Blue (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.: D2991 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? [X] Yes [] No		12. Major Assm. Dwg. No.: n/a
		13. Permit/Permit Application No.: n/a
		14. Required Response Date:

15. DATA TRANSMITTED

(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Approval Designator	(G) Reason for Transmittal	(H) Originator Disposition	(I) 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	MC Davenport	7/25/98							
2	1	Cog.Eng.	~~CE Graves~~		S2-48						
2	1	Cog. Mgr	JW Bailey	7/24/98	S2-48						
		QA									
		Safety									
		Env.									

18. MC Davenport ~~CE Graves~~ ~~3/24/98~~ 7/25/98 Signature of EDT Originator / Date	19. Authorized Representative for Receiving Organization / Date	20. JW Bailey ~~3/24/98~~ 7/24/98 J.W. Bailey Design Authority/ Cognizant Manager / Date	21. DOE APPROVAL (if required) Ctrl. No. [] Approved [] Approved w/comments [] Disapproved w/comments

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

EDT/ECN: 622237 UC: 506
Org Code: 8C452 Charge Code: D2991/HANA0600
B&R Code: EW3130010 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.

Product cut sheets in this document have been reviewed and are not Copyrighted.

TRADEMARK DISCLAIMER. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors.

Printed in the United States of America. To obtain copies of this document, contact: Document Control Services, P.O. Box 950, Mailstop H6-08, Richland WA 99352, Phone (509) 372-2420; Fax (509) 376-4989.

Release Approval 7/30/98 Date

DATE: HANFORD RELEASE
STA: 4 ID: 2
JUL 30 1998
Release Stamp

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

FLUOR DANIEL NORTHWEST INC.	CALCULATION IDENTIFICATION AND INDEX	Page i of iii Date 11/04/97

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

[X] Final Calculations

[] Check Calculations (On Calculation Dated)

[] Void Calculation (Reason Voided)

Incorporated in Final Drawings? [X] Yes [] No

This calculation verified by independent "check" calculations? [] Yes [X] No

Original and Revised Calculation Approvals:

	Rev. 0 Signature/Date	Rev. 1 Signature/Date	Rev. 2 Signature/Date
Originator	[illegible] 11/04/97		
Checked by	Danny L. Evans 11/6/97		
Approved by	Danny L. Evans 4/8/98		
Checked Against Approved Vendor Data	A. Ahmed 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

VIEL 'NC.	CALCULATION IDENTIFICATION AND INDEX Continuation Sheet	Page ii of iii Date 11/04/97

WO/Job No. W-320 Calculation No. W-320-27-049

Rev. 0 Signature/Date	Rev. 1 Signature/Date	Rev. 2 Signature/Date

INDEX

Description

REVISION

Description

ie

DUCFLUS2.NJJ

Page iii of iii

CALCULATION CROSS INDEX (Typical)

Subject Calculation No.: W-320-27-049

Results and conclusions of the subject | Does the output | Has the output

KEH 1975.00 (12/88)

DESIGN ANALYSIS

poration
TRIEVAL For TANK 241-C-106.
Flushing System
:ss Building

WO/Job No.: W-320
Date: 11/04/97
Checked: 11/6/97
Revised:

By: N. J. Juplo
By: D. L. [illegible]
By:

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

TS:

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

NS

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

ation.

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

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

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

chnical Paper # 410, Flow of Fluids.

Spray 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
:t: W-320, WASTE RETRIEVAL For TANK 241-C-106. Sizing of HVAC Duct Flushing System
on: C-Tank Farm/Process Building

WO/Job No.: W-320
Date: 11/04/97
Checked: 11/6/97
Revised:

By: N. J. Juplo
By: D. L. Evans
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 the10" 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.

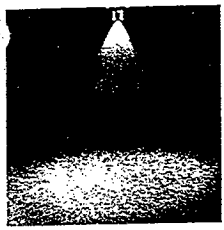
4.0. CONCLUSIONS:

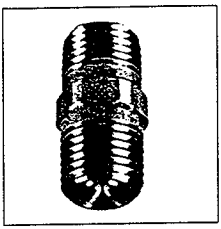
Based on the above analysis, a flushing system consisting of eight (8)1/4" spray nozzles with a maximum flow rate of 0.8 gpm each at 100 psi pressure, will meet the flushing requirement for the 10" HVAC duct 10"VT-1010-M5. In addition, an existing 1" line located in the Process Building can be utilized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

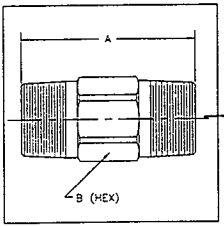
Appendix A

AXIAL FULL CONE WALL MOUNT NOZZLES

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







Inlet	Dimensions Inches A	Dimensions Inches B	Approx. Weight (oz.)
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 Type / Spray Angle 60°	90°	120°	Material Code 303 SS 16	316 SS 17	Brass 30	Nozzle Inlet/Mounting Thread Male NPT x Male NPT 1/4 x 1/4	3/8 x 3/8	1/2 x 1/2	Orifice Diam. (in.)*	Flow Rate (Gallons Per Minute) 20 psi	2 bar	40 psi	60 psi	80 psi	100 psi	Spray Width @ 40 psi H=10" 60°	H=20" 60°	H=10" 90°	H=20" 90°	H=10" 120°	H=20" 120°
480.404			O	O	O	BC/BC			.051	0.23	1.00	0.30	0.35	0.40	0.43						
480.444			O	O	O	BC/BC			.053	0.28	1.25	0.38	0.44	0.50	0.54						
480.484			O	O	O	BC/BC			.057	0.36	1.60	0.48	0.57	0.63	0.69						
480.504			O	O	O	BC/BC			.059	0.41	1.80	0.54	0.64	0.71	0.78						
480.524			O	O	O	BC/BC			.066	0.46	2.00	0.60	0.71	0.79	0.87						
480.564			O	O	O	BC/BC			.074	0.57	2.50	0.75	0.88	0.99	1.08						
480.604			O	O	O	BC/BC			.084	0.72	3.15	0.95	1.11	1.25	1.37	9°	22°				
480.644			O	O	O		BE/BE		.094	0.91	4.00	1.20	1.41	1.59	1.73						
480.684			O	O	O		BE/BE		.100	1.14	5.00	1.50	1.77	1.98	2.17						
480.704			O	O	O		BE/BE		.106	1.27	5.60	1.68	1.98	2.22	2.43						
480.724			O	O	O		BE/BE		.112	1.43	6.30	1.89	2.23	2.5	2.73						
480.764			O	O	O		BE/BE		.116	1.82	8.00	2.40	2.83	3.17	3.47						
480.784			O	O	O		BE/BE		.126	2.05	9.00	2.70	3.18	3.57	3.90						
480.804			O	O	O		BE/BE		.133	2.28	10.0	3.00	3.53	3.96	4.33						
480.844			O	O	O			BG/BG	.149	2.85	12.5	3.75	4.42	4.95	5.42						
480.884			O	O	O			BG/BG	.169	3.64	16.0	4.81	5.65	6.34	6.93						
480.406	480.408		O	O	O	BC/BC			.047	0.23	1.00	0.30	0.35	0.40	0.43						
480.446	480.448		O	O	O	BC/BC			.051	0.28	1.25	0.38	0.44	0.50	0.54						
480.486	480.488		O	O	O	BC/BC			.053	0.36	1.60	0.48	0.57	0.63	0.69						
480.506	480.508		O	O	O	BC/BC			.057	0.41	1.80	0.54	0.64	0.71	0.78	15°	34°	27°	61°		
480.526	480.528		O	O	O	BC/BC			.059	0.46	2.00	0.60	0.71	0.79	0.87						
480.566	480.568		O	O	O	BC/BC			.066	0.57	2.50	0.75	0.88	0.99	1.08						
480.606	480.608		O	O	O	BC/BC			.074	0.72	3.15	0.95	1.11	1.25	1.37						
480.646	480.648		O	O	O	BC/BC			.084	0.91	4.00	1.20	1.41	1.59	1.73						
480.686	480.688		O	O	O	BC/BC			.094	1.14	5.00	1.50	1.77	1.98	2.17						
480.706	480.708		O	O	O	BC/BC			.100	1.27	5.60	1.68	1.98	2.22	2.43						
480.726	480.728		O	O	O	BC/BC			.106	1.43	6.30	1.89	2.23	2.5	2.73						
480.746	480.748		O	O	O		BE/BE		.112	1.62	7.10	2.13	2.51	2.81	3.08						
480.766	480.768		O	O	O		BE/BE		.141	1.82	8.00	2.40	2.83	3.17	3.47						
480.786	480.788		O	O	O		BE/BE		.145	2.05	9.00	2.70	3.18	3.57	3.90	15°	38°	27°	63°		
480.806	480.808		O	O	O		BE/BE		.159	2.28	10.0	3.00	3.53	3.96	4.33						
480.846			O	O	O		BE/BE		.163	2.85	12.5	3.75	4.42	4.95	5.42						
480.886			O	O	O			BG/BG	.185	3.64	16.0	4.81	5.65	6.34	6.93						
480.926			O	O	O			BG/BG	.204	4.55	20.0	6.01	7.07	7.93	8.67						
480.966			O	O	O			BG/BG	.228	5.69	25.0	7.51	8.83	9.91	10.8						
480.006			O	O	O			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:

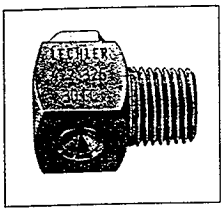
Type + Material Code + Connector No. = Order No.

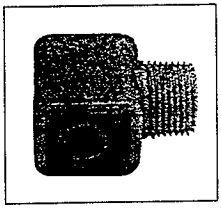
480. 608 30 BC.BC 480. 608. 30. BC. BC

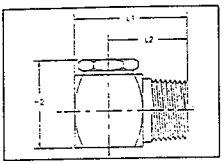
Material Code:
16 303 SS
17 316 SS
30 Brass

VANELESS FULL CONE NOZZLES

1/4" TO 1" NPT (M)







Nozzle Inlet Conn. (" NPT)	Dimensions in (in.) L1	L2	H2	Approx. Weight (oz.)
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	—
1/4*	1.10	.79	.63	—
3/8*	1.42	.98	.91	—
1/2*	1.95	1.32	1.50	—

* Mat. PVDF

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

The following sizes are available in molded PVDF:

Threaded Inlets			Integral Twist-Lok 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	422.726.5E.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	* See page 67.
422.568.5E.BC	422.886.5E.BE	422.128.5E.BK	

FULL CONE

Product Codes for Ordering: Nozzle Type, Spray Angle 90°	120°	Material Code 303 SS 16	316 SS 17	5E PVDF 30	NPT Code 1/4	3/8	1/2	3/4	1	Free Pass Diam. (in.)	Flow Rate (Gallons Per Minute) 10 psi	20 psi	40 psi	60 psi	80 psi	100 psi	Flow Rate (liters per minute) 2 bar	Spray Width @ 40 psi 8" H-10" 90°	8" H-10" 120°	8" H-20" 90°	8" H-20" 120°
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	○	•	○	—	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	○	•	○	—	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	○	•	○	—	BE	—	—	—	.164	1.2	1.7	8.0	2.4	3.0	3.5	3.9	15°	38°	27°	60°
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	○	•	○	—	—	BG	—	—	.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	—	•	—	—	—	—	BK	—	.502	9.7	13.	63.	19.	23.	27.	30.				
—	423.148	—	•	—	—	—	—	—	BM	.553	11.	15.	71.	22.	26.	31.	34.				
—	423.208	—	•	—	—	—	—	—	BM	.672	15.	21.	100.	31.	37.	43.	49.				

* 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
17 316 SS
30 Brass
5E PVDF

W320-27-050

Portable Exhauster Installation Analysis

FLUOR DANIEL NORTHWEST INC.	CALCULATION IDENTIFICATION AND INDEX	Page i of ii Date 2/26/98

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

Discipline: (27) Piping WO/Job No.: ER4319/W-320 Calculation No.: W320-27-050

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

Calculation Item: Portable Exhauster Installation 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

[X] Final Calculations

[] Check Calculations (On Calculation Dated)

[] Void Calculation (Reason Voided)

Incorporated in Final Drawings? [X] Yes [] No

This calculation verified by independent "check" calculations? [] Yes [X] No

Original and Revised Calculation Approvals:

	Rev. 0 Signature/Date	Rev. 1 Signature/Date	Rev. 2 Signature/Date
Originator	Kelly K Hancue 2/26/98		
Checked by	[illegible] 02/26/98		
Approved by	D.L. Evans 4/11/98		
~~Checked Against Approved Vendor Data~~ Final Review	M. Ahmed 4.11.98		

INDEX

Design Analysis Page No.	Description
1 - 3	Objective, Design Inputs, References, Conclusions
4 - 26	Calculations
A-1 to A-21	Appendix A - Autopipe Model "PEXCNDS"
B-1 to B-36	Appendix B - Reference Information

CALCULATION CROSS INDEX (Typical)

Subject Calculation No.: W320-27-050

Subject Calculation Revision No.	Superceded 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 interfacecalculation/ 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-2-818506, Sheet 1	~~0~~ 1	NA			✓		✓	
		H-2-818506, Sheet 2	~~0~~ 1				✓		✓	
		H-2-818506, Sheet 3	~~0~~ 1				✓		✓	D. L. Evans 7/21/98
		H-2-818507, Sheet 1	~~0~~ 1				✓		✓	
		H-2-818507, Sheet 2	~~0~~ 1				✓		✓	
		H-2-818507, Sheet 3	~~0~~ 1				✓		✓	

KEH 1975.00 (12/88)

DESIGN ANALYSIS

Client: Numatec
Subject: Portable Exhauster Installation Analysis
Location: 241-C / 241-AY

WO/Job No.: ER4319/W-320
Date: 12/15/97 By: Kelly Hayase
Checked: 12/19/97 By: N. J. JUPLO
Revised: 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)

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 — HVAC Alternate Emergency Ventilation Configuration
    H-2-818507, Sheets 1 - 3, Rev. 0 — HVAC Alternate Emergency Ventilation Configuration

DESIGN ANALYSIS

Client: Numatec
Subject: Portable Exhauster Installation Analysis
Location: 241-C / 241-AY

WO/Job No.: ER4319/W-320
Date: 12/15/97 By: Kelly Hayase
Checked: 12/19/97 By: N. J. JUPLO
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
Subject: Portable Exhauster Installation Analysis
Location: 241-C / 241-AY

WO/Job No.: ER4319/W-320
Date: 12/15/97 By: Kelly Hayase
Checked: 12/17/97 By: Kevin Cold
Revised: By:

CALCULATIONS:

Pipe Stress Analysis (For condensate drain lines)

Autopipe Analysis Input

Pipe: ½" 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 } (Ref. #6)
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)

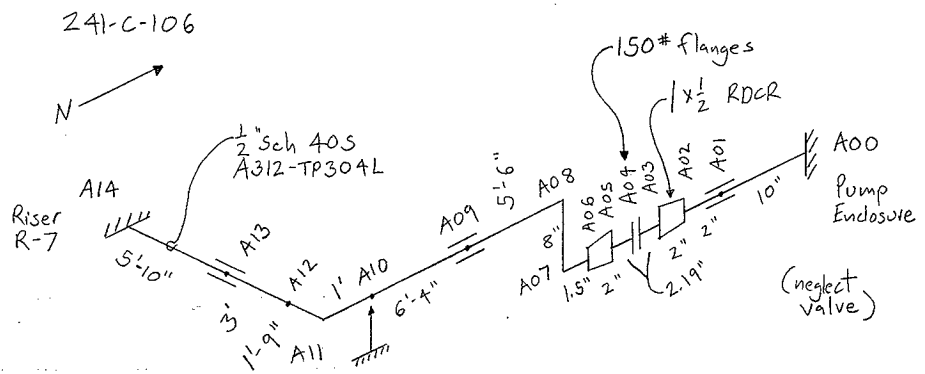
For 500 CFM Portable Exhauster, Δ = 0.28 inch
Assume similar for 1000 CFM Portable Exhauster

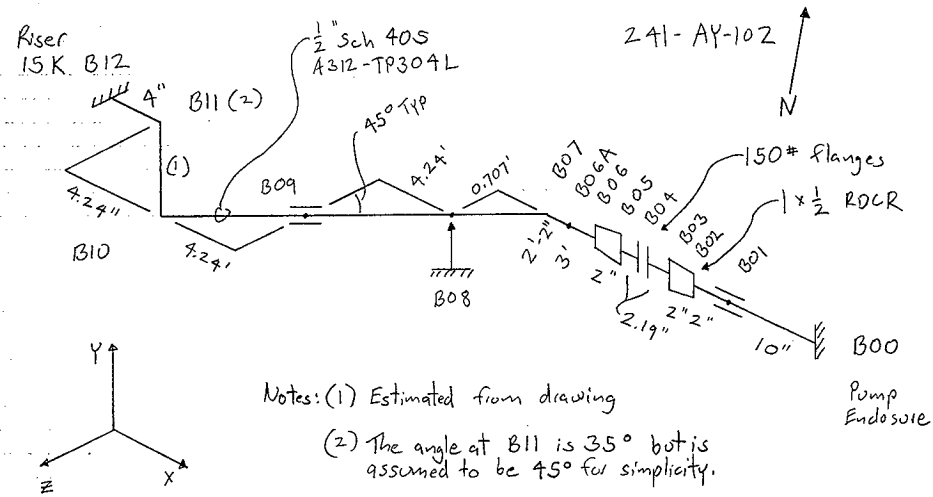
DESIGN ANALYSIS

Client Numatec
Subject Portable Exhauster Installation Analysis
Location 241-C / 241-AY

WO/Job No. ER 4319 / W-320
Date 12/15/97 By Kelly Hayase
Checked 12/17/97 By Kim Cahf
Revised By

Autopipe Model "PEXCNDS"





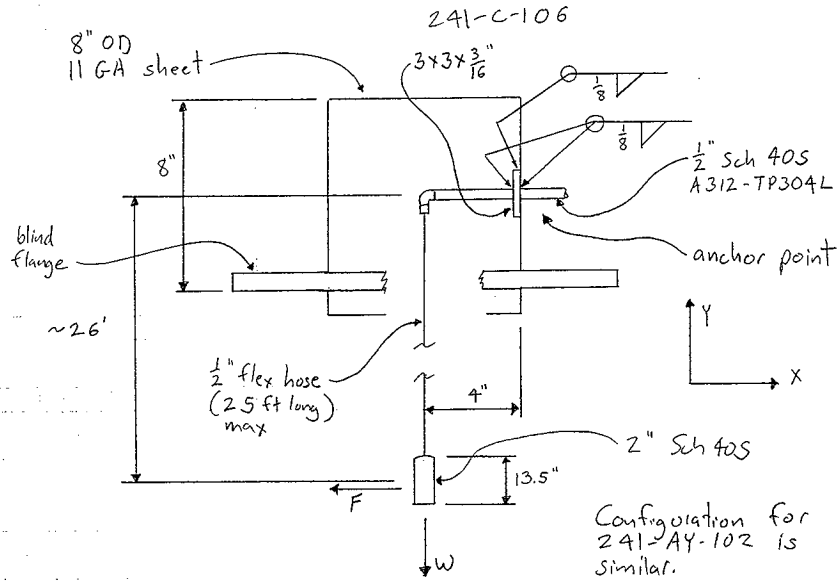
Notes: (1) Estimated from drawing

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

DESIGN ANALYSIS

Client 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. JUFLO
Location 241-C / 241-AY
Revised By

Hanging Flex Hose (For condensate drain line)



1/2" sch 40S

weight = 0.85 lb/ft S = 0.04069 in³

2" sch 40S

weight = 3.65 lb/ft

Assume weight of 1/2" flex hose equals weight of 1/2" pipe.

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

Hanging Flex Hose (continued)

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

$$W = 25.4\ lb$$

Forces at anchor point (Due to flex hose)

$$F_x = (0.42g)(25.4\ lb) = 11\ lb$$

$$F_y = (1.42g)(25.4\ lb) = 36\ lb$$

$$F_z = (0.42g)(25.4\ lb) = 11\ lb$$

$$M_x = 0$$

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

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

No moment in flex hose

Bending Stress in $\frac{1}{2}$" pipe

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

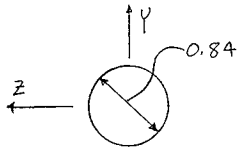
$$\sigma = 3700\ psi < 16{,}700\ psi \quad (831.3\ \text{allowable})$$

DESIGN ANALYSIS

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

Condensate drain line "anchor points" at risers

Analyze weld as a line (Ref. #10)



$A_w = \pi(0.84\ in) = 2.64\ in$

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

Force on weld from Autopipe Node Point B12

$F_x = 36\ lb$ $M_x = 0$

$F_y = 6\ lb$ $M_y = 65\ ft\cdot lb = 780\ in\cdot lb$

$F_z = 67\ lb$ $M_z = 7\ ft\cdot lb = 84\ in\cdot lb$

Total force on weld

Add force from hanging flex hose to loads from B12

$F_x = 11 + 36 = 47\ lb$ $M_x = 0$

$F_y = 36 + 6 = 42\ lb$ $M_y = 44 + 780 = 824\ in\cdot lb$

$F_z = 11 + 67 = 78\ lb$ $M_z = 144 + 84 = 228\ in\cdot lb$

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

$f_w = 1931\ lb/in$

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 N. J. JOBLO
Location 241-C / 241-AY
Revised By

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

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

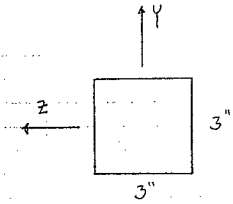
B31.3 allow

factor for shear

B31.3 factor for occasional loads

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

two sides



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

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

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

$f_w = 92$ lb/in

$$t_w = \frac{92 \text{ lb/in}}{(0.707)(16700 \text{ psi})(0.8)(1.33)} = 0.01 \text{ in} < \frac{1}{8}"$$

Therefore weld is acceptable.

DESIGN ANALYSIS

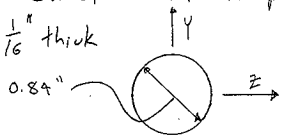
Client Numatec
Subject Portable Exhauster Installation Analysis
Location 241-C / 241-AY

WO/Job No. ER4319/W-320
Date 12/15/97 By Kelly Hayase
Checked 12/19/97 By N. J. JUPLO
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 adaquate.

Check weld at pump enclosure (Ref. # 18)



$A_w = \pi(0.84\,in) = 2.64\ in$

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

Force on weld, Autopipe Node Point B00

$F_x = 73\ lb$ $\quad M_x = 0$

$F_y = 19\ lb$ $\quad M_y = 22\ ft\cdot lb = 264\ in\cdot lb$

$F_z = 81\ lb$ $\quad M_z = 5\ ft\cdot lb = 60\ in\cdot lb$

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

$f_w = 618\ lb/in$

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

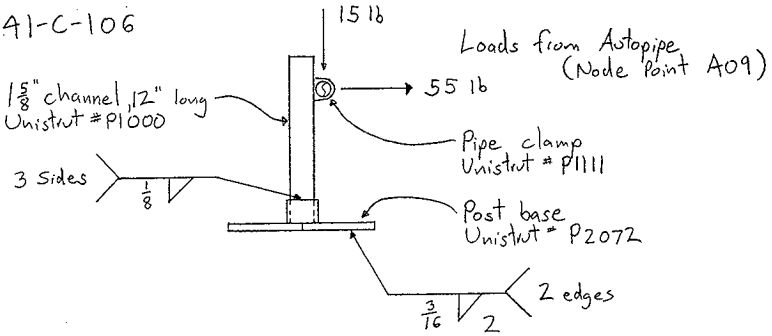
Therefore weld is acceptable

DESIGN ANALYSIS

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

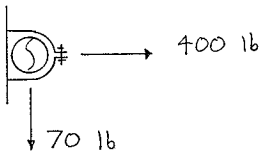
Pipe Support (For condensate drain line)

241-C-106



Pipe clamp allowable loads (Ref. # 9)

Unistrut # P1111



Therefore pipe clamp is acceptable

Channel allowable moment (Ref. # 8)

Unistrut # P1000

allowable moment = 5080 in·lb

actual moment = (12 in)(55 lb) = 660 in·lb

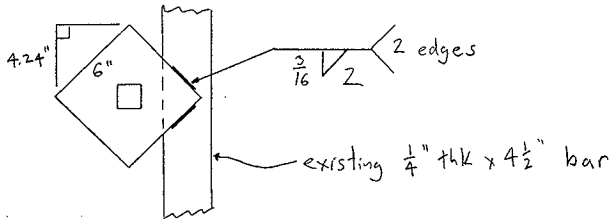
Therefore channel is acceptable.

DESIGN ANALYSIS

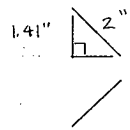
Client Numatec	WO/Job No. ER4319 / W-320		
Subject Portable Exhauster Installation Analysis	Date 12/15/97	By Kelly Hayase	
	Checked 12/19/97	By N. J. JUPLO	
Location 241-C / 241-AY	Revised	By	

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 as

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

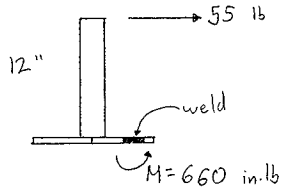
$$S_w = \frac{(1.41\text{ in})^2}{3} = 0.66\text{ in}^2$$

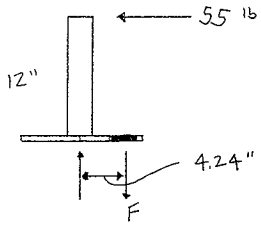
DESIGN ANALYSIS

Client 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	

Pipe Support (continued)

Worst case loadings





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

$F = 156$ lb (conservative)

For conservatism, assume loads act together

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

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

Therefore weld is acceptable

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

B31.3 allow for base metal A36

factor for shear

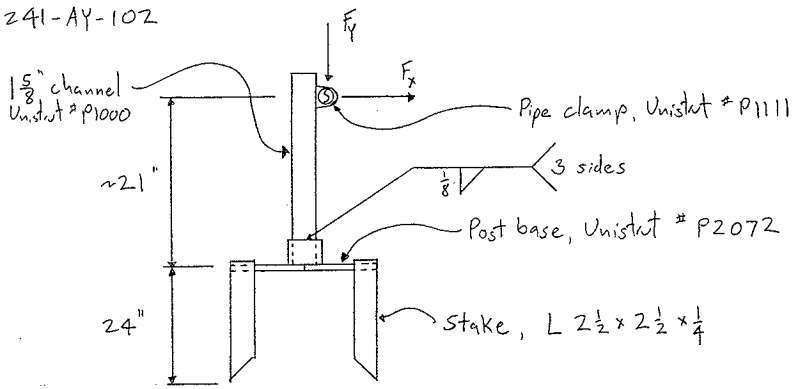
B31.3 factor for occasional loads

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

Pipe Support (continued)

241-AY-102



Loads from Autopipe (Node Point B09)

$F_Y = 15$ lb

F_X = Max of Wind or Seismic (See note on page 16)

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

However Autopipe used 1 1/2" thk insulation but actually is only 1" thk.

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

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

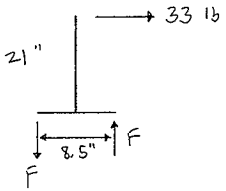
Pipe clamp is acceptable.

