422.486	422.488	○	○	BC	—	—	—	—	—	.075	.2	.3	1.6	.5	.6	.7	.7					
422.506	422.508	○	○	BC	—	—	—	—	—	.079	.2	.3	1.8	.5	.6	.7	.8					
422.526	422.528	○	○	BC	—	—	—	—	—	.083	.3	.4	2.0	.6	.7	.8	.9					
422.566	422.568	○	○	BC	—	—	—	—	—	.090	.3	.5	2.5	.7	.9	1.1	1.2					
422.606	422.608	○	○	BC	BE	—	—	—	—	.102	.4	.6	3.1	.9	1.2	1.3	1.5					
422.646	422.648	○	○	BC	BE	—	—	—	—	.118	.6	.8	4.0	1.2	1.5	1.7	1.9					
422.686	422.688	○	○	BC	BE	—	—	—	—	.130	.7	1.1	5.0	1.5	1.9	2.1	2.4					
422.706	422.708	○	○	BC	BE	—	—	—	—	.138	.8	1.2	5.6	1.7	2.1	2.4	2.7					
422.726	422.728	○	○	BC	BE	—	—	—	—	.146	.9	1.3	6.3	1.9	2.3	2.7	3.0					
422.766	422.768	○	○	BC	BE	—	—	—	—	.164	1.2	1.7	8.0	2.4	3.0	3.5	3.9					
422.786	422.788	○	○	—	BE	—	—	—	—	.173	1.4	1.9	9.0	2.7	3.4	3.9	4.4					
422.806	422.808	○	○	—	BE	—	—	—	—	.183	1.5	2.1	10	3.1	3.8	4.3	4.9					
422.846	422.848	○	○	—	BE	—	—	—	—	.205	1.9	2.7	12	3.8	4.7	5.4	6.1					
422.886	422.888	○	○	—	BE	—	—	—	—	.229	2.4	3.5	16	4.9	6.0	7.0	7.8					
422.926	422.928	○	○	—	BG	—	—	—	—	.308	3.1	4.3	20	6.2	7.6	8.7	9.8					
422.966	422.968	○	○	—	BG	—	—	—	—	.316	3.8	5.4	25	7.7	9.5	10	12.2					
423.006	423.008	○	○	—	BK	—	—	—	—	.343	4.8	6.9	31	9.7	11	13	15.4					
—	423.048	—	—	—	BK	—	—	—	—	.427	6.2	8.7	40	12	15	17	19					
—	423.088	—	—	—	BK	—	—	—	—	.450	7.7	10	50	15	18	21	24					
423.128	423.148	—	—	—	BK	—	—	—	—	.502	9.7	13	63	19	23	27	30					
423.148	423.168	—	—	—	BK	—	—	—	—	.553	11	15	71	22	26	31	34					
423.208	423.228	—	—	—	BM	—	—	—	—	.672	15	21	100	31	37	43	48					

* Available on quote.

** Nozzles are manufactured to spray performance, not free passage diameter.

Ordering Information:

Type + Material Code + NPT Code = Order No.

422. 406 16 BC 422. 406. 16 BC

Material Code:

16 303 SS 30 Brass

17 316 SS 5E PVDF

W320-27-050

Portable Exhauster Installation Analysis

Subject Calculation No.: W320-27-050

Page ii of 11

[illegible]

DESIGN ANALYSIS

Client: Numatec

Subject: Portable Exhauster Installation Analysis

Location: 241-C / 241-AY

WO/Job No.: ER4319/W-320

Date: 12/15/97

Checked: 12/19/97

Revised:

By: Kelly Hayase

By: N. J. JUPLO

By:

OBJECTIVE:

The objective of this calculation is to analyze the portable exhauster installation. The analysis includes a pipe stress analysis of the condensate drain piping and miscellaneous structural analyses.

DESIGN INPUTS:

CRITERIA AND SOURCE:

1. HNF-SD-W320-FDC-001, Rev. 4

GIVEN OR KNOWN DATA:

1. The portable exhauster fan is rated for 1000 cfm but will be operated at 500 cfm.
2. The portable exhauster installation is a temporary installation for emergency scenarios.
3. The portable exhauster installation is considered Safety Class. Loadings for the analysis of Safety Class systems will be based on Safety Class 1 loadings from Reference #6.

ASSUMPTIONS:

1. The portable exhauster installation will not be qualified for the Safety Class 1 missile load. Spare parts (per customer decision) would provide the required redundancy if the flex duct or condensate drain failed as a result of a Safety Class 1 missile impact.

METHODS TO BE USED:

Autopipe (Ref. #5) shall be used for the pipe stress analysis. All other analyses shall be performed using standard engineering principles and formulas.

REFERENCES/SOURCES:

1. ASME B31.3-1996, "Process Pipe" (Appx B-34 and B-35)
2. ASME N509-1989, "Nuclear Power Plant Air-Cleaning Units and Components" (Appx B-36)
3. ASME N510-1989, "Testing of Nuclear Air Treatment Systems"
4. Crane Technical Paper No. 410, "Flow of Fluids"
5. Autopipe Pipe Stress Analysis Program, Version 4.6, by Rebis.
6. FDNW Practice # 134.215.1217, "Design Loads for Facilities" (Appx B-32 and B-33)

DESIGN ANALYSIS

Client: Numatec

WO/Job No.: ER4319/MW-320

Subject: Portable Exhauster Installation Analysis

Date: 12/15/97

By: Kelly Hayase

Checked: 12/19/97

By: N. J. JUPLO

Location: 241-C / 241-AY

Revised:

By:

7. ANSI/ASCE 7-88, "Minimum Design Loads for Buildings and Other Structures" (Appx B-1 to B-5)
8. Unistrut General Engineering Catalog No. 12 (Appx B-6 to B-9)
9. Unistrut Seismic Bracing Systems, SBS-1 (Appx B-10)
10. Blodgett, "Design of Welded Structures"
11. SMACNA, "HVAC Systems Duct Design", 1981 ed. (Appx B-29)
12. Duravent Corporation, "Pressure Information for Blue Max and Max-Flyte Flexible Duct/Hose" (Appx B-30)
13. Randolph Austin Co., "Pumpheads and Capacities" (Appx B-11)
14. Duravent Corporation, "Specification Sheet for 8" ID 2PN" (Appx B-31)
15. HNF-SD-WM-DA-230, Rev. 0, "Design Calculations and Methods for 500 CFM Portable Exhauster, VTP-2212A" (Appx B-12)
16. Gaylord, "Structural Engineering Handbook", 4th Ed. (Appx B-13 to B-17)
17. WRC Bulletin 107, "Local Stresses in Spherical and Cylindrical Shells due to External Loadings" (Appx B-18 to B-28)
18. 1000 CFM Portable Exhauster Vendor Drawings (Farwell and Hendricks, Inc.)

96159-W03, Sheet 1, Rev. 5

96159-W04, Sheet 1, Rev. 4

19. Drawing Numbers:

H-2-818506, Sheets 1 - 3, Rev. 0

H-2-818507, Sheets 1 - 3, Rev. 0

HVAC Alternate Emergency Ventilation Configuration

HVAC Alternate Emergency Ventilation Configuration

DESIGN ANALYSIS

Client: Numatec

WO/Job No.: ER4319/W-320

Subject: Portable Exhauster Installation Analysis

Date: 12/15/97 By: Kelly Hayase

Checked: 12/19/97 By: H. J. JUPLO

Location: 241-C / 241-AY

Revised:

By:

CONCLUSIONS:

Based on the results of the analysis:

1. The portable exhauster installation satisfies the requirements of ASME B31.3 and ASME N509 for the design loads for Safety Class systems.
2. The portable exhauster installation will not be qualified for the Safety Class 1 missile load. Spare parts (per customer decision) would provide the required redundancy if the flex duct or condensate drain failed as a result of a Safety Class 1 missile impact.

DESIGN ANALYSIS

Client: Numatec

WO/Job No.: ER4319/W-320

Subject: Portable Exhauster Installation Analysis

Date: 12/15/97

By: Kelly Hayase

Checked: 12/17/97

By: Ken Caldwell

Location: 241-C / 241-AY

Revised:

By:

CALCULATIONS:

Pipe Stress Analysis (For condensate drain lines)

Autopipe Analysis Input

Pipe: 1/2" sch40S, A312-TP304L, with 1-1/2" thick fiberglass insulation (conservative, actually 1" thk)

Fluid: water

Pressure: 20 psig (maximum pressure for peristaltic pump on portable exhaust skid)

Min temperature: 40 °F (assumed because the pipe is heat traced and insulated during winter)

Max temperature: 200 °F (assumed)

Seismic input: Safety Class 1 Spectra, 0.2g, 5% damping (Ref. #6)

Wind input: 90 mph wind speed
Importance factor - 1.0
Exposure category - C
Gust response factor, G_z - 1.32 (Ref. #7, Table 8)
Force coefficient, C_f - 0.8 (Ref. #7, Table 12)

Seismic displacement of portable exhauster (Ref. #14)

For 500 CFM Portable Exhauster, Δ = 0.28 inch
Assume similar for 1000 CFM Portable Exhauster

DESIGN ANALYSIS

Client Normtec

WO/Job No. ER 4319 / W-320

Subject Portable Exhauster Installation Analysis

Date 12/15/97 By Kelly Hayase

Checked 12/17/97 By Kui Cui

Location 241-C / 241-A4

Revised

By

Autopipe Model "PEXCNDS"

Notes: (1) Estimated from drawing

(2) The angle at B11 is 35° but is assumed to be 45° for simplicity.

DESIGN ANALYSIS

Client NumatecWO/Job No. ER4319 / W-320Subject Portable Exhauster Installation AnalysisDate 12/15/97 By Kelly HayaseChecked 12/19/97 By N. J. JUPLOLocation 241-C / 241-AV

Revised

By

Hanging Flex Hose (For condensate drain line)

$\frac{1}{2}$ " sch 40S

$$\text{weight} = 0.85 \text{ lb/ft}$$

$$S = 0.04069 \text{ in}^3$$

2" sch 40S

$$\text{weight} = 3.65 \text{ lb/ft}$$

Assume weight of $\frac{1}{2}$ " flex hose equals weight of $\frac{1}{2}$ " pipe.

Seismic acceleration = 0.42g (max acceleration from SC-1 spectra, Ref. # 6)

DESIGN ANALYSIS

Client Numatec

WO/Job No. ER 4319 / W-320

Subject Portable Exhauster Installation Analysis

Date 12/15/97 By Kelly Hayse

Checked 12/19/97 By N. J. JUEL

Location 241-C / 241-AY

Revised

By

Hanging Flex Hose (continued)

$$W = (25 \text{ ft})(0.85 \text{ lb/ft}) + (13.5 \text{ in})\left(\frac{\text{ft}}{12 \text{ in}}\right)(3.65 \text{ lb/ft})$$

$$W = 25.4 \text{ lb}$$

Forces at anchor point (Due to flex hose)

$$F_x = (0.42g)(25.4 \text{ lb}) = 11 \text{ lb}$$

$$F_y = (1.42g)(25.4 \text{ lb}) = 36 \text{ lb}$$

$$F_z = (0.42g)(25.4 \text{ lb}) = 11 \text{ lb}$$

$$M_x = 0$$

$$M_y = (4 \text{ in})(11 \text{ lb}) = 44 \text{ in}\cdot\text{lb}$$

$$M_z = (4 \text{ in})(36 \text{ lb}) = 144 \text{ in}\cdot\text{lb}$$

No moment
in flex hoseBending Stress in $\frac{1}{2}$ " pipe

$$\sigma = \frac{M}{S} = \frac{\sqrt{144^2 + 44^2}}{0.04069 \text{ in}^3}$$

$$\sigma = 3700 \text{ psi} < 16,700 \text{ psi} \text{ (8313 allowable)}$$

DESIGN ANALYSIS

Client NumatecWO/Job No. ER 4319 / w-320Subject Portable Exhauster Installation AnalysisDate 12/15/97 By Kelly HavaseChecked 12/19/97 By N. J. JUPLOLocation 241-C / 241-A4

Revised By

Condensate drain line "anchor points" at risers

Analyze weld as a line

(Ref. #10)

$$A_w = \pi (0.84 \text{ in}) = 2.64 \text{ in}$$

$$S_w = \frac{\pi (0.84 \text{ in})^2}{4} = 0.55 \text{ in}^2$$

Force on weld from Autopipe Node Point B12

$$F_x = 36 \text{ lb}$$

$$M_x = 0$$

$$F_y = 6 \text{ lb}$$

$$M_y = 65 \text{ ft}\cdot\text{lb} = 780 \text{ in}\cdot\text{lb}$$

$$F_z = 67 \text{ lb}$$

$$M_z = 7 \text{ ft}\cdot\text{lb} = 84 \text{ in}\cdot\text{lb}$$

Total force on weld

Add force from hanging flex hose to loads from B12

$$F_x = 11 + 36 = 47 \text{ lb}$$

$$M_x = 0$$

$$F_y = 36 + 6 = 42 \text{ lb}$$

$$M_y = 44 + 780 = 824 \text{ in}\cdot\text{lb}$$

$$F_z = 11 + 67 = 78 \text{ lb}$$

$$M_z = 144 + 84 = 228 \text{ in}\cdot\text{lb}$$

$$f_w = \sqrt{\left(\frac{47 \text{ lb}}{2.64 \text{ in}} + \frac{824 \text{ in}\cdot\text{lb}}{0.55 \text{ in}^2} + \frac{228 \text{ in}\cdot\text{lb}}{0.55 \text{ in}^2} \right)^2 + \left(\frac{42 \text{ lb}}{2.64 \text{ in}} \right)^2 + \left(\frac{78 \text{ lb}}{2.64 \text{ in}} \right)^2}$$

$$f_w = 1931 \text{ lb/in}$$

DESIGN ANALYSIS

Client Numatec

WO/Job No. ER4319 / W-320

Subject Portable Exhauster Installation Analysis

Date 12/15/97

By Kelly Hayase

Checked 12/19/97

By M.J. SUPLO

Location 241-C / 241-A7

Revised

By

Condensate drain line "anchor points" at risers (continued)

$$t_w = \frac{f_w}{(0.707) \tau_{allow}} = \frac{1931 \text{ lb/in}}{(0.707)(16700 \text{ psi})(0.8)(1.33)}$$

B31.3 allow $\uparrow$ factor for shear $\uparrow$ B31.3 factor for occasional loads $\uparrow$

$$t_w = 0.154 \text{ in} < 2 \times \frac{1}{8} \text{ in} \quad \text{Therefore weld is acceptable.}$$

$\uparrow$ two sides

$$A_w = 4 \times 3 \text{ in} = 12 \text{ in}$$

$$S_w = (3 \text{ in})(3 \text{ in}) + \frac{(3 \text{ in})^2}{3} = 12 \text{ in}^2$$

$$f_w = \sqrt{\left(\frac{47 \text{ lb}}{12 \text{ in}} + \frac{824 \text{ in lb}}{12 \text{ in}^2} + \frac{228 \text{ in lb}}{12 \text{ in}^2} \right)^2 + \left(\frac{42 \text{ lb}}{12 \text{ in}} \right)^2 + \left(\frac{78 \text{ lb}}{12 \text{ in}} \right)^2}$$

$$f_w = 92 \text{ lb/in}$$

$$t_w = \frac{92 \text{ lb/in}}{(0.707)(16700 \text{ psi})(0.8)(1.33)} = 0.01 \text{ in} < \frac{1}{8} \text{ in} \quad \text{Therefore weld is acceptable.}$$

DESIGN ANALYSIS

Client <u>Numatec</u>	WO/Job No. <u>ER4319/w320</u>
Subject <u>Portable Exhauster Installation Analysis</u>	Date <u>12/15/97</u> By <u>Kelly Hayse</u>
	Checked <u>12/19/97</u> By <u>N. J. JUPLO</u>
Location <u>241-C / 241-A7</u>	Revised _____ By _____

Existing Pipe Support and Anchor on Portable Exhauster

Based on the low support forces, the existing pipe support on the portable exhauster is assumed to be adequate.

Check weld at pump enclosure (Ref. #18)

$$A_w = \pi (0.84 \text{ in}) = 2.64 \text{ in}$$

$$S_w = \frac{\pi (0.84 \text{ in})^2}{4} = 0.55 \text{ in}^2$$

Force on weld, Autopipe Node Point B00

$$F_x = 73 \text{ lb}$$

$$M_x = 0$$

$$F_y = 19 \text{ lb}$$

$$M_y = 22 \text{ ft}\cdot\text{lb} = 264 \text{ in}\cdot\text{lb}$$

$$F_z = 81 \text{ lb}$$

$$M_z = 5 \text{ ft}\cdot\text{lb} = 60 \text{ in}\cdot\text{lb}$$

$$f_w = \sqrt{\left(\frac{73 \text{ lb}}{2.64 \text{ in}} + \frac{264 \text{ in}\cdot\text{lb}}{0.55 \text{ in}^2} + \frac{60 \text{ in}\cdot\text{lb}}{0.55 \text{ in}^2}\right)^2 + \left(\frac{19 \text{ lb}}{2.64 \text{ in}}\right)^2 + \left(\frac{81 \text{ lb}}{2.64 \text{ in}}\right)^2}$$

$$f_w = 618 \text{ lb/in}$$

$$t_w = \frac{618 \text{ lb/in}}{(0.707)(16700 \text{ psi})(0.8)(1.33)} = 0.049 \text{ in} < \frac{1}{16} \text{ in}$$

Therefore weld is acceptable

DESIGN ANALYSIS

Client <u>Numatec</u>	WO/Job No. <u>ER4319/W-320</u>
Subject <u>Portable Exhauster Installation Analysis</u>	Date <u>12/15/97</u> By <u>Kelly Hayrise</u>
	Checked <u>12/19/97</u> By <u>N.J. JUPLO</u>
Location <u>241-C / 241-AY</u>	Revised By

Pipe Support (For condensate drain line)

241-C-106

Pipe clamp allowable loads (Ref. # 9)

Unistrut # P1111

Therefore pipe clamp is acceptable

Channel allowable moment (Ref. # 8)

Unistrut # P1000

$$\text{allowable moment} = 5080 \text{ in}\cdot\text{lb}$$

$$\text{actual moment} = (12 \text{ in})(55 \text{ lb}) = 660 \text{ in}\cdot\text{lb}$$

Therefore channel is acceptable.

DESIGN ANALYSIS

Client NumatecWO/Job No. ER 4319 / W-320Subject Portable Exhauster Installation AnalysisDate 12/15/97 By Kelly HayaseChecked 12/19/97 By N. J. JUPLOLocation 241-C / 241-AY

Revised

By

Pipe Support (continued)

The weakest link on the post base assembly is the $\frac{3}{16}$ " fillet welds, 2" long, on 2 edges.

Analyze weld as a line (Ref. #10)

now assume
9.5

$$\frac{1.41''}{9.5}$$

$$A_w = 2 \times 2 \text{ in} = 4 \text{ in}$$

$$S_w = \frac{(1.41 \text{ in})^2}{3} = 0.66 \text{ in}^2$$

DESIGN ANALYSIS

Client NumatecWO/Job No. ER4319 / W-320Subject Portable Exhauster Installation AnalysisDate 12/15/97 By Kelly HynseChecked 12/19/97 By N. J. JUPLOLocation 241-C / 241-AY

Revised

By

Pipe Support (continued)

Worst case loadings

$$F = \frac{(12 \text{ in})(55 \text{ lb})}{4.24 \text{ in}}$$

$$F = 156 \text{ lb (conservative)}$$

For conservatism, assume loads act together

$$f_w = \sqrt{\left(\frac{156 \text{ lb}}{4 \text{ in}} + \frac{660 \text{ in.-lb}}{0.66 \text{ in}^2}\right)^2 + \left(\frac{55 \text{ lb}}{4 \text{ in}}\right)^2} = 1039 \text{ lb/in}$$

$$t_w = \frac{f_w}{(0.707)S_{allow}} = \frac{1039 \text{ lb/in}}{(0.707)(17982 \text{ psi})} = 0.082 \text{ in} < \frac{3}{16}$$

$$S_{allow} = (16900 \text{ psi})(0.8)(1.33) = 17982 \text{ psi}$$

B31.3 allow
for base metal
A 3C

B31.3 factor for
occasional loads
factor for shear

Therefore
weld is
acceptable

DESIGN ANALYSIS

Client NimatecWO/Job No. ER4319 / W-320Subject Portable Exhauster Installation AnalysisDate 12/15/97 By Kelly HayaseChecked 12/19/97 By M. J. JUPLOLocation 241-C / 241-AY

Revised

By

Pipe Support (continued)

241-AY-102

Loads from Autopipe (Node Point B09)

$$F_y = 15 \text{ lb}$$

$$F_x = \text{Max of Wind or Seismic (See note on page 16)}$$

$$= 30 \text{ lb} + 11 \text{ lb (W1 + (GR+T1))}$$

However Autopipe used $1\frac{1}{2}$ " thk insulation but actually is only 1" thk.

$$\frac{0.84 \text{ in} + 2 \text{ in}}{0.84 \text{ in} + 3 \text{ in}} = 0.74$$

$$F_x = (30 \text{ lb})(0.74) + 11 \text{ lb} = 33 \text{ lb}$$

Pipe clamp is acceptable.

$$\text{Moment} = (33 \text{ lb})(21 \text{ in}) = 693 \text{ in-lb} < 5080 \text{ in-lb} \therefore \text{channel is acceptable}$$

DESIGN ANALYSIS

Client NumatecWO/Job No. ER 9319 / W-320Subject Portable Exhauster Installation AnalysisDate 12/15/97 By Kelly HayaseChecked 12/19/97 By A. J. JUPLOLocation Z41-C / Z41-AV

Revised

By

Pipe Support (Continued)

Uplift force F

$$F = \frac{(33 \text{ lb})(21 \text{ in})}{(8.5 \text{ in})} = 82 \text{ lb}$$

Uplift resistance of stake

$$Q = \left(\frac{1}{2} \gamma l^2\right) K p \tan \phi_f \quad (\text{Page 7-41, Ref. \# 16})$$

$$\gamma = 130 \frac{\text{lb}}{\text{ft}^3} = 0.075 \frac{\text{lb}}{\text{in}^3} \quad (\text{Page 7-26, Ref. \# 16})$$

$$l = 24 \text{ in}$$

$$K = 1.0 \quad (\text{Page 7-41, Ref. \# 16})$$

$$p = (2.5 \text{ in})(4) = 10 \text{ in} \quad (\text{perimeter of angle})$$

$$\tan \phi_f = 0.45 \quad (\text{Page 7-42, Ref. \# 16})$$

$$Q = \frac{1}{2} (0.075 \frac{\text{lb}}{\text{in}^3}) (24 \text{ in})^2 (1.0) (10 \text{ in}) (0.45)$$

$$Q = 97 \text{ lb} > 82 \text{ lb} \quad \underline{O.K.}$$

DESIGN ANALYSIS

Client Mmatic

WO/Job No. ER4319 / W-320

Subject Portable Exhauster Installation Analysis

Date 12/15/97 By Kelly Hayase

Checked 12/19/97 By H.J. JUPLO

Location 241-C / 241-AY

Revised

By

Pipe Support (Continued)

Lateral resistance of stake

$$Q = 3 B \gamma \left(\frac{1 + \sin \phi}{1 - \sin \phi} \right) \quad (\text{Page 7-43, Ref. \# 16})$$

$$B = 2.5 \text{ in}$$

$$\gamma = 0.075 \text{ lb/in}^3$$

$$\phi = 30^\circ \text{ (assumed)}$$

$$Z = 12 \text{ in (average depth)}$$

$$Q = 3(2.5 \text{ in})(0.075 \text{ lb/in})(12 \text{ in}) \left(\frac{1 + \sin 30}{1 - \sin 30} \right)$$

$$Q = 20 \text{ lb/in}$$

$$\text{Resistance} = (20 \text{ lb/in})(24 \text{ in}) = 480 \text{ lb} > 33 \text{ lb} \quad \underline{\text{OK}}$$

Note: ASME B31.3 considers all loads acting together for support and anchor analysis. FDNW Practice # 134.215.1217 does not consider wind and seismic loads acting together. Because this is a temporary installation, consider max of wind or seismic loads.

DESIGN ANALYSIS

Client Numatec	WO/Job No. ER 4319 / W-320
Subject Portable Extensometer Installation Analysis	Date 12/15/97 By Kelly Hayase
	Checked 12/19/97 By N. J. J. J. J. J.
Location 241-C / 241-AY	Revised By

8" Flex Duct

Wind Load on flex duct

$$F = q_z G_z C_f A_f \quad (\text{Ref. \#7, Table 4})$$

$$G_z = 1.32 \quad (\text{Table 8})$$

$$C_f = 1.0 \quad (\text{Table 12}) \quad h/D = 1/0.67 = 1.5$$

$$K_z = 0.8 \quad (\text{Table 6})$$

$$q_z = 0.00256 K_z (IV)^2 \quad (\text{Eq. 3})$$

$$q_z = 0.00256 (0.8) (1.0 \times 90)^2 = 17 \text{ psf}$$

$$A_f = (0.67 \text{ ft}) (18 \text{ ft}) = 12 \text{ ft}^2$$

$$F = (17 \text{ psf}) (1.32) (1.0) (12 \text{ ft}^2) = 270 \text{ lb}$$

$$\text{Wind force at each end } \frac{270 \text{ lb}}{2} = 135 \text{ lb}$$

Seismic load on flex duct can be neglected because of the small mass and high flexibility of the flex duct.

The pressure rating of the 8" flex duct (Dura-vent, Blue Max #2PN-C) is 10 in Hg vacuum and 11 psi pressure. (Ref. #12, Appx B-30) This is more than adequate for the operating conditions of the tanks.

DESIGN ANALYSIS

Client Numatec

WO/Job No. ER4319 / W-320

Subject Portable Exhauster Installation Analysis

Date 12/15/97 By Kelly Hawase

Checked 12/19/97 By A. J. Supko

Location 241-C / 241-AY

Revised By

8" Flex Duct (continued)

$$d = 8 \text{ in} - 2(0.1196 \text{ in}) = 7.7608 \text{ in}$$

$$S = \frac{\pi}{32} \left(\frac{D^4 - d^4}{D} \right) = \frac{\pi}{32} \left(\frac{8 \text{ in}^4 - 7.7608 \text{ in}^4}{8 \text{ in}} \right) = 5.7 \text{ in}^3$$

$$\sigma = \frac{M}{S} = \frac{(135 \text{ lb})(8 \text{ in})}{5.7 \text{ in}^3} = 189 \text{ psi} < \sigma_{\text{allow}} \quad \text{O.K.}$$

(neglect shear)

$$\sigma_{\text{allow}} = (0.6)(25000 \text{ psi}) = 15000 \text{ psi}$$

σ_{yield}
(Ref. #2, Para. 5.10.3.3)

Weld

$$A_w = \pi(8 \text{ in}) = 25 \text{ in}$$

$$S_w = \frac{\pi(8 \text{ in})^2}{4} = 50 \text{ in}^2$$

$$f_w = \sqrt{\left(\frac{(135 \text{ lb})(8 \text{ in})}{50 \text{ in}^2} \right)^2 + \left(\frac{135 \text{ lb}}{25 \text{ in}} \right)^2} = 22 \text{ lb/in}$$

$$t_w = \frac{f_w}{(0.707) \sigma_{\text{allow}}} = \frac{22 \text{ lb/in}}{(0.707)(15000 \text{ psi})(0.8)} = 0.003 \text{ in} < \frac{1}{8} \text{ in} \quad \text{O.K.}$$

DESIGN ANALYSIS

Client Numatec

WO/Job No. ER4319 / W-320

Subject Portable Exhauster Installation Analysis

Date 12/15/97 By Kelly Hovase

Checked 12/19/97 By N. J. SUPLO

Location 2A1-C / 2A1-A4

Revised

By

8" Flex. Duct (continued)

2A1-A4-102

$$\sigma = \frac{M}{S} = \frac{(135 \text{ lb})(9 \text{ in})}{8.496 \text{ in}^3} = 143 \text{ psi} < 15000 \text{ psi} = \text{Allow} \quad \text{o.k.}$$

(neglect shear)

Weld

$$A_w = \pi(6.625 \text{ in}) = 20.8 \text{ in}$$

$$S_w = \frac{\pi(6.625 \text{ in})^2}{4} = 34.5 \text{ in}^2$$

$$f_w = \sqrt{\left(\frac{(135 \text{ lb})(9 \text{ in})}{34.5 \text{ in}^2}\right)^2 + \left(\frac{135 \text{ lb}}{20.8 \text{ in}}\right)^2} = 36 \text{ lb/in}$$

$$\tau_w = \frac{36 \text{ lb/in}}{(0.707)(15000 \text{ psi})(0.8)} = 0.004 \text{ in} < \frac{3}{16} \text{ in} \quad \text{o.k.}$$

DESIGN ANALYSIS

Client NomatecWO/Job No. ER 4319 / W-320Subject Portable Exhauster Installation AnalysisDate 12/15/97 By Kelly HaysieChecked 12/19/97 By M. J. JureloLocation 241-C / 241-AY

Revised By

Local Stresses in 8" Duct due to Welded Condensate Drain
(Ref. # 17 for method)

$$\text{thickness } t = 0.1196 \text{ in}$$

$$r_o = 0.84 \text{ in} / 2 = 0.42 \text{ in}$$

$$R_m = 4 \text{ in}$$

$$\gamma = \frac{R_m}{t} = \frac{4}{0.1196} = 33$$

$$\beta = (0.875) \frac{r_o}{R_m} = (0.875) \left(\frac{0.42}{4} \right) = 0.092$$

$$\text{Total thickness } T = 0.1196 \text{ in} + 0.1875 \text{ in} = 0.3071 \text{ in}$$

The thickness of the pad shall only be used in the total thickness in the stress equations and shall not be considered in determining the geometric parameters.

Loads (From page 8)

$$P = 47 \text{ lb} \quad (F_x) \quad M_T = 0 \quad (M_x)$$

$$V_o = 78 \text{ lb} \quad (F_z) \quad M_c = 824 \text{ in. lb} \quad (M_y)$$

$$V_L = 42 \text{ lb} \quad (F_y) \quad M_L = 228 \text{ in. lb} \quad (M_z)$$

DESIGN ANALYSIS

Client: Numatec

WO/Job No.: ER4319/W-320

Subject: Portable Exhauster Installation Analysis

Date: 12/15/97

By: Kelly Hayase

Checked: 12/19/97

By: N. J. JUPLO

Location: 241-C / 241-AY

Revised:

By:

Local Stresses (continued)

Table 5—Computation Sheet for Local Stresses in Cylindrical Shells

*(See Appx B-18 to B-28 for Figures)

1. Applied Loads*

Radial load, $P = \frac{47}{1}$ lb.
Circ. Moment, $M_c = \frac{824}{1}$ in. lb.
Long. Moment, $M_L = \frac{278}{1}$ in. lb.
Torsion Moment, $M_t = \frac{0}{1}$ in. lb.
Shear Load, $V_c = \frac{78}{1}$ lb.
Shear Load, $V_L = \frac{42}{1}$ lb.

2. Geometric Parameters

$\gamma = \frac{R_m}{T} = \frac{33}{1}$
 $\beta = (0.875) \frac{r_o}{R_m} = \frac{0.092}{1}$

Stress Concentration due to:
a) membrane load, K_n
b) bending load, K_b

*NOTE: Enter all force values in accordance with sign convention

CYLINDRICAL SHELL

From Fig.	Read curves for	Compute absolute values of stress and enter result..	STRESSES - if load is opposite that shown, reverse signs shown							
			Au	AL	Bu	BL	Cu	CL	Du	DL
3C-08-4C	$\frac{N_0}{P/R_m} = 6.4$	$K_n \left(\frac{N_0}{P/R_m} \right) \cdot \frac{P}{R_m T} = 245$	245	-	-	-	245	-	-	-
1C-02-2C-2	$\frac{M_0}{P} = 0.14$	$K_b \left(\frac{M_0}{P} \right) \cdot \frac{6P}{T^2} = 419$	419	+	-	+	-419	+	-	+
2A	$\frac{M_0}{M_c/R_m \beta} = 0.90$	$K_n \left(\frac{M_0}{M_c/R_m \beta} \right) \cdot \frac{M_c}{R_m \beta T} = 1641$					1641	-	+	+
1A	$\frac{M_0}{M_c/R_m \beta} = 0.10$	$K_b \left(\frac{M_0}{M_c/R_m \beta} \right) \cdot \frac{6M_c}{R_m \beta T} = 1245$					1245	+	+	-
2B	$\frac{M_0}{M_L/R_m \beta} = 3.0$	$K_n \left(\frac{M_0}{M_L/R_m \beta} \right) \cdot \frac{M_L}{R_m \beta T} = 1513$	1513	-	+	+				
2B-1	$\frac{M_0}{M_L/R_m \beta} = 0.05$	$K_b \left(\frac{M_0}{M_L/R_m \beta} \right) \cdot \frac{6M_L}{R_m \beta T} = 1971$	1971	+	+	-				
Add algebraically for summation of 0 stresses, σ_0			4148				16550			
3C-08-4C	$\frac{N_0}{P/R_m} = 6.4$	$K_n \left(\frac{N_0}{P/R_m} \right) \cdot \frac{P}{R_m T} = 245$	245	-	-	-	245	-	-	-
1C-2	$\frac{M_0}{P} = 0.14$	$K_b \left(\frac{M_0}{P} \right) \cdot \frac{6P}{T^2} = 419$	419	+	-	+	-419	+	-	+
2A	$\frac{M_0}{M_c/R_m \beta} = 1.3$	$K_n \left(\frac{M_0}{M_c/R_m \beta} \right) \cdot \frac{M_c}{R_m \beta T} = 2370$					2370	-	+	+
2A	$\frac{M_0}{M_c/R_m \beta} = 0.05$	$K_b \left(\frac{M_0}{M_c/R_m \beta} \right) \cdot \frac{6M_c}{R_m \beta T} = 8547$					8547	+	+	-
2B	$\frac{M_0}{M_L/R_m \beta} = 0.90$	$K_n \left(\frac{M_0}{M_L/R_m \beta} \right) \cdot \frac{M_L}{R_m \beta T} = 454$	454	-	+	+				
2B-1	$\frac{M_0}{M_L/R_m \beta} = 0.08$	$K_b \left(\frac{M_0}{M_L/R_m \beta} \right) \cdot \frac{6M_L}{R_m \beta T} = 3153$	3153	+	+	-				
Add algebraically for summation of 2 stress, σ_2			4271				11581			
Shear stress due to Torsion, M_t			$\tau_0 = \tau_0 = \frac{M_t}{2\pi r_0^2 T} = 0$	+	+	+	+	+	+	+
Shear stress due to load, V_c			$\tau_0 = \tau_0 = \frac{V_c}{\pi r_0 T} = 192$	192	+	-	-			
Shear stress due to load, V_L			$\tau_0 = \tau_0 = \frac{V_L}{\pi r_0 T} = 104$				104	-	+	+
Add Algebraically for summation of shear stresses, τ_0			192				104			

DESIGN ANALYSIS

Client NumatecWO/Job No. ER4319 / W-320Subject Portable Exhauster Installation AnalysisDate 12/15/97 By Kelly HayaseChecked 12/19/97 By N.J. SUPLOLocation 241-C / 241-AY

Revised

By

Local Stresses (continued)

Combined Stress

$$S = \frac{1}{2} \left[\sigma_x + \sigma_\phi + \sqrt{(\sigma_x - \sigma_\phi)^2 + 4\tau^2} \right]$$

$$S = \frac{1}{2} \left[11581 \text{ psi} + 16550 \text{ psi} + \sqrt{(11581 \text{ psi} - 16550 \text{ psi})^2 + 4(192 \text{ psi})^2} \right]$$

$$S = 16557 \text{ psi}$$

$$\text{Total stress} = 16557 \text{ psi} + 189 \text{ psi} = 16746 \text{ psi} < \sigma_{\text{allow}} \quad \underline{\text{OK.}}$$

$$\sigma_{\text{allow}} = (0.9)(25000 \text{ psi}) = 22500 \text{ psi}$$

$\uparrow$ σ_{yield}
 (Ref. # 2,
 Para 5.10.3.3)

Based on comparison, local stresses in 8x6 Reducer due to welded condensate drain are acceptable.

DESIGN ANALYSIS

Client NumatecWO/Job No. ER 4319/W-320Subject Portable Exhauster Installation AnalysisDate 12/15/97 By Kelly HayaseChecked 12/19/97 By N.J. JUPLOLocation 241-C / 241-AY

Revised By

Flex Duct Support

241-AY-102

$$F = (17 \text{ psf})(1.32)(1.0)(0.67 \text{ ft})(7 \text{ ft}) = 105 \text{ lb}$$

$$R = \frac{(105 \text{ lb})(36 \text{ in})}{(12 \text{ in})} = 315 \text{ lb}$$

$$\text{Uplift force} = \frac{315 \text{ lb}}{4} = 79 \text{ lb} < 97 \text{ lb} = Q \quad \text{o.k.}$$

uplift resistance

$\left(\frac{2 \text{ stakes}}{\text{post base}} \right) (2 \text{ post bases each side})$

Lateral resistance is acceptable. $105 \text{ lb} < 480 \text{ lb}$ o.k.

DESIGN ANALYSIS

Client NuvertecWO/Job No. ER4319/W-320Subject Portable Exhauster Installation AnalysisDate 2/20/98 By Kelly HayseChecked 2/20/98 By N. J. JUPLOLocation 241-C / 241-AY

Revised

By

Flex Duct Support (Continued)

5 ft lengths of $9 \frac{9}{16}$ " wide 11 GA sheets will be placed on each duct support to support the flex duct. (to prevent sag)

Determine seismic load of flex duct + sheet

$$\text{weight of hose} = (1.75 \frac{\text{lb}}{\text{ft}})(7 \text{ ft}) = 12.25 \text{ lb}$$

$$\text{weight of sheet} = (60 \text{ in})(9.5625 \text{ in})(0.1196 \text{ in})(0.284 \frac{\text{lb}}{\text{in}^3}) = 19.5 \text{ lb}$$

$$\text{seismic load} = (1.5)(0.42g)(12.25 + 19.5 \text{ lb}) = 20 \text{ lb}$$

This is less than 105 lb wind force $\therefore$ page 23 is o.k.

Determine deflection at end of sheet (24 inches out)

$$w = (1.75 \frac{\text{lb}}{\text{ft}})(\frac{\text{ft}}{12 \text{ in}}) + (19.5 \text{ lb}/60 \text{ in}) = 0.47 \frac{\text{lb}}{\text{in}}$$

$$I = \frac{bh^3}{12} = \frac{(9.5625 \text{ in})(0.1196 \text{ in})^3}{12} = 0.00136 \text{ in}^4$$

$$\Delta = \frac{wL^4}{8EI} = \frac{(0.47 \frac{\text{lb}}{\text{in}})(24 \text{ in})^4}{8(30 \times 10^6 \text{ psi})(0.00136 \text{ in}^4)}$$

$$\Delta = 0.48 \text{ in} \approx \frac{1}{2}'' \quad \text{This is acceptable.}$$

DESIGN ANALYSIS

Client NumatecWO/Job No. ER4319 / W-320Subject Portable Exhauster Installation AnalysisDate 2/26/98 By Kelly HysseChecked 2/26/98 By N. J. JUPLOLocation 241-C / 241-A1

Revised

By

Flex. Duct Support

241-C-106

$$F = (17 \text{ psf})(1.32)(1.0)(0.67 \text{ ft})(9 \text{ ft}) = 135 \text{ lb}$$

$$R = \frac{(135 \text{ lb})(18 \text{ in})}{(12 \text{ in})} = 203 \text{ lb}$$

$$M = (135 \text{ lb})(18 \text{ in}) = 2430 \text{ in}\cdot\text{lb}$$

An uplift force
or a moment will
act on weld, depending
on direction of force.

DESIGN ANALYSIS

Client MumtecWO/Job No. ER4319 / W-320Subject Portable Exhauster Installation AnalysisDate 2/26/98By Kelly HayaseChecked 02/26/98By N. J. SUPLOLocation 241-C / 241-A^U

Revised

By

Flex Duct Support (Continued)

Analyze weld as a line

$$A_w = 2 \times 3 \text{ in} = 6 \text{ in}$$

$$S_{wz} = \frac{(3 \text{ in})^2}{3} = 3 \text{ in}^2$$

Assume weld takes all forces + moment, neglect 45° rotation

$$f_w = \sqrt{\left(\frac{203 \text{ lb}}{6 \text{ in}} + \frac{2430 \text{ in}\cdot\text{lb}}{3 \text{ in}^2}\right)^2 + \left(\frac{135 \text{ lb}}{6 \text{ in}}\right)^2} = 844 \text{ lb/in}$$

$$t_w = \frac{844 \frac{\text{lb}}{\text{in}}}{(0.707)(17982 \text{ psi})} = 0.066 < \frac{3}{16}''$$

Therefore weld
is acceptable

★									★★★★★★★	★★	★★★★★★★	★★★★★★★
★★★						★★			★★	★★	★★	★★
★★★	★★				★★★★★				★★	★★	★★	★★
★★	★★			★★	★★	★★	★★★★		★★★★★★★	★★	★★★★★★★	★★★★★★
★★★★★★★	★★	★★	★★	★★	★★	★★	★★		★★	★★	★★	★★
★★		★★	★★	★★	★★	★★	★★		★★	★★	★★	★★
★★	★★		★★	★★★★	★★	★★★★	★★		★★	★★	★★	★★

Pipe Stress Analysis and Design Program

Version: 4.60.03

Edition: Plus-DOS

Developed and Maintained by

Engineering Design Automation, Inc.
1600 Riviera Ave., Suite 300
Walnut Creek, CA 94596

AUTOPIPE SYSTEM DATA LISTING

SYSTEM NAME : PEXCND5

PROJECT ID : W-320 TANK 241-C-106 WASTE RETRIEVAL

PREPARED BY :

CHECKED BY :

PIPING CODE : B31.3

AMBIENT TEMP. (deg F) : 40.0

COMPONENT LIBRARY : AUTOPIPE

MATERIAL LIBRARY : AUTO8313

MODEL REVISION NUMBER : 31

POINT DATA LISTING

POINT NAME	TYPE	-----OFFSETS (ft)-----			PIPE ID	DESCRIPTION
		X	Y	Z		
*** SEGMENT A						
A00	Run	0	0	0	1/2"PIPE	
A01	Run	0	0	0.83		
A02	Redu	0	0	0.17		
A03	Run	0	0	0.17	1"PIPE	
A04	Run	0	0	0.18		
A05	Redu	0	0	0.18		
A06	Run	0	0	0.17	1/2"PIPE	
A07	Bend	0	0	0.13		Long Elbow, Radius = 0.75 inch Bend angle change = 90.00 deg Mid point at 50.00 percent SIF - In 1.25, Out = 1.04 Flex = 2.696
A08	Bend	0	0.67	0		Long Elbow, Radius = 0.75 inch Bend angle change = 90.00 deg Mid point at 50.00 percent SIF - In 1.25, Out = 1.04 Flex = 2.696
A09	Run	0	0	5.50		
A10	Run	0	0	6.33		
A11	Bend	0	0	1.00		Long Elbow, Radius = 0.75 inch Bend angle change = 90.00 deg Mid point at 50.00 percent SIF - In 1.25, Out = 1.04 Flex = 2.696
A12	Run	-1.75	0	0		
A13	Run	-3.00	0	0		
A14	Run	-5.83	0	0		
*** SEGMENT B						
B00	Run	-5.00	0	-5.00	1/2"PIPE	
B01	Run	-0.83	0	0		
B02	Redu	-0.17	0	0		
B03	Run	-0.17	0	0	1"PIPE	
B04	Run	-0.18	0	0		
B05	Redu	-0.18	0	0		
B06	Run	-0.17	0	0	1/2"PIPE	
B06A	Run	-3.00	0	0		
B07	Bend	-2.17	0	0		Long Elbow, Radius = 0.75 inch Bend angle change = 45.00 deg Mid point at 50.00 percent SIF - In 1.25, Out = 1.04 Flex = 2.696
B08	Run	-0.71	0	0.71		
B09	Run	-4.24	0	4.24		

POINT DATA LISTING

POINT NAME	TYPE	-----OFFSETS (ft)-----			PIPE ID	DESCRIPTION
		X	Y	Z		
B10	Bend	-4.24	0	4.24		Long Elbow, Radius = 0.75 inch Bend angle change = 90.00 deg Mid point at 50.00 percent SIF - In 1.25, Out = 1.04 Flex = 2.696
B11	Bend	-0.35	0	-0.35		Long Elbow, Radius = 0.75 inch Bend angle change = 45.00 deg Mid point at 50.00 percent SIF - In 1.25, Out = 1.04 Flex = 2.696
B12	Run	-0.33	0	0		

Total weight of empty pipes : 65 lb

COMPONENT DATA LISTING

POINT NAME	---COORDINATE(ft) X Y Z	DATA TYPE	DESCRIPTION
*** SEGMENT A			
A00	0.00 0.00 0.00	ANCHOR	Rigid Thermal movements : None
A01	0.00 0.00 0.83	DISPL GUIDE	User 1 ID : A01 1, Connected to Ground Stiffness = RIGID
A02	0.00 0.00 1.00	DISPL	User 1
A03	0.00 0.00 1.17		
A04	0.00 0.00 1.35	FLANGE	Weld neck SIF = 1.00 Rating = 150, Weight = 3 lb
		FLANGE	Weld neck SIF = 1.00 Rating = 150, Weight = 3 lb
A05	0.00 0.00 1.53		
A06	0.00 0.00 1.70		
A07 N	0.00 0.00 1.77		
A07	0.00 0.00 1.83	TI	
A07 M	0.00 0.02 1.81		
A07 F	0.00 0.06 1.83		
A08 N	0.00 0.60 1.83		
A08	0.00 0.67 1.83	TI	
A08 M	0.00 0.65 1.85		
A08 F	0.00 0.67 1.89		
A09	0.00 0.67 7.33	GUIDE	3 mass point(s) ID : A09 1, Connected to Ground Stiffness = RIGID
A10	0.00 0.67 13.66	Y-STOP	3 mass point(s) ID : A10 1, Connected to Ground
A11 N	0.00 0.67 14.60		
A11	0.00 0.67 14.66	TI	
A11 M	-0.02 0.67 14.64		
A11 F	-0.06 0.67 14.66		
A12	-1.75 0.67 14.66		
A13	-4.75 0.67 14.66	GUIDE	1 mass point(s) ID : A13 1, Connected to Ground Stiffness = RIGID
A14	-10.58 0.67 14.66	ANCHOR	3 mass point(s) Rigid Thermal movements : None
*** SEGMENT B			
B00	-5.00 0.00 -5.00	ANCHOR	Rigid Thermal movements : None
B01	-5.83 0.00 -5.00	DISPL GUIDE	User 1 ID : B01 1, Connected to Ground Stiffness = RIGID
B02	-6.00 0.00 -5.00	DISPL	User 1
B03	-6.17 0.00 -5.00		
B04	-6.35 0.00 -5.00	FLANGE	Weld neck SIF = 1.00 Rating = 150, Weight = 3 lb

COMPONENT DATA LISTING

POINT NAME	---COORDINATE(ft) X Y Z	DATA TYPE	DESCRIPTION
B05	-6.53 0.00 -5.00	FLANGE	Weld neck SIF = 1.00 Rating = 150, Weight = 3 lb
B06	-6.70 0.00 -5.00		1 mass point(s)
B06A	-9.70 0.00 -5.00		1 mass point(s)
B07 N	-11.85 0.00 -5.00		
B07	-11.87 0.00 -5.00	TI	
B07 M	-11.87 0.00 -5.00		
B07 F	-11.89 0.00 -4.98		
B08	-12.58 0.00 -4.29	Y-STOP	ID : B08 1, Connected to Ground 3 mass point(s)
B09	-16.82 0.00 -0.05	GUIDE	ID : B09 1, Connected to Ground Stiffness = RIGID 3 mass point(s)
B10 N	-21.02 0.00 4.14		
B10	-21.06 0.00 4.19	TI	
B10 M	-21.06 0.00 4.16		
B10 F	-21.10 0.00 4.14		
B11 N	-21.39 0.00 3.85		
B11	-21.41 0.00 3.83	TI	
B11 M	-21.41 0.00 3.84		
B11 F	-21.44 0.00 3.83		
B12	-21.75 0.00 3.83	ANCHOR	Rigid Thermal movements : None

Number of points in the system : 65

PEXCND5 W-320 TANK 241-C-106 WASTE RETRIEVAL Fluor Daniel Northwest
12/22/97 AutoPIPE+4.60 MODEL PAGE 7

PIPE DATA LISTING

Pipe ID/ Material	Nom/ Sch	O.D. inch	-----Thickness(inch)----- W.Th. Corr Mill Insu Ling				Spec Grav	Weight(lb/ft) Pipe Other Total			
1/2"PIPE A312-TP304L	0.500 40S	0.840	0.109	0	0.01	1.50	0	1.00	0.87	0.54	1.54
1"PIPE A312-TP304L	1.000 40S	1.315	0.133	0	0.02	1.50	0	1.00	1.72	0.64	2.74

PEXCND5 W-320 TANK 241-C-106 WASTE RETRIEVAL Fluor Daniel Northwest
12/22/97 AutoPIPE+4.60 MODEL PAGE 8

MATERIAL DATA LISTING

Material Name	Pipe ID	Density lb/cu.ft	Pois. Ratio	Temper. deg F	Modulus E6 psi	Expans. in/100ft	Allow. psi
A312-TP304L	1/2"PIPE	501.0	0.30	40.0 200.0	28.42	1.7688	16700.0 16700.0
A312-TP304L	1"PIPE	501.0	0.30	40.0 200.0	28.42	1.7688	16700.0 16700.0

PEXCND5 W-320 TANK 241-C-106 WASTE RETRIEVAL Fluor Daniel Northwest
12/22/97 AutoPIPE+4.60 MODEL PAGE 9

TEMPERATURE AND PRESSURE DATA								
-----C A S E 1-----			-----C A S E 2-----			-----C A S E 3-----		
POINT	PRESS.	TEMPER	EXPAN.	PRESS.	TEMPER	EXPAN.	PRESS.	TEMPER
NAME	psi	deg F	in/100ft	psi	deg F	in/100ft	psi	deg F
*** SEGMENT A								
A00	20.00	200	1.769					
A14	20.00	200	1.769					
*** SEGMENT B								
B00	20.00	200	1.769					
B12	20.00	200	1.769					

PEXCND5 W-320 TANK 241-C-106 WASTE RETRIEVAL Fluor Daniel Northwest
12/22/97 AutoPIPE+4.60 MODEL PAGE 10

FORCES AND DISPLACEMENTS								
(Force - lb , Moment - ft-lb , Tran. - in , Rot. - deg , Line - lb/ft)								
POINT	LOAD	TYPE	X	Y	Z	XX	YY	ZZ
NAME	CASE							
A00	U1	DISPL	0.28	0.00	0.28	0.000	0.000	0.000
A01	U1	DISPL	0.28	0.00	0.28	0.000	0.000	0.000
B00	U1	DISPL	0.28	0.00	0.28	0.000	0.000	0.000
B01	U1	DISPL	0.28	0.00	0.28	0.000	0.000	0.000

PEXCND\$ W-320 TANK 241-C-106 WASTE RETRIEVAL Fluor Daniel Northwest
12/22/97 AutoPIPE+4.60 RESULT PAGE 2

[illegible]

Pipe Stress Analysis and Design Program

Version: 4.60.03

Edition: Plus-DOS

Developed and Maintained by

Engineering Design Automation, Inc.
1600 Riviera Ave., Suite 300
Walnut Creek, CA 94596