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

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

Pipe Support (Continued)



Uplift force F

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

Uplift resistance of stake

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

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

$\ell = 24\ in$

$K = 1.0$ (Page 7-41, Ref. # 16)

$p = (2.5\ in)(4) = 10\ in$ (perimeter of angle)

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

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

$Q = 97\ lb > 82\ lb$ O.K.

Pipe Support (Continued)

Lateral resistance of stake

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

$B = 2.5$ in

$\gamma = 0.075$ lb/in^3

$\phi = 30°$ (assumed)

$z = 12$ in (average depth)

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

$Q = 20$ lb/in

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

8" Flex Duct

Wind Load on flex duct

$F = q_z G_z C_f A_f$ (Ref. #7, Table 4)

$G_z = 1.32$ (Table 8)

$C_f = 1.0$ (Table 12) $h/D = 1/0.67 = 1.5$

$K_z = 0.8$ (Table 6)

$q_z = 0.00256\, K_z (IV)^2$ (Eq. 3)

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

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

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

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

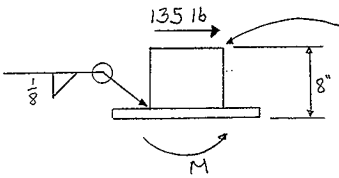
Seismic load on flex duct can be neglected because of the small mass and high flexibility of the flex duct.

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 adaquate for the operating conditions of the tanks.

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. Jurlo
Location 241-C / 241-AY
Revised By

8" Flex Duct (continued)

241-C-106



8" OD
11 GA sheet, A 240-304L
(0.1196 inch thk)

$D = 8\ in$

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

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

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

(neglect shear)

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

σ_{yield}

(Ref. #2, Para. 5.10.3.3)

Weld

$A_w = \pi(8\ in) = 25\ in$

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

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

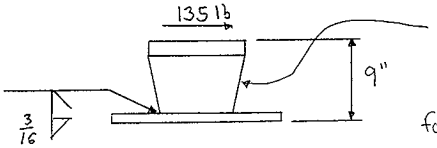
$$t_w = \frac{f_w}{(0.707)\tau_{allow}} = \frac{22\ lb/in}{(0.707)(15000\ psi)(0.8)} = 0.003\ in < \frac{1}{8}"\ O.K.$$

DESIGN ANALYSIS

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

8" Flex. Duct (continued)

241-AY-102



Reducer, 8 x 6, Sch 40S
A403 WP-S 304L

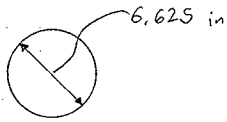
for 6" Sch 40S pipe

$S = 8.496 \text{ in}^3$

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

(neglect shear)

Weld



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

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

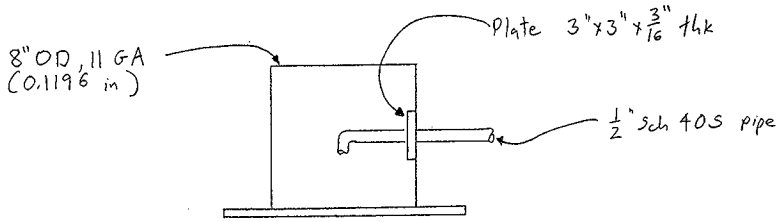
$$f_w = \sqrt{\left(\frac{(135 \text{ lb})(9 \text{ in})}{34.5 \text{ in}^2}\right)^2 + \left(\frac{135 \text{ lb}}{20.8 \text{ in}}\right)^2} = 36 \text{ lb/in}$$

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

DESIGN ANALYSIS

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

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



thickness $t = 0.1196$ in

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

$R_m = 4$ in

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

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

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

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

$V_c = 78$ lb (F_z) $\quad M_c = 824$ in.lb (M_y)

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

DESIGN ANALYSIS

Client: Numatec
Subject: Portable Exhauster Installation Analysis
Location: 241-C / 241-AY

WO/Job No.: ER4319/W-320
Date: 12/15/97 By: Kelly Hayase
Checked: 12/19/97 By: N. J. NUPLO
Revised: By:

Local Stresses (continued)

Table 5—Computation Sheet for Local Stresses in Cylindrical Shells

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

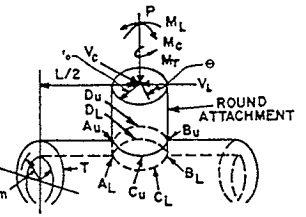
1. Applied Loads*
   - Radial load, P = 47 lb.
   - Circ. Moment, Mc = 824 in. lb.
   - Long. Moments, ML = 228 in. lb.
   - Torsion Moment, Mt = 0 in. lb.
   - Shear Load, Vc = 78 lb.
   - Shear Load, VL = 42 lb.

2. Geometry
   - Vessel thickness, T = 0.3071 in.
   - Attachment radius, r_o = 0.42 in.
   - Vessel radius, Rm = 4 in.

3. Geometric Parameters
   - γ $\frac{Rm}{T}$ = 33
   - β $(0.875)\frac{r_o}{Rm}$ = 0.092

Stress Concentration due to:
a) membrane load, Kn
b) bending load, Kb

*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 or~~ 4C	$\frac{M\phi}{P/Rm}$ = 6.4	$Kn\left(\frac{M\phi}{P/Rm}\right)\cdot\frac{P}{RmT}$ = 245	-245	−	−	−	-245	−	−	−
1C or ~~2C-1~~	$\frac{M\phi}{P}$ = 0.14	$Kb\left(\frac{M\phi}{P}\right)\cdot\frac{6P}{T^2}$ = 419	-419	+	−	+	-419	+	−	+
3A	$\frac{M\phi}{Mc/Rm^2\beta}$ = 0.90	$Kn\left(\frac{M\phi}{Mc/Rm^2\beta}\right)\cdot\frac{Mc}{Rm^2\beta T}$ = 1641					-1641	−	+	+
1A	$\frac{M\phi}{Mc/Rm\beta}$ = 0.10	$Kb\left(\frac{M\phi}{Mc/Rm\beta}\right)\cdot\frac{6Mc}{Rm\beta T^2}$ = 14245					-14245	+	+	−
3B	$\frac{M\phi}{ML/Rm^2\beta}$ = 3.0	$Kn\left(\frac{M\phi}{ML/Rm^2\beta}\right)\cdot\frac{ML}{Rm^2\beta T}$ = 1513	-1513	−	+	+				
~~1B or~~ 1B-1	$\frac{M\phi}{ML/Rm\beta}$ = 0.05	$Kb\left(\frac{M\phi}{ML/Rm\beta}\right)\cdot\frac{6ML}{Rm\beta T^2}$ = 1971	-1971	+	+	−				
Add algebraically for summation of ϕ stresses, $\sigma\phi$.			4148				16550			
~~3C or~~ 4C	$\frac{Mx}{P/Rm}$ = 6.4	$Kn\left(\frac{Mx}{P/Rm}\right)\cdot\frac{P}{RmT}$ = 245	-245	−	−	−	-245	−	−	−
1C-1 ~~or 2C~~	$\frac{Mx}{P}$ = 0.14	$Kb\left(\frac{Mx}{P}\right)\cdot\frac{6P}{T^2}$ = 419	-419	+	−	+	-419	+	−	+
4A	$\frac{Mx}{Mc/Rm^2\beta}$ = 1.3	$Kn\left(\frac{Mx}{Mc/Rm^2\beta}\right)\cdot\frac{Mc}{Rm^2\beta T}$ = 2370					-2370	−	+	+
2A	$\frac{Mx}{Mc/Rm\beta}$ = 0.06	$Kb\left(\frac{Mx}{Mc/Rm\beta}\right)\cdot\frac{6Mc}{Rm\beta T^2}$ = 8547					-8547	+	+	−
4B	$\frac{Mx}{ML/Rm^2\beta}$ = 0.90	$Kn\left(\frac{Mx}{ML/Rm^2\beta}\right)\cdot\frac{ML}{Rm^2\beta T}$ = 454	-454	−	+	+				
~~2B or~~ 2B-1	$\frac{Mx}{ML/Rm\beta}$ = 0.08	$Kb\left(\frac{Mx}{ML/Rm\beta}\right)\cdot\frac{6ML}{Rm\beta T^2}$ = 3153	-3153	+	+	−				
Add algebraically for summation of X stress, σx =			4271				11581			
Shear stress due to Torsion, Mt		$\tau x\phi = \tau\phi x = \frac{Mt}{2\pi r_o^2 T}$ = 0	+	+	+	+	+	+	+	+
Shear stress due to load, Vc		$\tau\phi = -\frac{Vc}{\pi r_o T}$ = 192	+192	+	−	−				
Shear stress due to load, VL		$\tau x\phi = \frac{VL}{\pi r_o T}$ = 104					-104	−	+	+
Add Algebraically for summation of shear stresses, τ =			192				104			

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)

Combined Stress

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

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

$$S = 16557\ psi$$

Total stress $= 16557\ psi + 189\ psi = 16746\ psi < \sigma_{allow}$ O.K.

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

σ_{yield}

(Ref. #2, Para 5.10.3.3)

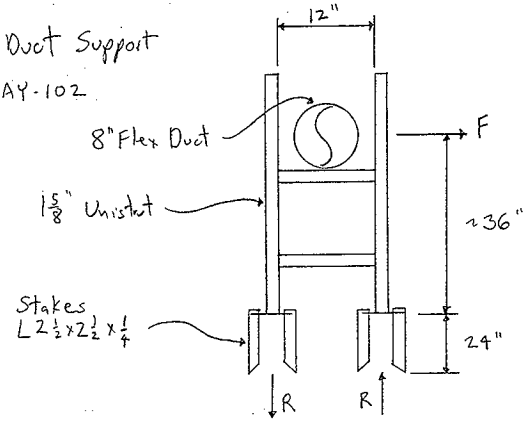
Based on comparison, local stresses in 8 x 6 Reducer due to welded condensate drain are acceptable.

DESIGN ANALYSIS

Client Numatec
WO/Job No. ER 4319 / 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

Flex Duct Support

241-AY-102



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

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

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

uplift resistance

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

Lateral resistance is acceptable. 105 lb < 480 lb <u>o.k.</u>

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

weight of hose = $(1.75\ ^{lb}/_{ft})(7\ ft) = 12.25\ lb$

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

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

This is less than 105 lb wind force ∴ page 23 is o.k.

Determine deflection at end of sheet (24 inches out)

$$w = \left(1.75\ \frac{lb}{ft}\right)\left(\frac{ft}{12\ in}\right) + \left(19.5\ lb/60\ in\right) = 0.47\ ^{lb}/_{in}$$

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

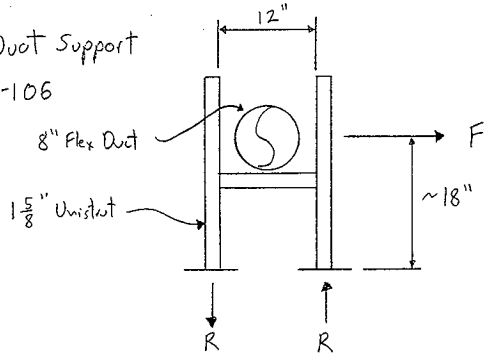
$$\Delta = \frac{wL^4}{8EI} = \frac{\left(0.47\ \frac{lb}{in}\right)(24\ in)^4}{8(30\times10^6\ psi)(0.00136\ in^4)}$$

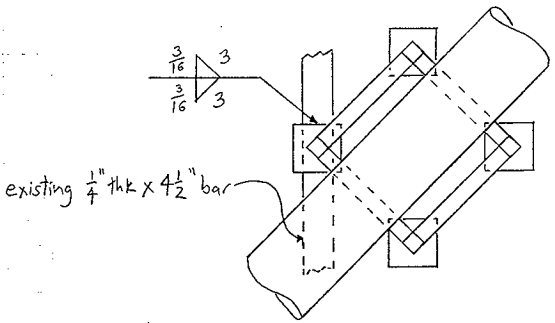
$\Delta = 0.48\ in \simeq \frac{1}{2}$" This is acceptable.

DESIGN ANALYSIS

Client Numatec	WO/Job No. ER4319 / W-320		
Subject Portable Exhauster Installation Analysis	Date 2/26/98	By Kelly Hayes	
	Checked 02/26/98	By N. J. JUPLO	
Location 241-C / 241-AY	Revised	By	

Flex Duct Support
241-C-106





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

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

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

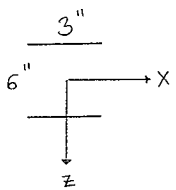
An uplift force or a moment will act on weld, depending on direction of force.

DESIGN ANALYSIS

Client Numatec
WO/Job No. ER4319 / W-320
Subject Portable Exhauster Installation Analysis
Date 2/26/98 By Kelly Hayase
Checked 02/26/98 By N. J. JUFLO
Location 241-C / 241-AY
Revised By

Flex Duct Support (Continued)

Analyze weld as a line



$A_w = 2 \times 3\ in = 6\ in$

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

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

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

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

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 : PEXCNDS

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

PREPARED BY : Kelly K Hanase
K HANASE

CHECKED BY : Kevin Clark 12/29/97

PIPING CODE : B31.3

AMBIENT TEMP. (deg F) : 40.0

COMPONENT LIBRARY : AUTOPIPE

MATERIAL LIBRARY : AUTOB313

MODEL REVISION NUMBER : 31

1C14PRINT

POINT DATA LISTING

POINT NAME	TYPE	OFFSETS (ft) X	Y	Z	PIPE ID	DESCRIPTION
*** 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) X	Y	Z	PIPE ID	DESCRIPTION
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

C O M P O N E N T D A T A L I S T I N G

POINT NAME	---COORDINATE(ft)--- X	Y	Z	DATA TYPE	DESCRIPTION
*** SEGMENT A					
A00	0.00	0.00	0.00	ANCHOR	Rigid Thermal movements : None
				DISPL	User 1
A01	0.00	0.00	0.83	GUIDE	ID : A01 1, Connected to Ground Stiffness = RIGID
				DISPL	User 1
A02	0.00	0.00	1.00		
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		3 mass point(s)
A09	0.00	0.67	7.33	GUIDE	ID : A09 1, Connected to Ground Stiffness = RIGID 3 mass point(s)
A10	0.00	0.67	13.66	Y-STOP	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		1 mass point(s)
A13	-4.75	0.67	14.66	GUIDE	ID : A13 1, Connected to Ground Stiffness = RIGID 3 mass point(s)
A14	-10.58	0.67	14.66	ANCHOR	Rigid Thermal movements : None
*** SEGMENT B					
B00	-5.00	0.00	-5.00	ANCHOR	Rigid Thermal movements : None
				DISPL	User 1
B01	-5.83	0.00	-5.00	GUIDE	ID : B01 1, Connected to Ground Stiffness = RIGID
				DISPL	User 1
B02	-6.00	0.00	-5.00		
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

C O M P O N E N T D A T A L I S T I N G

POINT NAME	---COORDINATE(ft)--- X	Y	Z	DATA TYPE	DESCRIPTION
				FLANGE	Weld neck SIF = 1.00 Rating = 150, Weight = 3 lb
B05	-6.53	0.00	-5.00		
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

P I P E D A T A L I S T I N G

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

M A T E R I A L D A T A L I S T I N G

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	28.42		16700.0
				200.0		1.7688	16700.0
A312-TP304L	1"PIPE	501.0	0.30	40.0	28.42		16700.0
				200.0		1.7688	16700.0

TEMPERATURE AND PRESSURE DATA

POINT NAME	CASE 1 PRESS. psi	CASE 1 TEMPER deg F	CASE 1 EXPAN. in/100ft	CASE 2 PRESS. psi	CASE 2 TEMPER deg F	CASE 2 EXPAN. in/100ft	CASE 3 PRESS. psi	CASE 3 TEMPER deg F	CASE 3 EXPAN. in/100ft
*** 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						

FORCES AND DISPLACEMENTS
(Force - lb , Moment - ft-lb , Tran. - in , Rot. - deg , Line - lb/ft)

POINT NAME	LOAD CASE	TYPE	X	Y	Z	XX	YY	ZZ
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

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

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

A N A L Y S I S S U M M A R Y

Current model revision number : 31

```
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/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
         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 ............. 0
         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	1.00	Automatic	Default
			Max Long	1.00		
Cold to T1	Expansion	Sum	Thermal 1	1.00	Automatic	Default
Sus. + W1	Occasion	Abs sum	Wind 1	1.00	Automatic	Default
			Max Sus	1.00		
Sus. + W2	Occasion	Abs sum	Wind 2	1.00	Automatic	Default
			Max Sus	1.00		
Sus. + U1	Occasion	Abs sum	User 1	1.00	Automatic	Default
			Max Sus	1.00		
Sus. + R1	Occasion	Abs sum	Response 1	1.00	Automatic	Default
			Max Sus	1.00		
Max P	Hoop		Max Hoop	1.00	Automatic	Default
SUS+WIND	Occasion	Abs sum	Wind 1	1.00	Automatic	User
			Wind 2	1.00		
			Max Sus	1.00		
SUS+SEIS	Occasion	Abs sum	Response 1	1.00	Automatic	User
			User 1	1.00		
			Max Sus	1.00		

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	1.00	User
		Thermal 1	1.00	
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

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	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

D I S P L A C E M E N T S

Point name	Load combination	TRANSLATIONS (in) X	Y	Z	ROTATIONS (deg) 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

D I S P L A C E M E N T S

Point name	Load combination	TRANSLATIONS (in) X	Y	Z	ROTATIONS (deg) 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

D I S P L A C E M E N T S

Point name	Load combination	TRANSLATIONS (in) X	Y	Z	ROTATIONS (deg) 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

D I S P L A C E M E N T S

Point name	Load combination	TRANSLATIONS (in) X	Y	Z	ROTATIONS (deg) 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	0.156	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

1C14PRINT

D I S P L A C E M E N T S

Point name	Load combination	TRANSLATIONS (in) X	Y	Z	ROTATIONS (deg) 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

D I S P L A C E M E N T S

Point name	Load combination	TRANSLATIONS (in) X	Y	Z	ROTATIONS (deg) 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

D I S P L A C E M E N T S

Point name	Load combination	TRANSLATIONS (in) X	Y	Z	ROTATIONS (deg) 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

D I S P L A C E M E N T S

Point name	Load combination	TRANSLATIONS (in) X	Y	Z	ROTATIONS (deg) 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

D I S P L A C E M E N T S

Point name	Load combination	TRANSLATIONS (in) X	Y	Z	ROTATIONS (deg) 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 ***

R E S T R A I N T R E A C T I O N S

Point name	Load combination	FORCES (lb) X	Y	Z	Result	MOMENTS (ft-lb) 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

R E S T R A I N T R E A C T I O N S

Point name	Load combination	FORCES (lb) X	Y	Z	Result	MOMENTS (ft-lb) X	Y	Z	Result
A13	Guide								
	GR	0	-9	0	9	0	0	0	0
	T1	0	0	5	5	0	0	0	0
	W1	0	0	-5	5	0	0	0	0
	W2	0	0	32	32	0	0	0	0
	U1	0	0	5	5	0	0	0	0
	R1	0	2	2	2	0	0	0	0
	GR+T1	0	-9	5	10	0	0	0	0
	TOTAL	0	11	49	50	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	1	0	1	0	0	0	0
	GR+T1	0	-10	0	10	0	0	0	0
	TOTAL	0	11	0	11	0	0	0	0

R E S T R A I N T R E A C T I O N S

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

ASME B31.3c (1992) CODE COMPLIANCE

Point name	Load combination	(Moments in ft-lb) In-Pl. Moment	Out-Pl. Moment	Torsion Moment	S.I.F In	S.I.F Out	Eq. no.	(Stress in psi) Load type	Code Stress	Code 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

ASME B31.3c (1992) CODE COMPLIANCE

Point name	Load combination	(Moments in ft-lb) In-Pl. Moment	Out-Pl. Moment	Torsion Moment	S.I.F In	S.I.F Out	Eq. no.	(Stress in psi) Load type	Code Stress	Code 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

ICN 4 REPRINT

ASME B31.3c (1992) CODE COMPLIANCE

Point name	Load combination	(Moments in ft-lb) In-Pl. Moment	Out-Pl. Moment	Torsion Moment	S.I.F In	Out	Eq. no.	Load type	(Stress in psi) Code Stress	Code Allow.
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	6	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

ASME B31.3c (1992) CODE COMPLIANCE

Point name	Load combination	(Moments in ft-lb) In-Pl. Moment	Out-Pl. Moment	Torsion Moment	S.I.F In	Out	Eq. no.	Load type	(Stress in psi) Code Stress	Code Allow.
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	4605	22211
	SUS+SEIS	5	2		1.00	1.00	(18)	OCC	2029	22211

KO4PR1MT

ASME B31.3c (1992) CODE COMPLIANCE

Point name	Load combination	(Moments in ft-lb) In-Pl. Moment	Out-Pl. Moment	Torsion Moment	S.I.F In	S.I.F Out	(Stress in psi) Eq. no.	Load type	Code Stress	Code Allow.
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	8328	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

ASME B31.3c (1992) CODE COMPLIANCE

Point name	Load combination	(Moments in ft-lb) In-Pl. Moment	Out-Pl. Moment	Torsion Moment	S.I.F In	S.I.F Out	(Stress in psi) Eq. no.	Load type	Code Stress	Code Allow.
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

ASME B31.3c (1992) CODE COMPLIANCE

Point name	Load combination	(Moments in ft-lb) In-Pl. Moment	Out-Pl. Moment	Torsion Moment	S.I.F In	S.I.F Out	(Stress in psi) Eq. no.	Load type	Code Stress	Code Allow.
B10 N-	Max P						(3a)	HOOP	80	16700
	GR + Max P	2	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	6	0	0	1.25	1.04	(17)	DISP	2246	25050
	SUS+WIND	30	2		1.25	1.04	(18)	OCC	11663	22211
	SUS+SEIS	5	3		1.25	1.04	(18)	OCC	2693	22211

ASME B31.3c (1992) CODE COMPLIANCE

Point name	Load combination	(Moments in ft-lb) In-Pl. Moment	Out-Pl. Moment	Torsion Moment	S.I.F In	S.I.F Out	(Stress in psi) Eq. no.	Load type	Code Stress	Code Allow.
B11 M	Max P						(3a)	HOOP	80	16700
	GR + Max P	0	3		1.25	1.04	(18)	SUST	1061	16700
	Cold to T1	6	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

S Y S T E M S U M M A R Y

Maximum occasional stress ratio

Point	: 812
Stress psi	: 15760
Allowable psi	: 22211
Ratio	: 0.71
Load combination	: SUS+WIND

Maximum hoop stress ratio

Point	: A03
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 * * *

Calculation W320-27-050

B-1 of B-36

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

Design wind loading	Buildings	Other structures	Flexible Buildings and Structures (Height/Least Horizontal Dimension > 5 or f < 1 Hz): Buildings	Flexible Buildings and Structures (Height/Least Horizontal Dimension > 5 or f < 1 Hz): 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†	$p = q\overline{G}C_p$ # q: q_z for windward wall evaluated at height z above ground q_h for leeward wall evaluated at mean roof height $\overline{G}$: obtained by rational analysis C_p: given in Fig. 2	$F = q_z\overline{G}C_fA_f$ q_z: evaluated at height z above ground $\overline{G}$: 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	$F = q_z G_zC_fA_f$ 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	$F = q_zG_zC_fA_f$ q_z: evaluated at height z above ground G_z: given in Table 8 C_f: given in Table 8 A_f: projected area normal to wind†

**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 ft^2 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.

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:

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

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)

	I	
Category*	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	0.86	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.

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.

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 1⅝" (41 MM) WIDTH SERIES CHANNEL

UNISTRUT

CHANNEL SELECTION CHART

Channel	Channel Dimensions				Material & Thickness			Hole Pattern Styles					
	Width		Height					KO	T	SL	HS	DS	H3
	In	mm	In	mm	Steel	Stain-less Steel	Alum.						
P1000	1⅝	41	1⅝	41	12 ga	12 ga	.109	■	■	■	■	■*	■*
P1100	1⅝	41	1⅝	41	14 ga	14 ga	—	■	■	■	■		
P2000	1⅝	41	1⅝	41	16 ga	—	—	■	■	■	■		
P3000	1⅝	41	1⅜	35	12 ga	—	—	■	■	■	■		
P3300	1⅝	41	⅞	22	12 ga	12 ga	—		■	■	■		
P4000	1⅝	41	13/16	21	16 ga	16 ga	.078		■	■	■		
P4100	1⅝	41	13/16	21	14 ga	—	—		■	■	■		
P5000	1⅝	41	3¼	83	12 ga	—	—	■	■	■	■		
P5500	1⅝	41	2 7/16	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 in^3	I in^4	Area in^2	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

* Effective section properties.

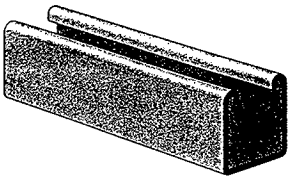
Channel	S in^3	I in^4	Area in^2	Weight Lbs/Ft
P9000	.203	.164	.384	2.05
P3301	.202	.177	.797	2.70
P1000	.202	.185	.556	1.90
P1100	.166	.149	.417	1.42
P3000	.154	.121	.503	1.70
P4101	.141	.114	.574	1.94
P2000	.140	.124	.340	1.16
P4001	.125	.101	.478	1.64
P3300	.072	.037	.398	1.35
P4100	.053	.025	.287	.97
P4000	.048	.023	.239	.82

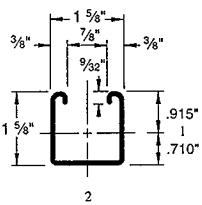
P1000® & P1001 CHANNELS

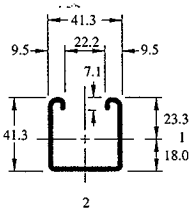
FOR 1⅝" (41 MM) WIDTH SERIES CHANNEL

UNISTRUT

P1000



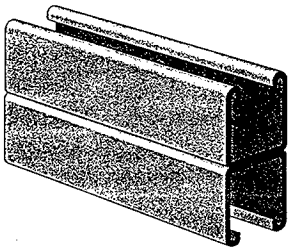


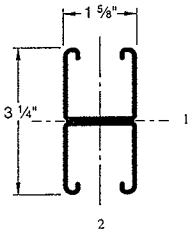


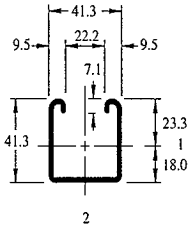
Pierced channels are found on pages 60 and 61.

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

P1001

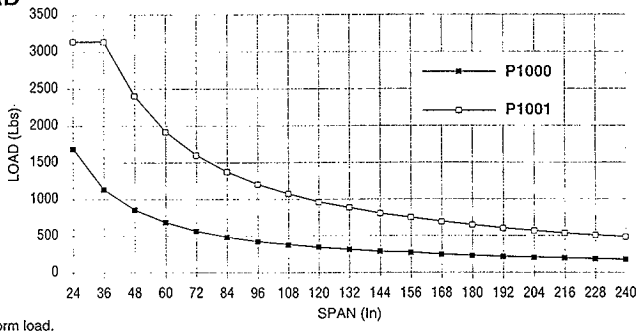






Weight: 380 Lbs/C Ft (566 kg/100 m)

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 1⅝" (41 MM) WIDTH SERIES CHANNEL

UNISTRUT

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	22610	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	**	**

**$\frac{KL}{r} > 200$

ELEMENTS OF SECTION

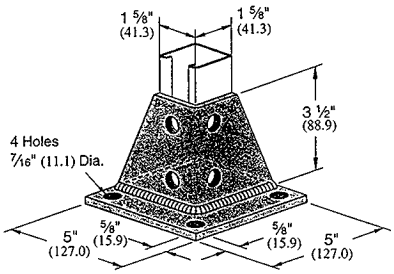
Channel	Areas of Section		Axis 1 - 1						Axis 2 - 2					
			I		S		r		I		S		r	
	In²	cm²	In⁴	cm⁴	In³	cm³	In	cm	In⁴	cm⁴	In³	cm³	In	cm
P1000	.556	3.6	.185	7.7	.202	3.3	.577	1.5	.236	9.8	.290	4.7	.651	1.7
P1001	1.112	7.2	.930	38.7	.572	9.4	.915	2.3	.472	19.6	.580	9.5	.651	1.7

I - Moment of Inertia S - Section Modulus r - Radius of Gyration

POST BASES
FOR 1⅝" (41 MM) WIDTH SERIES CHANNEL

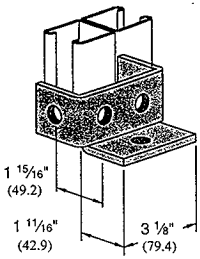
UNISTRUT

P1887



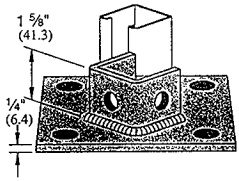
Wt/C 297 Lbs (134.8 kg)

P2453

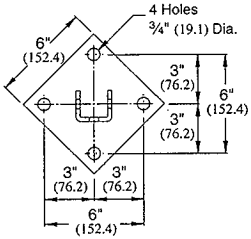


Wt/C 116 Lbs (52.6 kg)

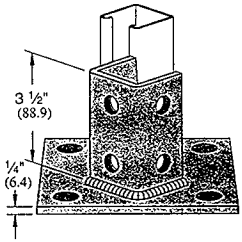
P2072



Wt/C 307 Lbs (139.3 kg)

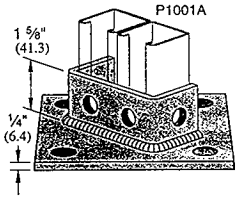


P2072 A



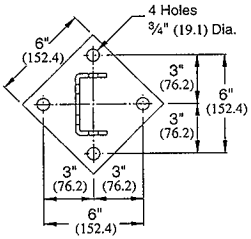
Wt/C 373 Lbs (169.2 kg)

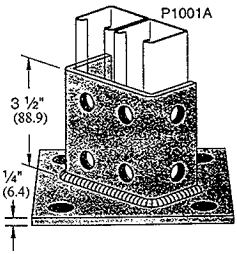
P2073



Wt/C 325 Lbs (147.4 kg)

P2073 A





Wt/C 408 Lbs (185.1 kg)

Hole Size	Hole Spacing	Width	Thickness
9/16" Diameter 14.3 mm	13/16" (20.6 mm) From End 1⅞" (47.6 mm) On Center	1⅝" 41.3 mm	¼" 6.4 mm

General Fittings

TRAPEZE FITTINGS
Pipe Clamps -P1100 Series

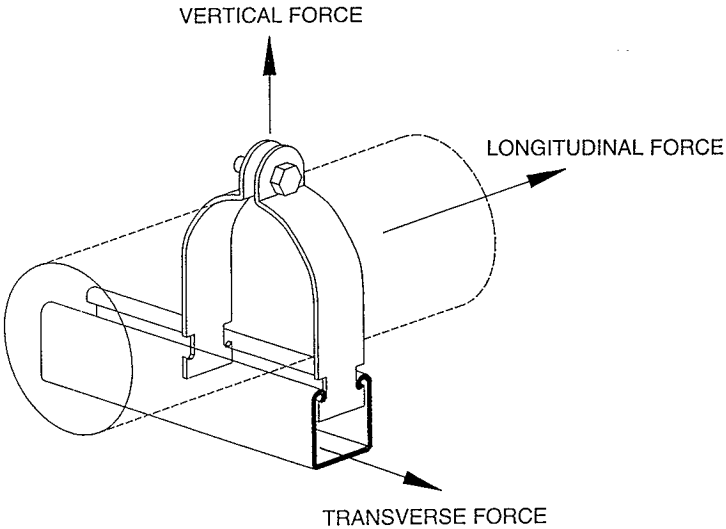


Table 6
P1100 SERIES PIPE CLAMPS

Unistrut Part Number	Pipe Size In	Pipe Size mm	Strap Thickness Ga	Strap Thickness mm	Screw Size In	Screw Size mm	Design Loads: Vertical Force Lbs.	Vertical Force N	Transverse Force Lbs.	Transverse Force N	Longitudinal Force Lbs.	Longitudinal Force 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

UNISTRUT
35660 Clinton Street
Wayne, Michigan 48184

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

WM
William Merkel
Structural Engineer

Date 7-22-93

Page 3-3

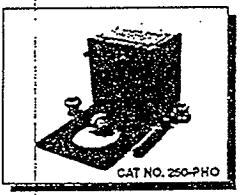
RANDOLPH AUSTIN CO.

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: 5/16" OD x 1/16" ID
1/4" OD x 1/8" ID
Dimensions: L 2¼" x W 2¼" x H 2 ¼"
Shaft Diameter: 3/16"


CAT NO. 250-PHO

SERIES 500 PUMPHEAD

Capacity: to 57 gph
Tube sizes: 3/8" OD x 3/16" ID
3/16" OD x 1/4" ID
Dimensions: L 4½" x W 4½" x H 5½"
Shaft Diameter: ½"

CAT NO. 500-PHO

CAT NO. 610-PHO

SERIES 610 PUMPHEAD

Capacity: to 255 gph
Tube sizes: 3/8" OD x 3/8" ID
3/4" OD x 1/8" ID
Dimension: L 6" x W 5½" x H 6¾"
Shaft Diameter: 5/8"

CAT NO. 750-PHO

SERIES 750 PUMPHEAD

Capacity: to 662 gph
Tube sizes: 15/16" OD x 1/4" ID
1 1/16" OD x 3/4" ID
Dimensions: L 9" x W 9½" x H 10¼"
Shaft Diameter: 3/4"

SERIES 880 PUMPHEAD

Capacity to: 1410 gph
Tube sizes: 1¼" OD x ¾" ID
1½" OD x 1" ID
Dimensions: L 16" x W 10½" H17"
Shaft Diameter: 1¼"

CAT NO. 880-PHO

KAISER ENGINEERS HANFORD

DESIGN ANALYSIS

Calc. No. n/a
Revision 0
Page No. 60 of

Client	WHC - TWRS Mitigation Systems Integration	WO/Job No.	
Subject	Structural Analysis of 500-CFM Saltwell Exhauster Skid	Date 12 Apr 96	By James Tuck
		Checked 5/21/96	By SKFarnworth
Location	TWRS Single Shell Tank Farms	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:

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

FOR SC-1 DESIGN BASIS EARTHQUAKE, LATERAL LOAD FACTOR EQUALS 0.63g, VERTICAL EQUALS 0.42g.