ANALYSIS SUMMARY

Current model revision number : 31

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Static - Date and Time of analysis ..... Dec 22, 1997 2:47 PM
Model Revision Number ..... 31
Number of load cases ..... 5
Load cases analyzed ..... GR T1 W1 W2 U1
Gaps/Friction/Welding considered ..... No
Hanger design run ..... No
Cut short included ..... No
Weight of contents included ..... Yes
Number of mass points per span ..... Automatic
Pressure stiffening case ..... Automatic
Water elevation for buoyancy ..... Not considered
Wind analysis method ..... Normal

```

Modal - Date and Time of analysis	Dec 22, 1997	2:47 PM
Model Revision Number	31	
Number of modes	14	
Cutoff frequency (Hz)	33.0	
Weight of contents included	Yes	
Number of mass points per span	Automatic	
Pressure stiffening case	Yes	
Water elevation for buoyancy loads	Not considered	
Wind analysis method	Normal	

Response - Date and time of analysis	Dec 22, 1997	2:47 PM
Model Revision Number	31	
Number of load cases	1	
Load cases analyzed	R1	
Date and time of modal analysis	Dec 22, 1997	2:47 PM
Number of modes	14	
Cutoff frequency (Hz)	33.0	
Model revision of modal analysis	31	
Weight of contents included	Yes	
Number of mass points per span	Automatic	
Pressure stiffening case	0	
Water elevation for buoyancy loads	Not considered	
Wind analysis method	Normal	

CODE COMPLIANCE COMBINATIONS

Combination	Category	Method	Load	Factor	Allowable	Remarks
GR + Max P	Sustain	Sum	Gravity Max Long	1.00 1.00	Automatic	Default
Cold to T1	Expansion	Sum	Thermal 1	1.00	Automatic	Default
Sus. + W1	Occasion	Abs sum	Wind 1 Max Sus	1.00 1.00	Automatic	Default
Sus. + W2	Occasion	Abs sum	Wind 2 Max Sus	1.00 1.00	Automatic	Default
Sus. + U1	Occasion	Abs sum	User 1 Max Sus	1.00 1.00	Automatic	Default
Sus. + R1	Occasion	Abs sum	Response 1 Max Sus	1.00 1.00	Automatic	Default
Max P	Hoop		Max Hoop	1.00	Automatic	Default
SUS+WIND	Occasion	Abs sum	Wind 1 Wind 2 Max Sus	1.00 1.00 1.00	Automatic	User
SUS+SEIS	Occasion	Abs sum	Response 1 User 1 Max Sus	1.00 1.00 1.00	Automatic	User

OTHER USER COMBINATIONS

Combination	Method	Load	Factor	Remarks
GR	Sum	Gravity	1.00	Default
T1	Sum	Thermal 1	1.00	Default
W1	Sum	Wind 1	1.00	Default
W2	Sum	Wind 2	1.00	Default
U1	Sum	User 1	1.00	Default
R1	Sum	Response 1	1.00	Default
GR+T1	Sum	Gravity Thermal 1	1.00 1.00	User
TOTAL	Abs sum	GR+T1	1.00	User

Wind 1 1.00
Wind 2 1.00
User 1 1.00
Response 1 1.00

CODE COMPLIANCE

Y - Factor 0.40
Weld efficiency factor 1.00
Range reduction factor 1.00
Design Pressure Factor 1.00
Minimum stress ratio used in reports... 0.00
Include corrosion in stress calcs. Y
Include torsion in code stress N
Include axial force in code stress N
Longitudinal pressure calculation PD/4t
Include rigorous pressure Not analyzed

WIND LOAD CASES :

Number of load cases analysed : 2

Wind shape factor : 1.000

Exposure factor for buried pipes : 0.000

Exposure factor for submerged pipes : 0.000

Exposed Segments - A B

Load case 1 - W1

Direction - Global X-axis

ANSI A58.1-82

Basic wind speed at 33 ft (10m): 90.00 mph

Exposure category : C

Gust response factor : 1.32

Force coefficient : 0.80

Importance factor : 1.00

Load case 2 - W2

Direction - Global Z-axis

ANSI A58.1-82

Basic wind speed at 33 ft (10m): 90.00 mph

Exposure category : C

Gust response factor : 1.32

Force coefficient : 0.80

Importance factor : 1.00

RESPONSE SPECTRUM LOAD CASES :

Number of load cases analysed : 1

Load case 1 - R1

Missing mass : Yes

ZPA : No

Combination method : Grouping

X- Spectrum : SC1

Multiplier : 1.00

SC1

Freq(Hz)	Grav()	Freq(Hz)	Grav()	Freq(Hz)	Grav()
0.100	0.01	0.160	0.03	0.250	0.06
0.400	0.10	0.600	0.16	1.100	0.28
1.640	0.42	8.000	0.42	12.000	0.34
20.000	0.26	33.000	0.20	100.000	0.20

Y- Spectrum : SC1

Multiplier : 1.00

SC1

Freq(Hz)	Grav()	Freq(Hz)	Grav()	Freq(Hz)	Grav()
0.100	0.01	0.160	0.03	0.250	0.06
0.400	0.10	0.600	0.16	1.100	0.28
1.640	0.42	8.000	0.42	12.000	0.34
20.000	0.26	33.000	0.20	100.000	0.20

Z- Spectrum : SC1

Multiplier : 1.00

SC1

Freq(Hz)	Grav()	Freq(Hz)	Grav()	Freq(Hz)	Grav()
0.100	0.01	0.160	0.03	0.250	0.06
0.400	0.10	0.600	0.16	1.100	0.28
1.640	0.42	8.000	0.42	12.000	0.34
20.000	0.26	33.000	0.20	100.000	0.20

FREQUENCIES

Mode Number	Frequency (Rads/sec)	Frequency (Hertz)	Period (Sec)	Participation factors		
				X	Y	Z
1	68.5170	10.9048	0.092	-0.070	0.002	0.001
2	70.8816	11.2812	0.089	0.005	-0.004	-0.056
3	74.4452	11.8483	0.084	-0.061	0.000	-0.001
4	78.9281	12.5618	0.080	0.000	-0.052	0.000
5	100.1454	15.9386	0.063	0.004	0.104	-0.130
6	106.4236	16.9378	0.059	0.000	0.046	0.000
7	109.4619	17.4214	0.057	0.182	-0.001	0.002
8	109.6878	17.4574	0.057	0.056	0.000	0.203
9	119.7931	19.0657	0.052	0.037	-0.063	0.049
10	130.8613	20.8272	0.048	-0.032	0.000	0.155
11	131.8344	20.9821	0.048	0.059	0.033	-0.072
12	134.0674	21.3375	0.047	0.000	0.225	0.000
13	167.1168	26.5975	0.038	-0.004	0.185	-0.075
14	183.7632	29.2468	0.034	-0.022	-0.101	-0.190

DISPLACEMENTS

Point name	Load combination	TRANSLATIONS (in)			ROTATIONS (deg)		
		X	Y	Z	X	Y	Z
*** Segment A begin ***							
A00	GR	0.000	0.000	0.000	0.000	0.000	0.000
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	W1	0.000	0.000	0.000	0.000	0.000	0.000
	W2	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.280	0.000	0.280	0.000	0.000	0.000
	R1	0.000	0.000	0.000	0.000	0.000	0.000
	GR+T1	0.000	0.000	0.000	0.000	0.000	0.000
	TOTAL	0.280	0.000	0.280	0.000	0.000	0.000
A01	GR	0.000	0.000	0.000	0.029	0.000	0.003
	T1	0.000	0.000	0.015	-0.003	-0.006	0.010
	W1	0.000	0.000	0.000	0.006	0.064	-0.137
	W2	0.000	0.000	0.000	0.018	0.001	-0.002
	U1	0.280	0.000	0.280	-0.004	-0.026	0.023
	R1	0.000	0.000	0.000	0.008	0.007	0.014
	GR+T1	0.000	0.000	0.015	0.026	-0.006	0.013
	TOTAL	0.280	0.000	0.295	0.062	0.105	0.190
A02	GR	0.000	-0.001	0.000	0.050	0.000	0.004
	T1	0.000	0.000	0.018	-0.006	-0.011	0.012
	W1	0.003	0.000	0.000	0.010	0.110	-0.164
	W2	0.000	-0.001	0.000	0.032	0.003	-0.003
	U1	0.279	0.000	0.280	-0.007	-0.046	0.027
	R1	0.000	0.000	0.000	0.015	0.012	0.017
	GR+T1	0.000	-0.001	0.018	0.044	-0.011	0.016
	TOTAL	0.283	0.003	0.298	0.108	0.182	0.227
A03	GR	0.000	-0.003	0.000	0.056	0.000	0.004
	T1	-0.001	0.000	0.021	-0.007	-0.013	0.013
	W1	0.007	-0.001	0.000	0.012	0.125	-0.175
	W2	0.000	-0.002	0.000	0.038	0.003	-0.003
	U1	0.277	0.000	0.280	-0.009	-0.054	0.029
	R1	0.001	0.001	0.000	0.017	0.014	0.019
	GR+T1	-0.001	-0.003	0.021	0.049	-0.013	0.017
	TOTAL	0.286	0.007	0.301	0.124	0.209	0.243
A04	GR	0.000	-0.006	0.000	0.058	0.000	0.005
	T1	-0.001	0.001	0.024	-0.007	-0.014	0.013
	W1	0.012	-0.001	0.000	0.013	0.131	-0.181
	W2	0.000	-0.004	0.000	0.041	0.003	-0.003
	U1	0.275	0.001	0.280	-0.009	-0.058	0.030
	R1	0.001	0.002	0.000	0.018	0.015	0.019
	GR+T1	-0.001	-0.005	0.024	0.051	-0.014	0.018
	TOTAL	0.290	0.012	0.304	0.132	0.221	0.251

DISPLACEMENTS

Point name	Load combination	TRANSLATIONS (in)			ROTATIONS (deg)		
		X	Y	Z	X	Y	Z
A05	GR	-0.000	-0.008	0.000	0.059	0.000	0.005
	T1	-0.002	0.001	0.027	-0.008	-0.014	0.013
	W1	0.017	-0.002	0.000	0.014	0.135	-0.187
	W2	0.000	-0.005	0.000	0.044	0.003	-0.003
	U1	0.273	0.001	0.280	-0.010	-0.061	0.031
	R1	0.002	0.002	0.000	0.019	0.015	0.020
	GR+T1	-0.002	-0.007	0.027	0.051	-0.014	0.018
	TOTAL	0.294	0.017	0.307	0.138	0.230	0.259
A06	GR	0.000	-0.010	0.000	0.061	0.000	0.005
	T1	-0.002	0.001	0.030	-0.009	-0.016	0.014
	W1	0.022	-0.002	0.000	0.016	0.140	-0.198
	W2	0.001	-0.007	0.000	0.050	0.004	-0.004
	U1	0.270	0.002	0.280	-0.011	-0.068	0.033
	R1	0.002	0.003	0.000	0.021	0.016	0.021
	GR+T1	-0.002	-0.009	0.030	0.052	-0.016	0.019
	TOTAL	0.298	0.022	0.310	0.150	0.243	0.275
A07 N	GR	0.000	-0.011	0.000	0.061	0.000	0.005
	T1	-0.003	0.001	0.031	-0.010	-0.017	0.015
	W1	0.024	-0.002	0.000	0.018	0.142	-0.209
	W2	0.001	-0.008	0.000	0.055	0.004	-0.004
	U1	0.269	0.002	0.280	-0.013	-0.074	0.034
	R1	0.003	0.003	0.000	0.022	0.016	0.022
	GR+T1	-0.003	-0.009	0.031	0.051	-0.017	0.020
	TOTAL	0.299	0.024	0.311	0.159	0.253	0.289
A07 M	GR	0.000	-0.011	0.000	0.063	0.000	0.005
	T1	-0.003	0.002	0.032	-0.013	-0.019	0.016
	W1	0.026	-0.003	0.000	0.021	0.148	-0.219
	W2	0.001	-0.008	0.000	0.067	0.004	-0.004
	U1	0.268	0.002	0.280	-0.016	-0.085	0.038
	R1	0.003	0.004	0.000	0.026	0.018	0.023
	GR+T1	-0.003	-0.009	0.032	0.050	-0.019	0.021
	TOTAL	0.301	0.026	0.313	0.180	0.273	0.305
A07 F	GR	0.000	-0.011	0.001	0.063	0.000	0.006
	T1	-0.003	0.003	0.032	-0.015	-0.020	0.017
	W1	0.029	-0.003	0.000	0.025	0.152	-0.233
	W2	0.001	-0.008	0.001	0.078	0.005	-0.004
	U1	0.268	0.002	0.280	-0.018	-0.092	0.042
	R1	0.003	0.004	0.000	0.029	0.018	0.025
	GR+T1	-0.003	-0.009	0.033	0.048	-0.020	0.023
	TOTAL	0.304	0.025	0.314	0.198	0.286	0.327

DISPLACEMENTS

Point name	Load combination	TRANSLATIONS (in)			ROTATIONS (deg)		
		X	Y	Z	X	Y	Z
A08 N	GR	-0.001	-0.011	0.008	0.066	0.000	0.008
	T1	-0.005	0.012	0.030	-0.016	-0.030	0.020
	W1	0.058	-0.003	0.004	0.028	0.162	-0.261
	W2	0.001	-0.008	0.011	0.085	0.007	-0.005
	U1	0.263	0.002	0.277	-0.021	-0.153	0.047
	R1	0.006	0.004	0.004	0.034	0.023	0.028
	GR+T1	-0.006	0.001	0.038	0.051	-0.030	0.027
	TOTAL	0.334	0.017	0.334	0.219	0.375	0.368
A08 M	GR	-0.001	-0.012	0.009	0.067	0.000	0.008
	T1	-0.005	0.013	0.030	-0.014	-0.031	0.020
	W1	0.061	-0.003	0.004	0.027	0.162	-0.260
	W2	0.001	-0.009	0.012	0.079	0.007	-0.005
	U1	0.262	0.002	0.277	-0.019	-0.160	0.049
	R1	0.007	0.004	0.004	0.033	0.024	0.028
	GR+T1	-0.006	0.001	0.039	0.053	-0.031	0.028
	TOTAL	0.336	0.019	0.336	0.211	0.385	0.370
A08 F	GR	-0.001	-0.012	0.009	0.068	0.000	0.008
	T1	-0.006	0.013	0.031	-0.012	-0.033	0.020
	W1	0.063	-0.003	0.004	0.024	0.163	-0.260
	W2	0.001	-0.009	0.012	0.073	0.008	-0.005
	U1	0.260	0.002	0.277	-0.018	-0.170	0.050
	R1	0.007	0.004	0.004	0.032	0.024	0.028
	GR+T1	-0.007	0.001	0.040	0.056	-0.033	0.028
	TOTAL	0.338	0.020	0.338	0.202	0.398	0.372
A09	GR	0.000	0.000	0.009	-0.001	0.002	0.030
	T1	0.000	0.000	0.127	0.014	0.118	0.013
	W1	0.000	0.000	0.004	-0.011	0.138	-0.159
	W2	0.000	0.000	0.012	-0.029	-0.028	-0.004
	U1	0.000	0.000	0.277	0.007	-0.112	0.031
	R1	0.000	0.000	0.005	0.024	0.030	0.021
	GR+T1	0.000	0.000	0.136	0.013	0.120	0.043
	TOTAL	0.000	0.000	0.434	0.085	0.428	0.258
A10	GR	0.001	0.000	0.009	-0.041	-0.004	0.056
	T1	0.200	0.000	0.239	-0.007	-0.001	0.004
	W1	0.098	0.000	0.004	0.010	-0.496	-0.042
	W2	-0.019	0.000	0.012	0.013	0.064	-0.004
	U1	0.023	0.000	0.277	-0.004	-0.061	0.009
	R1	0.006	0.000	0.005	0.038	0.031	0.019
	GR+T1	0.201	0.000	0.248	-0.048	-0.005	0.060
	TOTAL	0.347	0.000	0.546	0.113	0.658	0.132

DISPLACEMENTS

Point name	Load combination	TRANSLATIONS (in)			ROTATIONS (deg)		
		X	Y	Z	X	Y	Z
A11 N	GR	0.000	0.004	0.009	-0.012	-0.007	0.059
	T1	0.189	0.001	0.256	-0.006	-0.114	0.003
	W1	0.005	-0.002	0.004	0.011	-0.403	-0.024
	W2	-0.002	-0.002	0.012	0.012	0.111	-0.003
	U1	0.002	0.001	0.277	-0.004	-0.159	0.005
	R1	0.000	0.008	0.005	0.041	0.028	0.019
	GR+T1	0.189	0.006	0.265	-0.019	-0.120	0.063
	TOTAL	0.198	0.019	0.563	0.087	0.822	0.115
A11 M	GR	0.000	0.004	0.009	-0.012	-0.007	0.060
	T1	0.187	0.001	0.256	-0.006	-0.131	0.003
	W1	0.002	-0.002	0.003	0.011	-0.371	-0.023
	W2	0.000	-0.003	0.013	0.012	0.118	-0.003
	U1	0.001	0.001	0.276	-0.004	-0.175	0.005
	R1	0.000	0.008	0.005	0.041	0.027	0.019
	GR+T1	0.187	0.006	0.265	-0.018	-0.138	0.063
	TOTAL	0.190	0.019	0.561	0.087	0.830	0.113
A11 F	GR	0.000	0.004	0.009	-0.012	-0.007	0.060
	T1	0.186	0.001	0.255	-0.006	-0.149	0.003
	W1	0.000	-0.002	-0.001	0.011	-0.338	-0.022
	W2	0.000	-0.003	0.014	0.012	0.124	-0.003
	U1	0.000	0.001	0.275	-0.004	-0.191	0.005
	R1	0.000	0.009	0.005	0.041	0.026	0.019
	GR+T1	0.186	0.005	0.264	-0.018	-0.156	0.063
	TOTAL	0.186	0.019	0.558	0.086	0.836	0.112
A12	GR	0.000	-0.012	0.006	-0.010	-0.010	0.015
	T1	0.154	0.001	0.172	-0.005	-0.294	0.002
	W1	0.000	0.002	-0.057	0.010	-0.013	-0.003
	W2	0.000	-0.001	0.048	0.010	0.022	-0.003
	U1	0.000	0.000	0.181	-0.004	-0.317	0.001
	R1	0.000	0.010	0.008	0.034	0.008	0.009
	GR+T1	0.156	-0.011	0.178	-0.015	-0.304	0.017
	TOTAL	0.157	0.025	0.472	0.073	0.664	0.033
A13	GR	0.000	0.000	0.000	-0.007	-0.006	0.004
	T1	0.103	0.000	0.000	-0.003	-0.175	0.000
	W1	0.000	0.000	0.000	0.006	0.094	0.004
	W2	0.000	0.000	0.000	0.007	0.016	-0.001
	U1	0.000	0.000	0.000	-0.002	-0.180	-0.001
	R1	0.000	0.000	0.000	0.023	0.019	0.020
	GR+T1	0.103	0.000	0.000	-0.010	-0.180	0.004
	TOTAL	0.103	0.000	0.000	0.048	0.489	0.030

DISPLACEMENTS

Point name	Load combination	TRANSLATIONS (in)			ROTATIONS (deg)		
		X	Y	Z	X	Y	Z
A14	GR	0.000	0.000	0.000	0.000	0.000	0.000
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	W1	0.000	0.000	0.000	0.000	0.000	0.000
	W2	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	0.000	0.000	0.000	0.000	0.000
	R1	0.000	0.000	0.000	0.000	0.000	0.000
	GR+T1	0.000	0.000	0.000	0.000	0.000	0.000
	TOTAL	0.000	0.000	0.000	0.000	0.000	0.000

*** Segment A end ***

*** Segment B begin ***

B00	GR	0.000	0.000	0.000	0.000	0.000	0.000
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	W1	0.000	0.000	0.000	0.000	0.000	0.000
	W2	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.280	0.000	0.280	0.000	0.000	0.000
	R1	0.000	0.000	0.000	0.000	0.000	0.000
	GR+T1	0.000	0.000	0.000	0.000	0.000	0.000
	TOTAL	0.280	0.000	0.280	0.000	0.000	0.000

B01	GR	0.000	0.000	0.000	0.003	0.000	0.034
	T1	-0.015	0.000	0.000	0.000	-0.069	0.000
	W1	0.000	0.000	0.000	0.000	-0.014	0.000
	W2	0.000	0.000	0.000	0.000	0.071	0.000
	U1	0.280	0.000	0.280	0.000	0.010	0.000
	R1	0.000	0.000	0.000	0.004	0.006	0.005
	GR+T1	-0.015	0.000	0.000	0.003	-0.069	0.034
	TOTAL	0.295	0.000	0.280	0.007	0.171	0.040

B02	GR	0.000	-0.002	0.000	0.004	0.000	0.059
	T1	-0.018	0.000	-0.003	0.000	-0.121	0.000
	W1	0.000	0.000	-0.001	0.000	-0.025	0.000
	W2	0.000	0.000	0.003	0.000	0.123	0.000
	U1	0.280	0.000	0.280	0.000	0.018	0.000
	R1	0.000	0.000	0.000	0.005	0.011	0.009
	GR+T1	-0.018	-0.002	-0.003	0.004	-0.121	0.059
	TOTAL	0.298	0.002	0.288	0.008	0.298	0.068

B03	GR	0.000	-0.004	0.000	0.004	0.000	0.067
	T1	-0.021	0.000	-0.008	0.000	-0.142	0.000
	W1	0.000	0.000	-0.002	0.000	-0.029	0.000
	W2	0.000	0.000	0.008	0.000	0.141	0.000
	U1	0.280	0.000	0.281	0.000	0.021	0.000
	R1	0.000	0.001	0.001	0.005	0.012	0.010
	GR+T1	-0.021	-0.004	-0.008	0.004	-0.142	0.067
	TOTAL	0.301	0.004	0.300	0.009	0.345	0.077

DISPLACEMENTS

Point name	Load combination	TRANSLATIONS (in)			ROTATIONS (deg)		
		X	Y	Z	X	Y	Z
B04	GR	0.000	-0.007	0.000	0.004	0.000	0.070
	T1	-0.024	0.000	-0.014	0.000	-0.152	0.000
	W1	0.000	0.000	-0.003	0.000	-0.031	0.000
	W2	0.000	0.000	0.014	0.000	0.149	0.000
	U1	0.280	0.000	0.282	0.000	0.022	0.000
	R1	0.000	0.001	0.001	0.005	0.013	0.011
	GR+T1	-0.024	-0.007	-0.014	0.004	-0.152	0.070
	TOTAL	0.304	0.008	0.313	0.009	0.366	0.080

B05	GR	0.000	-0.009	0.000	0.004	0.000	0.072
	T1	-0.027	0.000	-0.020	0.000	-0.161	0.000
	W1	0.000	0.000	-0.004	0.000	-0.032	0.000
	W2	0.000	0.000	0.019	0.000	0.155	0.000
	U1	0.280	0.000	0.283	0.000	0.023	0.000
	R1	0.000	0.001	0.002	0.005	0.013	0.011
	GR+T1	-0.027	-0.009	-0.020	0.004	-0.161	0.072
	TOTAL	0.307	0.011	0.328	0.010	0.385	0.083

B06	GR	0.000	-0.012	0.000	0.005	0.000	0.075
	T1	-0.030	0.000	-0.026	0.000	-0.178	0.000
	W1	0.000	0.000	-0.005	0.000	-0.035	0.000
	W2	0.000	0.000	0.025	0.000	0.163	0.000
	U1	0.280	0.000	0.284	0.000	0.025	0.000
	R1	0.000	0.002	0.002	0.006	0.014	0.012
	GR+T1	-0.030	-0.012	-0.026	0.005	-0.178	0.075
	TOTAL	0.310	0.014	0.342	0.010	0.416	0.087

B06A	GR	0.000	-0.044	0.000	0.016	0.000	-0.023
	T1	-0.083	0.000	-0.276	0.000	-0.478	0.000
	W1	0.000	0.000	-0.029	0.000	0.013	0.000
	W2	0.000	0.000	0.090	0.000	-0.070	0.000
	U1	0.280	0.000	0.303	0.000	0.001	0.000
	R1	0.000	0.008	0.009	0.019	0.008	0.008
	GR+T1	-0.083	-0.044	-0.276	0.016	-0.478	-0.023
	TOTAL	0.364	0.052	0.707	0.035	0.570	0.031

B07 N	GR	0.000	-0.010	0.000	0.024	0.000	-0.107
	T1	-0.121	0.000	-0.439	0.000	-0.174	0.000
	W1	0.000	0.000	0.022	0.000	0.238	0.000
	W2	0.000	0.000	0.041	0.000	-0.015	0.000
	U1	0.280	0.000	0.275	0.000	-0.145	0.000
	R1	0.000	0.004	0.005	0.029	0.024	0.020
	GR+T1	-0.121	-0.010	-0.439	0.024	-0.174	-0.107
	TOTAL	0.402	0.014	0.781	0.053	0.596	0.126

DISPLACEMENTS

Point name	Load combination	TRANSLATIONS (in)			ROTATIONS (deg)		
		X	Y	Z	X	Y	Z
B07 M	GR	0.000	-0.009	0.000	0.024	0.000	-0.106
	T1	-0.122	0.000	-0.439	0.000	-0.158	0.000
	W1	0.000	0.000	0.023	0.000	0.247	0.000
	W2	0.000	0.000	0.041	0.000	0.002	0.000
	U1	0.280	0.000	0.274	0.000	-0.152	0.000
	R1	0.000	0.004	0.005	0.030	0.024	0.019
	GR+T1	-0.122	-0.009	-0.439	0.024	-0.158	-0.106
	TOTAL	0.402	0.013	0.782	0.053	0.583	0.126
B07 F	GR	0.000	-0.009	0.000	0.024	0.000	-0.106
	T1	-0.122	0.000	-0.440	0.000	-0.142	0.000
	W1	0.001	0.000	0.024	0.000	0.257	0.000
	W2	0.000	0.000	0.041	0.000	0.018	0.000
	U1	0.279	0.000	0.273	0.000	-0.158	0.000
	R1	0.000	0.004	0.005	0.030	0.024	0.019
	GR+T1	-0.122	-0.009	-0.440	0.024	-0.142	-0.106
	TOTAL	0.403	0.013	0.783	0.054	0.598	0.125
B08	GR	0.000	0.000	0.000	0.051	0.000	-0.073
	T1	-0.139	0.000	-0.432	0.000	0.069	0.000
	W1	0.044	0.000	0.066	0.000	0.302	0.000
	W2	0.016	0.000	0.056	0.000	0.159	0.000
	U1	0.251	0.000	0.245	0.000	-0.236	0.000
	R1	0.004	0.000	0.007	0.034	0.025	0.014
	GR+T1	-0.139	0.000	-0.432	0.051	0.069	-0.073
	TOTAL	0.453	0.000	0.806	0.085	0.791	0.087
B09	GR	0.000	0.000	0.000	0.057	0.000	-0.029
	T1	0.072	0.000	-0.072	0.000	0.254	0.000
	W1	-0.011	0.000	0.011	0.000	-0.079	0.000
	W2	0.020	0.000	0.020	0.000	-0.001	0.000
	U1	0.003	0.000	-0.003	0.000	-0.162	0.000
	R1	0.002	0.000	0.002	0.014	0.025	0.018
	GR+T1	0.072	0.000	-0.072	0.057	0.254	-0.029
	TOTAL	0.108	0.000	0.108	0.071	0.522	0.047
B10 N	GR	0.000	-0.005	0.000	-0.015	0.000	-0.064
	T1	0.008	0.000	0.013	0.000	-0.088	0.000
	W1	-0.008	0.000	0.014	0.000	-0.169	0.000
	W2	-0.015	0.000	0.025	0.000	-0.267	0.000
	U1	0.002	0.000	-0.004	0.000	0.048	0.000
	R1	0.002	0.001	0.003	0.006	0.033	0.016
	GR+T1	0.008	-0.005	0.013	-0.015	-0.088	-0.064
	TOTAL	0.035	0.006	0.059	0.020	0.605	0.080

DISPLACEMENTS

Point name	Load combination	TRANSLATIONS (in)			ROTATIONS (deg)		
		X	Y	Z	X	Y	Z
B10 M	GR	0.000	-0.004	0.000	-0.012	0.000	-0.060
	T1	0.007	0.000	0.013	0.000	-0.086	0.000
	W1	-0.009	0.000	0.013	0.000	-0.161	0.000
	W2	-0.016	0.000	0.023	0.000	-0.265	0.000
	U1	0.002	0.000	-0.003	0.000	0.045	0.000
	R1	0.002	0.001	0.003	0.005	0.032	0.014
	GR+T1	0.007	-0.004	0.013	-0.012	-0.086	-0.060
	TOTAL	0.036	0.005	0.054	0.017	0.589	0.074
B10 F	GR	0.000	-0.004	0.000	-0.011	0.000	-0.056
	T1	0.007	0.000	0.012	0.000	-0.083	0.000
	W1	-0.008	0.000	0.011	0.000	-0.152	0.000
	W2	-0.015	0.000	0.020	0.000	-0.259	0.000
	U1	0.002	0.000	-0.003	0.000	0.042	0.000
	R1	0.002	0.001	0.002	0.004	0.031	0.013
	GR+T1	0.007	-0.004	0.012	-0.011	-0.083	-0.056
	TOTAL	0.034	0.004	0.049	0.015	0.566	0.069
B11 N	GR	0.000	-0.001	0.000	0.000	0.000	-0.031
	T1	0.006	0.000	0.002	0.000	-0.056	0.000
	W1	0.000	0.000	0.003	0.000	-0.098	0.000
	W2	-0.001	0.000	0.006	0.000	-0.181	0.000
	U1	0.000	0.000	-0.001	0.000	0.026	0.000
	R1	0.000	0.000	0.001	0.001	0.021	0.007
	GR+T1	0.006	-0.001	0.002	0.000	-0.056	-0.031
	TOTAL	0.007	0.001	0.013	0.001	0.381	0.039
B11 M	GR	0.000	-0.001	0.000	-0.001	0.000	-0.028
	T1	0.006	0.000	0.002	0.000	-0.049	0.000
	W1	0.000	0.000	0.003	0.000	-0.085	0.000
	W2	0.000	0.000	0.006	0.000	-0.159	0.000
	U1	0.000	0.000	-0.001	0.000	0.023	0.000
	R1	0.000	0.000	0.001	0.001	0.018	0.006
	GR+T1	0.006	-0.001	0.002	-0.001	-0.049	-0.028
	TOTAL	0.006	0.001	0.012	0.002	0.334	0.035
B11 F	GR	0.000	-0.001	0.000	-0.001	0.000	-0.024
	T1	0.005	0.000	0.001	0.000	-0.042	0.000
	W1	0.000	0.000	0.003	0.000	-0.073	0.000
	W2	0.000	0.000	0.005	0.000	-0.136	0.000
	U1	0.000	0.000	-0.001	0.000	0.019	0.000
	R1	0.000	0.000	0.001	0.001	0.016	0.005
	GR+T1	0.005	-0.001	0.001	-0.001	-0.042	-0.024
	TOTAL	0.005	0.001	0.010	0.003	0.285	0.029

PEXCND5 W-320 TANK 241-C-106 WASTE RETRIEVAL Fluor Daniel Northwest
12/22/97 AutoPIPE+4.60 RESULT PAGE 17

DISPLACEMENTS

Point name	Load combination	TRANSLATIONS (in)			ROTATIONS (deg)		
		X	Y	Z	X	Y	Z
B12	GR	0.000	0.000	0.000	0.000	0.000	0.000
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	W1	0.000	0.000	0.000	0.000	0.000	0.000
	W2	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	0.000	0.000	0.000	0.000	0.000
	R1	0.000	0.000	0.000	0.000	0.000	0.000
	GR+T1	0.000	0.000	0.000	0.000	0.000	0.000
	TOTAL	0.000	0.000	0.000	0.000	0.000	0.000

*** Segment B end ***

PEXCND5 W-320 TANK 241-C-106 WASTE RETRIEVAL Fluor Daniel Northwest
12/22/97 AutoPIPE+4.60 RESULT PAGE 18

RESTRAINT REACTIONS

Point name	Load combination	FORCES (lb)				MOMENTS (ft-lb)			
		X	Y	Z	Result	X	Y	Z	Result
A00	Anchor								
	GR	0	14	0	14	-4	0	0	4
	T1	3	-2	-3	5	0	1	1	1
	W1	-29	3	4	29	-1	-8	-7	11
	W2	-1	9	14	17	-2	0	0	2
	U1	13	-2	-3	13	1	3	1	4
	R1	3	4	5	7	1	1	1	2
	GR+T1	3	12	-3	13	-3	1	1	4
	TOTAL	49	30	30	64	8	14	10	19
A01	Guide								
	GR	0	-26	0	26	0	0	0	0
	T1	-4	1	0	4	0	0	0	0
	W1	54	-2	0	54	0	0	0	0
	W2	1	-8	0	8	0	0	0	0
	U1	-15	2	0	15	0	0	0	0
	R1	5	6	0	8	0	0	0	0
	GR+T1	-4	-25	0	25	0	0	0	0
	TOTAL	79	44	0	90	0	0	0	0
A09	Guide								
	GR	0	-10	0	10	0	0	0	0
	T1	3	0	0	3	0	0	0	0
	W1	42	0	0	42	0	0	0	0
	W2	-1	-1	0	1	0	0	0	0
	U1	4	0	0	4	0	0	0	0
	R1	2	2	0	3	0	0	0	0
	GR+T1	3	-10	0	10	0	0	0	0
	TOTAL	52	13	0	53	0	0	0	0
A10	Y - Stop								
	GR	0	-9	0	9	0	0	0	0
	T1	0	0	0	0	0	0	0	0
	W1	0	0	0	0	0	0	0	0
	W2	0	0	0	0	0	0	0	0
	U1	0	0	0	0	0	0	0	0
	R1	0	2	0	2	0	0	0	0
	GR+T1	0	-9	0	9	0	0	0	0
	TOTAL	0	11	0	11	0	0	0	0

PEXCND5 W-320 TANK 241-C-106 WASTE RETRIEVAL Fluor Daniel Northwest
12/22/97 AutoPIPE+4.60 RESULT PAGE 19

RESTRAINT REACTIONS

Point name	Load combination	X	FORCES (lb)			Result	X	MOMENTS (ft-lb)			Result
			Y	Z				Y	Z		
A13	Guide										
	GR		0	-9	0	9	0	0	0	0	0
	T1		0	0	0	5	0	0	0	0	0
	W1		0	0	-5	5	0	0	0	0	0
	W2		0	0	32	32	0	0	0	0	0
	U1		0	0	5	5	0	0	0	0	0
	R1		0	2	2	2	0	0	0	0	0
	GR+T1		0	-9	5	10	0	0	0	0	0
	TOTAL		0	11	49	50	0	0	0	0	0

A14	Anchor										
	GR		0	-5	0	5	0	0	-4	4	
	T1		-2	0	-2	2	0	4	0	4	
	W1		19	0	1	19	0	-2	0	2	
	W2		1	0	17	17	0	-16	0	16	
	U1		-2	0	-2	3	0	4	0	4	
	R1		4	1	1	4	0	1	1	2	
	GR+T1		-2	-5	-2	5	0	4	-4	6	
	TOTAL		27	6	22	35	0	27	6	27	

B00	Anchor										
	GR		0	16	0	16	0	0	-4	4	
	T1		10	0	34	35	0	9	0	9	
	W1		20	0	7	21	0	-2	0	2	
	W2		35	0	-32	48	0	-9	0	9	
	U1		-4	0	-5	6	0	-1	0	1	
	R1		4	2	3	6	0	1	1	1	
	GR+T1		10	16	34	39	0	9	-4	10	
	TOTAL		73	19	81	111	0	22	5	23	

B01	Guide										
	GR		0	-29	0	29	0	0	0	0	
	T1		0	0	-39	39	0	0	0	0	
	W1		0	0	-9	9	0	0	0	0	
	W2		0	0	55	55	0	0	0	0	
	U1		0	0	6	6	0	0	0	0	
	R1		0	4	5	6	0	0	0	0	
	GR+T1		0	-29	-39	49	0	0	0	0	
	TOTAL		0	33	114	119	0	0	0	0	

B08	Y - Stop										
	GR		0	-10	0	10	0	0	0	0	
	T1		0	0	0	0	0	0	0	0	
	W1		0	0	0	0	0	0	0	0	
	W2		0	0	0	0	0	0	0	0	
	U1		0	0	0	0	0	0	0	0	
	R1		0	0	1	0	0	0	0	0	
	GR+T1		0	-10	0	10	0	0	0	0	
	TOTAL		0	11	0	11	0	0	0	0	

PEXCND5 W-320 TANK 241-C-106 WASTE RETRIEVAL Fluor Daniel Northwest
12/22/97 AutoPIPE+4.60 RESULT PAGE 20

RESTRAINT REACTIONS

Point name	Load combination	X	FORCES (lb)			Result	X	MOMENTS (ft-lb)			Result
			Y	Z				Y	Z		
B09	Guide										
	GR		0	-10	0	10	0	0	0	0	0
	T1		-3	0	-3	5	0	0	0	0	0
	W1		21	0	21	30	0	0	0	0	0
	W2		20	0	20	29	0	0	0	0	0
	U1		2	0	2	3	0	0	0	0	0
	R1		2	2	2	3	0	0	0	0	0
	GR+T1		-3	-10	-3	11	0	0	0	0	0
	TOTAL		48	12	48	69	0	0	0	0	0

B12	Anchor										
	GR		0	-5	0	5	0	0	-5	5	
	T1		-7	0	9	11	0	-9	0	9	
	W1		-3	0	16	16	0	-16	0	16	
	W2		-21	0	36	41	0	-31	0	31	
	U1		2	0	-3	4	0	4	0	4	
	R1		2	1	4	5	0	4	1	4	
	GR+T1		-7	-5	9	12	0	-9	-5	11	
	TOTAL		36	6	67	77	0	65	7	65	

Point name	Load combination	ASME B31.3c (1992) CODE COMPLIANCE (Moments in ft-lb)			(Stress in psi)		
		In-Pl. Moment	Out-Pl. Moment	Torsion Moment	S.I.F. In Out	Eq. Load no. type	Code Stress Allow.
*** Segment A begin ***							
A00	Max P					(3a) HOOP	80 16700
	GR + Max P	4	0		1.00 1.00	(18) SUST	1161 16700
	Cold to T1	0	1	1	1.00 1.00	(17) DISP	319 25050
	SUS+WIND	7	8		1.00 1.00	(18) OCC	3796 22211
	SUS+SEIS	5	4		1.00 1.00	(18) OCC	2557 22211
A01	Max P					(3a) HOOP	80 16700
	GR + Max P	8	0		1.00 1.00	(18) SUST	2438 16700
	Cold to T1	1	2	1	1.00 1.00	(17) DISP	594 25050
	SUS+WIND	15	18		1.00 1.00	(18) OCC	8156 22211
	SUS+SEIS	12	9		1.00 1.00	(18) OCC	5321 22211
A02	Max P					(3a) HOOP	80 16700
	GR + Max P	6	0		1.00 1.00	(18) SUST	1887 16700
	Cold to T1	1	2	1	1.00 1.00	(17) DISP	563 25050
	SUS+WIND	13	15		1.00 1.00	(18) OCC	6708 22211
	SUS+SEIS	10	9		1.00 1.00	(18) OCC	4572 22211
A03	Max P					(3a) HOOP	105 16700
	GR + Max P	4	0		1.00 1.00	(18) SUST	448 16700
	Cold to T1	1	1	1	1.00 1.00	(17) DISP	163 25050
	SUS+WIND	11	12		1.00 1.00	(18) OCC	1669 22211
	SUS+SEIS	8	8		1.00 1.00	(18) OCC	1212 22211
A04	Max P					(3a) HOOP	105 16700
	GR + Max P	3	0		1.00 1.00	(18) SUST	276 16700
	Cold to T1	1	1	1	1.00 1.00	(17) DISP	154 25050
	SUS+WIND	9	9		1.00 1.00	(18) OCC	1257 22211
	SUS+SEIS	6	7		1.00 1.00	(18) OCC	981 22211
A05	Max P					(3a) HOOP	105 16700
	GR + Max P	2	0		1.00 1.00	(18) SUST	195 16700
	Cold to T1	1	1	1	1.00 1.00	(17) DISP	146 25050
	SUS+WIND	8	6		1.00 1.00	(18) OCC	989 22211
	SUS+SEIS	5	7		1.00 1.00	(18) OCC	849 22211
A06	Max P					(3a) HOOP	80 16700
	GR + Max P	1	0		1.00 1.00	(18) SUST	287 16700
	Cold to T1	1	1	1	1.00 1.00	(17) DISP	456 25050
	SUS+WIND	8	3		1.00 1.00	(18) OCC	2499 22211
	SUS+SEIS	4	6		1.00 1.00	(18) OCC	2266 22211

Point name	Load combination	ASME B31.3c (1992) CODE COMPLIANCE (Moments in ft-lb)			(Stress in psi)		
		In-Pl. Moment	Out-Pl. Moment	Torsion	S.I.F. In Out	Eq. Load no. type	Code Stress Allow.
A07 N-	Max P					(3a) HOOP	80 16700
	GR + Max P	1	0		1.00 1.00	(18) SUST	208 16700
	Cold to T1	1	1		1 1.00 1.00	(17) DISP	450 25050
	SUS+WIND	8	2		1.00 1.00	(18) OCC	2339 22211
	SUS+SEIS	4	6		1.00 1.00	(18) OCC	2133 22211
A07 N+	Max P					(3a) HOOP	80 16700
	GR + Max P	1	0		1.25 1.04	(18) SUST	250 16700
	Cold to T1	1	1		1 1.25 1.04	(17) DISP	517 25050
	SUS+WIND	8	2		1.25 1.04	(18) OCC	2881 22211
	SUS+SEIS	4	6		1.25 1.04	(18) OCC	2344 22211
A07 M	Max P					(3a) HOOP	80 16700
	GR + Max P	0	0		1.25 1.04	(18) SUST	187 16700
	Cold to T1	1	1		0 1.25 1.04	(17) DISP	497 25050
	SUS+WIND	7	6		1.25 1.04	(18) OCC	3266 22211
	SUS+SEIS	3	5		1.25 1.04	(18) OCC	2140 22211
A07 F-	Max P					(3a) HOOP	80 16700
	GR + Max P	0	0		1.25 1.04	(18) SUST	168 16700
	Cold to T1	1	0		1 1.25 1.04	(17) DISP	447 25050
	SUS+WIND	6	7		1.25 1.04	(18) OCC	3141 22211
	SUS+SEIS	3	2		1.25 1.04	(18) OCC	1264 22211
A07 F+	Max P					(3a) HOOP	80 16700
	GR + Max P	0	0		1.00 1.00	(18) SUST	147 16700
	Cold to T1	1	0		1 1.00 1.00	(17) DISP	396 25050
	SUS+WIND	6	7		1.00 1.00	(18) OCC	2764 22211
	SUS+SEIS	3	2		1.00 1.00	(18) OCC	1072 22211
A08 N-	Max P					(3a) HOOP	80 16700
	GR + Max P	0	0		1.00 1.00	(18) SUST	158 16700
	Cold to T1	1	0		1 1.00 1.00	(17) DISP	341 25050
	SUS+WIND	4	0		1.00 1.00	(18) OCC	1090 22211
	SUS+SEIS	2	0		1.00 1.00	(18) OCC	586 22211
A08 N+	Max P					(3a) HOOP	80 16700
	GR + Max P	0	0		1.25 1.04	(18) SUST	183 16700
	Cold to T1	1	0		1 1.25 1.04	(17) DISP	383 25050
	SUS+WIND	4	0		1.25 1.04	(18) OCC	1346 22211
	SUS+SEIS	2	0		1.25 1.04	(18) OCC	717 22211

Point name	Load combination	ASME B31.3c (1992) (Moments in ft-lb)			CODE COMPLIANCE		(Stress in psi)		Code Stress	Allow.
		In-Pl. Moment	Out-Pl. Moment	Torsion Moment	S.I.F In	S.I.F Out	Eq. Load no.	type		
A08 M	Max P						(3a) HOOP		80	16700
	GR + Max P	0	0		1.25	1.04	(18) SUST		158	16700
	Cold to T1	1	1	1	1.25	1.04	(17) DISP		421	25050
	SUS+WIND	4	0		1.25	1.04	(18) OCC		1559	22211
	SUS+SEIS	2	4		1.25	1.04	(18) OCC		1483	22211
A08 F-	Max P						(3a) HOOP		80	16700
	GR + Max P	0	0		1.25	1.04	(18) SUST		101	16700
	Cold to T1	1	1	0	1.25	1.04	(17) DISP		432	25050
	SUS+WIND	4	0		1.25	1.04	(18) OCC		1591	22211
	SUS+SEIS	2	5		1.25	1.04	(18) OCC		1887	22211
A08 F+	Max P						(3a) HOOP		80	16700
	GR + Max P	0	0		1.00	1.00	(18) SUST		89	16700
	Cold to T1	1	1	0	1.00	1.00	(17) DISP		369	25050
	SUS+WIND	4	0		1.00	1.00	(18) OCC		1284	22211
	SUS+SEIS	2	5		1.00	1.00	(18) OCC		1768	22211
A09	Max P						(3a) HOOP		80	16700
	GR + Max P	0	0		1.00	1.00	(18) SUST		1787	16700
	Cold to T1	0	4	0	1.00	1.00	(17) DISP		1201	25050
	SUS+WIND	7	28		1.00	1.00	(18) OCC		10015	22211
	SUS+SEIS	7	8		1.00	1.00	(18) OCC		4099	22211
A10	Max P						(3a) HOOP		80	16700
	GR + Max P	4	0		1.00	1.00	(18) SUST		1101	16700
	Cold to T1	0	6	0	1.00	1.00	(17) DISP		1849	25050
	SUS+WIND	4	4		1.00	1.00	(18) OCC		2258	22211
	SUS+SEIS	5	6		1.00	1.00	(18) OCC		2838	22211
A11 N-	Max P						(3a) HOOP		80	16700
	GR + Max P	0	0		1.00	1.00	(18) SUST		124	16700
	Cold to T1	0	8	0	1.00	1.00	(17) DISP		2301	25050
	SUS+WIND	0	17		1.00	1.00	(18) OCC		5120	22211
	SUS+SEIS	0	8		1.00	1.00	(18) OCC		2442	22211
A11 N+	Max P						(3a) HOOP		80	16700
	GR + Max P	0	0		1.25	1.04	(18) SUST		135	16700
	Cold to T1	8	0	0	1.25	1.04	(17) DISP		2873	25050
	SUS+WIND	17	0		1.25	1.04	(18) OCC		6374	22211
	SUS+SEIS	8	0		1.25	1.04	(18) OCC		3029	22211

Point name	Load combination	ASME B31.3c (1992) (Moments in ft-lb)			CODE COMPLIANCE		(Stress in psi)		Code Stress	Allow.
		In-Pl. Moment	Out-Pl. Moment	Torsion Moment	S.I.F In	S.I.F Out	Eq. Load no.	type		
A11 M	Max P						(3a) HOOP		80	16700
	GR + Max P	0	0		1.25	1.04	(18) SUST		122	16700
	Cold to T1	8	0	0	1.25	1.04	(17) DISP		2878	25050
	SUS+WIND	18	1		1.25	1.04	(18) OCC		6578	22211
	SUS+SEIS	8	0		1.25	1.04	(18) OCC		3035	22211
A11 F-	Max P						(3a) HOOP		80	16700
	GR + Max P	0	0		1.25	1.04	(18) SUST		104	16700
	Cold to T1	8	0	0	1.25	1.04	(17) DISP		2838	25050
	SUS+WIND	17	1		1.25	1.04	(18) OCC		6458	22211
	SUS+SEIS	8	0		1.25	1.04	(18) OCC		2978	22211
A11 F+	Max P						(3a) HOOP		80	16700
	GR + Max P	0	0		1.00	1.00	(18) SUST		91	16700
	Cold to T1	0	8	0	1.00	1.00	(17) DISP		2273	25050
	SUS+WIND	1	17		1.00	1.00	(18) OCC		5181	22211
	SUS+SEIS	0	8		1.00	1.00	(18) OCC		2393	22211
A12	Max P						(3a) HOOP		80	16700
	GR + Max P	2	0		1.00	1.00	(18) SUST		738	16700
	Cold to T1	0	2	0	1.00	1.00	(17) DISP		706	25050
	SUS+WIND	3	15		1.00	1.00	(18) OCC		5188	22211
	SUS+SEIS	4	3		1.00	1.00	(18) OCC		1663	22211
A13	Max P						(3a) HOOP		80	16700
	GR + Max P	4	0		1.00	1.00	(18) SUST		1283	16700
	Cold to T1	0	7	0	1.00	1.00	(17) DISP		2081	25050
	SUS+WIND	4	19		1.00	1.00	(18) OCC		6902	22211
	SUS+SEIS	5	8		1.00	1.00	(18) OCC		3723	22211
A14	Max P						(3a) HOOP		80	16700
	GR + Max P	4	0		1.00	1.00	(18) SUST		1345	16700
	Cold to T1	0	4	0	1.00	1.00	(17) DISP		1040	25050
	SUS+WIND	5	18		1.00	1.00	(18) OCC		6688	22211
	SUS+SEIS	6	5		1.00	1.00	(18) OCC		2857	22211
*** Segment A end ***										
*** Segment B begin ***										
B00	Max P						(3a) HOOP		80	16700
	GR + Max P	4	0		1.00	1.00	(18) SUST		1361	16700
	Cold to T1	0	9	0	1.00	1.00	(17) DISP		2705	25050
	SUS+WIND	4	11		1.00	1.00	(18) OCC		4603	22211
	SUS+SEIS	5	2		1.00	1.00	(18) OCC		2029	22211

Point name	Load combination	ASME B31.3c (1992) CODE COMPLIANCE (Moments in ft-lb)			(Stress in psi)			Code Stress	Code Allow.
		In-Pl. Moment	Out-Pl. Moment	Torsion Moment	S.I.F. In	Eq. Load no.	Code type		
B01	Max P					(3a)	HOOP	80	16700
	GR + Max P	10	0		1.00	1.00	(18) SUST	2851	16700
	Cold to T1	0	19	0	1.00	1.00	(17) DISP	5587	25050
	SUS+WIND	10	24		1.00	1.00	(18) OCC	9845	22211
	SUS+SEIS	11	4		1.00	1.00	(18) OCC	4231	22211
B02	Max P					(3a)	HOOP	80	16700
	GR + Max P	8	0		1.00	1.00	(18) SUST	2302	16700
	Cold to T1	0	18	0	1.00	1.00	(17) DISP	5316	25050
	SUS+WIND	8	20		1.00	1.00	(18) OCC	8928	22211
	SUS+SEIS	9	4		1.00	1.00	(18) OCC	3534	22211
B03	Max P					(3a)	HOOP	105	16700
	GR + Max P	6	0		1.00	1.00	(18) SUST	576	16700
	Cold to T1	0	17	0	1.00	1.00	(17) DISP	1544	25050
	SUS+WIND	6	17		1.00	1.00	(18) OCC	2134	22211
	SUS+SEIS	7	4		1.00	1.00	(18) OCC	910	22211
B04	Max P					(3a)	HOOP	105	16700
	GR + Max P	4	0		1.00	1.00	(18) SUST	404	16700
	Cold to T1	0	16	0	1.00	1.00	(17) DISP	1453	25050
	SUS+WIND	4	14		1.00	1.00	(18) OCC	1671	22211
	SUS+SEIS	5	3		1.00	1.00	(18) OCC	695	22211
B05	Max P					(3a)	HOOP	105	16700
	GR + Max P	3	0		1.00	1.00	(18) SUST	324	16700
	Cold to T1	0	15	0	1.00	1.00	(17) DISP	1363	25050
	SUS+WIND	3	11		1.00	1.00	(18) OCC	1321	22211
	SUS+SEIS	4	3		1.00	1.00	(18) OCC	574	22211
B06	Max P					(3a)	HOOP	80	16700
	GR + Max P	2	0		1.00	1.00	(18) SUST	707	16700
	Cold to T1	0	14	0	1.00	1.00	(17) DISP	4172	25050
	SUS+WIND	2	8		1.00	1.00	(18) OCC	3190	22211
	SUS+SEIS	3	2		1.00	1.00	(18) OCC	1405	22211
B06A	Max P					(3a)	HOOP	80	16700
	GR + Max P	4	0		1.00	1.00	(18) SUST	1157	16700
	Cold to T1	0	2	0	1.00	1.00	(17) DISP	710	25050
	SUS+WIND	4	11		1.00	1.00	(18) OCC	4412	22211
	SUS+SEIS	5	3		1.00	1.00	(18) OCC	2215	22211

Point name	Load combination	ASME B31.3c (1992) CODE COMPLIANCE (Moments in ft-lb)			(Stress in psi)			Code Stress	Code Allow.
		In-Pl. Moment	Out-Pl. Moment	Torsion Moment	S.I.F. In	Eq. Load no.	Code type		
B07 N-	Max P					(3a)	HOOP	80	16700
	GR + Max P	0	0		1.00	1.00	(18) SUST	145	16700
	Cold to T1	0	14	0	1.00	1.00	(17) DISP	4200	25050
	SUS+WIND	0	23		1.00	1.00	(18) OCC	6860	22211
	SUS+SEIS	1	6		1.00	1.00	(18) OCC	2061	22211
B07 N+	Max P					(3a)	HOOP	80	16700
	GR + Max P	0	0		1.25	1.04	(18) SUST	149	16700
	Cold to T1	14	0	0	1.25	1.04	(17) DISP	5244	25050
	SUS+WIND	23	0		1.25	1.04	(18) OCC	8534	22211
	SUS+SEIS	6	1		1.25	1.04	(18) OCC	2541	22211
B07 M	Max P					(3a)	HOOP	80	16700
	GR + Max P	0	0		1.25	1.04	(18) SUST	187	16700
	Cold to T1	14	0	0	1.25	1.04	(17) DISP	5275	25050
	SUS+WIND	23	0		1.25	1.04	(18) OCC	8635	22211
	SUS+SEIS	7	1		1.25	1.04	(18) OCC	2590	22211
B07 F-	Max P					(3a)	HOOP	80	16700
	GR + Max P	0	1		1.25	1.04	(18) SUST	203	16700
	Cold to T1	14	0	0	1.25	1.04	(17) DISP	5267	25050
	SUS+WIND	23	1		1.25	1.04	(18) OCC	8513	22211
	SUS+SEIS	6	1		1.25	1.04	(18) OCC	2594	22211
B07 F+	Max P					(3a)	HOOP	80	16700
	GR + Max P	1	0		1.00	1.00	(18) SUST	196	16700
	Cold to T1	0	14	0	1.00	1.00	(17) DISP	4218	25050
	SUS+WIND	1	23		1.00	1.00	(18) OCC	6852	22211
	SUS+SEIS	1	6		1.00	1.00	(18) OCC	2113	22211
B08	Max P					(3a)	HOOP	80	16700
	GR + Max P	5	0		1.00	1.00	(18) SUST	1463	16700
	Cold to T1	0	11	0	1.00	1.00	(17) DISP	3315	25050
	SUS+WIND	5	5		1.00	1.00	(18) OCC	3031	22211
	SUS+SEIS	6	5		1.00	1.00	(18) OCC	2817	22211
B09	Max P					(3a)	HOOP	80	16700
	GR + Max P	5	0		1.00	1.00	(18) SUST	1534	16700
	Cold to T1	0	8	0	1.00	1.00	(17) DISP	2244	25050
	SUS+WIND	5	36		1.00	1.00	(18) OCC	12059	22211
	SUS+SEIS	6	7		1.00	1.00	(18) OCC	3649	22211

Point name	Load combination	ASME B31.3c (1992) CODE COMPLIANCE (Moments in ft-lb)			(Stress in psi)			Code Stress	Code Allow.
		In-Pl. Moment	Out-Pl. Moment	Torsion Moment	S.I.F In	Eq. Load Out	no. type		
B10 N-	Max P	2	0		1.00	1.00	(3a) HOOP	80	16700
	GR + Max P	0	0		1.00	1.00	(18) SUST	764	16700
	Cold to T1	0	1	0	1.00	1.00	(17) DISP	242	25050
	SUS+WIND	2	4		1.00	1.00	(18) OCC	1890	22211
	SUS+SEIS	3	2		1.00	1.00	(18) OCC	1473	22211
B10 N+	Max P						(3a) HOOP	80	16700
	GR + Max P	0	2		1.25	1.04	(18) SUST	793	16700
	Cold to T1	1	0	0	1.25	1.04	(17) DISP	303	25050
	SUS+WIND	4	2		1.25	1.04	(18) OCC	2199	22211
	SUS+SEIS	2	3		1.25	1.04	(18) OCC	1668	22211
B10 M	Max P						(3a) HOOP	80	16700
	GR + Max P	0	2		1.25	1.04	(18) SUST	672	16700
	Cold to T1	1	0	0	1.25	1.04	(17) DISP	400	25050
	SUS+WIND	6	2		1.25	1.04	(18) OCC	2726	22211
	SUS+SEIS	2	3		1.25	1.04	(18) OCC	1591	22211
B10 F-	Max P						(3a) HOOP	80	16700
	GR + Max P	0	0		1.25	1.04	(18) SUST	181	16700
	Cold to T1	2	0	0	1.25	1.04	(17) DISP	587	25050
	SUS+WIND	8	0		1.25	1.04	(18) OCC	3205	22211
	SUS+SEIS	3	1		1.25	1.04	(18) OCC	1150	22211
B10 F+	Max P						(3a) HOOP	80	16700
	GR + Max P	0	0		1.00	1.00	(18) SUST	175	16700
	Cold to T1	0	2	0	1.00	1.00	(17) DISP	470	25050
	SUS+WIND	0	8		1.00	1.00	(18) OCC	2597	22211
	SUS+SEIS	1	3		1.00	1.00	(18) OCC	952	22211
B11 N-	Max P						(3a) HOOP	80	16700
	GR + Max P	2	0		1.00	1.00	(18) SUST	732	16700
	Cold to T1	0	6	0	1.00	1.00	(17) DISP	1798	25050
	SUS+WIND	2	30		1.00	1.00	(18) OCC	9464	22211
	SUS+SEIS	3	5		1.00	1.00	(18) OCC	2282	22211
B11 N+	Max P						(3a) HOOP	80	16700
	GR + Max P	0	2		1.25	1.04	(18) SUST	760	16700
	Cold to T1	3	0	0	1.25	1.04	(17) DISP	2246	25050
	SUS+WIND	60	2		1.25	1.04	(18) OCC	11663	22211
	SUS+SEIS	5	3		1.25	1.04	(18) OCC	2693	22211

Point name	Load combination	ASME B31.3c (1992) CODE COMPLIANCE (Moments in ft-lb)			(Stress in psi)			Code Stress	Code Allow.
		In-Pl. Moment	Out-Pl. Moment	Torsion Moment	S.I.F In	Eq. Load Out	no. type		
B11 M	Max P						(3a) HOOP	80	16700
	GR + Max P	0	3		1.25	1.04	(18) SUST	1061	16700
	Cold to T1	0	0	0	1.25	1.04	(17) DISP	2345	25050
	SUS+WIND	31	3		1.25	1.04	(18) OCC	12454	22211
	SUS+SEIS	5	4		1.25	1.04	(18) OCC	3072	22211
B11 F-	Max P						(3a) HOOP	80	16700
	GR + Max P	0	4		1.25	1.04	(18) SUST	1207	16700
	Cold to T1	7	0	0	1.25	1.04	(17) DISP	2433	25050
	SUS+WIND	32	4		1.25	1.04	(18) OCC	13082	22211
	SUS+SEIS	6	5		1.25	1.04	(18) OCC	3290	22211
B11 F+	Max P						(3a) HOOP	80	16700
	GR + Max P	4	0		1.00	1.00	(18) SUST	1161	16700
	Cold to T1	0	7	0	1.00	1.00	(17) DISP	1949	25050
	SUS+WIND	4	32		1.00	1.00	(18) OCC	10671	22211
	SUS+SEIS	5	6		1.00	1.00	(18) OCC	2836	22211
B12	Max P						(3a) HOOP	80	16700
	GR + Max P	5	0		1.00	1.00	(18) SUST	1634	16700
	Cold to T1	0	9	0	1.00	1.00	(17) DISP	2742	25050
	SUS+WIND	5	48		1.00	1.00	(18) OCC	15760	22211
	SUS+SEIS	7	8		1.00	1.00	(18) OCC	3940	22211

*** Segment B end ***

SYSTEM SUMMARY

Maximum displacements (in)

Maximum X :	0.453	Point : B08	Load Comb.: TOTAL
Maximum Y :	0.052	Point : B06A	Load Comb.: TOTAL
Maximum Z :	0.806	Point : B08	Load Comb.: TOTAL
Max. total:	0.925	Point : B08	Load Comb.: TOTAL

Maximum rotations (deg)

Maximum X :	0.219	Point : A08 N	Load Comb.: TOTAL
Maximum Y :	0.836	Point : A11 F	Load Comb.: TOTAL
Maximum Z :	0.372	Point : A08 F	Load Comb.: TOTAL
Max. total:	0.847	Point : A11 F	Load Comb.: TOTAL

Maximum restraint forces(lb)

Maximum X :	79	Point : A01	Load Comb.: TOTAL
Maximum Y :	44	Point : A01	Load Comb.: TOTAL
Maximum Z :	114	Point : B01	Load Comb.: TOTAL
Max. total:	119	Point : B01	Load Comb.: TOTAL

Maximum restraint moments(ft-lb)

Maximum X :	8	Point : A00	Load Comb.: TOTAL
Maximum Y :	65	Point : B12	Load Comb.: TOTAL
Maximum Z :	10	Point : A00	Load Comb.: TOTAL
Max. total:	65	Point : B12	Load Comb.: TOTAL

SYSTEM SUMMARY

Maximum sustained stress

Point	:	B01
Stress psi	:	2851
Allowable psi	:	16700
Ratio	:	0.17
Load combination	:	GR + Max P

Maximum displacement stress

Point	:	B01
Stress psi	:	5587
Allowable psi	:	25050
Ratio	:	0.22
Load combination	:	Cold to T1

Maximum occasional stress

Point	:	B12
Stress psi	:	15760
Allowable psi	:	22211
Ratio	:	0.71
Load combination	:	SUS+WIND

Maximum hoop stress

Point	:	A03
Stress psi	:	105
Allowable psi	:	16700
Ratio	:	0.01
Load combination	:	Max P

Maximum sustained stress ratio

Point	:	B01
Stress psi	:	2851
Allowable psi	:	16700
Ratio	:	0.17
Load combination	:	GR + Max P

Maximum displacement stress ratio

Point	:	B01
Stress psi	:	5587
Allowable psi	:	25050
Ratio	:	0.22
Load combination	:	Cold to T1

PEXCHDS W-320 TANK 241-C-106 WASTE RETRIEVAL Fluor Daniel Northwest 31
12/22/97 Autopipe+4.60 RESULT PAGE

SYSTEM SUMMARY

Maximum occasional stress ratio

Point : 812
Stress psi : 17260
Allowable psi : 22211
Ratio : 0.71
Load combination : SUS+WIND

Maximum hoop stress ratio

Point : 403
Stress psi : 105
Allowable psi : 16700
Ratio : 0.01
Load combination : Max P

*** The system satisfies ASME B31.3 code requirements ***
*** for the selected options ***

Table 4
Design Wind Pressures, p , and Forces, F

Design wind loading	Flexible Buildings and Structures (Height/Least Horizontal Dimension > 5 or $f < 1$ Hz)			
	Buildings	Other structures	Buildings	Other structures
Main wind-force resisting systems	$p = qG_hC_p - q_h(GC_{pi})^{**}$ q : q_z for windward wall evaluated at height z above ground q_h for leeward wall, side walls, and roof-evaluated at mean roof height G_h : given in Table 8 C_p : given in Fig. 2 (Table 10 for arched roofs) GC_{pi} : given in Table 9	$F = q_zG_hC_fA_f$ q_z : evaluated at height z above ground G_h : given in Table 8 C_f : given in Tables 11-16 A_f : projected area normal to wind†	$p = q\bar{G}C_p^*$ q : q_z for windward wall evaluated at height z above ground q_h for leeward wall evaluated at mean roof height $\bar{G}$: obtained by rational analysis C_p : given in Fig. 2	$F = q_z\bar{G}C_fA_f$ q_z : evaluated at height z above ground $\bar{G}$: obtained by rational analysis C_f : given in Tables 11-16 A_f : projected area normal to wind†
	$h \leq 60$ ft	$h > 60$ ft		
Components and cladding‡	$p = q_h[(GC_p) - (GC_{pi})]^{**}$ q_h : evaluated at mean roof height using Exposure C (see 6.5.3) for all terrains GC_p : given in Figs. 3a and 3b GC_{pi} : given in Table 9	$p = q[(GC_p) - (GC_{pi})]^{**}$ q : q_z for positive pressure evaluated at height z above ground q_h for negative pressure evaluated at mean roof height GC_p : Given in Fig. 4‡ GC_{pi} : Given in Table 9	$F = q_zG_zC_fA_f$ q_z : evaluated at height z above ground G_z : given in Table 8 C_f : given in Tables 11-16 A_f : projected area normal to wind†	$p = q[(GC_p) - (GC_{pi})]^{**}$ q : q_z for positive pressure evaluated at height z above ground q_h for negative pressure evaluated at mean roof height GC_p : Given in Fig. 4 GC_{pi} : Given in Table 9

**Positive pressure acts toward surface and negative pressure acts away from surface; values of external and internal pressures shall be combined algebraically to ascertain most critical load.

*Pressure shall be applied simultaneously on windward and leeward walls and on roof surfaces as shown in Fig. 2.

† A_f is the projected area normal to the wind except where C_f is given for the surface area.

‡Major structural components supporting tributary areas greater than 700 ft² in extent may be designed using the provisions for main wind-force resisting systems.

§In the design of components and cladding for buildings having a mean roof height h , 60 ft < h < 90 ft, GC_p values of Fig. 3 may be used provided q is taken as q_h and Exposure C (see 6.5.3) is used for all terrains.

NOTE: Pressures are in pounds per square foot; forces are in pounds.

BUILDINGS AND OTHER STRUCTURES

6.4.3 Wind-Tunnel Procedure. Properly conducted wind-tunnel tests or similar tests employing fluids other than air may be used for the determination of design wind loads in lieu of the provisions of 6.4.2. This procedure is recommended for those buildings or structures having unusual geometric shapes, response characteristics, or site locations for which channeling effects or buffeting in the wake of upwind obstructions warrant special consideration, and for which no reliable documentation pertaining to wind effects is available in the literature. The procedure is also recommended for those buildings or structures for which more accurate wind-loading information is desired.

Tests for the determination of mean and fluctuating forces and pressures shall be considered to be properly conducted only if: (1) the natural wind has been modeled to account for the variation of wind speed with height; (2) the natural wind has been modeled to account for the intensity of the longitudinal component of turbulence; (3) the geometric scale of the structural model is not more than three times the geometric scale of the longitudinal component of turbulence; (4) the response characteristics of the wind-tunnel instrumentation are consistent with the measurements to be made; and (5) due regard is given to the dependence of forces and pressures on the Reynolds number.

Tests for the purpose of determining the dynamic response of a structure shall be considered to be properly conducted only if requirements (1) through (5) are satisfied and the structural model is scaled with due regard to length, mass distribution, stiffness, and damping.

6.5 Velocity Pressure

6.5.1 Procedure for Calculating Velocity Pressure. The velocity pressure q_z at height z shall be calculated from the formula:

$$q_z = 0.00256 K_z (V)^2 \quad (\text{Eq. 3})$$

where the basic wind speed V is selected in accordance with the provisions of 6.5.2, the importance factor I is set forth in Table 5, and the velocity pressure exposure coefficient K_z is given in Table 6 in accordance with the provisions of 6.5.3. The numerical coefficient 0.00256 shall be used except where sufficient climatic data are available to justify the selection of a different value of this factor for a specific design application.

6.5.2 Selection of Basic Wind Speed. The basic wind speed V used in the determination of design wind loads on buildings and other structures shall be as given in Fig. 1 for the contiguous United States and Alaska and in Table 7 for Hawaii and Puerto Rico except as provided in 6.5.2.1 and 6.5.2.2. The basic wind speed used shall be at least 70 mph.

6.5.2.1 Special Wind Regions. Special consideration shall be given to those regions for which records or experience indicates that the wind speeds are higher than those reflected in Fig. 1 and Table 7. Some special regions are indicated in Fig. 1; however, all mountainous terrain, gorges, and ocean promontories shall be examined for unusual wind conditions and the authority having jurisdiction shall, if necessary, adjust the values given in Fig. 1 and Table 7 to account for higher local winds. Where necessary, such adjustment shall be based on meteorological advice and an estimate of the basic wind

Table 5
Importance Factor, I (Wind Loads)

Category*	I	
	100 miles from hurricane oceanline and in other areas	At hurricane oceanline
I	1.00	1.05
II	1.07	1.11
III	1.07	1.11
IV	0.95	1.00

*See 1.4 and Table 1.

NOTES:

- (1) The building and structure classification categories are listed in Table 1.
- (2) For regions between the hurricane oceanline and 100 miles inland the importance factor I shall be determined by linear interpolation.
- (3) Hurricane oceanlines are the Atlantic and Gulf of Mexico coastal areas.

Table 6
Velocity Pressure Exposure Coefficient, K_z

Height above ground level, z (feet)	K_z			
	Exposure A	Exposure B	Exposure C	Exposure D
0 - 15	0.12	0.37	0.80	1.20
20	0.15	0.42	0.87	1.27
25	0.17	0.46	0.93	1.32
30	0.19	0.50	0.98	1.37
40	0.23	0.57	1.06	1.46
50	0.27	0.63	1.13	1.52
60	0.30	0.68	1.19	1.58
70	0.33	0.73	1.24	1.63
80	0.37	0.77	1.29	1.67
90	0.40	0.82	1.34	1.71
100	0.42	0.85	1.38	1.75
120	0.48	0.93	1.45	1.81
140	0.53	0.99	1.52	1.87
160	0.58	1.05	1.58	1.92
180	0.63	1.11	1.63	1.97
200	0.67	1.16	1.68	2.01
250	0.78	1.28	1.79	2.10
300	0.88	1.39	1.88	2.18
350	0.98	1.49	1.97	2.25
400	1.07	1.58	2.05	2.31
450	1.16	1.67	2.12	2.36
500	1.24	1.75	2.18	2.41

NOTES:

- (1) Linear interpolation for intermediate values of height z is acceptable.
- (2) For values of height z greater than 500 feet, K_z may be calculated from Eq. C3 in the Commentary.
- (3) Exposure categories are defined in 6.5.3.

Table 7
Basic Wind Speed, V

Location	V (mph)
Hawaii	80
Puerto Rico	95

NOTE: The unique topographical features common to the islands of Hawaii and Puerto Rico suggest that it may be advisable to adjust the values given in Table 7 to account for locally higher winds for structures sited near mountainous terrain, gorges, and ocean promontories.

speed obtained in accordance with the provisions of 6.5.2.2.

6.5.2.2 Estimation of Basic Wind Speeds from Climatic Data. Regional climatic data may be used in lieu of the basic wind speeds given in Fig. 1 and Table 7 provided: (1) acceptable extreme-value statistical-analysis procedures have been employed in reducing the data; (2) due regard is given to the length of record, averaging time, anemometer height, data quality, and terrain exposure; and (3) the basic wind speed used is not less than 70 mph.

6.5.2.3 Limitation. Tornadoes have not been considered in developing the basic wind-speed distributions. For those structures or buildings that must be designed to resist tornadic winds the designer is referred to the references in the Commentary (see C6.5.2.3) on tornado-resistant design.

6.5.3 Exposure Categories.

6.5.3.1 General. An exposure category that adequately reflects the characteristics of ground surface irregularities shall be determined for the site at which the building or structure is to be constructed.

BUILDINGS AND OTHER STRUCTURES

Table 8
Gust Response Factors, G_h and G_z

Height above ground level, z (feet)	G_h and G_z			
	Exposure A	Exposure B	Exposure C	Exposure D
0 - 15	2.36	1.65	1.32	1.15
20	2.20	1.59	1.29	1.14
25	2.09	1.54	1.27	1.13
30	2.01	1.51	1.26	1.12
40	1.88	1.46	1.23	1.11
50	1.79	1.42	1.21	1.10
60	1.73	1.39	1.20	1.09
70	1.67	1.36	1.19	1.08
80	1.63	1.34	1.18	1.08
90	1.59	1.32	1.17	1.07
100	1.56	1.31	1.16	1.07
120	1.50	1.28	1.15	1.06
140	1.46	1.26	1.14	1.05
160	1.43	1.24	1.13	1.05
180	1.40	1.23	1.12	1.04
200	1.37	1.21	1.11	1.04
250	1.32	1.19	1.10	1.03
300	1.28	1.16	1.09	1.02
350	1.25	1.15	1.08	1.02
400	1.22	1.13	1.07	1.01
450	1.20	1.12	1.06	1.01
500	1.18	1.11	1.06	1.00

NOTES:

- (1) For main wind-force resisting systems, use building or structure height $h = z$.
- (2) Linear interpolation is acceptable for intermediate values of z .
- (3) For height above ground of more than 500 feet, Eq. C5 of the Commentary may be used.
- (4) Value of gust response factor shall be not less than 1.0.

BUILDINGS AND OTHER STRUCTURES

Table 11
Force Coefficients for Monoslope Roofs over Unenclosed
Buildings and Other Structures, C_f

θ (degrees)	C_f for L/B Values of:						
	5	3	2	1	1/2	1/3	1/5
10	0.2	0.25	0.3	0.45	0.55	0.7	0.75
15	0.35	0.45	0.5	0.7	0.85	0.9	0.85
20	0.5	0.6	0.75	0.9	1.0	0.95	0.9
25	0.7	0.8	0.95	1.15	1.1	1.05	0.95
30	0.9	1.0	1.2	1.3	1.2	1.1	1.0

θ (degrees)	Location of Center of Pressure, X/L , for L/B Values of:		
	2 to 5	1	1/5 to 1/2
10 to 20	0.35	0.3	0.3
25	0.35	0.35	0.4
30	0.35	0.4	0.45

NOTES:

- (1) Wind forces act normal to the surface and shall be directed inward or outward.
- (2) Wind shall be assumed to deviate by ± 10 degrees from horizontal.
- (3) Notation:
 B : dimension of roof measured normal to wind direction, in feet;
 L : dimension of roof measured parallel to wind direction, in feet;
 X : distance to center of pressure from windward edge of roof, in feet;
 θ : angle of plane of roof from horizontal, in degrees.

Table 12
Force Coefficients for Chimneys, Tanks, and Similar Structures, C_f

Shape	Type of surface	C_f for h/D Values of:		
		1	7	25
Square (wind normal to a face)	All	1.3	1.4	2.0
Square (wind along diagonal)	All	1.0	1.1	1.5
Hexagonal or octagonal ($D\sqrt{q_z} > 2.5$)	All	1.0	1.2	1.4
Round ($D\sqrt{q_z} > 2.5$)	Moderately smooth	0.5	0.6	0.7
	Rough ($D'/D \approx 0.02$)	0.7	0.8	0.9
	Very rough ($D'/D \approx 0.08$)	0.8	1.0	1.2
Round ($D\sqrt{q_z} < 2.5$)	All	0.7	0.8	1.2

NOTES:

- (1) The design wind force shall be calculated based on the area of the structure project on a plane normal to the wind direction. The force shall be assumed to act parallel to the wind direction.
- (2) Linear interpolation may be used for h/D values other than shown.
- (3) Notation:
 D : diameter or least horizontal dimension, in feet;
 D' : depth of protruding elements such as ribs and spoilers, in feet; and
 h : height of structure, in feet.

CHANNELS & COMBINATIONS

FOR 1½" (41 MM) WIDTH SERIES CHANNEL

CHANNEL SELECTION CHART

Channel	Channel Dimensions				Material & Thickness			Hole Pattern Styles					
	Width		Height		Steel	Stainless Steel	Alum.	KO	T	SL	HS	DS	H3
	In	mm	In	mm									
P1000	1½	41	1½	41	12 ga	12 ga	.109						
P1100	1½	41	1½	41	14 ga	14 ga	—						
P2000	1½	41	1½	41	16 ga	—	—						
P3000	1½	41	1½	35	12 ga	—	—						
P3300	1½	41	¾	22	12 ga	12 ga	—						
P4000	1½	41	1½	21	16 ga	16 ga	.078						
P4100	1½	41	1½	21	14 ga	—	—						
P5000	1½	41	3¼	83	12 ga	—	—						
P5500	1½	41	27/16	62	12 ga	—	.109						

- This reference chart reflects the available channels and hole patterns manufactured by Unistrut Corporation.
- Stainless steel sections are also available on special order in "T," "SL" and "HS" hole pattern.
- Metric equivalent for material thickness: 12 ga. (2.7 mm); 14 ga. (1.9 mm); and 16 ga. (1.5 mm).

* Not available in aluminum.

CHANNELS & COMBINATIONS IN DESCENDING ORDER OF STRENGTH

Channel	S in²	I in⁴	Area in²	Weight Lbs/Ft
P5001	1.716*	5.578*	1.794	6.10
P1004 A	1.673	4.079	1.978	6.70
P5501	1.153	2.811	1.453	4.94
P1001 C41	1.145	1.860	2.223	7.60
P5000	.628	1.099	.897	3.05
P1001	.572	.930	1.112	3.80
P1101	.456	.741	.834	2.84
P3001	.431	.593	1.007	3.40
P5500	.391	.523	.726	2.47
P2001	.379	.616	.681	2.32
P9200	.297	.278	.489	2.23

Channel	S in²	I in⁴	Area in²	Weight Lbs/Ft
P9000	.203	.164	.384	2.05
P3301	.202	.177	.797	2.70
P1000	.202	.185	.556	1.90
P1100	.166	.149	.417	1.42
P3000	.154	.121	.503	1.70
P4101	.141	.114	.574	1.94
P2000	.140	.124	.340	1.16
P4001	.125	.101	.478	1.64
P3300	.072	.037	.398	1.35
P4100	.053	.025	.287	.97
P4000	.048	.023	.239	.82

* Effective section properties.

P1000® & P1001 CHANNELS

FOR 1 5/8" (41 MM) WIDTH SERIES CHANNEL

P1000

Pierced channels are found on pages 60 and 61.

Weight: 190 Lbs/C Ft (283 kg/100 m)

P1001

Weight: 380 Lbs/C Ft (566 kg/100 m)

BEAM LOAD*

*Maximum allowable uniform load.

Channel	Weight		Allowable Moment		Material Thickness		Standard Lengths		Finishes				Other Materials	
	Lbs/Ft	kg/m	In-Lb	N-m	In	mm	10'	20'	PL	GR	HG	PG	SS	EA
P1000	1.90	2.8	5,080	570	.105	2.7	■	■	■	■	■	■	■	■
P1001	3.80	5.7	14,390	1630	.105	2.7	■	■	■	■	■	■	■	■

Nominal thickness of 12 gage strip steel is .105 inches.

P1000 & P1001 CHANNELS

FOR 1 5/8" (41 MM) WIDTH SERIES CHANNEL

COLUMN LOADING DATA

Unbraced Height		Channel	Max. Allowable Load at Slot Face		Maximum Column Load Applied at C.G.							
					K = .65		K = .80		K = 1.0		K = 1.2	
In	mm		Lbs	kN	Lbs	kN	Lbs	kN	Lbs	kN	Lbs	kN
24	610	P1000	3400	15.1	9600	42.7	9500	42.3	9320	41.5	9100	40.5
		P1001	6360	28.3	23820	106.0	23560	104.8	23130	102.9	22810	100.6
36	914	P1000	3000	13.3	7640	34.0	7400	32.9	7000	31.1	6490	28.9
		P1001	6190	27.5	23190	103.2	22610	100.6	21640	96.3	20460	91.0
48	1219	P1000	2570	11.4	5910	26.3	5530	24.6	4980	22.2	4430	19.7
		P1001	5970	26.6	22310	99.2	21270	94.6	19560	87.0	17460	77.7
60	1524	P1000	2230	9.9	4780	21.3	4390	19.5	3850	17.1	3330	14.8
		P1001	5690	25.3	21180	94.2	19560	87.0	16870	75.0	13590	60.5
72	1829	P1000	1970	8.8	4090	18.2	3680	16.4	3140	14.0	2650	11.8
		P1001	5360	23.8	19790	88.0	17460	77.7	13590	60.5	9570	42.6
84	2134	P1000	1760	7.8	3600	16.0	3170	14.1	2630	11.7	2160	9.6
		P1001	4970	22.1	18150	80.7	14980	66.6	10130	45.1	7030	31.3
96	2438	P1000	1580	7.0	3220	14.3	2770	12.3	2240	10.0	1800	8.0
		P1001	4510	20.1	16270	72.4	12120	53.9	7750	34.5	5380	23.9
108	2743	P1000	1430	6.4	2910	12.9	2450	10.9	1930	8.6	**	**
		P1001	4030	17.9	14120	62.8	9570	42.6	6130	27.3	4250	18.9
120	3048	P1000	1290	5.7	2640	11.7	2180	9.7	**	**	**	**
		P1001	3610	16.1	11750	52.3	7750	34.5	4960	22.1	**	**

**KL / r > 200

ELEMENTS OF SECTION

Channel	Areas of Section		Axis 1 - 1						Axis 2 - 2					
			I		S		r		I		S		r	
	In ²	cm ²	In ⁴	cm ⁴	In ³	cm ³	In	cm	In ⁴	cm ⁴	In ³	cm ³	In	cm
P1000	556	3.6	185	7.7	202	3.3	577	1.5	236	9.8	290	4.7	651	1.7
P1001	1112	7.2	930	38.7	572	9.4	915	2.3	472	19.6	580	9.5	651	1.7

I - Moment of Inertia

S - Section Modulus

r - Radius of Gyration

POST BASES

FOR 1½" (41 MM) WIDTH SERIES CHANNEL

P1887

P2453

P2072

Wt/C 307 Lbs (139.3 kg)

P2072 A

Wt/C 373 Lbs (169.2 kg)

P2073

Wt/C 325 Lbs (147.4 kg)

P2073 A

Wt/C 408 Lbs (185.1 kg)

Hole Size	Hole Spacing	Width	Thickness
5/16" Diameter 14.3 mm	13/16" (20.6 mm) From End 1 7/8" (47.6 mm) On Center	1 1/2" 41.3 mm	1/4" 6.4 mm

TRAPEZE FITTINGS Pipe Clamps - P1100 Series

Calculation W320-27-050

6-10 of 6-36

Table 6 P1100 SERIES PIPE CLAMPS												
Unistrut Part Number	Pipe Size		Strap Thickness		Screw Size		Design Loads					
	In	mm	Ga	mm	In	mm	Vertical Force		Transverse Force		Longitudinal Force	
							Lbs.	N	Lbs.	N	Lbs.	N
P1111	1/2	15	16	1.5	1/4	6	400	1780	70	310	50	220
P1112	3/4	20	14	1.9	1/4	6	600	2670	100	440	70	310
P1113	1	25	14	1.9	1/4	6	600	2670	150	670	80	360
P1114	1 1/4	32	14	1.9	1/4	6	600	2670	150	670	150	670
P1115	1 1/2	40	12	2.7	1/4	6	800	3560	240	1070	150	670
P1117	2	50	12	2.7	1/4	6	800	3560	240	1070	200	890
P1118	2 1/2	65	12	2.7	5/16	8	800	3560	240	1070	200	890
P1119	3	80	12	2.7	5/16	8	800	3560	240	1070	200	890
P1120	3 1/2	90	11	3.0	3/8	10	1000	4450	320	1420	200	890
P1121	4	100	11	3.0	3/8	10	1000	4450	320	1420	200	890
P1123	5	125	11	3.0	3/8	10	1000	4450	320	1420	200	890
P1124	6	150	10	3.4	3/8	10	1000	4450	450	2000	375	1670
P1126	8	200	10	3.4	3/8	10	1000	4450	550	2450	500	2220

Renewed

R-0120

JUL 22 '93

Office of Statewide Health Planning
and Development
Fixed Equipment Anchorage

RENEWED - VALID FOR 3 YEARS (MAXIMUM)
DATE 7/22/93 BY *[Signature]*

WM
William Merkel
Structural Engineer

35660 Clinton Street
Wayne, Michigan 48184

(800) 521-7730
FAX: (313) 721-4106

Date
7-22-93

Page
3-3

RANDOLPH
AUSTIN CO.

PUMPHEADS & CAPACITIES

Randolph Pumps are available in sizes ranging from small volume laboratory types to large volume in-plant models. They are ideal for transferring corrosives, abrasives, sterile solutions and other problem fluids. In addition, viscous liquids (at reduced flow rates) dry powders, and gases can be handled. A vacuum of about 26 inches of mercury and a pressure of 20 pounds per square inch can be achieved with this pump. Capacity ratings were determined in tests with water at ambient temperature and atmospheric pressure.

SERIES 250 PUMPHEAD

Capacity: to 447 ml/min.
Tube sizes: $\frac{1}{16}$ " OD x $\frac{1}{16}$ " ID
 $\frac{1}{8}$ " OD x $\frac{1}{16}$ " ID
Dimensions: L 2 $\frac{1}{2}$ " x W 2 $\frac{1}{2}$ " x H 2 $\frac{1}{4}$ "
Shaft Diameter: $\frac{1}{16}$ "

CAT NO. 250-PHO

SERIES 500 PUMPHEAD

Capacity: to 57 gph
Tube sizes: $\frac{1}{16}$ " OD x $\frac{1}{16}$ " ID
 $\frac{7}{16}$ " OD x $\frac{1}{16}$ " ID
Dimensions: L 4 $\frac{1}{2}$ " x W 4 $\frac{1}{2}$ " x H 5 $\frac{1}{2}$ "
Shaft Diameter: $\frac{1}{4}$ "

CAT NO. 500-PHO

CAT NO. 610-PHO

SERIES 610 PUMPHEAD

Capacity: to 255 gph
Tube sizes: $\frac{1}{16}$ " OD x $\frac{1}{16}$ " ID
 $\frac{1}{4}$ " OD x $\frac{1}{16}$ " ID
Dimension: L 8" x W 5 $\frac{1}{2}$ " x H 6 $\frac{1}{2}$ "
Shaft Diameter: $\frac{1}{4}$ "

CAT NO. 750-PHO

SERIES 750 PUMPHEAD

Capacity: to 662 gph
Tube sizes: $\frac{1}{16}$ " OD x $\frac{1}{16}$ " ID
 $1\frac{1}{16}$ " OD x $\frac{1}{16}$ " ID
Dimensions: L 9" x W 9 $\frac{1}{2}$ " x H 10 $\frac{1}{4}$ "
Shaft Diameter: $\frac{1}{4}$ "

HNF-2479, Rev. 0
Page B-60

SERIES 880 PUMPHEAD

Capacity to: 1410 gph
Tube sizes: $1\frac{1}{16}$ " OD x $\frac{1}{16}$ " ID
 $1\frac{1}{2}$ " OD x 1" ID
Dimensions: L 16" x W 10 $\frac{1}{2}$ " H 17"
Shaft Diameter: 1 $\frac{1}{4}$ "

CAT NO. 880-PHO

**KAISER ENGINEERS
HANFORD**Calc. No. n/a
Revision 0
Page No. 60 of**DESIGN ANALYSIS**

Client WHC - TWRS Mitigation Systems
Integration
Subject Structural Analysis of 500-CFM
Saltwell Exhauster Skid
Location TWRS Single Shell Tank Farms

WO/Job No.
Date 12 Apr 96 By James Tuck
Checked 5/21/96 By SKFarnworth
Revised By

N. SEISMIC DISPLACEMENT OF SYSTEM, CONT'D:

∴ NAT. FREQUENCY OF SKID IN LATERAL DIRECTION IS:

$$f = 3.13 \sqrt{\frac{1}{0.02}} = 22 \text{ Hz.}$$

∴ MAX. LATERAL MOVEMENT OF SKID DURING A
SC-2 SEISMIC EVENT EQUALS:

$$\chi = \frac{5(386.4)(0.55)^2}{4\pi^2(22)^2(0.5)(0.74)} = 0.083 \text{ IN.}$$

FOR SC-1 DESIGN BASIS EARTHQUAKE, LATERAL LOAD
FACTOR EQUALS 0.639, VERTICAL EQUALS 0.429.

$$\therefore g_H = \sqrt{2(0.63)^2} = 0.89 g.$$

∴ MAX. DISPLACEMENT EQUALS

$$\chi = \frac{5(386.4)(0.89)^2}{4\pi^2(22)^2(0.5)(1-0.42)} = \underline{0.28 \text{ IN.}}$$

MAX. VERTICAL SEISMIC LOAD EQUALS:

$$g_V = (0.42)(7300) = 3066 \text{ LB.}$$

∴ MAX. DOME LOAD EQUALS

$$V_{\text{MAX}} = 7300 + 3066 = 10.4 \text{ KIPS}$$

TABLE 3 Unit Weights of Soils and Coefficients of Earth Pressure*

Type of soil	Weight of moist soil γ , pcf		Weights of submerged soil γ' , pcf		Coefficient of active earth pressure k_a				Coefficient of passive earth pressure k_p		
	Min	Max	Min	Max	For backfill	For soils in place	Friction angle		For soils in place	Friction angle	
							Internal ϕ	On wall δ		Internal ϕ	On wall δ
Clean sand:											
Dense.....	110	140	65	78	....	0.20	38	20	9.0	38	25
Medium.....	110	130	60	68	....	0.25	34	17	7.0	34	23
Loose.....	90	125	56	63	0.35	0.30	30	15	5.0	30	20
Silty sand:											
Dense.....	110	150	70	88	....	0.25	....	....	7.0	....	....
Medium.....	110	130	60	68	....	0.30	....	....	5.0	....	....
Loose.....	80	125	50	63	0.50	0.35	....	....	3.0	....	....
Silt and clay:											
Silt and clay.....	$\frac{165(1+w)}{1+2.65w}$		$\frac{103}{1+2.65w}$		1.00	$1 - \frac{q_u}{\bar{\sigma} + \gamma z}$	....	....	$1 + \frac{q_u}{\bar{\sigma} + \gamma z}$		

*After K. Terzaghi, Ref. 8.
 $\gamma \bar{\sigma}$ = effective unit pressure on top surface of stratum, q_u = unconfined compressive stress, w = natural water content in percent of dry weight, z = depth below top surface of stratum. Use γ where applicable.

Piles In Clay 7-41

Fig. 26 Failure loads—pile-load tests.

If piles are to be driven through a soft layer and into a firm stratum, the support provided by the soft layer may disappear as the layer consolidates so that all the load is transmitted to the firm stratum. The capacity of the latter may be determined by conducting a pair of load tests, one on a pile driven into the firm stratum and the second, which must be carried to failure, on a pile stopping 2 to 3 ft above the firm stratum. By subtracting the load carried in the soft layer from the load for the pile penetrating the firm stratum the support of the latter is obtained. A careful analysis of these conditions is required. If the soft layer is likely to settle as a consequence of the new construction, it may ultimately tend to drag down the piles with a load equivalent to the temporary support it originally provided. This is known as negative skin friction and further reduces the usable capacity of the pile support provided by the firm stratum.

36. Piles in Sand Piles driven into sand generally act in friction, point bearing, or in combination. Their ultimate capacity can be estimated from a formula such as Janbu's (Table 6) or, in the case of friction piles, by

$$Q_{ult} = \left(\frac{1}{2} \gamma l^2 - \frac{1}{2} \gamma_w l_w^2 \right) k \pi d \tan \phi_f \quad (31)$$

where Q_{ult} = ultimate load capacity neglecting point resistance

γ = saturated unit weight of soil

l = length of pile

γ_w = unit weight of water

l_w = length of pile below water table

d = pile diameter

k = coefficient of lateral earth pressure

$\tan \phi_f$ = coefficient of friction between sand and pile

Values of k and $\tan \phi_f$ are difficult to evaluate. For driven or vibrated piles, k may be taken as 1.0, but it should not exceed 0.4 if the piles are jetted into the sand. The coefficient of friction may be selected from Table 7.

It should be recognized that these procedures are not precise and, where possible, pile load tests should be conducted as a more reliable indication of pile behavior.

37. Piles In Clay The capacity of a pile driven into clay cannot be reliably predicted from a pile-driving formula. It is best to use the results of a pile load test. However, tests are rather expensive, and the following somewhat less satisfactory procedure may be employed. The ultimate bearing capacity of a single cylindrical friction pile is approximately equal to the adhesion that can be developed between the pile and the surrounding soil times the embedded surface area of the pile. The adhesion is difficult to estimate as it may range from about one-half to one-tenth of the unconfined compressive strength. In general, the stiffer the clay, the smaller the relative adhesion factor (Fig. 27). If Fig. 27 is used, a safety factor of 3 should be used for the maximum probable loading. However, a

7-42 Retaining Structures and Foundations

TABLE 7 Coefficient of Friction

Pile material	$\tan \phi_f$	
	Driven piles	Jettied or drilled piles
Timber.....	0.65	0.53
Steel: pipe, BP, fluted.....	0.45	0.36
Concrete.....	0.65	0.53
Corrugated steel shells.....	0.70	0.58

Fig. 27 The adhesion on piles compared with the cohesive strength of clay. (After Tomlinson.²¹)

safety factor of at least 2 should be used for the extreme maximum loading of the pertinent building-code load requirement. The relatively small contribution from *end bearing* in the case of friction piles is generally neglected in the analysis of a single pile. If the subsoil contains well-defined layers of varying strength, the adhesion in each layer should be independently determined. Because of the uncertainty in determining the adhesion in stiff to hard clays, pile load tests should always be used to check the design load whenever friction piles are driven into such deposits.

For most foundations, friction piles are driven in groups. Therefore, it is necessary to investigate the ultimate load capacity of the group to be certain that it is not less than the product of the load on a single pile and the number of piles, irrespective of how the single-pile load may have been determined. The design capacity is the minimum of these two procedures.

The load capacity of a group of friction piles consists of the shearing resistance on the surface perimeter of the pile group plus the bearing capacity on the plan area of the group at the level of the pile tips. Thus

$$Q_d = (B + L)lq_{u1} + 2.5q_{u2}\left(1 + \frac{0.3B}{L}\right)BL \quad (32)$$

where Q_d = ultimate load on group, tons
 B = width of pile group, out to out, ft

L = length of pile group, out to out, ft

l = pile length, ft

q_{ul} = average unconfined compressive strength of clay within length l , tons/ft²

q_{uz} = average unconfined compressive strength within a distance B below the pile tips, tons/ft²

The maximum probable loading on the group should not exceed $Q_d/3$. Although the base bearing capacity may contribute considerably to the capacity of the pile group, it should be noted that the greatest benefit of a friction pile foundation is obtained with the longest piles possible within the limits of economy. The longer the pile, the smaller the settlement in most instances.

Piles driven into clays that increase materially in strength with depth may be analyzed as for friction piles. However, the point resistance, which may represent a sizable proportion of the pile capacity, can be determined only by means of loading tests. The safe load on a group may be taken as the safe load per pile as determined from load tests times the number of piles in the group. In some localities pile-driving formulas have been adjusted to indicate safe loads corresponding to the pile-driving resistance. Such formulas should never be used outside the geological region in which they were developed.

Piles driven through relatively soft materials to a stiff or hard clay act in point bearing. The load capacity of a group of such piles is equal to the product of the number of piles in the group and the safe load per pile without regard to their spacing. However, these conditions are ideal for the development of negative skin friction (Art. 35), which may be a sizable proportion of the pile load capacity. The magnitude of the negative skin friction can be determined from pile load tests (Sec. 6, Art. 17). It may also be estimated as the average shearing resistance of the soft material multiplied by the surface area of the embedded piles.

38. Settlement of Pile Foundations Any pile foundation which has a compressible stratum located below the pile tips is likely to settle, and the magnitude of the settlement should be predicted. It is computed in the same manner as for footings on clay except that the change in pressure Δp is determined somewhat differently depending upon whether the piles act in point bearing or as friction piles.

For a point-bearing pile foundation, the load on the pile group is assumed to be applied to the subsoil at the level of the pile tips on an area equal to the plan area of the pile group. Below the tips, it is considered to be spread uniformly at an angle of 30° from the vertical.

The settlement of a group of friction piles is computed in a similar manner. However, the level of the application of the load to the subsoil is less certain, as load is transferred through much of the length of the piles. A commonly used approximate procedure is based on the assumption that the load is applied at the lower third point of the piles. The load is assumed to spread at an angle of 30° from the vertical, and any compressible material below the lower third point is assumed to contribute to the settlement of the group.

39. Laterally Loaded Piles Where a pile-supported structure is subjected to lateral loads, the vertical piles may provide more lateral resistance than is commonly realized. Prevailing rules of thumb commonly permit an arbitrary lateral load per pile—often 1000 lb—without any consideration as to the type of pile or the soil in which it is driven. Since a pile-supported structure does not transmit load directly to the soil beneath the pile cap, frictional resistance should not be assumed between the base of the structure and the underlying soil. Therefore, the piles must be adequate to resist all lateral loads.

The ultimate lateral bearing pressure per unit length of pile at a given depth in clay is

$$Q_d = 9cB = 4.5q_uB \quad (33)$$

and in sands

$$Q_d = 3B\gamma z \frac{1 + \sin \phi}{1 - \sin \phi} \quad (34)$$

7-44 Retaining Structures and Foundations

where Q_d = ultimate load per unit length of pile, lb/ft

c = cohesion, psf

q_u = unconfined compressive strength, psf

B = width of pile, ft

γ = effective unit weight of soil, pcf

z = depth, ft

ϕ = angle of shearing resistance

The working load should not exceed $Q_d/2$ beyond a depth of $4B$ under any circumstance.

For lateral loads smaller than $Q_d/2$, the soil reaction at any depth is given by

$$w = \frac{C_w Q_{hg}}{T} \quad (35)$$

where w = soil reaction, lb/in

C_w = soil reaction coefficient from Fig. 28

Q_{hg} = shear at ground surface, lb

T = relative stiffness of pile = $\frac{5EI}{n_h}$, in

EI = flexural stiffness of pile, lb-in²

n_h = constant of horizontal subgrade reaction, lb/in³

Fig. 28 Coefficients for soil reaction, laterally loaded piles.
(From Prakash, 1962.²²)

Fig. 1A—Moment $M_\phi / (M_c / R_m \beta)$ due to an external circumferential moment M , on a circular cylinder

Fig. 2A—Moment $M_x/(M_c/R_m \beta)$ due to an external circumferential moment M_c on a circular cylind

Fig. 3A—Membrane force $N_\phi / (M_c / R_m \beta)$ due to an external circumferential moment M_c on a circular cylinder

Fig. 4A—Membrane force $N_x / (M_e / R_m^2 \beta)$ due to an external circumferential moment M_e on a circular cylinder

Fig. 1B-1—Moment $M_4/(M_1/R_m\beta)$ due to an external longitudinal moment M_1 on a circular cylinder

Fig. 2B-1—Moment $M_x/(M_c/R_m\beta)$ due to an external longitudinal moment M_c on a circular cylinder

Fig. 3B—Membrane force $N_\phi / (M_L / R_m^2 \beta)$ due to an external longitudinal moment M_L on a circular cylinder

Fig. 4B—Membrane force $N_x / (M_L / R_m)$ due to an external longitudinal moment M_L on a circular cylinder

Fig. 1C—Bending moment M_o/P due to an external radial load P on a circular cylinder (transverse a)

Fig. 1C-1—Bending moment $\frac{M}{P}$ due to an external radial load P on a circular cylinder (longitudinal axis)

Fig. 4C—Membrane force $N_x/(P/R_m)$ due to an external radial load P on a circular cylinder (transverse axis)
 —Membrane force $N_y/(P/R_m)$ due to an external radial load R on a circular cylinder (longitudinal axis)

HNF-2479, Rev. 0
Page B-78

SECTION VI

A DUCT FRICTION TABLES AND CHARTS

SHADED AREAS INDICATE SUGGESTED VELOCITY AND FRICTION RATE DESIGN LIMITS

(Based on Standard Air of 0.075 lb per cu ft density flowing through average, clean, round, hot dipped galvanized metal ducts ($\epsilon=0.0005$ ft.) having approximately 40 joints per 100 ft.) Caution: Do not extrapolate below chart.

Figure 6-1 FRICTION OF AIR IN STRAIGHT DUCTS FOR VOLUMES OF 10 TO 2000 CFM (2)

PRESSURE INFORMATION FOR Blue Max AND Max-FLYTE FLEXIBLE DUCT/HOSE

Blue Max and Max-FLYTE hoses are engineered to operate safely and efficiently in the pressure ranges required in most industrial fume and dust control systems. DURA-VENT Corporation suggests that the following points be considered when service at higher pressures is intended.

1. If more volume is needed, it is better to go to a larger I.D. rather than to increased pressure in a smaller hose. This is especially true where bends are present or the hose is being flexed while under pressure. Bends and flexing decrease working and burst pressures.
2. In high-velocity applications, installing the duct/hose so that the direction of flow is with the hose lap will help extend the life of the hose.
3. When pressures in excess of 3 p.s.i. are anticipated and cuffed ends are required, it is recommended that fabric cuffs be used rather than molded cuffs.
4. At least two (2) extra coats of neoprene should be added to the hose for high pressure applications.
5. Under vacuum, flexible duct/hose tends to contract and lose flexibility. Use short, straight lengths for high vacuum service and keep bends to a minimum. Be sure both ends are securely fastened.
6. For high pressure and volume service, such as Car Wash driers, a nylon hose offers the best value for the money spent.
7. For safe operations and to maximize duct/hose life, stay within the Manufacturer's recommended working pressure limits. Remember, Engineering Data in this publication is gathered on new hose under optimum conditions. Time and use tend to lessen performance values. Combinations of adverse conditions can shorten hose life significantly, especially excessive pressure combined with bending or flexing.

Post-It/Fax Note		7871	
To	From	Date	
By	Victoria		
Co.			
Phone #			
Fax #			

PRESSURE NOMOGRAPH

POSITIVE AND NEGATIVE PRESSURE LIMITS

(POSITIVE PRESSURE IN P.S.I. — NEGATIVE PRESSURE IN IN. HG)

HOSE I.D. INCHES	2CN-2 (2PN)			2NN-2			1CN-2EP		1NN-2EP	
	BURST PRESSURE	WORKING PRESSURE	MAXIMUM NEGATIVE PRESSURE	BURST PRESSURE	WORKING PRESSURE	MAXIMUM NEGATIVE PRESSURE	BURST PRESSURE	WORKING PRESSURE	BURST PRESSURE	WORKING PRESSURE
1	130	43	30	125	41	30				
1¼	128	42	30	125	41	30				
1½	128	42	30	125	41	30				
2	105	35	28	100	33	28				
2½	84	28	28	80	27	28				
3	73	24	27	70	23	27				
4	57	19	25	55	18	25	39	13	40	13
5	48	16	18	43	14	18				
6	48	16	14	43	14	14	34	11	35	11
7	35	11	12	35	12	12				
8	35	11	10	33	11	10	30	10	30	10
10	30	10	5	30	10	5	25	8	25	8
12	25	9	3	24	8	3	22	7	20	7
14	20	7	2	20	6	2				
16	17	6	2	15	5	2				
18	13	4	1	10	3	1				

Data shown above are for straight lengths @ 70°F

DURA-VENT

1177 MARKLEY DRIVE
PLYMOUTH, IN 46563
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(219) 838-2432
FAX: (219) 836-2505

Calculation W320-27-050

B-31 of B-36

S P E C I F I C A T I O N S H E E T8" I D 2 P NCONSTRUCTION:

2PLY NEOPRENE IMPREGINATED POLYESTER DUCT WITH A
CONTINUOUS SPRING STEEL WIRE HELIX USED AS A
SUPPORT.

TEMPERATURE:

-40 F TO +250 F

MATERIAL SPECIFICATIONS:

WEIGHT:	9 OZ. (+ OR - .50Z SQ/YD)
TENSIL:	WARP-133 FILL- 95 LBS - UNCOATED
TENSIL:	WARP-170 FILL- 140 LBS - COATED
ABRASION:	CYCLES TO FABRIC- 180/ CYCLES THRU FAB-500
CLOTH:	100% POLYESTER SHEETING
FLAME RESIS:	1) UL94-V0
	2) MINS 540-106-1 (MARE ISLAND NSY)
	3) CALIFORNIA T-19
	4) NFPA 701 - LARGE SCALE

PRESSURE RATE:

POSITIVE- 11 PSI NEGATIVE- 10" MERCURY

BEND RADIUS:

6.5 CENTERLINE BEND RADIUS

WIEGHT:

1.75 LBS PER FOOT

COATINGS:

THIS PRODUCT IS ALSO AVAILABLE WITH TWO
DIFFERENT TYPES OF ADDITIONAL COATINGS. 1)
NEOPRENE COATING TO EXTEND DUCT LIFE AGAINST
ABRASION AND SEALS DUCT, 2) URETHANE TO
EXTEND DUCT LIFE AGAINST ABRASION AND GIVES DUCT
A SLICK FINISH TO PREVENT INTERNAL BUILD-UP OF
PRODUCT.

FLUOR DANIEL NORTHWEST

DESIGN LOADS FOR FACILITIES

1) General Use	Safety Class 4
----------------	----------------

- (a) PNNL currently uses the DOE Order 6430.1A safety class designations. The design of PNNL Nonsafety Class facilities shall use the General Use Safety Class 4 design load criteria as a minimum. The design of emergency facilities, mission dependent facilities, or other facilities may use Moderate Hazard Safety Class 2 or Important/Low Hazard Safety Class 3 criteria. The use of these higher criteria shall be determined by PNNL prior to design and transmitted to others as needed through normal project documentation.

Safety Class
Upgrades

Safety Class designation or Facility Use Category may be upgraded by DOE direction to provide additional conservatism.

NON-REACTOR
FACILITIESSafety Class 1
Structures,
Systems, and
Components

Safety Class 1 structures, systems, components, and equipment (DOE Order 6430.1A, Safety Class) 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. Included in this category are those systems, components, and equipment vital for safe shutdown.

Safety Class 1 structures, systems, components, and equipment are designed for nominal dead, live, snow, and soil loads (as defined in ASCE 7-88), for normal operating loads as defined in the facility functional design criteria, and for the natural phenomena loading of extreme wind, earthquake, ashfall, and flood. Structures, systems, components, and equipment of any safety class need not be subjected simultaneously to any combination of extreme wind, earthquake ground motions, ashfall, and flood. Load combinations and allowable stresses for these loads are noted in Section, "Load Combination and Allowable Stresses." Application of these load combinations and allowable stresses for supports of systems, components, and equipment is appropriate.

Wind Loads

Non-reactor Safety Class 1 (UCRL-15910 High Hazard) structures, systems, components, and equipment are designed for wind loads in accordance with ASCE 7-88 using the following criteria:

"Fastest Mile" Wind Speed @Height (H) = 10 meters (33 feet)	40 m/s (90 miles per hour)
Importance Factor	1.0
Exposure Class	C
Missile (horizontal)	50 x 100 mm (2 x 4) Timber Plank 7 kg (15 pounds) @ 22 m/s (50 miles per hour) maximum trajectory height = 15 m (50 feet).

These requirements apply except where adjacent structures or high ground create a potential for missile impacts at higher elevations.

FLUOR DANIEL NORTHWEST

DESIGN LOADS FOR FACILITIES

TABLE 2
 0.2 g Response-Spectra Control Points
 (Corresponds to Figure 3)

Control Point	2% Damping		5% Damping		7% Damping		10% Damping		12% Damping	
	f(Hz)	g	f(Hz)	g	f(Hz)	g	f(Hz)	g	f(Hz)	g
E	0.10	0.012	0.10	0.0102	0.10	0.0095	0.10	0.0088	0.10	0.0083
	0.16	0.031	0.16	0.026	0.16	0.024	0.16	0.023	0.16	0.021
	0.26	0.084	0.25	0.065	0.25	0.059	0.24	0.052	0.24	0.048
D	0.40	0.129	0.40	0.104	0.40	0.095	0.40	0.087	0.40	0.080
	0.60	0.192	0.60	0.155	0.60	0.142	0.60	0.130	0.60	0.120
	1.10	0.351	1.10	0.283	1.10	0.261	1.10	0.237	1.10	0.220
C	1.73	0.550	1.64	0.420	1.60	0.380	1.53	0.330	1.50	0.300
B	8.00	0.550	8.00	0.420	8.00	0.380	8.00	0.330	8.00	0.300
	12.00	0.412	12.00	0.340	12.00	0.316	12.00	0.286	12.00	0.267
	20.00	0.286	20.00	0.260	20.00	0.251	20.00	0.239	20.00	0.231
A	33.00	0.200	33.00	0.200	33.00	0.200	33.00	0.200	33.00	0.200
A'	100.0	0.200	100.0	0.200	100.0	0.200	100.0	0.200	100.0	0.200

The response spectra accelerations for the Safety Class 1 0.20g DBE shall be

- scaled by 0.60 to obtain the response spectra accelerations for the Safety Class 2 and 3 0.12g DBE; and
- scaled by 0.45 to obtain the response spectra accelerations for the Safety Class 4 0.09g DBE.

- (a) (d) The total number of pressure-temperature variations above the design conditions shall not exceed 1000 during the life of the piping system.

(e) In no case shall the increased pressure exceed the test pressure used under para. 345 for the piping system.

(f) Occasional variations above design conditions shall remain within one of the following limits for pressure design.

(1) Subject to the owner's approval, it is permissible to exceed the pressure rating or the allowable stress for pressure design at the temperature of the increased condition by not more than:

(a) 33% for no more than 10 hr at any one time and no more than 100 hr/yr; or

(b) 20% for no more than 50 hr at any one time and no more than 500 hr/yr.

The effects of such variations shall be determined by the designer to be safe over the service life of the piping system by methods acceptable to the owner. (See Appendix V.)

(2) When the variation is self-limiting (e.g., due to a pressure relieving event), and lasts no more than 50 hr at any one time and not more than 500 hr/year, it is permissible to exceed the pressure rating or the allowable stress for pressure design at the temperature of the increased condition by not more than 20%.

(g) The combined effects of the sustained and cyclic variations on the serviceability of all components in the system shall have been evaluated.

(h) Temperature variations below the minimum temperature shown in Appendix A are not permitted unless the requirements of para. 323.2.2 are met for the lowest temperature during the variation.

(i) The application of pressures exceeding pressure-temperature ratings of valves may under certain conditions cause loss of seat tightness or difficulty of operation. The differential pressure on the valve closure element should not exceed the maximum differential pressure rating established by the valve manufacturer. Such applications are the owner's responsibility.

302.2.5 Ratings at Junction of Different Services. When two services that operate at different pressure-temperature conditions are connected, the valve segregating the two services shall be rated for the more severe service condition. If the valve will operate at a different temperature due to its remoteness from a header or piece of equipment, this valve (and any mating flanges) may be selected on the basis of the different temperature, provided it can withstand the required pressure tests on each side of the valve. For piping on either side of the valve, however, each system shall be

designed for the conditions of the service to which it is connected.

302.3 Allowable Stresses and Other Stress Limits

302.3.1 General. The allowable stresses defined in (a), (b), and (c) below shall be used in design calculations unless modified by other provisions of this Code.

(a) *Tension.* Basic allowable stresses S in tension for metals and design stresses S for bolting materials, listed in Tables A-1 and A-2, respectively, are determined in accordance with para. 302.3.2.

In equations elsewhere in the Code where the product SE appears, the value S is multiplied by one of the following quality factors¹:

(1) casting quality factor E_c as defined in para. 302.3.3 and tabulated for various material specifications in Table A-1A, and for various levels of supplementary examination in Table 302.3.3C; or

(2) longitudinal weld joint factor E_j as defined in 302.3.4 and tabulated for various material specifications and classes in Table A-1B, and for various types of joints and supplementary examinations in Table 302.3.4.

The stress values in Tables A-1 and A-2 are grouped by materials and product forms, and are for stated temperatures up to the limit provided in para. 323.2.1(a). Straight line interpolation between temperatures is permissible. The temperature intended is the design temperature (see para. 301.3).

(b) *Shear and Bearing.* Allowable stresses in shear shall be 0.80 times the basic allowable stress in tension tabulated in Table A-1 or A-2. Allowable stress in bearing shall be 1.60 times that value.

(c) *Compression.* Allowable stresses in compression shall be no greater than the basic allowable stresses in tension as tabulated in Appendix A. Consideration shall be given to structural stability.

302.3.2 Bases for Design Stresses.² The bases for establishing design stress values for bolting materials and allowable stress values for other metallic materials in this Code are as follows.

¹If a component is made of castings joined by longitudinal welds, both a casting and a weld joint quality factor shall be applied. The equivalent quality factor E is the product of E_c , Table A-1A, and E_j , Table A-1B.

²These bases are the same as those for BPV Code, Section VIII, Division 2, given in Section II, Part D. Stress values in B31.3, Appendix A, at temperatures below the creep range generally are the same as those listed in Section II, Part D, Tables 2A and 2B, and in Table 3 for bolting, corresponding to those bases. They have been adjusted as necessary to exclude casting quality factors and longitudinal weld

302.3.6 Limits of Calculated Stresses due to Occasional Loads

(a) *Operation.* The sum of the longitudinal stresses due to pressure, weight, and other sustained loadings S_L and of the stresses produced by occasional loads, such as wind or earthquake, may be as much as 1.33 times the basic allowable stress given in Appendix A. For castings, the basic allowable stress shall be multiplied by the casting quality factor E_c . Where the allowable stress value exceeds two-thirds of yield strength at temperature, the allowable stress value must be reduced as specified in para. 302.3.2(e). Wind and earthquake forces need not be considered as acting concurrently.

(b) *Test.* Stresses due to test conditions are not subject to the limitations in para. 302.3. It is not necessary to consider other occasional loads, such as wind and earthquake, as occurring concurrently with test loads.

302.4 Allowances

In determining the minimum required thickness of a piping component, allowances shall be included for corrosion, erosion, and thread depth or groove depth. See definition for c in para. 304.1.1(b).

302.4.1 Mechanical Strength. When necessary, the wall thickness shall be increased to prevent overstress, damage, collapse, or buckling due to superimposed loads from supports, ice formation, backfill, or other causes. Where increasing the thickness would excessively increase local stresses or the risk of brittle fracture, or is otherwise impracticable, the required strength may be obtained through additional supports, braces, or other means without an increased wall thickness. Particular consideration should be given to the mechanical strength of small pipe connections to piping or equipment.

PART 2 PRESSURE DESIGN OF PIPING COMPONENTS

303 GENERAL

Components manufactured in accordance with standards listed in Table 326.1 shall be considered suitable for use at pressure-temperature ratings in accordance with para. 302.2.1. The rules in para. 304 are intended for pressure design of components not covered in Table 326.1, but may be used for a special or more rigorous design of such components. Designs shall be checked

for adequacy of mechanical strength under applicable loadings enumerated in para. 301.

304 PRESSURE DESIGN OF COMPONENTS**304.1 Straight Pipe****304.1.1 General**

(a) The required thickness of straight sections of pipe shall be determined in accordance with Eq. (2):

$$t_m = t + c \quad (2)$$

The minimum thickness T for the pipe selected, considering manufacturer's minus tolerance, shall be not less than t_m .

(b) The following nomenclature is used in the equations for pressure design of straight pipe.

t_m = minimum required thickness, including mechanical, corrosion, and erosion allowances

t = pressure design thickness, as calculated in accordance with para. 304.1.2 for internal pressure or as determined in accordance with para. 304.1.3 for external pressure

c = the sum of the mechanical allowances (thread or groove depth) plus corrosion and erosion allowances. For threaded components, the nominal thread depth (dimension h of ASME B1.20.1, or equivalent) shall apply. For machined surfaces or grooves where the tolerance is not specified, the tolerance shall be assumed to be 0.5 mm (0.02 in.) in addition to the specified depth of the cut.

T = pipe wall thickness (measured or minimum per purchase specification)

d = inside diameter of pipe. For pressure design calculation, the inside diameter of the pipe is the maximum value allowable under the purchase specification.

P = internal design gage pressure

D = outside diameter of pipe as listed in tables of standards or specifications or as measured

E = quality factor from Table A-1A or A-1B

S = stress value for material from Table A-1

Y = coefficient from Table 304.1.1, valid for $t < D/6$ and for materials shown. The value of Y may be interpolated for intermediate temperatures.

For $t \geq D/6$,

$$Y = \frac{d + 2c}{D + d + 2c}$$

5.10.3.2 Loadings. Stresses and deflections, or charts used to determine them, shall be based on calculations that consider the following loads where applicable.

(a) Differential pressure across the duct wall as affected by:

(1) maximum positive or negative pressure during all conditions of operation accounting for possible damper positions;

(2) pressure transients due to:

(a) pipe breaks, including both postulated Loss-of-Coolant Accident (LOCA) and lesser pipe break incidents which may cause external pressure rises and/or internal pressure pulses originating in sections of duct with openings in possible pipe break areas;

(b) extreme wind conditions, including tornado, hurricane;

(c) rapid damper, plenum door, or valve closure;

(b) duct weight, including insulation;

(c) duct sections with exposed top surfaces, which could be used as a walkway or crawl space, shall be capable of supporting a 250 lb weight concentrated midway between hangers;

(d) seismic forces;

(e) thermal expansion.

5.10.3.3 Stress. Allowable stress shall be 0.6 of the yield stress for loads encountered during normal plant operation and shutdown, and shall be 0.9 of the yield stress for combined loads which include the Safe Shutdown Earthquake and Design Basis Tornado.

5.10.3.4 Static Deflection. Allowable static deflections shall not exceed the following values:

(a) plate or sheet: $\frac{1}{8}$ in. per ft of the maximum unsupported panel span in direction of airflow but not more than $\frac{1}{4}$ in. relative to stiffeners;

(b) stiffeners and flange connections: $\frac{1}{8}$ in. per ft of span but not more than $\frac{1}{4}$ in;

(c) flange connection to dampers and fans: $\frac{1}{160}$ of the span or $\frac{1}{8}$ in. maximum.

5.10.4 Duct Construction. Transverse joints shall be gasketed flange, seal-welded flange, or butt-welded. Longitudinal seams shall be either all-welded, seal-welded mechanical, or in accordance with SMACNA — High Pressure Duct Construction Standards (Pittsburgh Lock or ASME Lock Seam) as required to meet structural and leaktightness requirements of paras. 5.10.3 and 4.14, respectively.

Mechanical lock seams, if used, must meet seismic structural design requirements. For all-welded joints,

the minimum duct thickness shall be 18 gauge (0.047 in.) to ensure reliability of the weld. Turning vanes, where used, shall be reinforced and fastened to the duct elbow by welding to withstand the loading specified. Radius elbows, where used, should have a minimum centering radius of 1.0 times the width or diameter of the duct in the plane of the bend.

Placement and design of hangers and supports shall meet the stress criteria given in para. 5.10.3.3 when considering the sources of load given in para. 5.10.3.2.

Stiffeners shall be of sufficient size and quantity and welded to the duct to meet the structural requirements of para. 5.10.3. Stiffener materials shall be compatible with the material of the duct.

Supports shall be formed of fabricated structural members of a material compatible with the duct and stiffeners. Supports shall be securely fastened to building members by welding or by the use of bolts. Supports shall be fastened to the duct or stiffeners in accordance with the structural requirements.

Accessories shall be provided, as required, for the termination of the duct at outlets and inlets. Access doors shall be provided for inspection and maintenance of devices mounted inside the duct. Access doors shall be designed and installed to minimize leakage in accordance with the allowable leakage of para. 4.14.

Duct ends of flexible connectors shall be supported and positioned such that they do not tension the fabric.

5.10.5 Welding. Welding shall be in accordance with para. 7.3.

5.10.6 Materials. Ducts may be fabricated from stainless steel, carbon steel, galvanized steel sheet, plate, pipe, or rolled structural sections. Structural members may be fabricated from plain or galvanized carbon steel.

Stainless steel shall conform to ASTM A 666 or ASTM A 240. Carbon steel shall conform to ASTM A 36 for structural shapes or ASTM A 283 Grade C or D, or ASTM A 284 Grade C or D for plate. Carbon steel shall be hot-rolled pickled and oiled per ASTM A 570, or hot-rolled pickled and oiled, or cold-rolled per ASTM A 606 or A 607. Galvanized steel shall be in accordance with ASTM A 526 or A 527, coated to ASTM A 525, Coating Designation G90.

Use of nonmetallic materials in fabrication or installation of ducts and duct components shall, in addition to considerations of allowable stress, be based on resistance to deterioration from contaminants, heat,

W320-27-051

Jumper Flushing Supply Head Analysis

12/24/97

This sheet shows the status and description of the attached Design Analysis sheets.

Discipline: (27) Piping

WO/Job No.: ER4319/W-320

Calculation No.: W320-27-051

Project No. & Name: W-320 Tank 241-C-106 Waste Retrieval

Calculation Item: Jumper Flushing Supply Head Analysis

These calculations apply to:

Dwg. No.: See References

Rev. No.

Dwg. No.:

Rev. No.

Other (Study, CDR):

Rev. No.

The status of these calculations is:

- ☐ Preliminary Calculations
- ☒ Final Calculations
- ☐ Check Calculations (On Calculation Dated)
- ☐ Void Calculation (Reason Voided)

Incorporated in Final Drawings?

☒ Yes ☐ No

This calculation verified by independent "check" calculations?

☐ Yes ☒ No

Original and Revised Calculation Approvals:

	Rev. 0 Signature/Date	Rev. 1 Signature/Date	Rev. 2 Signature/Date
Originator	Kelly K. Hargreaves 12/24/97		
Checked by	Ken C. Hargreaves 12/31/97		
Approved by	Danny J. Evans 1/5/98		
Checked Against Approved Vendor Data	M. Ahmed 4.11.98		

INDEX

Design Analysis
Page No.

Description

1 - 2	Objective, Design Inputs, References, Conclusions
3 - 4	Calculation
A-1 to A-15	Appendix A - Autopipe Model "FLUSH"

Subject Calculation No.: W320-27-051

Page ii of 11

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DESIGN ANALYSIS

Client: Numatec

WO/Job No.: ER4319/W-320

Subject: Jumper Flushing Supply Head Analysis

Date: 12/24/97 By: Kelly Hayase

Checked: 12/31/97

By: Kevin Cleveland

Location: 241-AY

Revised:

By:

OBJECTIVE:

The objective of this calculation is to analyze the addition of the jumper flushing supply heads to Jumpers AY-02A-U11-A-(C) and AY-02E-U2-A-(B).

DESIGN INPUTS:**CRITERIA AND SOURCE:**

1. HNF-SD-W320-FDC-001, Rev. 4

GIVEN OR KNOWN DATA:

1. ECN W-320-696

ASSUMPTIONS:

1. For conservatism, the jumper flushing supply heads shall be assumed to be Safety Class (for analysis purposes). Therefore, the jumper flushing supply heads shall be analyzed to Safety Class 1 loads as defined in Reference #2.

METHODS TO BE USED:

Autopipe (Ref. #1) shall be used for the pipe stress analysis of the flush jumpers.

The flush jumpers will be added to Jumpers AY-02A-U11-A-(C) and AY-02E-U2-A-(B). These jumpers have been analyzed in Reference #3, without the flush jumpers attached.

- a) The addition of the flush jumpers will not affect the thermal analysis of Jumpers AY-02A-U11-A-(C) and AY-02E-U2-A-(B) in Ref. #3 because one end of the flush jumpers is free to expand thermally (connected to hose).
- b) The addition of the flush jumpers will have a negligible effect on the sustained load analysis of Jumpers AY-02A-U11-A-(C) and AY-02E-U2-A-(B) in Ref. #3 because of the light weight (approximately 77 lbs) of the flush jumpers.
- c) The addition of the flush jumpers will affect the seismic analysis of Jumpers AY-02A-U11-A-(C) and AY-02E-U2-A-(B) in Ref. #3. The maximum stress due to the cantilevered affect of the flush jumper will occur near the connection point between the flush jumper and the rest of the jumper. The rest of the stresses in Jumpers AY-02A-U11-A-(C) and AY-02E-U2-A-(B) will be affected only slightly because of the small mass of the flush jumper.
- d) The flush jumpers will be analyzed independently from Jumpers AY-02A-U11-A-(C) and AY-02E-U2-A-(B) in Ref. #3. The model of the flush jumpers will include the connector head and the pipe after the connector head to the first branch point on the main pipe of Jumpers AY-02A-U11-A-(C) and AY-02E-U2-A-(B). The sustained and the thermal analyses of the flush

DESIGN ANALYSIS

Client: Numatec

Subject: Jumper Flushing Supply Head Analysis

Location: 241-AY

WO/Job No.: ER4319/W-320

Date: 12/24/97 By: Kelly Hayase

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Revised:

By:

jumper are not critical but shall be included in the Autopipe analysis for completeness. The seismic analysis will include the portion of Jumpers AY-02A-U11-A-(C) and AY-02E-U2-A-(B) which will experience the maximum stresses.

- e) If the analysis of the flush jumpers show that the maximum stresses are acceptable, then Jumpers AY-02A-U11-A-(C) and AY-02E-U2-A-(B) in Ref. #3 will not need to be re-analyzed.

The seismic input for the flush jumper should be the structural response spectra of Jumpers AY-02A-U11-A-(C) and AY-02E-U2-A-(B) because the flush jumpers are connected to the jumpers instead of directly to ground. However, for simplification, the ground response spectra from Ref. #2 is used. To account for possible differences between the ground response spectra and the structural response spectra of the jumpers, a factor of 2 is multiplied to the ground response spectra from Ref. #2.

REFERENCES/SOURCES:

1. Autopipe Pipe Stress Analysis Program, Version 4.6, by Rebis Inc.
2. FDNW Practice # 134.215.1217, "Design Loads for Facilities"
3. Calculation W320-27-029, Rev. 3, "AY Farm Jumper Stress Analysis"
4. ASME B31.3-1996, "Process Pipe"
5. ECN W-320-696
6. Drawings: H-2-818501, Sheet 1, Rev. 2
H-2-818503, Sheet 1, Rev. 2
H-2-818510, Sheet 1, Rev. 0

CONCLUSIONS:

Based on the results of this calculation, the jumper flushing supply heads stresses satisfies the requirements of ASME B31.3 for the design loads for Safety Class systems. The addition of the flush jumpers to Jumpers AY-02A-U11-A-(C) and AY-02E-U2-A-(B) is acceptable, and Ref. #3 will not need to be revised.

DESIGN ANALYSIS

Client: Numatec

WO/Job No.: ER4319/W-320

Subject: Jumper Flushing Supply Head Analysis

Date: 12/24/97

By: Kelly Hayase

Checked: 12/31/97

By: Kevin Cleveland

Location: 241-AY

Revised:

By:

CALCULATIONS:

Autopipe Analysis Input

Pipe: 2" and 3" Sch 40S pipe, ASTM A312-TP304L

Fluid: Water

Pressure: 400 psig (assumed conservative, the design pressure of the SN and SL pipe is 320 psig)

Temperature: A thermal analysis of the flush jumper is not critical because the jumper is fixed at one end and free (connected to hose) at the other end. However, for completeness of the Autopipe analysis, an ambient temperature of 70°F and an operating temperature of 150°F is used.

Seismic Input: Safety Class 1 Spectra, 0.2g (Ref. #2), with a factor of 2 applied

**FLUOR DANIEL
NORTHWEST INC.**

Calc. No.: W320-27-051

Revision: 0

Page No.: 4 of 4

DESIGN ANALYSIS

Client: Numatec

Subject: Jumper Flushing Supply Head Analysis

Location: 241-AY

WO/Job No.: ER4319/W-320

Date: 12/24/97

Checked: 12/31/97

Revised:

By: Kelly Hayase

By: Kevin Cleveland

By:

Autopipe Model
"FLUSH"

POINT DATA LISTING

POINT NAME	TYPE	---OFFSETS (ft)---			PIPE ID	DESCRIPTION
		X	Y	Z		
*** SEGMENT A						
A00	Run	0	0	0	3"PIPE	
A01	Bend	0	0	-0.83		Long Elbow, Radius = 4.50 inch Bend angle change = 90.00 deg Mid point at 50.00 percent SIF - In 1.78, Out = 1.48 Flex = 4.577
A02	Redu	0	0.38	0		
A03	Run	0	0.29	0	2"PIPE	
A04	Bend	0	0.47	0		Long Elbow, Radius = 3.00 inch Bend angle change = 90.00 deg Mid point at 50.00 percent SIF - In 1.73, Out = 1.44 Flex = 4.404
A05	Bend	-0.50	0	0		Long Elbow, Radius = 3.00 inch Bend angle change = 90.00 deg Mid point at 50.00 percent SIF - In 1.73, Out = 1.44 Flex = 4.404
A06	Bend	0	0	0.96		Long Elbow, Radius = 3.00 inch Bend angle change = 90.00 deg Mid point at 50.00 percent SIF - In 1.73, Out = 1.44 Flex = 4.404
A07	Bend	0	0.78	0		Short Elbow, Radius = 2.00 inch Bend angle change = 90.00 deg Mid point at 50.00 percent SIF - In 2.27, Out = 1.89 Flex = 6.606
A08	Bend	0	0	-0.42		Long Elbow, Radius = 3.00 inch Bend angle change = 90.00 deg Mid point at 50.00 percent SIF - In 1.73, Out = 1.44 Flex = 4.404
A09	Valv	0	0.25	0		Rating = 150, Weight = 20 lb Surface factor = 4.00, SIF = 1.00
A10	Run	0	0.43	0		
A11	Valv	0	2.86	0		Rating = 150, Weight = 20 lb Surface factor = 4.00, SIF = 1.00
A12	Run	0	0.43	0		
A13	Run	0	1.11	0		

POINT DATA LISTING

POINT NAME	TYPE	---OFFSETS (ft)---			PIPE ID	DESCRIPTION
		X	Y	Z		
*** SEGMENT B						
B00	Run	3.00	0	-3.00	2"PIPE	
B01	Bend	-0.46	0	0		Short Elbow, Radius = 2.00 inch Bend angle change = 90.00 deg Mid point at 50.00 percent SIF - In 2.27, Out = 1.89 Flex = 6.606
B02	Bend	0	0.69	0		Short Elbow, Radius = 2.00 inch Bend angle change = 90.00 deg Mid point at 50.00 percent SIF - In 1.73, Out = 1.89 Flex = 6.606
B03	Bend	0	0	-0.42		Long Elbow, Radius = 3.00 inch Bend angle change = 90.00 deg Mid point at 50.00 percent SIF - In 1.73, Out = 1.44 Flex = 4.404
B04	Valv	0	0.25	0		Rating = 150, Weight = 20 lb Surface factor = 4.00, SIF = 1.00
B05	Run	0	0.43	0		
B06	Valv	0	2.86	0		Rating = 150, Weight = 20 lb Surface factor = 4.00, SIF = 1.00
B07	Run	0	0.43	0		
B08	Run	0	1.11	0		

Total weight of empty pipes : 62 lb

COMPONENT DATA LISTING

POINT NAME	---COORDINATE(ft) X Y Z	DATA TYPE	DESCRIPTION
------------	----------------------------	-----------	-------------