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

∴ MAX. DISPLACEMENT EQUALS

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

MAX. VERTICAL SEISMIC LOAD EQUALS:

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

∴ MAX. DOME LOAD EQUALS

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

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

Type of soil	Weight of moist soil γ, pcf		Weight of submerged soil γ', pcf		Coefficient of active earth pressure k_a				Coefficient of passive earth pressure k_p		
					For backfill	For soils in place	Friction angle		For soils in place	Friction angle	
	Min	Max	Min	Max			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	95	130	60	68	....	0.30	...	...	5.0		
Loose	80	125	50	63	0.50	0.35	...	...	3.0		
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.
†$\bar{\sigma}$ = 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.

Calculation WS20-27-050

B-13 & B-36

·Calculation W320-27-050 B-14 & B-36

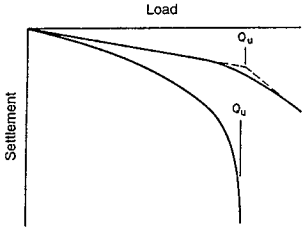


Fig. 26 Failure loads—pile-load tests.

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

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

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

TABLE 7 Coefficient of Friction

Pile material	tan ϕ_f	
	Driven piles	Jetted 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

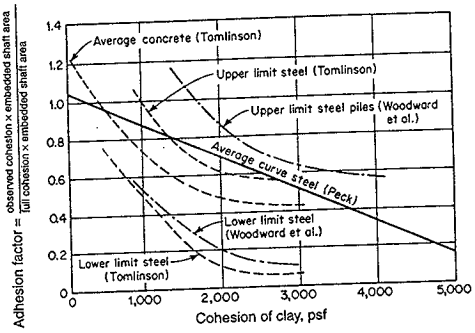


Fig. 27 The adhesion on piles compared with the cohesive strength of clay. *(After Tomlinson.[21])*

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

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

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_{u1} = average unconfined compressive strength of clay within length l, tons/ft^2
q_{u2} = average unconfined compressive strength within a distance B below the pile tips, tons/ft^2

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

$$Q_d = 9cB = 4.5q_uB \tag{33}$$

and in sands

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

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

$$w = \frac{C_w Q_{hg}}{T} \tag{35}$$

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 = $\sqrt[5]{EI/n_h}$, in
EI = flexural stiffness of pile, lb-in^2
n_h = constant of horizontal subgrade reaction, lb/in^3

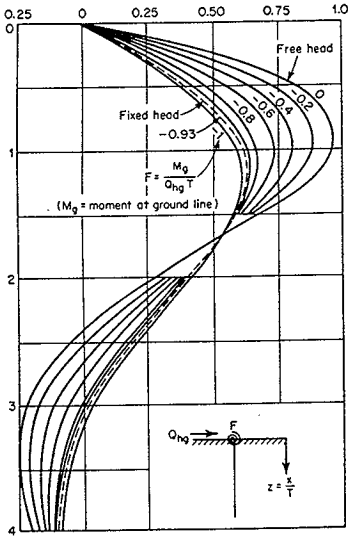


Fig. 28 Coefficients for soil reaction, laterally loaded piles. *(From Prakash, 1962.[22])*

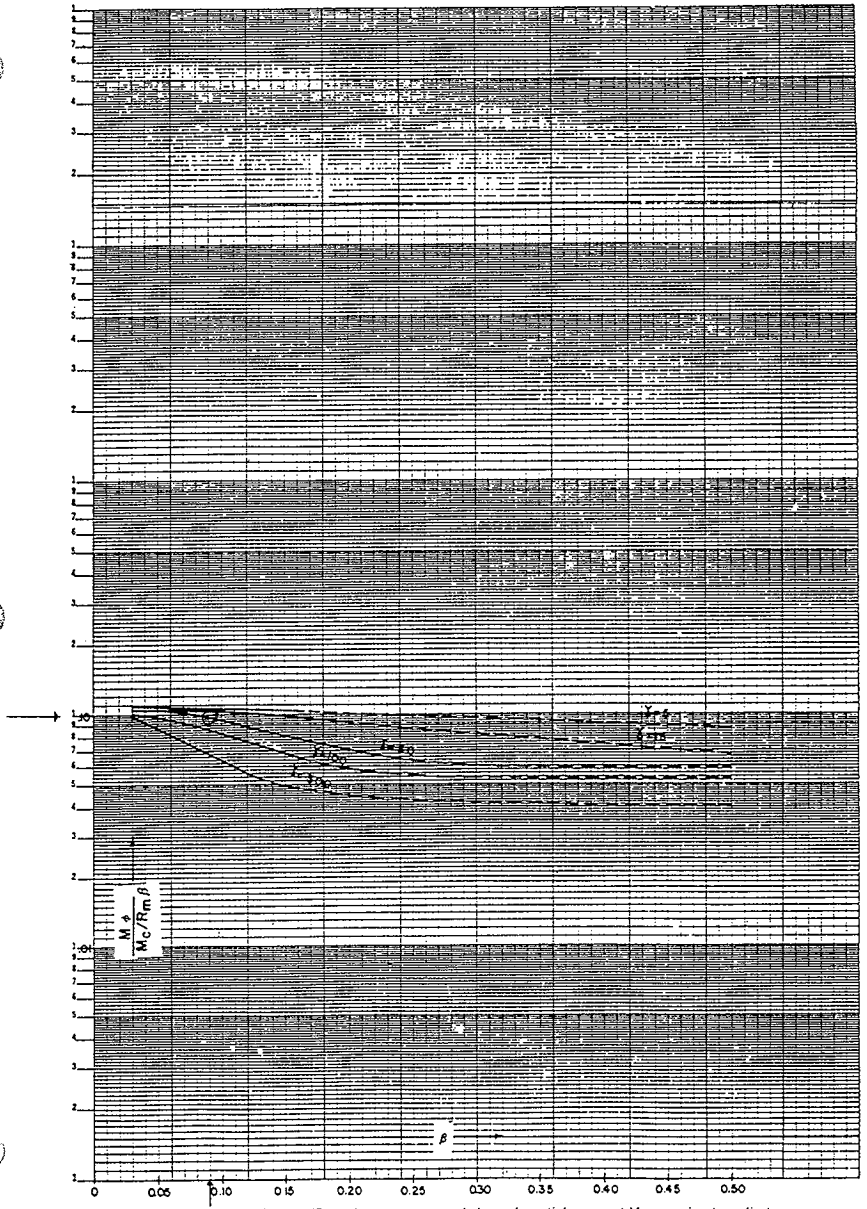


Fig. 1A—Moment $M_\phi/(M_c/R_m\beta)$ due to an external circumferential moment M_c on a circular cylinder

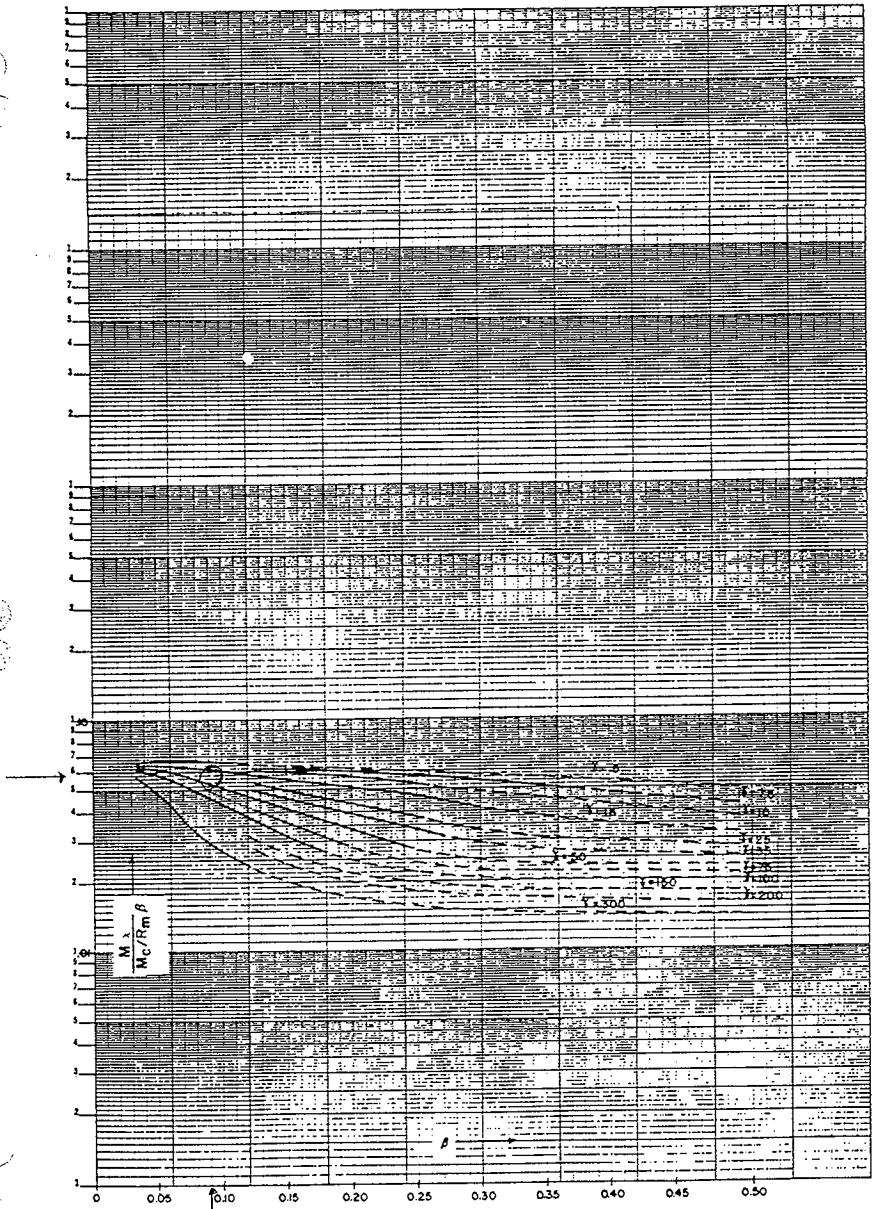


Fig. 2A—Moment $M_x/(M_c/R_m\beta)$ due to an external circumferential moment M_c on a circular cylinc

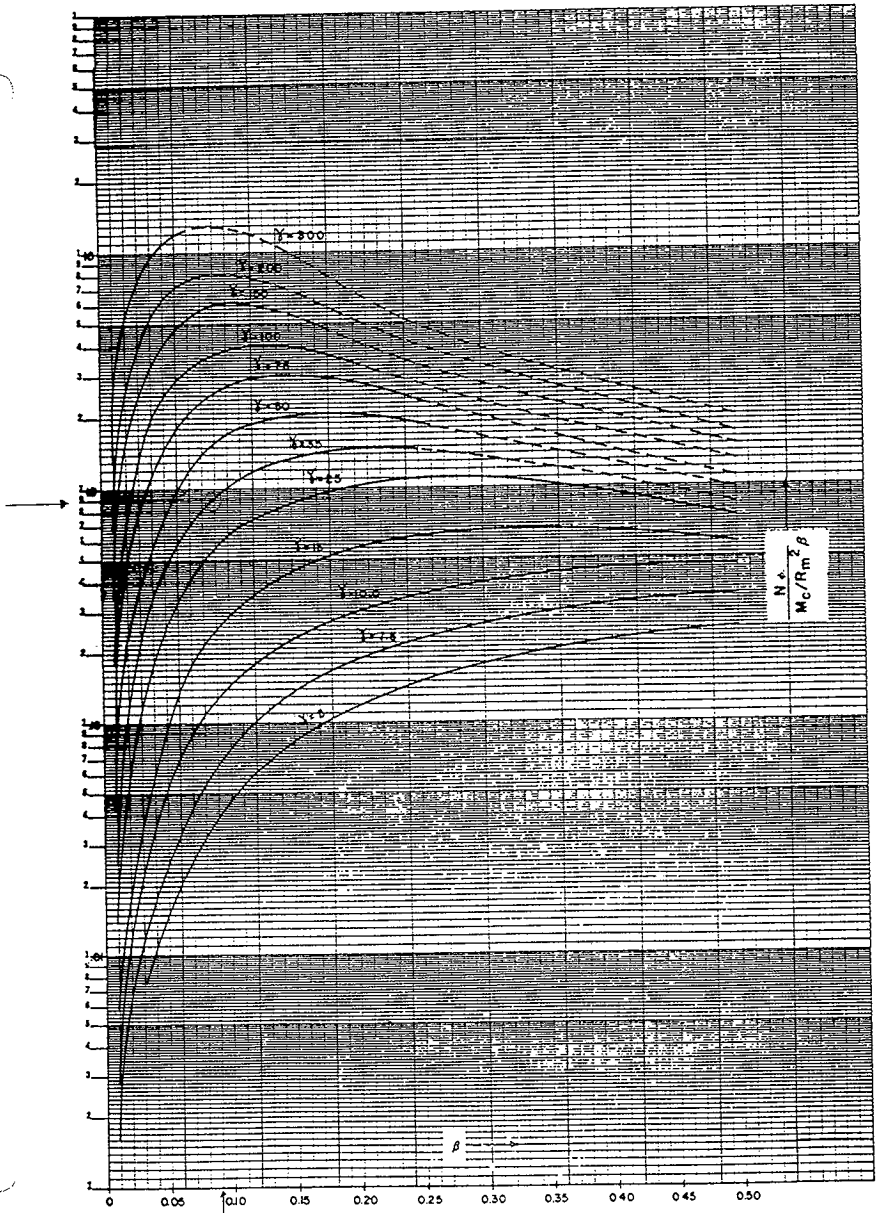


Fig. 3A—Membrane force $N_\phi/(M_c/R_m^2\beta)$ due to an external circumferential moment M_c on a circular cylinder

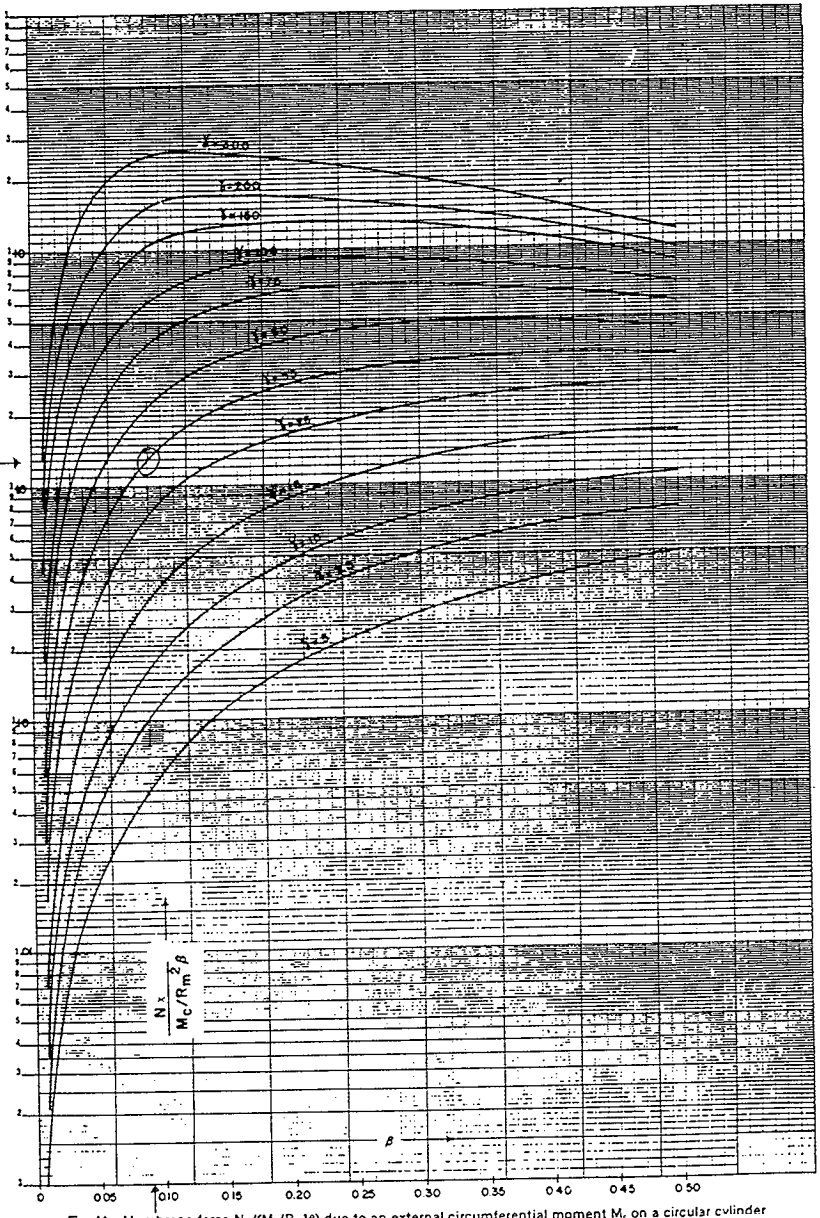


Fig. 4A—Membrane force $N_x/(M_c/R_m^2\beta)$ due to an external circumferential moment M_c on a circular cylinder

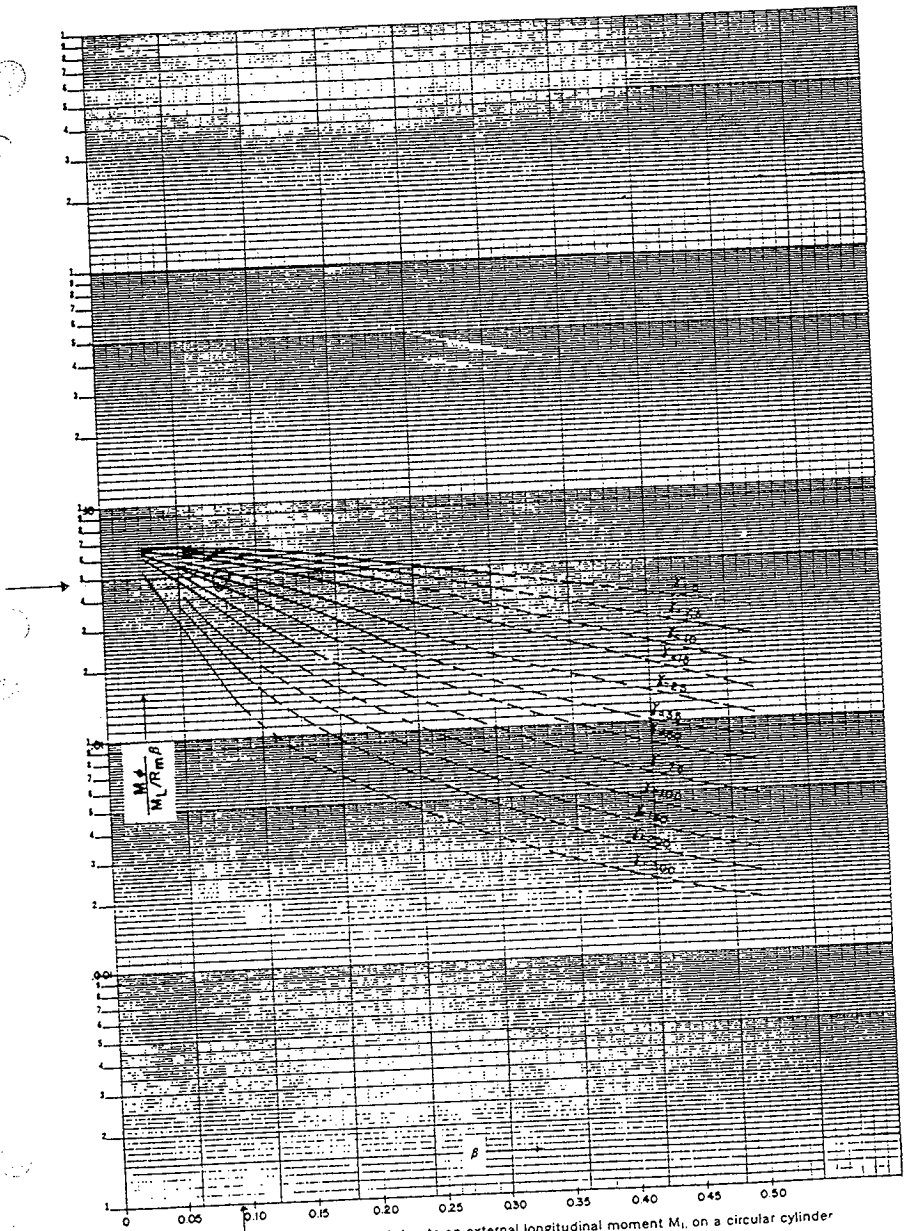


Fig. 1B-1—Moment $M_\phi/(M_L/R_m\beta)$ due to an external longitudinal moment M_L on a circular cylinder

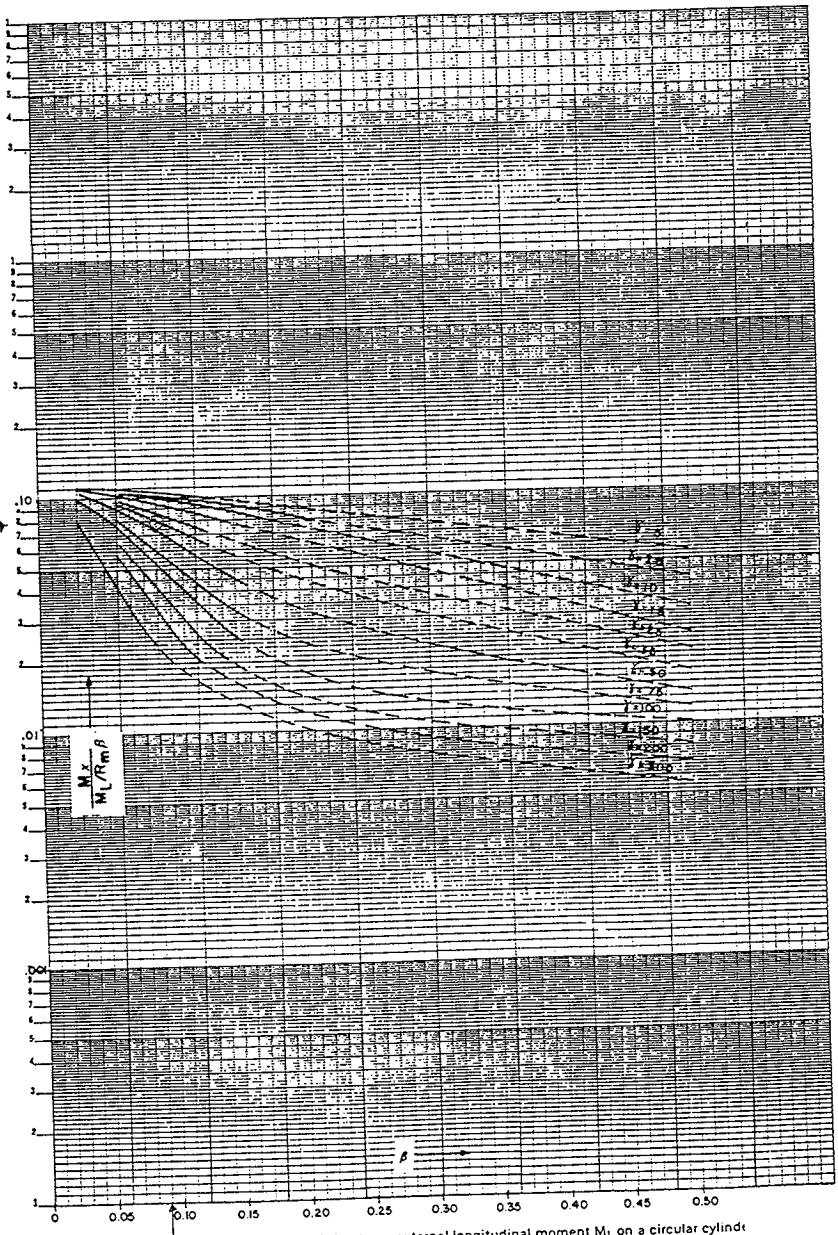


Fig. 2B-1—Moment $M_x/(M_L/R_m\beta)$ due to an external longitudinal moment M_L on a circular cylinde

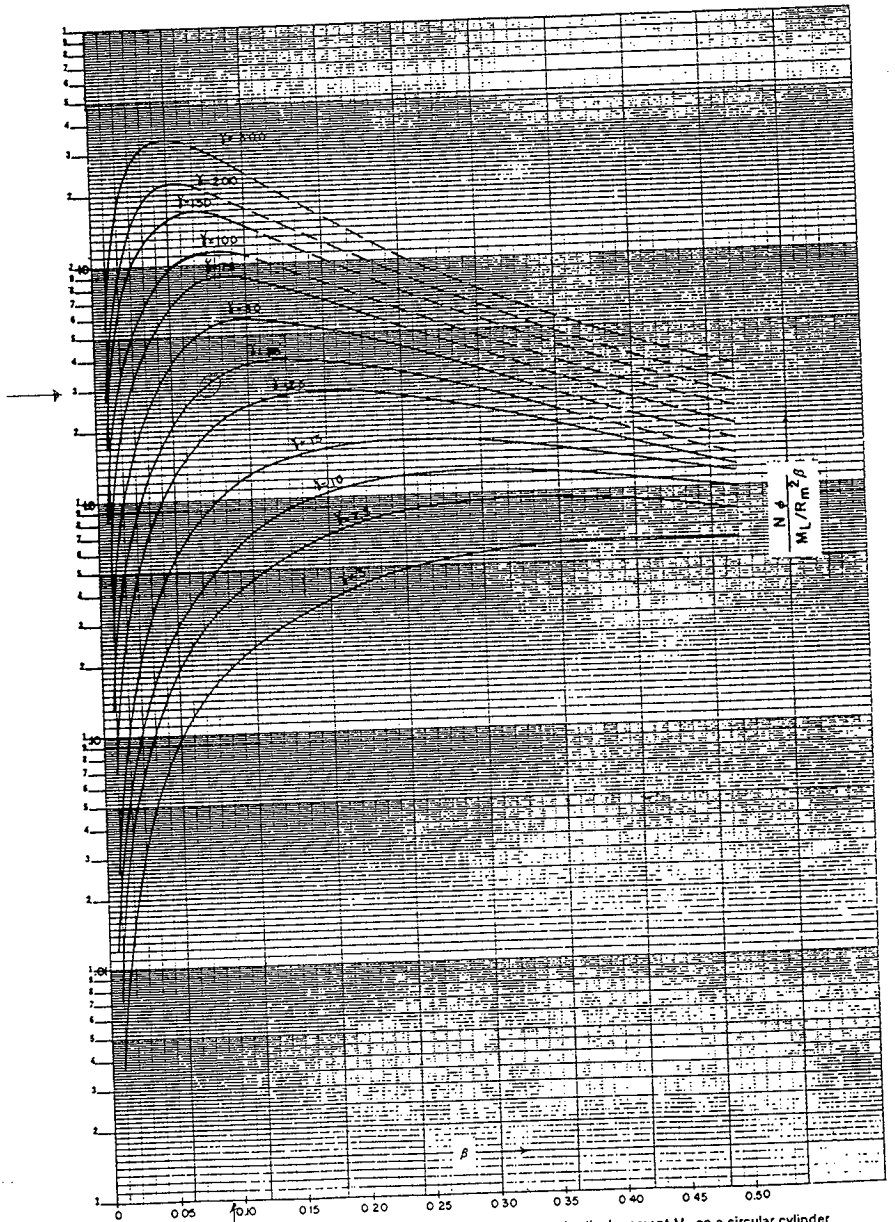


Fig. 3B—Membrane force $N_\phi/(M_L/R_m^2\beta)$ due to an external longitudinal moment M_L on a circular cylinder

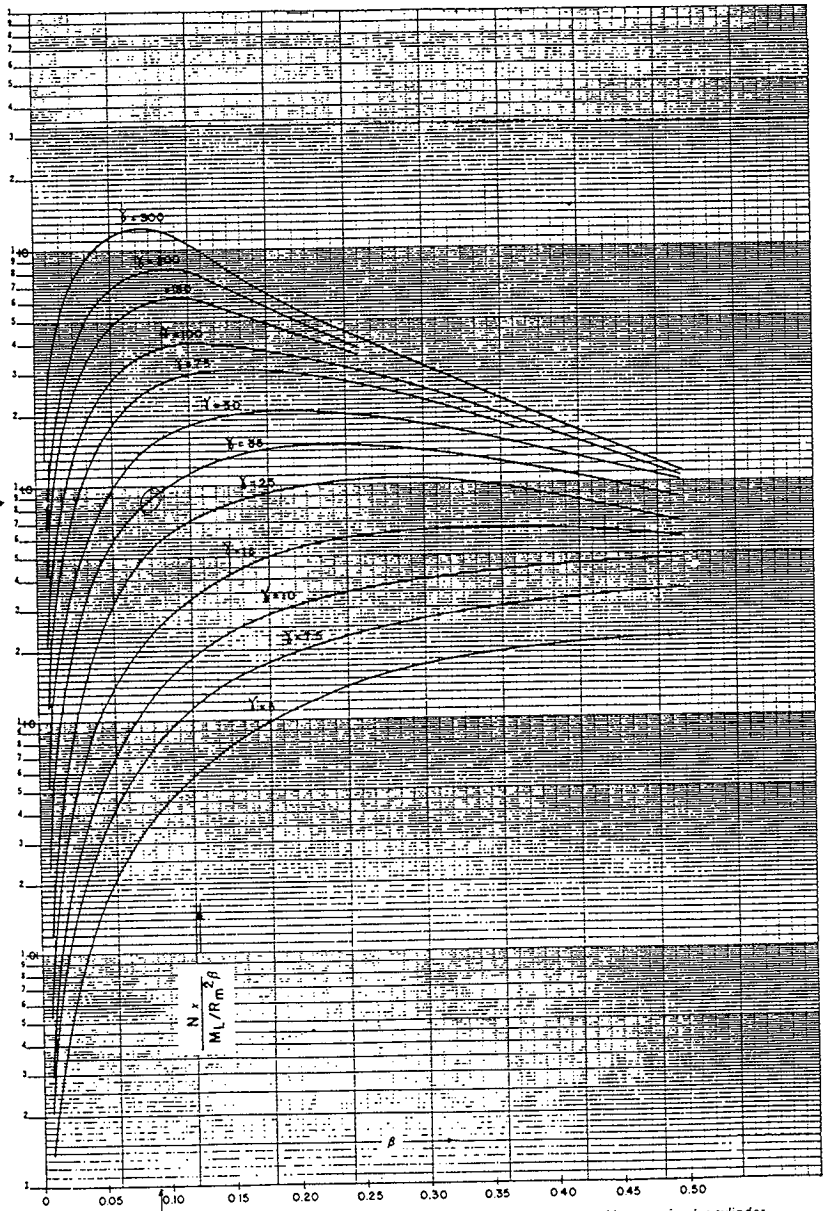


Fig. 4B—Membrane force $N_x/(M_L/R_m^2\beta)$ due to an external longitudinal moment M_L on a circular cylinder

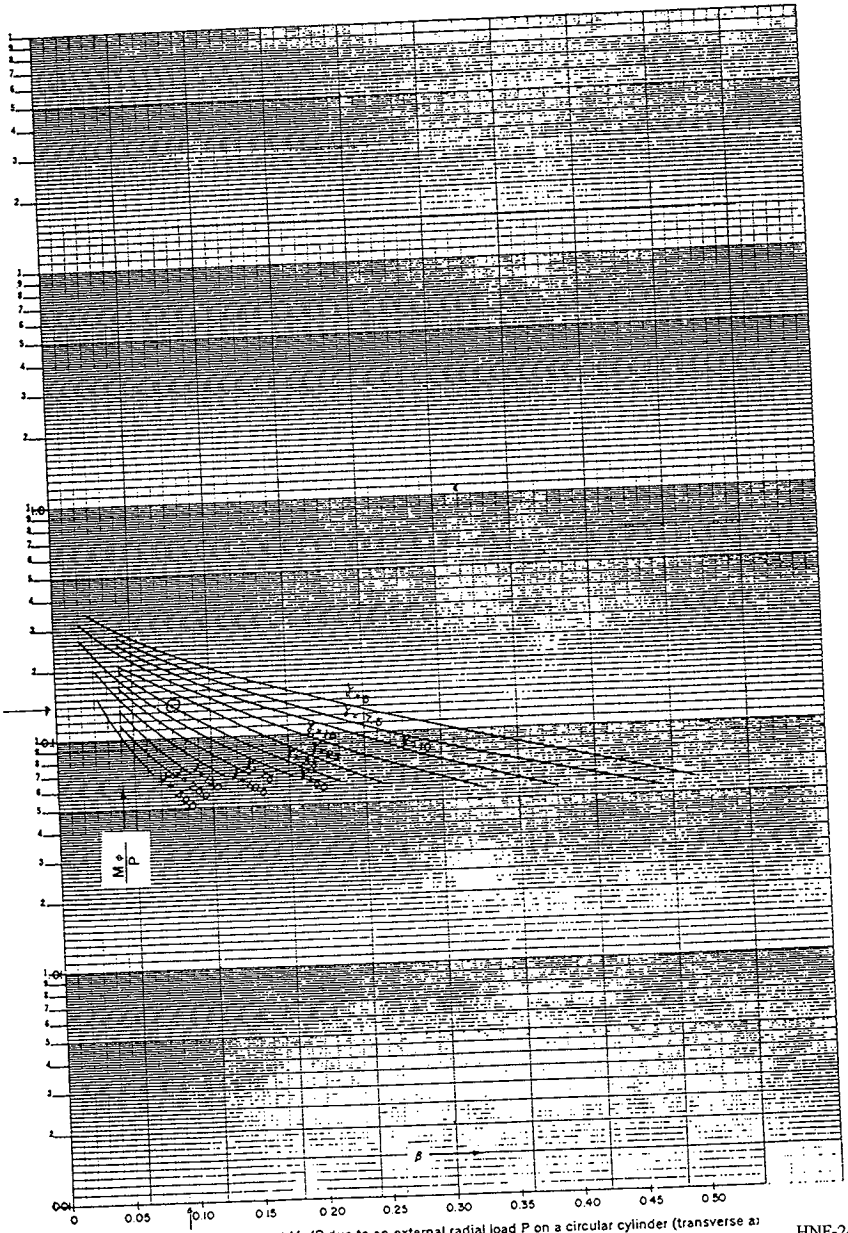


Fig. 1C—Bending moment M_θ/P due to an external radial load P on a circular cylinder (transverse a)

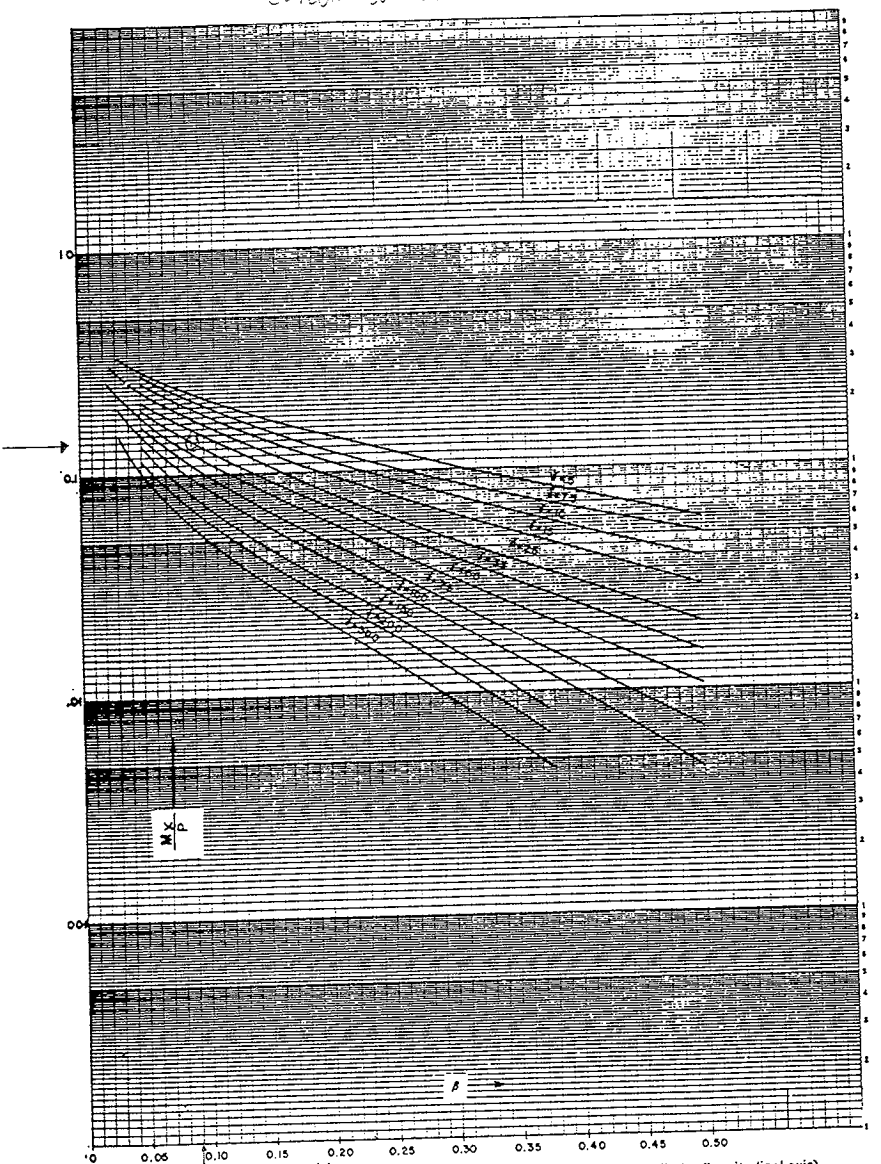


Fig. 1C-1—Bending moment $\frac{M_x}{P}$ due to an external radial load P on a circular cylinder (longitudinal axis)

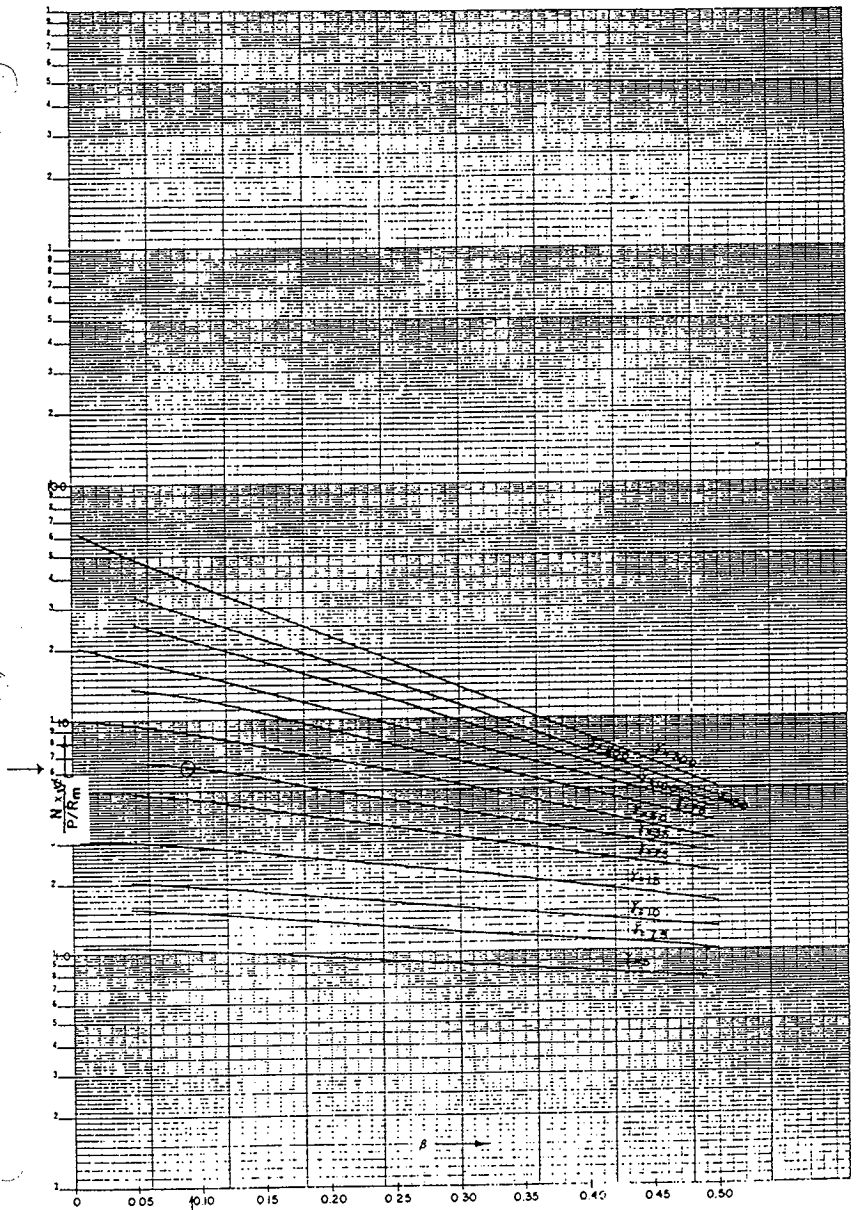
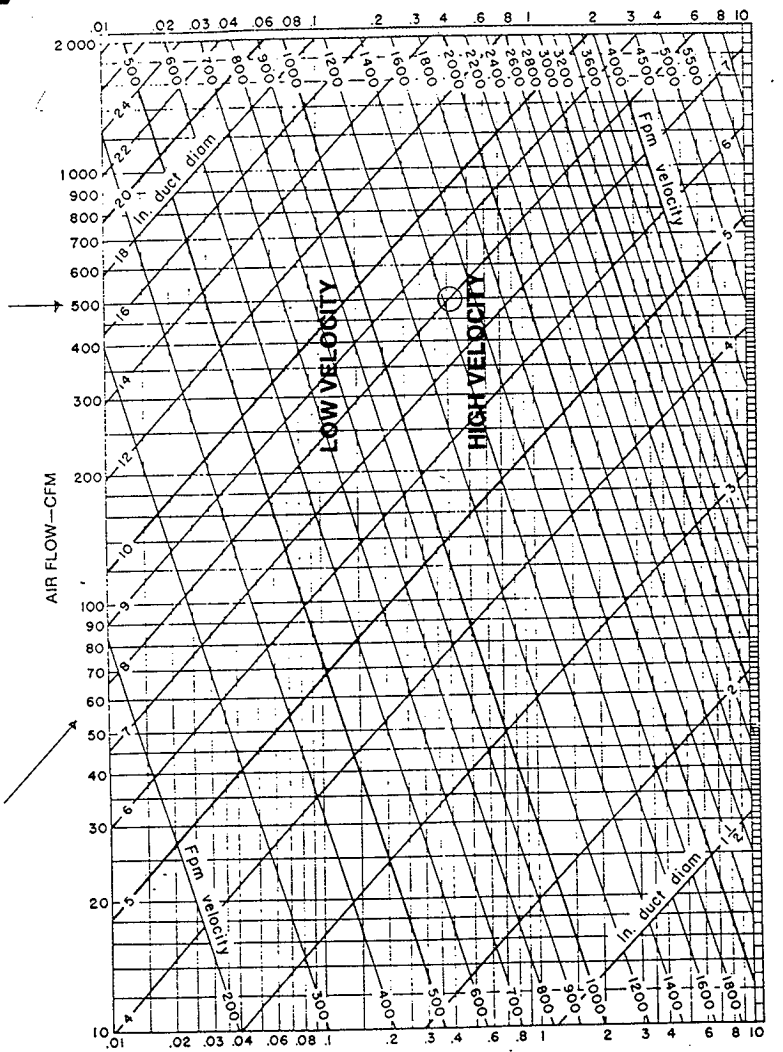


Fig. 4C—Membrane force $N_x/(P/R_m)$ due to an external radial load P on a circular cylinder (transverse axis)
—Membrane force $N_\phi/(P/R_m)$ due to an external radial load P on a circular cylinder (longitudinal axis)

A DUCT FRICTION TABLES AND CHARTS



(Based on Standard Air of 0.075 lb per cu ft density flowing through average, clean, round, hot dipped galvanized metal ducts (ϵ = 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)

Calculation W320-27-050

B-30 of B-36

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 7671

To: Bob

Co./Dept.

Phone #

Fax # 509-373-5972

Date

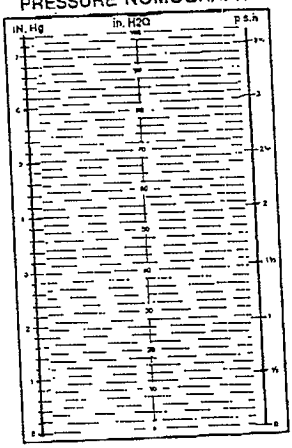
# of pages ▶

From: Victoria

Co.

Phone #

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	39	13	40	13
4	57	19	25	55	18	25				
5	48	16	18	43	14	18	34	11	35	11
6	48	16	14	43	14	14				
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

Calculation W320-27-050 B-31 of B-36

DURA-VENT
1177 MARKLEY DRIVE
PLYMOUTH, IN 46563
1-800-348-6500
(219) 936-2432
FAX: (219) 936-2505

SPECIFICATION SHEET

8" ID 2PN

CONSTRUCTION: 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 - .5OZ 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-VO 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 TO EXTEND DUCT LIFE AGAINST ABRASION AND GIVES DUCT A SLICK FINISH TO PREVENT INTERNAL BUILD-UP OF PRODUCT.

GENUINE Blue Flex FLEXIBLE DUCT HOSE

	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 FACILITIES

Safety 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.

Practice 134 215 1217
Publication Date 25Apr97
Attachment 01 - Sheet 9 of 11

Calculation W320-27-050

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
D	0.26	0.084	0.25	0.065	0.25	0.059	0.24	0.052	0.24	0.048
	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 0.20*g* DBE shall be

- scaled by 0.60 to obtain the response spectra accelerations for the Safety Class 2 and 3 0.12*g* DBE; and
- scaled by 0.45 to obtain the response spectra accelerations for the Safety Class 4 0.09*g* 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 factors[1]:

(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.

---

[1]If 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.

[2]These 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):

$$t_m = t + c \tag{2}$$

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: ⅛ in. per ft of the maximum unsupported panel span in direction of airflow but not more than ¾ in. relative to stiffeners;

(*b*) stiffeners and flange connections: ⅛ in. per ft of span but not more than ¾ in;

(*c*) flange connection to dampers and fans: 1/360 of the span or ⅛ 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

FLUOR DANIEL NORTHWEST INC.	CALCULATION IDENTIFICATION AND INDEX	Page i of ii Date 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

[X] Final Calculations

[] Check Calculations (On Calculation Dated)

[] Void Calculation (Reason Voided)

Incorporated in Final Drawings? [X] Yes [] No

This calculation verified by independent "check" calculations? [] Yes [X] No

Original and Revised Calculation Approvals:

	Rev. 0 Signature/Date	Rev. 1 Signature/Date	Rev. 2 Signature/Date
Originator	Kelly K. Hangar 12/24/97		
Checked by	Kevin Ash 12/31/97		
Approved by	Danny L. Evans 1/5/98		
Checked Against Approved Vendor Data	A. 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"

CALCULATION CROSS INDEX (Typical)

Subject Calculation No.: W320-27-051

Subject Calculation Revision No.	Superceded 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 interfacecalculation/ 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-2-818501, Sheet 1	~~2~~ 3	NA			✓		✓	
		H-2-818503, Sheet 1	~~2~~ 3				✓		✓	D.L. Evans 7/21/98
		H-2-818510, Sheet 1	~~0~~ 1				✓		✓	
		ECN W-320-696	---				✓		✓	

KEH 1975.00 (12/88)

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
Checked: 12/31/97 By: Kevin Cleveland
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 affect 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

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
Subject: Jumper Flushing Supply Head Analysis
Location: 241-AY

WO/Job No.: ER4319/W-320
Date: 12/24/97 By: Kelly Hayase
Checked: 12/31/97 By: Kevin Cleveland
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

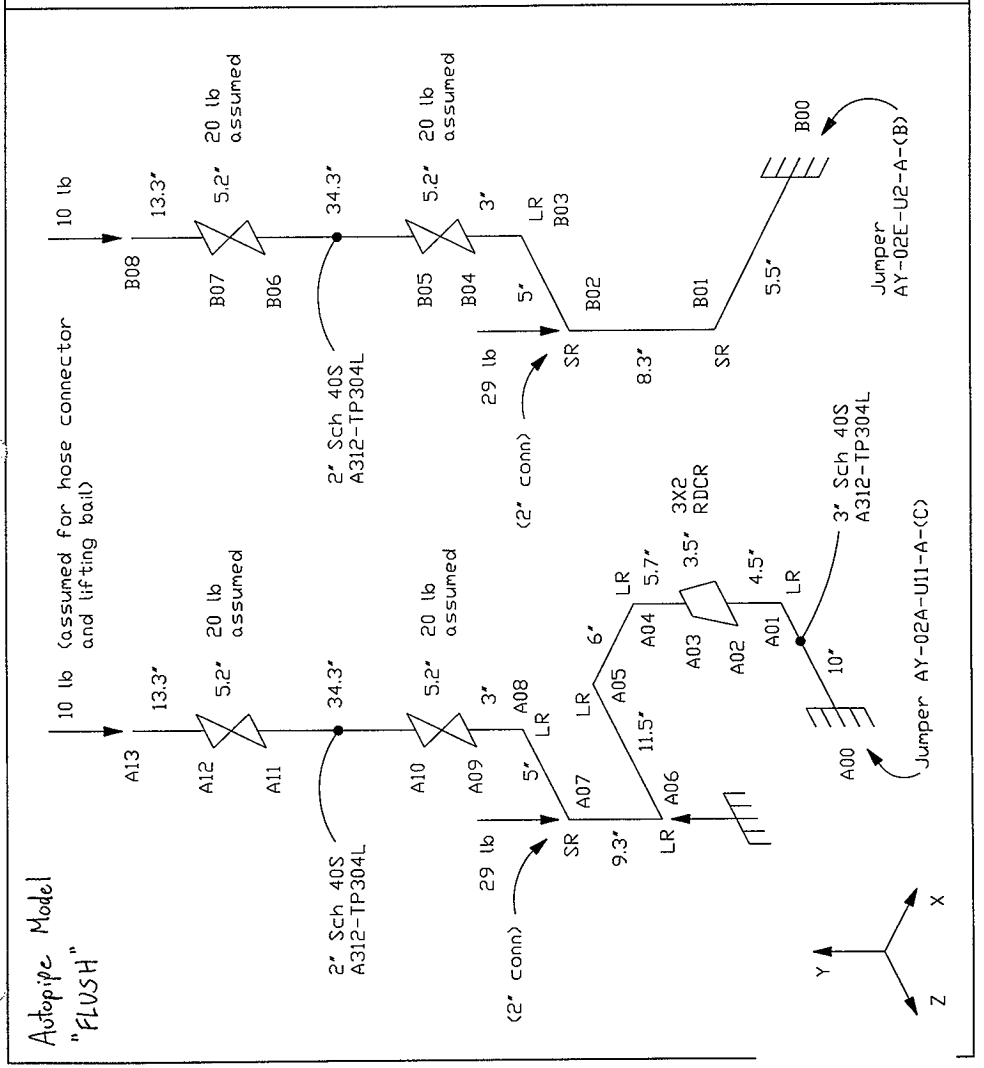
FLUOR DANIEL
NORTHWEST INC.

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 By: Kelly Hayase
Checked: 12/31/97 By: Kevin Cleveland
Revised: By:



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

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 : FLUSH

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

PREPARED BY : Kelly K. Hayase
K. HAYASE

CHECKED BY : Ken Cold 12/31/97

PIPING CODE : B31.3

AMBIENT TEMP. (deg F) : 70.0

COMPONENT LIBRARY : AUTOPIPE

MATERIAL LIBRARY : AUTOB313

MODEL REVISION NUMBER : 5

POINT DATA LISTING

POINT NAME	TYPE	OFFSETS (ft) X	Y	Z	PIPE ID	DESCRIPTION
*** 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) X	Y	Z	PIPE ID	DESCRIPTION
*** 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 2.27, 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

P I P E D A T A L I S T I N G

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

M A T E R I A L D A T A L I S T I N G

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	28.30		16700.0
				150.0		0.8985	16700.0
A312-TP304L	2"PIPE	501.0	0.30	70.0	28.30		16700.0
				150.0		0.8985	16700.0

TEMPERATURE AND PRESSURE DATA

POINT NAME	-----CASE 1------ PRESS. psi	TEMPER deg F	EXPAN. in/100ft	-----CASE 2------ PRESS. psi	TEMPER deg F	EXPAN. in/100ft	-----CASE 3------ PRESS. psi	TEMPER deg F	EXPAN. 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						


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

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

A N A L Y S I S S U M M A R Y

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 ................... No
         Weight of contents included .......... Yes
         Pressure stiffening case ............. 0
         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 ...................... 5
         Cutoff frequency (Hz) ................ 33.0
         Weight of contents included .......... Yes
         Pressure stiffening case ............. 0
         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 ................. 1
         Load cases analyzed .................. 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	1.00	Automatic	Default
			Max Long	1.00		
Cold to T1	Expansion	Sum	Thermal 1	1.00	Automatic	Default
Sus. + R1	Occasion	Abs sum	Response 1	1.00	Automatic	Default
			Max Sus	1.00		
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

IC/T-PRINT

D I S P L A C E M E N T S

Point name	Load combination	TRANSLATIONS (in) X	Y	Z	ROTATIONS (deg) 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	0.001	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

D I S P L A C E M E N T S

Point name	Load combination	TRANSLATIONS (in) X	Y	Z	ROTATIONS (deg) 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

D I S P L A C E M E N T S

Point name	Load combination	TRANSLATIONS (in) X	Y	Z	ROTATIONS (deg) 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

D I S P L A C E M E N T S

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

ASME B31.3c (1992) CODE COMPLIANCE

Point name	Load combination	(Moments in ft-lb) In-Pl. Moment	Out-Pl. Moment	Torsion Moment	S.I.F In	S.I.F Out	Eq. no.	(Stress in psi) Load type	Code Stress	Code Allow.
*** 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	21	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	21	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	21	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	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

ASME B31.3c (1992) CODE COMPLIANCE

Point name	Load combination	(Moments in ft-lb) In-Pl. Moment	Out-Pl. Moment	Torsion Moment	S.I.F In	S.I.F Out	(Stress in psi) Eq. no.	Load type	Code Stress	Code Allow.
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

ASME B31.3c (1992) CODE COMPLIANCE

Point name	Load combination	(Moments in ft-lb) In-Pl. Moment	Out-Pl. Moment	Torsion Moment	S.I.F In	S.I.F Out	(Stress in psi) Eq. no.	Load type	Code Stress	Code Allow.
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

ASME B31.3c (1992) CODE COMPLIANCE

Point name	Load combination	(Moments in ft-lb) In-Pl. Moment	Out-Pl. Moment	Torsion Moment	S.I.F In	S.I.F Out	(Stress in psi) Eq. no.	Load 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
	Sus. + R1	197	13		1.73	1.44	(18)	OCC	8872	22211
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
	Sus. + R1	180	130		1.73	1.44	(18)	OCC	9376	22211
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
	Sus. + R1	167	172		1.73	1.44	(18)	OCC	9686	22211
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
	Sus. + R1	167	172		1.00	1.00	(18)	OCC	6664	22211
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
	Sus. + R1	167	171		1.00	1.00	(18)	OCC	6661	22211
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
	Sus. + R1	147	151		1.00	1.00	(18)	OCC	6064	22211
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
	Sus. + R1	29	29		1.00	1.00	(18)	OCC	2416	22211
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
	Sus. + R1	17	17		1.00	1.00	(18)	OCC	2058	22211
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
	Sus. + R1	0	0		1.00	1.00	(18)	OCC	1542	22211

*** Segment A end ***

*** Segment B begin ***

ASME B31.3c (1992) CODE COMPLIANCE

Point name	Load combination	(Moments in ft-lb) In-Pl. Moment	Out-Pl. Moment	Torsion Moment	S.I.F In	S.I.F Out	(Stress in psi) Eq. no.	Load 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
	Sus. + R1	265	33		1.00	1.00	(18)	OCC	7271	22211
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
	Sus. + R1	233	23		1.00	1.00	(18)	OCC	6555	22211
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
	Sus. + R1	233	23		2.27	1.89	(18)	OCC	12899	22211
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
	Sus. + R1	218	169		2.27	1.89	(18)	OCC	14409	22211
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
	Sus. + R1	207	236		2.27	1.89	(18)	OCC	15841	22211
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
	Sus. + R1	236	207		1.00	1.00	(18)	OCC	8444	22211
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
	Sus. + R1	219	189		1.00	1.00	(18)	OCC	7923	22211
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
	Sus. + R1	219	189		2.27	1.89	(18)	OCC	14981	22211
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
	Sus. + R1	208	142		2.27	1.89	(18)	OCC	13368	22211
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
	Sus. + R1	197	12		2.27	1.89	(18)	OCC	11114	22211

ASME B31.3c (1992) CODE COMPLIANCE

Point name	Load combination	(Moments in ft-lb) In-Pl. Moment	Out-Pl. Moment	Torsion Moment	S.I.F In	S.I.F Out	(Stress in psi) Eq. no.	Load type	Code Stress	Code Allow.
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 M	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

ASME B31.3c (1992) CODE COMPLIANCE

Point name	Load combination	(Moments in ft-lb) In-Pl. Moment	Out-Pl. Moment	Torsion Moment	S.I.F In	S.I.F Out	(Stress in psi) Eq. no.	Load type	Code Stress	Code Allow.
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 ***

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

LC-24-PRINT

S Y S T E M S U M M A R Y

Maximum occasional stress ratio

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

Maximum hoop stress ratio

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

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

W320-27-053

New Supernate Jumper Analysis

FLUOR DANIEL NORTHWEST INC.	CALCULATION IDENTIFICATION AND INDEX	Page i of ii Date 1/12/98

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

[X] Final Calculations

[] Check Calculations (On Calculation Dated)

[] Void Calculation (Reason Voided)

Incorporated in Final Drawings? [X] Yes [] No

This calculation verified by independent "check" calculations? [] Yes [X] 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 Ward 1/20/98		
Approved by	D.L. Evans 4/1/98		
Checked Against Approved Vendor Data	A. Ahmed 4.1.98		

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

CALCULATION CROSS INDEX (Typical)

Subject Calculation No.: W320-27-053

Subject Calculation Revision No.	Superceded 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 interfacecalculation/ 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-2-818504, Sheet 1	01	NA			✓		✓	7/21/98 DL Evans
		H-2-818504, Sheet 2	01				✓		✓	7/21/98 DL Evans

KEH 1975.00 (12/88)

DESIGN ANALYSIS

Client: Numatec
Subject: New Supernate Jumper Analysis
Location: 241-AY

WO/Job No.: ER4319/W-320
Date: 1/12/98 By: Kelly Hayase
Checked: 1/20/98 By: K. Cleveland
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/W-320
Date: 1/12/98 By: Kelly Hayase
Checked: 1/20/98 By: K. Cleveland
Revised: 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
Subject: New Supernate Jumper Analysis
Location: 241-AY

WO/Job No.: ER4319/W-320
Date: 1/12/98 By: Kelly Hayase
Checked: 1/20/98 By: K. Cleveland
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
Subject: New Supernate Jumper Analysis
Location: 241-AY

WO/Job No.: ER4319/W-320
Date: 1/12/98 By: Kelly Hayase
Checked: 1/20/98 By: K. Cleveland
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 = fyz/Fyz + mx/Mx + myz/Myz < 1.0

Where: fyz = Resultant shear force (wrt connector axis) on connector determined from the analysis
mx = Torsion on connector determined from the analysis
myz = Resultant bending force (wrt connector axis) on connector determined from the analysis
Fyz = Acceptable shear load from Table 3.4, Reference #4
Mx = Acceptable torsional load from Table 3.4, Reference #4
Myz = Acceptable bending load from Table 3.4, Reference #4

For 2" Connector
Fyz = 1330 lb
Mx = 260 ft·lb
Myz = 365 ft·lb

For 4" Connector
Fyz = 2220 lb
Mx = 780 ft·lb
Myz = 1170 ft·lb

Table 2: Connector Loads

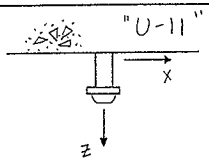
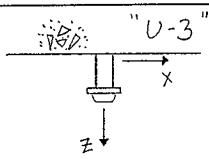
Node	Axial lb	Shear lb	Shear lb	Resultant Shear	Torsion ft·lb	Moment ft·lb	Moment ft·lb	Resultant Moment	Interaction
A01 4"	60	145	37	150	8	14	189	190	0.24
A15 2"	163	83	456	463	9	51	19	54	0.53
B08 4"	484	89	187	207	37	334	23	335	0.43

DESIGN ANALYSIS

Client: Numatec
Subject: New Supernate Jumper Analysis
Location: 241-AY

WO/Job No.: ER4319/W-320
Date: 1/12/98 By: Kelly Hayase
Checked: 1/20/98 By: K. Cleveland
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

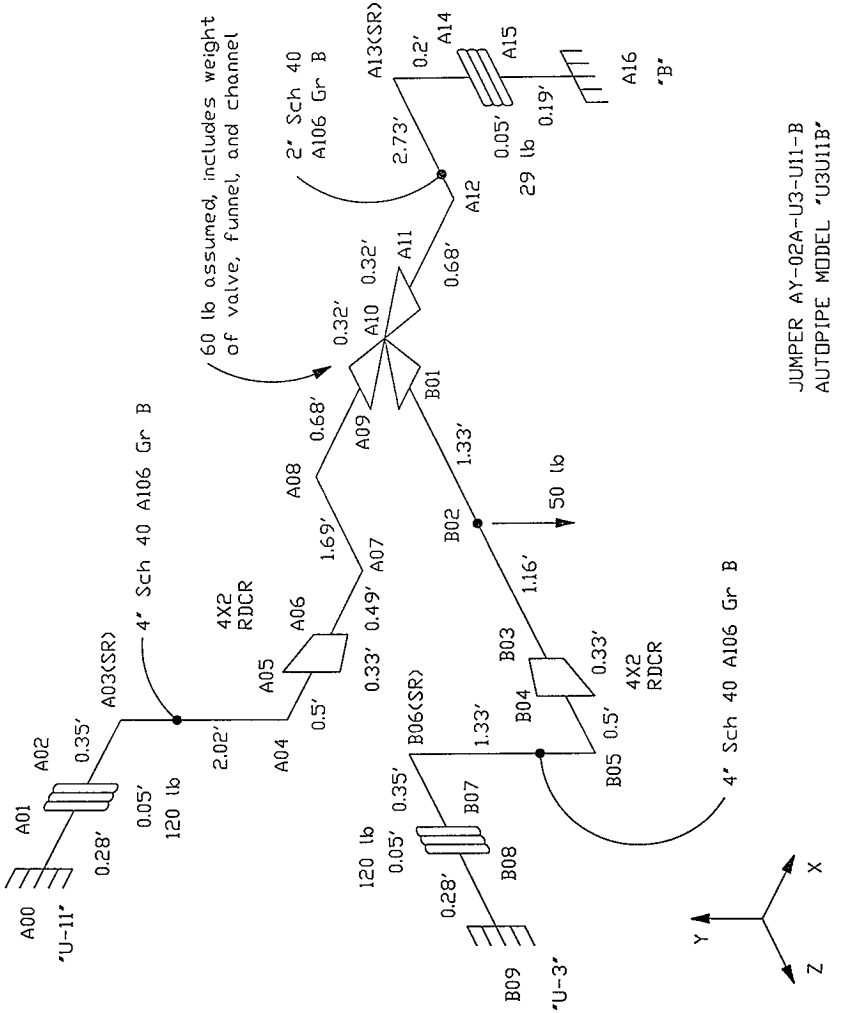
FLUOR DANIEL
NORTHWEST INC.

Calc. No.: W320-27-053
Revision: 0
Page No.: 6 of 15

DESIGN ANALYSIS

Client: Numatec
Subject: New Supernate Jumper Analysis
Location: 241-AY

WO/Job No.: ER4319/W-320
Date: 1/12/98 By: Kelly Hayase
Checked: 1/20/98 By: K. Cleveland
Revised: By:



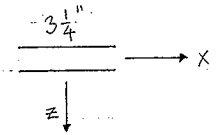
DESIGN ANALYSIS

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 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 adaquate for the 420 lb jumper weight.

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



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

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

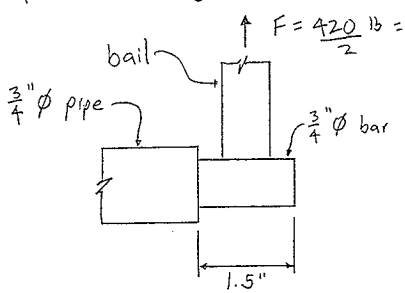
$$f_{w\,allow} = 7733(w) \text{ lb/in} = 7733\left(\tfrac{3}{16}\right) = 1450 \text{ lb/in} \quad (\text{Ref. \# 9})$$

DESIGN ANALYSIS

Client Numatec	WO/Job No. ER4319/ W-320		
Subject New Supernate Jumper Analysis	Date 1/12/98	By Kelly Haysse	
	Checked 1/20/98	By K. Cleveland	
Location 241-AY	Revised	By	

Lifting bail (continued)

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



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

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

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

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

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

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

O.K.

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

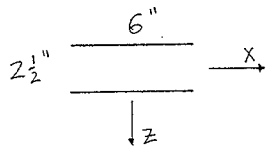
O.K.

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

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



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

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

factor for impact load

jumper weight

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

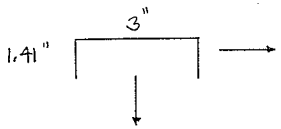
$$t_w = \frac{f_w}{(0.707)\sigma_{allow}} = \frac{70\text{ lb/in}}{(0.707)(16900\text{ psi})(0.8)} = 0.01\text{ in} < \tfrac{3}{16}\text{" fillet weld}$$

B31.3 allow for A36

factor for shear

O.K.

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



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

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

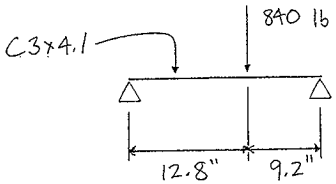
$$t_w = \frac{72\text{ lb}}{(0.707)(16900\text{ psi})(0.8)} = 0.01\text{ in} < \tfrac{1}{8}\text{" fillet weld}$$

O.K.

DESIGN ANALYSIS

Client Numatec	WO/Job No. ER 4319/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 bending stress in C3x4.1 (during installation / lifting)



$S = 0.202\ in^3$

neglect gusset plate

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

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

O.K.

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

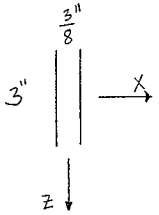
B31.3 allow for A36

factor for occasional loads

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 weld between bar and pipe (installed)

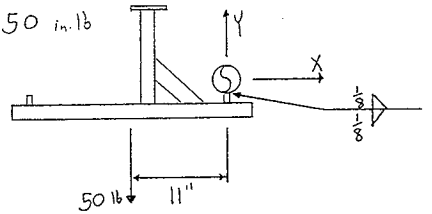


$A_w = 2 \times 3\text{ in} = 6\text{ in}$

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

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

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



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

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

O.K.

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 in pipe due to welded bar (installed)

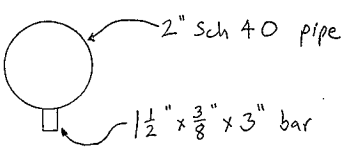
Determine exact weight of dunnage

C3×4.1	$(3\ ft)(4.1\ lb/ft)$	= 12.3 lb
6"×6"×½" plate	$(6\ in)(6\ in)(0.5\ in)(0.283\ lb/in^3)$	= 5.1 lb
10"×3"×¼" plate	$(10\ in)(3\ in)(0.25\ in)(0.283\ lb/in^3)$	= 2.1 lb
1½"×¼"×3" bar	$(1.5\ in)(0.25\ in)(3\ in)(0.283\ lb/in^3)$	= 0.3 lb
1½"×⅜"×3" bar	$(1.5\ in)(0.375\ in)(3\ in)(0.283\ lb/in^3)$	= 0.5 lb
lifting bail		~ 10 lb
		30.3 lb

Use $P = 31$ lb

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

Geometric properties



$C_1 = 0.1875"$

$C_2 = 1.5"$

$T = 0.154"$

$R_m = 1.1105"$

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

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

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

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

Local stresses (continued)

Radial load (P)

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

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

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

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

Circumferential moment (M_c)

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

$$C_c = 0.31 \qquad (N_\phi)$$

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

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

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

FLUOR DANIEL NORTHWEST INC.

Calc. No.: W320-27-053
Revision: 0
Page No.: 14 of 15

DESIGN ANALYSIS

Client: Numatec
Subject: New Supernate Jumper Analysis
Location: 241-AY

WO/Job No.: ER4319/W-320
Date: 1/12/98 By: Kelly Hayase
Checked: 1/20/98 By: K. Cleveland
Revised: By:

Local stresses (continued)

Table 5—Computation Sheet for Local Stresses in Cylindrical Shells

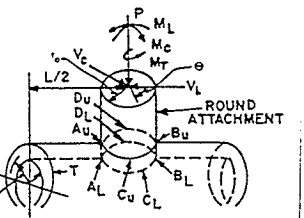
1. Applied Loads*
   - Radial load, $P =$ 31 lb.
   - Circ. Moment, $M_c =$ 341 in. lb.
   - Long. Moments, $M_L =$ — in. lb.
   - Torsion Moment, $M_T =$ — in. lb.
   - Shear Load, $V_c =$ — lb.
   - Shear Load, $V_L =$ — lb.

2. Geometry
   - Vessel thickness, $T =$ 0.154 in.
   - Attachment radius, $r_o =$ — in.
   - Vessel radius, $R_m =$ 1.1105 in.

3. Geometric Parameters
   - $\gamma = \frac{R_m}{T} =$ 7.2
   - $\beta = (0.875)\frac{r_o}{R_m} =$ —

Stress Concentration due to:
a) membrane load, Kn 1.0
b) bending load, Kb 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							
				Au	AL	Bu	BL	Cu	CL	Du	DL
0.75	~~3C or~~ 4C	$\frac{M\phi}{P/R_m} = 1.0$	$K_n\left(\frac{M\phi}{P/R_m}\right)\cdot\frac{P}{R_mT} =$ 181	–	–	–	–	181	–	–	–
0.41	1C or ~~2C-1~~	$\frac{M\phi}{P}$ 0.064	$K_b\left(\frac{M\phi}{P}\right)\cdot\frac{6P}{T^2} =$ 502	–	+	–	+	502	+	–	+
0.34	3A	$\frac{M\phi}{M_c/R_m^2\beta} =$ 0.3	$K_n\left(\frac{M\phi}{M_c/R_m^2\beta}\right)\cdot\frac{M_c}{R_m^2\beta T} =$ X0.31 491					491	–	+	+
0.44	1A	$\frac{M\phi}{M_c/R_m\beta} =$ 0.08	$K_b\left(\frac{M\phi}{M_c/R_m\beta}\right)\cdot\frac{6M_c}{R_m\beta T^2} =$ 14125					14125	+	+	–
	3B	$\frac{M\phi}{ML/R_m^2\beta} =$	$K_n\left(\frac{M\phi}{ML/R_m^2\beta}\right)\cdot\frac{ML}{R_m^2\beta T} =$	–	–	+	+				