```

*** SEGMENT A
A00      0.00      0.00      0.00 ANCHOR Rigid
        Thermal movements : None

A01 N      0.00      0.00     -0.46
A01      0.00      0.00     -0.83 TI
A01 M      0.00      0.11     -0.72
A01 F      0.00      0.37     -0.83
A02      0.00      0.38     -0.83
A03      0.00      0.66     -0.83
A04 N      0.00      0.89     -0.83
A04      0.00      1.14     -0.83 TI
A04 M     -0.07      1.07     -0.83
A04 F     -0.25      1.14     -0.83
A05 N     -0.25      1.14     -0.83
A05      -0.50      1.14     -0.83 TI
A05 M     -0.43      1.14     -0.76
A05 F     -0.50      1.14     -0.58
A06 N     -0.50      1.14     -0.13
A06      -0.50      1.14      0.13 TI
A06 M     -0.50      1.21      0.05 Y-STOP ID : A06 M1, Connected to Ground
A06 F     -0.50      1.39      0.13
A07 N     -0.50      1.75      0.13
A07      -0.50      1.91      0.13 TI
A07 M     -0.50      1.87      0.08 WEIGHT 29 lb , No offsets
A07 F     -0.50      1.91      0.04
A08 N     -0.50      1.91     -0.04
A08      -0.50      1.91     -0.29 TI
A08 M     -0.50      1.99     -0.22
A08 F     -0.50      2.16     -0.29
A09      -0.50      2.16     -0.29
A10      -0.50      2.60     -0.29
A11      -0.50      5.45     -0.29
A12      -0.50      5.88     -0.29
A13      -0.50      6.99     -0.29 WEIGHT 10 lb , No offsets
    
```

```

*** SEGMENT B
B00      3.00      0.00     -3.00 ANCHOR Rigid
        Thermal movements : None

B01 N      2.71      0.00     -3.00
B01      2.54      0.00     -3.00 TI
B01 M      2.59      0.05     -3.00
B01 F      2.54      0.17     -3.00
B02 N      2.54      0.52     -3.00
B02      2.54      0.69     -3.00 TI
B02 M      2.54      0.64     -3.05 WEIGHT 29 lb , No offsets
B02 F      2.54      0.69     -3.17
B03 N      2.54      0.69     -3.17
B03      2.54      0.69     -3.42 TI
B03 M      2.54      0.76     -3.34
    
```

COMPONENT DATA LISTING

POINT NAME	---COORDINATE(ft) X Y Z	DATA TYPE	DESCRIPTION
------------	----------------------------	-----------	-------------

```

B03 F      2.54      0.94     -3.42
B04      2.54      0.94     -3.42
B05      2.54      1.37     -3.42
B06      2.54      4.23     -3.42
B07      2.54      4.66     -3.42
B08      2.54      5.77     -3.42 WEIGHT 10 lb , No offsets
    
```

Number of points in the system : 50

FLUSH W-320 TANK 241-C-106 WASTE RETRIEVAL Fluor Daniel Northwest
12/22/97 AutoPIPE+4.60 MODEL PAGE 7

PIPE DATA LISTING

Pipe ID/ Material	Nom/ Sch	O.D. inch	-----Thickness(inch)-----				Spec Grav	Weight(lb/ft)			
			W.Th.	Corr	Mill	Insu		Ling	Pipe	Other	Total
3"PIPE A312-TP304L 40S	3.000	3.500	0.216	0	0.03	0	0	1.00	7.75	0	10.96
2"PIPE A312-TP304L 40S	2.000	2.375	0.154	0	0.02	0	0	1.00	3.74	0	5.19

FLUSH W-320 TANK 241-C-106 WASTE RETRIEVAL Fluor Daniel Northwest
12/22/97 AutoPIPE+4.60 MODEL PAGE 8

MATERIAL DATA LISTING

Material Name	Pipe ID	Density lb/cu.ft	Pois. Ratio	Temper. deg F	Modulus E6 psi	Expans. in/100ft	Allow. psi
A312-TP304L 3"PIPE		501.0	0.30	70.0 150.0	28.30	0.8985	16700.0 16700.0
A312-TP304L 2"PIPE		501.0	0.30	70.0 150.0	28.30	0.8985	16700.0 16700.0

FLUSH W-320 TANK 241-C-106 WASTE RETRIEVAL Fluor Daniel Northwest
12/22/97 AutoPIPE+4.60 MODEL PAGE 9

TEMPERATURE AND PRESSURE DATA

-----C A S E 1-----				-----C A S E 2-----				-----C A S E 3-----				
POINT	PRESS.	TEMPER	EXPAN.	PRESS.	TEMPER	EXPAN.	PRESS.	TEMPER	EXPAN.	PRESS.	TEMPER	EXPAN.
NAME	psi	deg F	in/100ft	psi	deg F	in/100ft	psi	deg F	in/100ft	psi	deg F	in/100ft

*** SEGMENT A

A00	400	150	0.898
A03	400	150	0.898
A13	400	150	0.898

*** SEGMENT B

B00	400	150	0.898
B08	400	150	0.898

FLUSH W-320 TANK 241-C-106 WASTE RETRIEVAL Fluor Daniel Northwest
12/22/97 AutoPIPE+4.60 RESULT PAGE 1

```

          *
        ***                ***** ** ***** *****
          **                ** ** ** ** ** ** ** ** ** 
        ** **                ** ** ** **   **
          ** **                ** ** **   **
        ** **                ** ** **   **
          ***** ** ** ** **   ** **   **
        ***** ** ** **   ** **   **
          ** **                ** **   **
        ** **                ** **   **
          ** **                ** **   **
    