	1B or 1B-1	$\frac{M\phi}{ML/R_m\beta} =$	$K_b\left(\frac{M\phi}{ML/R_m\beta}\right)\cdot\frac{6ML}{R_m\beta T^2} =$	–	+	+	–				
	Add algebraically for summation of $\sigma\phi$							15299			
0.59	~~3C or~~ 4C	$\frac{M_x}{P/R_m} = 1.0$	$K_n\left(\frac{M_x}{P/R_m}\right)\cdot\frac{P}{R_mT} =$ 181	–	–	–	–	181	–	–	–
0.62	1C-1 ~~or 2C~~	$\frac{M_x}{P} = 0.05$	$K_b\left(\frac{M_x}{P}\right)\cdot\frac{6P}{T^2} =$ 392	–	+	–	+	392	+	–	+
0.34	4A	$\frac{M_x}{M_c/R_m^2\beta} =$ 0.58	$K_n\left(\frac{M_x}{M_c/R_m^2\beta}\right)\cdot\frac{M_c}{R_m^2\beta T} =$ X0.49 1501					1501	–	+	+
0.62	2A	$\frac{M_x}{M_c/R_m\beta} =$ 0.043	$K_b\left(\frac{M_x}{M_c/R_m\beta}\right)\cdot\frac{6M_c}{R_m\beta T^2} =$ 5388					5388	+	+	–
	4B	$\frac{M_x}{ML/R_m^2\beta} =$	$K_n\left(\frac{M_x}{ML/R_m^2\beta}\right)\cdot\frac{ML}{R_m^2\beta T} =$	–	–	+	+				
	2B or 2B-1	$\frac{M_x}{ML/R_m\beta} =$	$K_b\left(\frac{M_x}{ML/R_m\beta}\right)\cdot\frac{6ML}{R_m\beta T^2} =$	–	+	+	–				
	Add algebraically for summation of X stress, $\sigma_x =$							7462			
	Shear stress due to Torsion, M_T		$\tau\phi x = \tau x\phi = \frac{M_T}{2\pi r_o^2 T}$	+	+	+	+	+	+	+	+
	Shear stress due to load, V_c		$\tau x\phi = \frac{V_c}{\pi r_o T}$	+	+	–	–				
	Shear stress due to load, V_L		$\tau x\phi = \frac{V_L}{\pi r_o T}$					–	–	+	+
	Add Algebraically for summation of shear stresses, $\tau x\phi$										

Client Numatec
WO/Job No. ER4319 / W-320
Subject New Supernate Jumper Analysis
Date 1/12/98 By Kelly Haynse
Checked 1/20/98 By K. Cleveland
Location 241-AY
Revised By

Combine local stresses & global stresses

Hoop stress

15299 psi + 3350 psi = 18649 psi < 20,000 psi = σ_{allow}

(max from Autopipe)

O.K.

Sustained stress

7462 psi + 4269 psi = 11731 psi < 20,000 psi = σ_{allow}

(max from Autopipe)

O.K.

Displacement stress

7462 psi + 7662 psi = 15124 psi < 30,000 psi = σ_{allow}

(max from Autopipe)

O.K.

Occasional stress

7462 psi + 5696 psi = 13158 psi < 26600 psi = σ_{allow}

(max from Autopipe)

O.K.

POINT DATA LISTING

POINT NAME	TYPE	OFFSETS (ft) X	Y	Z	PIPE ID	DESCRIPTION
*** SEGMENT A						
A00	Run	0	0	0	4"PIPE	
A01	Flex	0.28	0	0		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
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	
A07	Bend	0.49	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
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	
A12	Bend	0.68	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
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	-1.87	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		
A10	3.00	-2.02	-1.69	TEE	B16.9 welding 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	-4.25		
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		
A16	4.00	-2.46	-4.42	ANCHOR	Rigid Thermal movements : None
*** SEGMENT B					
A10	3.00	-2.02	-1.69	TEE	B16.9 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	2.63	ANCHOR	Rigid Thermal movements : None

Number of points in the system : 51

P I P E D A T A L I S T I N G

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	4 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

M A T E R I A L D A T A L I S T I N G

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

TEMPERATURE AND PRESSURE DATA

POINT NAME	CASE 1 PRESS. psi	CASE 1 TEMPER deg F	CASE 1 EXPAN. in/100ft	CASE 2 PRESS. psi	CASE 2 TEMPER deg F	CASE 2 EXPAN. in/100ft	CASE 3 PRESS. psi	CASE 3 TEMPER deg F	CASE 3 EXPAN. 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						


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

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

A N A L Y S I S S U M M A R Y

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

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	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

D I S P L A C E M E N T S

Point name	Load combination	TRANSLATIONS (in) X	Y	Z	ROTATIONS (deg) 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
	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
A01	GR	0.000	0.000	0.000	0.000	0.000	-0.001
	T1	0.003	0.000	0.000	0.000	0.000	-0.001
	R1	0.000	0.000	0.000	0.000	0.000	0.000
	GR+T1	0.003	0.000	0.000	0.000	0.000	-0.002
	TOTAL	0.003	0.000	0.000	0.000	0.000	0.002
A02	GR	0.000	0.000	0.000	-0.031	0.004	-0.023
	T1	0.003	0.000	0.000	0.024	-0.007	-0.054
	R1	0.000	0.000	0.000	0.018	0.004	0.014
	GR+T1	0.003	-0.001	0.000	-0.006	-0.003	-0.077
	TOTAL	0.003	0.001	0.000	0.025	0.007	0.091
A03 N	GR	0.000	0.000	0.000	-0.031	0.004	-0.023
	T1	0.003	0.000	0.000	0.024	-0.007	-0.054
	R1	0.000	0.000	0.000	0.018	0.004	0.014
	GR+T1	0.003	-0.001	0.000	-0.006	-0.003	-0.077
	TOTAL	0.003	0.001	0.000	0.025	0.007	0.091
A03 M	GR	-0.001	-0.001	0.000	-0.031	0.004	-0.026
	T1	0.004	-0.004	0.000	0.024	-0.008	-0.062
	R1	0.000	0.001	0.000	0.018	0.004	0.017
	GR+T1	0.004	-0.006	0.000	-0.007	-0.004	-0.088
	TOTAL	0.004	0.007	0.001	0.025	0.008	0.105
A03 F	GR	-0.002	-0.002	0.002	-0.032	0.004	-0.027
	T1	0.002	-0.008	-0.001	0.024	-0.008	-0.070
	R1	0.001	0.001	0.001	0.019	0.005	0.019
	GR+T1	0.000	-0.010	0.001	-0.007	-0.004	-0.097
	TOTAL	0.001	0.011	0.002	0.026	0.009	0.116
A04 N	GR	-0.009	-0.002	0.010	-0.032	0.004	-0.028
	T1	-0.016	-0.021	-0.007	0.025	-0.009	-0.073
	R1	0.006	0.001	0.006	0.019	0.005	0.019
	GR+T1	-0.024	-0.023	0.003	-0.008	-0.005	-0.101
	TOTAL	0.030	0.024	0.008	0.026	0.010	0.120

D I S P L A C E M E N T S

Point name	Load combination	TRANSLATIONS (in) X	Y	Z	ROTATIONS (deg) X	Y	Z
A04 M	GR	-0.011	-0.003	0.012	-0.034	0.004	-0.032
	T1	-0.020	-0.026	-0.009	0.024	-0.009	-0.075
	R1	0.007	0.002	0.007	0.018	0.006	0.018
	GR+T1	-0.031	-0.029	0.003	-0.010	-0.006	-0.107
	TOTAL	0.038	0.031	0.010	0.028	0.011	0.126
A04 F	GR	-0.012	-0.005	0.013	-0.035	0.003	-0.034
	T1	-0.018	-0.034	-0.009	0.024	-0.011	-0.077
	R1	0.008	0.003	0.007	0.018	0.007	0.018
	GR+T1	-0.030	-0.039	0.004	-0.011	-0.007	-0.111
	TOTAL	0.038	0.042	0.011	0.029	0.014	0.128
A05	GR	-0.012	-0.005	0.013	-0.035	0.003	-0.034
	T1	-0.018	-0.034	-0.009	0.024	-0.011	-0.077
	R1	0.008	0.003	0.007	0.018	0.007	0.018
	GR+T1	-0.030	-0.039	0.004	-0.011	-0.007	-0.111
	TOTAL	0.038	0.042	0.011	0.029	0.014	0.128
A06	GR	-0.012	-0.008	0.013	-0.036	0.003	-0.035
	T1	-0.015	-0.039	-0.008	0.024	-0.011	-0.077
	R1	0.008	0.004	0.007	0.018	0.007	0.017
	GR+T1	-0.027	-0.047	0.005	-0.012	-0.008	-0.112
	TOTAL	0.035	0.051	0.011	0.030	0.015	0.129
A07 N	GR	-0.012	-0.010	0.012	-0.039	0.003	-0.035
	T1	-0.012	-0.043	-0.007	0.024	-0.013	-0.077
	R1	0.008	0.005	0.006	0.018	0.009	0.016
	GR+T1	-0.024	-0.052	0.005	-0.015	-0.010	-0.112
	TOTAL	0.032	0.058	0.011	0.033	0.019	0.128
A07 M	GR	-0.012	-0.012	0.012	-0.042	0.002	-0.036
	T1	-0.010	-0.045	-0.008	0.025	-0.021	-0.074
	R1	0.008	0.006	0.006	0.018	0.015	0.014
	GR+T1	-0.022	-0.057	0.005	-0.018	-0.019	-0.111
	TOTAL	0.030	0.063	0.011	0.036	0.034	0.124
A07 F	GR	-0.012	-0.014	0.012	-0.048	0.001	-0.037
	T1	-0.009	-0.045	-0.009	0.026	-0.030	-0.072
	R1	0.009	0.006	0.006	0.018	0.020	0.012
	GR+T1	-0.021	-0.059	0.003	-0.021	-0.030	-0.109
	TOTAL	0.029	0.066	0.009	0.040	0.050	0.122
A08 N	GR	-0.012	-0.026	0.012	-0.045	0.005	-0.031
	T1	0.002	-0.038	-0.021	0.037	-0.057	-0.065
	R1	0.014	0.010	0.006	0.016	0.020	0.009
	GR+T1	-0.011	-0.064	-0.009	-0.009	-0.052	-0.096
	TOTAL	0.025	0.073	0.015	0.025	0.072	0.105

D I S P L A C E M E N T S

Point name	Load combination	TRANSLATIONS (in) X	Y	Z	ROTATIONS (deg) 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	-0.055
	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

D I S P L A C E M E N T S

Point name	Load combination	TRANSLATIONS (in) X	Y	Z	ROTATIONS (deg) 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	0.016	-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

D I S P L A C E M E N T S

Point name	Load combination	TRANSLATIONS (in) X	Y	Z	ROTATIONS (deg) X	Y	Z
B01	GR	-0.011	-0.031	0.008	-0.022	0.024	-0.016
	T1	0.007	-0.051	0.005	0.066	-0.134	-0.047
	R1	0.014	0.011	0.003	0.008	0.012	0.005
	GR+T1	-0.004	-0.081	0.013	0.044	-0.110	-0.064
	TOTAL	0.018	0.092	0.016	0.052	0.122	0.069
B02	GR	-0.006	-0.021	0.008	-0.047	0.014	-0.012
	T1	-0.018	-0.062	0.018	0.000	-0.053	-0.071
	R1	0.012	0.007	0.003	0.016	0.012	0.014
	GR+T1	-0.024	-0.082	0.026	-0.047	-0.039	-0.083
	TOTAL	0.036	0.090	0.030	0.063	0.051	0.096
B03	GR	-0.003	-0.009	0.008	-0.043	0.007	-0.008
	T1	-0.025	-0.049	0.030	-0.116	-0.011	-0.091
	R1	0.009	0.003	0.003	0.015	0.012	0.022
	GR+T1	-0.028	-0.058	0.038	-0.160	-0.003	-0.099
	TOTAL	0.038	0.061	0.041	0.175	0.016	0.121
B04	GR	-0.003	-0.006	0.008	-0.041	0.007	-0.008
	T1	-0.026	-0.041	0.034	-0.127	-0.009	-0.093
	R1	0.008	0.002	0.003	0.015	0.012	0.023
	GR+T1	-0.029	-0.046	0.042	-0.168	-0.002	-0.100
	TOTAL	0.037	0.049	0.045	0.183	0.014	0.123
B05 N	GR	-0.003	-0.006	0.008	-0.041	0.007	-0.008
	T1	-0.026	-0.040	0.034	-0.127	-0.009	-0.093
	R1	0.008	0.002	0.003	0.015	0.012	0.023
	GR+T1	-0.029	-0.046	0.042	-0.168	-0.002	-0.100
	TOTAL	0.037	0.048	0.045	0.183	0.014	0.123
B05 M	GR	-0.002	-0.003	0.007	-0.035	0.006	-0.007
	T1	-0.023	-0.029	0.033	-0.152	-0.005	-0.094
	R1	0.007	0.001	0.003	0.013	0.012	0.023
	GR+T1	-0.026	-0.032	0.040	-0.187	0.001	-0.102
	TOTAL	0.032	0.033	0.043	0.200	0.012	0.125
B05 F	GR	-0.002	-0.002	0.005	-0.028	0.006	-0.007
	T1	-0.016	-0.020	0.022	-0.169	-0.004	-0.096
	R1	0.005	0.001	0.002	0.011	0.012	0.024
	GR+T1	-0.018	-0.022	0.027	-0.197	0.001	-0.103
	TOTAL	0.023	0.023	0.029	0.208	0.013	0.126
B06 N	GR	-0.001	-0.002	0.002	-0.027	0.005	-0.007
	T1	-0.006	-0.015	0.005	-0.169	-0.004	-0.096
	R1	0.002	0.001	0.001	0.011	0.011	0.024
	GR+T1	-0.007	-0.017	0.006	-0.196	0.002	-0.103
	TOTAL	0.010	0.018	0.007	0.207	0.013	0.126

D I S P L A C E M E N T S

Point name	Load combination	TRANSLATIONS (in) X	Y	Z	ROTATIONS (deg) X	Y	Z
B06 M	GR	0.000	-0.001	0.000	-0.025	0.005	-0.006
	T1	-0.002	-0.009	-0.002	-0.153	-0.004	-0.095
	R1	0.001	0.001	0.000	0.010	0.011	0.023
	GR+T1	-0.002	-0.011	-0.002	-0.178	0.002	-0.101
	TOTAL	0.003	0.011	0.002	0.188	0.012	0.125
B06 F	GR	0.000	0.000	0.000	-0.023	0.004	-0.006
	T1	0.000	-0.001	-0.003	-0.132	-0.003	-0.095
	R1	0.000	0.000	0.000	0.009	0.009	0.023
	GR+T1	0.000	-0.001	-0.003	-0.155	0.001	-0.101
	TOTAL	0.000	0.001	0.003	0.163	0.011	0.124
B07	GR	0.000	0.000	0.000	-0.023	0.004	-0.006
	T1	0.000	-0.001	-0.003	-0.132	-0.003	-0.095
	R1	0.000	0.000	0.000	0.009	0.009	0.023
	GR+T1	0.000	-0.001	-0.003	-0.155	0.001	-0.101
	TOTAL	0.000	0.001	0.003	0.163	0.011	0.124
B08	GR	0.000	0.000	0.000	-0.001	0.000	0.000
	T1	0.000	0.000	-0.003	-0.003	0.000	0.000
	R1	0.000	0.000	0.000	0.000	0.000	0.000
	GR+T1	0.000	0.000	-0.003	-0.004	0.000	0.000
	TOTAL	0.000	0.000	0.003	0.004	0.000	0.000
B09	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 B end ***

RESTRAINT REACTIONS

Point name	Load combination	FORCES (lb) X	Y	Z	Result	MOMENTS (ft-lb) 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
B09	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	355
	TOTAL	89	192	485	529	381	42	37	386

GLOBAL FORCES & MOMENTS

Point name	Load combination	FORCES (lb) X	Y	Z	Result	MOMENTS (ft-lb) X	Y	Z	Result
*** 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

G L O B A L F O R C E S & M O M E N T S

Point name	Load combination	FORCES (lb) X	Y	Z	Result	MOMENTS (ft-lb) X	Y	Z	Result
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	19
	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	11	35
	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

G L O B A L F O R C E S & M O M E N T S

Point name	Load combination	FORCES (lb) X	Y	Z	Result	MOMENTS (ft-lb) X	Y	Z	Result
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

G L O B A L F O R C E S & M O M E N T S

Point name	Load combination	FORCES (lb) X	Y	Z	Result	MOMENTS (ft-lb) 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	14	13	34	39	28	31	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	4	1	1	4
	GR+T1	65	-115	-416	436	124	-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 ***

G L O B A L F O R C E S & M O M E N T S

Point name	Load combination	FORCES (lb) X	Y	Z	Result	MOMENTS (ft-lb) 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	9	14	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

G L O B A L F O R C E S & M O M E N T S

Point name	Load combination	FORCES (lb) X	Y	Z	Result	MOMENTS (ft-lb) X	Y	Z	Result
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	34
	T1	-46	95	510	521	-134	-24	-13	137
	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) In-Pl. Moment	Out-Pl. Moment	Torsion Moment	S.I.F In	Out	Eq. no.	(Stress in psi) Load type	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	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	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	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	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	2.13	(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	2.13	(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	2.13	(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	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	1.00	(17)	DISP	163	30000
	Sus. + R1	33	56		1.00	1.00	(18)	OCC	1760	26600

ASME B31.3c (1992) CODE COMPLIANCE

Point name	Load combination	(Moments in ft-lb) In-Pl. Moment	Out-Pl. Moment	Torsion Moment	S.I.F In	S.I.F Out	Eq. no.	Load type	(Stress in psi) Code Stress	Code Allow.
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	1	4		1.00	1.00	(18)	SUST	1317	20000
	Cold to T1	5	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	1173	30000
	Sus. + R1	14	27		1.73	1.44	(18)	OCC	2318	26600

ASME B31.3c (1992) CODE COMPLIANCE

Point name	Load combination	(Moments in ft-lb) In-Pl. Moment	Out-Pl. Moment	Torsion Moment	S.I.F In	S.I.F Out	Eq. no.	Load type	(Stress in psi) Code Stress	Code Allow.
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

ASME B31.3c (1992) CODE COMPLIANCE

Point name	Load combination	(Moments in ft-lb) In-Pl. Moment	Out-Pl. Moment	Torsion Moment	S.I.F In	Out	(Stress in psi) Eq. no.	Load type	Code Stress	Code Allow.
A11 -	Max P						(3a)	HOOP	2687	20000
	GR + Max P	22	8		1.00	1.00	(18)	SUST	1738	20000
	Cold to T1	46	120	67	1.00	1.00	(17)	DISP	3103	30000
	Sus. + R1	30	29		1.00	1.00	(18)	OCC	2207	26600
A11 +	Max P						(3a)	HOOP	2687	20000
	GR + Max P	22	8		1.00	1.00	(18)	SUST	1738	20000
	Cold to T1	46	120	67	1.00	1.00	(17)	DISP	3103	30000
	Sus. + R1	30	29		1.00	1.00	(18)	OCC	2207	26600
A12 N-	Max P						(3a)	HOOP	2687	20000
	GR + Max P	10	30		1.00	1.00	(18)	SUST	1916	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						(3a)	HOOP	2687	20000
	GR + Max P	30	10		1.73	1.44	(18)	SUST	2399	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						(3a)	HOOP	2687	20000
	GR + Max P	45	63		1.73	1.44	(18)	SUST	3799	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						(3a)	HOOP	2687	20000
	GR + Max P	45	63		1.73	1.44	(18)	SUST	3799	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						(3a)	HOOP	2687	20000
	GR + Max P	48	80		1.73	1.44	(18)	SUST	4269	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						(3a)	HOOP	2687	20000
	GR + Max P	80	48		1.00	1.00	(18)	SUST	3224	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						(3a)	HOOP	2687	20000
	GR + Max P	9	0		1.00	1.00	(18)	SUST	1432	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						(3a)	HOOP	2687	20000
	GR + Max P	9	0		2.27	1.89	(18)	SUST	1684	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

ASME B31.3c (1992) CODE COMPLIANCE

Point name	Load combination	(Moments in ft-lb) In-Pl. Moment	Out-Pl. Moment	Torsion Moment	S.I.F In	Out	(Stress in psi) Eq. no.	Load type	Code Stress	Code Allow.
A13 M	Max P						(3a)	HOOP	2687	20000
	GR + Max P	19	1		2.27	1.89	(18)	SUST	2155	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						(3a)	HOOP	2687	20000
	GR + Max P	32	2		2.27	1.89	(18)	SUST	2778	20000
	Cold to T1	42	12	9	2.27	1.89	(17)	DISP	2096	30000
	Sus. + R1	42	3		2.27	1.89	(18)	OCC	3296	26600
A13 F+	Max P						(3a)	HOOP	2687	20000
	GR + Max P	32	2		1.00	1.00	(18)	SUST	1915	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						(3a)	HOOP	2687	20000
	GR + Max P	35	2		1.00	1.00	(18)	SUST	1986	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						(3a)	HOOP	2687	20000
	GR + Max P	40	3		1.00	1.00	(18)	SUST	2084	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						(3a)	HOOP	2687	20000
	GR + Max P	56	7		1.00	1.00	(18)	SUST	2452	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 ***

Point name	Load combination	(Moments in ft-lb) In-Pl. Moment	Out-Pl. Moment	Torsion Moment	S.I.F In	Out	(Stress in psi) Eq. no.	Load type	Code Stress	Code Allow.
A10	Max P						(3a)	HOOP	2687	20000
	GR + Max P	21	55		1.19	1.25	(18)	SUST	2713	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						(3a)	HOOP	2687	20000
	GR + Max P	52	20		1.00	1.00	(18)	SUST	2432	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						(3a)	HOOP	2687	20000
	GR + Max P	52	20		1.00	1.00	(18)	SUST	2432	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

Point name	Load combination	(Moments in ft-lb) In-Pl. Moment	Out-Pl. Moment	Torsion Moment	S.I.F In	S.I.F Out	(Stress in psi) Eq. no.	Load type	Code Stress	Code 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	2393	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) CODE COMPLIANCE

Point name	Load combination	(Moments in ft-lb) In-Pl. Moment	Out-Pl. Moment	Torsion Moment	S.I.F In	S.I.F Out	(Stress in psi) Eq. no.	Load 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 ***

S Y S T E M S U M M A R Y

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

S Y S T E M S U M M A R Y

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

S Y S T E M S U M M A R Y

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

S Y S T E M S U M M A R Y

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 * * *

KK7-4PRINT

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 Kuy and Kuz 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:

fx = -114 lbf fy = 419 lbf fz = 237 lbf
mx = -7 ft-lbf my = -58 ft-lbf mz = 173 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: fx = -114 lbf, Fx = 7,370 lbf (Table 3.4), -fx < Fx, OK
Unseat: fx < 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:

Shear: $fyz = sqrt(fy^2+fz^2) = sqrt(419^2+237^2) = 482$ ft-lbf
Torsion: $|mx| = 7$ ft-lbf
Bending: $myz = sqrt(my^2+mz^2) = sqrt(58^2+173^2) = 182$ ft-lbf

$I = fyz/Fyz + |mx|/Mx + myz/Myz = 482/1330 + 7/260 + 182/365 = 0.90$ 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	Fx (lbf)	Fy (lbf)	Fz (lbf)	Mx (ft-lbf)	My (ft-lbf)	Mz (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

Table 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 Loads[1]

Connector Size	Axial Force Fx[2] (lbf)	Shear Fyz[4] (lbf)	Torsion Mx (ft-lbf)	Bending Myz (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

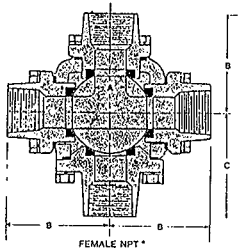
Acceptable Piping Reactions

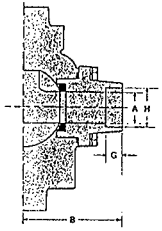
As in the standard connector, acceptable piping reactions have been determined only for a pre-load torque of 50 lbf-ft.

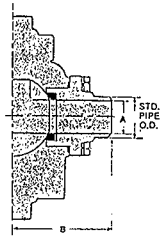
Limits are placed on net piping loads to the block in order to guard against lift-off of the block from an insert. Such lift-off is characterized by pivoting of the block about the other two inserts or by sliding up an inclined plane. Net incoming piping moments and forces are limited by the equation

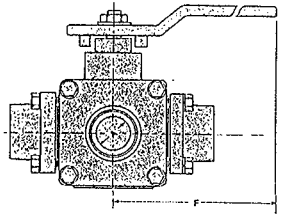
$$\frac{F_z + M_T/R}{F_{alim} - F_x} + \frac{M_o}{M_{olim} - F_x R/2} < 1$$

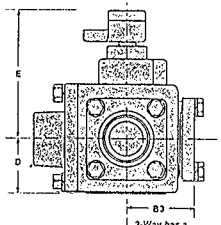
Dimensions for 3 & 4-way MP



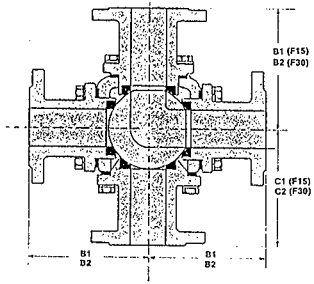


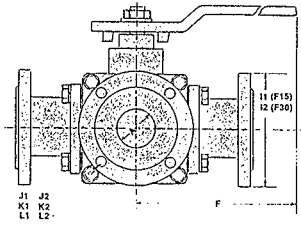


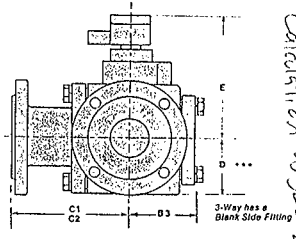




DRAWINGS ARE FOR ILLUSTRATION PURPOSES ONLY... PLEASE CONSULT FACTORY PRIOR TO ANY FABRICATION OR INSTALLATION WORK







Female NPT • Socket • Butt Weld

PIPE SIZE (Inch)	A Port Dia.	B CL to Side Face	B3 CL to Blank Face	C CL to End Face	D Center to Bottom	E Center to Top	F Handle Length	G Socket Weld Depth	H Socket Weld Dia.	3-Way Wt. (Lbs.) S/S & C/S**
½"	.62"	2.00"	1.47"	2.00"	2.00"	4.56"	5.50"	.81"	.86"	8
¾"	.62"	2.00"	1.47"	2.00"	2.00"	4.56"	5.50"	.81"	1.06"	8
1"	1.00"	2.36"	2.00"	2.36"	1.56"	3.72"	6.00"	.94"	1.34"	12
1¼"	1.00"	2.38"	2.00"	2.38"	1.56"	3.72"	6.00"	.62"‡	1.69"	12
1½"	1.50"	3.28"	2.88"	3.28"	2.25"	5.17"	8.00"	1.16"	1.92"	28
2"	2.00"	3.88"	3.30"	3.88"	2.62"	5.61"	8.00"	1.12"	2.41"	40
3"	2.25"	5.53"	3.75"	5.53"	3.75"	9.56"	11.62"	1.88"	3.55"	65

‡ shown. See Flow Charts, pages 5 & 6, for other possibilities.
his for other metals and for 4-Way supplied upon request.

STANDARD BORE DEPTH.

150# RF Flange (F15)

PIPE SIZE (Inch)	A Port Dia.	B1 CL to Side	B3 Blank Side	C1 CL to End	D CL to Bottom	E CL to Top	I1 Flg. O.D.	F Handle Length	J1 Dia. B.C.	K1 No. Bolt Holes	L1 Bolt Dia.	3-Way Wt. (Lbs.)** S/S & C/S
1½"	1.50"	5.28"	2.88"	5.28"	2.25"	5.17"	5.00"	8.00"	3.88"	4	.50"	46
2"	2.00"	5.97"	3.30"	5.97"	2.62"	5.61"	6.00"	8.00"	4.75"	4	.62"	64
3"	2.25"	7.28"	3.75"	7.28"	3.75"	9.56"	7.50"	11.62"	6.00"	4	.62"	105
4"	3.00"	8.50"	5.00"	8.50"	5.00"	11.25"	9.00"	13.75"	7.50"	8	.62"	220

300# RF Flange (F30)

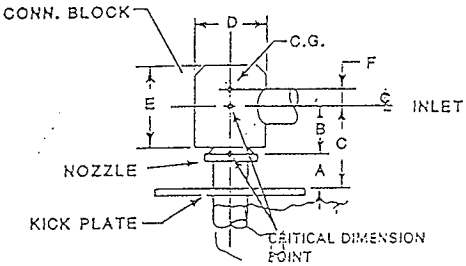
PIPE SIZE (Inch)	A Port Dia.	B2 CL to Side	D3 Blank Side	C2 CL to End	D CL to Bottom	E CL to Top	I2 Flg. O.D.	F Handle Length	J2 Dia. B.C.	K2 No. Bolt Holes	L2 Bolt Dia.	3-Way Wt. (Lbs.)** S/S & C/S
1½"	1.50"	5.41"	2.88"	5.41"	2.25"	5.17"	6.12"	8.00"	4.50"	4	.75"	57
2"	2.00"	6.09"	3.30"	6.09"	2.62"	5.61"	6.50"	8.00"	5.00"	8	.62"	76
3"	2.25"	7.47"*	3.75"	7.47"*	3.75"	9.56"	8.25"	11.62"	6.62"	8	.75"	117
4"	3.00"	8.81"	5.00"	8.81"	5.00"	11.25"	10.00"	13.75"	7.88"	8	.75"	252

Note: Consult factory for 6" MP valve.

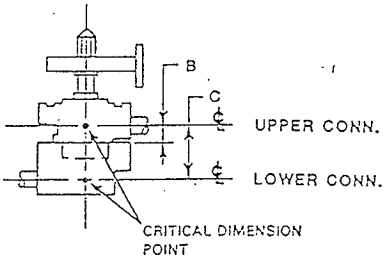
Calculation 03602-033

8.0 DESIGN DATA

8.1 PUREX Connector



PROCESS CONNECTOR



ELECTRICAL CONNECTOR

Connector Block		Dimensions (inches)						Horizontal		Vertical	
Size	Type	A	B	C	D	E	F	Weight (lbs.)	Drawing No.	Weight (lbs.)	Drawing No.
1	1 x 1	1-7/8	1-23/32	3-19/32	2-1/2	2-1/2		15.5	H-2-32410-1	15.5	H-2-32410-2
1	Blank	1-7/8	1-23/32	3-19/32	2-1/2	2-1/2		15	H-2-32410-3	16.5	H-2-32410-4
2	2 x 2	2-1/4	2-7/16	4-11/16	3-3/8	3-5/8	1-1/8	29	H-2-32420-1	29	H-2-32420-2
2	2 x 1½ Dip tube	2-1/4	2-7/16	4-11/16	3-3/8	3-5/8				29	H-2-32420-5
2	3 Way 3 1/2 .	2-9/32	2-13/32	4-11/16	3-3/8	3-5/8	1-1/8	31.5	H-2-32427-1	32	H-2-32427-2
2	Recirculation									31.5	H-2-32427-7
2	Thermowell	2-1/4	2-7/8	5-1/8	3-3/8					*	H-2-90154
2	Blank	2-1/4	2-7/8	4-11/16	3-3/8	3-5/8	1-1/8	32	H-2-32420-3	34.5	H-2-32420-4
3	3 x 3	3	3-9/13	6-9/16	5	5-9/16	1-7/16	76	H-2-32430-1	77	H-2-32430-2
3	3 x 2 Dip Tube	3	3-9/13	6-9/16	5	5-9/16				80	H-2-32430-5
3	2 x 3	3	3-9/13	6-9/16	5	5-9/16	1-7/16	76	H-2-32430-3	77	H-2-32430-4
3	2 x 2 Dip Tube	3	3-9/13	6-9/16	5	5-9/16				83	H-2-32430-6
3	3-Way 3 1/2	3	3-9/13	6-9/16	5	5-9/16				87.5	H-2-32437-1
3	Thermowell	3	3-9/13	6-9/16	5	5-9/16				*	H-2-90156
3	Blank	3	3-9/13	6-9/16	5	5-9/16	1-7/16	87.5	H-2-32430-7	93	H-2-32430-8
4	4 x 4	3-3/8	4-5/32	7-17/32	6-3/8	6-1/2	1-11/16	120	H-2-32440-1	122	H-2-32440-2
4	4 x 3 Dip Tube	3-3/8	4-5/32	7-17/32	6-3/8	6-1/2				126	H-2-32440-3
4	3 x 3 Dip Tube	3-3/8	4-5/32	7-17/32	6-3/8	6-1/2				131	H-2-32440-4
4	2 x 3 Dip Tube	3-3/8	4-5/32	7-17/32	6-3/8	6-1/2				135	H-2-32440-5
4	Blank	3-3/8	4-5/32	7-17/32	6-3/8	6-1/2	1-11/16	150	H-2-32440-6	153	H-2-32440-7
	Elec. Upper		1-11/16					56	H-2-32400-2	7-Point	
	Eqpt. Conn. Lower			5-19/32				29	H-2-32401-2	7-Point	
	Wall Conn. Lower			5-27/32					H-2-32408-1	7-Point	

*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

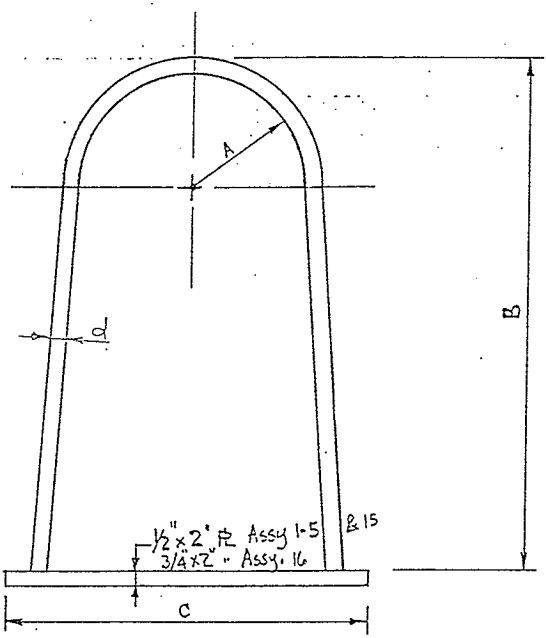
The lifting bails as detailed in drawing H-2-90161, Revision 1, are identified with their respective capacities in Table 1, above. The calculations are shown in Appendices A and J. All pertinent ANSYS runs are shown in Appendices B through I.

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.

DESIGN CALCULATION WHC-SD-WM-DA-063, Rev 0

(1) Drawing H-2-90161 (2) Doc. No. _____ (3) Page 10 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. Markey Date 7/6/90

(10)



TYP. BAIL ELEV.

See REF. 7 Dwg. 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 (stainless steel); 1, 3, 5, 15 & 16 CS (carbon 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 C. C. Mackey Date 7/6/90

(10)

Allowable Stresses

Impact Level II

bail & Plate, allowable bending stress, σ_b | REF. 1

$\sigma_b = \frac{1}{3}$ (Yield) or $\frac{1}{5}$ (Ultimate)

Carbon Steel (CS)

REF. 3 | Yield stress, F_y = 36000 Psi for A36 steel
Ultimate Stress, F_u = 58000 Psi "

$\therefore \sigma_b = \frac{1}{3} \times 36000 = 12000$ Psi
or $= \frac{1}{5} \times 58000 = 11600$ Psi

Use $\sigma_b = 11600$ Psi

Stainless Steel (SST)

REF. 5 | Type 304, $F_y = \cancel{25000}\ 30000$ Psi, $F_u = \cancel{70000}\ 75000$ Psi

$\sigma_b = \frac{1}{3} \times \cancel{25000}\ 30000 = 8333$ Psi $= 10,000$
or $= \frac{1}{5} \times \cancel{70000}\ 75000 = 14000$ Psi

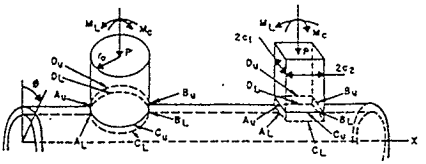
Use $\sigma_b = \cancel{8333}\ 10,000$ Psi

Allowable stress in Weld

REF. 3 | shear Capacity $= (\frac{2}{3})$ (Tension Capacity)

$\therefore f_w = (\frac{2}{3})(11600)(w)$ (size of weld) $= 7733\,(w)$ #/in (CS)
$f_w = (2/3)(8333)(w) = 5555\,(w)$ #/in (SST)

Table 4—Sign Convention for Stresses Resulting from Radial and Moment Loading on a Cylindrical Shell



STRESS	LOCATION	LOADING P	LOADING M_L	LOADING M_c