```

Pipe Stress Analysis and Design Program

Version: 4.60.03

Edition: Plus-DOS

Developed and Maintained by

Engineering Design Automation, Inc.
1600 Riviera Ave., Suite 300
Walnut Creek, CA 94596

ANALYSIS SUMMARY

Current model revision number : 5

Static - Date and Time of analysis Dec 22, 1997 2:48 PM
 Model Revision Number 5
 Number of load cases 2
 Load cases analyzed GR T1
 Gaps/Friction/Yielding considered No
 Hanger design run No
 Cut short included Yes
 Weight of contents included 0
 Pressure stiffening case Not considered
 Water elevation for buoyancy loads Not considered

Modal - Date and Time of analysis Dec 22, 1997 2:48 PM
 Model Revision Number 5
 Number of modes 33.0
 Cutoff frequency (Hz) Yes
 Weight of contents included 0
 Pressure stiffening case Not considered
 Water elevation for buoyancy loads Not considered

Response - Date and Time of analysis Dec 22, 1997 2:48 PM
 Model Revision Number 5
 Number of load cases R1
 Date and time of modal analysis Dec 22, 1997 2:48 PM
 Number of modes 5
 Cutoff frequency (Hz) 33.0
 Model revision of modal analysis 5
 Weight of contents included Yes
 Pressure stiffening case 0
 Water elevation for buoyancy loads Not considered

CODE COMPLIANCE COMBINATIONS

Combination	Category	Method	Load	Factor	Allowable	Remarks
GR + Max P	Sustain	Sum	Gravity Max Long	1.00 1.00	Automatic	Default
Cold to T1	Expansion	Sum	Thermal 1	1.00	Automatic	Default
Sus. + R1	Occasion	Abs sum	Response 1 Max Sus	1.00 1.00	Automatic	Default
Max P	Hoop		Max Hoop	1.00	Automatic	Default

OTHER USER COMBINATIONS

Combination	Method	Load	Factor	Remarks
GR	Sum	Gravity	1.00	Default
T1	Sum	Thermal 1	1.00	Default
R1	Sum	Response 1	1.00	Default

CODE COMPLIANCE

Y - Factor 0.40
 Weld efficiency factor 1.00
 Range reduction factor 1.00
 Design Pressure Factor 1.00
 Minimum stress ratio used in reports... 0.00
 Include corrosion in stress calcs. Y
 Include torsion in code stress N
 Include axial force in code stress N
 Longitudinal pressure calculation PD/4t
 Include rigorous pressure Not analyzed

RESPONSE SPECTRUM LOAD CASES :

Number of load cases analysed : 1

Load case 1 - R1

Missing mass : Yes
ZPA : No

Combination method : Grouping

X- Spectrum : SC1
Multiplier : 2.00

SC1

Freq(Hz)	Grav()	Freq(Hz)	Grav()	Freq(Hz)	Grav()
0.100	0.01	0.160	0.03	0.250	0.06
0.400	0.10	0.600	0.16	1.100	0.28
1.640	0.42	8.000	0.42	12.000	0.34
20.000	0.26	33.000	0.20	100.000	0.20

Y- Spectrum : SC1
Multiplier : 2.00

SC1

Freq(Hz)	Grav()	Freq(Hz)	Grav()	Freq(Hz)	Grav()
0.100	0.01	0.160	0.03	0.250	0.06
0.400	0.10	0.600	0.16	1.100	0.28
1.640	0.42	8.000	0.42	12.000	0.34
20.000	0.26	33.000	0.20	100.000	0.20

Z- Spectrum : SC1
Multiplier : 2.00

SC1

Freq(Hz)	Grav()	Freq(Hz)	Grav()	Freq(Hz)	Grav()
0.100	0.01	0.160	0.03	0.250	0.06
0.400	0.10	0.600	0.16	1.100	0.28
1.640	0.42	8.000	0.42	12.000	0.34
20.000	0.26	33.000	0.20	100.000	0.20

F R E Q U E N C I E S

Mode Number	Frequency (Rads/sec)	Frequency (Hertz)	Period (Sec)	Participation factors X	Y	Z
1	21.4344	3.4114	0.293	0.350	0.018	0.216
2	27.5783	4.3892	0.228	0.208	-0.028	-0.320
3	28.6932	4.5667	0.219	0.056	-0.033	-0.368
4	29.5853	4.7086	0.212	-0.377	-0.012	-0.052
5	142.3572	22.6568	0.044	0.303	0.009	0.162

DISPLACEMENTS

Point name	Load combination	TRANSLATIONS (in)			ROTATIONS (deg)		
		X	Y	Z	X	Y	Z
*** Segment A begin ***							
A00	GR	0.000	0.000	0.000	0.000	0.000	0.000
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	R1	0.000	0.000	0.000	0.000	0.000	0.000
A01 N	GR	0.000	0.000	0.000	-0.001	0.000	0.001
	T1	0.000	0.000	-0.004	0.001	0.000	0.001
	R1	0.000	0.001	0.000	0.010	0.000	0.015
A01 M	GR	0.000	0.000	0.000	-0.003	0.000	0.002
	T1	0.000	0.001	-0.006	0.004	0.001	0.002
	R1	0.001	0.002	0.001	0.029	0.005	0.028
A01 F	GR	0.000	0.000	0.000	-0.003	0.001	0.003
	T1	0.000	0.004	-0.007	0.009	0.001	0.005
	R1	0.003	0.002	0.003	0.044	0.010	0.055
A02	GR	0.000	0.000	0.000	-0.003	0.001	0.003
	T1	0.000	0.004	-0.007	0.009	0.001	0.005
	R1	0.003	0.002	0.003	0.044	0.010	0.055
A03	GR	0.000	0.000	0.000	-0.003	0.001	0.004
	T1	-0.001	0.006	-0.006	0.011	0.001	0.006
	R1	0.007	0.002	0.005	0.050	0.008	0.068
A04 N	GR	-0.001	0.000	-0.001	-0.004	0.001	0.005
	T1	-0.001	0.008	-0.006	0.014	0.001	0.008
	R1	0.011	0.002	0.008	0.060	0.008	0.090
A04 M	GR	-0.001	0.000	-0.001	-0.005	0.001	0.010
	T1	-0.002	0.010	-0.005	0.026	0.004	0.015
	R1	0.015	0.004	0.011	0.098	0.017	0.170
A04 F	GR	-0.001	-0.001	-0.001	-0.005	0.000	0.014
	T1	-0.004	0.010	-0.004	0.032	0.007	0.021
	R1	0.018	0.012	0.014	0.118	0.039	0.247
A05 N	GR	-0.001	-0.001	-0.001	-0.005	0.000	0.014
	T1	-0.004	0.010	-0.004	0.032	0.007	0.021
	R1	0.018	0.012	0.014	0.118	0.039	0.247
A05 M	GR	-0.001	-0.001	-0.001	-0.005	0.000	0.015
	T1	-0.005	0.008	-0.004	0.038	0.007	0.026
	R1	0.019	0.020	0.015	0.118	0.052	0.304

DISPLACEMENTS

Point name	Load combination	TRANSLATIONS (in)			ROTATIONS (deg)		
		X	Y	Z	X	Y	Z
A05 F	GR	-0.001	-0.001	-0.001	-0.007	0.000	0.014
	T1	-0.006	0.006	-0.002	0.048	0.007	0.029
	R1	0.021	0.021	0.016	0.135	0.061	0.328
A06 N	GR	-0.001	-0.001	-0.001	-0.010	0.000	0.014
	T1	-0.005	0.001	0.002	0.051	0.007	0.029
	R1	0.027	0.007	0.016	0.158	0.062	0.383
A06 M	GR	-0.001	0.000	-0.001	-0.019	0.000	0.014
	T1	-0.005	0.000	0.005	0.053	0.007	0.029
	R1	0.035	0.000	0.019	0.215	0.075	0.415
A06 F	GR	-0.002	0.000	-0.002	-0.030	0.000	0.014
	T1	-0.006	0.001	0.007	0.053	0.007	0.029
	R1	0.053	0.004	0.028	0.282	0.089	0.482
A07 N	GR	-0.003	0.000	-0.004	-0.035	0.000	0.014
	T1	-0.008	0.004	0.011	0.053	0.007	0.029
	R1	0.090	0.004	0.050	0.310	0.085	0.513
A07 M	GR	-0.003	0.000	-0.005	-0.047	0.000	0.014
	T1	-0.009	0.006	0.012	0.053	0.007	0.029
	R1	0.102	0.001	0.058	0.375	0.067	0.574
A07 F	GR	-0.003	-0.001	-0.006	-0.056	0.000	0.014
	T1	-0.010	0.007	0.012	0.053	0.007	0.029
	R1	0.107	0.010	0.062	0.439	0.049	0.599
A08 N	GR	-0.003	-0.001	-0.006	-0.056	0.000	0.014
	T1	-0.010	0.007	0.012	0.053	0.007	0.029
	R1	0.107	0.011	0.062	0.439	0.049	0.599
A08 M	GR	-0.004	-0.004	-0.007	-0.060	0.000	0.014
	T1	-0.010	0.010	0.011	0.053	0.007	0.029
	R1	0.115	0.028	0.069	0.504	0.039	0.628
A08 F	GR	-0.004	-0.005	-0.009	-0.061	0.000	0.014
	T1	-0.011	0.012	0.012	0.053	0.007	0.029
	R1	0.139	0.036	0.088	0.566	0.036	0.685
A09	GR	-0.004	-0.005	-0.009	-0.061	0.000	0.014
	T1	-0.011	0.012	0.012	0.053	0.007	0.029
	R1	0.139	0.036	0.088	0.566	0.036	0.685
A10	GR	-0.005	-0.005	-0.015	-0.061	0.000	0.014
	T1	-0.014	0.016	0.017	0.053	0.007	0.029
	R1	0.201	0.036	0.138	0.566	0.036	0.685

DISPLACEMENTS

Point name	Load combination	TRANSLATIONS (in)			ROTATIONS (deg)		
		X	Y	Z	X	Y	Z
A11	GR	-0.014	-0.005	-0.051	-0.061	0.000	0.014
	T1	-0.031	0.042	0.048	0.053	0.007	0.029
	R1	0.651	0.036	0.515	0.674	0.036	0.796
A12	GR	-0.015	-0.005	-0.056	-0.061	0.000	0.014
	T1	-0.034	0.046	0.053	0.053	0.007	0.029
	R1	0.723	0.036	0.576	0.674	0.036	0.796
A13	GR	-0.019	-0.005	-0.070	-0.061	0.000	0.014
	T1	-0.040	0.056	0.065	0.053	0.007	0.029
	R1	0.908	0.036	0.733	0.678	0.036	0.800

*** Segment A end ***

*** Segment B begin ***

B00	GR	0.000	0.000	0.000	0.000	0.000	0.000
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	R1	0.000	0.000	0.000	0.000	0.000	0.000
B01 N	GR	0.000	0.000	0.000	-0.005	0.000	0.004
	T1	-0.003	0.000	0.000	0.000	0.000	0.000
	R1	0.000	0.001	0.000	0.035	0.004	0.028
B01 M	GR	0.000	0.000	0.000	-0.009	-0.003	0.009
	T1	-0.004	0.000	0.000	0.000	0.000	0.000
	R1	0.001	0.002	0.001	0.062	0.026	0.109
B01 F	GR	0.000	-0.001	-0.001	-0.020	-0.006	0.009
	T1	-0.004	0.001	0.000	0.000	0.000	0.000
	R1	0.005	0.004	0.003	0.129	0.045	0.188
B02 N	GR	-0.001	-0.001	-0.002	-0.025	-0.006	0.009
	T1	-0.004	0.005	0.000	0.000	0.000	0.000
	R1	0.020	0.004	0.014	0.160	0.047	0.219
B02 M	GR	-0.001	-0.001	-0.003	-0.036	-0.006	0.009
	T1	-0.004	0.006	0.000	0.000	0.000	0.000
	R1	0.026	0.005	0.019	0.229	0.061	0.281
B02 F	GR	-0.001	-0.002	-0.003	-0.045	-0.006	0.009
	T1	-0.004	0.006	-0.001	0.000	0.000	0.000
	R1	0.031	0.010	0.022	0.297	0.080	0.306
B03 N	GR	-0.001	-0.002	-0.003	-0.045	-0.006	0.009
	T1	-0.004	0.006	-0.002	0.000	0.000	0.000
	R1	0.031	0.010	0.022	0.297	0.080	0.306

DISPLACEMENTS

Point name	Load combination	TRANSLATIONS (in)			ROTATIONS (deg)		
		X	Y	Z	X	Y	Z
B03 M	GR	-0.001	-0.004	-0.004	-0.049	-0.006	0.009
	T1	-0.004	0.007	-0.003	0.000	0.000	0.000
	R1	0.039	0.022	0.027	0.363	0.095	0.336
B03 F	GR	-0.001	-0.004	-0.006	-0.050	-0.006	0.009
	T1	-0.004	0.008	-0.004	0.000	0.000	0.000
	R1	0.054	0.028	0.041	0.427	0.109	0.392
B04	GR	-0.001	-0.004	-0.006	-0.050	-0.006	0.009
	T1	-0.004	0.008	-0.004	0.000	0.000	0.000
	R1	0.054	0.028	0.042	0.427	0.109	0.392
B05	GR	-0.002	-0.004	-0.010	-0.050	-0.006	0.009
	T1	-0.004	0.012	-0.004	0.000	0.000	0.000
	R1	0.089	0.028	0.080	0.428	0.109	0.393
B06	GR	-0.008	-0.005	-0.040	-0.050	-0.006	0.009
	T1	-0.004	0.038	-0.004	0.000	0.000	0.000
	R1	0.365	0.028	0.377	0.538	0.109	0.504
B07	GR	-0.008	-0.005	-0.045	-0.050	-0.006	0.009
	T1	-0.004	0.042	-0.004	0.000	0.000	0.000
	R1	0.411	0.028	0.425	0.538	0.109	0.504
B08	GR	-0.011	-0.005	-0.057	-0.050	-0.006	0.009
	T1	-0.004	0.052	-0.004	0.000	0.000	0.000
	R1	0.529	0.028	0.551	0.542	0.109	0.509

*** Segment B end ***

RESTRAINT REACTIONS

Point name	Load combination	FORCES (lb)				MOMENTS (ft-lb)			
		X	Y	Z	Result	X	Y	Z	Result
A00	Anchor								
	GR	0	-45	0	45	-36	0	14	38
	T1	0	-41	0	41	2	0	21	21
A06 M	R1	59	260	57	272	264	31	260	372
	Y - Stop								
	GR	0	-85	0	85	0	0	0	0
B00	T1	0	41	0	41	0	0	0	0
	R1	0	260	0	260	0	0	0	0
B00	Anchor								
	GR	0	-109	0	109	-32	0	49	59
	T1	0	0	0	0	0	0	0	0
B00	R1	53	44	52	86	212	33	216	304

ASME B31.3c (1992) CODE COMPLIANCE

Point name	Load combination	(Moments in ft-lb)			S.L.F		(Stress in psi)		Code Stress	Code Allow.	
		In-Pl. Moment	Out-Pl. Moment	Torsion Moment	In	Out	Eg. Load no.	type			
*** Segment A begin ***											
A00	Max P						(3a) HOOP	3544	16700		
	GR + Max P	36	0		1.00	1.00	(18) SUST	1870	16700		
	Cold to T1	2	0		1.00	1.00	(17) DISP	145	25050		
	Sus. + R1	300	31		1.00	1.00	(18) OCC	3720	22211		
A01 N-	Max P						(3a) HOOP	3544	16700		
	GR + Max P	17	0		1.00	1.00	(18) SUST	1736	16700		
	Cold to T1	21	0		1.00	1.00	(17) DISP	205	25050		
	Sus. + R1	190	32		1.00	1.00	(18) OCC	2962	22211		
A01 N+	Max P						(3a) HOOP	3544	16700		
	GR + Max P	17	0		1.78	1.48	(18) SUST	1827	16700		
	Cold to T1	21	0		1.78	1.48	(17) DISP	297	25050		
	Sus. + R1	190	31		1.78	1.48	(18) OCC	3992	22211		
A01 M	Max P						(3a) HOOP	3544	16700		
	GR + Max P	7	10		1.78	1.48	(18) SUST	1750	16700		
	Cold to T1	32	15		1.78	1.48	(17) DISP	435	25050		
	Sus. + R1	144	165		1.78	1.48	(18) OCC	4080	22211		
A01 F-	Max P						(3a) HOOP	3544	16700		
	GR + Max P	3	14		1.78	1.48	(18) SUST	1767	16700		
	Cold to T1	36	21		0	1.78	1.48	(17) DISP	498	25050	
	Sus. + R1	129	255		1.78	1.48	(18) OCC	4703	22211		
A01 F+	Max P						(3a) HOOP	3544	16700		
	GR + Max P	3	14		1.00	1.00	(18) SUST	1718	16700		
	Cold to T1	36	21		0	1.00	1.00	(17) DISP	292	25050	
	Sus. + R1	129	256		1.00	1.00	(18) OCC	3615	22211		
A02	Max P						(3a) HOOP	3544	16700		
	GR + Max P	3	14		1.00	1.00	(18) SUST	1718	16700		
	Cold to T1	36	21		0	1.00	1.00	(17) DISP	292	25050	
	Sus. + R1	129	255		1.00	1.00	(18) OCC	3614	22211		
A03	Max P						(3a) HOOP	3359	16700		
	GR + Max P	3	14		1.00	1.00	(18) SUST	1843	16700		
	Cold to T1	36	21		0	1.00	1.00	(17) DISP	897	25050	
	Sus. + R1	122	242		1.00	1.00	(18) OCC	7347	22211		
A04 N-	Max P						(3a) HOOP	3359	16700		
	GR + Max P	3	14		1.00	1.00	(18) SUST	1843	16700		
	Cold to T1	36	21		0	1.00	1.00	(17) DISP	897	25050	
	Sus. + R1	119	231		1.00	1.00	(18) OCC	7112	22211		

Point name	Load combination	ASME B31.3c (1992) (Moments in ft-lb)			CODE COMPLIANCE		(Stress in psi)		Code Stress	Code Allow.
		In-Pl. Moment	Out-Pl. Moment	Torsion Moment	S.I.F In	S.I.F Out	Eq. Load type	in psi		
A04 N+	Max P						(3a) HOOP	3359	16700	
	GR + Max P	14	3		1.73	1.44	(18) SUST	2060	16700	
	Cold to T1	21	36	0	1.73	1.44	(17) DISP	1362	25050	
	Sus. + R1	231	119		1.73	1.44	(18) OCC	10871	22211	
A04 M	Max P						(3a) HOOP	3359	16700	
	GR + Max P	12	2		1.73	1.44	(18) SUST	1979	16700	
	Cold to T1	18	26	26	1.73	1.44	(17) DISP	1169	25050	
	Sus. + R1	219	108		1.73	1.44	(18) OCC	10328	22211	
A04 F-	Max P						(3a) HOOP	3359	16700	
	GR + Max P	7	0		1.73	1.44	(18) SUST	1791	16700	
	Cold to T1	10	0	36	1.73	1.44	(17) DISP	869	25050	
	Sus. + R1	212	39		1.73	1.44	(18) OCC	9489	22211	
A04 F+	Max P						(3a) HOOP	3359	16700	
	GR + Max P	7	0		1.00	1.00	(18) SUST	1686	16700	
	Cold to T1	10	0	36	1.00	1.00	(17) DISP	811	25050	
	Sus. + R1	212	39		1.00	1.00	(18) OCC	6154	22211	
A05 N-	Max P						(3a) HOOP	3359	16700	
	GR + Max P	7	0		1.00	1.00	(18) SUST	1685	16700	
	Cold to T1	10	0	36	1.00	1.00	(17) DISP	810	25050	
	Sus. + R1	212	39		1.00	1.00	(18) OCC	6154	22211	
A05 N+	Max P						(3a) HOOP	3359	16700	
	GR + Max P	0	7		1.73	1.44	(18) SUST	1748	16700	
	Cold to T1	0	10	36	1.73	1.44	(17) DISP	843	25050	
	Sus. + R1	39	211		1.73	1.44	(18) OCC	8233	22211	
A05 M	Max P						(3a) HOOP	3359	16700	
	GR + Max P	0	2		1.73	1.44	(18) SUST	1603	16700	
	Cold to T1	0	26	22	1.73	1.44	(17) DISP	919	25050	
	Sus. + R1	31	82		1.73	1.44	(18) OCC	4337	22211	
A05 F-	Max P						(3a) HOOP	3359	16700	
	GR + Max P	0	9		1.73	1.44	(18) SUST	1830	16700	
	Cold to T1	0	26	0	1.73	1.44	(17) DISP	809	25050	
	Sus. + R1	21	117		1.73	1.44	(18) OCC	5247	22211	
A05 F+	Max P						(3a) HOOP	3359	16700	
	GR + Max P	9	0		1.00	1.00	(18) SUST	1742	16700	
	Cold to T1	26	0	0	1.00	1.00	(17) DISP	560	25050	
	Sus. + R1	118	21		1.00	1.00	(18) OCC	4113	22211	
A06 N-	Max P						(3a) HOOP	3359	16700	
	GR + Max P	20	0		1.00	1.00	(18) SUST	1980	16700	
	Cold to T1	7	0	0	1.00	1.00	(17) DISP	156	25050	
	Sus. + R1	199	8		1.00	1.00	(18) OCC	5809	22211	

Point name	Load combination	ASME B31.3c (1992) (Moments in ft-lb)			CODE COMPLIANCE		(Stress in psi)		Code Stress	Code Allow.
		In-Pl. Moment	Out-Pl. Moment	Torsion Moment	S.I.F In	S.I.F Out	Eq. Load type	in psi		
A06 N+	Max P						(3a) HOOP	3359	16700	
	GR + Max P	20	0		1.73	1.44	(18) SUST	2300	16700	
	Cold to T1	7	0	0	1.73	1.44	(17) DISP	270	25050	
	Sus. + R1	199	8		1.73	1.44	(18) OCC	8930	22211	
A06 M	Max P						(3a) HOOP	3359	16700	
	GR + Max P	24	0		1.73	1.44	(18) SUST	2448	16700	
	Cold to T1	0	0	0	1.73	1.44	(17) DISP	0	25050	
	Sus. + R1	238	144		1.73	1.44	(18) OCC	11533	22211	
A06 F-	Max P						(3a) HOOP	3359	16700	
	GR + Max P	32	0		1.73	1.44	(18) SUST	2738	16700	
	Cold to T1	0	0	0	1.73	1.44	(17) DISP	0	25050	
	Sus. + R1	238	211		1.73	1.44	(18) OCC	12758	22211	
A06 F+	Max P						(3a) HOOP	3359	16700	
	GR + Max P	32	0		1.00	1.00	(18) SUST	2233	16700	
	Cold to T1	0	0	0	1.00	1.00	(17) DISP	0	25050	
	Sus. + R1	238	211		1.00	1.00	(18) OCC	8533	22211	
A07 N-	Max P						(3a) HOOP	3359	16700	
	GR + Max P	32	0		1.00	1.00	(18) SUST	2233	16700	
	Cold to T1	0	0	0	1.00	1.00	(17) DISP	0	25050	
	Sus. + R1	220	192		1.00	1.00	(18) OCC	7984	22211	
A07 N+	Max P						(3a) HOOP	3359	16700	
	GR + Max P	32	0		2.27	1.89	(18) SUST	3109	16700	
	Cold to T1	0	0	0	2.27	1.89	(17) DISP	0	25050	
	Sus. + R1	220	192		2.27	1.89	(18) OCC	15100	22211	
A07 M	Max P						(3a) HOOP	3359	16700	
	GR + Max P	27	0		2.27	1.89	(18) SUST	2863	16700	
	Cold to T1	0	0	0	2.27	1.89	(17) DISP	0	25050	
	Sus. + R1	209	144		2.27	1.89	(18) OCC	13458	22211	
A07 F-	Max P						(3a) HOOP	3359	16700	
	GR + Max P	18	0		2.27	1.89	(18) SUST	2438	16700	
	Cold to T1	0	0	0	2.27	1.89	(17) DISP	0	25050	
	Sus. + R1	198	12		2.27	1.89	(18) OCC	11159	22211	
A07 F+	Max P						(3a) HOOP	3359	16700	
	GR + Max P	18	0		1.00	1.00	(18) SUST	1937	16700	
	Cold to T1	0	0	0	1.00	1.00	(17) DISP	0	25050	
	Sus. + R1	198	12		1.00	1.00	(18) OCC	5783	22211	
A08 N-	Max P						(3a) HOOP	3359	16700	
	GR + Max P	18	0		1.00	1.00	(18) SUST	1932	16700	
	Cold to T1	0	0	0	1.00	1.00	(17) DISP	0	25050	
	Sus. + R1	197	12		1.00	1.00	(18) OCC	5777	22211	

Point name	Load combination	ASME B31.3c (1992) (Moments in ft-lb)			CODE COMPLIANCE		(Stress in psi)		Code	
		In-Pl. Moment	Out-Pl. Moment	Torsion Moment	S.I.F In Out	Eq. Load no. type	Code Stress	Code Allow.		
A08 N+	Max P					(3a) HOOP	3359	16700		
	GR + Max P	18	0		1.73 1.44	(18) SUST	2216	16700		
	Cold to T1	0	0	0	1.73 1.44	(17) DISP	0	25050		
A08 M	Max P					(3a) HOOP	3359	16700		
	GR + Max P	5	0		1.73 1.44	(18) SUST	1737	16700		
	Cold to T1	0	0	0	1.73 1.44	(17) DISP	0	25050		
A08 F-	Max P					(3a) HOOP	3359	16700		
	GR + Max P	0	0		1.73 1.44	(18) SUST	1542	16700		
	Cold to T1	0	0	0	1.73 1.44	(17) DISP	0	25050		
A08 F+	Max P					(3a) HOOP	3359	16700		
	GR + Max P	0	0		1.00 1.00	(18) SUST	1542	16700		
	Cold to T1	0	0	0	1.00 1.00	(17) DISP	0	25050		
A09	Max P					(3a) HOOP	3359	16700		
	GR + Max P	0	0		1.00 1.00	(18) SUST	1542	16700		
	Cold to T1	0	0	0	1.00 1.00	(17) DISP	0	25050		
A10	Max P					(3a) HOOP	3359	16700		
	GR + Max P	0	0		1.00 1.00	(18) SUST	1542	16700		
	Cold to T1	0	0	0	1.00 1.00	(17) DISP	0	25050		
A11	Max P					(3a) HOOP	3359	16700		
	GR + Max P	0	0		1.00 1.00	(18) SUST	1542	16700		
	Cold to T1	0	0	0	1.00 1.00	(17) DISP	0	25050		
A12	Max P					(3a) HOOP	3359	16700		
	GR + Max P	0	0		1.00 1.00	(18) SUST	1542	16700		
	Cold to T1	0	0	0	1.00 1.00	(17) DISP	0	25050		
A13	Max P					(3a) HOOP	3359	16700		
	GR + Max P	0	0		1.00 1.00	(18) SUST	1542	16700		
	Cold to T1	0	0	0	1.00 1.00	(17) DISP	0	25050		

*** Segment A end ***

*** Segment B begin ***

Point name	Load combination	ASME B31.3c (1992) (Moments in ft-lb)			CODE COMPLIANCE		(Stress in psi)		Code	
		In-Pl. Moment	Out-Pl. Moment	Torsion Moment	S.I.F In Out	Eq. Load no. type	Code Stress	Code Allow.		
B00	Max P					(3a) HOOP	3359	16700		
	GR + Max P	49	0		1.00 1.00	(18) SUST	2599	16700		
	Cold to T1	0	0	0	1.00 1.00	(17) DISP	0	25050		
B01 N-	Max P					(3a) HOOP	3359	16700		
	GR + Max P	18	0		1.00 1.00	(18) SUST	1924	16700		
	Cold to T1	0	0	0	1.00 1.00	(17) DISP	0	25050		
B01 N+	Max P					(3a) HOOP	3359	16700		
	GR + Max P	18	0		2.27 1.89	(18) SUST	2408	16700		
	Cold to T1	0	0	0	2.27 1.89	(17) DISP	0	25050		
B01 M	Max P					(3a) HOOP	3359	16700		
	GR + Max P	5	23		2.27 1.89	(18) SUST	2495	16700		
	Cold to T1	0	0	0	2.27 1.89	(17) DISP	0	25050		
B01 F-	Max P					(3a) HOOP	3359	16700		
	GR + Max P	0	32		2.27 1.89	(18) SUST	2842	16700		
	Cold to T1	0	0	0	2.27 1.89	(17) DISP	0	25050		
B01 F+	Max P					(3a) HOOP	3359	16700		
	GR + Max P	32	0		1.00 1.00	(18) SUST	2229	16700		
	Cold to T1	0	0	0	1.00 1.00	(17) DISP	0	25050		
B02 N-	Max P					(3a) HOOP	3359	16700		
	GR + Max P	32	0		1.00 1.00	(18) SUST	2229	16700		
	Cold to T1	0	0	0	1.00 1.00	(17) DISP	0	25050		
B02 N+	Max P					(3a) HOOP	3359	16700		
	GR + Max P	32	0		2.27 1.89	(18) SUST	3101	16700		
	Cold to T1	0	0	0	2.27 1.89	(17) DISP	0	25050		
B02 M	Max P					(3a) HOOP	3359	16700		
	GR + Max P	27	0		2.27 1.89	(18) SUST	2855	16700		
	Cold to T1	0	0	0	2.27 1.89	(17) DISP	0	25050		
B02 F-	Max P					(3a) HOOP	3359	16700		
	GR + Max P	18	0		2.27 1.89	(18) SUST	2430	16700		
	Cold to T1	0	0	0	2.27 1.89	(17) DISP	0	25050		

Point name	Load combination	ASME B31.3c (1992) (Moments in ft-lb)			CODE COMPLIANCE		(Stress in psi)		Code Stress	Code Allow.
		In-Pl. Moment	Out-Pl. Moment	Torsion Moment	S.I.F. In	S.I.F. Out	Eq. Load no. type	Eq. Load no. type		
B02 F+	Max P						(3a) HOOP		3359	16700
	GR + Max P	18	0		1.00	1.00	(18) SUST		1934	16700
	Cold to T1	0	0	0	1.00	1.00	(17) DISP		0	25050
	Sus. + R1	197	12		1.00	1.00	(18) OCC		5763	22211
B03 N-	Max P						(3a) HOOP		3359	16700
	GR + Max P	18	0		1.00	1.00	(18) SUST		1930	16700
	Cold to T1	0	0	0	1.00	1.00	(17) DISP		0	25050
	Sus. + R1	197	12		1.00	1.00	(18) OCC		5759	22211
B03 N+	Max P						(3a) HOOP		3359	16700
	GR + Max P	18	0		1.73	1.44	(18) SUST		2214	16700
	Cold to T1	0	0	0	1.73	1.44	(17) DISP		0	25050
	Sus. + R1	197	13		1.73	1.44	(18) OCC		8843	22211
B03 H	Max P						(3a) HOOP		3359	16700
	GR + Max P	5	0		1.73	1.44	(18) SUST		1739	16700
	Cold to T1	0	0	0	1.73	1.44	(17) DISP		0	25050
	Sus. + R1	180	128		1.73	1.44	(18) OCC		9321	22211
B03 F-	Max P						(3a) HOOP		3359	16700
	GR + Max P	0	0		1.73	1.44	(18) SUST		1542	16700
	Cold to T1	0	0	0	1.73	1.44	(17) DISP		0	25050
	Sus. + R1	166	170		1.73	1.44	(18) OCC		9631	22211
B03 F+	Max P						(3a) HOOP		3359	16700
	GR + Max P	0	0		1.00	1.00	(18) SUST		1542	16700
	Cold to T1	0	0	0	1.00	1.00	(17) DISP		0	25050
	Sus. + R1	166	170		1.00	1.00	(18) OCC		6625	22211
B04	Max P						(3a) HOOP		3359	16700
	GR + Max P	0	0		1.00	1.00	(18) SUST		1542	16700
	Cold to T1	0	0	0	1.00	1.00	(17) DISP		0	25050
	Sus. + R1	166	169		1.00	1.00	(18) OCC		6623	22211
B05	Max P						(3a) HOOP		3359	16700
	GR + Max P	0	0		1.00	1.00	(18) SUST		1542	16700
	Cold to T1	0	0	0	1.00	1.00	(17) DISP		0	25050
	Sus. + R1	147	150		1.00	1.00	(18) OCC		6037	22211
B06	Max P						(3a) HOOP		3359	16700
	GR + Max P	0	0		1.00	1.00	(18) SUST		1542	16700
	Cold to T1	0	0	0	1.00	1.00	(17) DISP		0	25050
	Sus. + R1	29	29		1.00	1.00	(18) OCC		2415	22211
B07	Max P						(3a) HOOP		3359	16700
	GR + Max P	0	0		1.00	1.00	(18) SUST		1542	16700
	Cold to T1	0	0	0	1.00	1.00	(17) DISP		0	25050
	Sus. + R1	17	17		1.00	1.00	(18) OCC		2058	22211

Point name	Load combination	ASME B31.3c (1992) (Moments in ft-lb)			CODE COMPLIANCE		(Stress in psi)		Code Stress	Code Allow.
		In-Pl. Moment	Out-Pl. Moment	Torsion Moment	S.I.F. In	S.I.F. Out	Eq. Load no. type	Eq. Load no. type		
B08	Max P						(3a) HOOP		3359	16700
	GR + Max P	0	0		1.00	1.00	(18) SUST		1542	16700
	Cold to T1	0	0	0	1.00	1.00	(17) DISP		0	25050
	Sus. + R1	0	0		1.00	1.00	(18) OCC		1542	22211

*** Segment B end ***

HNF-2479, Rev. 0
Page C-19

SYSTEM SUMMARY

Maximum displacements (in)

Maximum X :	0.908	Point : A13	Load Comb.: R1
Maximum Y :	0.056	Point : A13	Load Comb.: T1
Maximum Z :	0.733	Point : A13	Load Comb.: R1
Max. total:	1.167	Point : A13	Load Comb.: R1

Maximum rotations (deg)

Maximum X :	0.678	Point : A13	Load Comb.: R1
Maximum Y :	0.109	Point : B03 F	Load Comb.: R1
Maximum Z :	0.800	Point : A13	Load Comb.: R1
Max. total:	1.049	Point : A13	Load Comb.: R1

Maximum restraint forces(lb)

Maximum X :	59	Point : A00	Load Comb.: R1
Maximum Y :	260	Point : A00	Load Comb.: R1
Maximum Z :	57	Point : A00	Load Comb.: R1
Max. total:	272	Point : A00	Load Comb.: R1

Maximum restraint moments(ft-lb)

Maximum X :	264	Point : A00	Load Comb.: R1
Maximum Y :	33	Point : B00	Load Comb.: R1
Maximum Z :	260	Point : A00	Load Comb.: R1
Max. total:	372	Point : A00	Load Comb.: R1

SYSTEM SUMMARY

Maximum sustained stress

Point	:	A07 N
Stress	psi	: 3109
Allowable	psi	: 16700
Ratio	:	: 0.19
Load combination	:	: GR + Max P

Maximum displacement stress

Point	:	A04 N
Stress	psi	: 1362
Allowable	psi	: 25050
Ratio	:	: 0.05
Load combination	:	: Cold to T1

Maximum occasional stress

Point	:	B01 F
Stress	psi	: 15841
Allowable	psi	: 22211
Ratio	:	: 0.71
Load combination	:	: Sus. + R1

Maximum hoop stress

Point	:	A00
Stress	psi	: 3544
Allowable	psi	: 16700
Ratio	:	: 0.21
Load combination	:	: Max P

Maximum sustained stress ratio

Point	:	A07 N
Stress	psi	: 3109
Allowable	psi	: 16700
Ratio	:	: 0.19
Load combination	:	: GR + Max P

Maximum displacement stress ratio

Point	:	A04 N
Stress	psi	: 1362
Allowable	psi	: 25050
Ratio	:	: 0.05
Load combination	:	: Cold to T1

U-320 TANK 241-C-106 WASTE RETRIEVAL ELIOT Daniel Northwest
 12/22/97 AUCB/PE44, 60 RESULT PAGE 20

SYSTEM SUMMARY

Maximum occasional stress ratio

Point : B01 F
 Stress psi : 15841
 Allowable psi : 22211
 Ratio : 0.71
 Load combination : Sub. + R1

Maximum hoop stress ratio

Point : A00
 Stress psi : 3544
 Allowable psi : 16000
 Ratio : 0.22
 Load combination : Max P

*** The system satisfies ASME B31.3 code requirements ***
 *** for the selected options ***

W320-27-053

New Supernate Jumper Analysis

This sheet shows the status and description of the attached Design Analysis sheets.

Discipline: (27) Piping

WO/Job No.: ER4319/W-320

Calculation No.: W320-27-053

Project No. & Name: W-320 Tank 241-C-106 Waste Retrieval

Calculation Item: New Supernate Jumper Analysis

These calculations apply to:

Dwg. No.: See References

Rev. No.

Dwg. No.:

Rev. No.

Other (Study, CDR):

Rev. No.

The status of these calculations is:

- ☐ Preliminary Calculations
- ☒ Final Calculations
- ☐ Check Calculations (On Calculation Dated)
- ☐ Void Calculation (Reason Voided)

Incorporated in Final Drawings?

☒ Yes ☐ No

This calculation verified by independent "check" calculations?

☐ Yes ☒ No

Original and Revised Calculation Approvals:

	Rev. 0 Signature/Date	Rev. 1 Signature/Date	Rev. 2 Signature/Date
Originator	Kelly K. Hagane 1/12/98		
Checked by	Kevin Caldwell 1/20/98		
Approved by	D.P. Swanson 4/11/98		
Checked Against Approved Vendor Data	M. Ahmed 4.11.98		

INDEX

Design Analysis
Page No.

Description

1 - 2	Objective, Design Inputs, References, Conclusions
3 - 15	Calculation
A-1 to A-19	Appendix A - Autopipe Model "U3U11B"
B-1 to B-19	Appendix B - Reference Information

Subject Calculation No.: W320-27-053

Page ii of ii

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DESIGN ANALYSIS

Client: Numatec

WO/Job No.: ER4319/W-320

Subject: New Supernate Jumper Analysis

Date: 1/12/98

By: Kelly Hayase

Checked: 1/20/98

By: K. Cleveland

Location: 241-AY

Revised:

By:

OBJECTIVE:

The objective of this calculation is to analyze the new supernate jumper, Jumper Assembly AY-02A-U3-U11-B.

DESIGN INPUTS:**CRITERIA AND SOURCE:**

1. HNF-SD-W320-FDC-001, Rev. 4

GIVEN OR KNOWN DATA:

1. Jumper Assembly AY-02A-U3-U11-B shall be used only for supernate transfers.

ASSUMPTIONS:

1. For conservatism, the jumper shall be analyzed to Safety Class seismic loads. (ie; Safety Class 1 seismic loads as defined in Reference #3 shall be used)
2. Purex connectors are used on Project W-320 for jumper connectors. However, this calculation shall use Integral Seal Block (ISB) connectors for the analysis. It is assumed that the ISB connector stiffnesses and allowable piping loads are comparable to those of the Purex connector.

METHODS TO BE USED:

1. Autopipe Pipe Stress Analysis Program shall be used for the analysis of the new supernate jumper.
2. Autopipe does not have a standard component which to model 3-way valves. Autopipe models a standard two way valve as being 100 times stiffer than the connecting pipe material at the start of the valve. (Ref. #2, M1.6) Therefore this analysis shall use a modified pipe to model a 3-way valve. (The pipe identifier shall be 2"-3way) The modified pipe shall have a Modulus of Elasticity 100 times greater than steel with all of the other properties the same as a 2" pipe. The weight of the 3-way valve will be located at the junction point/center of the valve. The lengths of these modified pipe segments shall be the length of the valve.
3. The ISB connectors shall be modeled as short radius elbows and flexible joints with stiffnesses provided in Table 3.5 of Reference #4. The translational stiffnesses are rigid per the recommendations of Reference #4. The piping loads at the connectors shall be compared to the ISB connector allowable piping loads.
4. During installation of the jumper assembly, the jumper will be lifted by the bail. This produces a different state of stress in the pipe and the dunnage than the installed condition. Therefore a separate analysis is required for the jumper in the lifting condition.

DESIGN ANALYSIS

Client: Numatec

Subject: New Supernate Jumper Analysis

Location: 241-AY

WO/Job No.: ER4319/WV-320

Date: 1/12/98

Checked: 1/20/98

Revised:

By: Kelly Hayase

By: K. Cleveland

By:

REFERENCES/SOURCES:

1. ASME B31.3-1996, "Process Pipe"
2. Autopipe Pipe Stress Analysis Program, Version 4.6, by Rebis Inc.
3. FDNW Practice # 134.215.1217, "Design Loads for Facilities"
4. WHC-SD-W236A-DA-002, Rev. 0, "Stress Analysis of Single Port Integral Seal Block (ISB) Jumper Connector for 2-, 3-, and 4-in. Sizes." (Appx B-1 to B-4)
5. SD-RE-DGS-002, Rev. 3 (Appx B-6)
6. PBM Multi-Port Ball Valves, Reference Book Sec. IV (Appx B-5)
7. Calculation W320-27-029, Rev. 3, "AY Farm - Jumper Stress Analysis"
8. WRC Bulletin 107, "Local Stresses in Spherical and Cylindrical Shells due to External Loadings", Wichman, Hopper, and Mershon, 1979. (Appx B-11 to B-19)
9. WHC-SD-WM-DA-063, Rev. 0, "Capacities of Standard Lifting Bails, Dwg H-2-90161, Rev. 1" (Appx B-7 to B-10)
10. HNF-SD-W320-FDC-001, Rev. 4, "Functional Design Criteria for Tank 241-C-106 Waste Retrieval, Project W-320"
11. Construction Spec. W-320-C7, Section 15493.
12. Drawing Numbers H-2-818504, Sheet 1, Rev. 0
 H-2-818504, Sheet 2, Rev. 0
 H-2-90161, Sheet 1, Rev. 4

CONCLUSIONS:

1. Based on the results of this calculation, the new supernate jumper, Jumper Assembly AY-02A-U3-U11-B, satisfies the requirements of ASME B31.3 for the design loads for Safety Class systems.
2. The piping loads on the connectors satisfy the allowable piping loads for the ISB connector, therefore the Purex connector is judged to be acceptable.
3. The nozzle/wall anchor loads are summarized in Table 3. These loads are the same magnitude as the loads determined in Reference #7, therefore, they are acceptable.
4. The jumper assembly is acceptable during the lifting condition.

DESIGN ANALYSIS

Client: Numatec

WO/Job No.: ER4319/W-320

Subject: New Supernate Jumper Analysis

Date: 1/12/98

By: Kelly Hayase

Checked: 1/20/98

By: K. Cleveland

Location: 241-AY

Revised:

By:

CALCULATIONS:

Autopipe Analysis Input:

Pipe: 2" and 4" sch 40, A106 Gr B

Fluid: Supernate, SG = 1.12 (Ref. #10)

Pressure: 320 psig (Ref. #11)

Temperature range: 40 to 180 °F (Ref. #10)

Seismic Input: Safety Class 1 spectra, 0.2g, 5% damping (Ref. #3)

Table 1: Connector Stiffnesses used in Autopipe

	Axial lb/in	Shear lb/in	Torsion ft-lb/deg	Bending ft-lb/deg
2" Connector	1.35×10^7	Rigid	107	659
4" Connector	2.33×10^7	Rigid	304	2080

DESIGN ANALYSIS

Client: Numatec

WO/Job No.: ER4319/W-320

Subject: New Supernate Jumper Analysis

Date: 1/12/98

By: Kelly Hayase

Checked: 1/20/98

By: K. Cleveland

Location: 241-AY

Revised:

By:

Check Piping Loads on Connector

All the axial piping loads from the jumper analyses (Table 2) satisfy the seating and unseating limits on the connectors. (See Table 3.3 and 3.4 of Reference #4)

All the shear, torsion, and bending piping loads (Table 2) satisfy the interaction check for the connectors.

$$I = f_{yz}/F_{yz} + m_x/M_x + m_y/M_y < 1.0$$

Where: f_{yz} = Resultant shear force (wrt connector axis) on connector determined from the analysis

m_x = Torsion on connector determined from the analysis

m_y = Resultant bending force (wrt connector axis) on connector determined from the analysis

F_{yz} = Acceptable shear load from Table 3.4, Reference #4

M_x = Acceptable torsional load from Table 3.4, Reference #4

M_y = Acceptable bending load from Table 3.4, Reference #4

For 2" Connector $F_{yz} = 1330$ lb
 $M_x = 260$ ft-lb
 $M_y = 365$ ft-lb

For 4" Connector $F_{yz} = 2220$ lb
 $M_x = 780$ ft-lb
 $M_y = 1170$ ft-lb

Table 2: Connector Loads

Node	Axial lb	Shear lb	Shear lb	Resultant Shear	Torsion ft-lb	Moment ft-lb	Moment ft-lb	Resultant Moment	Interaction
A01 4"	60	145	37	150	8	14	189	190	0.24
A15 2"	163	83	456	463	9	51	19	54	0.53
B08 4"	484	89	187	207	37	334	23	335	0.43

DESIGN ANALYSIS

Client: Numatec

Subject: New Supernate Jumper Analysis

WO/Job No.: ER4319/W-320

Date: 1/12/98

Checked: 1/20/98

By: Kelly Hayase

By: K. Cleveland

Location: 241-AY

Revised:

By:

Table 3: Total Nozzle/Wall Anchor Loads

Node	Orientation	Fx lb	Fy lb	Fz lb	Mx ft-lb	My ft-lb	Mz ft-lb
A00		58	289	76	258	19	8
B09		89	192	485	381	42	37

DESIGN ANALYSIS

Client: Numatec

Subject: New Supernate Jumper Analysis

Location: 241-AY

WO/Job No.: ER4319/W-320

Date: 1/12/98

Checked: 1/20/98

Revised:

By: Kelly Hayase

By: K. Cleveland

By:

JUMPER AY-02A-U3-U11-B
AUTOPIPE MODEL "U3U11B"

DESIGN ANALYSIS

Client NumatecWO/Job No. ER4319/W-320Subject New Supernate Jumper AnalysisDate 1/12/98By Kelly HayaseChecked 1/20/98By K. ClevelandLocation 241-AY

Revised

By

Check lifting bail capacity (Ref. # 9)

The $\frac{3}{4}$ " diameter bar and $\frac{5}{16}$ " weld on the lifting bail (Detail F) is similar to the Standard Rigid Lifting Bail Assembly 5. Assembly 5 is rated for 475 lb, which is dictated by the stress in the bar. (Ref. # 9) Therefore, the $\frac{3}{4}$ " diameter bar and $\frac{5}{16}$ " weld on the lifting bail is adequate for the 420 lb jumper weight.

$\frac{3}{16}$ " weld between the $\frac{3}{4}$ " pipe and $\frac{1}{2} \times 2\frac{1}{2} \times 7$ " plate

$3\frac{1}{4}$ "

→ x

$$A_w = 2 \times 3.25 \text{ in} = 6.5 \text{ in}$$

⊥

$$f_w = \frac{420 \text{ lb}}{6.5 \text{ in}} = 65 \text{ lb/in} < 1450 \text{ lb/in} = f_{wallow} \quad \text{O.K.}$$

$$f_{wallow} = 7733 (\text{w}) \text{ lb/in} = 7733 \left(\frac{3}{16}\right) = 1450 \text{ lb/in} \quad (\text{Ref. \# 9})$$

DESIGN ANALYSIS

Client NumatecWO/Job No. ER 4319/ W-320Subject New Supernate Jumper AnalysisDate 1/12/98By Kelly HaysseChecked 1/20/98By R. ClevelandLocation 241-A4

Revised

By

Lifting bail (continued)

 $\frac{3}{4}$ " bar sticking out of $\frac{3}{4}$ " pipe

$$\uparrow F = \frac{420 \text{ lb}}{2} = 210 \text{ lb}$$

$$A = \pi r^2 = \pi (0.375 \text{ in})^2$$

$$A = 0.44 \text{ in}^2$$

$$S = \frac{\pi r^3}{4} = \frac{\pi (0.375 \text{ in})^3}{4}$$

$$S = 0.041 \text{ in}^3$$

$$M = (1.5 \text{ in})(210 \text{ lb}) = 315 \text{ in}\cdot\text{lb}$$

$$\sigma = \frac{315 \text{ in}\cdot\text{lb}}{0.041 \text{ in}^3} = 7683 \text{ psi} < 11600 \text{ psi} = \sigma_{\text{allow}} \quad (\text{Ref. \# 9})$$

O.K.

$$\tau = \frac{210 \text{ lb}}{0.44 \text{ in}^2} = 477 \text{ psi} < 7733 \text{ psi} = \tau_{\text{allow}} \quad (\text{Ref. \# 9})$$

O.K.

All other components of the lifting bail are not critical,
therefore the lifting bail is acceptable.

DESIGN ANALYSIS

Client NumatecWO/Job No. ER4319/W-320Subject New Superate Jumper AnalysisDate 1/12/98 By Kelly HayaseChecked 1/20/98 By K. ClevelandLocation 241-AY

Revised

By

Check final weld between lifting bail base and 6"x6" plate

$$A_w = 2 \times 6 \text{ in} = 12 \text{ in}$$

$$\text{Force on weld } F_y = 2 \times 420 \text{ lb} = 840 \text{ lb}$$

factor for impact load jumper weight

$$f_w = \frac{840 \text{ lb}}{12 \text{ in}} = 70 \text{ lb/in}$$

$$t_w = \frac{f_w}{(0.707) \sigma_{\text{allow}}} = \frac{70 \text{ lb/in}}{(0.707)(16900 \text{ psi})(0.8)} = 0.01 \text{ in} < \frac{3}{16} \text{ in fillet weld}$$

831.3 allow
for A36

factor for shear

O.K.

Check weld between 6"x6" plate (under) and C3x4.1

$$A_w = 2(3 \text{ in} + 2 \times 1.41 \text{ in}) = 11.64 \text{ in}$$

$$f_w = \frac{840 \text{ lb}}{11.64 \text{ in}} = 72$$

$$t_w = \frac{72 \text{ lb}}{(0.707)(16900 \text{ psi})(0.8)} = 0.01 \text{ in} < \frac{1}{8} \text{ in fillet weld}$$

O.K.

DESIGN ANALYSIS

Client <u>Nurmatec</u>	WO/Job No. <u>ER 4319/w-320</u>
Subject <u>New Superate Jumper Analysis</u>	Date <u>1/12/98</u> By <u>Kelly Hayase</u>
	Checked <u>1/20/98</u> By <u>K. Cleveland</u>
Location <u>241-AY</u>	Revised _____ By _____

Check bending stress in C3x4.1 (during installation/lifting)

$$S = 0.202 \text{ in}^3$$

neglect gusset plate

$$M = \frac{(840 \text{ lb})(12.8 \text{ in})(9.2 \text{ in})}{(22 \text{ in})} = 4496 \text{ in}\cdot\text{lb}$$

$$\sigma = \frac{M}{S} = \frac{4496 \text{ in}\cdot\text{lb}}{0.202 \text{ in}^3} = 22257 \text{ psi} < 22477 \text{ psi} = \sigma_{\text{allow}}$$

O.K.

$$\sigma_{\text{allow}} = (16900 \text{ psi})(1.33) = 22477 \text{ psi}$$

↖ B31.3 allow
for A36

↖ factor for
occasional loads

DESIGN ANALYSIS

Client Numatec

WO/Job No. ER 4319/W-320

Subject New Superate Jumper Analysis

Date 1/12/98 By Kelly Havase

Checked 1/20/98 By K. Cleveland

Location 241-AV

Revised By

Check weld between bar and pipe (installed)

$$A_w = 2 \times 3 \text{ in} = 6 \text{ in}$$

$$S_w = 0.375 \text{ in} \times 3 \text{ in} = 1.125 \text{ in}^2$$

Force on weld $F_y \approx 50 \text{ lb}$ (assumed, conservative)

$$M_z = (50 \text{ lb})(11 \text{ in}) = 550 \text{ in}\cdot\text{lb}$$

$$f_w = \frac{50 \text{ lb}}{6 \text{ in}} + \frac{550 \text{ in}\cdot\text{lb}}{1.125 \text{ in}^2} = 497 \text{ lb/in}$$

$$t_w = \frac{497 \text{ lb/in}}{(0.707)(16900 \text{ psi})(0.8)} = 0.05 \text{ in} < \frac{1}{8} \text{ in fillet weld}$$

O.K.

DESIGN ANALYSIS

Client NymatecWO/Job No. ER4319 / W-320Subject New Supernate Jumper AnalysisDate 1/12/98 By Kelly HayaseChecked 1/20/98 By K. ClevelandLocation 241-AY

Revised _____ By _____

Local stresses in pipe due to welded bar (installed)

Determine exact weight of dunnage

$$C 3 \times 4.1 \quad (3 \text{ ft})(4.1 \text{ lb/ft}) = 12.3 \text{ lb}$$

$$6" \times 6" \times \frac{1}{2}" \text{ plate} \quad (6 \text{ in})(6 \text{ in})(0.5 \text{ in})(0.283 \text{ lb/in}^3) = 5.1 \text{ lb}$$

$$10" \times 3" \times \frac{1}{4}" \text{ plate} \quad (10 \text{ in})(3 \text{ in})(0.25 \text{ in})(0.283 \text{ lb/in}^3) = 2.1 \text{ lb}$$

$$\frac{1}{2}" \times \frac{1}{4}" \times 3" \text{ bar} \quad (1.5 \text{ in})(0.25 \text{ in})(3 \text{ in})(0.283 \text{ lb/in}^3) = 0.3 \text{ lb}$$

$$\frac{1}{2}" \times \frac{3}{8}" \times 3" \text{ bar} \quad (1.5 \text{ in})(0.375 \text{ in})(3 \text{ in})(0.283 \text{ lb/in}^3) = 0.5 \text{ lb}$$

lifting bail

$$\sim 10 \text{ lb}$$

$$\underline{\underline{30.3 \text{ lb}}}$$

Use $P = 31 \text{ lb}$

$$M_c = (31 \text{ lb})(11 \text{ in}) = 341 \text{ in}\cdot\text{lb}$$

Geometric properties

$$G_1 = 0.1875"$$

$$G_2 = 1.5"$$

$$T = 0.154"$$

$$R_m = 1.1105"$$

$$\beta_1 = \frac{0.1875}{1.1105} = 0.17$$

$$\beta_2 = \frac{1.5}{1.1105} = 1.35$$

$$\gamma = \frac{1.1105}{0.154} = 7.2$$

$$\frac{\beta_1}{\beta_2} = 0.125$$

DESIGN ANALYSIS

Client NomatecWO/Job No. ER 4319 / W-320Subject New Supernate Jumper AnalysisDate 1/12/98 By Kelly HayaseChecked 1/20/98 By K. ClevelandLocation 241-AF

Revised By

Local stresses (continued)

Radial load (P)

$$\beta = \left[1 - \frac{4}{3}(1-0.125)(1-1.48) \right] \sqrt{(0.17)(1.35)} = 0.75 \quad (N_{\phi})$$

$$\beta = \left[1 - \frac{4}{3}(1-0.125)(1-1.2) \right] \sqrt{(0.17)(1.35)} = 0.59 \quad (N_x)$$

$$\beta = \left[1 - \frac{4}{3}(1-0.125)(1-0.88) \right] \sqrt{(0.17)(1.35)} = 0.41 \quad (M_{\phi})$$

$$\beta = \left[1 - \frac{4}{3}(1-0.125)(1-1.25) \right] \sqrt{(0.17)(1.35)} = 0.62 \quad (M_x)$$

Circumferential moment (M_c)

$$\beta = \sqrt[3]{(0.17)^2(1.35)} = 0.34 \quad (N_{\phi} + N_x)$$

$$C_c = 0.31 \quad (N_{\phi})$$

$$C_c = 0.49 \quad (N_x)$$

$$\beta = 1.31 \sqrt[3]{(0.17)^2(1.35)} = 0.44 \quad (M_{\phi})$$

$$\beta = 1.84 \sqrt[3]{(0.17)^2(1.35)} = 0.62 \quad (M_x)$$

DESIGN ANALYSIS

Client: Numatec

WO/Job No.: ER4319/W-320

Subject: New Supernate Jumper Analysis

Date: 1/12/98

By: Kelly Hayase

Checked: 1/20/98

By: K. Cleveland

Location: 241-AY

Revised:

By:

Local stresses (continued)

Table 5—Computation Sheet for Local Stresses in Cylindrical Shells

1. Applied Loads

Radial load, $P = 31$ lb.
Circ. Moment, $M_c = 34$ in. lb.
Long. Moment, $M_L = 1$ in. lb.
Torsion Moment, $M_t = 1$ in. lb.
Shear Load, $V_c = 1$ lb.
Shear Load, $V_L = 1$ lb.

2. Geometric Parameters

$$\gamma = \frac{R_m}{T} = 7.2$$

$$\beta = (0.875) \frac{r_o}{R_m} = 1$$

Stress Concentration due to:
a) membrane load, $K_n = 1.0$
b) bending load, $K_b = 1.0$

*NOTE: Enter all force values in accordance with sign convention

CYLINDRICAL SHELL

β	From Fig.	Read curves for	Compute absolute values of stress and enter result	STRESSES - if load is opposite that shown, reverse signs shown							
				A _u	A _L	B _u	B _L	C _u	C _L	D _u	D _L
0.75	3C-3D	$\frac{N\beta}{P/R_m} = 1.0$	$K_n \left(\frac{N\beta}{P/R_m} \right) \cdot \frac{P}{R_m T} = 181$	-	-	-	-	181	-	-	-
0.41	1C or 3E	$\frac{N\beta}{P} = 0.064$	$K_b \left(\frac{N\beta}{P} \right) \cdot \frac{6P}{T^2} = 502$	-	+	-	+	502	+	-	+
0.34	3A	$\frac{N\beta}{M_c/R_m T^2} = 0.3$	$K_n \left(\frac{N\beta}{M_c/R_m T^2} \right) \cdot \frac{M_c}{R_m^2 \beta T} = 491$					491	-	+	+
0.44	1A	$\frac{N\beta}{M_c/R_m \beta} = 0.08$	$K_b \left(\frac{N\beta}{M_c/R_m \beta} \right) \cdot \frac{6M_c}{R_m \beta T^2} = 1425$					1425	+	+	-
	3B	$\frac{N\beta}{M_L/R_m T^2} = 1$	$K_n \left(\frac{N\beta}{M_L/R_m T^2} \right) \cdot \frac{M_L}{R_m \beta T} =$	-	-	+	+				
	1B or 1B-1	$\frac{N\beta}{M_L/R_m \beta} = 1$	$K_b \left(\frac{N\beta}{M_L/R_m \beta} \right) \cdot \frac{6M_L}{R_m \beta T^2} =$	-	+	+	-				
Add algebraically for summation of σ stresses, σ_{Σ}								15299			
0.59	3C-3D	$\frac{N\beta}{P/R_m} = 1.0$	$K_n \left(\frac{N\beta}{P/R_m} \right) \cdot \frac{P}{R_m T} = 181$	-	-	-	-	181	-	-	-
0.62	1C-1	$\frac{N\beta}{P} = 0.05$	$K_b \left(\frac{N\beta}{P} \right) \cdot \frac{6P}{T^2} = 392$	-	+	-	+	392	+	-	+
0.34	4A	$\frac{N\beta}{M_c/R_m T^2} = 0.58$	$K_n \left(\frac{N\beta}{M_c/R_m T^2} \right) \cdot \frac{M_c}{R_m^2 \beta T} = 501$					501	-	+	+
0.62	2A	$\frac{N\beta}{M_c/R_m \beta} = 0.053$	$K_b \left(\frac{N\beta}{M_c/R_m \beta} \right) \cdot \frac{6M_c}{R_m \beta T^2} = 5388$					5388	+	+	-
	4B	$\frac{N\beta}{M_L/R_m T^2} = 1$	$K_n \left(\frac{N\beta}{M_L/R_m T^2} \right) \cdot \frac{M_L}{R_m \beta T} =$	-	-	+	+				
	2B or 2B-1	$\frac{N\beta}{M_L/R_m \beta} = 1$	$K_b \left(\frac{N\beta}{M_L/R_m \beta} \right) \cdot \frac{6M_L}{R_m \beta T^2} =$	-	+	+	-				
Add algebraically for summation of τ stresses, τ_{Σ}								7462			
Shear stress due to Torsion, M_t				$\tau_{\Sigma} = \tau_{\Sigma} = \frac{M_t}{2\pi r_o^2 T}$	+	+	+	+	+	+	+
Shear stress due to load, V_c				$\tau_{\Sigma} = \tau_{\Sigma} = \frac{V_c}{\pi r_o T}$	+	+	-	-			
Shear stress due to load, V_L				$\tau_{\Sigma} = \tau_{\Sigma} = \frac{V_L}{\pi r_o T}$					-	-	+
Add Algebraically for summation of shear stresses, τ_{Σ}											

DESIGN ANALYSIS

Client Numatec	WO/Job No. ER 4319 / W-320
Subject New Superate Jumper Analysis	Date 1/12/98 By Kelly Hayase
	Checked 1/20/98 By K. Cleland
Location 241-A4	Revised By

Combine local stresses + global stresses

Hoop stress

$$15299 \text{ psi} + 3350 \text{ psi} = 18649 \text{ psi} < 20,000 \text{ psi} = \text{Allow}$$

(max from Autopipe) O.K.

Sustained stress

$$7462 \text{ psi} + 4269 \text{ psi} = 11731 \text{ psi} < 20,000 \text{ psi} = \text{Allow}$$

(max from Autopipe) O.K.

Displacement stress

$$7462 \text{ psi} + 7662 \text{ psi} = 15124 \text{ psi} < 30,000 \text{ psi} = \text{Allow}$$

(max from Autopipe) O.K.

Occasional stress

$$7462 \text{ psi} + 5696 \text{ psi} = 13158 \text{ psi} < 26600 \text{ psi} = \text{Allow}$$

(max from Autopipe) O.K.

POINT DATA LISTING

POINT NAME	TYPE	-----OFFSETS (ft)-----			PIPE ID	DESCRIPTION
		X	Y	Z		
*** SEGMENT A						
A00	Run	0	0	0	4"PIPE	Wt= 120 lb , Ar= 12.7 sq.in
A01	Flex	0.28	0	0		Axial= 23300000 Tors= 304.0
						Y-Shear= RIGID Bend= 2080.0
						Z-Shear= RIGID Bend= 2080.0
A02	Run	0.05	0	0		
A03	Bend	0.35	0	0		Short Elbow, Radius = 4.00 inch
						Bend angle change = 90.00 deg
						Mid point at 50.00 percent
						SIF - In 2.56, Out = 2.13
						Flex = 7.908
A04	Bend	0	-2.02	0		Long Elbow, Radius = 6.00 inch
						Bend angle change = 90.00 deg
						Mid point at 50.00 percent
						SIF - In 1.95, Out = 1.63
						Flex = 5.272
A05	Redu	0.50	0	0		
A06	Run	0.33	0	0	2"PIPE	Long Elbow, Radius = 3.00 inch
A07	Bend	0.49	0	0		Bend angle change = 90.00 deg
						Mid point at 50.00 percent
						SIF - In 1.73, Out = 1.44
						Flex = 4.404
A08	Bend	0	0	-1.69		Long Elbow, Radius = 3.00 inch
						Bend angle change = 90.00 deg
						Mid point at 50.00 percent
						SIF - In 1.73, Out = 1.44
						Flex = 4.404
A09	Run	0.68	0	0	2"-3WAY	
A10	Tee	0.32	0	0		
A11	Run	0.32	0	0	2"PIPE	Long Elbow, Radius = 3.00 inch
A12	Bend	0.68	0	0		Bend angle change = 90.00 deg
						Mid point at 50.00 percent
						SIF - In 1.73, Out = 1.44
						Flex = 4.404
A13	Bend	0	0	-2.73		Short Elbow, Radius = 2.00 inch
						Bend angle change = 90.00 deg
						Mid point at 50.00 percent
						SIF - In 2.27, Out = 1.89
						Flex = 6.606

POINT DATA LISTING

POINT NAME	TYPE	-----OFFSETS (ft)----- X Y Z			PIPE ID	DESCRIPTION
A14	Flex	0	-0.20	0		Wt= 29 lb , Ar= 3.4 sq.in Axial= 13500000 Tors= 107.0 Y-Shear= RIGID Bend= 659.0 Z-Shear= RIGID Bend= 659.0
A15	Run	0	-0.05	0		
A16	Run	0	-0.19	0		
*** SEGMENT B						
A10	Tee	3.00	-2.02	-1.69	2"-3WAY	
B01	Run	0	0	0.32	2"PIPE	
B02	Run	0	0	1.33		
B03	Redu	0	0	1.16		
B04	Run	0	0	0.33	4"PIPE	
B05	Bend	0	0	0.50		Long Elbow, Radius = 6.00 inch Bend angle change = 90.00 deg Mid point at 50.00 percent SIF - In 1.95, Out = 1.63 Flex = 5.272
B06	Bend	0	1.33	0		Short Elbow, Radius = 4.00 inch Bend angle change = 90.00 deg Mid point at 50.00 percent SIF - In 2.56, Out = 2.13 Flex = 7.908
B07	Flex	0	0	0.35		Wt= 120 lb , Ar= 12.7 sq.in Axial= 23300000 Tors= 304.0 Y-Shear= RIGID Bend= 2080.0 Z-Shear= RIGID Bend= 2080.0
B08	Run	0	0	0.05		
B09	Run	0	0	0.28		

Total weight of empty pipes : 105 lb

COMPONENT DATA LISTING

POINT NAME	---COORDINATE(ft) X Y Z	DATA TYPE	DESCRIPTION
*** SEGMENT A			
A00	0.00 0.00 0.00	ANCHOR Rigid	Thermal movements : None
A01	0.28 0.00 0.00		
A02	0.33 0.00 0.00		
A03 N	0.34 0.00 0.00		
A03	0.68 0.00 0.00	TI	
A03 M	0.58 -0.10 0.00		
A03 F	0.68 -0.33 0.00		
A04 N	0.68 -1.52 0.00		
A04	0.68 -2.02 0.00	TI	
A04 M	0.82 -1.07 0.00		
A04 F	1.18 -2.02 0.00		
A05	1.18 -2.02 0.00		
A06	1.51 -2.02 0.00		
A07 N	1.75 -2.02 0.00		
A07	2.00 -2.02 0.00	TI	
A07 M	1.92 -2.02 -0.07		
A07 F	2.00 -2.02 -0.25		
A08 N	2.00 -2.02 -1.44		
A08	2.00 -2.02 -1.69	TI	
A08 M	2.07 -2.02 -1.62		
A08 F	2.25 -2.02 -1.69		
A09	2.68 -2.02 -1.69	TEE	816.9 welding tee
A10	3.00 -2.02 -1.69	TEE	SIF - In = 1.19, Out = 1.25 WEIGHT 60 lb , No offsets
A11	3.32 -2.02 -1.69		
A12 N	3.75 -2.02 -1.69		
A12	4.00 -2.02 -1.69	TI	
A12 M	3.92 -2.02 -1.76		
A12 F	4.00 -2.02 -1.94		
A13 N	4.00 -2.02 -1.25		
A13	4.00 -2.02 -4.42	TI	
A13 M	4.00 -2.07 -4.37		
A13 F	4.00 -2.19 -4.42		
A14	4.00 -2.22 -4.42		
A15	4.00 -2.27 -4.42	ANCHOR Rigid	Thermal movements : None
A16	4.00 -2.46 -4.42		

*** SEGMENT B			
A10	3.00 -2.02 -1.69	TEE	816.9 welding tee
			SIF - In = 1.19, Out = 1.25
B01	3.00 -2.02 -1.37		
B02	3.00 -2.02 -0.04	WEIGHT 50 lb	, No offsets
B03	3.00 -2.02 1.12		
B04	3.00 -2.02 1.45		
B05 N	3.00 -2.02 1.45		

COMPONENT DATA LISTING

POINT NAME	---COORDINATE(ft) X Y Z	DATA TYPE	DESCRIPTION
B05	3.00 -2.02 1.95	TI	
B05 M	3.00 -1.87 1.80		
B05 F	3.00 -1.52 1.95		
B06 N	3.00 -1.02 1.95		
B06	3.00 -0.69 1.95	TI	
B06 M	3.00 -0.79 2.05		
B06 F	3.00 -0.69 2.28		
B07	3.00 -0.69 2.30		
B08	3.00 -0.69 2.35		
B09	3.00 -0.69 2.65	ANCHOR Rigid	Thermal movements : None

Number of points in the system : 51

HNF-2479, Rev. 0
Page D-19

PIPE DATA LISTING

Pipe ID/ Material	Nom/ Sch	O.D. inch	-----Thickness(inch)----- W.Th. Corr Mill Insu Ling	Spec Grav	Weight(lb/ft) Pipe Other Total
4"PIPE A106-B	40	4.500	0.237 0 0.03 0 0	1.12	10.78 0 16.96
2"PIPE A106-B	2.000 40	2.375	0.154 0 0.02 0 0	1.12	3.65 0 5.28
2"-3WAY NS	2.000 40	2.375	0.154 0 0.02 0 0	1.12	3.65 0 5.28

MATERIAL DATA LISTING

Material Name	Pipe ID	Density lb/cu.ft	Pois. Ratio	Temper. deg F	Modulus E6 psi	Expans. in/100ft	Allow. psi
A106-B	4"PIPE	489.0	0.30	40.0 180.0	29.62	1.0406	20000.0 20000.0
A106-B	2"PIPE	489.0	0.30	40.0 180.0	29.62	1.0406	20000.0 20000.0
NS	2"-3WAY	489.0	0.30	40.0 180.0	2900.00	1.0920	20000.0 20000.0

U3U118 W-302 TANK 241-C-106 WASTE RETRIEVAL Fluor Daniel Northwest
01/06/98 AutoPIPE+4.60 MODEL PAGE 9

TEMPERATURE AND PRESSURE DATA
-----C A S E 1-----C A S E 2-----C A S E 3-----
POINT PRESS. TEMPER EXPAN. PRESS. TEMPER EXPAN. PRESS. TEMPER EXPAN.
NAME psi deg F in/100ft psi deg F in/100ft psi deg F in/100ft

*** SEGMENT A
A00 320 180 1.041
A06 320 180 1.041
A09 320 180 1.092
A11 320 180 1.041
A12 N 320 180 1.092
A12 F 320 180 1.041
A16 320 180 1.041

*** SEGMENT B
A10 320 180 1.092
B01 320 180 1.041
B04 320 180 1.041
B09 320 180 1.041

U3U118 W-302 TANK 241-C-106 WASTE RETRIEVAL Fluor Daniel Northwest
01/06/98 AutoPIPE+4.60 RESULT PAGE 1

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Pipe Stress Analysis and Design Program

Version: 4.60.03

Edition: Plus-DOS

Developed and Maintained by

Engineering Design Automation, Inc.
1600 Riviera Ave., Suite 300
Walnut Creek, CA 94596

ANALYSIS SUMMARY

Current model revision number : 3

Static - Date and Time of analysis Jan 6, 1998 12:50 PM
 Model Revision Number 3
 Number of load cases 2
 Load cases analyzed GR T1
 Gaps/Friction/Yielding considered No
 Hanger design run No
 Cut short included No
 Weight of contents included Yes
 Number of mass points per span Automatic
 Pressure stiffening case 0
 Water elevation for buoyancy loads Not considered

Modal - Date and Time of analysis Jan 6, 1998 12:50 PM
 Model Revision Number 3
 Number of modes 3
 Cutoff frequency (Hz) 33.0
 Weight of contents included Yes
 Number of mass points per span Automatic
 Pressure stiffening case 0
 Water elevation for buoyancy loads Not considered

Response - Date and Time of analysis Jan 6, 1998 12:50 PM
 Model Revision Number 3
 Number of load cases 1
 Load cases analyzed R1
 Date and time of modal analysis Jan 6, 1998 12:50 PM
 Number of modes 3
 Cutoff frequency (Hz) 33.0
 Model revision of modal analysis 3
 Weight of contents included Yes
 Number of mass points per span Automatic
 Pressure stiffening case 0
 Water elevation for buoyancy loads Not considered

CODE COMPLIANCE COMBINATIONS

Combination	Category	Method	Load	Factor	Allowable	Remarks
GR + Max P	Sustain	Sum	Gravity Max Long	1.00 1.00	Automatic	Default
Cold to T1	Expansion	Sum	Thermal 1	1.00	Automatic	Default
Sus. + R1	Occasion	Abs sum	Response 1 Max Sus	1.00 1.00	Automatic	Default
Max P	Hoop		Max Hoop	1.00	Automatic	Default

OTHER USER COMBINATIONS

Combination	Method	Load	Factor	Remarks
GR	Sum	Gravity	1.00	Default
T1	Sum	Thermal 1	1.00	Default
R1	Sum	Response 1	1.00	Default
GR+T1	Sum	Gravity Thermal 1	1.00 1.00	User
TOTAL	Abs sum	GR+T1 Response 1	1.00 1.00	User

CODE COMPLIANCE

Y - Factor	0.40
Weld efficiency factor	1.00
Range reduction factor	1.00
Design Pressure Factor	1.00
Minimum stress ratio used in reports	0.00
Include corrosion in stress calcs.	Y
Include torsion in code stress	N
Include axial force in code stress	N
Longitudinal pressure calculation	PD/4t
Include rigorous pressure	Not analyzed

RESPONSE SPECTRUM LOAD CASES :

Number of load cases analysed : 1

Load case 1 - R1

Missing mass : Yes
ZPA : No

Combination method : SRSS

X- Spectrum : SC1
Multiplier : 1.00

SC1

Freq(Hz)	Grav()	Freq(Hz)	Grav()	Freq(Hz)	Grav()
0.100	0.01	0.160	0.03	0.250	0.06
0.400	0.10	0.600	0.16	1.100	0.28
1.640	0.42	8.000	0.42	12.000	0.34
20.000	0.26	33.000	0.20	100.000	0.20

Y- Spectrum : SC1
Multiplier : 1.00

SC1

Freq(Hz)	Grav()	Freq(Hz)	Grav()	Freq(Hz)	Grav()
0.100	0.01	0.160	0.03	0.250	0.06
0.400	0.10	0.600	0.16	1.100	0.28
1.640	0.42	8.000	0.42	12.000	0.34
20.000	0.26	33.000	0.20	100.000	0.20

Z- Spectrum : SC1
Multiplier : 1.00

SC1

Freq(Hz)	Grav()	Freq(Hz)	Grav()	Freq(Hz)	Grav()
0.100	0.01	0.160	0.03	0.250	0.06
0.400	0.10	0.600	0.16	1.100	0.28
1.640	0.42	8.000	0.42	12.000	0.34
20.000	0.26	33.000	0.20	100.000	0.20

FREQUENCIES

Mode Number	Frequency (Rads/sec)	Frequency (Hertz)	Period (Sec)	Participation factors		
				X	Y	Z
1	90.9203	14.4704	0.069	-0.589	-0.338	0.144
2	123.7139	19.6897	0.051	0.393	-0.453	0.276
3	200.7691	31.9534	0.031	-0.052	-0.231	-0.395

DISPLACEMENTS

Point name	Load combination	TRANSLATIONS (in)			ROTATIONS (deg)		
		X	Y	Z	X	Y	Z
A08 M	GR	-0.013	-0.028	0.012	-0.036	0.013	-0.027
	T1	0.005	-0.037	-0.022	0.049	-0.087	-0.060
	R1	0.014	0.010	0.006	0.012	0.016	0.008
	GR+T1	-0.008	-0.065	-0.010	0.014	-0.074	-0.087
	TOTAL	0.022	0.075	0.015	0.026	0.090	0.095
A08 F	GR	-0.013	-0.029	0.012	-0.030	0.021	-0.020
	T1	0.008	-0.039	-0.019	0.057	-0.118	-0.052
	R1	0.015	0.010	0.005	0.010	0.013	0.006
	GR+T1	-0.005	-0.068	-0.007	0.027	-0.098	-0.072
	TOTAL	0.019	0.078	0.012	0.037	0.111	0.078
A09	GR	-0.013	-0.031	0.010	-0.022	0.024	-0.016
	T1	0.013	-0.043	-0.008	0.066	-0.134	-0.047
	R1	0.015	0.011	0.004	0.008	0.012	0.005
	GR+T1	0.000	-0.074	0.002	0.044	-0.110	-0.064
	TOTAL	0.015	0.085	0.006	0.052	0.123	0.069
A10	GR	-0.013	-0.032	0.008	-0.022	0.024	-0.016
	T1	0.016	-0.046	0.001	0.066	-0.134	-0.047
	R1	0.015	0.011	0.003	0.008	0.012	0.005
	GR+T1	0.003	-0.078	0.009	0.044	-0.110	-0.064
	TOTAL	0.018	0.089	0.012	0.052	0.123	0.069
A11	GR	-0.013	-0.033	0.006	-0.022	0.024	-0.016
	T1	0.020	-0.049	0.010	0.066	-0.135	-0.047
	R1	0.015	0.011	0.002	0.008	0.012	0.005
	GR+T1	0.007	-0.083	0.017	0.044	-0.110	-0.063
	TOTAL	0.022	0.094	0.019	0.052	0.123	0.069
A12 N	GR	-0.013	-0.034	0.004	-0.001	0.022	-0.013
	T1	0.024	-0.053	0.023	0.082	-0.137	-0.042
	R1	0.015	0.012	0.001	0.001	0.010	0.005
	GR+T1	0.011	-0.088	0.027	0.081	-0.114	-0.035
	TOTAL	0.026	0.099	0.029	0.082	0.125	0.060
A12 M	GR	-0.013	-0.035	0.003	0.012	0.008	-0.004
	T1	0.028	-0.053	0.027	0.093	-0.085	-0.034
	R1	0.015	0.012	0.001	0.004	0.009	0.003
	GR+T1	0.015	-0.088	0.030	0.105	-0.077	-0.038
	TOTAL	0.029	0.100	0.032	0.109	0.086	0.041
A12 F	GR	-0.013	-0.034	0.003	0.039	-0.009	0.003
	T1	0.030	-0.050	0.026	0.110	-0.014	-0.029
	R1	0.014	0.011	0.001	0.013	0.018	0.004
	GR+T1	0.017	-0.084	0.030	0.149	-0.022	-0.026
	TOTAL	0.031	0.095	0.031	0.162	0.040	0.030

DISPLACEMENTS

Point name	Load combination	TRANSLATIONS (in)			ROTATIONS (deg)		
		X	Y	Z	X	Y	Z
A13 N	GR	-0.001	-0.003	0.003	0.075	-0.032	0.005
	T1	0.005	0.002	0.003	0.079	0.087	-0.032
	R1	0.001	0.001	0.001	0.025	0.031	0.004
	GR+T1	0.003	0.000	0.006	0.154	0.055	-0.026
	TOTAL	0.004	0.001	0.007	0.179	0.086	0.031
A13 M	GR	-0.001	-0.001	0.003	0.070	-0.032	0.005
	T1	0.002	0.003	0.001	0.039	0.087	-0.032
	R1	0.000	0.000	0.001	0.023	0.031	0.004
	GR+T1	0.002	0.003	0.003	0.109	0.055	-0.026
	TOTAL	0.002	0.003	0.004	0.132	0.086	0.031
A13 F	GR	0.000	0.000	0.001	0.061	-0.031	0.005
	T1	0.000	0.002	0.000	0.013	0.086	-0.029
	R1	0.000	0.000	0.000	0.020	0.030	0.004
	GR+T1	0.000	0.002	0.001	0.074	0.054	-0.024
	TOTAL	0.000	0.002	0.001	0.094	0.085	0.028
A14	GR	0.000	0.000	0.000	0.060	-0.031	0.005
	T1	0.000	0.002	0.000	0.012	0.085	-0.028
	R1	0.000	0.000	0.000	0.020	0.030	0.004
	GR+T1	0.000	0.002	0.000	0.073	0.054	-0.024
	TOTAL	0.000	0.002	0.000	0.093	0.084	0.027
A15	GR	0.000	0.000	0.000	0.004	0.000	0.000
	T1	0.000	0.002	0.000	-0.004	0.001	-0.002
	R1	0.000	0.000	0.000	0.001	0.000	0.000
	GR+T1	0.000	0.002	0.000	0.000	0.001	-0.002
	TOTAL	0.000	0.002	0.000	0.001	0.001	0.002
A16	GR	0.000	0.000	0.000	0.000	0.000	0.000
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	R1	0.000	0.000	0.000	0.000	0.000	0.000
	GR+T1	0.000	0.000	0.000	0.000	0.000	0.000
	TOTAL	0.000	0.000	0.000	0.000	0.000	0.000
*** Segment A end ***							
*** Segment B begin ***							
A10	GR	-0.013	-0.032	0.008	-0.022	0.024	-0.016
	T1	0.015	-0.046	0.001	0.066	-0.134	-0.047
	R1	0.015	0.011	0.003	0.008	0.012	0.005
	GR+T1	0.003	-0.078	0.009	0.044	-0.110	-0.064
	TOTAL	0.018	0.089	0.012	0.052	0.123	0.069

USU118 W-502 TANK 241-C-106 WASTE RETRIEVAL
Autopipe+4.60 RESULT PAGE 10
01/06/98

Point name	Load combination	DISPLACEMENTS		
		TRANSLATIONS (in)	ROTATIONS (deg)	Z
B01	GR	-0.011	-0.031	-0.008
	T1	0.007	-0.051	0.005
	R1	0.014	0.011	0.003
	GR+T1	-0.004	-0.081	0.013
	TOTAL	0.018	0.092	0.016
B02	GR	-0.006	-0.021	0.008
	T1	-0.018	-0.053	0.007
	R1	0.012	0.003	0.012
	GR+T1	-0.026	-0.062	0.026
	TOTAL	0.036	0.090	0.030
B03	GR	-0.003	-0.009	0.008
	T1	-0.025	-0.049	0.030
	R1	0.009	0.003	0.012
	GR+T1	-0.028	-0.058	0.038
	TOTAL	0.038	0.061	0.041
B04	GR	-0.003	-0.006	0.006
	T1	-0.026	-0.041	0.034
	R1	0.008	0.002	0.003
	GR+T1	-0.029	-0.046	0.042
	TOTAL	0.037	0.049	0.045
B05 N	GR	-0.003	-0.006	0.008
	T1	-0.026	-0.040	0.034
	R1	0.008	0.002	0.003
	GR+T1	-0.029	-0.046	0.042
	TOTAL	0.037	0.048	0.045
B05 M	GR	-0.002	-0.003	0.007
	T1	-0.023	-0.005	0.033
	R1	0.007	0.001	0.003
	GR+T1	-0.026	-0.032	0.040
	TOTAL	0.032	0.033	0.043
B05 F	GR	-0.002	-0.002	0.005
	T1	-0.016	-0.020	0.022
	R1	0.005	0.001	0.012
	GR+T1	-0.018	-0.022	0.027
	TOTAL	0.023	0.023	0.029
B06 N	GR	-0.001	-0.002	0.002
	T1	-0.008	-0.005	0.016
	R1	0.002	0.001	0.001
	GR+T1	-0.007	-0.001	0.006
	TOTAL	0.010	0.018	0.017
B06 M	GR	-0.022	-0.024	-0.016
	T1	-0.047	-0.134	-0.047
	R1	0.005	0.012	0.008
	GR+T1	-0.064	-0.110	0.043
	TOTAL	0.069	0.122	0.052

Calculation W320-27-053

USU118 W-502 TANK 241-C-106 WASTE RETRIEVAL
Autopipe+4.60 RESULT PAGE 11
01/06/98

Point name	Load combination	DISPLACEMENTS		
		TRANSLATIONS (in)	ROTATIONS (deg)	Z
B06 F	GR	0.000	0.000	0.000
	T1	-0.001	-0.003	0.004
	R1	0.000	0.000	0.009
	GR+T1	-0.001	-0.003	0.009
	TOTAL	0.000	0.000	0.000
B07	GR	0.000	0.000	0.000
	T1	-0.001	-0.003	0.004
	R1	0.000	0.000	0.009
	GR+T1	-0.001	-0.003	0.009
	TOTAL	0.000	0.000	0.000
B08	GR	0.000	0.000	0.000
	T1	-0.001	-0.003	0.004
	R1	0.000	0.000	0.009
	GR+T1	-0.001	-0.003	0.009
	TOTAL	0.000	0.000	0.000
B09	GR	0.000	0.000	0.000
	T1	-0.001	-0.003	0.004
	R1	0.000	0.000	0.009
	GR+T1	-0.001	-0.003	0.009
	TOTAL	0.000	0.000	0.000
*** Segment B end ***				

Page A-10 of A-19

RESTRAINT REACTIONS

Point name	Load combination	FORCES (lb)				MOMENTS (ft-lb)			
		X	Y	Z	Result	X	Y	Z	Result
A00	Anchor								
	GR	18	-212	-8	212	-9	10	-109	109
	T1	-40	-25	-4	47	7	-13	-117	118
	R1	54	53	46	88	6	16	32	36
	GR+T1	-22	-236	-12	238	-2	-3	-226	226
	TOTAL	76	289	58	305	8	19	258	259
A16	Anchor								
	GR	-21	-76	90	120	56	-3	7	57
	T1	85	-71	-506	518	-97	9	-35	104
	R1	18	17	40	47	20	3	6	21
	GR+T1	65	-147	-416	446	-40	6	-28	50
	TOTAL	83	164	456	492	61	9	34	70
809	Anchor								
	GR	3	-233	-82	247	-114	8	-2	115
	T1	-46	95	510	521	-239	7	-29	241
	R1	47	55	57	92	28	27	7	39
	GR+T1	-43	-137	428	451	-354	15	-31	353
	TOTAL	89	192	485	529	381	42	37	386

GLOBAL FORCES & MOMENTS

Point name	Load combination	X	FORCES (lb)			Result	X	MOMENTS (ft-lb)			Result
			Y	Z				Y	Z		
*** Segment A begin ***											
A00	GR	-18	212	8	212		9	-10	109	109	
	T1	40	25	4	47		-7	13	117	118	
	R1	54	52	45	88		6	16	32	36	
	GR+T1	22	236	12	238		2	3	226	226	
	TOTAL	76	289	57	304		8	19	258	259	
A01	GR	-18	87	8	89		9	-8	50	51	
	T1	40	25	4	47		-7	14	111	112	
	R1	38	34	26	57		6	8	29	31	
	GR+T1	22	112	12	114		2	6	160	160	
	TOTAL	60	145	37	161		8	14	189	190	
A02	GR	-18	87	8	89		9	-7	42	44	
	T1	40	25	4	47		-7	14	109	110	
	R1	28	19	10	36		6	8	29	31	
	GR+T1	22	112	12	114		2	7	152	152	
	TOTAL	50	131	22	142		8	15	181	182	
A03 N	GR	-18	87	8	89		9	-7	41	43	
	T1	40	25	4	47		-7	14	109	110	
	R1	28	19	10	35		6	8	29	31	
	GR+T1	22	111	12	114		2	7	150	150	
	TOTAL	50	130	22	141		8	15	179	180	
A03 M	GR	-18	82	8	84		10	-5	23	26	
	T1	40	25	4	47		-7	15	99	101	
	R1	28	19	9	35		5	10	28	31	
	GR+T1	22	107	12	110		3	10	122	123	
	TOTAL	50	126	21	137		8	20	151	152	
A03 F	GR	-18	78	8	80		12	-5	19	23	
	T1	40	25	4	47		-6	15	88	89	
	R1	27	18	9	34		4	11	23	26	
	GR+T1	22	102	12	105		6	11	107	108	
	TOTAL	49	120	21	132		10	22	130	132	
A04 N	GR	-18	58	8	61		21	-5	40	46	
	T1	40	25	4	47		-1	15	41	44	
	R1	26	17	8	32		11	11	16	22	
	GR+T1	22	82	12	86		20	11	81	84	
	TOTAL	48	100	20	112		31	22	96	104	

GLOBAL FORCES & MOMENTS

Point name	Load combination	X	FORCES (lb)			Result	X	MOMENTS (ft-lb)			Result
			Y	Z				Y	Z		
A04 M	GR	-18	51	8	54	24	-3	38	46		
	T1	40	25	4	47	0	16	23	28		
	R1	25	17	8	31	14	12	21	28		
	GR+T1	22	76	12	80	24	13	62	67		
	TOTAL	47	93	20	106	38	24	82	94		
A04 F	GR	-18	44	8	48	25	-1	24	35		
	T1	40	25	4	47	1	17	9	20		
	R1	24	17	8	31	15	14	18	27		
	GR+T1	22	69	12	73	26	17	33	45		
	TOTAL	46	86	20	100	41	30	51	72		
A05	GR	-18	44	8	48	25	-1	24	35		
	T1	40	25	4	47	1	17	9	20		
	R1	24	17	8	31	15	14	18	27		
	GR+T1	22	69	12	73	26	17	33	45		
	TOTAL	46	86	20	100	41	30	51	72		
A06	GR	-18	41	8	45	25	2	10	27		
	T1	40	25	4	47	1	19	0	19		
	R1	24	17	9	31	15	16	13	25		
	GR+T1	22	65	12	70	26	21	35	46		
	TOTAL	46	83	20	97	41	36	24	60		
A07 N	GR	-18	39	8	44	25	4	1	26		
	T1	40	25	4	47	1	20	-5	20		
	R1	23	17	9	30	15	17	10	25		
	GR+T1	22	64	12	69	26	24	-5	35		
	TOTAL	45	82	21	96	41	41	15	60		
A07 M	GR	-18	38	8	43	22	4	-6	24		
	T1	40	25	4	47	-1	23	-10	25		
	R1	23	18	9	30	14	17	8	23		
	GR+T1	22	63	12	68	21	27	-16	38		
	TOTAL	45	81	21	95	35	44	24	61		
A07 F	GR	-18	37	8	42	16	1	-9	18		
	T1	40	25	4	47	-6	31	-12	33		
	R1	23	18	9	30	11	13	7	19		
	GR+T1	22	62	12	67	10	32	-21	39		
	TOTAL	45	80	21	94	21	45	28	57		
A08 N	GR	-18	31	8	37	-25	-19	-9	33		
	T1	40	25	4	47	-35	78	-12	86		
	R1	22	17	10	29	12	15	7	20		
	GR+T1	22	56	12	61	-60	58	-21	86		
	TOTAL	44	73	22	88	72	73	28	106		

GLOBAL FORCES & MOMENTS

Point name	Load combination	X	FORCES (lb)			Result	X	MOMENTS (ft-lb)			Result
			Y	Z				Y	Z		
A08 M	GR	-18	30	8	36	30	-22	-11	39		
	T1	40	25	4	47	-39	85	-13	94		
	R1	21	17	10	29	15	18	6	24		
	GR+T1	22	55	12	60	-70	63	-25	97		
	TOTAL	43	72	22	86	85	81	31	121		
A08 F	GR	-18	29	8	35	-32	-22	-16	42		
	T1	40	25	4	47	-41	88	-18	99		
	R1	21	17	10	29	16	18	6	25		
	GR+T1	22	54	12	59	-74	67	-34	105		
	TOTAL	43	70	22	85	90	85	40	130		
A09	GR	-18	27	8	33	-32	-18	-28	47		
	T1	40	25	4	47	-41	90	-28	103		
	R1	20	17	10	28	16	15	10	24		
	GR+T1	22	51	12	57	-74	72	-57	117		
	TOTAL	42	68	22	83	90	86	67	141		
A10 -	GR	-18	25	8	32	-32	-16	-37	52		
	T1	40	25	4	47	-41	91	-36	107		
	R1	20	17	10	28	16	12	14	25		
	GR+T1	22	50	12	56	-74	76	-73	128		
	TOTAL	42	66	22	82	90	88	87	153		
A10 +	GR	-21	-26	90	96	-88	-37	-31	100		
	T1	85	-71	-506	518	-67	282	-69	298		
	R1	11	10	32	36	30	20	11	38		
	GR+T1	65	-97	-416	432	-155	245	-99	306		
	TOTAL	75	107	448	467	185	265	111	342		
A11	GR	-21	-28	90	96	-88	-8	-22	91		
	T1	85	-71	-506	518	-67	120	-46	145		
	R1	11	10	33	36	30	20	8	37		
	GR+T1	65	-99	-416	432	-155	112	-68	203		
	TOTAL	76	109	449	468	185	132	76	240		
A12 N	GR	-21	-30	90	97	-88	30	-10	93		
	T1	85	-71	-506	518	-67	-97	-16	119		
	R1	12	11	33	36	30	28	4	41		
	GR+T1	65	-101	-416	433	-155	-67	-25	170		
	TOTAL	76	112	449	469	185	95	29	210		
A12 M	GR	-21	-31	90	97	-85	45	-4	97		
	T1	85	-71	-506	518	-62	-181	-3	191		
	R1	12	11	33	37	30	31	2	43		
	GR+T1	65	-102	-416	433	-147	-136	-7	200		
	TOTAL	77	113	449	469	177	167	9	243		

GLOBAL FORCES & MOMENTS

Point name	Load combination	FORCES (lb)				MOMENTS (ft-lb)			
		X	Y	Z	Result	X	Y	Z	Result
A12 F	GR	-21	-32	90	98	-80	48	-2	93
	T1	85	-71	-506	518	-49	-203	2	209
	R1	13	14	34	39	14	3	1	41
	GR+T1	65	-103	-416	433	-129	-155	0	202
	TOTAL	78	116	450	471	157	186	2	243
A13 N	GR	-21	-45	90	102	9	0	-2	9
	T1	85	-71	-506	518	114	-5	2	114
	R1	14	14	34	39	124	1	4	124
	GR+T1	65	-115	-416	436	128	-5	0	124
	TOTAL	79	129	450	475	128	6	2	128
A13 M	GR	-21	-45	90	103	19	-2	-1	19
	T1	85	-71	-506	518	98	5	-2	98
	R1	14	14	34	40	7	3	1	7
	GR+T1	65	-116	-416	437	117	3	-3	117
	TOTAL	79	130	450	475	123	5	4	124
A13 F	GR	-21	-46	90	103	32	-3	2	32
	T1	85	-71	-506	518	42	9	-12	44
	R1	14	14	34	40	11	3	2	11
	GR+T1	65	-117	-416	437	74	6	-10	74
	TOTAL	79	130	450	475	84	9	12	85
A14	GR	-21	-75	90	119	35	-3	2	35
	T1	85	-71	-506	518	23	9	-15	29
	R1	15	15	37	43	12	3	2	12
	GR+T1	65	-146	-416	446	58	6	-13	60
	TOTAL	80	161	453	487	70	9	15	72
A15	GR	-21	-75	90	119	40	-3	3	40
	T1	85	-71	-506	518	-2	9	-19	22
	R1	18	17	40	47	13	3	3	14
	GR+T1	65	-146	-416	446	38	6	-16	41
	TOTAL	83	163	456	491	51	9	19	55
A16	GR	-21	-76	90	120	56	-3	7	57
	T1	85	-71	-506	518	-97	9	-35	104
	R1	18	17	40	47	20	3	6	21
	GR+T1	65	-147	-416	446	-40	6	-28	50
	TOTAL	83	164	456	491	61	9	34	70

*** Segment A end ***

*** Segment B begin ***

GLOBAL FORCES & MOMENTS

Point name	Load combination	FORCES (lb)				MOMENTS (ft-lb)			
		X	Y	Z	Result	X	Y	Z	Result
A10	GR	3	-9	-82	83	55	21	-6	59
	T1	-46	95	510	521	26	-190	32	195
	R1	10	13	27	31	27	12	14	33
	GR+T1	-43	87	428	439	81	-169	26	190
	TOTAL	52	100	454	468	109	181	41	215
B01	GR	3	-10	-82	83	52	20	-6	56
	T1	-46	95	510	521	56	-176	32	187
	R1	9	14	26	31	24	11	14	30
	GR+T1	-43	85	428	438	109	-156	26	192
	TOTAL	52	99	454	468	132	167	41	217
B02 -	GR	3	-17	-82	84	34	16	-6	38
	T1	-46	95	510	521	183	-115	32	219
	R1	14	9	26	31	10	15	14	23
	GR+T1	-43	78	428	437	217	-99	26	240
	TOTAL	52	92	454	466	227	114	41	257
B02 +	GR	3	-67	-82	106	34	16	-6	38
	T1	-46	95	510	521	183	-115	32	219
	R1	12	21	26	35	10	15	14	23
	GR+T1	-43	28	428	431	217	-99	26	240
	TOTAL	55	49	454	459	227	114	41	257
B03	GR	3	-73	-82	110	-48	13	-6	50
	T1	-46	95	510	521	294	-62	32	302
	R1	13	22	26	36	18	8	14	24
	GR+T1	-43	22	428	430	246	-49	26	252
	TOTAL	56	44	454	459	264	57	41	273
B04	GR	3	-77	-82	113	-73	12	-6	74
	T1	-46	95	510	521	325	-47	32	330
	R1	13	22	26	36	25	9	14	30
	GR+T1	-43	18	428	430	253	-35	26	257
	TOTAL	56	40	454	459	278	44	41	284
B05 N	GR	3	-77	-82	113	-73	12	-6	74
	T1	-46	95	510	521	326	-47	32	331
	R1	14	22	26	37	25	9	14	30
	GR+T1	-43	18	428	430	253	-35	26	257
	TOTAL	57	40	454	459	278	44	41	284
B05 M	GR	3	-84	-82	117	-89	10	-5	90
	T1	-46	95	510	521	285	-30	26	288
	R1	15	22	26	38	29	12	12	34
	GR+T1	-43	12	428	430	196	-20	20	198
	TOTAL	58	34	454	459	224	32	32	229

GLOBAL FORCES & MOMENTS

Point name	Load combination	FORCES (lb)			Result	MOMENTS (ft-lb)			Result
		X	Y	Z		X	Y	Z	
B05 F	GR	3	-90	-82	122	-73	10	-4	74
	T1	-46	95	510	521	119	-24	9	122
	R1	16	23	27	39	24	14	7	28
	GR+T1	-43	5	428	430	46	-14	5	48
	TOTAL	59	28	454	459	70	28	12	76
B06 N	GR	3	-99	-82	129	-32	10	-3	134
	T1	-46	95	510	521	-134	-24	-13	37
	R1	17	23	27	40	14	14	2	20
	GR+T1	-43	-3	428	430	-166	-14	-16	168
	TOTAL	60	27	455	459	181	28	18	184
B06 M	GR	3	-103	-82	132	-23	10	-2	25
	T1	-46	95	510	521	-245	-19	-24	247
	R1	17	24	27	40	14	15	5	21
	GR+T1	-43	-8	428	430	-268	-9	-26	269
	TOTAL	60	32	455	460	282	25	32	285
B06 F	GR	3	-108	-82	135	-40	9	-2	41
	T1	-46	95	510	521	-272	-8	-29	274
	R1	17	24	27	40	17	19	7	26
	GR+T1	-43	-12	428	430	-312	1	-31	314
	TOTAL	60	36	455	461	329	19	37	332
B07	GR	3	-228	-82	242	-41	9	-2	42
	T1	-46	95	510	521	-271	-8	-29	273
	R1	28	37	39	61	17	19	7	26
	GR+T1	-43	-133	428	450	-312	1	-31	314
	TOTAL	71	169	467	502	329	20	37	332
B08	GR	3	-228	-82	242	-50	9	-2	50
	T1	-46	95	510	521	-266	-5	-29	268
	R1	46	54	56	91	18	20	7	28
	GR+T1	-43	-133	428	450	-316	3	-31	317
	TOTAL	89	187	484	527	334	23	37	337
B09	GR	3	-233	-82	247	-114	8	-2	115
	T1	-46	95	510	521	-239	7	-29	241
	R1	46	54	56	91	28	27	7	39
	GR+T1	-43	-137	428	451	-354	15	-31	355
	TOTAL	89	192	484	528	381	42	37	386

*** Segment B end ***

ASME B31.3c (1992) CODE COMPLIANCE

Point name	Load combination	(MOMENTS in ft-lb)			S.I.F		(Stress in psi)		
		In-Pl. Moment	Out-Pl. Moment	Torsion Moment	In	Out	Eq. Load no.	Code Stress	Code Allow.
*** Segment A begin ***									
A00	Max P						(3a) HOOP	3350	20000
	GR + Max P	109	10		1.00	1.00	(18) SUST	1926	20000
	Cold to T1	117	13		7	1.00	(17) DISP	442	30000
	Sus. + R1	141	26		1.00	1.00	(18) OCC	2059	26600
A01	Max P						(3a) HOOP	3350	20000
	GR + Max P	50	8		1.00	1.00	(18) SUST	1707	20000
	Cold to T1	111	14		7	1.00	(17) DISP	417	30000
	Sus. + R1	79	16		1.00	1.00	(18) OCC	1819	26600
A02	Max P						(3a) HOOP	3350	20000
	GR + Max P	42	7		1.00	1.00	(18) SUST	1680	20000
	Cold to T1	109	14		7	1.00	(17) DISP	412	30000
	Sus. + R1	72	15		1.00	1.00	(18) OCC	1793	26600
A03 N-	Max P						(3a) HOOP	3350	20000
	GR + Max P	41	7		1.00	1.00	(18) SUST	1675	20000
	Cold to T1	109	14		7	1.00	(17) DISP	411	30000
	Sus. + R1	70	15		1.00	1.00	(18) OCC	1789	26600
A03 N+	Max P						(3a) HOOP	3350	20000
	GR + Max P	41	7		2.56	2.13	(18) SUST	1917	20000
	Cold to T1	109	14		7	2.56	(17) DISP	1047	30000
	Sus. + R1	70	15		2.56	2.13	(18) OCC	2204	26600
A03 M	Max P						(3a) HOOP	3350	20000
	GR + Max P	23	3		2.56	2.13	(18) SUST	1741	20000
	Cold to T1	99	6		16	2.56	(17) DISP	951	30000
	Sus. + R1	51	8		2.56	2.13	(18) OCC	2014	26600
A03 F-	Max P						(3a) HOOP	3350	20000
	GR + Max P	19	12		2.56	2.13	(18) SUST	1726	20000
	Cold to T1	88	6		15	2.56	(17) DISP	840	30000
	Sus. + R1	42	16		2.56	2.13	(18) OCC	1951	26600
A03 F+	Max P						(3a) HOOP	3350	20000
	GR + Max P	12	19		1.00	1.00	(18) SUST	1604	20000
	Cold to T1	6	88		15	1.00	(17) DISP	333	30000
	Sus. + R1	16	42		1.00	1.00	(18) OCC	1692	26600
A04 N-	Max P						(3a) HOOP	3350	20000
	GR + Max P	21	40		1.00	1.00	(18) SUST	1689	20000
	Cold to T1	1	41		15	1.00	(17) DISP	163	30000
	Sus. + R1	33	56		1.00	1.00	(18) OCC	1760	26600

Point name	Load combination	ASME B31.3c (1992) CODE COMPLIANCE (Moments in ft-lb)			S.I.F		(Stress in psi)		Code Stress	Code Allow.
		In-Pl. Moment	Out-Pl. Moment	Torsion Moment	In	Out	Eq. Load no.	Load type		
A04 N+	Max P						(3a)	HOOP	3350	20000
	GR + Max P	40	21		1.95	1.63	(18)	SUST	1839	20000
	Cold to T1	41	1	15	1.95	1.63	(17)	DISP	302	30000
	Sus. + R1	56	33		1.95	1.63	(18)	OCC	1971	26600
A04 M	Max P						(3a)	HOOP	3350	20000
	GR + Max P	38	15		1.95	1.63	(18)	SUST	1813	20000
	Cold to T1	23	11	11	1.95	1.63	(17)	DISP	187	30000
	Sus. + R1	59	31		1.95	1.63	(18)	OCC	1995	26600
A04 F-	Max P						(3a)	HOOP	3350	20000
	GR + Max P	24	1		1.95	1.63	(18)	SUST	1696	20000
	Cold to T1	9	17	1	1.95	1.63	(17)	DISP	124	30000
	Sus. + R1	43	14		1.95	1.63	(18)	OCC	1854	26600
A04 F+	Max P						(3a)	HOOP	3350	20000
	GR + Max P	24	1		1.00	1.00	(18)	SUST	1610	20000
	Cold to T1	9	17	1	1.00	1.00	(17)	DISP	73	30000
	Sus. + R1	43	14		1.00	1.00	(18)	OCC	1695	26600
A05	Max P						(3a)	HOOP	3350	20000
	GR + Max P	24	1		1.00	1.00	(18)	SUST	1609	20000
	Cold to T1	9	17	1	1.00	1.00	(17)	DISP	73	30000
	Sus. + R1	43	14		1.00	1.00	(18)	OCC	1695	26600
A06	Max P						(3a)	HOOP	2687	20000
	GR + Max P	10	2		1.00	1.00	(18)	SUST	1456	20000
	Cold to T1	0	19	1	1.00	1.00	(17)	DISP	402	30000
	Sus. + R1	23	17		1.00	1.00	(18)	OCC	1892	26600
A07 N-	Max P						(3a)	HOOP	2687	20000
	GR + Max P	5	4		1.00	1.00	(18)	SUST	1317	20000
	Cold to T1	1	20	1	1.00	1.00	(17)	DISP	438	30000
	Sus. + R1	10	21		1.00	1.00	(18)	OCC	1737	26600
A07 N+	Max P						(3a)	HOOP	2687	20000
	GR + Max P	4	1		1.73	1.44	(18)	SUST	1378	20000
	Cold to T1	20	5	1	1.73	1.44	(17)	DISP	750	30000
	Sus. + R1	21	10		1.73	1.44	(18)	OCC	2077	26600
A07 M	Max P						(3a)	HOOP	2687	20000
	GR + Max P	4	11		1.73	1.44	(18)	SUST	1617	20000
	Cold to T1	23	8	6	1.73	1.44	(17)	DISP	906	30000
	Sus. + R1	21	26		1.73	1.44	(18)	OCC	2377	26600
A07 F-	Max P						(3a)	HOOP	2687	20000
	GR + Max P	1	16		1.73	1.44	(18)	SUST	1724	20000
	Cold to T1	31	6	12	1.73	1.44	(17)	DISP	1177	30000
	Sus. + R1	14	27		1.73	1.44	(18)	OCC	2318	26600

Point name	Load combination	ASME B31.3c (1992) CODE COMPLIANCE (Moments in ft-lb)			S.I.F		(Stress in psi)		Code Stress	Code Allow.
		In-Pl. Moment	Out-Pl. Moment	Torsion Moment	In	Out	Eq. Load no.	Load type		
A07 F+	Max P						(3a)	HOOP	2687	20000
	GR + Max P	16	1		1.00	1.00	(18)	SUST	1573	20000
	Cold to T1	6	31	12	1.00	1.00	(17)	DISP	710	30000
	Sus. + R1	27	14		1.00	1.00	(18)	OCC	1941	26600
A08 N-	Max P						(3a)	HOOP	2687	20000
	GR + Max P	25	19		1.00	1.00	(18)	SUST	1910	20000
	Cold to T1	35	78	12	1.00	1.00	(17)	DISP	1838	30000
	Sus. + R1	37	34		1.00	1.00	(18)	OCC	2322	26600
A08 N+	Max P						(3a)	HOOP	2687	20000
	GR + Max P	19	25		1.73	1.44	(18)	SUST	2288	20000
	Cold to T1	78	35	12	1.73	1.44	(17)	DISP	3082	30000
	Sus. + R1	34	37		1.73	1.44	(18)	OCC	2956	26600
A08 M	Max P						(3a)	HOOP	2687	20000
	GR + Max P	22	29		1.73	1.44	(18)	SUST	2453	20000
	Cold to T1	85	37	18	1.73	1.44	(17)	DISP	3373	30000
	Sus. + R1	40	41		1.73	1.44	(18)	OCC	3206	26600
A08 F-	Max P						(3a)	HOOP	2687	20000
	GR + Max P	22	16		1.73	1.44	(18)	SUST	2190	20000
	Cold to T1	88	18	41	1.73	1.44	(17)	DISP	3439	30000
	Sus. + R1	40	22		1.73	1.44	(18)	OCC	2882	26600
A08 F+	Max P						(3a)	HOOP	2687	20000
	GR + Max P	16	22		1.00	1.00	(18)	SUST	1820	20000
	Cold to T1	18	88	41	1.00	1.00	(17)	DISP	2122	30000
	Sus. + R1	22	40		1.00	1.00	(18)	OCC	2225	26600
A09 -	Max P						(3a)	HOOP	2687	20000
	GR + Max P	28	18		1.00	1.00	(18)	SUST	1959	20000
	Cold to T1	28	90	41	1.00	1.00	(17)	DISP	2207	30000
	Sus. + R1	38	33		1.00	1.00	(18)	OCC	2333	26600
A09 +	Max P						(3a)	HOOP	2687	20000
	GR + Max P	28	18		1.00	1.00	(18)	SUST	1959	20000
	Cold to T1	28	90	41	1.00	1.00	(17)	DISP	2207	30000
	Sus. + R1	38	33		1.00	1.00	(18)	OCC	2333	26600
A10 -	Max P						(3a)	HOOP	2687	20000
	GR + Max P	16	37		1.19	1.25	(18)	SUST	2297	20000
	Cold to T1	91	36	41	1.19	1.25	(17)	DISP	2670	30000
	Sus. + R1	28	51		1.19	1.25	(18)	OCC	2789	26600
A10 +	Max P						(3a)	HOOP	2687	20000
	GR + Max P	37	31		1.19	1.25	(18)	SUST	2485	20000
	Cold to T1	282	69	67	1.19	1.25	(17)	DISP	7540	30000
	Sus. + R1	57	42		1.19	1.25	(18)	OCC	3082	26600

Point name	Load combination	ASME B31.3c (1992) (Moments in ft-lb)			CODE COMPLIANCE		(Stress in psi)		Code Stress	Code Allow.
		In-Pl. Moment	Out-Pl. Moment	Torsion Moment	S.I.F In	S.I.F Out	Eq. no.	Load type		
A11 - Max P	GR + Max P	22	8		1.00	1.00	(18)	SUST	2687	20000
	Cold to T1	46	120	67	1.00	1.00	(17)	DISP	3103	20000
	Sus. + R1	30	29		1.00	1.00	(18)	OCC	2207	26600
A11 + Max P	GR + Max P	22	8		1.00	1.00	(18)	SUST	2687	20000
	Cold to T1	46	120	67	1.00	1.00	(17)	DISP	3103	20000
	Sus. + R1	30	29		1.00	1.00	(18)	OCC	2207	26600
A12 N- Max P	GR + Max P	10	30		1.00	1.00	(18)	SUST	2687	20000
	Cold to T1	16	97	67	1.00	1.00	(17)	DISP	2553	30000
	Sus. + R1	13	58		1.00	1.00	(18)	OCC	2512	26600
A12 N+ Max P	GR + Max P	30	10		1.73	1.44	(18)	SUST	2687	20000
	Cold to T1	97	16	67	1.73	1.44	(17)	DISP	3916	30000
	Sus. + R1	58	13		1.73	1.44	(18)	OCC	3429	26600
A12 M- Max P	GR + Max P	45	63		1.73	1.44	(18)	SUST	2687	20000
	Cold to T1	181	46	42	1.73	1.44	(17)	DISP	6901	30000
	Sus. + R1	76	85		1.73	1.44	(18)	OCC	5137	26600
A12 M+ Max P	GR + Max P	45	63		1.73	1.44	(18)	SUST	2687	20000
	Cold to T1	181	46	42	1.73	1.44	(17)	DISP	6901	30000
	Sus. + R1	76	85		1.73	1.44	(18)	OCC	5137	26600
A12 F- Max P	GR + Max P	48	80		1.73	1.44	(18)	SUST	2687	20000
	Cold to T1	203	49	2	1.73	1.44	(17)	DISP	7662	30000
	Sus. + R1	79	107		1.73	1.44	(18)	OCC	5696	26600
A12 F+ Max P	GR + Max P	80	48		1.00	1.00	(18)	SUST	2687	20000
	Cold to T1	49	203	2	1.00	1.00	(17)	DISP	4463	30000
	Sus. + R1	107	79		1.00	1.00	(18)	OCC	4111	26600
A13 N- Max P	GR + Max P	9	0		1.00	1.00	(18)	SUST	2687	20000
	Cold to T1	114	5	2	1.00	1.00	(17)	DISP	2449	30000
	Sus. + R1	13	1		1.00	1.00	(18)	OCC	1520	26600
A13 N+ Max P	GR + Max P	9	0		2.27	1.89	(18)	SUST	2687	20000
	Cold to T1	114	5	2	2.27	1.89	(17)	DISP	5556	30000
	Sus. + R1	13	1		2.27	1.89	(18)	OCC	1881	26600

Point name	Load combination	ASME B31.3c (1992) (Moments in ft-lb)			CODE COMPLIANCE		(Stress in psi)		Code Stress	Code Allow.
		In-Pl. Moment	Out-Pl. Moment	Torsion Moment	S.I.F In	S.I.F Out	Eq. no.	Load type		
A13 M Max P	GR + Max P	19	1		2.27	1.89	(18)	SUST	2687	20000
	Cold to T1	98	5	2	2.27	1.89	(17)	DISP	4762	30000
	Sus. + R1	25	3		2.27	1.89	(18)	OCC	2478	26600
A13 F- Max P	GR + Max P	32	2		2.27	1.89	(18)	SUST	2687	20000
	Cold to T1	42	12	9	2.27	1.89	(17)	DISP	2896	30000
	Sus. + R1	42	3		2.27	1.89	(18)	OCC	3296	26600
A13 F+ Max P	GR + Max P	32	2		1.00	1.00	(18)	SUST	2687	20000
	Cold to T1	42	12	9	1.00	1.00	(17)	DISP	951	30000
	Sus. + R1	42	3		1.00	1.00	(18)	OCC	2144	26600
A14 Max P	GR + Max P	35	2		1.00	1.00	(18)	SUST	2687	20000
	Cold to T1	23	15	9	1.00	1.00	(17)	DISP	625	30000
	Sus. + R1	47	4		1.00	1.00	(18)	OCC	2241	26600
A15 Max P	GR + Max P	40	3		1.00	1.00	(18)	SUST	2687	20000
	Cold to T1	2	19	9	1.00	1.00	(17)	DISP	461	30000
	Sus. + R1	53	6		1.00	1.00	(18)	OCC	2375	26600
A16 Max P	GR + Max P	56	7		1.00	1.00	(18)	SUST	2687	20000
	Cold to T1	97	35	9	1.00	1.00	(17)	DISP	2217	30000
	Sus. + R1	76	13		1.00	1.00	(18)	OCC	2898	26600
*** Segment A end ***										
*** Segment B begin ***										
A10 Max P	GR + Max P	21	55		1.19	1.25	(18)	SUST	2687	20000
	Cold to T1	190	26	32	1.19	1.25	(17)	DISP	4645	30000
	Sus. + R1	33	83		1.19	1.25	(18)	OCC	3459	26600
B01 - Max P	GR + Max P	52	20		1.00	1.00	(18)	SUST	2687	20000
	Cold to T1	56	176	32	1.00	1.00	(17)	DISP	4012	30000
	Sus. + R1	76	32		1.00	1.00	(18)	OCC	2992	26600
B01 + Max P	GR + Max P	52	20		1.00	1.00	(18)	SUST	2687	20000
	Cold to T1	56	176	32	1.00	1.00	(17)	DISP	4012	30000
	Sus. + R1	76	32		1.00	1.00	(18)	OCC	2992	26600

		ASME B31.3c (1992)			CODE COMPLIANCE		(Stress in psi)		Code	
Point name	Load combination	In-Pl. Moment	Out-Pl. Moment	Torsion Moment	S.I.F In	S.I.F Out	Eq. Load no.	type	Stress	Allow.
B02	Max P						(3a)	HOOP	2687	20000
	GR + Max P	34	16		1.00	1.00	(18)	SUST	2035	20000
	Cold to T1	183	115	32	1.00	1.00	(17)	DISP	4681	30000
	Sus. + R1	44	31		1.00	1.00	(18)	OCC	2418	26600
B03	Max P						(3a)	HOOP	2687	20000
	GR + Max P	48	13		1.00	1.00	(18)	SUST	2293	20000
	Cold to T1	294	62	32	1.00	1.00	(17)	DISP	6467	30000
	Sus. + R1	66	20		1.00	1.00	(18)	OCC	2713	26600
B04	Max P						(3a)	HOOP	3350	20000
	GR + Max P	73	12		1.00	1.00	(18)	SUST	1794	20000
	Cold to T1	325	47	32	1.00	1.00	(17)	DISP	1233	30000
	Sus. + R1	97	21		1.00	1.00	(18)	OCC	1892	26600
B05 N-	Max P						(3a)	HOOP	3350	20000
	GR + Max P	73	12		1.00	1.00	(18)	SUST	1794	20000
	Cold to T1	326	47	32	1.00	1.00	(17)	DISP	1234	30000
	Sus. + R1	98	21		1.00	1.00	(18)	OCC	1893	26600
B05 N+	Max P						(3a)	HOOP	3350	20000
	GR + Max P	73	12		1.95	1.63	(18)	SUST	2055	20000
	Cold to T1	326	47	32	1.95	1.63	(17)	DISP	2293	30000
	Sus. + R1	98	21		1.95	1.63	(18)	OCC	2244	26600
B05 M	Max P						(3a)	HOOP	3350	20000
	GR + Max P	89	11		1.95	1.63	(18)	SUST	2172	20000
	Cold to T1	285	40	3	1.95	1.63	(17)	DISP	2090	30000
	Sus. + R1	118	18		1.95	1.63	(18)	OCC	2386	26600
B05 F-	Max P						(3a)	HOOP	3350	20000
	GR + Max P	73	4		1.95	1.63	(18)	SUST	2051	20000
	Cold to T1	119	9	24	1.95	1.63	(17)	DISP	874	30000
	Sus. + R1	97	11		1.95	1.63	(18)	OCC	2228	26600
B05 F+	Max P						(3a)	HOOP	3350	20000
	GR + Max P	73	4		1.00	1.00	(18)	SUST	1792	20000
	Cold to T1	119	9	24	1.00	1.00	(17)	DISP	454	30000
	Sus. + R1	97	11		1.00	1.00	(18)	OCC	1884	26600
B06 N-	Max P						(3a)	HOOP	3350	20000
	GR + Max P	32	3		1.00	1.00	(18)	SUST	1640	20000
	Cold to T1	134	13	24	1.00	1.00	(17)	DISP	511	30000
	Sus. + R1	46	4		1.00	1.00	(18)	OCC	1693	26600
B06 N+	Max P						(3a)	HOOP	3350	20000
	GR + Max P	32	3		2.56	2.13	(18)	SUST	1827	20000
	Cold to T1	134	13	24	2.56	2.13	(17)	DISP	1289	30000
	Sus. + R1	46	4		2.56	2.13	(18)	OCC	1964	26600

		ASME B31.3c (1992) (Moments in ft.-lb)			CODE COMPLIANCE			(Stress in psi)	
Point name	Load combination	In-Pl. Moment	Out-Pl. Moment	Torsion Moment	S.I.F In	S.I.F Out	Eq. Load no. type	Code Stress	Code Allow.
B06 M	Max P						(3a) HOOP	3350	20000
	GR + Max P	23	8		2.56	2.13	(18) SUST	1747	20000
	Cold to T1	245	4	31	2.56	2.13	(17) DISP	2343	30000
	Sus. + R1	37	22		2.56	2.13	(18) OCC	1921	26600
B06 F-	Max P						(3a) HOOP	3350	20000
	GR + Max P	40	9		2.56	2.13	(18) SUST	1905	20000
	Cold to T1	272	8	29	2.56	2.13	(17) DISP	2604	30000
	Sus. + R1	57	28		2.56	2.13	(18) OCC	2125	26600
B06 F+	Max P						(3a) HOOP	3350	20000
	GR + Max P	40	9		1.00	1.00	(18) SUST	1671	20000
	Cold to T1	272	8	29	1.00	1.00	(17) DISP	1023	30000
	Sus. + R1	57	28		1.00	1.00	(18) OCC	1765	26600
B07	Max P						(3a) HOOP	3350	20000
	GR + Max P	41	9		1.00	1.00	(18) SUST	1676	20000
	Cold to T1	271	8	29	1.00	1.00	(17) DISP	1018	30000
	Sus. + R1	58	28		1.00	1.00	(18) OCC	1772	26600
B08	Max P						(3a) HOOP	3350	20000
	GR + Max P	50	9		1.00	1.00	(18) SUST	1707	20000
	Cold to T1	266	5	29	1.00	1.00	(17) DISP	1000	30000
	Sus. + R1	68	28		1.00	1.00	(18) OCC	1806	26600
B09	Max P						(3a) HOOP	3350	20000
	GR + Max P	114	8		1.00	1.00	(18) SUST	1947	20000
	Cold to T1	239	7	29	1.00	1.00	(17) DISP	901	30000
	Sus. + R1	142	35		1.00	1.00	(18) OCC	2091	26600

*** Segment B end ***

HNF-2479, Rev. 0
Page D-33

SYSTEM SUMMARY

Maximum displacements (in)

Maximum X :	0.038	Point : A04 F	Load Comb.: TOTAL
Maximum Y :	0.100	Point : A12 M	Load Comb.: TOTAL
Maximum Z :	0.045	Point : B05 N	Load Comb.: TOTAL
Max. total:	0.109	Point : A12 M	Load Comb.: TOTAL

Maximum rotations (deg)

Maximum X :	0.208	Point : B05 F	Load Comb.: TOTAL
Maximum Y :	-0.137	Point : A12 N	Load Comb.: T1
Maximum Z :	0.129	Point : A06	Load Comb.: TOTAL
Max. total:	0.244	Point : B05 F	Load Comb.: TOTAL

Maximum restraint forces(lb)

Maximum X :	89	Point : B09	Load Comb.: TOTAL
Maximum Y :	289	Point : A00	Load Comb.: TOTAL
Maximum Z :	510	Point : B09	Load Comb.: T1
Max. total:	529	Point : B09	Load Comb.: TOTAL

Maximum restraint moments(ft-lb)

Maximum X :	381	Point : B09	Load Comb.: TOTAL
Maximum Y :	42	Point : B09	Load Comb.: TOTAL
Maximum Z :	258	Point : A00	Load Comb.: TOTAL
Max. total:	386	Point : B09	Load Comb.: TOTAL

SYSTEM SUMMARY

Maximum pipe forces (lb)

Maximum X :	89	Point : B08	Load Comb.: TOTAL
Maximum Y :	289	Point : A00	Load Comb.: TOTAL
Maximum Z :	510	Point : A10	Load Comb.: T1
Max. total:	528	Point : B09	Load Comb.: TOTAL

Maximum pipe moments (ft-lb)

Maximum X :	381	Point : B09	Load Comb.: TOTAL
Maximum Y :	282	Point : A10	Load Comb.: T1
Maximum Z :	258	Point : A00	Load Comb.: TOTAL
Max. total:	386	Point : B09	Load Comb.: TOTAL

SYSTEM SUMMARY

Maximum sustained stress

Point : A12 F
Stress psi : 4269
Allowable psi : 20000
Ratio : 0.21
Load combination : GR + Max P

Maximum displacement stress

Point : A12 F
Stress psi : 7662
Allowable psi : 30000
Ratio : 0.26
Load combination : Cold to T1

Maximum occasional stress

Point : A12 F
Stress psi : 5696
Allowable psi : 26600
Ratio : 0.21
Load combination : Sus. + R1

Maximum hoop stress

Point : A00
Stress psi : 3350
Allowable psi : 20000
Ratio : 0.17
Load combination : Max P

Maximum sustained stress ratio

Point : A12 F
Stress psi : 4269
Allowable psi : 20000
Ratio : 0.21
Load combination : GR + Max P

Maximum displacement stress ratio

Point : A12 F
Stress psi : 7662
Allowable psi : 30000
Ratio : 0.26
Load combination : Cold to T1

SYSTEM SUMMARY

Maximum occasional stress ratio

Point : A12 F
Stress psi : 5696
Allowable psi : 26600
Ratio : 0.21
Load combination : Sus. + R1

Maximum hoop stress ratio

Point : A00
Stress psi : 3350
Allowable psi : 20000
Ratio : 0.17
Load combination : Max P

*** The system satisfies ASME B31.3 code requirements ***
*** for the selected options ***

System Model Results

A system model was developed to determine stresses in all structural components except the block from the non-axial external piping loads. These structural components include the block top region under the screw bearing point. Only the 50 lbf-ft pre-load torque was considered. Acceptable load components of the piping external forces and moments are factored into Table 3.4. In all cases, except for the axial force, the acceptable levels are limited by the strength of the hook eyes under the condition of tight clearances between the pin and hook which transmits lateral hook moments to the pin. Further discussion is provided in Section 5.5.5, and suggestions for further work that could increase the allowable loads is given in Section 6.1.

The system model also provides stiffnesses, given in Table 3.5, for the connector assemblies under the external piping load components. They could be used by the piping analyst to calculate spring stiffnesses for the piping model to provide relief in the calculation of actual reactions. It is recommended that the piping model have a rigid link from the piping attachment point to the center of the spherical block-nozzle interface, and that the stiffnesses be used at this point. In this case, the lateral stiffnesses K_{uy} and K_{uz} may be taken as rigid.

Acceptable External Piping Loads

Actual axial piping forces (with respect to the connector) should be checked against limits in Tables 3.3 and 3.4 for unseating and seating limits, respectively. Any combination of the remaining five components of loading is acceptable if the absolute sum of ratios of the applied force/moment components of shear, torsion and bending to the limit values of Table 3.4, is less than unity. The two components of shear force or bending moment should be combined with a circular interaction rule by forming the square root of the sum of the squares.

Acceptable loads of Table 3.4 do not reflect the 1/3 increase in allowable stresses permitted in Section 1.5.6 of (AISC, 1989) for wind and seismic loads. Thus, jumper piping analysis reactions based on seismic loading could be compared with values of Table 3.4 increased by 1/3 provided that analysis reactions based on the non-seismic loadings compare favorably with the table as shown.

An example is provided by the worst case in a preliminary study of MWTF jumper piping provided in Appendix F. At pressure and temperature and with forces referenced to the intersection of the pipe and block centerlines, the piping analysis force and moment components are:

$f_x = -114 \text{ lbf}$ $f_y = 419 \text{ lbf}$ $f_z = 237 \text{ lbf}$
 $m_x = -7 \text{ ft-lbf}$ $m_y = -58 \text{ ft-lbf}$ $m_z = 173 \text{ ft-lbf}$
 Connector size = 2 in.
 Pre-load torque = 50 ft-lbf.
 Temperature = 250 °F

Figure 1 provides the coordinate system for interpretation of the components. Then the axial force is checked as follows:

Seating: $f_x = -114 \text{ lbf}$, $F_x = 7,370 \text{ lbf}$ (Table 3.4), $-f_x < F_x$, OK
 Unseat: $f_x < 0$, no check necessary.

The interaction of shear, torsion and bending is formed by comparing the applied values with the limits of Table 3.4 and summing:

$$\text{Shear: } f_{yz} = \sqrt{f_y^2 + f_z^2} = \sqrt{419^2 + 237^2} = 482 \text{ ft-lbf}$$

$$\text{Torsion: } |m_x| = 7 \text{ ft-lbf}$$

$$\text{Bending: } m_{yz} = \sqrt{m_y^2 + m_z^2} = \sqrt{58^2 + 173^2} = 182 \text{ ft-lbf}$$

$$I = f_{yz}/F_{yz} + |m_x|/M_x + m_{yz}/M_{yz} = 482/1330 + 7/260 + 182/365 = 0.90 \text{ OK}$$

Note that the unseating axial force limit is dependent on pre-load, pressure and temperature. For example, if the axial load is positive, it tends to unseat the block. At 4,000 lbf in a cold condition with a 2-in. connector, Table 3.3 shows a 3,390 lbf limit indicating that the condition is unacceptable. Such axial forces are unlikely under piping thermal expansion environments at temperature. Axial piping forces which tend to increase the seating force need not be checked against Table 3.3. All axial forces are to be checked against the limits of Table 3.4.

Table 3.1. Nominal System Model Piping Reaction Loads.

Connector Size	F _x (lbf)	F _y (lbf)	F _z (lbf)	M _x (ft-lbf)	M _y (ft-lbf)	M _z (ft-lbf)
2-in.	2,300	1,000	400	1,600	1,600	2,000
3-in.	15,000	2,000	2,000	7,000	7,000	4,000
4-in.	27,000	3,000	3,000	13,000	13,000	7,000

Table 3.2. Axial Load Capacities of the Supporting Components (One Hook).

Component	Material	2 in. (lbf)	3 in. (lbf)	4 in. (lbf)	Remarks
Hook	ASTM A 747 Grade CB7Cu-1 or CB7Cu-2, H1075 Ht. Tr.	5,943	8,750	12,717	See App. A
Hook Pin	As required by Table 4.1	14,420	24,930	35,400	See App. C
Operating Nut	ASTM A 148	9,705	14,669	27,580	See App. A
Operating Screw	ASTM A 193 Grade B7 C.S.	19,442	37,895	53,149	See App. A

WHC-SD-W236A-DA-002
Rev. 0Table 3.3. Seating Forces for Various Pre-loads ¹.

Connector Size	Torque (ft-lbf)	Cold (lbf)	Hot ² (lbf)
2-in.	50	3,390	9,160
	180	15,200	21,000
3-in.	50	-1,920	6,210
	490	20,600	28,700
4-in.	50	-4,310	6,310
	230	2,560	13,700

1. Internal pressure = 400 psi. Cold springing effects are not included.
2. Hot condition temperature = 250 °F

Table 3.4. Standard Connector Acceptable Piping Loads¹

Connector Size	Axial Force F _x ² (lbf)	Shear F _{yz} ⁴ (lbf)	Torsion M _x (ft-lbf)	Bending M _{yz} (ft-lbf)
2-in.	7,370 ^{3,6}	1,330 ⁵	260	365 ⁵
3-in.	38,100 ^{3,7}	1,540	410	630
4-in.	42,100 ^{3,7}	2,220	780	1,170

1. Design pressure = 400 psi, temperature = 250 °F, pre-load torque = 50 ft-lbf. Acceptable loads do not reflect the 1/3 increase in allowable stresses permitted in Section 1.5.6 of (AISC, 1989) for wind and seismic loads.
2. To be limited by forces that would unseat the block nozzle interface per Table 3.3.
3. Limited by block analysis at the same design parameters.
4. Referenced to intersection of piping and connector centerlines.
5. Reduce by 25% for 304L/316L nozzle material.
6. Reduce by 35% for 304L/316L block material.
7. Reduce by 25% for 304L/316L block material.

Table 3.5. Connector Stiffnesses to Piping Reaction Loads (Standard Configuration).

Connector size ⁴	Kux ^{1,2} , lbf/in	Kuy ³ , lbf/in	Kuz ³ , lbf/in	Krotx, lbf-in/rad	Kroty, lbf-in/rad	Krotz, lbf-in/rad
2-in.	1.35e+7	2.78e+4	2.78e+4	7.38e+4	4.53e+5	4.53e+5
3-in.	1.90e+7	2.47e+4	2.47e+4	1.02e+5	9.16e+5	9.16e+5
4-in.	2.33e+7	2.52e+4	2.52e+4	2.09e+5	1.43e+6	1.43e+6

1. See ANSYS (1992) for notation. See Figure 1 for the coordinate system.
2. Applicable only for a positive seating force.
3. Kuy and Kuz should be taken as rigid provided that the piping model runs a rigid link from the pipe-block interface to the center of the spherical seating surface. This is the preferred modeling method.
4. Connector stiffnesses shown relate to flexibility between the pipe attachment and nozzle flange area. They do not account for the straight pipe flexibility from the nozzle flange area to the concrete or other anchor point. Applicable pre-load torque is 50 ft-lbf.

Conditions of Design

Since the hook-nozzle load application point was taken at the center of the flange overhang, validity of the analysis requires that a substantial majority, say 80%, of the maximum possible hook-flange contact area be achieved.

Connector Boundaries

Validity of the analysis herein extends from the pipe opening of the block to the flange of the nozzle. The applicable region of the analysis does not include the pipe and the weld attachment at the opening or the non-standard pipe between the nozzle flange and kick-plate or concrete embedment.

3.2 THREE-WAY CONFIGURATION

Acceptable Piping Reactions

As in the standard connector, acceptable piping reactions have been determined only for a pre-load torque of 50 lbf-ft.

Limits are placed on net piping loads to the block in order to guard against lift-off of the block from an insert. Such lift-off is characterized by pivoting of the block about the other two inserts or by sliding up an inclined plane. Net incoming piping moments and forces are limited by the equation

$$\frac{F_x \cdot M_T / R}{F_{alim} - F_x} + \frac{M_o}{M_{alim} - F_x R / 2} < 1$$

8.0 DESIGN DATA

8.1 PUREX Connector

ELECTRICAL CONNECTOR

PROCESS CONNECTOR

Size	Type	A	B	C	D	E	F	Weight (lbs.)	Drawing No.	Weight (lbs.)	Drawing No.	Vertical
1	1 x 1	1-7/8	1-23/32	2-1/2	2-1/2	2-1/2	2-1/2	15.5	H-2-32410-1	15.5	H-2-32410-3	16.5
1	Blank	1-7/8	1-23/32	2-1/2	2-1/2	2-1/2	2-1/2	15.5	H-2-32410-1	15.5	H-2-32410-3	16.5
2	2 x 2	2-1/4	2-7/16	3-3/8	3-5/8	1-1/8	29	H-2-32420-1	29	H-2-32420-1	29	H-2-32420-2
2	2 x 1 1/2 Dip Tube	2-7/16	2-7/16	3-3/8	3-5/8	29	H-2-32420-5	29	H-2-32420-5	29	H-2-32420-5	29
2	3 Way 3 1/2	2-9/32	2-9/32	3-3/8	3-5/8	1-1/8	31.5	H-2-32427-1	31.5	H-2-32427-1	31.5	H-2-32427-1
2	Rejection	2-1/4	2-7/8	3-3/8	3-5/8	1-1/8	31.5	H-2-32427-1	31.5	H-2-32427-1	31.5	H-2-32427-1
2	Thermowell	2-1/4	2-7/8	3-3/8	3-5/8	1-1/8	31.5	H-2-32427-1	31.5	H-2-32427-1	31.5	H-2-32427-1
3	3 x 3	3	3	3	3	3	3	3	H-2-32430-1	3	H-2-32430-1	3
3	3 x 2 Dip Tube	3	3	3	3	3	3	3	H-2-32430-1	3	H-2-32430-1	3
3	2 x 3	3	3	3	3	3	3	3	H-2-32430-1	3	H-2-32430-1	3
3	2 x 2 Dip Tube	3	3	3	3	3	3	3	H-2-32430-1	3	H-2-32430-1	3
3	3 Way 3 1/2	3	3	3	3	3	3	3	H-2-32430-1	3	H-2-32430-1	3
3	Thermowell	3	3	3	3	3	3	3	H-2-32430-1	3	H-2-32430-1	3
3	Blank	3	3	3	3	3	3	3	H-2-32430-1	3	H-2-32430-1	3
4	4 x 4	4-5/32	4-5/32	5-3/8	5-3/8	1-11/16	120	H-2-32440-1	120	H-2-32440-1	120	H-2-32440-2
4	4 x 3 Dip Tube	4-5/32	4-5/32	5-3/8	5-3/8	1-11/16	120	H-2-32440-1	120	H-2-32440-1	120	H-2-32440-2
4	3 x 3 Dip Tube	4-5/32	4-5/32	5-3/8	5-3/8	1-11/16	120	H-2-32440-1	120	H-2-32440-1	120	H-2-32440-2
4	3 x 3 Dip Tube	4-5/32	4-5/32	5-3/8	5-3/8	1-11/16	120	H-2-32440-1	120	H-2-32440-1	120	H-2-32440-2
4	2 x 2 Dip Tube	4-5/32	4-5/32	5-3/8	5-3/8	1-11/16	120	H-2-32440-1	120	H-2-32440-1	120	H-2-32440-2
4	Blank	4-5/32	4-5/32	5-3/8	5-3/8	1-11/16	120	H-2-32440-1	120	H-2-32440-1	120	H-2-32440-2
5	5 x 5	5-11/16	5-11/16	6-3/8	6-3/8	1-11/16	150	H-2-32450-1	150	H-2-32450-1	150	H-2-32450-2
5	5 x 4	5-11/16	5-11/16	6-3/8	6-3/8	1-11/16	150	H-2-32450-1	150	H-2-32450-1	150	H-2-32450-2
5	5 x 3	5-11/16	5-11/16	6-3/8	6-3/8	1-11/16	150	H-2-32450-1	150	H-2-32450-1	150	H-2-32450-2
5	5 x 2	5-11/16	5-11/16	6-3/8	6-3/8	1-11/16	150	H-2-32450-1	150	H-2-32450-1	150	H-2-32450-2
5	5 x 1	5-11/16	5-11/16	6-3/8	6-3/8	1-11/16	150	H-2-32450-1	150	H-2-32450-1	150	H-2-32450-2
5	Blank	5-11/16	5-11/16	6-3/8	6-3/8	1-11/16	150	H-2-32450-1	150	H-2-32450-1	150	H-2-32450-2
6	6 x 6	6-11/16	6-11/16	7-3/8	7-3/8	1-11/16	175	H-2-32460-1	175	H-2-32460-1	175	H-2-32460-2
6	6 x 5	6-11/16	6-11/16	7-3/8	7-3/8	1-11/16	175	H-2-32460-1	175	H-2-32460-1	175	H-2-32460-2
6	6 x 4	6-11/16	6-11/16	7-3/8	7-3/8	1-11/16	175	H-2-32460-1	175	H-2-32460-1	175	H-2-32460-2
6	6 x 3	6-11/16	6-11/16	7-3/8	7-3/8	1-11/16	175	H-2-32460-1	175	H-2-32460-1	175	H-2-32460-2
6	6 x 2	6-11/16	6-11/16	7-3/8	7-3/8	1-11/16	175	H-2-32460-1	175	H-2-32460-1	175	H-2-32460-2
6	6 x 1	6-11/16	6-11/16	7-3/8	7-3/8	1-11/16	175	H-2-32460-1	175	H-2-32460-1	175	H-2-32460-2
6	Blank	6-11/16	6-11/16	7-3/8	7-3/8	1-11/16	175	H-2-32460-1	175	H-2-32460-1	175	H-2-32460-2
7	7 x 7	7-11/16	7-11/16	8-3/8	8-3/8	1-11/16	200	H-2-32470-1	200	H-2-32470-1	200	H-2-32470-2
7	7 x 6	7-11/16	7-11/16	8-3/8	8-3/8	1-11/16	200	H-2-32470-1	200	H-2-32470-1	200	H-2-32470-2
7	7 x 5	7-11/16	7-11/16	8-3/8	8-3/8	1-11/16	200	H-2-32470-1	200	H-2-32470-1	200	H-2-32470-2
7	7 x 4	7-11/16	7-11/16	8-3/8	8-3/8	1-11/16	200	H-2-32470-1	200	H-2-32470-1	200	H-2-32470-2
7	7 x 3	7-11/16	7-11/16	8-3/8	8-3/8	1-11/16	200	H-2-32470-1	200	H-2-32470-1	200	H-2-32470-2
7	7 x 2	7-11/16	7-11/16	8-3/8	8-3/8	1-11/16	200	H-2-32470-1	200	H-2-32470-1	200	H-2-32470-2
7	7 x 1	7-11/16	7-11/16	8-3/8	8-3/8	1-11/16	200	H-2-32470-1	200	H-2-32470-1	200	H-2-32470-2
7	Blank	7-11/16	7-11/16	8-3/8	8-3/8	1-11/16	200	H-2-32470-1	200	H-2-32470-1	200	H-2-32470-2
8	8 x 8	8-11/16	8-11/16	9-3/8	9-3/8	1-11/16	225	H-2-32480-1	225	H-2-32480-1	225	H-2-32480-2
8	8 x 7	8-11/16	8-11/16	9-3/8	9-3/8	1-11/16	225	H-2-32480-1	225	H-2-32480-1	225	H-2-32480-2
8	8 x 6	8-11/16	8-11/16	9-3/8	9-3/8	1-11/16	225	H-2-32480-1	225	H-2-32480-1	225	H-2-32480-2
8	8 x 5	8-11/16	8-11/16	9-3/8	9-3/8	1-11/16	225	H-2-32480-1	225	H-2-32480-1	225	H-2-32480-2
8	8 x 4	8-11/16	8-11/16	9-3/8	9-3/8	1-11/16	225	H-2-32480-1	225	H-2-32480-1	225	H-2-32480-2
8	8 x 3	8-11/16	8-11/16	9-3/8	9-3/8	1-11/16	225	H-2-32480-1	225	H-2-32480-1	225	H-2-32480-2
8	8 x 2	8-11/16	8-11/16	9-3/8	9-3/8	1-11/16	225	H-2-32480-1	225	H-2-32480-1	225	H-2-32480-2
8	8 x 1	8-11/16	8-11/16	9-3/8	9-3/8	1-11/16	225	H-2-32480-1	225	H-2-32480-1	225	H-2-32480-2
8	Blank	8-11/16	8-11/16	9-3/8	9-3/8	1-11/16	225	H-2-32480-1	225	H-2-32480-1	225	H-2-32480-2
9	9 x 9	9-11/16	9-11/16	10-3/8	10-3/8	1-11/16	250	H-2-32490-1	250	H-2-32490-1	250	H-2-32490-2
9	9 x 8	9-11/16	9-11/16	10-3/8	10-3/8	1-11/16	250	H-2-32490-1	250	H-2-32490-1	250	H-2-32490-2
9	9 x 7	9-11/16	9-11/16	10-3/8	10-3/8	1-11/16	250	H-2-32490-1	250	H-2-32490-1	250	H-2-32490-2
9	9 x 6	9-11/16	9-11/16	10-3/8	10-3/8	1-11/16	250	H-2-32490-1	250	H-2-32490-1	250	H-2-32490-2
9	9 x 5	9-11/16	9-11/16	10-3/8	10-3/8	1-11/16	250	H-2-32490-1	250	H-2-32490-1	250	H-2-32490-2
9	9 x 4	9-11/16	9-11/16	10-3/8	10-3/8	1-11/16	250	H-2-32490-1	250	H-2-32490-1	250	H-2-32490-2
9	9 x 3	9-11/16	9-11/16	10-3/8	10-3/8	1-11/16	250	H-2-32490-1	250	H-2-32490-1	250	H-2-32490-2
9	9 x 2	9-11/16	9-11/16	10-3/8	10-3/8	1-11/16	250	H-2-32490-1	250	H-2-32490-1	250	H-2-32490-2
9	9 x 1	9-11/16	9-11/16	10-3/8	10-3/8	1-11/16	250	H-2-32490-1	250	H-2-32490-1	250	H-2-32490-2
9	Blank	9-11/16	9-11/16	10-3/8	10-3/8	1-11/16	250	H-2-32490-1	250	H-2-32490-1	250	H-2-32490-2
10	10 x 10	10-11/16	10-11/16	11-3/8	11-3/8	1-11/16	275	H-2-32500-1	275	H-2-32500-1	275	H-2-32500-2
10	10 x 9	10-11/16	10-11/16	11-3/8	11-3/8	1-11/16	275	H-2-32500-1	275	H-2-32500-1	275	H-2-32500-2
10	10 x 8	10-11/16	10-11/16	11-3/8	11-3/8	1-11/16	275	H-2-32500-1	275	H-2-32500-1	275	H-2-32500-2
10	10 x 7	10-11/16	10-11/16	11-3/8	11-3/8	1-11/16	275	H-2-32500-1	275	H-2-32500-1	275	H-2-32500-2
10	10 x 6	10-11/16	10-11/16	11-3/8	11-3/8	1-11/16	275	H-2-32500-1	275	H-2-32500-1	275	H-2-32500-2
10	10 x 5	10-11/16	10-11/16	11-3/8	11-3/8	1-11/16	275	H-2-32500-1	275	H-2-32500-1	275	H-2-32500-2
10	10 x 4	10-11/16	10-11/16	11-3/8	11-3/8	1-11/16	275	H-2-32500-1	275	H-2-32500-1	275	H-2-32500-2
10	10 x 3	10-11/16	10-11/16	11-3/8	11-3/8	1-11/16	275	H-2-32500-1	275	H-2-32500-1	275	H-2-32500-2
10	10 x 2	10-11/16	10-11/16	11-3/8	11-3/8	1-11/16	275	H-2-32500-1	275	H-2-32500-1	275	H-2-32500-2
10	10 x 1	10-11/16	10-11/16	11-3/8	11-3/8	1-11/16	275	H-2-32500-1	275	H-2-32500-1	275	H-2-32500-2
10	Blank	10-11/16	10-11/16	11-3/8	11-3/8	1-11/16	275	H-2-32500-1	275	H-2-32500-1	275	H-2-32500-2

* Establish Weight from Drawing

1.0 INTRODUCTION

This analysis determines the capacities of the lifting bails shown in Drawing H-2-90161, Revision 1. The drawing details six different assemblies of bails in two groups. The grouping is based on materials. Three of the six bails are of carbon steel (CS); the material for the other three is stainless steel (SST). The bails vary in geometry within the group. In addition, this drawing also includes two assemblies of bails by an Engineering Change Notice #117198 (ECN), Reference 8 and Appendix K. All bails are required to withstand the loads of support assemblies, equipment, or other attached loads. This analysis does not evaluate the supporting assemblies.

2.0 DISCUSSION

The lifting bails as designed are considered to be "below-the-hook" items and are associated with critical lifts, in accordance with the Hanford Hoisting and Rigging Manual (Reference 1). The allowable loads, therefore, have a factor of safety of 3 based on the yield strength and 5 based on the ultimate strength. The ANSYS computer program was used to perform the structural analysis of the lifting bails and to determine their capacities. The lifted item may lie in the vertical plane or in the horizontal plane; therefore, it is necessary to determine the capacities of the bails in vertical and horizontal (lateral) lifts.

Two load options for the vertical lift were used. These options are based on the varied locations of the attachment of the flat bar of the lifting bail to the supporting assembly to be lifted. For a standard lifting bail, this attachment is considered to be within the bail. When the attachment falls beyond the bail, further analysis will be required.

Two sets of ANSYS analyses were performed for each of the Assemblies 1, 3, 5, 15, and 16. Assemblies 2, 4, and 6 are identical to Assemblies 1, 3, and 5, respectively, except for material. Hence, the capacities of Assemblies 2, 4, and 6 were determined by linear interpolation of the capacities of Assemblies 1, 3, and 5.

The weld between the bail and the flat bar has been modified to satisfy the minimum size requirement (Reference 6, Table 7.2). The capacities of the bails were determined by using the critical stress in the bail (rod), flat bar, or weld connections. The calculations indicated that the stress in the bail (rod) dictated the capacity of the bails.

3.0 SUMMARY OF RESULTS

The capacities of the lifting bails are shown in the table below.

TABLE 1

DRAWING H-2-90161, REVISION 1

Lifting Bail Assembly Number	Material	CAPACITY, LBS.	
		Vertical Lift	Lateral Lift
1	CS	410	70
2	SST	295	50
3	CS	390	56
4	SST	280	40
5	CS	475	68
6	SST	340	49
15	CS	795	125
16	CS	1490	260

CS = Carbon steel
SST = Stainless steel

4.0 CONCLUSIONS

The lifting bails as detailed in drawing H-2-90161, Revision 1, are identified with their respective capacities in Table 1, above. The calculations are shown in Appendices A and J. All pertinent ANSYS runs are shown in Appendices B through I.

The capacities of the bails, as shown in Table 1, shall be compared to the reactions at the bails. The reaction varies with the location of the bail and the center of gravity of the supporting assembly. The users of standard bails should determine the center of gravity of the supporting assembly and the lifting bail reaction. These data should be used to select an appropriate lifting bail assembly, as shown in Table 1.

- (1) Drawing H-2-90161 (2) Doc. No. _____ (3) Page 10 of 11 52
 (4) Building 200 Area (Gen.) (5) Rev. _____ (6) Job No. _____
 (7) Subject Lifting Rail Capacity
 (8) Originator M. A. ISLAM Date 12.12.89
 (9) Checker T. C. Maskey Date 7/6/90

(10)

HNF-2479, Rev. 0
Page D-44

TYP. BAIL ELEV.

See
REF. 7Dwg. H-2-
90161 Rev 1
and
ECN 117198

Dimension..	Assembly No.				
	1 & 2*	3 & 4*	5 & 6*	15	16
d	5/8"	5/8"	3/4"	7/8"	1 1/4"
A	1 1/2"	1 1/2"	2"	1 3/4"	2 1/2"
B	8"	10"	14"	10"	14"
C	5"	5"	7"	6"	8 1/4"

* 2, 4, 6 SST; 1, 3, 5, 15 & 16 CS (Carbon Steel)
(stainless steel)

(1) Drawing H-2-90161 (2) Doc. No. _____ (3) Page 12 of 152
 (4) Building 200 Area (Gen.) (5) Rev. _____ (6) Job No. _____
 (7) Subject Lifting Bail Capacity
 (8) Originator M. A. ISLAM Date 12.12.89
 (9) Checker T. C. Masheer Date 7/6/90

(10)

Allowable StressesHNF-2479, Rev. 0
Page D-45Impact Level IIbail & Plate, allowable bending stress, σ_b

$$\sigma_b = \frac{1}{3} (\text{Yield}) \text{ or } \frac{1}{3} (\text{Ultimate})$$

REF.
1Carbon Steel (CS)

REF. 3

Yield stress, $F_y = 36000$ Psi for A36 steelUltimate stress, $F_u = 58000$ Psi

$$\therefore \sigma_b = \frac{1}{3} \times 36000 = 12000 \text{ Psi}$$

$$\text{or } = \frac{1}{3} \times 58000 = 11600 \text{ Psi}$$

$$\text{Use } \underline{\sigma_b = 11600 \text{ Psi}}$$

Stainless Steel (SST)

REF 5

Type 304 $\frac{1}{2}$, $F_y = 25000$ Psi, $F_u = 70000$ Psi

$$\sigma_b = \frac{1}{3} \times 25000 = 8333 \text{ Psi} = 10,000$$

$$\text{or } = \frac{1}{3} \times 70000 = 14000 \text{ Psi}$$

$$\text{Use } \underline{\sigma_b = 8333 \text{ Psi}}$$

Allowable stress in Weld

REF 3

shear Capacity = $(\frac{2}{3})$ (Tension Capacity)

$$\therefore f_w = (\frac{2}{3}) (11600) (w)^{\text{size of weld}} = 7733 (w) \frac{\#}{\text{in}} (\text{CS})$$

$$f_w = (\frac{2}{3}) (8333) (w) = 5555 (w) \frac{\#}{\text{in}} (\text{SST})$$

Table 4—Sign Convention for Stresses Resulting from Radial and Moment Loading on a Cylindrical Shell

STRESS	LOCATION	LOADING		
		P	M_x	M_y
Membrane $\frac{P}{t} \pm \frac{M}{R}$	Au, AL	—	—	—
	Av, AL	—	—	—
	Cu, CL	—	—	—
	Cv, CL	—	—	—
Bending $\frac{M}{tR} \pm \frac{P}{2t}$	Au, AL	+	+	+
	Av, AL	+	+	+
	Cu, CL	+	+	+
	Cv, CL	+	+	+
Bending $\frac{M}{tR} \pm \frac{P}{2t}$	Au, AL	+	+	+
	Av, AL	+	+	+
	Cu, CL	+	+	+
	Cv, CL	+	+	+

NOTE: 1. Sign convention for stresses: — tension, — compression.
2. Based on membrane deformation, bending, and loading in the direction of the shell axis.

tensile bending stresses result at A and C on the inside of the vessel, and B and D on the outside of the vessel. Similarly, compressive bending stresses result at A and C on the outside and B and D on the inside.

In this manner Table 4 has been developed to show the signs of stresses resulting from various external loading conditions. These stresses are located in the vessel wall at its juncture with the attachment. Use of Table 4 permits one to use the nondimensional curves presented in the following procedure with a minimum of encumbrance and concern for sign convention.

The numerous stress components can be readily accounted for if a scheme similar to that shown in Table 5 is adopted. In using this scheme it is to be noted that the Maximum Shear Theory has been used to determine equivalent stress intensities. Also it is to be noted that evaluation of stresses resulting from internal pressure has been omitted.

Test work conducted by PVRC has shown that stresses attenuate rapidly at points removed from the attachment-to-shell juncture, the maximum stress usually being located at the juncture. However, in the general case of arbitrary loading, one has no assurance that the absolute maximum stress intensity will be located at one of the eight points considered in the above discussion. The maximum stress intensity could be located at some intermediate point around the juncture under an arbitrary load, or under a longitudinal moment with the circumstances outlined in para. 4.4 and

Appendix A.

4.2 Parameters

The results of Bijlaard's work have been plotted in terms of nondimensional geometric parameters by use of an electronic computer. Hence, the first step in this procedure is to evaluate the applicable geometric parameters γ and β .

4.2.1 SHELL PARAMETER (γ). The shell parameter is given by the ratio of the shell mid-radius to shell thickness thus:

$$\gamma = R_m / T$$

4.2.2 ATTACHMENT PARAMETER (β). For cylindrical shells, either round or rectangular attachments may be considered in the following manner:

4.2.2.1 Round Attachment: For a round attachment the parameter β is evaluated using the expression:

$$\beta = \frac{0.875 r_n}{R_m}$$

4.2.2.2 Square Attachment: For a square attachment the parameter is evaluated by:

$$\beta = \beta_1 = \beta_2 = \frac{c_1}{R_m} = \frac{c_2}{R_m}$$

4.2.2.3 Rectangular Attachment Subject to Radial Load (P): For this case β is evaluated as follows:

$$\beta_1 = \frac{c_1}{R_m} \quad \beta_2 = \frac{c_2}{R_m}$$

If $\beta_1 > 1$, $\beta =$

$$\left[1 - \frac{1}{3} \left(\frac{\beta_1}{\beta_2} - 1 \right) (1 - K_1) \right] \sqrt{\beta_1 \beta_2}$$

If $\beta_1 < 1$, $\beta =$

$$\left[1 - \frac{4}{3} \left(1 - \frac{\beta_1}{\beta_2} \right) (1 - K_2) \right] \sqrt{\beta_1 \beta_2}$$

where K values are obtained from Table 6.

4.2.2.4 Rectangular Attachment Subject to Circumferential Moment (M_c):

4.2.2.4.1: When considering membrane forces (N): $\beta = \sqrt{\beta_1 \beta_2}$. Then multiply values of N (M_c / R_m) so determined by C , from Table 7 (see para. 4.3).

4.2.2.4.2: When considering bending moment (M): $\beta = K \sqrt{\beta_1 \beta_2}$, where K , is given in Table 7.

4.2.2.5 Rectangular Attachment Subject to Longitudinal Moment (M_L):

4.2.2.5.1: When considering membrane forces (N): $\beta = \sqrt{\beta_1 \beta_2}$. Then multiply values of

Table 6—Radial Load (P)

	N_s	N_z	M_s	M_z
K_1	0.91	1.68	1.76	1.2
K_2	1.48	1.2	0.83	1.25

NOTE: Above holds approximately within limits $4 \geq \beta_1/\beta_2 \geq 1/4$.

calculated in para. 4.2, enter Fig. 3C or 4C and read off the dimensionless membrane force $[N_{oi}/P/R_n]$.

Step 2. By the same procedure used in Step 1, enter Fig. 1C or 2C-1 and find the dimensionless bending moment $[M_o/P]$.

Step 3. Using applicable values of P , R_n , and T , find the circumferential membrane stress (N_o/T) by:

$$\frac{N_o}{T} = \left[\frac{N_o}{P/R_n} \right] \cdot \left[\frac{P}{R_n T} \right]$$

Step 4. By a procedure similar to that used in Step 3, find the circumferential bending stress $(6M_o/T^2)$ thus:

$$\frac{6M_o}{T^2} = \left[\frac{M_o}{P} \right] \cdot \left[\frac{6P}{T^2} \right]$$

Step 5. Combine the circumferential membrane and bending stresses by use of the general stress

equation (Section 2), together with the proper choice of sign (Table 4); i.e.:

$$\sigma_o = K_s \frac{N_o}{T} \pm K_b \frac{6M_o}{T^2}$$

4.3.1.2 *Longitudinal Stresses (σ_z)*: Follow the 5 steps outlined in 4.3.1.1 except that $[N_z/P/R_n]$ is obtained using Fig. 3C or 4C; and $[M_z/P]$, using Fig. 1C-1 or 2C. It follows that:

$$\frac{N_z}{T} = \left[\frac{N_z}{P/R_n} \right] \cdot \left[\frac{P}{R_n T} \right]$$

$$\frac{6M_z}{T^2} = \left[\frac{M_z}{P} \right] \cdot \left[\frac{6P}{T^2} \right] \text{ and}$$

$$\sigma_z = K_s \frac{N_z}{T} \pm K_b \frac{6M_z}{T^2}$$

4.3.2 STRESSES RESULTING FROM CIRCUMFERENTIAL MOMENT, M_c

4.3.2.1 *Circumferential Stresses (σ_s)*:

Step 1. Using the applicable values of β and γ calculated in para. 4.2, enter Fig. 3A and read off the dimensionless membrane force $N_s/(M_c/R_n^2\beta)$.

Step 2. By the same procedure used in Step 1, enter Fig. 1A and find the dimensionless bending moment $M_s/(M_c/R_n\beta)$.

Step 3. Using applicable values of M_c , R_n , β

Table 7—Circumferential Moment (M_c)

β_1 / β_2	γ	K_s for θ	K_s for M_s	K_s for M_z	C_s for N_s	C_s for N_z
$1/4$	15	1.09	1.31	1.84	0.31	0.49
	50	1.04	1.24	1.62	0.21	0.46
	100	0.97	1.16	1.45	0.15	0.44
	300	0.92	1.02	1.17	0.09	0.46
	15	1.00	1.09	1.36	0.64	0.75
$1/2$	50	0.98	1.08	1.31	0.57	0.75
	100	0.94	1.04	1.26	0.51	0.76
	300	0.95	0.99	1.13	0.39	0.77
	15	(1.00)	(1.20)	(0.97)	(1.7)	(1.3)
	100	1.19	1.10	0.95	1.43	1.12
2	300	...	(1.00)	(0.90)	(1.3)	(1.00)
	15	(1.00)	(1.47)	(1.08)	(1.75)	(1.31)
	100	1.49	1.38	1.06	1.49	0.81
	300	...	(1.27)	(0.98)	(1.36)	(0.74)

NOTE: The values in parenthesis determined by an approximate solution.

Table 8—Longitudinal Moment (M_L)

β_2 / β_1	γ	K_L for θ	K_L for M_o	K_L for M_z	C_L for N_s	C_L for N_z
$1/4$	15	1.14	1.80	1.24	0.75	0.43
	50	1.13	1.65	1.16	0.77	0.33
	100	1.18	1.59	1.11	0.80	0.24
	300	1.31	1.56	1.11	0.90	0.07
	15	(1.00)	(1.08)	(1.04)	(0.90)	(0.76)
$1/2$	100	1.00	1.07	1.02	0.97	0.68
	300	(1.00)	(1.05)	(1.02)	(1.10)	(0.60)
	15	...	(0.94)	(1.12)	(0.87)	(1.30)
	100	1.09	0.89	1.07	0.81	1.15
	300	...	(0.78)	(0.90)	(0.80)	(1.50)
2	15	1.39	0.90	1.24	0.68	1.20
	100	1.18	0.81	1.12	0.51	1.03
	300	...	(0.64)	(0.83)	(0.50)	(1.33)

NOTE: The values in parenthesis determined by an approximate solution.

Fig. 1A—Moment $M_\phi / (M_c / R_m \beta)$ due to an external circumferential moment M_c on a circular cylinder

Fig. 2A—Moment $M_x/(M_c/R_m)\beta$ due to an external circumferential moment M_c on a circular cylinder

Fig. 3A—Membrane force $N_x / (M_c / R_m^2 \beta)$ due to an external circumferential moment M_c on a circular cylinder

Fig. 4A—Membrane force $N_c / (M_e / R_m \beta)$ due to an external circumferential moment M_e on a circular cylinder

Fig. 1C—Bending moment M_o/P due to an external radial load P on a circular cylinder (transverse axis)

Calculation 11520-21-053

U-10 11

Fig. 1C-1—Bending moment $\frac{M_x}{P}$ due to an external radial load P on a circular cylinder (longitudinal axis)

Fig. 4C—Membrane force $N_x/(P/R_m)$ due to an external radial load P on a circular cylinder (transverse axis)
 —Membrane force $N_y/(P/R_m)$ due to an external radial load P on a circular cylinder (longitudinal axis)

W320-27-54

System Curves for Portable Exhauster
Installation

This sheet shows the status and description of the attached Design Analysis sheets.

Discipline: (27) Piping

WO/Job No.: ER4319/W-320

Calculation No.: W320-27-054

Project No. & Name: W-320 Tank 241-C-106 Waste Retrieval

Calculation Item: System Curves for Portable Exhauster Installation

These calculations apply to:

Dwg. No.: See References

Rev. No.

Dwg. No.:

Rev. No.

Other (Study, CDR):

Rev. No.

The status of these calculations is:

- ☐ Preliminary Calculations
- ☒ Final Calculations
- ☐ Check Calculations (On Calculation Dated)
- ☐ Void Calculation (Reason Voided)

Incorporated in Final Drawings?

☒ Yes ☐ No

This calculation verified by independent "check" calculations?

☐ Yes ☒ No

Original and Revised Calculation Approvals:

	Rev. 0 Signature/Date	Rev. 1 Signature/Date	Rev. 2 Signature/Date
Originator	Kelly K. Hagan 2/18/98		
Checked by	Ken Old 3/2/98		
Approved by	D. L. Evans 4/11/98		
Checked Against Approved Vendor Data	R. Ahmed 4.11.98		

INDEX

Design Analysis Page No.	Description
1 - 2	Objective, Design Inputs, References, Conclusions
3 - 4	Calculations
A-1 to A-5	Appendix A - System Curves
B-1 to B-11	Appendix B - Pipe-Flo Model ANNULUS2
C-1 to C-13	Appendix C - Pipe-Flo results of ANNULUS2
D-1 to D-20	Appendix D - Pipe-Flo Model ANNULUS
E-1 to E-13	Appendix E - Pipe-Flo results of ANNULUS
F-1 to F-15	Appendix F - Pipe-Flo Model ANNU-PEX
G-1 to G-13	Appendix G - Pipe-Flo results of ANNU-PEX
H-1 to H-2	Appendix H - References

CALCULATION CROSS INDEX (Typical)

Subject Calculation No.: W320-27-054

Page ii of ii

Subject Calculation Revision No.	Superseded by Calculation No.	These interfacing calculation/documents provide input to the subject calculation, and if revised may require revision of the subject calculation.		Results and conclusions of the subject calculation are used in these interfacing calculations and/or documents		Does the output interface calculation/documents require revision?		Has the output interface calculation/documents been revised?		Discipline manager's signature and date indicating evaluation complete.
		Calculation/Document No.	Revision No.	Calculation/Document No.	Revision No.	Yes	No	Yes	No	
0	NA	H-2-64307, Sheet 1	4	NA			✓		✓
		H-2-77324, Sheet 1	2				✓		✓	
		H-2-77325, Sheet 1	1				✓		✓	
		H-2-77326, Sheet 1	2				✓		✓	
		H-2-77326, Sheet 2	2				✓		✓	
		H-2-77326, Sheet 3	2				✓		✓	
		H-2-818506, Sheet 1	01				✓		✓	
		H-2-818506, Sheet 2	01				✓		✓	
		H-2-818507, Sheet 1	01				✓		✓	
		H-2-818507, Sheet 2	01				✓		✓	
		H-2-818507, Sheet 4	01				✓		✓	

DESIGN ANALYSIS

Client: Numatec

WO/Job No.: ER4319/W-320

Subject: System Curves for Portable Exhauster Installation

Date: 2/18/98

By: Kelly Hayase

Checked: 3/2/98

By: *Kelly Hayase*

Location: 241-C/241-AY

Revised:

By:

OBJECTIVE:

The objective of this calculation is to generate the system curves for the portable exhauster installation. There are three scenarios for installing the portable exhauster; exhaust the dome space for Tank 241-C-106, exhaust the dome space for Tank 241-AY-102, and exhaust the annulus for Tank 241-AY-102.

DESIGN INPUTS:

CRITERIA AND SOURCE:

1. HNF-SD-W320-FDC-001, Rev. 4

GIVEN OR KNOWN DATA:

1. The existing configuration of the annulus vent piping and under tank air distribution channels.
2. Test data of flow rate versus annulus vacuum pressure. (Ref. #4)

ASSUMPTIONS:

1. The air shall be assumed to be 50°F. This is consistent with the test data of flow rate versus annulus vacuum pressure. Note: higher air temperatures would result in lower pressure drops because of the lower air density, and vice versa.

METHODS TO BE USED:

The computer program Pipe-Flo (Ref. #2) shall be used for this calculation. Pipe-Flo uses the Darcy-Weisbach equation to calculate the pressure drop in a pipe. Refer to the Pipe-Flo manual for a more detailed discussion of the methods used by the program.

REFERENCES/SOURCES:

1. HNF-SD-W320-FDC-001, Rev. 4.
2. Pipe-Flo Computer Program Version 5.01, by Engineered Software Inc.
3. Crane Technical Paper No. 410, 1991.
4. CC:Mail message from Steve Shaw (1/26/98) discussing test data. (Appendix H-1)
5. HNF-SD-W320-ER-002, Rev. 0, "Project W-320 Thermal Evaluation" (Appendix H-2)

DESIGN ANALYSIS

Client: Numatec

WO/Job No.: ER4319/W-320

Subject: System Curves for Portable Exhauster Installation

Date: 2/18/98

By: Kelly Hayase

Checked: 3/2/98

By: Ken Wood

Location: 241-C/241-AY

Revised:

By:

6. Drawing Numbers:

H-2-64307, Sheet 1, Rev. 4
H-2-77324, Sheet 1, Rev. 2
H-2-77325, Sheet 1, Rev. 1
H-2-77326, Sheet 1, Rev. 2
H-2-77326, Sheet 2, Rev. 2
H-2-77326, Sheet 3, Rev. 2
H-2-818506, Sheet 1, Rev. 0
H-2-818506, Sheet 2, Rev. 0
H-2-818507, Sheet 1, Rev. 0
H-2-818507, Sheet 2, Rev. 0
H-2-818507, Sheet 4, Rev. 0

CONCLUSIONS:

1. Figure A-1, Appendix A shows the annulus vacuum versus annulus air flow rate as determined from this analysis. The test data points from Reference #4 are also included to validate the results of the analysis. Upon comparison, the Pipe-Flo model closely represents the actual tested conditions. The annulus vacuum versus the air flow rate as determined from HNF-SD-W320-ER-002 (Ref. #5) was plotted for information only.
2. The system curve for the portable exhauster connected to the dome space of Tanks 241-C-106 and 241-AY-102 is given in Figure A-2, Appendix A.
3. The system curve for the portable exhauster connected to the annulus of Tank 241-AY-102 is given in Figure A-3, Appendix A.

DESIGN ANALYSIS

Client: Numatec

WO/Job No.: ER4319/W-320

Subject: System Curves for Portable Exhauster Installation

Date: 2/18/98

By: Kelly Hayase

Checked: 3/2/98

By: Ken Ciel

Location: 241-C/241-AY

Revised:

By:

CALCULATIONS:

Discussion of the Pipe-Flo analysis:

- The following properties of air was used for the analysis:

Temperature: 50°F
Density: 0.0779 lb/ft³
Viscosity: 0.0176 cpois

- The rectangular slots of the air distribution system under the tank was modeled as pipe based on the equivalent diameter, D_e , of the rectangular cross section as follows:

For a (a x b) rectangle: $D_e = 2ab/(a+b)$

3" x 1-1/2" rectangle: $D_e = 2(3)(1.5)/(3+1.5) = 2$ in Use 2" Sch 40 pipe
(d = 2.067 in)

2" x 1-1/2" rectangle: $D_e = 2(2)(1.5)/(2+1.5) = 1.71$ in Use 2" Sch 160 pipe
(d = 1.687 in)

1-1/2" x 1-1/2" rectangle: $D_e = 2(1.5)(1.5)/(1.5+1.5) = 1.5$ in Use 1-1/2" Sch 80 pipe
(d = 1.5 in)

- The annulus was modeled as pipe based on the equivalent diameter, D_e , as follows:

For outer diameter D_o and inner diameter D_i : $D_e = D_o - D_i$

$D_o = 40'$ and $D_i = 37.5'$ $D_e = 40 - 37.5 = 2.5$ ft = 30 in Use 32" Sch 40 pipe
(d = 30.624 in)

- The air distribution system under the tank consists of three sections; an inner ring of 18 radial slots, a middle ring of 36 radial slots, and an outer ring of 72 radial slots. Therefore, for each inner slot, there are 2 middle slots and 4 outer slots. This pattern was modeled with pipe flow (Model name "ANNULUS2") to determine the pressure drop from the 1'-6" air distributor to the annulus for one of the 18 initial flow paths of the inner ring. The pressure drop was calculated for different flow rates of air and was multiplied to represent the pressure drop for the entire air distribution system.
- The modeling of the remainder of the annulus vent piping was straight forward and did not require any simplifications. The four 6" drop legs to the 6" annulus nozzles are blocked and therefore not included in the analysis.

Revised:

- HNF-2479, Rev. 0
Page E-6

DESIGN ANALYSIS

Client: Numatec

WO/Job No.: ER4319/W-320

Subject: System Curves for Portable Exhauster Installation

Date: 2/18/98

By: Kelly Hayase

Checked: 3/21/98

By: Kim Gill

Location: 241-C/241-AY

Revised:

By:

Appendix A System Curves

Figure A-2: System Curve
Vacuum at Portable Exhauster Skid Intake vs Flow Rate
(C-106 and AY-102 Dome Space at -2 "H₂O)

Note: The flow in the 20' riser is in the transition zone (Reynold's Number) for flow rates around 200 CFM, therefore the curve is not smooth.

Figure A-3: System Curve
Vacuum at Portable Exhauster Skid Intake
vs Flow Rate (AY-102 Annulus)

cfm	cfm/18	cfm/6	Δp	$\Delta p \times 3$	K	Annulus Vacuum psig	Annulus Vacuum "H ₂ O"	HNF-SD- W320-ER 002 "H ₂ O"	Vacuum at skid intake psig	Vacuum at skid intake "H ₂ O"
100	5.56	16.67	0.001	0.003	558.2	0.004	0.11	0.1	0.006	0.17
200	11.11	33.33	0.004	0.012	558.6	0.013	0.36	0.4	0.026	0.72
300	16.67	50.00	0.009	0.027	558.4	0.04	1.11	0.8	0.057	1.58
400	22.22	66.67	0.016	0.048	558.4	0.078	2.16	1.3	0.099	2.75
500	27.78	83.33	0.025	0.075	558.5	0.126	3.49	2	0.153	4.24
600	33.33	100.00	0.035	0.105	542.9	0.181	5.02	2.9	0.215	5.96
700	38.89	116.67	0.048	0.144	547	0.249	6.90	4	0.291	8.07
800	44.44	133.33	0.062	0.186	541	0.325	9.01	5.1	0.376	10.43
900	50.00	150.00	0.078	0.234	537.8	0.41	11.37	6.3	0.472	13.09
1000	55.56	166.67	0.096	0.288	536.1	0.506	14.03	7.8	0.58	16.08
1100	61.11	183.33	0.115	0.345	530.8	0.609	16.89	9.4	0.696	19.30
1200	66.67	200.00	0.137	0.411	531.3	0.725	20.10	11.4	0.826	22.90
1300	72.22	216.67	0.16	0.48	528.7	0.848	23.51	13.9	0.965	26.76

annulus air
flow rate

air flow rate thru
one of the 18
original flow
paths

air flow rate thru
3 of the 18
original flow
paths

Δp thru one of
the 18 original
flow paths
determined from
"ANNULUS2"

Δp thru 3 of the
18 original
flow paths

K determined by
Pipe-Flo (given
flow and Δp)

Determined from
"ANNULUS"

"Blocked"

Determined from
"ANNU-PEX"

scfm	Tank Vacuum "H ₂ O	Δp Thru Hose "H ₂ O	Vacuum at skid intake "H ₂ O
100	2	0.06	2.06
200	2	0.36	2.36
300	2	0.47	2.47
400	2	0.58	2.58
500	2	0.75	2.75
600	2	0.94	2.94
700	2	1.16	3.16
800	2	1.41	3.41
900	2	1.72	3.72
1000	2	2.05	4.05
1100	2	2.41	4.41
1200	2	2.80	4.80
1300	2	3.24	5.24

 Difference between vacuum at
 skid intake and annulus vacuum
 (including riser)

DESIGN ANALYSIS

Client: Numatec

WO/Job No.: ER4319/W-320

Subject: System Curves for Portable Exhauster Installation

Date: 2/18/98

By: Kelly Hayase

Checked: 3/2/98

By: Kei Cui

Location: 241-C/241-AY

Revised:

By:

Appendix B: Pipe-Flo Model ANNULUS2

y: Fluor Daniel NW
st:
y: Fluor Daniel NW

System: ANNULUS2
rev: 01/29/98 10:30 am

B-2 of B-11

ted: 01/26/98 9:46 am
file:
ecs: 3

SYSTEM REPORT

Pipes: 16
Nodes: 13
Pumps/Comps: 0

SYSTEM NODES

ELEVATION ft	PIPELINES IN	PIPELINES OUT
623		air dist
623	air dist	a
623	a	b c
623	b	d
623	c	e
623	d	f g
623	e	h i
623	f	k
623	g j	l
623	h	j m
623	i	n
623	k l m n	o
663.17	o	

PIPELINE	SPEC	FROM_NODE	TO_NODE	PUMP/COMP
a	01	B	C	
air dist	03	A	B	
b	02	C	D	
c	02	C	E	
d	02	D	F	
e	02	E	G	
f	03	F	H	
g	03	F	I	
h	03	G	J	
i	03	G	K	
j	03	J	I	
k	03	H	L	
l	03	I	L	
m	03	J	L	
n	03	K	L	
o	01	L	M	

/N

System: ANNULUS2
rev: 01/29/98 10:30 am

B-4 of B-11

/N

PIPELIST REPORT

6 am

Pipes: 16
Nodes: 13
Pumps/Comps: 0

SPECIFICATIONS

PIPE MATERIAL
Sch / RoughnessFLUID
Temp / Pres

VALVE TABLE

DESIGN LIMITS
Vel / PresSteel
Sch 40
0.012 inAir
50 °F
0 psi gStandard
Standard0 - 40 ft/sec
-14.4 - 14.4 psi g

Size for: 6 ft/sec

Steel
Sch 160
0.012 inAir
50 °F
0 psi gStandard
Standard0 - 40 ft/sec
-14.4 - 14.4 psi g

Size for: 6 ft/sec

Steel
Sch 80
0.012 inAir
50 °F
0 psi gStandard
Standard0 - 40 ft/sec
-14.4 - 14.4 psi g

Size for: 6 ft/sec

For concrete,
Ref. # 5

Calculation W320-27-054

IC	MATERIAL Size / Sch	LENGTH ft	FLUID Temp / Pres	VALVES Total-K
	Steel 2 in / 40	7	Air 50 °F / 0 psi g	0.5
	Steel 20 in / 80	1	Air 50 °F / 0 psi g	0
	Steel 2 in / 160	1	Air 50 °F / 0 psi g	1.198
	Steel 2 in / 160	1	Air 50 °F / 0 psi g	1.198
	Steel 2 in / 160	12	Air 50 °F / 0 psi g	1.198
	Steel 2 in / 160	12	Air 50 °F / 0 psi g	1.198
	Steel 1.5 in / 80	1.2	Air 50 °F / 0 psi g	1.233
	Steel 1.5 in / 80	1.2	Air 50 °F / 0 psi g	1.233
	Steel 1.5 in / 80	1.2	Air 50 °F / 0 psi g	1.233
	Steel 1.5 in / 80	1.2	Air 50 °F / 0 psi g	1.233
	Steel 1.5 in / 80	1.2	Air 50 °F / 0 psi g	0
	Steel 1.5 in / 80	16.75	Air 50 °F / 0 psi g	2.233
	Steel 1.5 in / 80	16.75	Air 50 °F / 0 psi g	2.233
	Steel 1.5 in / 80	16.75	Air 50 °F / 0 psi g	2.233
	Steel 1.5 in / 80	16.75	Air 50 °F / 0 psi g	2.233
	Steel 32 in / 40	40.17	Air 50 °F / 0 psi g	0

MATERIALS REPORT

am

Pipes: 16
Nodes: 13
Pumps/Comps: 0

PIPE MATERIALS LIST

PEC	MATERIAL Size / Sch	LENGTH ft	VALVES & FITTINGS
J1	Steel 2 in / 40	7	1-Entrance Sharp-Edged
J3	Steel 20 in / 80	1	
J2	Steel 2 in / 160	1	1-Tee Flow Thru Branch
J2	Steel 2 in / 160	1	1-Tee Flow Thru Branch
J2	Steel 2 in / 160	12	1-Tee Flow Thru Branch
O2	Steel 2 in / 160	12	1-Tee Flow Thru Branch
O3	Steel 1.5 in / 80	1.2	1-Tee Flow Thru Branch
O3	Steel 1.5 in / 80	1.2	1-Tee Flow Thru Branch
O3	Steel 1.5 in / 80	1.2	1-Tee Flow Thru Branch
O3	Steel 1.5 in / 80	1.2	1-Tee Flow Thru Branch
O3	Steel 1.5 in / 80	1.2	1-Tee Flow Thru Branch
O3	Steel 1.5 in / 80	16.75	1-Tee Flow Thru Branch 1-Exit Sharp-Edged
O3	Steel 1.5 in / 80	16.75	1-Tee Flow Thru Branch 1-Exit Sharp-Edged
O3	Steel 1.5 in / 80	16.75	1-Tee Flow Thru Branch 1-Exit Sharp-Edged
O3	Steel 1.5 in / 80	16.75	1-Tee Flow Thru Branch 1-Exit Sharp-Edged
O1	Steel 32 in / 40	40.17	

Calculation W320-27-054

PIPE SUMMARY

SEWERAGE

B-7 of B-11

ERIAL	SCHEDULE	SIZE	LENGTH
	160	2 in	26 ft
	40	2 in	7 ft
		32 in	40.17 ft
	80	1.5 in	73 ft
		20 in	1 ft

VALVE & FITTING SUMMARY

MATERIAL	SCHEDULE	VALVES & FITTINGS
Steel	40	
Size: 2 in		1-Entrance Sharp-Edged
Steel	160	
Size: 2 in		4-Tee Flow Thru Branch
Steel	80	
Size: 1.5 in		8-Tee Flow Thru Branch
		4-Exit Sharp-Edged

Calculation W320-27-054

B-8 of B-11

Calculation W320-27-054

HNF-2479, Rev. 0
Page E-21

Company: Fluor Daniel NW

Project:

by: Fluor Daniel NW

Comments:

Version: PIPE-FLOW ver 5.01

02/17/98 9:37 am

Lineitem: ANNULUS2

flow rate: cfm

pressure: psig

level & grade: ft

US2
8 10:30 am

Deviation: 0.00456 %
after: 6 iterations

rates require constant fluid properties in all pipelines. Fluid properties in the first specification were used in this

LINEUP SUMMARIES

	DEMAND cfm	NODE	DEMAND cfm
>>>	55.56		

Flows IN: 0 cfm
Flows OUT: 55.56 cfm
NET FLOWS OUT: 55.56 cfm

LINEUP SUMMARIES

	FLOW cfm	PRESSURE SOURCE	SET psi g	LEVEL ft
<<<	55.56	A	0	0

Flows IN: 55.56 cfm
Flows OUT: 0 cfm
NET FLOWS IN: 55.56 cfm

Calculation W320-27054

B-10 of B-11

ELEVATION ft	DEMAND cfm	PRESSURE psi g	H GRADE ft
623		0 (source)	623
623		0	623
623		-0.025	576.8
623		-0.036	556.6
623		-0.036	556.6
623		-0.068	496.5
623		-0.068	496.5
623		-0.073	487.6
623		-0.073	487.6
623		-0.073	487.6
623		-0.073	487.6
623		-0.096	445.7
663.17	> 55.56	-0.118	445.7

Calculation W320-27-054

PIPELINE	FROM	TO	FLOW cfm	VEL ft/sec	dP psi g	HL ft
a	B	C	55.56	39.77	0.025	46.16
dist	A	B	55.56	0.528	0	0
b	C	D	27.78	29.85	0.011	20.2
c	C	E	27.78	29.85	0.011	20.2
d	D	F	27.78	29.85	0.033	60.13
e	E	G	27.78	29.85	0.033	60.13
f	F	H	13.89	18.88	0.005	8.935
g	F	I	13.89	18.88	0.005	8.935
h	G	J	13.89	18.88	0.005	8.935
i	G	K	13.89	18.88	0.005	8.935
j	J	I	0	0	0	0
k	H	L	13.89	18.88	0.023	41.88
l	I	L	13.89	18.88	0.023	41.88
m	J	L	13.89	18.88	0.023	41.88
n	K	L	13.89	18.88	0.023	41.88
o	L	M	55.56	0.181	0.022	0

DESIGN ANALYSIS

Client: Numatec

WO/Job No.: ER4319/W-320

Subject: System Curves for Portable Exhauster Installation

Date: 2/18/98

By: Kelly Hayase

Checked: 3/2/98

By: Ken Coak

Location: 241-C/241-AY

Revised:

By:

**Appendix C: Pipe-Flo results of ANNULUS2 for different flow rates used
as input into Pipe-Flo Model ANNULUS**

C-1 of C-13

02/17/98 9:38 am	Company: Fluor Daniel NW
Lineup: ANNULUS2	Project:
flow rate: cfm	by: Fluor Daniel NW
pressure: psia	Comments:
level & grade: ft	Version: PIPE-FLO ver 5.01

Calculation W320-27-054

Calculation W320-27-054

C-2 of C-13

Company: Fluor Daniel NW Project: by: Fluor Daniel NW Comments: Version: PIPE-FLO ver 5.01	02/17/98 9:39 am Linelist: ANNULUS2 Lineup: ANNULUS2 flow rate: cfm pressure: psia level & grade: ft
---	--

C-3 of C-13

Company: Fluor Daniel NW	02/17/98 9:39 am
Project: by: Fluor Daniel NW	Linelist: ANNULUS2
Comments:	flow rate: cfm
	pressure: psig
	level & grade: ft
Version: PIPE-FLO ver 5.01	

Calculation W320-27-054

Calculation by 320-27-054

C-A of C-13

Company: Fluor Daniel NW	02/17/98 9:39 am
Project:	Linelist: ANNULUS2
by: Fluor Daniel NW	Lineup: ANNULUS2
Comments:	flow rate: cfm
	pressure: psig
Version: PIPE-FLO ver 5.01	level & grade: ft

C-5 of C-13

02/17/98 9:40 am	Linelet: ANNULUS2
Lineup: ANNULUS2	flow rate: cfm
pressure: psi	level & grade: ft
Company: Fluor Daniel NW	Project: Fluor Daniel NW
Comments:	Version: PIPE-FLO ver 5.01

Calculation w320-27-054

Calculation W320-27-054

C-6 of C-13

Company: Fluor Daniel NW	02/17/98 9:40 am
Project: by: Fluor Daniel NW	Linelist: ANNULUS2
Comments:	Lineup: ANNULUS2
Version: PIPE-FLO ver 5.01	flow rate: cfm
	pressure: psi
	level & grade: ft

C-7 & C-13

02/17/98 9:40 am	ANNULUS2
Lineup: ANNULUS2	ANNULUS2
flow rate: cfm	ANNULUS2
pressure: psi	ANNULUS2
level & grade: ft	ANNULUS2

Company: Fluor Daniel NW
 Project: Fluor Daniel NW
 Comments:
 Version: PIPE-FLO ver 5.01

Calculation W320-27-054

C-8 of C-13

Company: Fluor Daniel NW	02/17/98 9:41 am
Project: Fluor Daniel NW	Line list: ANNULUS2
by: Fluor Daniel NW	Lineup: ANNULUS2
Comments:	flow rate: cfm
	pressure: psig
Version: PIPE-FLO ver 5.01	level & grade: ft

Calculation W320-27-054

C-9 of C-13

Company: Fluor Daniel NW Project: by: Fluor Daniel NW Comments: Version: PIPE-FLO ver 5.01	02/17/98 9:46 am Linelist: ANNULUS2 Lineup: ANNULUS2 flow rate: cfm pressure: psi level & grade: ft
---	---

C-10 of C-13

Calculation w320-27-054

02/17/98 9:47 am	Line list: ANNULUS2
Project: ANNULUS2	Flow rate: cfm
Comments:	Pressure: psig
Version: PIPE-FLO ver 5.01	Level & grade: ft

Calculation W320-27.054

C-11 of C-13

Company: Fluor Daniel NW Project: by: Fluor Daniel NW Comments: Version: PIPE-FLO ver 5.01	02/17/98 9:47 am Linelist: ANNULUS2 Lineup: ANNULUS2 flow rate: cfm pressure: psi level & grade: ft
---	---

C-12 of C-13

Company: Fluor Daniel NW	02/17/98 9:47 am
Project: Fluor Daniel NW	Linelist: ANNULUS2
Comments:	Lineup: ANNULUS2
	flow rate: cfm
	pressure: psi
	level & grade: ft
Version: PIPE-FLO ver 5.01	

Calculation W320-27.054

C-13 of C-13

Company: Fluor Daniel NW
 Project: Fluor Daniel NW
 Comments:
 Version: PIPE-FLO ver 5.01

02/17/98 9:48 am
 Linelist: ANNULUS2
 Lineup: ANNULUS2
 flow rate: cfm
 pressure: psia
 level & grade: ft

Calculation W320-27-054

DESIGN ANALYSIS

Client: Numatec

WO/Job No.: ER4319/W-320

Subject: System Curves for Portable Exhauster Installation

Date: 2/18/98

By: Kelly Hayase

Checked: 3/2/98

By: H. C.

Location: 241-C/241-AY

Revised:

By:

Appendix D: Pipe-Flo Model ANNULUS

HNF-2479, Rev. 0
Page 40 E-40

Modeling the air distributor as two separate pipes is acceptable because there is no pressure drop thru the 16" air distributor.

Annulus (Segments ZT, ZU, ZV, ZW, ZX)

Segments U, V, W, X, Y, and Z each represent 3 of the 18 original flow paths. Therefore the pressure drop across each of these is 3 times the pressure drop of ANNULUS2. (not including elevation change)

Company: Fluor Daniel NW
Project: by: Fluor Daniel NW
Comments:

02/17/98 9:52 am
Line list: ANNULUS
Lineup:
Flow rate: cfm
Pressure: psia
Level & grade: ft

SYSTEM REPORT

Pipes: 50
Nodes: 38
Pumps/Comps: 0

3 am

SYSTEM NODES

ELEVATION ft	PIPELINES IN	PIPELINES OUT
674.43	zl	zq
674.44	i	n
674.8	zk zq	zr
677.33	b	c m
677.35	zj zo	zp
673.49	zi zn	zo
673.37	c	d l
673.22	zh zm	zn
672.69	f	j
672.79	zg	zm
677.5	a	b g
681.86		a
673.37	d	e
673.07	e	f
674.83	g	h
674.52	h	i
671.44	j	k
658.77	k	o
682.33	zs	
671.62	l	p
669.58	m	q

Calculation W320-27-054

0-3.0-20

ELEVATION ft	PIPELINES IN	PIPELINES OUT
670.92	n	r
623	o p q r	s t
623	s	u v w
623	t	x y z
663.17	u	za zt
663.17	v zt	zb zu
663.17	w zu	zc zv
663.17	x zv	zd zw
663.17	y zw	ze zx
663.17	z zx	zf
669.17	za	zg
669.5	zb	zh
669.5	zc	zi
671.5	zd	zj
670.5	ze	zk
668.5	zf	zl
677.5	zp zr	zs

Calculation W320-27-054

SPEC	FROM_NODE	TO_NODE
01	In	I
01	I	D-in
01	D-in	F
01	F	J
01	J	K
01	K	H-in
01	I	L
01	L	M
01	M	B
01	H-in	N
01	N	O
01	F	P
01	D-in	Q
01	B	R
01	O	S
01	P	S
01	Q	S
01	R	S
01	S	T
01	S	U
01	T	V
01	T	W
01	T	X
01	U	Y
01	U	Z
01	U	ZA
01	V	ZB
01	W	ZC
01	X	ZD
01	Y	ZE
01	Z	ZF
01	ZA	ZG
01	ZB	H-out
01	ZC	G
01	ZD	E
01	ZE	D-out
01	ZF	C
01	ZG	A
01	H-out	G
01	G	E
01	E	D-out
01	D-out	ZH

Calculation W320-27-054

SYSTEM PIPES

02/17/98 9:52 am

D-5 of D-20

PIPELINE	SPEC	FROM_NODE	TO_NODE	PUMP/COMP
zq	01	A	C	
zr	01	C	ZH	
zs	01	ZH	Out	
zt	01	V	W	
zu	01	W	X	
zv	01	X	Y	
zw	01	Y	Z	
zx	01	Z	ZA	

Company: Fluor Daniel NW
Project:
by: Fluor Daniel NW

02/17/98 9:52 am
System: ANNULUS
rev: 02/17/98 9:51 am

0-6 of 0-20

PIPELIST REPORT

Created: 01/26/98 11:38 am
Design file:
Pipe Specs: 1

Pipes: 50
Nodes: 38
Pumps/Comps: 0

SPECIFICATIONS

SPECIFICATION	PIPE MATERIAL Sch / Roughness	FLUID Temp / Pres	VALVE TABLE	DESIGN LIMITS Vel / Pres
01 Sch40 rev: 01/29/98 10:40 am	Steel Sch 40 0.0018 in Size for: 6 ft/sec	Air 50 °F 0 psi g	Standard Standard	0 - 40 ft/sec -14.4 - 14.4 psi g

PIPELINE	SPEC	MATERIAL Size / Sch	LENGTH ft	FLUID Temp / Pres	VALVES Total-K
	01	Steel 12 in / 40	45	Air 50 °F / 0 psi g	0.9994
b	01	Steel 14 in / 40	31	Air 50 °F / 0 psi g	0.8908
c	01	Steel 14 in / 40	71	Air 50 °F / 0 psi g	0.76
d	01	Steel 14 in / 40	1	Air 50 °F / 0 psi g	0.1164
e	01	Steel 10 in / 40	30	Air 50 °F / 0 psi g	1.429
f	01	Steel 6 in / 40	40	Air 50 °F / 0 psi g	0.1478
g	01	Steel 14 in / 40	9	Air 50 °F / 0 psi g	1.388
h	01	Steel 10 in / 40	17	Air 50 °F / 0 psi g	0.1047
i	01	Steel 8 in / 40	13	Air 50 °F / 0 psi g	0.1396
j	01	Steel 6 in / 40	1.25	Air 50 °F / 0 psi g	2.599
k	01	Steel 3 in / 40	12.67	Air 50 °F / 0 psi g	0.05435
l	01	Steel 3 in / 40	1.75	Air 50 °F / 0 psi g	1.094
m	01	Steel 3 in / 40	7.75	Air 50 °F / 0 psi g	1.094
n	01	Steel 3 in / 40	3.5	Air 50 °F / 0 psi g	1.094
o	01	Steel 4 in / 40	85	Air 50 °F / 0 psi g	1.913
p	01	Steel 4 in / 40	98	Air 50 °F / 0 psi g	1.913
q	01	Steel 4 in / 40	96	Air 50 °F / 0 psi g	1.913
r	01	Steel 4 in / 40	97	Air 50 °F / 0 psi g	1.913
s	01	Steel 20 in / 40	1	Air 50 °F / 0 psi g	0
t	01	Steel 20 in / 40	1	Air 50 °F / 0 psi g	0
u	01	Steel 8 in / 40	1	Air 50 °F / 0 psi g	536.1
v	01	Steel 8 in / 40	1	Air 50 °F / 0 psi g	536.1
w	01	Steel 8 in / 40	1	Air 50 °F / 0 psi g	536.1
x	01	Steel 8 in / 40	1	Air 50 °F / 0 psi g	536.1

B-5 of B-11

PIPELINE	SPEC	MATERIAL Size / Sch	LENGTH ft	FLUID Temp / Pres	VALVES Total-K
a	01	Steel 2 in / 40	7	Air 50 °F / 0 psi g	0.5
air dist	03	Steel 20 in / 80	1	Air 50 °F / 0 psi g	0
b	02	Steel 2 in / 160	1	Air 50 °F / 0 psi g	1.198
c	02	Steel 2 in / 160	1	Air 50 °F / 0 psi g	1.198
d	02	Steel 2 in / 160	12	Air 50 °F / 0 psi g	1.198
e	02	Steel 2 in / 160	12	Air 50 °F / 0 psi g	1.198
f	03	Steel 1.5 in / 80	1.2	Air 50 °F / 0 psi g	1.233
g	03	Steel 1.5 in / 80	1.2	Air 50 °F / 0 psi g	1.233
h	03	Steel 1.5 in / 80	1.2	Air 50 °F / 0 psi g	1.233
i	03	Steel 1.5 in / 80	1.2	Air 50 °F / 0 psi g	1.233
j	03	Steel 1.5 in / 80	1.2	Air 50 °F / 0 psi g	0
k	03	Steel 1.5 in / 80	16.75	Air 50 °F / 0 psi g	2.233
l	03	Steel 1.5 in / 80	16.75	Air 50 °F / 0 psi g	2.233
m	03	Steel 1.5 in / 80	16.75	Air 50 °F / 0 psi g	2.233
n	03	Steel 1.5 in / 80	16.75	Air 50 °F / 0 psi g	2.233
o	01	Steel 32 in / 40	40.17	Air 50 °F / 0 psi g	0

Company: Fluor Daniel NW
Project:
by: Fluor Daniel NW

02/17/98 9:36 am
System: ANNULUS2
rev: 01/29/98 10:30 am

B-6 of B-11

MATERIALS REPORT

Created: 01/26/98 9:46 am
Design file:
Pipe Specs: 3

Pipes: 16
Nodes: 13
Pumps/Comps: 0

PIPE MATERIALS LIST

PIPELINE	SPEC	MATERIAL Size / Sch	LENGTH ft	VALVES & FITTINGS
a	01	Steel 2 in / 40	7	1-Entrance Sharp-Edged
air dist	03	Steel 20 in / 80	1	
b	02	Steel 2 in / 160	1	1-Tee Flow Thru Branch
c	02	Steel 2 in / 160	1	1-Tee Flow Thru Branch
d	02	Steel 2 in / 160	12	1-Tee Flow Thru Branch
e	02	Steel 2 in / 160	12	1-Tee Flow Thru Branch
f	03	Steel 1.5 in / 80	1.2	1-Tee Flow Thru Branch
g	03	Steel 1.5 in / 80	1.2	1-Tee Flow Thru Branch
h	03	Steel 1.5 in / 80	1.2	1-Tee Flow Thru Branch
i	03	Steel 1.5 in / 80	1.2	1-Tee Flow Thru Branch
j	03	Steel 1.5 in / 80	1.2	
k	03	Steel 1.5 in / 80	16.75	1-Tee Flow Thru Branch 1-Exit Sharp-Edged
l	03	Steel 1.5 in / 80	16.75	1-Tee Flow Thru Branch 1-Exit Sharp-Edged
m	03	Steel 1.5 in / 80	16.75	1-Tee Flow Thru Branch 1-Exit Sharp-Edged
n	03	Steel 1.5 in / 80	16.75	1-Tee Flow Thru Branch 1-Exit Sharp-Edged
o	01	Steel 32 in / 40	40.17	

PIPE MATERIAL	SCHEDULE	SIZE	LENGTH
Steel	160	2 in	26 ft
Steel	40	2 in	7 ft
		32 in	40.17 ft
Steel	80	1.5 in	73 ft
		20 in	1 ft

VALVE & FITTING SUMMARY

SPECIFICATION	MATERIAL	SCHEDULE	VALVES & FITTINGS
01 1	Steel	40	
	Size: 2 in		1-Entrance Sharp-Edged
02 2	Steel	160	
	Size: 2 in		4-Tee Flow Thru Branch
03 3	Steel	80	
	Size: 1.5 in		8-Tee Flow Thru Branch
			4-Exit Sharp-Edged

Calculation W320-27-054

Company: Fluor Daniel NW
Project:
by: Fluor Daniel NW
Comments:

Version: PIPE-FLO ver 5.01

02/17/98 9:37 am
Linelist: ANNULUS2
Lineup: ANNULUS2
flow rate: cfm
pressure: psi_a
level & grade: ft

B-8 of B-11

System: ANNULUS2
rev: 01/29/98 10:30 am

Deviation: 0.00456 %
after: 6 iterations

Volumetric flow rates require constant fluid properties in all pipelines. Fluid properties in the first specification were used in this calculation.

LINEUP SUMMARIES

NODE	DEMAND cfm	NODE	DEMAND cfm
M	>>> 55.56		

Flows IN: 0 cfm
Flows OUT: 55.56 cfm
NET FLOWS OUT: 55.56 cfm

LINEUP SUMMARIES

PIPELINE	FLOW cfm	PRESSURE SOURCE	SET psi g	LEVEL ft
air dist	<<< 55.56	A	0	0

Flows IN: 55.56 cfm
Flows OUT: 0 cfm
NET FLOWS IN: 55.56 cfm

B-10 of B-11

NODE	ELEVATION ft	DEMAND cfm	PRESSURE psi g	H GRADE ft
A	623		0 (source)	623
B	623		0	623
C	623		-0.025	576.8
D	623		-0.036	556.6
E	623		-0.036	556.6
F	623		-0.068	496.5
G	623		-0.068	496.5
H	623		-0.073	487.6
I	623		-0.073	487.6
J	623		-0.073	487.6
K	623		-0.073	487.6
L	623		-0.096	445.7
M	663.17	> 55.56	-0.118	445.7

B-11 of B-11

PIPELINE	FROM	TO	FLOW cfm	VEL ft/sec	dP psi g	HL ft
a	B	C	55.56	39.77	0.025	46.16
dist	A	B	55.56	0.528	0	0
b	C	D	27.78	29.85	0.011	20.2
c	C	E	27.78	29.85	0.011	20.2
d	D	F	27.78	29.85	0.033	60.13
e	E	G	27.78	29.85	0.033	60.13
f	F	H	13.89	18.88	0.005	8.935
g	F	I	13.89	18.88	0.005	8.935
h	G	J	13.89	18.88	0.005	8.935
i	G	K	13.89	18.88	0.005	8.935
j	J	I	0	0	0	0
k	H	L	13.89	18.88	0.023	41.88
l	I	L	13.89	18.88	0.023	41.88
m	J	L	13.89	18.88	0.023	41.88
n	K	L	13.89	18.88	0.023	41.88
o	L	M	55.56	0.181	0.022	0

C-2 of C-13

02/17/98 9:39 am Line1ist: ANNULUS2 Lineup: ANNULUS2 flow rate: cfm pressure: psia level & grade: ft	Company: Fluor Daniel NW Project: by: Fluor Daniel NW Comments: Version: PIPE-FLO ver 5.01
---	---

Calculation w320-27-054

Calculation W310-27-054

C-1 of C-13

Company: Fluor Daniel NW	02/17/98 9:38 am
Project: by: Fluor Daniel NW	Linelist: ANNULUS2
Comments:	Lineup: ANNULUS2
Version: PIPE-FLO ver 5.01	flow rate: cfm
	pressure: psi _g
	level & grade: ft

DESIGN ANALYSIS

Client: Numatec

Subject: System Curves for Portable Exhauster Installation

Location: 241-C/241-AY

WO/Job No.: ER4319/W-320

Date: 2/18/98

Checked: 3/2/98

Revised:

By: Kelly Hayase

By: Ken Cold

By:

Appendix C: Pipe-Flo results of ANNULUS2 for different flow rates used
as input into Pipe-Flo Model ANNULUS

D-8 & D-20

PIPELINE	SPEC	MATERIAL Size / Sch	LENGTH ft	FLUID Temp / Pres	VALVES Total-K
	01	Steel 8 in / 40	1	Air 50 °F / 0 psi g	536.1
z	01	Steel 8 in / 40	1	Air 50 °F / 0 psi g	536.1
za	01	Steel 4 in / 40	6	Air 50 °F / 0 psi g	0.835
zb	01	Steel 4 in / 40	6.33	Air 50 °F / 0 psi g	0.835
zc	01	Steel 4 in / 40	6.33	Air 50 °F / 0 psi g	0.835
zd	01	Steel 4 in / 40	8.33	Air 50 °F / 0 psi g	0.835
ze	01	Steel 4 in / 40	7.33	Air 50 °F / 0 psi g	0.835
zf	01	Steel 4 in / 40	5.33	Air 50 °F / 0 psi g	0.835
zg	01	Steel 6 in / 40	12	Air 50 °F / 0 psi g	0.4908
zh	01	Steel 6 in / 40	12	Air 50 °F / 0 psi g	1.312
zi	01	Steel 6 in / 40	12	Air 50 °F / 0 psi g	1.312
zj	01	Steel 6 in / 40	14	Air 50 °F / 0 psi g	1.312
zk	01	Steel 6 in / 40	12	Air 50 °F / 0 psi g	1.312
zl	01	Steel 6 in / 40	20	Air 50 °F / 0 psi g	0.8474
zm	01	Steel 8 in / 40	50	Air 50 °F / 0 psi g	0.5276
zn	01	Steel 12 in / 40	53	Air 50 °F / 0 psi g	0.2574
zo	01	Steel 12 in / 40	47	Air 50 °F / 0 psi g	0.3861
zp	01	Steel 12 in / 40	27	Air 50 °F / 0 psi g	0.1287
zq	01	Steel 8 in / 40	51	Air 50 °F / 0 psi g	0.1396
zr	01	Steel 8 in / 40	21	Air 50 °F / 0 psi g	0.4701
zs	01	Steel 16 in / 40	15	Air 50 °F / 0 psi g	1.013
zt	01	Steel 32 in / 40	40	Air 50 °F / 0 psi g	0
zu	01	Steel 32 in / 40	40	Air 50 °F / 0 psi g	0
zv	01	Steel 32 in / 40	40	Air 50 °F / 0 psi g	0

HNF-2479, Rev. 0
Page E-57

D-9 of D-20

PIPELINE	SPEC	MATERIAL Size / Sch	LENGTH ft	FLUID Temp / Pres	VALVES Total-K
w	01	Steel 32 in / 40	40	Air 50 °F / 0 psi g	0
zx	01	Steel 32 in / 40	40	Air 50 °F / 0 psi g	0

Company: Fluor Daniel NW
Project:
by: Fluor Daniel NW

02/17/98 9:52 am
System: ANNULUS
rev: 02/17/98 9:51 am

0-10 of 0-20

MATERIALS REPORT

Created: 01/26/98 11:38 am
Design file:
Type Specs: 1

Pipes: 50
Nodes: 38
Pumps/Comps: 0

PIPE MATERIALS LIST

PIPELINE	SPEC	MATERIAL Size / Sch	LENGTH ft	VALVES & FITTINGS
a	01	Steel 12 in / 40	45	3-Elbow Long - r/d 1.5 @ 90° 1-Butterfly Valve
b	01	Steel 14 in / 40	31	1-Tee Flow Thru Branch 1-Elbow Long - r/d 1.5 @ 45°
c	01	Steel 14 in / 40	71	4-Elbow Long - r/d 1.5 @ 45° 1-Tee Flow Thru Run
d	01	Steel 14 in / 40	1	1-Reducer Contraction 14 X 10
e	01	Steel 10 in / 40	30	1-Elbow Long - r/d 1.5 @ 45° 1-Tee Flow Thru Run 1-Reducer Contraction 10 X 6
f	01	Steel 6 in / 40	40	1-Elbow Long - r/d 1.5 @ 45°
g	01	Steel 14 in / 40	9	2-Elbow Long - r/d 1.5 @ 45° 1-Tee Flow Thru Branch 1-Reducer Contraction 14 X 10 1-Tee Flow Thru Run
h	01	Steel 10 in / 40	17	1-Reducer Contraction 10 X 8
i	01	Steel 8 in / 40	13	1-Elbow Long - r/d 1.5 @ 45°
j	01	Steel 6 in / 40	1.25	1-Elbow Long - r/d 1.5 @ 90° 1-Reducer Contraction 6 X 3
k	01	Steel 3 in / 40	12.67	1-Reducer Enlargement 4 X 3
l	01	Steel 3 in / 40	1.75	1-Tee Flow Thru Branch 1-Reducer Enlargement 4 X 3
m	01	Steel 3 in / 40	7.75	1-Tee Flow Thru Branch 1-Reducer Enlargement 4 X 3

PIPE MATERIALS LIST

02/17/98 9:52 am

D-11 of D-20

PIPELINE	SPEC	MATERIAL Size / Sch	LENGTH ft	VALVES & FITTINGS
n	01	Steel 3 in / 40	3.5	1-Tee Flow Thru Branch 1-Reducer Enlargement 4 X 3
o	01	Steel 4 in / 40	85	4-Elbow Long - r/d 1.5 @ 90° 1-Exit Sharp-Edged
p	01	Steel 4 in / 40	98	4-Elbow Long - r/d 1.5 @ 90° 1-Exit Sharp-Edged
q	01	Steel 4 in / 40	96	4-Elbow Long - r/d 1.5 @ 90° 1-Exit Sharp-Edged
r	01	Steel 4 in / 40	97	4-Elbow Long - r/d 1.5 @ 90° 1-Exit Sharp-Edged
s	01	Steel 20 in / 40	1	
t	01	Steel 20 in / 40	1	
u	01	Steel 8 in / 40	1	1-Fixed K 536.1
v	01	Steel 8 in / 40	1	1-Fixed K 536.1
w	01	Steel 8 in / 40	1	1-Fixed K 536.1
x	01	Steel 8 in / 40	1	1-Fixed K 536.1
y	01	Steel 8 in / 40	1	1-Fixed K 536.1
z	01	Steel 8 in / 40	1	1-Fixed K 536.1
za	01	Steel 4 in / 40	6	1-Entrance Sharp-Edged 1-Reducer Contraction 8 X 4 1-Reducer Enlargement 6 X 4
zb	01	Steel 4 in / 40	6.33	1-Entrance Sharp-Edged 1-Reducer Contraction 8 X 4 1-Reducer Enlargement 6 X 4
zc	01	Steel 4 in / 40	6.33	1-Entrance Sharp-Edged 1-Reducer Contraction 8 X 4 1-Reducer Enlargement 6 X 4
zd	01	Steel	8.33	1-Entrance Sharp-Edged

HNF-2479, Rev. 0
Page E-60

0-12 of 0-20

PIPELINE	SPEC	MATERIAL Size / Sch	LENGTH ft	VALVES & FITTINGS
		4 in / 40		1-Reducer Contraction 8 X 4 1-Reducer Enlargement 6 X 4
ze	01	Steel 4 in / 40	7.33	1-Entrance Sharp-Edged 1-Reducer Contraction 8 X 4 1-Reducer Enlargement 6 X 4
zf	01	Steel 4 in / 40	5.33	1-Entrance Sharp-Edged 1-Reducer Contraction 8 X 4 1-Reducer Enlargement 6 X 4
zg	01	Steel 6 in / 40	12	2-Elbow Long - r/d 1.5 @ 90° 1-Reducer Enlargement 8 X 6
zh	01	Steel 6 in / 40	12	2-Elbow Long - r/d 1.5 @ 90° 1-Tee Flow Thru Branch
zi	01	Steel 6 in / 40	12	2-Elbow Long - r/d 1.5 @ 90° 1-Tee Flow Thru Branch
zj	01	Steel 6 in / 40	14	2-Elbow Long - r/d 1.5 @ 90° 1-Tee Flow Thru Branch
zk	01	Steel 6 in / 40	12	2-Elbow Long - r/d 1.5 @ 90° 1-Tee Flow Thru Branch
zl	01	Steel 6 in / 40	20	3-Elbow Long - r/d 1.5 @ 90° 1-Elbow Long - r/d 1.5 @ 45° 1-Reducer Enlargement 8 X 6
zm	01	Steel 8 in / 40	50	1-Elbow Long - r/d 1.5 @ 90° 1-Elbow Long - r/d 1.5 @ 45° 1-Reducer Enlargement 12 X 8
zn	01	Steel 12 in / 40	53	2-Elbow Long - r/d 1.5 @ 45°
zo	01	Steel 12 in / 40	47	3-Elbow Long - r/d 1.5 @ 45°
zp	01	Steel 12 in / 40	27	1-Elbow Long - r/d 1.5 @ 45°
zq	01	Steel 8 in / 40	51	1-Elbow Long - r/d 1.5 @ 45°
zr	01	Steel 8 in / 40	21	2-Elbow Long - r/d 1.5 @ 45° 1-Reducer Enlargement 12 X 8

PIPE MATERIALS LIST

02/17/98 9:52 am

D-13 of D-20

PIPELINE	SPEC	MATERIAL Size / Sch	LENGTH ft	VALVES & FITTINGS
zs	01	Steel 16 in / 40	15	1-Reducer Enlargement 16 X 12 1-Elbow Long - r/d 1.5 @ 90° 1-Tee Flow Thru Branch
zt	01	Steel 32 in / 40	40	
zu	01	Steel 32 in / 40	40	
zv	01	Steel 32 in / 40	40	
zw	01	Steel 32 in / 40	40	
zx	01	Steel 32 in / 40	40	

D-14 of D-20

PIPE MATERIAL	SCHEDULE	SIZE	LENGTH
Steel	40	3 in	25.67 ft
		4 in	415.65 ft
		6 in	123.25 ft
		8 in	141 ft
		10 in	47 ft
		12 in	172 ft
		14 in	112 ft
		16 in	15 ft
		20 in	2 ft
		32 in	200 ft

VALVE & FITTING SUMMARY

SPECIFICATION	MATERIAL	SCHEDULE	VALVES & FITTINGS
01 Sch40	Steel	40	
			Size: 3 in
			4-Reducer Enlargement 4 X 3
			3-Tee Flow Thru Branch
			Size: 4 in
			16-Elbow Long - r/d 1.5 @ 90°
			4-Exit Sharp-Edged
			6-Entrance Sharp-Edged
			6-Reducer Contraction 8 X 4
			6-Reducer Enlargement 6 X 4
			Size: 6 in
			2-Elbow Long - r/d 1.5 @ 45°
			14-Elbow Long - r/d 1.5 @ 90°
			1-Reducer Contraction 6 X 3
			2-Reducer Enlargement 8 X 6
			4-Tee Flow Thru Branch
			Size: 8 in
			5-Elbow Long - r/d 1.5 @ 45°
			6-Fixed K 536.1
			1-Elbow Long - r/d 1.5 @ 90°
			2-Reducer Enlargement 12 X 8
			Size: 10 in
			1-Elbow Long - r/d 1.5 @ 45°
			1-Tee Flow Thru Run
			1-Reducer Contraction 10 X 6
			1-Reducer Contraction 10 X 8
			Size: 12 in
			3-Elbow Long - r/d 1.5 @ 90°
			1-Butterfly Valve
			6-Elbow Long - r/d 1.5 @ 45°
			Size: 14 in
			2-Tee Flow Thru Branch
			7-Elbow Long - r/d 1.5 @ 45°

Calculation w 320-27-054

D-15 of D-20

SPECIFICATION

MATERIAL

SCHEDULE

VALVES & FITTINGS

Size: 14 in

2-Tee Flow Thru Run

2-Reducer Contraction 14 X 10

Size: 16 in

1-Reducer Enlargement 16 X 12

1-Elbow Long - r/d 1.5 @ 90°

1-Tee Flow Thru Branch

D-16 of D-20

<p>Company: Fluor Daniel NW Project: by: Fluor Daniel NW Comments: Version: PIPE-FLO ver 5.01</p>	<p>02/17/98 9:54 am Lineup: ANNULUS flow rate: cfm pressure: psig level & grade: ft</p>
---	---

Calculation W320-27-054

System: ANNULUS
rev: 02/17/98 9:51 am

Deviation: 0.00167 %
after: 13 iterations

Volumetric flow rates require constant fluid properties in all pipelines. Fluid properties in the first specification were used in this calculation.

LINEUP SUMMARIES

NODE	DEMAND cfm	NODE	DEMAND cfm
------	---------------	------	---------------

Out	>>> 1000		
-----	----------	--	--

Flows IN: 0 cfm
Flows OUT: 1000 cfm

NET FLOWS OUT: 1000 cfm

LINEUP SUMMARIES

PIPELINE	FLOW cfm	PRESSURE SOURCE	SET psi g	LEVEL ft
----------	-------------	--------------------	--------------	-------------

a	<<< 1000	In	0	0
---	----------	----	---	---

Flows IN: 1000 cfm
Flows OUT: 0 cfm

NET FLOWS IN: 1000 cfm

NODE	ELEVATION ft	DEMAND cfm	PRESSURE psi g	H GRADE ft
A	674.43		-0.525	-295.7
B	674.44		-0.004	666.8
C	674.8		-0.526	-297.6
D-in	677.33		-0.007	665.1
D-out	677.35		-0.528	-300
E	673.49		-0.525	-297.6
F	673.37		-0.006	662.5
G	673.22		-0.524	-296.5
H-in	672.69		-0.014	647.7
H-out	672.79		-0.523	-294.2
I	677.5		-0.005	669
In	681.86		0 (source)	681.9
J	673.37		-0.006	662.4
K	673.07		-0.007	660.3
L	674.83		-0.003	668.5
M	674.52		-0.004	668
N	671.44		-0.023	628.8
O	658.77		-0.078	515.4
Out	682.33	> 1000	-0.534	-305.6
P	671.62		-0.075	533.8
Q	669.58		-0.089	504.4
R	670.92		-0.078	526.6
S	623		-0.196	260
T	623		-0.196	260
U	623		-0.196	260
V	663.17		-0.506	-272.6
W	663.17		-0.506	-272.6
X	663.17		-0.506	-272.6
Y	663.17		-0.506	-272.6
Z	663.17		-0.506	-272.6
ZA	663.17		-0.506	-272.6
ZB	669.17		-0.519	-291.2
ZC	669.5		-0.519	-291.2
ZD	669.5		-0.520	-292
ZE	671.5		-0.522	-294.1
ZF	670.5		-0.521	-292.3
ZG	668.5		-0.519	-290.6
ZH	677.5		-0.530	-302

D-19 of D-20

PIPELINE	FROM	TO	FLOW cfm	VEL ft/sec	dP psi g	HL ft
a	In	I	1000	21.46	0.005	12.86
b	I	D-in	749.9	13.32	0.002	3.916
c	D-In	F	510	9.056	0	2.635
d	F	J	257.4	4.571	0	0.045
e	J	K	257.4	7.841	0	2.121
f	K	H-in	257.4	21.4	0.007	12.61
g	I	L	250.1	4.441	(0.001)	0.484
h	L	M	250.1	7.619	0	0.502
i	M	B	250.1	12.01	0	1.249
j	H-in	N	257.4	21.4	0.010	18.83
k	N	O	257.4	* 83.64	0.054	113.5
l	F	P	252.6	* 82.08	0.069	128.7
m	D-in	Q	239.9	* 77.95	0.083	160.7
n	B	R	250.1	* 81.27	0.074	140.2
o	O	S	257.4	* 48.57	0.119	255.3
p	P	S	252.6	* 47.67	0.122	273.7
q	Q	S	239.9	* 45.27	0.107	244.3
r	R	S	250.1	* 47.19	0.118	266.5
s	S	T	500	4.321	0	0.004
t	S	U	500	4.321	0	0.004
u	T	V	166.7	8.003	0.310	532.7
v	T	W	166.7	8.003	0.310	532.7
w	T	X	166.7	8.003	0.310	532.7
x	U	Y	166.7	8.003	0.310	532.7
y	U	Z	166.7	8.003	0.310	532.7
z	U	ZA	166.7	8.003	0.310	532.7
za	V	ZB	166.4	31.39	0.013	18.58
zb	W	ZC	164.6	31.06	0.013	18.51
zc	X	ZD	168.5	31.79	0.014	19.37
zd	Y	ZE	168.8	31.86	0.016	21.44
ze	Z	ZF	165.3	31.18	0.015	19.61
zf	ZA	ZG	166.5	31.42	0.013	17.96
zg	ZB	H-out	166.4	13.83	0.004	3.025
zh	ZC	G	164.6	13.69	0.005	5.35
zi	ZD	E	168.5	14.01	0.005	5.597
zj	ZE	D-out	168.8	14.04	0.006	5.89
zk	ZF	C	165.3	13.74	0.005	5.392
zl	ZG	A	166.5	13.84	0.006	5.137
zm	H-out	G	166.4	7.988	0.001	2.254
zn	G	E	330.9	7.103	0	1.105
zo	E	D-out	499.4	10.72	0.003	2.37

HNF-2479, Rev. 0
Page E-68

D-20 of D-20

PIPELINE	FROM	TO	FLOW cfm	VEL ft/sec	dP psi g	HL ft
z	D-out	ZH	668.2	14.34	0.001	2.05
zq	A	C	166.5	7.995	0.001	1.907
zr	C	ZH	331.8	15.93	0.004	4.378
zs	ZH	Out	1000	13.59	0.005	3.529
zt	V	W	0.306	0	0	0
zu	W	X	2.385	0.008	0	0
zv	X	Y	0.596	0.002	0	0
zw	Z	<-> Y	1.572	0.005	0	0
zx	ZA	<-> Z	0.163	0	0	0

DESIGN ANALYSIS

Client: Numatec

WO/Job No.: ER4319/W-320

Subject: System Curves for Portable Exhauster Installation

Date: 2/18/98 By: Kelly Hayase

Checked: 3/2/98 By: *Kim Clark*

Location: 241-C/241-AY

Revised:

By:

Appendix E: Pipe-Flo results of ANNULUS used to generate the system curve

Out: -0.00

02/17/98 9:56 am

Linelist: ANNULUS

flow rate: cfm

Level & grade: ft

Calculation W320-27-054

Calculation W320-27-054

Company: Fluor Daniel NW
 Project: Fluor Daniel NW
 by: Fluor Daniel NW
 Comments:

Version: PIPE-FLO ver 5.01

02/17/98 9:57 am
 Linelist: ANNULUS
 Lineup: ANNULUS
 flow rate: cfm
 pressure: psi_g
 level & grade: ft

E-2 of E-13

02/17/98 9:59 am
Linelist: ANNULUS
Lineup: ANNULUS
flow rate: cfm
pressure: psi
level & grade: ft

Version: PIPE-FLO ver 5.01

HNF-2479, Rev. 0
Page E-73

Calculation W320-27-054

Calculation W320-27-054

HNF-2479, Rev. 0
Page E-74

E-4 of E-13

Company: Fluor Daniel NW
Project: Fluor Daniel NW
Comments: PIPF-FLO ver 5.01
Version: PIPF-FLO ver 5.01
Line1st: ANNUUS
Lineup: ANNUUS
flow rate: cfm
pressure: psi
level & grade: ft
02/17/98 9:59 am

02/17/98 10:00 am
 Linelist: ANNULUS
 Lineup: ANNULUS
 flow rate: cfm
 pressure: psi
 level & grade: ft

Calculation W320-27-054

E-6 of E-13

HNF-2479, Rev. 0
Page E-76

Calculation W320-27-054

Company: Fluor Daniel NW

Project: by: Fluor Daniel NW

Comments:

Version: PIPE-FLO ver 5.01

02/17/98 10:02 am
Linelet: ANNULUS
Lineup: ANNULUS
flow rate: cfm
pressure: psig
level & grade: ft

E-7 of E-13

HNF-2479, Rev. 0
Page E-77

Calculation W320-27-054

Company: Fluor Daniel NW

Project: by: Fluor Daniel NW

Comments:

Version: PIPE-FLO ver 5.01

02/17/98 10:03 am

LineList: ANNULUS

flow rate: cfm

pressure: psi

level & grade: ft

Calculation W320-27-054

HNF-2479, Rev. 0
Page E-78

Company: Fluor Daniel NW
Project: Fluor Daniel NW
Comments:
Version: PPE-FLO ver 5.01

Line list: ANNULUS
Lineup: ANNULUS
Flow rate: cfm
Pressure: psig
Level & grade: ft

E-8 of E-13

HNF-2479, Rev. 0
Page E-79

Calculation W320-27-094

E-9 of E-13

Company: Fluor Daniel NW

Project: by: Fluor Daniel NW

Comments:

Version: PIPE-FLO ver 5.01

02/17/98 10:06 am

Line1st: ANNULUS

Lineup: ANNULUS

flow rate: cfm

pressure: psig

level & grade: ft

Calculation W320-27-054

HNF-2479, Rev. 0
Page E-80

E-10 of E-13

Company: Fluor Daniel NW
Project:
by: Fluor Daniel NW
Comments:

Version: PIPE-FLO ver 5.01

02/17/98 10:09 am
Linelist: ANNULUS
Lineup: ANNULUS
flow rate: cfm
pressure: psi
level & grade: ft

0 @ 0

In: 0

Calculation W320-27.054

E-11 of E-13

Company: Fluor Daniel NW
 Project:
 by: Fluor Daniel NW
 Comments:

Version: PIPE-FLO ver 5.01

02/17/98 10:11 am
 Linelist: ANNULUS
 Lineup: ANNULUS
 flow rate: cfm
 pressure: psi_a
 level & grade: ft

E-12 of E-13

02/17/98 10:13 am
 Linelist: ANNUULUS
 Lineup: ANNUULUS
 flow rate: cfm
 pressure: psia
 level & grade: ft

Company: Fluor Daniel NW
 Project: Fluor Daniel NW
 by: Fluor Daniel NW
 Comments:

Version: PIPE-FLO ver 5.01

HNF-2479, Rev. 0
 Page E-82

Calculation W320-27-054

Calculation W320-27-054

HNF-2479, Rev. 0
Page E-83

E-13 of E-13

Company: Fluor Daniel NW
Project:
by: Fluor Daniel NW
Comments:

Version: PIPE-FLO ver 5.01

02/17/98 10:14 am
Linelist: ANNULUS
Lineup: ANNULUS
flow rate: cfm
pressure: psig
level & grade: ft

DESIGN ANALYSIS

Client: Numatec

WO/Job No.: ER4319/W-320

Subject: System Curves for Portable Exhauster Installation

Date: 2/18/98

By: Kelly Hayase

Checked: 3/2/98

By: *Kai Carl*

Location: 241-C/241-AY

Revised:

By:

Appendix F: Pipe-Flo Model ANNU-PEX

F-1 of F-15

HNF-2479, Rev. 0
Page E-85

Company: Fluor Daniel NW
Project: Fluor Daniel NW
Comments: PIPE-FLO ver 5.01
Version: PIPE-FLO ver 5.01

02/18/98 2:02 pm
Linelist: ANNU-PEX
Lineup: flow rate: cfm
pressure: psig
level & grade: ft

Calculation W320-27-054

Company: Fluor Daniel NW
Project:
by: Fluor Daniel NW

02/18/98 2:03 pm
System: ANNU-PEX
rev: 02/18/98 2:02 pm

F-2 of F-15

SYSTEM REPORT

Created: 01/26/98 11:38 am
Design file:
Pipe Specs: 1

Pipes: 33
Nodes: 26
Pumps/Comps: 1

SYSTEM NODES

NODE	ELEVATION ft	PIPELINES IN	PIPELINES OUT
B	674.44	i	n
D-in	677.33	b	c m
F	673.37	c	d l
H-in	672.69	f	j
I	677.5	a	b g
In	681.86		a
J	673.37	d	e
K	673.07	e	f
L	674.83	g	h
M	674.52	h	i
N	671.44	j	k
O	658.77	k	o
P	671.62	l	p
Q	669.58	m	q
R	670.92	n	r
S	623	o p q r	s t
T	623	s	u v w
U	623	t	x y z
V	663.17	u	zt

HNF-2479, Rev. 0
Page E-86

SYSTEM NODES

02/18/98 2:03 pm

F-3 of F-15

NODE	ELEVATION ft	PIPELINES IN	PIPELINES OUT
W	663.17	v zt	zu
X	663.17	w zu	zv
Y	663.17	x zv	zw zy
Z	663.17	y zw	zx
ZA	663.17	z zx	
ZI	680	zy	zz
ZJ	683	zz	

PIPELINE	SPEC	FROM_NODE	TO_NODE	PUMP/COMP
a	01	In	I	
b	01	I	D-in	
c	01	D-in	F	
d	01	F	J	
e	01	J	K	
f	01	K	H-in	
g	01	I	L	
h	01	L	M	
i	01	M	B	
j	01	H-in	N	
k	01	N	O	
l	01	F	P	
m	01	D-in	Q	
n	01	B	R	
o	01	O	S	
p	01	P	S	
q	01	Q	S	
r	01	R	S	
s	01	S	T	
t	01	S	U	
u	01	T	V	
v	01	T	W	
w	01	T	X	
x	01	U	Y	
y	01	U	Z	
z	01	U	ZA	
zt	01	V	W	
zu	01	W	X	
zv	01	X	Y	
zw	01	Y	Z	
zx	01	Z	ZA	
zy	01	Y	ZI	
zz	<01>	ZI	ZJ	

Company: Fluor Daniel NW
Project:
by: Fluor Daniel NW

02/18/98 2:03 pm
System: ANNU-PEX
rev: 02/18/98 2:02 pm F-5 of F-15

PIPELIST REPORT

Created: 01/26/98 11:38 am
Design file:
Pipe Specs: 1

Pipes: 33
Nodes: 26
Pumps/Comps: 1

SPECIFICATIONS

SPECIFICATION	PIPE MATERIAL Sch / Roughness	FLUID Temp / Pres	VALVE TABLE	DESIGN LIMITS Vel / Pres
01 Sch40 rev: 01/29/98 11:21 am	Steel Sch 40 0.0018 in Size for: 6 ft/sec	Air 50 °F 0 psi g	Standard Standard	0 - 40 ft/sec -14.4 - 14.4 psi g

HNF-2479, Rev. 0
Page E-89

PIPELINE	SPEC	MATERIAL Size / Sch	LENGTH ft	FLUID Temp / Pres	VALVES Total-K
a	01	Steel 12 in / 40	45	Air 50 °F / 0 psi g	0.9994
b	01	Steel 14 in / 40	31	Air 50 °F / 0 psi g	0.8908
c	01	Steel 14 in / 40	71	Air 50 °F / 0 psi g	0.76
d	01	Steel 14 in / 40	1	Air 50 °F / 0 psi g	0.1164
e	01	Steel 10 in / 40	30	Air 50 °F / 0 psi g	1.429
f	01	Steel 6 in / 40	40	Air 50 °F / 0 psi g	0.1478
g	01	Steel 14 in / 40	9	Air 50 °F / 0 psi g	1.388
h	01	Steel 10 in / 40	17	Air 50 °F / 0 psi g	0.1047
i	01	Steel 8 in / 40	13	Air 50 °F / 0 psi g	0.1396
j	01	Steel 6 in / 40	1.25	Air 50 °F / 0 psi g	2.599
k	01	Steel 3 in / 40	12.67	Air 50 °F / 0 psi g	0.05435
l	01	Steel 3 in / 40	1.75	Air 50 °F / 0 psi g	1.094
m	01	Steel 3 in / 40	7.75	Air 50 °F / 0 psi g	1.094
n	01	Steel 3 in / 40	3.5	Air 50 °F / 0 psi g	1.094
o	01	Steel 4 in / 40	85	Air 50 °F / 0 psi g	1.913
p	01	Steel 4 in / 40	98	Air 50 °F / 0 psi g	1.913
q	01	Steel 4 in / 40	96	Air 50 °F / 0 psi g	1.913
r	01	Steel 4 in / 40	97	Air 50 °F / 0 psi g	1.913
s	01	Steel 20 in / 40	1	Air 50 °F / 0 psi g	0
t	01	Steel 20 in / 40	1	Air 50 °F / 0 psi g	0
u	01	Steel 8 in / 40	1	Air 50 °F / 0 psi g	536.1
v	01	Steel 8 in / 40	1	Air 50 °F / 0 psi g	536.1
w	01	Steel 8 in / 40	1	Air 50 °F / 0 psi g	536.1
x	01	Steel 8 in / 40	1	Air 50 °F / 0 psi g	536.1

F-7.8 F-15

PIPELINE	SPEC	MATERIAL Size / Sch	LENGTH ft	FLUID Temp / Pres	VALVES Total-K
y	01	Steel 8 in / 40	1	Air 50 °F / 0 psi g	536.1
z	01	Steel 8 in / 40	1	Air 50 °F / 0 psi g	536.1
zt	01	Steel 32 in / 40	40	Air 50 °F / 0 psi g	0
zu	01	Steel 32 in / 40	40	Air 50 °F / 0 psi g	0
zv	01	Steel 32 in / 40	40	Air 50 °F / 0 psi g	0
zw	01	Steel 32 in / 40	40	Air 50 °F / 0 psi g	0
zx	01	Steel 32 in / 40	40	Air 50 °F / 0 psi g	0
zy	01	Steel 12 in / 40	20	Air 50 °F / 0 psi g	1
zz	<01>	Steel 8 in / 80 roughness: 0.018 in	45	Air 50 °F / 0 psi g	0.699

MATERIALS REPORT

Pipes: 33
Nodes: 26
Pumps/Comps: 1

Created: 01/26/98 11:38 am
Design file:
Pipe Specs: 1

PIPE MATERIALS LIST

PIPELINE	SPEC	MATERIAL Size / Sch	LENGTH ft	VALVES & FITTINGS
a	01	Steel 12 in / 40	45	3-Elbow Long - r/d 1.5 @ 90° 1-Butterfly Valve
b	01	Steel 14 in / 40	31	1-Tee Flow Thru Branch 1-Elbow Long - r/d 1.5 @ 45°
c	01	Steel 14 in / 40	71	4-Elbow Long - r/d 1.5 @ 45° 1-Tee Flow Thru Run
d	01	Steel 14 in / 40	1	1-Reducer Contraction 14 X 10
e	01	Steel 10 in / 40	30	1-Elbow Long - r/d 1.5 @ 45° 1-Tee Flow Thru Run 1-Reducer Contraction 10 X 6
f	01	Steel 6 in / 40	40	1-Elbow Long - r/d 1.5 @ 45°
g	01	Steel 14 in / 40	9	2-Elbow Long - r/d 1.5 @ 45° 1-Tee Flow Thru Branch 1-Reducer Contraction 14 X 10 1-Tee Flow Thru Run
h	01	Steel 10 in / 40	17	1-Reducer Contraction 10 X 8
i	01	Steel 8 in / 40	13	1-Elbow Long - r/d 1.5 @ 45°
j	01	Steel 6 in / 40	1.25	1-Elbow Long - r/d 1.5 @ 90° 1-Reducer Contraction 6 X 3
k	01	Steel 3 in / 40	12.67	1-Reducer Enlargement 4 X 3
l	01	Steel 3 in / 40	1.75	1-Tee Flow Thru Branch 1-Reducer Enlargement 4 X 3
m	01	Steel 3 in / 40	7.75	1-Tee Flow Thru Branch 1-Reducer Enlargement 4 X 3

F-9 of F-15

PIPELINE	SPEC	MATERIAL Size / Sch	LENGTH ft	VALVES & FITTINGS
n	01	Steel 3 in / 40	3.5	1-Tee Flow Thru Branch 1-Reducer Enlargement 4 X 3
o	01	Steel 4 in / 40	85	4-Elbow Long - r/d 1.5 @ 90° 1-Exit Sharp-Edged
p	01	Steel 4 in / 40	98	4-Elbow Long - r/d 1.5 @ 90° 1-Exit Sharp-Edged
q	01	Steel 4 in / 40	96	4-Elbow Long - r/d 1.5 @ 90° 1-Exit Sharp-Edged
r	01	Steel 4 in / 40	97	4-Elbow Long - r/d 1.5 @ 90° 1-Exit Sharp-Edged
s	01	Steel 20 in / 40	1	
t	01	Steel 20 in / 40	1	
u	01	Steel 8 in / 40	1	1-Fixed K 536.1
v	01	Steel 8 in / 40	1	1-Fixed K 536.1
w	01	Steel 8 in / 40	1	1-Fixed K 536.1
x	01	Steel 8 in / 40	1	1-Fixed K 536.1
y	01	Steel 8 in / 40	1	1-Fixed K 536.1
z	01	Steel 8 in / 40	1	1-Fixed K 536.1
zt	01	Steel 32 in / 40	40	
zu	01	Steel 32 in / 40	40	
zv	01	Steel 32 in / 40	40	
zw	01	Steel 32 in / 40	40	
zx	01	Steel 32 in / 40	40	
zy	01	Steel 12 in / 40	20	1-Exit Sharp-Edged

HNF-2479, Rev. 0
Page E-93

PIPE MATERIALS LIST

02/18/98 2:03 pm

F-10 of F-15

PIPELINE	SPEC	MATERIAL Size / Sch	LENGTH ft	VALVES & FITTINGS
zz	<01>	Steel 8 in / 80	45	1-Elbow Long - r/d 1.5 @ 90° 1-Entrance Sharp-Edged

PIPE MATERIAL	SCHEDULE	SIZE	LENGTH
Steel	40	3 in	25.67 ft
		4 in	376 ft
		6 in	41.25 ft
		8 in	19 ft
		10 in	47 ft
		12 in	65 ft
		14 in	112 ft
		20 in	2 ft
		32 in	200 ft
Steel	80	8 in	45 ft

VALVE & FITTING SUMMARY

SPECIFICATION	MATERIAL	SCHEDULE	VALVES & FITTINGS
01 Sch40	Steel	40	
			Size: 3 in
			4-Reducer Enlargement 4 X 3
			3-Tee Flow Thru Branch
			Size: 4 in
			16-Elbow Long - r/d 1.5 @ 90°
			4-Exit Sharp-Edged
			Size: 6 in
			1-Elbow Long - r/d 1.5 @ 45°
			1-Elbow Long - r/d 1.5 @ 90°
			1-Reducer Contraction 6 X 3
			Size: 8 in
			1-Elbow Long - r/d 1.5 @ 45°
			6-Fixed K 536.1
			1-Elbow Long - r/d 1.5 @ 90°
			1-Entrance Sharp-Edged
			Size: 10 in
			1-Elbow Long - r/d 1.5 @ 45°
			1-Tee Flow Thru Run
			1-Reducer Contraction 10 X 6
			1-Reducer Contraction 10 X 8
			Size: 12 in
			3-Elbow Long - r/d 1.5 @ 90°
			1-Butterfly Valve
			1-Exit Sharp-Edged
			Size: 14 in
			2-Tee Flow Thru Branch
			7-Elbow Long - r/d 1.5 @ 45°
			2-Tee Flow Thru Run
			2-Reducer Contraction 14 X 10

F-12 of F-15

Company:	Fluor Daniel NW
Project:	Fluor Daniel NW
by:	Fluor Daniel NW
Comments:	
Version:	PIPE-FLO ver 5.01
02/18/98 2:04 pm	Lineup: ANNU-PEX
	flow rate: cfm
	pressure: psig
	level & grade: ft

Calculation W320-27-054

System: ANNU-PEX
rev: 02/18/98 2:02 pm

Deviation: 8.7e-005 %
after: 16 iterations

Volumetric flow rates require constant fluid properties in all pipelines. Fluid properties in the first specification were used in this calculation.

LINEUP SUMMARIES

NODE	DEMAND cfm	NODE	DEMAND cfm
ZJ	>>> 1000		

Flows IN: 0 cfm
Flows OUT: 1000 cfm
NET FLOWS OUT: 1000 cfm

LINEUP SUMMARIES

PIPELINE	FLOW cfm	PRESSURE SOURCE	SET psi g	LEVEL ft
a	<<< 1000	In	0	0

Flows IN: 1000 cfm
Flows OUT: 0 cfm
NET FLOWS IN: 1000 cfm

NODE	ELEVATION ft	DEMAND cfm	PRESSURE psi g	H GRADE ft
B	674.44		-0.004	666.8
D-in	677.33		-0.007	665.1
F	673.37		-0.006	662.5
H-in	672.69		-0.014	647.7
I	677.5		-0.005	669
In	681.86		0 (source)	681.9
J	673.37		-0.006	662.4
K	673.07		-0.007	660.3
L	674.83		-0.003	668.5
M	674.52		-0.004	668
N	671.44		-0.023	628.8
O	658.77		-0.078	515.4
P	671.62		-0.075	533.8
Q	669.58		-0.089	504.4
R	670.92		-0.078	526.6
S	623		-0.196	260
T	623		-0.196	260
U	623		-0.196	260
V	663.17		-0.506	-272.6
W	663.17		-0.506	-272.6
X	663.17		-0.506	-272.6
Y	663.17		-0.506	-272.7
Z	663.17		-0.506	-272.6
ZA	663.17		-0.506	-272.6
ZI	680		-0.520	-282.3
ZJ	683	> 1000	-0.580	-389.5

F-15 of F-15

PIPELINE	FROM	TO	FLOW cfm	VEL ft/sec	dP psi g	HL ft
b	In	I	1000	21.46	0.005	12.86
c	I	D-in	749.9	13.32	0.002	3.916
d	D-in	F	510	9.056	0	2.635
e	F	J	257.4	4.571	0	0.045
f	J	K	257.4	7.841	0	2.121
g	K	H-in	257.4	21.4	0.007	12.61
h	I	L	250.1	4.441	(0.001)	0.484
i	L	M	250.1	7.619	0	0.502
j	M	B	250.1	12.01	0	1.249
k	H-in	N	257.4	21.4	0.010	18.83
l	N	O	257.4	* 83.64	0.054	113.5
m	F	P	252.6	* 82.08	0.069	128.7
n	D-in	Q	239.9	* 77.95	0.083	160.7
o	B	R	250.1	* 81.27	0.074	140.2
p	O	S	257.4	* 48.57	0.119	255.3
q	P	S	252.6	* 47.67	0.122	273.7
r	Q	S	239.9	* 45.27	0.107	244.3
s	R	S	250.1	* 47.19	0.118	266.5
t	S	T	500	4.321	0	0.004
u	S	U	500	4.321	0	0.004
v	T	V	166.7	8.003	0.310	532.7
w	T	W	166.7	8.003	0.310	532.7
x	T	X	166.7	8.003	0.310	532.7
y	U	Y	166.7	8.003	0.310	532.7
z	U	Z	166.7	8.003	0.310	532.7
zt	V	W	166.7	0.544	0	0.002
zu	W	X	333.3	1.087	0	0.008
zv	X	Y	500	1.631	0	0.016
zw	Z	<-> Y	333.3	1.087	0	0.008
zx	ZA	<-> Z	166.7	0.544	0	0.002
zy	Y	ZI	1000	21.46	0.014	9.686
zz	ZI	ZJ	1000	* 52.61	0.060	107.2

HNF-2479, Rev. 0
Page E-99

Calculation W520-27-054

DESIGN ANALYSIS

Client: Numatec

WO/Job No.: ER4319/W-320

Subject: System Curves for Portable Exhauster Installation

Date: 2/18/98

By: Kelly Hayase

Checked: 3/2/98

By: Kim Clark

Location: 241-C/241-AY

Revised:

By:

Appendix G: Pipe-Flo results of ANNU-PEX used to generate the system curve

G-1 of G-13

02/18/98 2:06 pm	Line list: ANNU-PEX
Project: Fluor Daniel NW	Lineup: ANNU-PEX
by: Fluor Daniel NW	flow rate: cfm
Comments:	pressure: psig
Version: PIPE-FLO ver 5.01	level & grade: ft

Calculation W320-27-054

Calculation W320-27-0.54

HNF-2479, Rev. 0
Page E-102

Company: Fluor Daniel NW
Project: Fluor Daniel NW
by: Fluor Daniel NW
Comments: Version: PIPE-FLO ver 5.01

Level & grade: ft
flow rate: cfm
pressure: psig
Lineup: ANNU-PEX
Lineist: ANNU-PEX
02/18/98 2:07 pm

6-2 of 6-13

02/18/98 2:08 pm
Linelist: ANNU-PEX
Lineup: ANNU-PEX
flow rate: cfm
pressure: psig
level & grade: ft

G-4 of G-13

02/18/98 2:28 pm
Linelist: ANNU-PEX
Lineup: ANNU-PEX
flow rate: cfm
pressure: psig
level & grade: ft

Company: Fluor Daniel NW
Project: Fluor Daniel NW
by: Fluor Daniel NW
Comments: Version: PIPE-FLO ver 5.01

Calculation W320-27-054

Calculation W320-27-054

G-5085-13

Company: Fluor Daniel NW	Project: Fluor Daniel NW	Comments: by: Fluor Daniel NW
Version: PIPE-FLO ver 5.01	Level & grade: ft	pressure: psig
	flow rate: cfm	Lineup: ANNU-PEX
	Lineist: ANNU-PEX	2:28 pm
	02/18/98	

G-6 of G-13

02/18/98 2:30 pm
Line list: ANNU-PEX
Lineup: ANNU-PEX
flow rate: cfm
pressure: psig
level & grade: ft

Company: Fluor Daniel NW
 Project: Fluor Daniel NW
 Comments: PIPE-FLO ver 5.01
 Version: PIPE-FLO ver 5.01

Calculation W320-27-054

Calculation W520-27-054

Company: Fluor Daniel NW
Project:
by: Fluor Daniel NW
Comments:

Version: PIPE-FLO ver 5.01

02/18/98 2:31 pm
Linelist: ANNU-PEX
Lineup: ANNU-PEX
flow rate: cfm
pressure: psi_a
level & grade: ft

G-7.0.8 G-13

G-8 of G-13

02/18/98 2:32 pm
Linelist: ANNU-PEX
Lineup: ANNU-PEX
flow rate: cfm
pressure: psig
level & grade: ft

Company: Fluor Daniel NW
Project: Fluor Daniel NW
Comments: PIPE-FLO ver 5.01
Version: PIPE-FLO ver 5.01

Calculation w320-27-054

G-9 of G-13

02/18/98 2:34 pm
Lineitem: ANNU-PEX
Lineup: ANNU-PEX
flow rate: cfm
pressure: psig
level & grade: ft

Company: Fluor Daniel NW
 Project: Fluor Daniel NW
 Comments:
 Version: PIPE-FLO ver 5.01

Calculation W320-27-054

G-11 of G-13

Company: Fluor Daniel NW Project: by: Fluor Daniel NW Comments: Version: PIPE-FLO ver 5.01	02/18/98 2:36 pm Linelist: ANNU-PEX Lineup: ANNU-PEX flow rate: cfm pressure: psig level & grade: ft
---	--

Calculation W320-27-054

G-12 of G-13

HNF-2479, Rev. 0
Page E-112

Company: Fluor Daniel NW
Project: Fluor Daniel NW
Comments:
Version: PIPE-FLO ver 5.01

02/18/98 2:38 pm
Linelist: ANNU-PEX
flow rate: cfm
pressure: psig
level & grade: ft

Calculation W320-27-054

G-13 of G-13

HNF-2479, Rev. 0
Page E-113

Company: Fluor Daniel NW
Project: Fluor Daniel NW
by: Fluor Daniel NW
Comments:
Version: PIPE-FLO ver 5.01

02/18/98 2:40 pm
Linelist: ANNU-PEX
Lineup: ANNU-PEX
flow rate: cfm
pressure: psig
level & grade: ft

Calculation W320-27-054

DESIGN ANALYSIS

Client: Numatec

WO/Job No.: ER4319/W-320

Subject: System Curves for Portable Exhauster Installation

Date: 2/18/98

By: Kelly Hayase

Checked: 3/2/98

By: Ken Cook

Location: 241-C/241-AY

Revised:

By:

Appendix H: References

Author: Steven W (Steve) Shaw at HANFORD12E
Date: 1/26/98 6:56 AM
TO: John W Bailey at HANFORD10C
TO: Owen D Nelson at HANFORD21E
TO: William J (Bill) Powell at HANFORD04E
TO: Ryan A Dodd at HANFORD05E
TO: Joseph M Jones at HANFORD05E
TO: Ronald L Legg at HANFORD11B
TO: Daniel G (Dan) Baide at HANFORD04A
TO: Jack W Lentsch at HANFORD24E
TO: Mark M Jennings at HANFORD11C
TO: Kenneth J Anderson at HANFORD10A
TO: Jeffrey E Andrews at HANFORD04E
Subject: 102-AV ANNULUS VENT SYSTEM TESTING

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

Just to keep everybody up to speed, and to apologize again for calling on Saturday:

Friday night, after resheaving the fan, we were able to close T-V-1 all the way, and got several good data points for the system curve.

800 FPM @ 14 in wg vacuum
850 FPM @ 15 in wg
900 FPM @ 15.5 in wg (highly suspect due to flow instability).
MK-6501 full open.

However, due to an omission in the OTP, we were not able to operate the radial inlet damper to the fan. At this point 1000 FPM flow velocities through the annulus will not be obtainable. What we would hope to obtain by operation of the radial inlet damper would be to stabilize the flow at something less than 900 FPM.

The HOPE is that by closing the radial inlet damper, we will change the velocity profile/inlet path into the fan, and achieve a stable flow velocity. However, by closing the damper, it must be assumed that we will take a pressure loss with a corresponding decrease in flow.

Calculation W320-27-054

Figure 2-11. Floor Volumetric Flow vs. Annulus Vacuum or System Pressure Drop—6-Inch Annulus Inlet Lines Blocked and Unblocked.

W320-27-055

Nozzle Plate & Encasement Plate Analysis

Fluor Daniel NORTHWEST, INC

CALCULATION IDENTIFICATION AND INDEX

Page i of iii

Date 7/17/98

This sheet shows the status and description of the attached Design Analysis sheets.

Discipline	27, Piping and Vessels	WO/Job No: W320	Calculation No.	W320-27-055
Project No. & Name	Project W-320, Waste Retrieval for Tank 241-C-106			
Calculation Item	Nozzle Plate & Encasement Plate Analysis.			

These calculations apply to:

Dwg. No.	H-2-818522 & H-2-818523	Rev. No.	1
Dwg. No.	H-2-818542 & H-2-818543	Rev. No.	2
Other (Study, CDR)			

The status of these calculations is:

- ☐ Preliminary Calculations
- ☒ Final Calculations
- ☐ Check Calculations (On Calculation Dated _____)
- ☐ Void Calculation (Reason Voided _____)

Incorporated in Final Drawings?

☒ Yes ☐ No

This calculation verified by independent "check" calculation?

☐ Yes ☒ No

Original and Revised Calculation Approvals:

	Rev. 0 Signature / Date	Rev. 1 Signature / Date	Rev. 2 Signature / Date
Originator	MM Ahmed 7/17/98		
Checked by	Sean Fargo 7-21-98		
Approved by	Dan L. Evans 7/23/98		
Checked Against Approved Vendor Data	7.23.98		

Design Analysis

Page No.

INDEX

Description

i	Calculation Identification and Index
ii	Calculation Cross Index
iii	Design Verification Screening Criteria
1	Objective, Introduction, Design Criteria, Design inputs
2	Design methodology
3	Calculations, References and Conclusion
4-7	Process, Encasement & Jumper piping load consolidation
8-11	Nozzle Kick Off Plate Analysis
12-13	Encasement pipe Plate Analysis
Appdx-A	Reference Material

CALCULATION CROSS INDEX (Typical)

Subject Calculation No. W320-27-055

Page ii of iii

Subject Calculation Revision No.	Superseded by Calculation No.	These interfacing calculation/documents provide input to the subject calculation, and if revised may require revision of the subject calculation.		Results and conclusions of the subject calculation are used in these interfacing calculations and/or documents.		Does the output interface calculation/ documents require revision?		Has the output interface calculation/ documents been revised?		Discipline manager's signature and date indicating evaluation is complete
		Calculation/Document No.	Revision. No.	Calculation/Document No.	Revision. No.	Yes	No	Yes	No	
0	NA	Dwg.# H-2-818522	1	NA			X		X
0	NA	Dwg# H-2-818523	1	NA			X		X	
0	NA	Dwg# H-2-818542	2	NA			X		X	
0	NA	Dwg# H-2-818543	2	NA			X		X	
0	NA	Calc# W320-27-013	3	NA			X		X	
0	NA	Calc# W320-27-014	2	NA			X		X	
0	NA	Calc# W320-27-016	1	NA			X		X	
0	NA	Calc# W320-27-029	3	NA			X		X	

KEH 1975.00 (12/88)

DESIGN VERIFICATION SCREENING CRITERIA

Project/Document No. W320-27-055

When the design or design change affects hardware, independent design verification must be performed if one or more of the following questions must be answered affirmatively (YES).

YES

NO

<u> </u>	<u> X </u>	1. Does the design or design change involved meet the established criteria to be considered Safety Class?
<u> </u>	<u> X </u>	2. Does this design or design change cause or permit changes to Safety Class instrument or alarm setpoints outside of previously approved operational limits?
<u> </u>	<u> X </u>	3. Does this design or design change significantly affect the nuclear or environmental safety consequences of a malfunction or failure of the structure, system, or component?
<u> </u>	<u> X </u>	4. Does this design or design change involve or change design that has previously undergone formal design verification?

Assigned Lead Engineer

7.17.98

Date

Engineering Manager

7.23.98

Date

Original Design Package Distribution:

Project Manager

Engineering Manager

Technical Document Control

Design Change Distribution:

Attach to Design Change Notice

DESIGN ANALYSIS

Client Numatec Hanford Inc

Subject Project W-320, Waste retrieval for Tank 241-C-106

Nozzle Plate & Encasement Plate Analysis

Location 200W.

WO/Job No.

Date: July 17, 98

Checked 7/24/98

Revised

Filename: W320p1ts

By: M. M. Ahmed *MM*By: S. Fargo *SAR*

By:

OBJECTIVE:

The objective of this calculation is two fold:

Analyze the nozzle kick off plates located inside of the pit wall for primary process pipe and jumper pipe loads.

Analyze the encasement pipe cover plates located outside of the pit wall for encasement pipe loads.

To meet the requirements of ASME code B31.3 allowable stresses.

INTRODUCTION:

The transfer lines passing through pit (pump & sluice) walls penetrations have plates connected to piping on either side of the pit wall as detailed on drawings (Ref:7).

Nozzle plate located inside the pit, is a standard size-4 Purex nozzle kick off plate (3/8"X13"X13") is welded to primary & jumper pipe on one side and encasement pipe on other side.

Encasement pipe plate 3/8"X14"X14" (Ref: Dwg H-2-818523) is welded to encasement pipe on the out side of the pit wall.

DESIGN CRITERIA:

1. Project W-320, Tank 241-C-106 Sluicing, Functional Design Criteria: WHC-SD-W320-FDC-001, Rev-5.
2. ASME code B31.3-1993, Chemical and Petroleum Refinery Piping.

DESIGN INPUTS:

Design Pressure:	325 psi	(FDC)
Design Temperature	180° F	
Safety Class:		
Process Pipe	Safety Significant.	
Encasement pipe	General Service.	
Jumpers	General Service.	

DESIGN METHODOLOGY:**LOAD COMBINATION:**

The nozzle plate is subjected to loads from process primary pipe on one side and jumper piping loads from other side. The process pipe loads are obtained from calculation: W320-27-0013, Process pipe stress analysis (Ref:2). The jumper piping loads are obtained from calculations W320-27-016 for C-Farm jumper nozzles U6 & U9(Ref:4) and W320-27-029 for AY-Farm jumper nozzles U2 & U11(Ref:5).

FLUOR DANIEL NW

Calc no: W320-27-055

Rev no: 0

Page no: 2 OF 13

DESIGN ANALYSIS

Client Numatec Hanford Inc

Subject Project W-320, Waste retrieval for Tank 241-C-106

Nozzle Plate & Encasement Plate Analysis

Location 200W.

WO/Job No.

Date: July 17, 98

Checked 7/19/98

Revised

Filename: W320plt

By: M. M. Ahmed *MA*

By: S. Fargo *SAR*

By:

The sustain (GR+P) and thermal loads are combined together algebraically for each nozzle (U2, U6, U9 & U11) separately

The seismic loads (process & jumper pipe loads) for each nozzles are combined absolutely. The nozzle loads for each nozzle are tabulated on Excel spread sheets and documented on pages 4 thru 7 of this calculation.

NOZZLE PLATE ANALYSIS:

The nozzle plate, since welded to encasement pipe on one side and process pipe on the other side, is treated as an integral pipe enclosure plate. Further the plate is not attached to any structure. As such the plate is considered to be pipe integral attachment and governed by the piping code B31.3 criteria for allowable stresses.

Review of summation of loads (as listed on pages 4 thru 7) indicates that nozzle-U2 plate is subjected to much higher loads compared to other nozzles. Since nozzle plate design is typical for all the nozzles, the plate is evaluated for nozzle U2 loads as a worst case.

The bending stress in the plate is computed using the methodology specified in Formulas for Stress & Strain by Roark and Young (Ref:6) for annular plate subjected to axisymmetric loading. The plate bending stress is calculated using Table-24, Case-1f formula for axial load, Case-2f for internal design pressure and Case-24 for bending moment (trunnion) loadings.

The plate bending stress so obtained for all three loadings are summed to get total plate stress. Two separate cases, one for sustained (GR+P) & thermal loads and second case for seismic loads are performed individually.

ENCASEMENT PLATE ANALYSIS:

The encasement pipe plate is square plate with circular opening for encasement pipe. The Table-26, Case-1 formula for rectangular plate with all edges simply supported (bearing against concrete wall) and subjected to a load at center as specified in reference-6 is used to compute the plate bending stress.

As in the case of nozzle plate, two separate loading cases (thermal & seismic) are evaluated. The encasement pipe loads (thermal & seismic) are soil frictional forces exerted on pipe when pipe translates due to thermal and seismic moments. These loads are calculated by multiplying unit friction forces (thermal and seismic) obtained from Ref:3 and length of the straight run of the pipe from pit wall to the first bend (See succeeding pages for documentation).

ALLOWABLE STRESSES:

ASME code B31.3 (Ref:1) criteria for allowable stresses as outlined below is used to check actual plate stresses.

$S_n = S_c = 20,000$ psi

for ASTM 240 SST plate from Appendix-A, Table-1A

FLUOR DANIEL NW

Calc no: W320-27-055

Rev no: 0

Page no: 3 OF 13

DESIGN ANALYSIS

Client Numatec Hanford Inc

Subject Project W-320, Waste retrieval for Tank 241-C-106

Nozzle Plate & Encasement Plate Analysis

Location 200W.

WO/Job No.

Date: July 17, 98

Checked 7/19/98

Revised

Filename: W320plt

By: M. M. Ahmed

By: S. Fargo

By:

Case-1: Gr + Pr + Th

Sustained Stress (Gr + Pr) =

$$S_L < S_h$$

Para 302.3.5^o

Thermal (Displacement) Stress

$$S_A < f(1.25 S_c + 0.25 S_h) \quad \text{Eqn: (1a)}$$

Adding above two cases together: $f = 1$ for less than 7000 cycles during the life of plant and $S_h = S_c$.
GR + Pr + Th

$$S_L + S_A < 2.5 S_h = 50,000 \text{ psi}$$

Case-2: Seismic (Occasional)

Occasional Stress

$$S_{occ} < 1.33 S_h = 26,600 \text{ psi} \quad \text{Para 302.3.6}$$

CALCULATIONS:

The analysis of nozzle plate is documented on pages 8 thru 11

The analysis of encasement pipe plate is documented on pages 12 thru 13

REFERENCES:

1. ASME Code B31.3-1993, Chemical Plant and Petroleum Refinery Piping.
2. Project W-320 Calculation no: W320-27-013, Rev-3 "Process Pipe Stress Analysis".
3. Project W-320 Calculation no: W320-27-014, Rev-2 "Encasement Pipe Stress Analysis".
4. Project W-320 Calculation no: W320-27-016, Rev-1 "C-Farm Jumper Stress Analysis".
5. Project W-320 Calculation no: W320-27-029, Rev-0 "Miscellaneous Jumper pipe Stress Analysis-AY Farm.
6. Roark and Young, Formulas for Stress and Strain. Fifth Edition.
7. Project W-320 Drawings:
H-2-818522 Rev-1
H-2-818523 Rev-1
H-2-818542 Rev-2
H-2-818543 Rev-2

CONCLUSION:

As evident from the succeeding analysis, the stresses in nozzle plate as well as encasement plate have met the requirements of ASME Code B31.3 for sustain, thermal and seismic loadings exerted by the piping system.

FLUOR DANIEL
NORTHWEST INC.

DESIGN ANALYSIS

Client: Numatec hanford Inc.
 Subject: Project W-320, Waste Retrieval for Tank 241-C-106
 Nozzle Plate & Encasement Plate Analysis
 Location: 241-AP

Calc no: W320-27-055
 Rev no: 0
 Page no: 4 of 13
 File name: W320U2
 Date: 7-17-98
 Chk'd: 7/19/98
 Revised:
 By: M. M. Ahmed
 By: S. Fargo

PIT WALL PIPING LOAD CONSOLIDATION SUMMARY

NOZZLE/LOCATION PIPE ORIENTATION	LOAD CASES	Fx lb	Fy lb	Fz lb	Mx ft-lb	My ft-lb	Mz ft-lb	REF CALC NO
Nozz-U2 / 241-AY-02E Sluice Pit	GR+P+TH	LATERAL	VERTICA	AXIAL				
AutoPipe Orientation	Primary Pipe	-663	-67	964	-81	2783	-3	Ref:2 Autopipe: TRAN-SP Node-A167
	Jumper Pipe	125	865	-157	-449	-63	387	Ref:5 Autopipe: AY02E-R2
	Total GR+P+TH	-508	798	812	530	2720	384	Node-B12
	Seismic							
	Primary Pipe	0	0	0	0	0	0	Ref:2 Autopipe: TRAN-SP
	Jumper Pipe	102	86	125	94	53	68	Ref:5 Autopipe: AY02E-R2
	Total Seismic	102	86	125	94	53	68	

Encasement Pipe Loads:

Encasement pipe is subjected to soil frictional force along the pipe axis when pipe translates due to thermal or seismic movements. These frictional forces are calculated by the product of the length of straight pipe run from pitwall to first bend and the friction force per unit length obtained from Encasement pipe stress Analysis Calculation no: W320-27-014 Rev-2 (Ref:3)

L = 10 feet = 120 inches f(thermal) = 23.18 lbs/inch f(seismic) = 24.48 lbs/inch

Fa (thermal) = 120 X 23.18 = 2856 lbs

Fa (seismic) = 120 X 24.48 = 2938 lbs

Ref:3

FLUOR DANIEL
NORTHWEST INC.

DESIGN ANALYSIS

Client: Numatec hanford Inc.
 Subject: Project W-320, Waste Retrieval for Tank 241-C-106
 Transfer line & Jumper pipe Connecting Plate Analysis
 Location: 241-AP

Calc no:W320-27-055
 Rev no: 0
 Page no:5 of 13
 File name: w320U6
 Date: 7-17-98
 Chk'd: 7/19/98
 Revised:

By: M. M. Ahmed *Ma*
 By: S. Fargo *SAE*
 By:

PIT WALL PIPING LOAD CONSOLIDATION SUMMARY

NOZZLE/LOCATION PIPE ORIENTATION	LOAD CASES	Fx	Fy	Fz	Mx	My	Mz	REF CALC NO
Nozzle-U6 / 241-C-06C Sluice Pit	GR+P+TH	AXIAL	VERTICAL	LATERAL				
AutoPipe orientation	Primary Pipe	378	-45	30	24	-288	36	Ref.2 AutoPipe: TRAN-SP N0de-A00
	Jumper Pipe	-723	205	2407	-120	-581	-82	Ref.4 AutoPipe: MA-J6A
	Total GR+P+TH	-345	160	2437	-96	-869	-46	Node-A00
	Seismic							
	Primary Pipe	264	0	207	0	452	0	Ref.2 AutoPipe: TRAN-SP
	Jumper Pipe	12	1	6	5	6	2	Ref.4 AutoPipe: MA-J6A
	Total Seismic	276	1	6	5	6	2	

Encasement Pipe Loads:

Encasement pipe is subjected to soil frictional force along the pipe axis when pipe translates due to thermal or seismic movements. These frictional forces are calculated by the product of the length of straight pipe run from pitwall to first bend and the friction force per unit length obtained from Encasement pipe stress Analysis Calculation no:W320-27-014 Rev-2 (Ref:3)

L = 16.8 feet = 201.6 inches f(thermal) = 23.18 lbs/inch f(seismic) = 24.48 lbs/inch

Fa (thermal) = 201.6 X 23.18 = 4673 lbs

Fa (seismic) = 201.6 X 24.48 = 4935 lbs

Ref:3

**FLUOR DANIEL
NORTHWEST INC.**

DESIGN ANALYSIS

Client: Numatec hanford Inc.

Subject: Project W-320, Waste Retrieval for Tank 241-C-106

Nozzle Plate & Encasement Plate Analysis

Location: 241-AP

Calc no: W320-27-055

Rev no: 0

Page no: 6 of 13

File name: W320U9

Date: 7-17-98

Chk'd: 7/19/98

Revised:

By: M. M. Ahmed *Ma*

By: S. Fargo *SAR*

By:

PIT WALL PIPING LOAD CONSOLIDATION SUMMARY

NOZZLE/LOCATION PIPE ORIENTATION	LOAD CASES	Fx	Fy	Fz	Mx	My	Mz	REF CALC NO
Nozz-U9 / 241-C-06 Pump Pit	GR+P+TH	AXIAL	VERTICA	LATERAL				
AutoPipe Orientation	Primary Pipe	990	156	-564	223	-1317	-437	Ref:2 Autopipe: TRAN-SL Node-A00
	Jumper Pipe	-212	-321	-137	-167	2	-249	Ref:4 Autopipe: MA-C06A Node-A00
	Total GR+P+TH	778	-165	-701	56	-1315	-686	
	Seismic							
	Primary Pipe	57	0	74	0	173	0	Ref:2 Autopipe: TRAN-SL
	Jumper Pipe	320	128	261	133	196	151	Ref:4 Autopipe: MA-C06A
	Total Seismic	377	128	335	133	369	151	

Encasement Pipe Loads:

Encasemnet pipe is subjected to soil frictional force along the pipe axis when pipe translates due to thermal or seismic movements. These frictional forces are calculated by the product of the length of straigh pipe run from pitwall to first bend and the friction force per unit length obtained from Encasement pipe stress Analysis Calculation no:W320-27-014 Rev-2 (Ref:3)

L = 18 feet = 216 inches f(thermal) = 23.18 lbs/inch f(seismic) = 24.48 lbs/inch

Fa (thermal) = 216 X 23.18 = 5007 lbs

Fa (seismic) = 216 X 24.48 = 5288 lbs

Ref:3

FLUOR DANIEL
NORTHWEST INC.

DESIGN ANALYSIS

Client: Numatec hanford Inc.
 Subject: Project W-320, Waste Retrieval for Tank 241-C-106
 Transfer line & Jumper pipe Connecting Plate Analysis
 Location: 241-AP

Calc no: W320-27-055

Rev no: 0

Page no: 7 of 13

File name: U11

Date: 7-17-98

Chk'd: 7/19/98

Revised:

By: M. M. Ahmed

By: S. Fargo

By:

PIT WALL PIPING LOAD CONSOLIDATION SUMMARY

NOZZLE/LOCATION PIPE ORIENTATION	LOAD CASES	Fx	Fy	Fz	Mx	My	Mz	REF CALC NO
Nozzl-U11 / 241-AY-02A PUMP PIT	GR+P+TH	AXIAL	VERTICA	LATERAL				
Autopipe Orientation	Primary Pipe	-530	-78	305	-9	-1060	-112	Ref:2 Autopipe: TRAN-SL Node-A171
	Jumper Pipe	52	-390	-63	35	20	183	Ref:5 AutoPipe: AY02A1R2
	Total GR+P+TH	-478	-468	242	26	-1040	71	Node-A00
	Seismic							
	Primary Pipe	0	0	0	0	0	0	Ref:2 Autopipe: TRAN-SL
	Jumper Pipe	90	102	205	27	200	209	Ref:4 AutoPipe: AY02A2R2
	Total Seismic	90	102	205	27	206	209	Node-A00

Encasement Pipe Loads:

Encasement pipe is subjected to soil frictional force along the pipe axis when pipe translates due to thermal or seismic movements. These frictional forces are calculated by the product of the length of straight pipe run from pitwall to first bend and the friction force per unit length obtained from Encasement pipe stress Analysis Calculation no: W320-27-014 Rev-2 (Ref:3)

L = 11.5 feet = 138 inches f(thermal) = 23.18 lbs/inch f(seismic) = 24.48 lbs/inch

Fa (thermal) = 138 X 23.18 = 3199 lbs

Fa (seismic) = 138 X 24.48 = 3378 lbs

Ref:3

FLUOR DANIEL
NORTHWEST

DESIGN ANALYSIS

Calc. No. W320-27-055

Revision 0

Page No. 8 of 13

Client: Numatec Hanford Inc.

WO/Job No. W-320

File: W320U2

Subject: Project W-320 Waste Retrieval for Tank 241-C-Date: July 17, 1998

By: M.M. Ahmed

Nozzle Plate & Encasement Plate Analysis

Checked: 7/19/98

By: S. Fargo

Location: 200W

Revised: _____

By: _____

NOZZLE KICK OFF PLATE ANALYSIS:

NOZZLE KICK OFF PLATE

$$a = \frac{6.625}{2} \text{ in} \quad a = 3.313 \text{ in}$$

$$b = \frac{4.5}{2} \text{ in} \quad b = 2.25 \text{ in}$$

$$\frac{b}{a} = 0.679$$

$$t = 0.375 \text{ in}$$

Load Case-1: (Sustained+Thermal)

As evident from preceeding pages, the Nozzle-U2 located in the 241-AY-02E Sluice Pit is subjected to highest GR+P+TH loads compared to other nozzles. As such following analysis considers Nozzle-U2 loads.

AXIAL LOADING

Table-24, Case-1f (Ref.6)

Annular plate with a concentrated load applied @ center, outer edge (Enc.pipe) fixed and inner edge (Process Pipe) guided.

$$F_x = 812 \text{ lb}$$

$$K_{mr b} = 0.147$$

$$\text{Prorating for } b/a = 0.68$$

$$w = \frac{F_x}{2 \cdot \pi \cdot b}$$

$$w = 57.437 \cdot \frac{\text{lb}}{\text{in}}$$

$$M = K_{mr b} \cdot w \cdot a$$

$$M = 27.968 \cdot \text{lb}$$

$$\sigma_{\text{axial}} = \frac{6 \cdot M}{t^2}$$

$$\sigma_{\text{axial}} = 1193.316 \cdot \frac{\text{lb}}{\text{in}^2}$$

FLUOR DANIEL
NORTHWEST

DESIGN ANALYSIS

Calc. No. W320-27-055
Revision 0
Page No. 9 of 13

Client: Numatec Hanford Inc

WO/Job No. W-320

File: W320U2

Subject: Project W-320 Waste Retrieval for Tank 241-C Date: July 17, 1998
Nozzle Plate & Encasement Plate Analysis

By: M.M. Ahmed *MM*

Checked: 7/21/98

By: S. Fargo *SF*

Location: 200W

Revised: _____

By: _____

PRESSURE LOADING:

Table-24, Case-2f (Ref:6): Annular plate subjected to internal design pressure of 325 psi, end conditions being same as above.

$$q = 325 \cdot \frac{\text{lb}}{\text{in}^2}$$

$$K_{\text{mrb}} = 0.0175$$

$$M = K_{\text{mrb}} \cdot q \cdot a^2$$

$$M = 62.407 \cdot \text{lb}$$

$$\sigma_{\text{pressure}} = \frac{6 \cdot M}{t^2}$$

$$\sigma_{\text{pressure}} = 2662.698 \cdot \frac{\text{lb}}{\text{in}^2}$$

MOMENT LOADING:

Table-24, Case-21 (Ref:6)

Central couple on a plate with a fixed edge (trunnion loading)

$$M_y = 2720 \cdot \text{ft} \cdot \text{lb}$$

$$M_z = 384 \cdot \text{ft} \cdot \text{lb}$$

$$M_r = (M_y^2 + M_z^2)^{0.5}$$

$$M_r = 32963.666 \cdot \text{in} \cdot \text{lb}$$

$$\beta = 0.523$$

$$\alpha = 0.02$$

$$\text{prorating for } b/a = 0.68$$

$$\sigma_{\text{moment}} = \frac{\beta \cdot M_r}{t^2 \cdot a}$$

$$\sigma_{\text{moment}} = 37009.973 \cdot \frac{\text{lb}}{\text{in}^2}$$

TOTAL PLATE STRESS DUE TO SUSTAINED & THERMAL LOADS:

$$\sigma_{\text{total}} = \sigma_{\text{axial}} + \sigma_{\text{pressure}} + \sigma_{\text{moment}}$$

$$\sigma_{\text{total}} = 40865.987 \cdot \frac{\text{lb}}{\text{in}^2}$$

FLUOR DANIEL
NORTHWEST

DESIGN ANALYSIS

Calc. No. W320-27-055
Revision 0
Page No. 10 of 13

Client: Numatec Hanford Inc

WO/Job No. W-320

File: W320U2

Subject: Project W-320 Waste Retrieval for Tank 241-C Date: July 17, 1998
Nozzle Plate & Encasement Plate Analysis

By: M.M. Ahmed *MA*

Checked: 7/21/98

By: S. Fargo *SAR*

Location: 200W

Revised: _____

By: _____

Allowable Stresses per ASME Code B31.3(Ref.1): $f = 1$

$$S_h = 20000 \cdot \frac{\text{lb}}{\text{in}^2}$$

$$S_c = 20000 \cdot \frac{\text{lb}}{\text{in}^2}$$

For Sustained loads (GR+P) "SI": $S_L = S_h$

Para 302.3.5(c)

For Thermal loads: $S_a = f(1.25 \cdot S_c + 0.25 \cdot S_h)$

Eqn: (1a)

$$S_a = 30000 \cdot \frac{\text{lb}}{\text{in}^2}$$

Allowable Stress for GR+P+TH loads: $S_L + S_a = 50000 \cdot \frac{\text{lb}}{\text{in}^2} > \sigma_{\text{total}} = 40865.987 \cdot \frac{\text{lb}}{\text{in}^2}$

SEISMIC LOAD CASE:

Seismic loads at nozzle U-9 are critical

$$F_x = 377 \cdot \text{lb}$$

$$M_y = 369 \cdot \text{ft} \cdot \text{lb}$$

$$M_z = 151 \cdot \text{ft} \cdot \text{lb}$$

$$M_r = (M_y^2 + M_z^2)^{0.5}$$

$$M_r = 4784.405 \cdot \text{in} \cdot \text{lb}$$

FLUOR DANIEL
NORTHWEST

DESIGN ANALYSIS

Calc. No. W320-27-055
Revision 0
Page No. 11 of 13

Client: Numatec Hanford Inc
Subject: Project W-320 Waste Retrieval for Tank 241-C
Nozzle Plate & Encasement Plate Analysis
Location: 200W

WO/Job No. W-320

Date: July 17, 1998

Checked: 7/21/98

Revised: _____

File: W320U2

By: M.M. Ahmed

By: S. Fargo

By: _____

AXIAL LOADING

Table-24, Case-1f (Ref:6)

Annular plate with a concentrated load applied @ center, outer edge (Enc.pipe)
fixed and inner edge (Process Pipe) guided.

$$K_{mr} = 0.147$$

Prorating for $b/a = 0.68$

$$w = \frac{F \cdot x}{2 \cdot \pi \cdot b}$$

$$w = 26.667 \cdot \frac{\text{lb}}{\text{in}}$$

$$M = K_{mr} \cdot w \cdot a$$

$$M = 12.985 \cdot \text{lb}$$

$$\sigma_{\text{axial}} = \frac{6 \cdot M}{t^2}$$

$$\sigma_{\text{axial}} = 554.04 \cdot \frac{\text{lb}}{\text{in}^2}$$

MOMENT LOADING:

Table-24, Case-21 (Ref:6)

Central couple on a plate with a fixed edge (trunnion loading)

$$\beta = 0.523$$

$$\alpha = 0.02$$

prorating for $b/a = 0.68$

$$\sigma_{\text{moment}} = \frac{\beta \cdot M}{t^2 \cdot a}$$

$$\sigma_{\text{moment}} = 5371.693 \cdot \frac{\text{lb}}{\text{in}^2}$$

Total Plate seismic stress:

$$\sigma_{\text{seismic}} = \sigma_{\text{axial}} + \sigma_{\text{moment}}$$

$$\sigma_{\text{seismic}} = 5925.733 \cdot \frac{\text{lb}}{\text{in}^2}$$

<

$$S_{\text{occ}} = 1.33 \cdot S_h$$

$$S_{\text{occ}} = 26600 \cdot \frac{\text{lb}}{\text{in}^2}$$

Ref:1

FLUOR DANIEL
NORTHWEST

DESIGN ANALYSIS

Calc. No. W320-27-055
Revision 0
Page No. 12 of 13

Client: Numatec Hanford Inc

WO/Job No. W-320

File: W320U2

Subject: Project W-320 Waste Retrieval for Tank 241-C Date: July 17, 1998

By: M.M. Ahmed *la*

Nozzle Plate & Encasement Plate Analysis

Checked: 7/21/98

By: S. Fargo *SF*

Location: 200W

Revised: _____

By: _____

ENCASEMENT PLATE ANALYSIS:

Table-26, Case-1a: Rectangular plate simply supported on all four edges and load applied uniformly.

Critical encasement pipe load is at Nozzle-U9:

$$F_{\text{thermal}} = 5007\text{-lb}$$

$$F_{\text{seismic}} = 5288\text{-lb}$$

ENCASEMENT PIPE PLATE

$$a = 14\text{-in}$$

$$t = 0.375\text{-in}$$

$$b = 14\text{-in}$$

$$\frac{a}{b} = 1$$

$$\beta = 0.2874$$

FLUOR DANIEL
NORTHWEST

DESIGN ANALYSIS

Calc. No. W320-27-055

Revision 0

Page No. 13 of 13

Client: Numatec Hanford Inc

WO/Job No. W-320

File: W320U2

Subject: Project W-320 Waste Retrieval for Tank 241-C Date: July 17, 1998

By: M.M. Ahmed

Nozzle Plate & Encasement Plate Analysis

Checked: 7/21/98

By: S. Fargo

Location: 200W

Revised: _____

By: _____

$$q_t = \frac{F_{\text{thermal}}}{a \cdot b}$$

$$q_t = 25.546 \cdot \frac{\text{lb}}{\text{in}^2}$$

$$q_s = \frac{F_{\text{seismic}}}{a \cdot b}$$

$$q_s = 26.98 \cdot \frac{\text{lb}}{\text{in}^2}$$

Thermal Stress:

$$\sigma_t = \frac{\beta \cdot q_t \cdot b^2}{t^2}$$

$$\sigma_t = 10232.973 \cdot \frac{\text{lb}}{\text{in}^2}$$

<

$$S_a = 30000 \cdot \frac{\text{lb}}{\text{in}^2}$$

Seismic Stress:

$$\sigma_s = \frac{\beta \cdot q_s \cdot b^2}{t^2}$$

$$\sigma_s = 10807.262 \cdot \frac{\text{lb}}{\text{in}^2}$$

<

$$S_{\text{occ}} = 26600 \cdot \frac{\text{lb}}{\text{in}^2}$$

Cale: W320-27-055

APPENDIX - A

TRAN-SP PROJECT W-320 ES-320-M3, M4, M5, M6 ICF Kaiser Hanford Company
09/05/96 SUPERNATE LINE PROCESS PIPE REV. 2 AutoPIPE+4.60 RESULT PAGE 109

SUPPORT FORCES

Point/ Supp. ID	Connect/ Type	Load Combination	Dirn	LOCAL Force	Deform	GLOBAL Dirn	Force	Deform
						Z		-0.096
	RESP	back			0.000	X		0.000
						Y		0.000
						Z		0.000
	TOTAL	back	79	0.000		X	79	0.240
						Y		0.000
						Z		0.096

HNF-2479, Rev. 0
Page F-18

TRAN-SP PROJECT W-320 ES-320-M3, M4, M5, M6 ICF Kaiser Hanford Company
09/05/96 SUPERNATE LINE PROCESS PIPE REV. 2 AutoPIPE+4.60 RESULT PAGE 110

RESTRAINT REACTIONS

Point name	Load combination	FORCES (lb)			Result	MOMENTS (ft-lb)			Result
		X	Y	Z		X	Y	Z	
A00	Anchor								
	GR	0	-45	0	45	24	0	36	45
	T1	372	0	27	373	0	-294	0	294
	P1	6	0	3	7	0	6	0	6
	SUM	378	-45	30	382	24	-288	36	291
	RESP	264	0	207	336	0	452	0	452
	TOTAL	642	45	237	686	24	740	36	741
	NOZ-G								
	C-06C								
	Swire Pit								
A01	Guide								
	GR	0	-160	0	160	0	0	0	0
	T1	0	0	-183	183	0	0	0	0
	P1	0	0	-6	6	0	0	0	0
	SUM	0	-160	-189	248	0	0	0	0
	RESP	0	0	396	396	0	0	0	0
	TOTAL	0	160	585	607	0	0	0	0
A02	Inclined								
	GR	0	-69	0	69	0	0	0	0
	T1	0	0	0	0	0	0	0	0
	P1	0	0	0	0	0	0	0	0
	SUM	0	-69	0	69	0	0	0	0
	RESP	0	0	0	0	0	0	0	0
	TOTAL	0	69	0	69	0	0	0	0
A04	Inclined								
	GR	0	-132	0	132	0	0	0	0
	T1	0	0	0	0	0	0	0	0
	P1	0	0	0	0	0	0	0	0
	SUM	0	-132	0	132	0	0	0	0
	RESP	0	0	0	0	0	0	0	0
	TOTAL	0	132	0	132	0	0	0	0
A05	Guide								
	GR	0	-208	0	208	0	0	0	0
	T1	-173	0	-173	245	0	0	0	0
	P1	-3	0	-3	4	0	0	0	0
	SUM	-176	-208	-176	324	0	0	0	0
	RESP	127	0	127	180	0	0	0	0
	TOTAL	303	208	303	477	0	0	0	0

RESTRAINT REACTIONS

Point name	Load combination	X	FORCES (lb)		Result	X	MOMENTS (ft-lb)		Result
			Y	Z			Y	Z	
A00 C-106A PUMP PIPE NOZ-L19	Anchor								
	GR	0	156	0	156	223	0	-437	490
	T1	977	0	-557	1125	0	-1299	0	1299
	P1	13	0	-7	15	0	-17	0	17
	SUM	990	156	-564	1150	223	-1317	-437	1405
	RESP	57	0	74	94	0	173	0	173
	TOTAL	1047	156	638	1236	223	1490	437	1568
A01	Guide								
	GR	0	-514	0	514	0	0	0	0
	T1	0	0	1067	1067	0	0	0	0
	P1	0	0	14	14	0	0	0	0
	SUM	0	-514	1081	1197	0	0	0	0
	RESP	0	0	137	137	0	0	0	0
	TOTAL	0	514	1218	1322	0	0	0	0
A05	Guide								
	GR	0	-399	0	399	0	0	0	0
	T1	-427	0	427	603	0	0	0	0
	P1	-6	0	6	8	0	0	0	0
	SUM	-432	-399	432	730	0	0	0	0
	RESP	10	0	10	14	0	0	0	0
	TOTAL	443	399	443	742	0	0	0	0
A06	Guide								
	GR	0	-167	0	167	0	0	0	0
	T1	533	0	-533	753	0	0	0	0
	P1	7	0	-7	10	0	0	0	0
	SUM	540	-167	-540	781	0	0	0	0
	RESP	53	0	53	75	0	0	0	0
	TOTAL	593	167	593	855	0	0	0	0
A07	Inclined								
	GR	0	-143	0	143	0	0	0	0
	T1	0	0	0	0	0	0	0	0
	P1	0	0	0	0	0	0	0	0
	SUM	0	-143	0	143	0	0	0	0
	RESP	0	0	0	0	0	0	0	0
	TOTAL	0	143	0	143	0	0	0	0

RESTRAINT REACTIONS

Point name	Load combination	X	FORCES (lb)		Result	X	MOMENTS (ft-lb)		Result
			Y	Z			Y	Z	
A10	Inclined								
	GR	0	-137	0	137	0	0	0	0
	T1	0	0	0	0	0	0	0	0
	P1	0	0	0	0	0	0	0	0
	SUM	0	-137	0	137	0	0	0	0
	RESP	0	0	0	0	0	0	0	0
	TOTAL	0	137	0	137	0	0	0	0
A12	Inclined								
	GR	0	-112	0	112	0	0	0	0
	T1	0	0	0	0	0	0	0	0
	P1	0	0	0	0	0	0	0	0
	SUM	0	-112	0	112	0	0	0	0
	RESP	0	0	0	0	0	0	0	0
	TOTAL	0	112	0	112	0	0	0	0
A13	Guide								
	GR	0	-176	0	176	0	0	0	0
	T1	-407	0	407	576	0	0	0	0
	P1	-5	0	5	8	0	0	0	0
	SUM	-413	-176	-413	610	0	0	0	0
	RESP	59	0	59	84	0	0	0	0
	TOTAL	472	176	472	691	0	0	0	0
A14	Guide								
	GR	0	-219	0	219	0	0	0	0
	T1	86	0	-86	121	0	0	0	0
	P1	1	0	-1	2	0	0	0	0
	SUM	87	-219	-87	251	0	0	0	0
	RESP	32	0	32	45	0	0	0	0
	TOTAL	119	219	119	276	0	0	0	0
A15	Guide								
	GR	0	-210	0	210	0	0	0	0
	T1	-23	0	23	32	0	0	0	0
	P1	0	0	0	0	0	0	0	0
	SUM	-23	-210	23	213	0	0	0	0
	RESP	9	0	9	12	0	0	0	0
	TOTAL	32	210	32	215	0	0	0	0

RESTRAINT REACTIONS

Point name	Load combination	FORCES (lb)			Result	MOMENTS (ft-lb)			Result
		X	Y	Z		X	Y	Z	
A164	Guide								
	GR	0	-197	0	197	0	0	0	0
	T1	0	0	-407	407	0	0	0	0
	P1	0	0	-6	6	0	0	0	0
	SUM	0	-197	-412	457	0	0	0	0
	RESP	0	0	0	0	0	0	0	0
A165	TOTAL	0	197	412	457	0	0	0	0
	Inclined								
	GR	0	-143	0	143	0	0	0	0
	T1	0	0	0	0	0	0	0	0
	P1	0	0	0	0	0	0	0	0
	SUM	0	-143	0	143	0	0	0	0
A168	RESP	0	0	0	0	0	0	0	0
	TOTAL	0	143	0	143	0	0	0	0
	Inclined								
	GR	0	-129	0	129	0	0	0	0
	T1	0	0	0	0	0	0	0	0
	P1	0	0	0	0	0	0	0	0
A170	SUM	0	-129	0	129	0	0	0	0
	RESP	0	0	0	0	0	0	0	0
	TOTAL	0	129	0	129	0	0	0	0
	Inclined								
	GR	0	-109	0	109	0	0	0	0
	T1	0	0	0	0	0	0	0	0
A171	P1	0	0	0	0	0	0	0	0
	SUM	0	-109	0	109	0	0	0	0
	RESP	0	0	0	0	0	0	0	0
	TOTAL	0	109	0	109	0	0	0	0
	Anchor								
	GR	0	-78	0	78	-9	0	-112	112
N6Z-W1	T1	-523	0	300	603	0	-1045	0	1045
	P1	-7	0	4	8	0	-15	0	15
	SUM	-530	-78	305	616	-9	-1060	-112	1066
	RESP	0	0	0	0	0	0	0	0
	TOTAL	530	78	305	616	9	1060	112	1066

PUMPIT
241-AY-02A

HNF-2479, Rev. 0
Page F-21

ASME B31.3c (1992) CODE COMPLIANCE

Point name	Load combination	(Moments in ft-lb)			S.I.F		(Stress in psi)		Code Stress	Code Allow.
		In-Pl. Moment	Out-Pl. Moment	Torsion Moment	In	Out	Eq. no.	Load type		
*** Segment A begin ***										
A00	Max P						(3a)	HOOP	4844	16700
	GR + Max P	437	17		1.00	1.00	(18)	SUST	4157	16700
	Cold to T1	0	1299		0	1.00	(17)	DISP	4851	25050
	SRSS	0	163		1.00	1.00	(18)	OCC	784	22211
A01	Max P						(3a)	HOOP	4844	16700
	GR + Max P	1109	35		1.00	1.00	(18)	SUST	7386	16700
	Cold to T1	0	2638		0	1.00	(17)	DISP	9847	25050
	SRSS	0	332		1.00	1.00	(18)	OCC	1592	22211
A02	Max P						(3a)	HOOP	4844	16700
	GR + Max P	305	29		1.00	1.00	(18)	SUST	3530	16700
	Cold to T1	0	2202		0	1.00	(17)	DISP	8220	25050
	SRSS	0	232		1.00	1.00	(18)	OCC	1114	22211
A03 N-	Max P						(3a)	HOOP	4844	16700
	GR + Max P	312	30		1.00	1.00	(18)	SUST	3567	16700
	Cold to T1	0	2262		0	1.00	(17)	DISP	8445	25050
	SRSS	0	238		1.00	1.00	(18)	OCC	1141	22211
A03 N+	Max P						(3a)	HOOP	4844	16700
	GR + Max P	30	312		1.00	1.00	(18)	SUST	3567	16700
	Cold to T1	2262	0		0	1.00	(17)	DISP	8445	25050
	SRSS	238	0		1.00	1.00	(18)	OCC	1141	22211
A03 M	Max P						(3a)	HOOP	4844	16700
	GR + Max P	35	440		1.00	1.00	(18)	SUST	4177	16700
	Cold to T1	2665	0		0	1.00	(17)	DISP	9949	25050
	SRSS	280	0		1.00	1.00	(18)	OCC	1344	22211
A03 F-	Max P						(3a)	HOOP	4844	16700
	GR + Max P	33	470		1.00	1.00	(18)	SUST	4321	16700
	Cold to T1	2510	0		0	1.00	(17)	DISP	9369	25050
	SRSS	284	0		1.00	1.00	(18)	OCC	1364	22211
A03 F+	Max P						(3a)	HOOP	4844	16700
	GR + Max P	470	33		1.00	1.00	(18)	SUST	4321	16700
	Cold to T1	0	2510		0	1.00	(17)	DISP	9369	25050
	SRSS	0	284		1.00	1.00	(18)	OCC	1364	22211

ELEVATION

SUPERNATE PIPING FROM C106 TO AY102
PROCESS LINE - 4" S100-M8
ENCASEMENT LINE - 6" M268 AT 36" RAD (45° BENDS)
ENCASEMENT LINE - 8" M268 AT 40° RAD (90° BENDS)

PLAN

ELEVATION

PLAN

ELEVATION

SLURRY PIPING FROM C106 TO AY102
PROCESS LINE - 4" S100-M8
ENCASEMENT LINE - 6" M268 AT 36" RAD (45° BENDS)
ENCASEMENT LINE - 8" M268 AT 40° RAD (90° BENDS)

U.S. DEPARTMENT OF ENERGY	
NATIONAL LABORATORY	
PITTSBURGH, PA 15260	
PROJECT: ES-320-M3	
DRAWING: ES-320-M3	
DATE: 10/1/88	
BY: J. L. HARRIS	
CHECKED: J. L. HARRIS	
APPROVED: J. L. HARRIS	
SCALE: 1" = 10'	
SHEET: 1 OF 1	

MATCHLINE, CONT TO THIS DWG, ZN 7-B

PLAN

NOTE:

1. ALL ELBOW BENDS ARE 5'-4" RADIUS, 4"-10" W/8" PIPE EDC M28a

MATCHLINE, CONT TO ES-320-M3, ZN 8-C

MATCHLINE, CONT FROM THIS DWG, ZN 1-E

PLAN

U.S. DEPARTMENT OF ENERGY	
NATIONAL BUREAU OF STANDARDS	
PIPING	
TRANSFER LINE PLAN	
ES-320-M4	
0	
PRELIMINARY	
DATE: 12-15-60	
BY: J. W. MOORE	
CHECKED: J. W. MOORE	
APPROVED: J. W. MOORE	
SCALE: 1"=10'	
SHEET: 1 OF 1

PLAN

PLAN

NOTE:
1. ALL ELBOW BEND ARE 5'-0" RADIUS, 4" W/6" PIPE END USES

U.S. DEPARTMENT OF ENERGY		PROJECT NO. ES-320-M5	
OFFICE OF NEUTRONICS		SHEET NO. 1	
U.S. NAVY		DATE: 10/17/60	
NAVY ENGINEERING CENTER		DRAWN BY: J. L. BROWN	
NAVY ENGINEERING CENTER		CHECKED BY: J. L. BROWN	
NAVY ENGINEERING CENTER		APPROVED BY: J. L. BROWN	
NAVY ENGINEERING CENTER		PROJECT TITLE: TRANSFER LINE PLAN	
NAVY ENGINEERING CENTER		PROJECT NO. ES-320-M5	
NAVY ENGINEERING CENTER		SHEET NO. 1	
NAVY ENGINEERING CENTER		DATE: 10/17/60	
NAVY ENGINEERING CENTER		DRAWN BY: J. L. BROWN	
NAVY ENGINEERING CENTER		CHECKED BY: J. L. BROWN	
NAVY ENGINEERING CENTER		APPROVED BY: J. L. BROWN

NOTE:

1. ALL ELBOW BENDS ARE 3'-4" RADIUS, 4" M9 W/8" PIPE ENC M268.

[illegible]

DESIGN ANALYSIS

Calc No. W320-27-029

Revision No. 03

Page No. 10 of 10

Client WESTINGHOUSE HANFORD COMPANY WO/Job No. ER4319
Subject AY FARM- JUMPER STRESS ANALYSIS Date 8/31/95
PROJECT W-320 WASTE RETRIEVAL FOR TANK C-106 Checked 9/11/95
Location C TANK FARM - 200W. Revised

Filename: AY02E.WP
By: M. M. Ahmed
By: M. K. Pal
By:

Rev 3 By: K. Hayase 11/26/97
Chk By: M. Ahmed 3.18.98

Rev-2, By: M. Ahmed 3-12-97
Checked By: D. L. Stone 3-12-97

PROJECT W-320: JUMPER ASSY FOR SLUICE PIT

Valve at A03A should be closer to A04, however, the overall length between A03 & A07 is correct, therefore OK as is.

SUPPORT FORCES

Point/ Supp. ID	Connect/ Type	Load Combination	Dirn	LOCAL Force	Deform	Dirn	GLOBAL Force	Deform
1 1 Stiff	Y - Stop :RIGID	GR+T1	down right	3379	0.000 0.020	X Y Z	-0.020 0.000 -0.005	
		RESPONSE	down left	714	0.000 0.000	X Y Z	284 714 0.011	0.000
		TOTAL	down left	4093	0.000 0.020	X Y Z	284 4093 0.016	0.020
		GR	down	3248	0.000	X Y Z	-0.001 0.000 -0.001	
		T1	up	2031	0.000	X Y Z	0.005 0.000 -0.018	
		GR+T1	down	1217	0.000	X Y Z	0.005 0.000 -0.019	
		RESPONSE	down	1161	0.000	X Y Z	0.001 0.000 0.012	
		TOTAL	down	2378	0.000	X Y Z	0.005 0.000 0.031	

RESTRAINT REACTIONS

Point name	Load combination	FORCES (lb)			Result	MOMENTS (ft-lb)			Result
		X	Y	Z		X	Y	Z	
A00	Anchor								
	GR	-33	-67	-1	75	2	2	6	6
	T1	-158	-262	-74	315	-99	24	37	108
	GR+T1	-190	-330	-75	308	-97	26	43	109
	RESPONSE	133	221	477	542	147	0	45	154
	TOTAL	323	551	552	844	244	26	88	261
A02	Guide								
	GR	0	-216	0	216	0	0	0	0
	T1	0	216	0	216	0	0	0	0
	GR+T1	0	0	0	0	0	0	0	0
	RESPONSE	1388	1160	0	1809	0	0	0	0
	TOTAL	1388	1160	0	1809	0	0	0	0
A09	Guide								
	GR	0	-361	0	361	0	0	0	0
	T1	0	-461	0	461	0	0	0	0
	GR+T1	0	-822	0	822	0	0	0	0
	RESPONSE	347	633	0	722	0	0	0	0
	TOTAL	347	1455	0	1496	0	0	0	0
B01	Guide								
	GR	48	-670	0	672	0	0	0	0
	T1	-48	-2709	0	2710	0	0	0	0
	GR+T1	0	-3379	0	3379	0	0	0	0
	RESPONSE	284	714	0	768	0	0	0	0
	TOTAL	284	4093	0	4102	0	0	0	0
B12	Anchor								
	GR	-23	-243	13	245	-103	14	40	112
	T1	147	1108	144	1127	553	-78	-427	703
	GR+T1	125	865	157	888	449	-63	-387	596
	RESPONSE	102	86	125	183	94	53	68	128
	TOTAL	227	950	282	1017	543	117	456	719
1	Y - Stop								
	GR	0	-3248	0	3248	0	0	0	0
	T1	0	2031	0	2031	0	0	0	0
	GR+T1	0	-1217	0	1217	0	0	0	0
	RESPONSE	0	1161	0	1161	0	0	0	0
	TOTAL	0	2378	0	2378	0	0	0	0

JUMPER ASSEMBLY U6-A / SLUICE PIT C-06C

DRAWING: H-2-818515

FILE NAME: J6A-S AP FILE NAME: MA-J6A

PREPARED BY: M. M. AHMED

PLAN

$$\text{Ans } 36.6 = 0.454$$

$$\text{Cob } 53.4 = -0.99$$

△
-
H
W
A

MA-J6A W320- C-FARM JUMPER STRESS ANALYSIS ICF KAISER HANFORD COMPANY
09/11/95 JUMPER C-06C-6-A AutoPIPE+4.60 RESULT PAGE 14

SUPPORT FORCES

Point/ Supp. ID	Connect/ Type	Load Combination	LOCAL		GLOBAL	
			Dirn	Force	Dirn	Force

*** End of system , no supports encountered. ***

MA-J6A W320- C-FARM JUMPER STRESS ANALYSIS ICF KAISER HANFORD COMPANY
09/11/95 JUMPER C-06C-6-A AutoPIPE+4.60 RESULT PAGE 15

RESTRAINT REACTIONS

Point name	Load combination	FORCES (lb)			MOMENTS (ft-lb)			Result
		X	Y	Z	X	Y	Z	
A00	Anchor							
	GR	6	-222	29	224	55	7	38
	T1	-447	427	-2062	2153	76	-588	-60
	R1	9	1	7	12	4	5	3
	R2	1	0	1	1	0	1	0
	R3	0	0	0	0	0	0	0
	GR+T1	-441	205	-2034	2091	131	-581	-22
	SEIS	10	1	8	13	4	6	4
	TOTAL	451	206	2042	2101	135	586	26
A11	Anchor							
	GR	-6	-208	-29	210	-27	0	12
	T1	447	-427	2062	2153	458	8	-175
	R1	10	1	7	12	3	1	0
	R2	1	0	1	1	0	0	0
	R3	0	0	0	0	0	0	0
	GR+T1	441	-635	2034	2175	431	7	-163
	SEIS	11	1	8	14	3	2	0
	TOTAL	452	636	2042	2186	434	9	164

HNF-2479, Rev. 0
Page F-30

1. FOR GENERAL NOTES, LEGEND AND KEY PLAN SEE H-2-818518.

[illegible][illegible]

HNF-2479, Rev. 0
Page F-33

Client WESTINGHOUSE HANFORD COMPANY
Subject AY FARM - JUMPER STRESS ANALYSIS
PROJECT W-320 WASTE RETRIEVAL for TANK 241-C-106
Location C TANK FARM - 200 W. AREA

WO/Job No. ER4319 Filename: C06A.WP
Date 9-11-95 By: M.M. Ahmed
Checked 9/11/95 By: M.K. Pal
Revised / / By:

Rev-1: By: *M. Ahmed* 6-28-96
Checked By: *PL. S. S. S.* 7-1-96

REF - 4

RESTRAINT REACTIONS

Point name	Load combination	FORCES (lb)				MOMENTS (ft-lb)			
		X	Y	Z	Result	X	Y	Z	Result
A00	Anchor								
	GR	57	-358	9	362	-28	-39	-186	193
	T1	-290	37	-32	294	-11	41	-80	81
	GR+T1	-233	-321	-23	397	-39	2	-266	269
	RESPONSE	295	128	132	347	79	196	129	248
	TOTAL	528	449	155	710	118	198	395	458
B07	Anchor								
	GR	5	-167	2	167	-1	0	-4	4
	T1	8	-197	-103	222	1	21	-48	52
	GR+T1	13	-363	-102	378	1	21	-52	56
	RESPONSE	326	86	169	377	56	15	90	107
	TOTAL	339	450	270	625	56	35	142	156
5	Anchor								
	GR	0	0	0	0	50	4	2	50
	T1	0	0	0	0	-4	-72	284	293
	GR+T1	0	0	0	0	46	-69	286	298
	RESPONSE	0	0	0	0	94	60	123	166
	TOTAL	0	0	0	0	140	129	409	451
C01	Anchor								
	GR	22	-231	-6	232	29	3	0	29
	T1	-279	-14	-24319	24321	2	-35	0	35
	GR+T1	-257	-245	-24325	24328	31	-32	0	44
	RESPONSE	281	1062	314	1142	133	35	0	137
	TOTAL	538	1307	24639	24680	163	67	0	177
3	Anchor								
	GR	0	0	0	0	-80	13	-134	156
	T1	0	0	0	0	-41	-167	748	767
	GR+T1	0	0	0	0	-121	-155	614	645
	RESPONSE	0	0	0	0	200	240	397	506
	TOTAL	0	0	0	0	321	395	1011	1132
D01	Anchor								
	GR	-84	154	-5	175	19	10	0	22
	T1	561	262	24455	24463	33	-70	0	77
	GR+T1	477	416	24450	24458	52	-60	0	79
	RESPONSE	560	1180	316	1344	148	70	0	163
	TOTAL	1037	1596	24766	24839	200	130	0	238

RESTRAINT REACTIONS

Point name	Load combination	FORCES (lb)				MOMENTS (ft-lb)			
		X	Y	Z	Result	X	Y	Z	Result
5	Anchor								
	GR	0	0	0	0	50	4	2	50
	T1	0	0	0	0	-4	-72	284	293
	GR+T1	0	0	0	0	46	-69	286	298
	RESPONSE	0	0	0	0	94	60	123	166
	TOTAL	0	0	0	0	140	129	409	451

Node: A

GR+T1:

$$\begin{aligned}
 F_a &= -233 \cos 30 - 23 \cos 60 = -212 \text{ \#} \\
 F_L &= -233 \sin 30 - 23 \sin 60 = -137 \text{ \#} \\
 M_a &= -39 \cos 30 - 266 \cos 60 = -167 \text{ ft \#} \\
 M_L &= -39 \sin 30 - 266 \sin 60 = -249 \text{ ft \#}
 \end{aligned}$$

SEISMIC:

$$\begin{aligned}
 F_a &= 295 \cos 30 + 132 \cos 60 = 320 \text{ \#} \\
 M_a &= 79 \cos 30 + 129 \cos 60 = 133 \text{ ft \#} \\
 F_L &= 295 \sin 30 + 132 \sin 60 = 261 \text{ \#} \\
 M_L &= 79 \sin 30 + 129 \sin 60 = 151 \text{ ft \#}
 \end{aligned}$$

Client WESTINGHOUSE HANFORD COMPANY
Subject AY FARM- JUMPER STRESS ANALYSIS
PROJECT W-320 WASTE RETRIEVAL FOR TANK C-106
Location C TANK FARM - 200W.

WO/Job No. ER4319
Date 8/31/95
Checked 9/11/95
Revised

Filename: AY02E.WP
By: M. M. Ahmed
By: M. K. Pal
By:

Rev-2, By: *A. Ahmed* 3-12-97
Checked By: *DL Stone* 3-12-97

JUMPER ASSEMBLY PUMP PIT: AY-02A-U11-A

DWG: H-2-818501
ACAD FILE: AY02A1
APIPE FILE: AY02A1R2
& AY02A2R2

PREPARED BY:
MM AHMED

CHECKED BY:
DL STONE

- NOTES: 1. THREE WAY VLAVE IS MODELLED AS THREE VALVES EACH WEIGHING 22 Lbs.
2. FLOW METER'S WEIGH 153# IS IMPOSED AT THREE SUPPORT LOCATIONS.
3. Y-STOP AT NODE "7" IS NOT CONSIDERED FOR DYNAMIC ANALYSIS.

AY02A1R2 PROJECT W-320: TANK 241-C-106 SLUICING FLUOR DANIEL NORTHWEST, INC.
03/12/97 AY-02A-U11-A JUMPER HYDRO STATIC ANAL. AutoPIPE+4.60 RESULT PAGE 10

SUPPORT FORCES

Point/ Supp. ID	Connect/ Type	Load Combination	Dirn	LOCAL		Dirn	GLOBAL	
				Force	Deform		Force	Deform
B01	9	GR	down	26	0.000	X	-0.013	
B01 1	Guide		right		0.013	Y	-26	0.000
Stiff	:RIGID		forw		0.008	Z		0.008
	T1		down	1	0.000	X	0.003	
			left		0.003	Y	-1	0.000
			forw		0.001	Z		0.001
	GR+T1		down	26	0.000	X	-0.010	
			right		0.010	Y	-26	0.000
			forw		0.009	Z		0.009
B04	5	GR	down	47	0.000	X	-0.014	
B04 1	Guide		left		0.014	Y	-47	0.000
Stiff	:RIGID		back		0.008	Z		0.008
	T1		down	1	0.000	X	0.003	
			right		0.003	Y	-1	0.000
			back		0.001	Z		0.001
	GR+T1		down	48	0.000	X	-0.010	
			left		0.010	Y	-48	0.000
			back		0.009	Z		0.009
7	Y - Stop	GR	down	146	0.000	X	0.016	
7 1			-Z		0.028	Y	-146	0.000
Stiff	:RIGID		+X		0.016	Z		-0.028
	T1		down	2	0.000	X	0.033	
			+Z		0.013	Y	-2	0.000
			+X		0.033	Z		0.013
	GR+T1		down	147	0.000	X	0.049	
			-Z		0.016	Y	-147	0.000
			+X		0.049	Z		-0.016

AY02A1R2 PROJECT W-320: TANK 241-C-106 SLUICING FLUOR DANIEL NORTHWEST, INC.
03/12/97 AY-02A-U11-A JUMPER HYDRO STATIC ANAL. AutoPIPE+4.60 RESULT PAGE 11

RESTRAINT REACTIONS

Point name	Load combination	FORCES (lb)			Result	MOMENTS (ft-lb)			Result
		X	Y	Z		X	Y	Z	
ADD	Anchor								
GR		19	-424	0	424	191	54	-33	201
T1		-82	33	-52	102	-8	-34	-2	35
GR+T1		-63	-390	-52	399	183	20	-35	187
AY-02A	Anchor								
A22									
PUMP PIT									
GR		-19	-531	0	532	-421	23	-112	436
T1		82	-32	52	102	1	-20	-31	36
GR+T1		63	-563	52	569	-420	3	-142	443
B01	Guide								
GR		0	-26	0	26	0	0	0	0
T1		0	-1	0	1	0	0	0	0
GR+T1		0	-26	0	26	0	0	0	0
B04	Guide								
GR		0	-47	0	47	0	0	0	0
T1		0	-1	0	1	0	0	0	0
GR+T1		0	-48	0	48	0	0	0	0
7	Y - Stop								
GR		0	-146	0	146	0	0	0	0
T1		0	-2	0	2	0	0	0	0
GR+T1		0	-147	0	147	0	0	0	0

RESTRAINT REACTIONS

Point name	Load combination	X	FORCES (lb)			Result	X	MOMENTS (ft-lb)			Result
			Y	Z				Y	Z		
A00 U-11 AY-02A PUMP PIT	Anchor										
	R1	189	48	46	201		100	173	26		202
	R2	73	83	42	118		180	93	6		202
	R3	29	36	65	80		39	37	4		54
	RESPONSE	205	102	90	266		209	200	27		291
A22	Anchor										
	R1	80	59	30	104		52	31	38		72
	R2	29	130	51	143		94	9	32		100
	R3	13	46	80	93		79	3	25		83
	RESPONSE	86	150	99	200		133	32	56		148
B01	Guide										
	R1	233	23	0	234		0	0	0		0
	R2	270	31	0	272		0	0	0		0
	R3	186	9	0	186		0	0	0		0
	RESPONSE	402	40	0	404		0	0	0		0
B04	Guide										
	R1	37	28	0	46		0	0	0		0
	R2	56	41	0	69		0	0	0		0
	R3	34	11	0	36		0	0	0		0
	RESPONSE	75	51	0	91		0	0	0		0

LOCAL FORCES & MOMENTS

Point name	Load combination	X	FORCES (lb)			Result	X	MOMENTS (ft-lb)			Result
			Y	Z				Y	Z		
*** Segment A begin ***											
A00	R1	46	48	189	200	26	173	100	202		
	R2	42	83	73	118	6	93	180	202		
	R3	65	36	29	80	4	37	39	54		
	RESPONSE	90	102	205	246	27	200	209	291		
A01	R1	46	48	188	199	26	126	89	157		
	R2	42	78	73	115	6	75	163	179		
	R3	59	36	29	75	4	29	36	47		
	RESPONSE	86	98	204	242	27	150	189	243		
A03	R1	46	47	187	198	26	108	85	139		
	R2	42	75	73	113	6	68	157	171		
	R3	55	36	29	72	4	27	35	45		
	RESPONSE	83	96	203	239	27	130	182	225		
A04 N	R1	46	37	189	198	26	98	78	128		
	R2	42	80	68	113	6	45	159	165		
	R3	55	34	32	72	4	22	37	43		
	RESPONSE	83	94	204	239	27	110	181	213		
A04 M	R1	39	44	189	198	33	43	72	90		
	R2	36	82	67	112	26	17	139	143		
	R3	43	47	32	72	15	7	34	38		
	RESPONSE	69	105	203	239	45	47	160	173		
A04 F	R1	37	189	46	198	35	72	38	88		
	R2	79	67	41	112	23	125	22	129		
	R3	34	32	54	71	12	32	13	36		
	RESPONSE	94	203	82	238	44	148	45	161		
A05 N	R1	37	46	187	196	35	124	81	152		
	R2	79	41	67	111	23	52	112	126		
	R3	34	53	32	70	12	27	39	49		
	RESPONSE	93	81	202	236	44	137	144	203		
A05 M	R1	39	44	186	195	140	129	89	210		
	R2	35	80	67	110	63	45	95	123		
	R3	42	46	32	70	32	22	54	67		
	RESPONSE	67	102	200	235	157	138	141	232		
A05 F	R1	47	46	182	193	217	69	81	242		
	R2	39	73	72	109	86	14	79	117		
	R3	51	36	29	69	43	11	65	79		
	RESPONSE	79	93	198	232	237	71	130	280		

PARTS - MATERIAL LIST		PARTS - MATERIAL LIST	
QUANTITY	PART/ASSEMBLY NUMBER	DESCRIPTION	UNIT
1	-010	ASSEMBLY	1
1	-020	SUPPORT FRAME SUB-ASSEMBLY	1
1	-001	BROCKET, PLATE 1/2" THK	1
2	-002	BROCKET, PLATE 1/2" THK	2
2	-003	U-BOLT, BAR 9/16"	2
1	-004	U-BOLT, BAR 9/16"	1
1	-005	U-BOLT, BAR 9/16"	1
1	-006	U-BOLT, BAR 9/16"	1
1	-007	U-BOLT, BAR 9/16"	1
1	-008	U-BOLT, BAR 9/16"	1
1	-009	U-BOLT, BAR 9/16"	1
1	-010	U-BOLT, BAR 9/16"	1
1	-011	U-BOLT, BAR 9/16"	1
1	-012	U-BOLT, BAR 9/16"	1
1	-013	U-BOLT, BAR 9/16"	1
1	-014	U-BOLT, BAR 9/16"	1
1	-015	U-BOLT, BAR 9/16"	1
1	-016	U-BOLT, BAR 9/16"	1
1	-017	U-BOLT, BAR 9/16"	1
1	-018	U-BOLT, BAR 9/16"	1
1	-019	U-BOLT, BAR 9/16"	1
1	-020	U-BOLT, BAR 9/16"	1
1	-021	U-BOLT, BAR 9/16"	1
1	-022	U-BOLT, BAR 9/16"	1
1	-023	U-BOLT, BAR 9/16"	1
1	-024	U-BOLT, BAR 9/16"	1
1	-025	U-BOLT, BAR 9/16"	1
1	-026	U-BOLT, BAR 9/16"	1
1	-027	U-BOLT, BAR 9/16"	1
1	-028	U-BOLT, BAR 9/16"	1
1	-029	U-BOLT, BAR 9/16"	1
1	-030	U-BOLT, BAR 9/16"	1
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1	-035	U-BOLT, BAR 9/16"	1
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1	-043	U-BOLT, BAR 9/16"	1
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1	-049	U-BOLT, BAR 9/16"	1
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1	-051	U-BOLT, BAR 9/16"	1
1	-052	U-BOLT, BAR 9/16"	1
1	-053	U-BOLT, BAR 9/16"	1
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1	-055	U-BOLT, BAR 9/16"	1
1	-056	U-BOLT, BAR 9/16"	1
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1	-081	U-BOLT, BAR 9/16"	1
1	-082	U-BOLT, BAR 9/16"	1
1	-083	U-BOLT, BAR 9/16"	1
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1	-085	U-BOLT, BAR 9/16"	1
1	-086	U-BOLT, BAR 9/16"	1
1	-087	U-BOLT, BAR 9/16"	1
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1	-097	U-BOLT, BAR 9/16"	1
1	-098	U-BOLT, BAR 9/16"	1
1	-099	U-BOLT, BAR 9/16"	1
1	-100	U-BOLT, BAR 9/16"	1
1	-101	U-BOLT, BAR 9/16"	1
1	-102	U-BOLT, BAR 9/16"	1
1	-103	U-BOLT, BAR 9/16"	1
1	-104	U-BOLT, BAR 9/16"	1
1	-105	U-BOLT, BAR 9/16"	1
1	-106	U-BOLT, BAR 9/16"	1
1	-107	U-BOLT, BAR 9/16"	1
1	-108	U-BOLT, BAR 9/16"	1
1	-109	U-BOLT, BAR 9/16"	1
1	-110	U-BOLT, BAR 9/16"	1
1	-111	U-BOLT, BAR 9/16"	1
1	-112	U-BOLT, BAR 9/16"	1
1	-113	U-BOLT, BAR 9/16"	1
1	-114	U-BOLT, BAR 9/16"	1
1	-115	U-BOLT, BAR 9/16"	1
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1	-126	U-BOLT, BAR 9/16"	1
1	-127	U-BOLT, BAR 9/16"	1
1	-128	U-BOLT, BAR 9/16"	1
1	-129	U-BOLT, BAR 9/16"	1
1	-130	U-BOLT, BAR 9/16"	1
1	-131	U-BOLT, BAR 9/16"	1
1	-132	U-BOLT, BAR 9/16"	1
1	-133	U-BOLT, BAR 9/16"	1
1	-134	U-BOLT, BAR 9/16"	1
1	-135	U-BOLT, BAR 9/16"	1
1	-136	U-BOLT, BAR 9/16"	1
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1	-140	U-BOLT, BAR 9/16"	1
1	-141	U-BOLT, BAR 9/16"	1
1	-142	U-BOLT, BAR 9/16"	1
1	-143	U-BOLT, BAR 9/16"	1
1	-144	U-BOLT, BAR 9/16"	1
1	-145	U-BOLT, BAR 9/16"	1
1	-146	U-BOLT, BAR 9/16"	1
1	-147	U-BOLT, BAR 9/16"	1
1	-148	U-BOLT, BAR 9/16"	1
1	-149	U-BOLT, BAR 9/16"	1
1	-150	U-BOLT, BAR 9/16"	1
1	-151	U-BOLT, BAR 9/16"	1
1	-152	U-BOLT, BAR 9/16"	1
1	-153	U-BOLT, BAR 9/16"	1
1	-154	U-BOLT, BAR 9/16"	1
1	-155	U-BOLT, BAR 9/16"	1
1	-156	U-BOLT, BAR 9/16"	1
1	-157	U-BOLT, BAR 9/16"	1
1	-158	U-BOLT, BAR 9/16"	1
1	-159	U-BOLT, BAR 9/16"	1
1	-160	U-BOLT, BAR 9/16"	1
1	-161	U-BOLT, BAR 9/16"	1
1	-162	U-BOLT, BAR 9/16"	1
1	-163	U-BOLT, BAR 9/16"	1
1	-164	U-BOLT, BAR 9/16"	1
1	-165	U-BOLT, BAR 9/16"	1
1	-166	U-BOLT, BAR 9/16"	1
1	-167	U-BOLT, BAR 9/16"	1
1	-168	U-BOLT, BAR 9/16"	1
1	-169	U-BOLT, BAR 9/16"	1
1	-170	U-BOLT, BAR 9/16"	1
1	-171	U-BOLT, BAR 9/16"	1
1	-172	U-BOLT, BAR 9/16"	1
1	-173	U-BOLT, BAR 9/16"	1
1	-174	U-BOLT, BAR 9/16"	1
1	-175	U-BOLT, BAR 9/16"	1
1	-176	U-BOLT, BAR 9/16"	1
1	-177	U-BOLT, BAR 9/16"	1
1	-178	U-BOLT, BAR 9/16"	1
1	-179	U-BOLT, BAR 9/16"	1
1	-180	U-BOLT, BAR 9/16"	1
1	-181	U-BOLT, BAR 9/16"	1
1	-182	U-BOLT, BAR 9/16"	1
1	-183	U-BOLT, BAR 9/16"	1
1	-184	U-BOLT, BAR 9/16"	1
1	-185	U-BOLT, BAR 9/16"	1
1	-186	U-BOLT, BAR 9/16"	1
1	-187	U-BOLT, BAR 9/16"	1
1	-188	U-BOLT, BAR 9/16"	1
1	-189	U-BOLT, BAR 9/16"	1
1	-190	U-BOLT, BAR 9/16"	1
1	-191	U-BOLT, BAR 9/16"	1
1	-192	U-BOLT, BAR 9/16"	1
1	-193	U-BOLT, BAR 9/16"	1
1	-194	U-BOLT, BAR 9/16"	1
1	-195	U-BOLT, BAR 9/16"	1
1	-196	U-BOLT, BAR 9/16"	1
1	-197	U-BOLT, BAR 9/16"	1
1	-198	U-BOLT, BAR 9/16"	1
1	-199	U-BOLT, BAR 9/16"	1
1	-200	U-BOLT, BAR 9/16"	1
1	-201	U-BOLT, BAR 9/16"	1
1	-202	U-BOLT, BAR 9/16"	1
1	-203	U-BOLT, BAR 9/16"	1
1	-204	U-BOLT, BAR 9/16"	1
1	-205	U-BOLT, BAR 9/16"	1
1	-206	U-BOLT, BAR 9/16"	1
1	-207	U-BOLT, BAR 9/16"	1
1	-208	U-BOLT, BAR 9/16"	1
1	-209	U-BOLT, BAR 9/16"	1
1	-210	U-BOLT, BAR 9/16"	1
1	-211	U-BOLT, BAR 9/16"	1
1	-212	U-BOLT, BAR 9/16"	1
1	-213	U-BOLT, BAR 9/16"	1
1	-214	U-BOLT, BAR 9/16"	1
1	-215	U-BOLT, BAR 9/16"	1
1	-216	U-BOLT, BAR 9/16"	1
1	-217	U-BOLT, BAR 9/16"	1
1	-218	U-BOLT, BAR 9/16"	1
1	-219	U-BOLT, BAR 9/16"	1
1	-220	U-BOLT, BAR 9/16"	1
1	-221	U-BOLT, BAR 9/16"	1
1	-222	U-BOLT, BAR 9/16"	1
1	-223	U-BOLT, BAR 9/16"	1
1	-224	U-BOLT, BAR 9/16"	1
1	-225	U-BOLT, BAR 9/16"	1
1	-226	U-BOLT, BAR 9/16"	1
1	-227	U-BOLT, BAR 9/16"	1
1	-228	U-BOLT, BAR 9/16"	1
1	-229	U-BOLT, BAR 9/16"	1
1	-230	U-BOLT, BAR 9/16"	1
1	-231	U-BOLT, BAR 9/16"	1
1	-232	U-BOLT, BAR 9/16"	1
1	-233	U-BOLT, BAR 9/16"	1
1	-234	U-BOLT, BAR 9/16"	1
1	-235	U-BOLT, BAR 9/16"	1
1	-236	U-BOLT, BAR 9/16"	1
1	-237	U-BOLT, BAR 9/16"	1
1	-238	U-BOLT, BAR 9/16"	1
1	-239	U-BOLT, BAR 9/16"	1
1	-240	U-BOLT, BAR 9/16"	1
1	-241	U-BOLT, BAR 9/16"	1
1	-242	U-BOLT, BAR 9/16"	1
1	-243	U-BOLT, BAR 9/16"	1
1	-244	U-BOLT, BAR 9/16"	1
1	-245	U-BOLT, BAR 9/16"	1
1	-246	U-BOLT, BAR 9/16"	1
1	-247	U-BOLT, BAR 9/16"	1
1	-248	U-BOLT, BAR 9/16"	1
1	-249	U-BOLT, BAR 9/16"	1
1	-250	U-BOLT, BAR 9/16"	1
1	-251	U-BOLT, BAR 9/16"	1
1	-252	U-BOLT, BAR 9/16"	1
1	-253	U-BOLT, BAR 9/16"	1
1	-254	U-BOLT, BAR 9/16"	1
1	-255	U-BOLT, BAR 9/16"	1
1	-256	U-BOLT, BAR 9/16"	1
1	-257	U-BOLT, BAR 9/16"	1
1	-258	U-BOLT, BAR 9/16"	1
1	-259	U-BOLT, BAR 9/16"	1
1	-260	U-BOLT, BAR 9/16"	1
1	-261	U-BOLT, BAR 9/16"	1
1	-262	U-BOLT, BAR 9/16"	1
1	-263	U-BOLT, BAR 9/16"	1
1	-264	U-BOLT, BAR 9/16"	1
1	-265	U-BOLT, BAR 9/16"	1
1	-266	U-BOLT, BAR 9/16"	1
1	-267	U-BOLT, BAR 9/16"	1
1	-268	U-BOLT, BAR 9/16"	1
1	-269	U-BOLT, BAR 9/16"	1
1	-270	U-BOLT, BAR 9/16"	1
1	-271	U-BOLT, BAR 9/16"	1
1	-272	U-BOLT, BAR 9/16"	1
1	-273	U-BOLT, BAR 9/16"	1
1	-274	U-BOLT, BAR 9/16"	1
1	-275	U-BOLT, BAR 9/16"	1
1	-276	U-BOLT, BAR 9/16"	1
1	-277	U-BOLT, BAR 9/16"	1
1	-278	U-BOLT, BAR 9/16"	1
1	-279	U-BOLT, BAR 9/16"	1
1	-280	U-BOLT, BAR 9/16"	1
1	-281	U-BOLT, BAR 9/16"	1
1	-282	U-BOLT, BAR 9/16"	1
1	-283	U-BOLT, BAR 9/16"	1
1	-284	U-BOLT, BAR 9/16"	1
1	-285	U-BOLT, BAR 9/16"	1
1	-286	U-BOLT, BAR 9/16"	1
1	-287	U-BOLT, BAR 9/16"	1
1	-288	U-BOLT, BAR 9/16"	1
1	-289	U-BOLT, BAR 9/16"	1
1	-290	U-BOLT, BAR 9/16"	1
1	-291	U-BOLT, BAR 9/16"	1
1	-292	U-BOLT, BAR 9/16"	1
1	-293	U-BOLT, BAR 9/16"	1
1	-294	U-BOLT, BAR 9/16"	1
1	-295	U-BOLT, BAR 9/16"	1
1	-296	U-BOLT, BAR 9/16"	1
1	-297	U-BOLT, BAR 9/16"	1
1	-298	U-BOLT, BAR 9/16"	1
1	-299	U-BOLT, BAR 9/16"	1
1	-300	U-BOLT, BAR 9/16"	1
1	-301	U-BOLT, BAR 9/16"	1
1	-302	U-BOLT, BAR 9/16"	1
1	-303	U-BOLT, BAR 9/16"	1
1	-304	U-BOLT, BAR 9/16"	1
1	-305	U-BOLT, BAR 9/16"	1
1	-306	U-BOLT, BAR 9/16"	1
1	-307	U-BOLT, BAR 9/16"	1
1	-308	U-BOLT, BAR 9/16"	1
1	-309	U-BOLT, BAR 9/16"	1
1	-310	U-BOLT, BAR 9/16"	1
1	-311	U-BOLT, BAR 9/16"	1
1	-312	U-BOLT, BAR 9/16"	1
1	-313	U-BOLT, BAR 9/16"	1
1	-314	U-BOLT, BAR 9/16"	1

PARTS/MATERIAL LIST (CONTINUED TO SHEET 2)

• **UNFUND**

WIRING RUN NUMBER. SEE ELECTRICAL DRAWING
N-2-81899 FOR CABLE TYPE, WIRE NUMBERS
AND DESTINATION.

[illegible]

BIDDING PARTS MATERIAL LIST CONTINUED FROM SHEET 11 OF 11				
QUANTITY REQUIRED	PART/DASH NUMBER	NOMENCLATURE/DESCRIPTION (ICONT FROM SHEET 1)	MATERIAL/REFERENCE	SHEET NO.
		ASSEMBLY		1 1
		SUPPORT FRAME SUB-ASSEMBLY		1 2
8		STUD BOLT, 3/4"-10UNC-2A x 6" LG	ASTM A 193 OR B8 304	30
8		STUD BOLT, 3/4"-10UNC-2A x 6 1/2" LG	ASTM A 193 OR B8 304	31
1		WASHING SCREW, 3/4"-10UNC-2A x 3" L HEX HD	ANSI B18.2.1 C	32
1	64	HEAVY HEX NUT, 3/4"-10UNC-2B	ASTM A 194 OR B8 303	33
4		HEX NUT, 1/2"-13UNC-2B	ANSI B18.2.2 C	34
				35
				36
AR		CHANNEL, C4 x 5.4	ASTM A 36	37
AR		PLATE, 1/2"	ASTM A 36	38
1		PLATE 1/2" x 6" x 6"	ASTM A 36	39
AR		BAR 1/2" DIA	ASTM A 36	40
				41
				42
AR		PIPE, 4" SCHED 40S	ASTM A 312 GR TP 304L	43
AR		PIPE, 2" SCHED 40S	ASTM A 312 GR TP 304L	44
1		ELBOW, 90° LR 4" SCHED 40S BW	ASTM A 403 WP-S 304L	45
2		ELBOW, 90° LR 3" SCHED 40S BW	ASTM A 403 WP-S 304L	46
1		ELBOW, 90° LR 2" SCHED 40S BW	ASTM A 403 WP-S 304L	47
		ELBOW, 45° 4" SCHED 40S BW	ASTM A 403 WP-S 304L	48
1		RDCR ELBOW, 90° LR 4" x 3" SCHED 40S BW	ASTM A 403 WP-S 304L	49
2		CONC RDCR 3" x 2" SCHED 40S BW	ASTM A 403 WP-S 304L	50
1		FLANGE, 3" 300W RF WELD NECK	ASTM A 182 GR F 304L	51
1		ECC RDCR, 4" x 3" SCHED 40S BW	ASTM A 403 WP-S 304L	52
2		ELBOW, 90° SR 4" SCHED 40S BW	ASTM A 403 WP-S 304L	53

EXPRESS 3-21-57		CASE NO. CONSTRUCTION NUMBER 3 DATE 02/18/57	
NAME DR. B. MEYER, JR. LAST MEYER FIRST B. MIDDLE MEYER SUFFIX JR. ADDRESS SEE DR/AT FORM CITY SEE DR/AT FORM STATE SEE DR/AT FORM ZIP SEE DR/AT FORM		U.S. DEPARTMENT OF ENERGY Richmond Operations Office FLOUNDER DANIEL NORTHWEST, INC. JUMPER ASSEMBLY PUMP PIT AY-02A-U11-A-(C) W-320 TANK 241-C-106 SLUICING	
EMPLOYER SEE DR/AT FORM POSITION SEE DR/AT FORM DATE SEE DR/AT FORM		IDENTIFICATION NAME 241-C NUMBER 0405 H-2-818501 0 NAME SHOWING DATE 606537 WEEK 2 W 2

PLAN-EXIST PUMP PIT
SCALE 1/4"=1'-0"

EXIST PIT WALL
CORE DRILL
INSTALL NEW JOINTS FOR NEW PIPING
AND MANUFACTURERS RECOMMENDATIONS.

1 CORE DRILL DETAIL (SHOWN)
SCALE 1/4"=1'-0"

2 CORE DRILL DETAIL (AS NOTED)
SCALE 1/4"=1'-0"

A SECTION
SCALE 1/4"=1'-0"

NOTES:

1. EXCAVATE BACKFILL AND COMPACT FOR CORE DRILLS IN ACCORDANCE WITH SPEC. SECTION 02200.
2. EXCAVATION PROFILES SHALL BE AS SHOWN ON DRAWINGS OR AS REQUIRED TO MINIMIZE EXCESSIVE MATERIAL QUANTITIES.
3. SEE 2-231827/SHI FOR EXISTING PIPING DESCRIPTION, REFERENCE & NUMBER DESCRIPTION.
4. CORE DRILLS SHALL BE IN ACCORDANCE WITH SPEC. SECTION 03300.
5. UPON COMPLETION OF CORE DRILLING ACTIVITIES, RESTORE EXISTING PIPING, CONDUITS, AND STRUCTURES TO OPERATIONAL CONFIGURATION/CONDITION.
6. EXISTING CONCRETE PITS ARE CLASSIFIED AS SAFETY CLASS. OTHER ITEMS SHOWN ON DRAWINGS ARE GENERAL SERVICES UNLESS NOTED OTHERWISE.

PROJECT NO.	608341
U.S. DEPARTMENT OF ENERGY	
OFFICE OF ENERGY RESEARCH AND DEVELOPMENT	
STRUCTURAL	
241-C-06A PUMP PIT MOD	
PLAN SECTION & DETAILS	
DATE	10/1/81
BY	W. DAVISON
CHECKED BY	W. DAVISON
APPROVED BY	W. DAVISON
SCALE	1/4"=1'-0"
FIGURE NO.	2
SHEET NO.	2
TOTAL SHEETS	2

1. SEE H-2-818526, SH1 FOR EXISTING PIPING DESCRIPTION, REFERENCE & NUMBER DESCRIPTION.
2. FOR ADDITIONAL NOTES SEE H-2-818443, SH1.

H-2-41344	STRL-CONC PL SLUICING PT	H-2-41344	STRL-CONC PL SLUICING PT
H-2-73051	DRAWING LIST	H-2-818423	DRAWING LIST
SH 2			
INDEXED	TITLE	INDEXED	TITLE
GROUPED PHYSICALLY LIST		NOT USED BY	

[illegible]

PLAN
SCALE 1/2"=1'-0"

DETAIL
SCALE 1/4"=1'-0"

SECTION A-A
SCALE 1/4"=1'-0"

SECTION B-B
SCALE 1/4"=1'-0"

AS-BUILT DIMENSIONS			
NOZZLE	X	Y	Z
8			
9			

NOTE:

1. SEE GENERAL NOTES, LEGEND AND KEY PLAN.
2. ALL "SL" PIPING, INCLUDING ITS CONTAINMENT AND ATTACHMENT RELS, SHALL BE CLASSIFIED AS "SL" (SEE SPECIFICATION (CS)). ALL OTHER PIPING SHALL BE CLASSIFIED "CS" (SEE SPECIFICATION (CS)).

U.S. DEPARTMENT OF ENERGY		PROJECT NO. 605441	
ICF Kaiser Engineers Company		DRAWING NO. 241-C-06A	
PUMP PIT C-06A		PLAN, SECTIONS & DETAIL	
F-2-818522		1	
F-2-818522		2	
F-2-818522		3	
F-2-818522		4	
F-2-818522		5	
F-2-818522		6	
F-2-818522		7	
F-2-818522		8	
F-2-818522		9	
F-2-818522		10	
F-2-818522		11	
F-2-818522		12	
F-2-818522		13	
F-2-818522		14	
F-2-818522		15	
F-2-818522		16	
F-2-818522		17	
F-2-818522		18	
F-2-818522		19	
F-2-818522		20	
F-2-818522		21	
F-2-818522		22	
F-2-818522		23	
F-2-818522		24	
F-2-818522		25	
F-2-818522		26	
F-2-818522		27	
F-2-818522		28	
F-2-818522		29	
F-2-818522		30	
F-2-818522		31	
F-2-818522		32	
F-2-818522		33	
F-2-818522		34	
F-2-818522		35	
F-2-818522		36	
F-2-818522		37	
F-2-818522		38	
F-2-818522		39	
F-2-818522		40	
F-2-818522		41	
F-2-818522		42	
F-2-818522		43	
F-2-818522		44	
F-2-818522		45	
F-2-818522		46	
F-2-818522		47	
F-2-818522		48	
F-2-818522		49	
F-2-818522		50	
F-2-818522		51	
F-2-818522		52	
F-2-818522		53	
F-2-818522		54	
F-2-818522		55	
F-2-818522		56	
F-2-818522		57	
F-2-818522		58	
F-2-818522		59	
F-2-818522		60	
F-2-818522		61	
F-2-818522		62	
F-2-818522		63	
F-2-818522		64	
F-2-818522		65	
F-2-818522		66	
F-2-818522		67	
F-2-818522		68	
F-2-818522		69	
F-2-818522		70	
F-2-818522		71	
F-2-818522		72	
F-2-818522		73	
F-2-818522		74	
F-2-818522		75	
F-2-818522		76	
F-2-818522		77	
F-2-818522		78	
F-2-818522		79	
F-2-818522		80	
F-2-818522		81	
F-2-818522		82	
F-2-818522		83	
F-2-818522		84	
F-2-818522		85	
F-2-818522		86	
F-2-818522		87	
F-2-818522		88	
F-2-818522		89	
F-2-818522		90	
F-2-818522		91	
F-2-818522		92	
F-2-818522		93	
F-2-818522		94	
F-2-818522		95	
F-2-818522		96	
F-2-818522		97	
F-2-818522		98	
F-2-818522		99	
F-2-818522		100

2 DETAIL
SH 1 SCALE: 3\"/>

ELEVATION

4 DETAIL
SH 1 SCALE: 2\"/>

ELEVATION

5 DETAIL
SH 1 SCALE: 2\"/>

NOTE: VALVE HANDLE & POSITIONING
TUBES WITH 1/2\"/>

3 DETAIL VALVE EXTENSION HANDLE
SH 1 SCALE: 1/2\"/>

NOTE:

1. FOR NOTES, SEE SHEET 1.
2. ASSEMBLY SECTION SUCH THAT
VALVE IS IN THE OPEN POSITION.
1 1/2\"/>
3. INFORMATION CONCERNING SAFETY
CLASSIFICATION OF COMPONENTS.

PROJECT: 2701-10	DATE: 12-15-81
DESIGNED BY: J. L. JONES	U.S. DEPARTMENT OF ENERGY
CHECKED BY: J. L. JONES	OFFICE OF NUCLEAR ENERGY RESEARCH & DEVELOPMENT
APPROVED BY: J. L. JONES	PIPING
DATE: 12-15-81	PUMP PIT C-06A
SCALE: 1/2\"/>	DETAILS
PROJECT: 2701-10	DATE: 12-15-81
PROJECT: 2701-10	DATE: 12-15-81

AS-BUILT DIMENSIONS			
NOZZLE	X	Y	Z
6			
7			
8			
9			

NOTE:

1. FOR GENERAL NOTES, LEGEND AND KEY PLAN, SEE DWG H-2-818518.
2. "SM" M-9 PIPING, INCLUDING IT'S CONTAINMENT AND ATTACHMENT WELDS, SHALL BE SAFETY CLASSIFICATION (SS). ALL OTHER WORK SHALL BE SAFETY CLASSIFICATION (G).

[illegible][illegible]

3/4" NOMINAL

3 DEFIAL
SCALE 3"=1'-0"

NORTH

PLAN
SCALE 1"=1'-0"

SECTION A-A
SCALE 1"=1'-0"

ELEVATION
END VIEW
SCALE 1"=1'-0"

SECTION B-B
SCALE 1"=1'-0"

AS-BUILT DIMENSIONS			
NOZZLE	X	Y	Z
U-11	3'-5"	5'-3 1/4"	3'-3 1/4"
U-10	3'-5"	5'-3 1/4"	3'-3 1/4"
U-9	3'-5"	5'-3 1/4"	3'-3 1/4"
U-8	3'-5"	5'-3 1/4"	3'-3 1/4"
U-7	3'-5"	5'-3 1/4"	3'-3 1/4"
U-6	3'-5"	5'-3 1/4"	3'-3 1/4"
U-5	3'-5"	5'-3 1/4"	3'-3 1/4"
U-4	3'-5"	5'-3 1/4"	3'-3 1/4"
U-3	3'-5"	5'-3 1/4"	3'-3 1/4"
U-2	3'-5"	5'-3 1/4"	3'-3 1/4"
U-1	3'-5"	5'-3 1/4"	3'-3 1/4"

DIMENSIONS SHALL BE LISTED TO THE CLOSEST 1/8" OF AN INCH

NOTE:

1. FOR GENERAL NOTES, LEGEND AND KEY PLAN, SEE H-2-818518.
2. ALL 1/4" PIPING SHALL BE SAFETY CLASSIFICATION (SSL).
3. ALL OTHER WORK SHALL BE SAFETY CLASSIFICATION (SSL).

ESSENTIAL DRAWING

PROJECT	241-AY-02A
CONTRACT	241-AY-02A
DATE	11/18/18
BY	C. O. JONES
CHECKED	C. O. JONES
DESIGNED	C. O. JONES
ENGINEER	C. O. JONES
PROJECT	241-AY-02A
CONTRACT	241-AY-02A
DATE	11/18/18
BY	C. O. JONES
CHECKED	C. O. JONES
DESIGNED	C. O. JONES
ENGINEER	C. O. JONES

NORTH

PLAN

SECTION A-A

SECTION B-B

AS-BUILT DIMENSIONS			
NOZZLE	X	Y	Z
U-2	1' 0 1/2"	2' 3 3/4" ± 1/2"	1' 0 1/2"
U-1	1' 0 1/2"	1' 0 1/2"	1' 0 1/2"
U-3	1' 0 1/2"	1' 0 1/2"	1' 0 1/2"

DIMENSIONS SHALL BE LIMITED TO THE CLOSEST 1/4\"/>

NOTE:

1. FOR GENERAL NOTES, LEGEND AND KEY PLAN, SEE H-2-818518.
2. ALL DIMENSIONS SHALL BE TO FACE UNLESS OTHERWISE NOTED.

ESSENTIAL DRAWING

SECTION B-B

SECTION A-A

DATE	10/1/79	BY	SS	NO.	608537
U.S. DEPARTMENT OF ENERGY					
NATIONAL BUREAU OF STANDARDS					
PIPELINE DIVISION					
SLUICE PIT A1-OZE					
SECTION					
H-2-818544					
REV. 0					
DATE 10/1/79					
BY SS					
NO. 608537					
U.S. DEPARTMENT OF ENERGY					
NATIONAL BUREAU OF STANDARDS					
PIPELINE DIVISION					
SLUICE PIT A1-OZE					
SECTION					
H-2-818544					
REV. 0					
DATE 10/1/79					
BY SS					
NO. 608537					

HWT, 70% MIN. USED.
TYP & PL. INSTALL PER CONST
SPEC W-320-C7, SECTION 0505

1 DETAIL

5 DETAIL

1 DETAIL

2 DETAIL

2 DETAIL

3 DETAIL

4 DETAIL

7 DETAIL

END VIEW

8 DETAIL

NOTE:
1. FOR NOTES, SEE SHEET 1.

U.S. DEPARTMENT OF ENERGY		OFFICE OF ENERGY RESEARCH & DEVELOPMENT	
GENERAL INVESTIGATIVE DIVISION		PITTING CORROSION SECTION	
PROJECT NO. 231-106		SUBJECT: SLUICE PIT AY-02E	
DRAWN BY: G. D. JONES		CHECKED BY: G. D. JONES	
DATE: 11/11/78		SCALE: 3/16\"/>	
PROJECT NO. 231-106		SUBJECT: SLUICE PIT AY-02E	
DRAWN BY: G. D. JONES		CHECKED BY: G. D. JONES	
DATE: 11/11/78		SCALE: 3/16\"/>	

PT NO.	DESCRIPTION	MATL/REF
1	STANDARD SQUARE KICK-OFF PLATE 1"	ASTM A-240 SST
2	STANDARD SQUARE KICK-OFF PLATE 1"	ASTM A-36 CS
3	STANDARD SQUARE KICK-OFF PLATE 2"	ASTM A-240 SST
4	STANDARD SQUARE KICK-OFF PLATE 2"	ASTM A-36 CS
5	STANDARD SQUARE KICK-OFF PLATE 3"	ASTM A-240 SST
6	STANDARD SQUARE KICK-OFF PLATE 3"	ASTM A-36 CS
7	STANDARD SQUARE KICK-OFF PLATE 4"	ASTM A-240 SST
8	STANDARD SQUARE KICK-OFF PLATE 4"	ASTM A-36 CS

PART NO.	CONNECTOR SIZE	A"	B"	C"
1,2	1"	1 1/8"	6 1/4"	7 3/8"
3,4	2"	2 1/8"	6 1/4"	8 3/8"
5,6	3"	3 1/8"	7 1/4"	9 3/8"
7,8	4"	4 1/8"	8 1/4"	10 3/8"

GENERAL NOTES

- BREAK ALL SHARP EDGES AND CORNERS.
- IDENTIFY PART THROUGH PER HS-0015 TYPE WITH DWS NO. PART NO. AND DRAWING REVISION NO. IN LOCATION INDICATED, USING .09 MIN. HIGH CHARACTERS.

1 2 3 4 5 6 7 8 STANDARD SQUARE KICK-OFF PLATE

CAUTION
NOT COMPLETE WITHOUT
CURRENT STATUS OF OUT-
ECNS FROM DATA-BASE

NOV 18 1991

REV	DATE	BY	CHKD	APPV	DESCRIPTION	REV	DATE	BY	CHKD	APPV	DESCRIPTION
1					ADDED TO PART	1					
2					REVISED NOTE 2	2					
3					ADDED TO PART	3					
4					REVISED NOTE 2	4					
5					ADDED TO PART	5					
6					REVISED NOTE 2	6					
7					ADDED TO PART	7					
8					REVISED NOTE 2	8					
9					ADDED TO PART	9					
10					REVISED NOTE 2	10					

REV	DATE	BY	CHKD	APPV	DESCRIPTION
1					ADDED TO PART
2					REVISED NOTE 2
3					ADDED TO PART
4					REVISED NOTE 2
5					ADDED TO PART
6					REVISED NOTE 2
7					ADDED TO PART
8					REVISED NOTE 2
9					ADDED TO PART
10					REVISED NOTE 2

2 NOZZLE SCHED 40
AS MACHINED

3 NOZZLE SCHED 80
AS MACHINED

CAUTION

NOT COMPLETE WITHOUT
CURRENT STATUS OF OUTSTANDING
ISSUES FROM DATA BASE

STANDARD PART

U. S. Department of Energy Rockwell Hanford Operations Richland, Washington 99312	DATE 10/1/77	BY J. L. HARRIS
MALE NOZZLE 4" PUREX	NO. 1201	REV. 1
FULL SIZE 1201 GEN 4500	NO. 1201	REV. 1
REGD. H-2-90187	NO. 1201	REV. 1

U. S. Department of Energy Rockwell Hanford Operations Richland, Washington 99312	DATE 10/1/77	BY J. L. HARRIS
MALE NOZZLE 4" PUREX	NO. 1201	REV. 1
FULL SIZE 1201 GEN 4500	NO. 1201	REV. 1
REGD. H-2-90187	NO. 1201	REV. 1

① NOZZLE INVESTMENT CASTING

TYPICAL SECTION FOR OBTAINING TEST SPECIMENS

THIS DRAWING IS
CURRENT STATUS OF
COMPLETE WITHIN
DRAWING DATE 14
EXAMINING
NOTICE

THIS DRAWING REPLACES H-2-32446 REV 14

STANDARD PART

DRAWING APPROVALS		DATE		U.S. Department of Energy Rockwell Hanford Operations Richland, Washington 99312	
<i>[Signature]</i>		10/1/76		MALE NOZZLE	
<i>[Signature]</i>		10/1/76		4' PUREX	
<i>[Signature]</i>		10/1/76		FULL SIZE 200 GPM 2500	
NOT RECD		H-2-90187		112	

DRAWING NO.		REVISED		REVISIONS	
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DISTRIBUTION SHEET

To	From	Page 1 of 1			
Distribution	JW Bailey	Date 25 July 1998			
Project Title/Work Order		EDT No. 622237			
Project W-320 Tank 106-C, HNF-2479, Piping Calculations, Vol. 9		ECN No. n/a			
Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
JW Bailey	S2-48				
W-320 Project Files	R1-29				