Membrane $\frac{PR}{T}$ & $\frac{M_L R}{T}$	A_u A_L	−		+
	C_u C_L B_u B_L	−	+	
Bending $\frac{6M_L}{T^2}$	A_u A_L	− +		− +
	C_u C_L B_u B_L	+ − + −	+ − + −	
Bending $\frac{6M_c}{T^2}$	A_u A_L	+ +		+ +
	C_u C_L B_u B_L	+ − + −	+ − + −	

NOTE: (1) Sign convention for stresses. (2) [illegible]

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 encumbency 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:

$$\beta = \frac{0.875\, r_u}{R_m}$$

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:

$$\beta_1 = \frac{c_1}{R_m} \qquad \beta_2 = \frac{c_2}{R_m}$$

If $\frac{\beta_1}{\beta_2} > 1$, $\beta =$

$$\left[1 - \frac{1}{3}\left(\frac{\beta_1}{\beta_2} - 1\right)\left(1 - K_1\right)\right]\sqrt{\beta_1 \beta_2}$$

If $\frac{\beta_1}{\beta_2} < 1$, $\beta =$

$$\left[1 - \frac{4}{3}\left(1 - \frac{\beta_1}{\beta_2}\right)\left(1 - K_2\right)\right]\sqrt{\beta_1 \beta_2}$$

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_t): $\beta = \sqrt[4]{\beta_1^2 \beta_2^2}$. Then multiply values of $N_t/(M_c/R_m^2\beta)$ so determined by C_r from Table 7 (see para. 4.3).

4.2.2.4.2: When considering bending moment (M_t): $\beta = K_r\sqrt{\beta_1^2\beta_2^2}$ where K_r 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_t): $\beta = \sqrt[4]{\beta_1 \beta_2^2}$. Then multiply values of

Table 6—Radial Load (P)

	N_ϕ	N_x	M_ϕ	M_x
K_1	0.91	1.68	1.76	1.2
K_2	1.48	1.2	0.88	1.25

NOTE: Above holds approximately within limits $4 \geq \beta_1/\beta_2 \geq 1/3$.

calculated in para.4.2, enter Fig.3C or 4C and read off the dimensionless membrane force $[N_\phi/P/R_m]$.

Step 2. By the same procedure used in Step 1, enter Fig. 1C or 2C-1 and find the dimensionless bending moment $[M_\phi/P]$.

Step 3. Using applicable values of P, R_m, and T, find the circumferential membrane stress (N_ϕ/T) by:

$$\frac{N_\phi}{T} = \left[\frac{N_\phi}{P/R_m}\right] \cdot \left[\frac{P}{R_m T}\right]$$

Step 4. By a procedure similar to that used in Step 3, find the circumferential bending stress $(6M_\phi/T^2)$ thus:

$$\frac{6M_\phi}{T^2} = \left[\frac{M_\phi}{P}\right] \cdot \left[\frac{6P}{T^2}\right].$$

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.:

$$\sigma_\phi = K_a \frac{N_\phi}{T} \pm K_b \frac{6M_\phi}{T^2}$$

4.3.1.2 Longitudinal Stresses (σ_x): Follow the 5 steps outlined in 4.3.1.1 except that $[N_x/P/R_m]$ is obtained using Fig.3C or 4C; and $[M_x/P]$, using Fig.1C-1 or 2C. It follows that:

$$\frac{N_x}{T} = \left[\frac{N_x}{P/R_m}\right] \cdot \left[\frac{P}{R_m T}\right],$$

$$\frac{6M_x}{T^2} = \left[\frac{M_x}{P}\right] \cdot \left[\frac{6P}{T^2}\right] \text{ and}$$

$$\sigma_x = K_a \frac{N_x}{T} \pm K_b \frac{6M_x}{T^2}$$

4.3.2 STRESSES RESULTING FROM CIRCUMFERENTIAL MOMENT, M_c.

4.3.2.1 Circumferential Stresses (σ_ϕ):

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 $N_\phi/(M_c/R_m^2\beta)$.

Step 2. By the same procedure used in Step 1, enter Fig. 1A and find the dimensionless bending moment $M_\phi/(M_c/R_m\beta)$.

Step 3. Using applicable values of M_c, R_m, β

Table 7—Circumferential Moment (M_c)

β_1/β_2	γ	K_c for θ	K_c for M_ϕ	K_c for M_x	C_c for N_ϕ	C_c for N_x
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
1/2	15	1.00	1.09	1.36	0.64	0.75
	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
2	15	(1.00)	(1.20)	(0.97)	(1.7)	(1.3)
	100	1.19	1.10	0.95	1.43	1.12
	300	...	(1.00)	(0.90)	(1.3)	(1.00)
4	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_ϕ	K_L for M_x	C_L for N_ϕ	C_L for N_x
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
1/2	15	(1.00)	(1.08)	(1.04)	(0.90)	(0.76)
	100	1.00	1.07	1.02	0.97	0.68
	300	(1.00)	(1.05)	(1.02)	(1.10)	(0.60)
2	15	...	(0.94)	(1.12)	(0.87)	(1.30)
	100	1.09	0.89	1.07	0.81	1.15
	300	...	(0.79)	(0.90)	(0.80)	(1.50)
4	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.

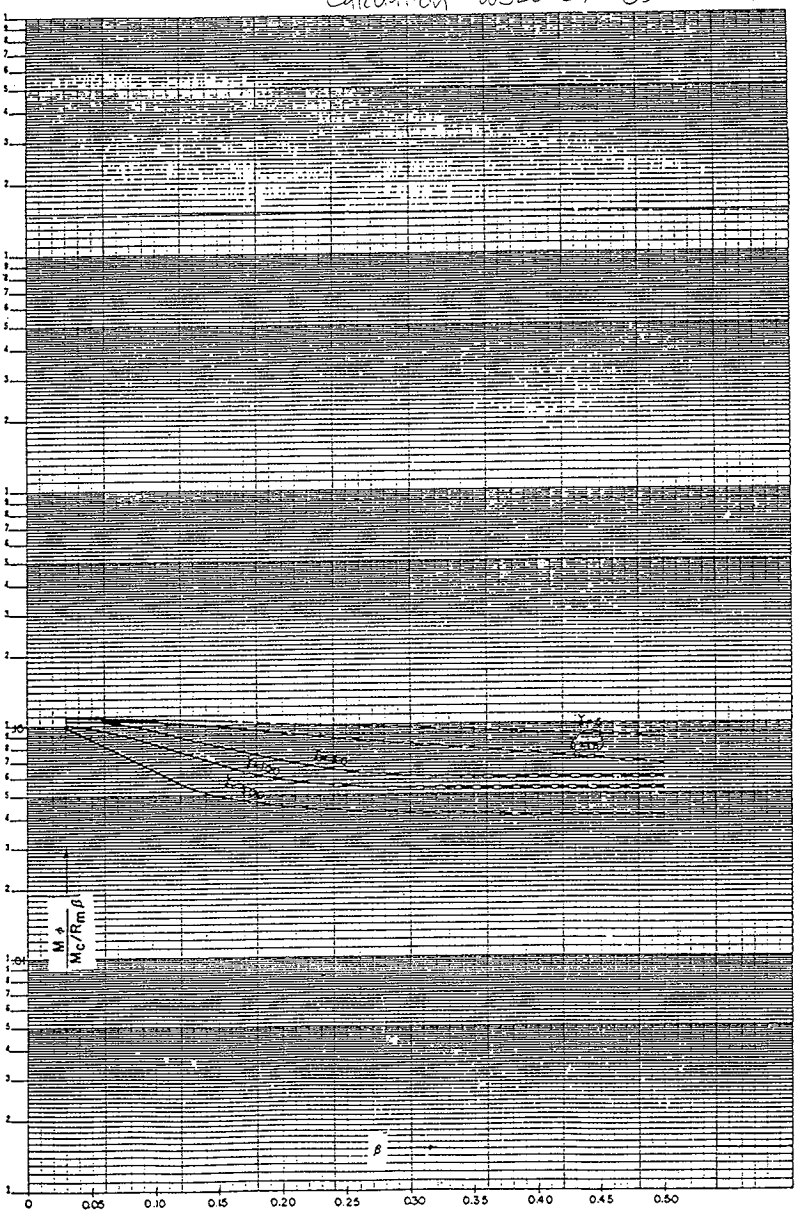


Fig. 1A—Moment $M_\phi/(M_c/R_m\beta)$ due to an external circumferential moment M_c on a circular cylinder

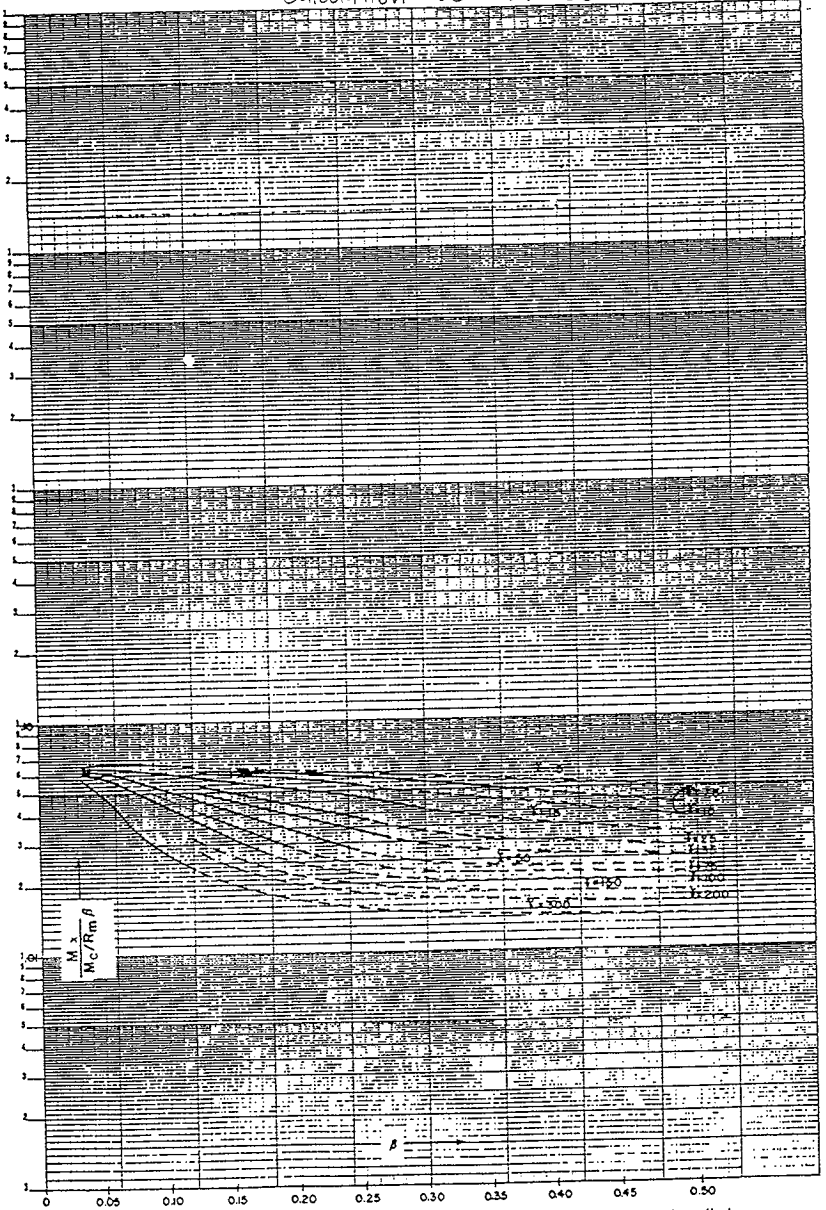


Fig. 2A—Moment $M_x/(M_c/R_m\beta)$ due to an external circumferential moment M_c on a circular cylinder

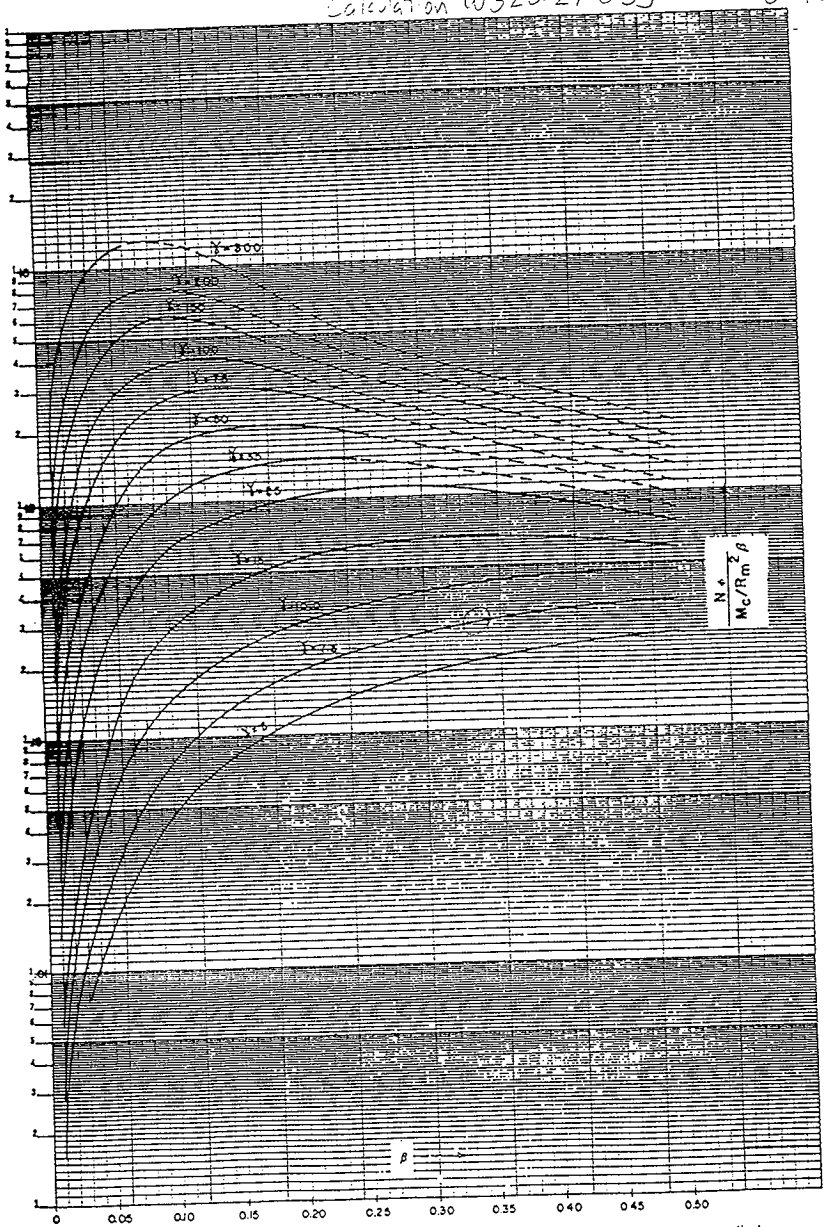


Fig. 3A—Membrane force $N_\phi/(M_c/R_m^2\beta)$ due to an external circumferential moment M_c on a circular cylinder

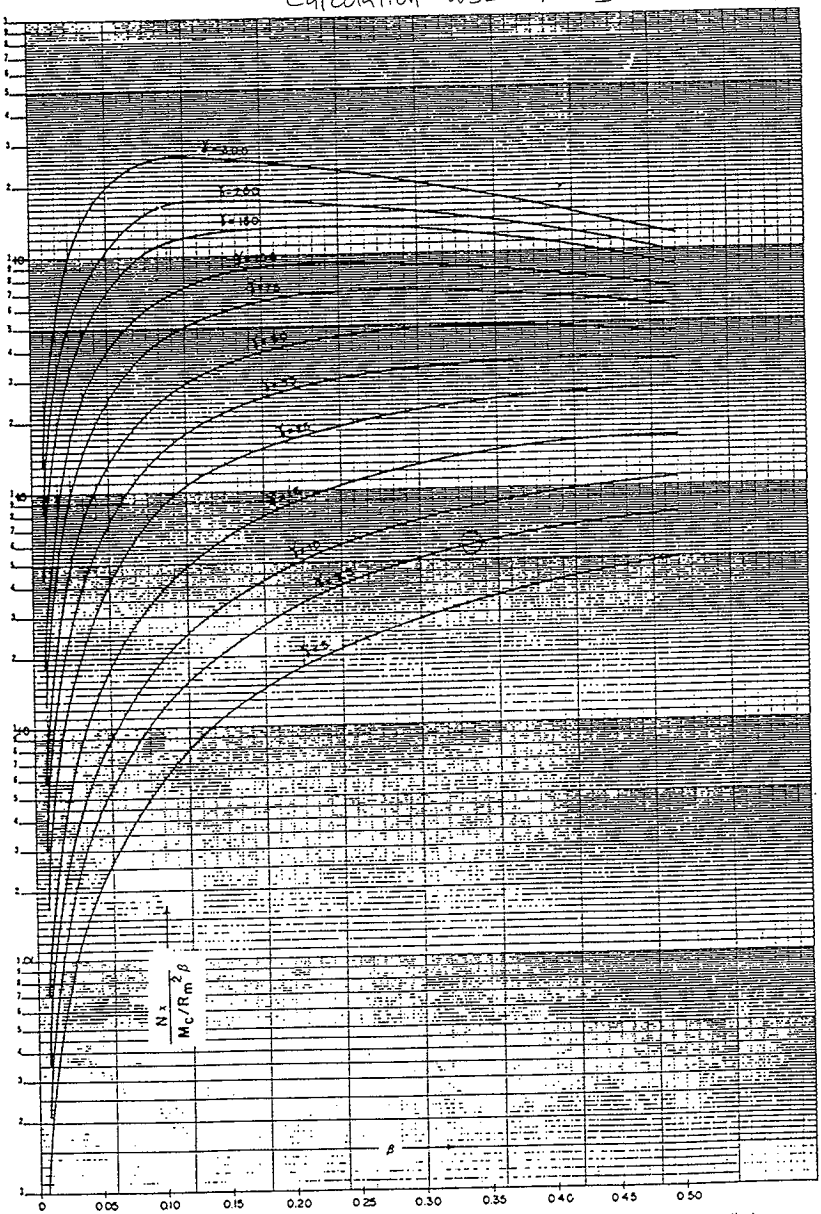


Fig. 4A—Membrane force $N_x/(M_c/R_m^2\beta)$ due to an external circumferential moment M_c on a circular cylinder

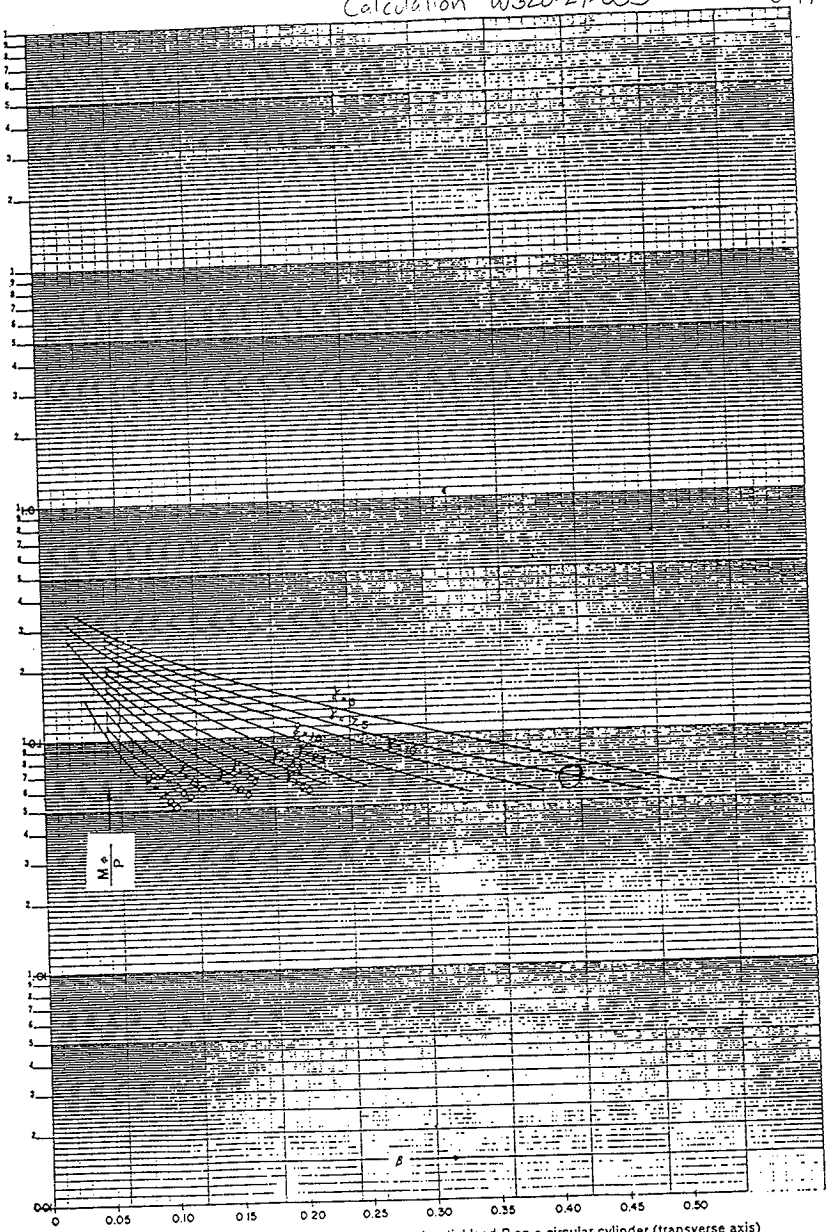


Fig. 1C—Bending moment M_e/P due to an external radial load P on a circular cylinder (transverse axis)

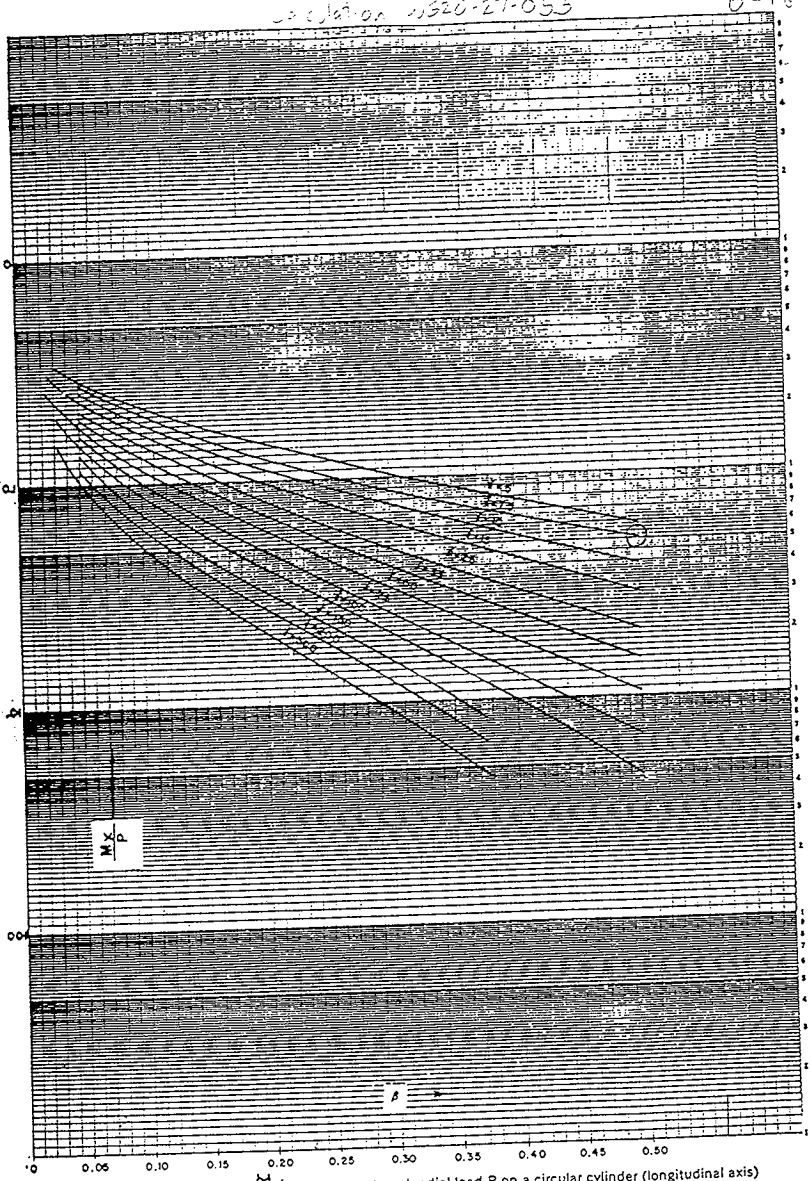


Fig. 1C-1—Bending moment $\frac{M_x}{P}$ due to an external radial load P on a circular cylinder (longitudinal axis)

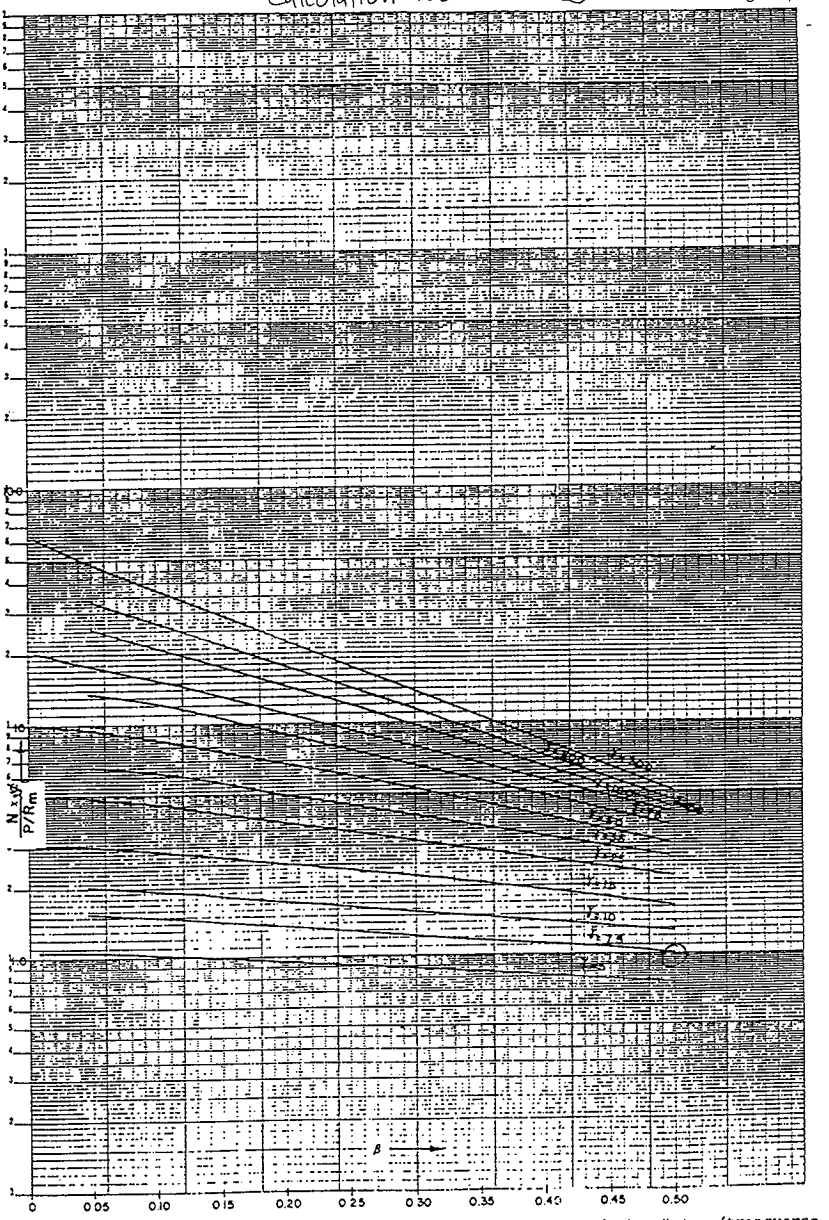


Fig. 4C—Membrane force $N_x/(P/R_m)$ due to an external radial load P on a circular cylinder (transverse axis)
—Membrane force $N_y/(P/R_m)$ due to an external radial load P on a circular cylinder (longitudinal axis)

W320-27-54

System Curves for Portable Exhauster Installation

FLUOR DANIEL NORTHWEST INC.	CALCULATION IDENTIFICATION AND INDEX	Page i of ii Date 2/18/98

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

[X] Final Calculations

[] Check Calculations (On Calculation Dated)

[] Void Calculation (Reason Voided)

Incorporated in Final Drawings? [X] Yes [] No

This calculation verified by independent "check" calculations? [] Yes [X] No

Original and Revised Calculation Approvals:

	Rev. 0 Signature/Date	Rev. 1 Signature/Date	Rev. 2 Signature/Date
Originator	Kelly K Hanger 2/18/98		
Checked by	Kevin Ahmed 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 ANNUULUS
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

Subject Calculation Revision No.	Superceded 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 interfacecalculation/ 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				✓		✓	D.L. Evans 7/21/98
		H-2-77326, Sheet 3	2				✓		✓	
		H-2-818506, Sheet 1	~~0~~ 1				✓		✓	
		H-2-818506, Sheet 2	~~0~~ 1				✓		✓	
		H-2-818507, Sheet 1	~~0~~ 1				✓		✓	
		H-2-818507, Sheet 2	~~0~~ 1				✓		✓	
		H-2-818507, Sheet 4	~~0~~ 1				✓		✓	

KEH 1975.00 (12/88)

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 By: Kelly Hayase
Checked: 3/2/98 By: Kevin Clark
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 vise 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
Subject: System Curves for Portable Exhauster Installation
Location: 241-C/241-AY

WO/Job No.: ER4319/W-320
Date: 2/18/98 By: Kelly Hayase
Checked: 3/2/98 By: Kevin Clark
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
Subject: System Curves for Portable Exhauster Installation
Location: 241-C/241-AY

WO/Job No.: ER4319/W-320
Date: 2/18/98 By: Kelly Hayase
Checked: 3/2/98 By: Ken Ord
Revised: By:

CALCULATIONS:

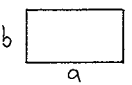
Discussion of the Pipe-Flo analysis:

1. The following properties of air was used for the analysis:

   Temperature: 50°F
   Density: 0.0779 lb/ft^3
   Viscosity: 0.0176 cpois

2. 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)

3. 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)

4. 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.

5. 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.

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 By: Kelly Hayase
Checked: 3/2/98 By: KH
Revised: By:

6. As determined from the analysis, there is no pressure drop resulting from air flow in the 1'-6" air distributor or the annulus. The only pressure difference in the annulus is due to the 40 ft change in elevation from the bottom of the annulus to the top.

7. Test data from Reference # 4 800 fpm (984 cfm) 14" WG vacuum in annulus
850 fpm (1045 cfm) 15" WG vacuum in annulus

8. The system curve for the portable exhauster connected to the dome space of Tanks 241-C-106 and 241-AY-102 was determined from the analysis of the portable exhauster connected to the annulus of Tank 241-AY-102. The pressure drop from the annulus to the portable exhauster skid intake from Pipe-Flo Model ANNU-PEX represents the pressure drop thru the riser and the flex duct. The pressure drop was added to the dome space vacuum to get the system curve for the portable exhauster connected to the dome space. Although the flex duct is 25 ft longer connecting to the annulus than the dome space, this difference is not critical.

9. The 8" ID flexible duct was modeled as 8" Schedule 80 pipe (ID = 7.625") with a roughness factor equal to 0.018" (which is ten times that of steel). This was to account for the possible contraction of the duct ID under vacuum and the rough surface of the duct.

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 By: Kelly Hayase
Checked: 3/2/98 By: Ken Cell
Revised: By:

Appendix A System Curves

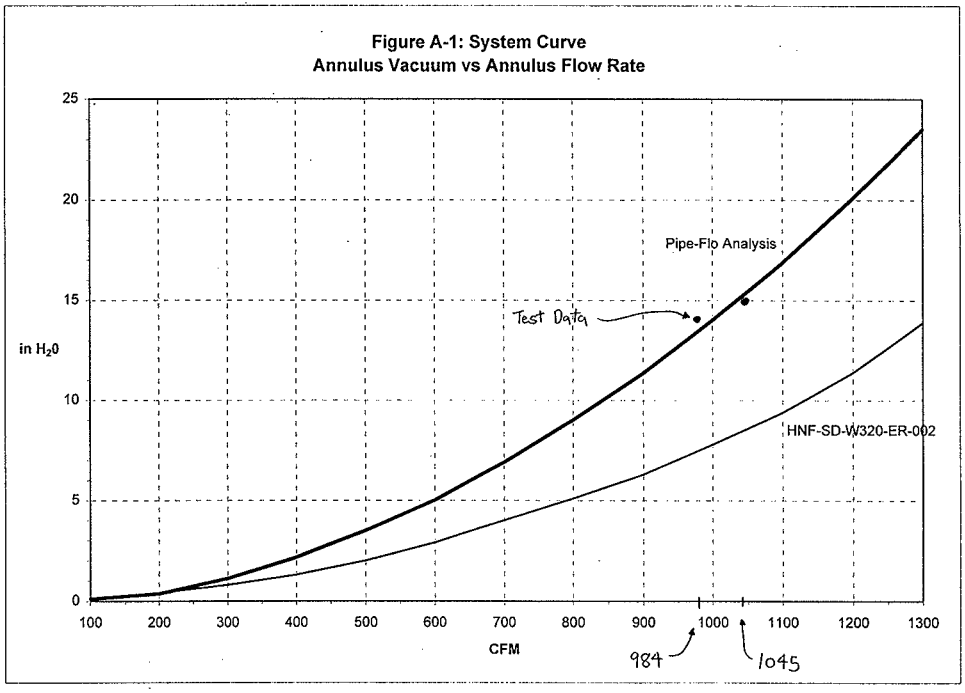
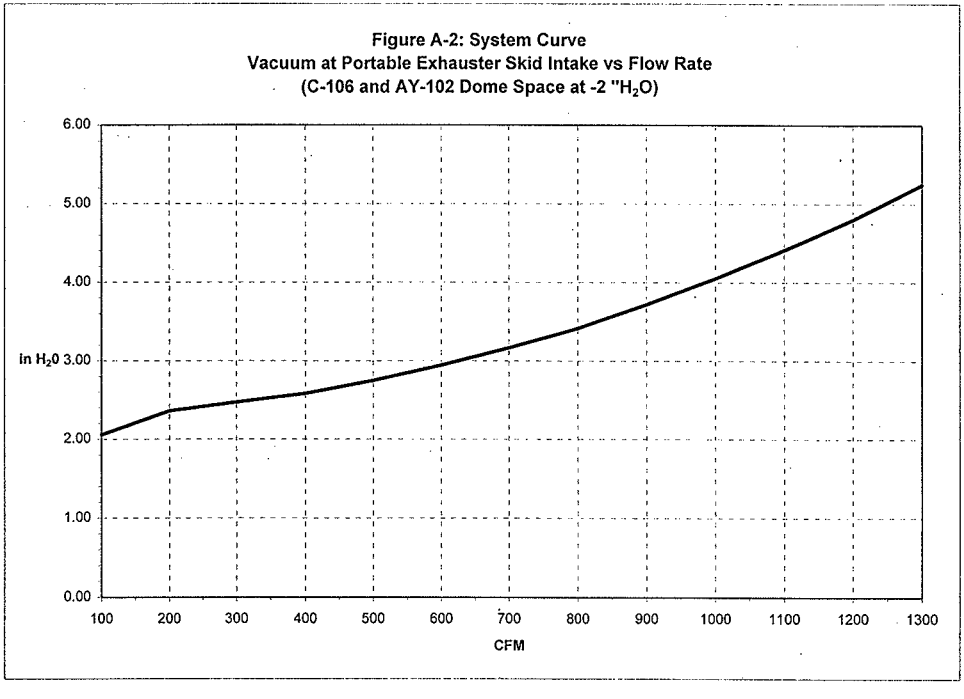


Figure A-1: System Curve
Annulus Vacuum vs Annulus Flow Rate
in H_2O
25
20
15
10
5
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
CFM
Pipe-Flo Analysis
Test Data
HNF-SD-W320-ER-002
984
1045



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.

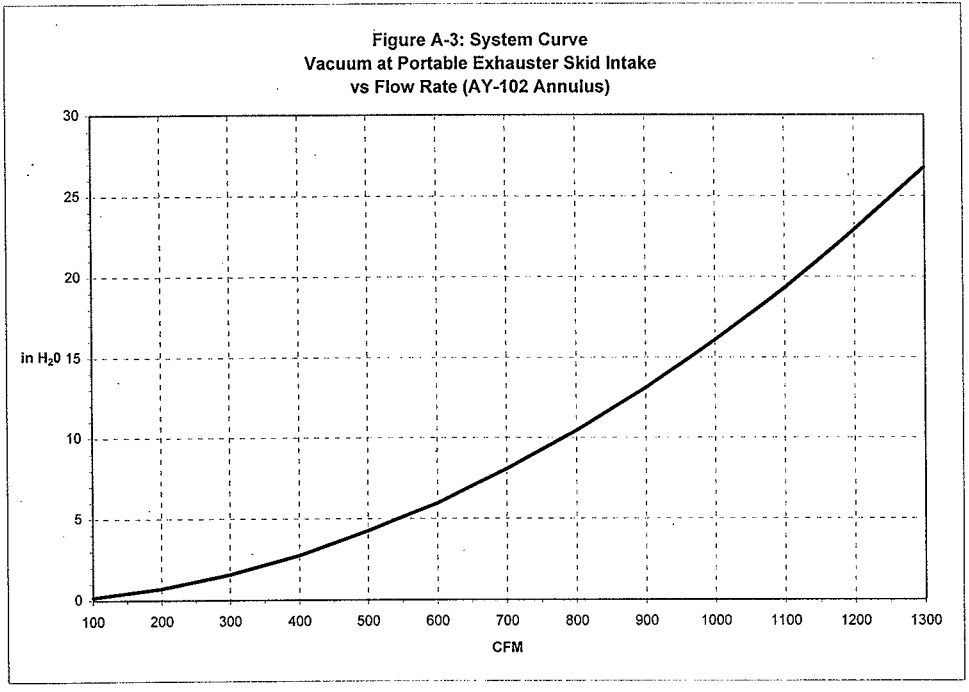


Figure A-3: System Curve
Vacuum at Portable Exhauster Skid Intake
vs Flow Rate (AY-102 Annulus)
in H_20
30
25
20
15
10
5
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
CFM

cfm	cfm/18	cfm/6	Δp	Δp x 3	K	Annulus Vacuum psig	Annulus Vacuum "H_2O	HNF-SD-W320-ER 002 "H_2O	Vacuum at skid intake psig	Vacuum at skid intake "H_2O
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_2O	Δp Thru Hose "H_2O	Vacuum at skid intake "H_2O
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

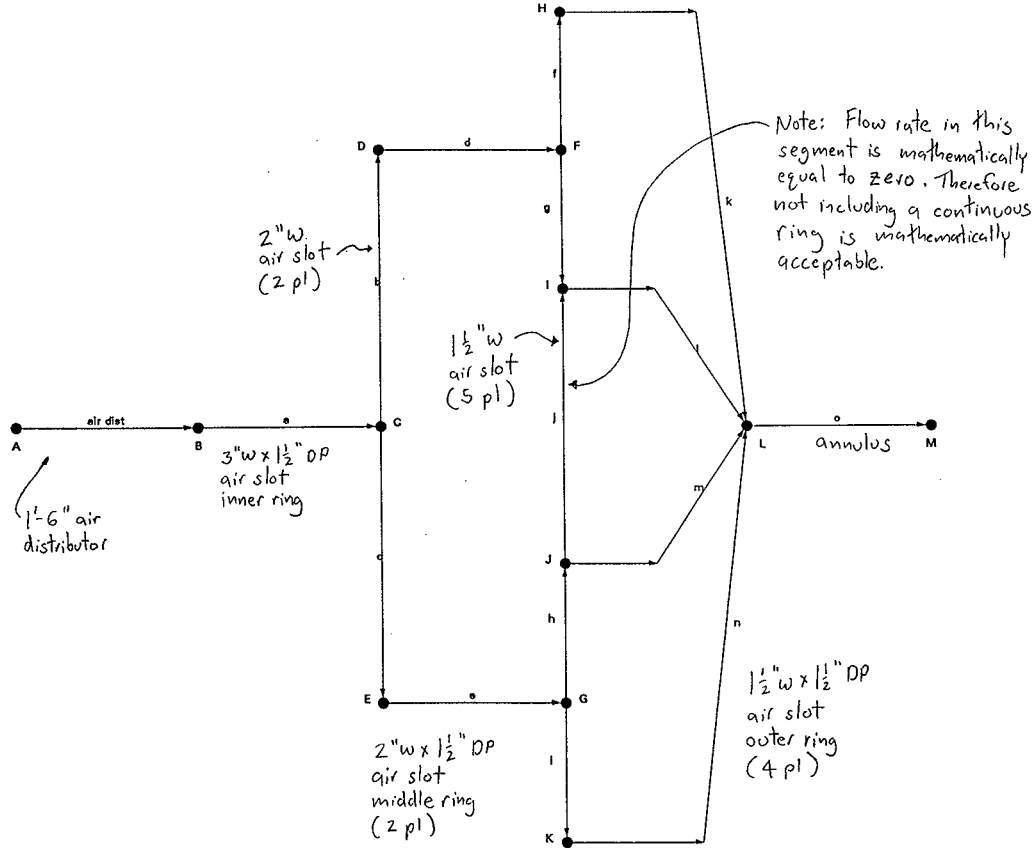
Difference between vacuum at skid intake and annulus vacuum (including riser)

DESIGN ANALYSIS

Client: Numatec
Subject: System Curves for Portable Exhauster Installation
Location: 241-C/241-AY

WO/Job No.: ER4319/W-320
Date: 2/18/98 By: Kelly Hayase
Checked: 3/2/98 By: Kei Cal
Revised: By:

Appendix B: Pipe-Flo Model ANNULUS2



Company:	Fluor Daniel NW	02/17/98	9:36 am
Project:		**Linelist:**	ANNULUS2
by:	Fluor Daniel NW	**Lineup:**	
Comments:		**flow rate:**	cfm
		pressure:	psi_g
Version:	PIPE-FLO ver 5.01	**level & grade:**	ft

Calculation W320-27-054

B-1 of B-11

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	

System: ANNULUS2 B-4 of B-11
rev: 01/29/98 10:30 am

PIPELIST REPORT

Pipes: 16
Nodes: 13
Pumps/Comps: 0

SPECIFICATIONS

PIPE MATERIAL Sch / Roughness	FLUID Temp / Pres	VALVE TABLE	DESIGN LIMITS Vel / Pres
Steel Sch 40 0.012 in Size for: 6 ft/sec	Air 50 °F 0 psi g	Standard Standard	0 - 40 ft/sec -14.4 - 14.4 psi g
Steel Sch 160 0.012 in Size for: 6 ft/sec	Air 50 °F 0 psi g	Standard Standard	0 - 40 ft/sec -14.4 - 14.4 psi g
Steel Sch 80 0.012 in Size for: 6 ft/sec	Air 50 °F 0 psi g	Standard Standard	0 - 40 ft/sec -14.4 - 14.4 psi g

For concrete,
Ref. # 5

Calculation W320-27-054

B-5 of B-11

:C	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
l	Steel 32 in / 40	40.17	Air 50 °F / 0 psi g	0

Calculation W320-27-054

MATERIALS REPORT

am

Pipes: 16
Nodes: 13
Pumps/Comps: 0

PIPE MATERIALS LIST

PEC	MATERIAL Size / Sch	LENGTH ft	VALVES & FITTINGS
)1	Steel 2 in / 40	7	1-Entrance Sharp-Edged
)3	Steel 20 in / 80	1	
)2	Steel 2 in / 160	1	1-Tee Flow Thru Branch
)2	Steel 2 in / 160	1	1-Tee Flow Thru Branch
)2	Steel 2 in / 160	12	1-Tee Flow Thru Branch
02	Steel 2 in / 160	12	1-Tee Flow Thru Branch
03	Steel 1.5 in / 80	1.2	1-Tee Flow Thru Branch
03	Steel 1.5 in / 80	1.2	1-Tee Flow Thru Branch
03	Steel 1.5 in / 80	1.2	1-Tee Flow Thru Branch
03	Steel 1.5 in / 80	1.2	1-Tee Flow Thru Branch
03	Steel 1.5 in / 80	1.2	
03	Steel 1.5 in / 80	16.75	1-Tee Flow Thru Branch 1-Exit Sharp-Edged
03	Steel 1.5 in / 80	16.75	1-Tee Flow Thru Branch 1-Exit Sharp-Edged
03	Steel 1.5 in / 80	16.75	1-Tee Flow Thru Branch 1-Exit Sharp-Edged
03	Steel 1.5 in / 80	16.75	1-Tee Flow Thru Branch 1-Exit Sharp-Edged
01	Steel 32 in / 40	40.17	

Calculation W320-27-054

PIPE SUMMARY

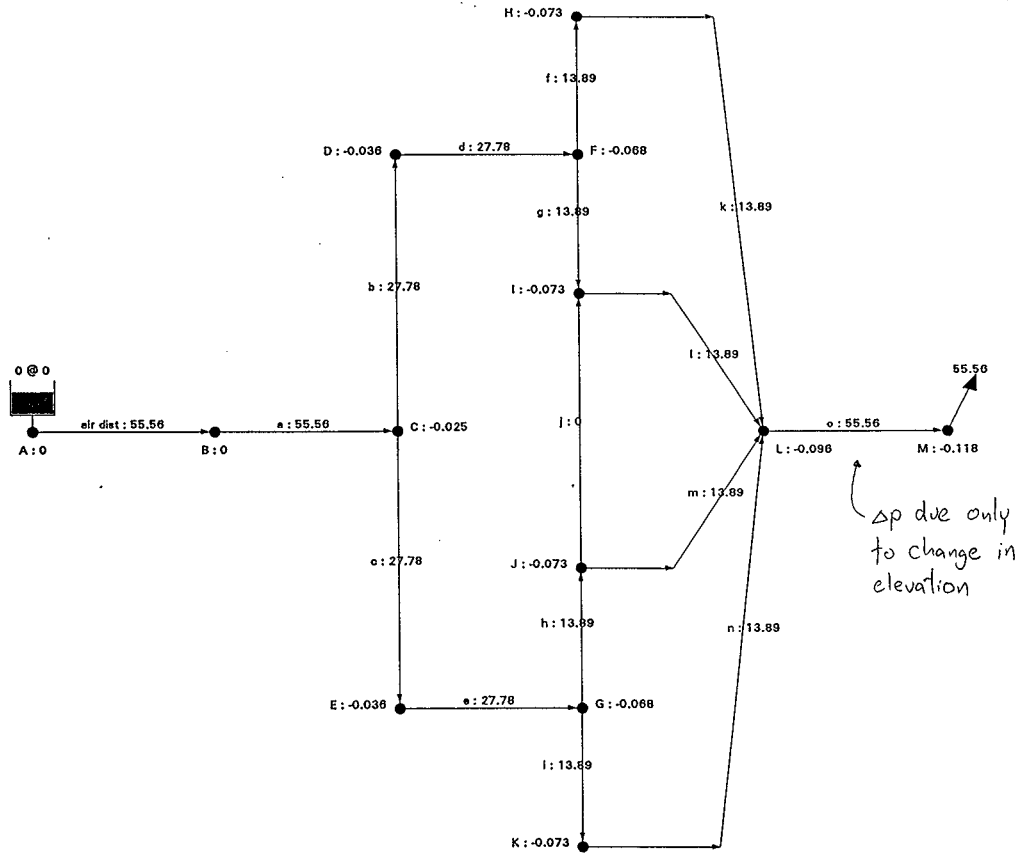
B-7 of B-11

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



Δp due only to change in elevation

Company:	Fluor Daniel NW	02/17/98	9:37 am
Project:		**Linelist:**	ANNULUS2
by:	Fluor Daniel NW	**Lineup:**	ANNULUS2
Comments:		**flow rate:**	cfm
		pressure:	psi_g
Version:	PIPE-FLO ver 5.01	**level & grade:**	ft

Calculation W320-27-054

B-8 of B-11

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 W320-27-054

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

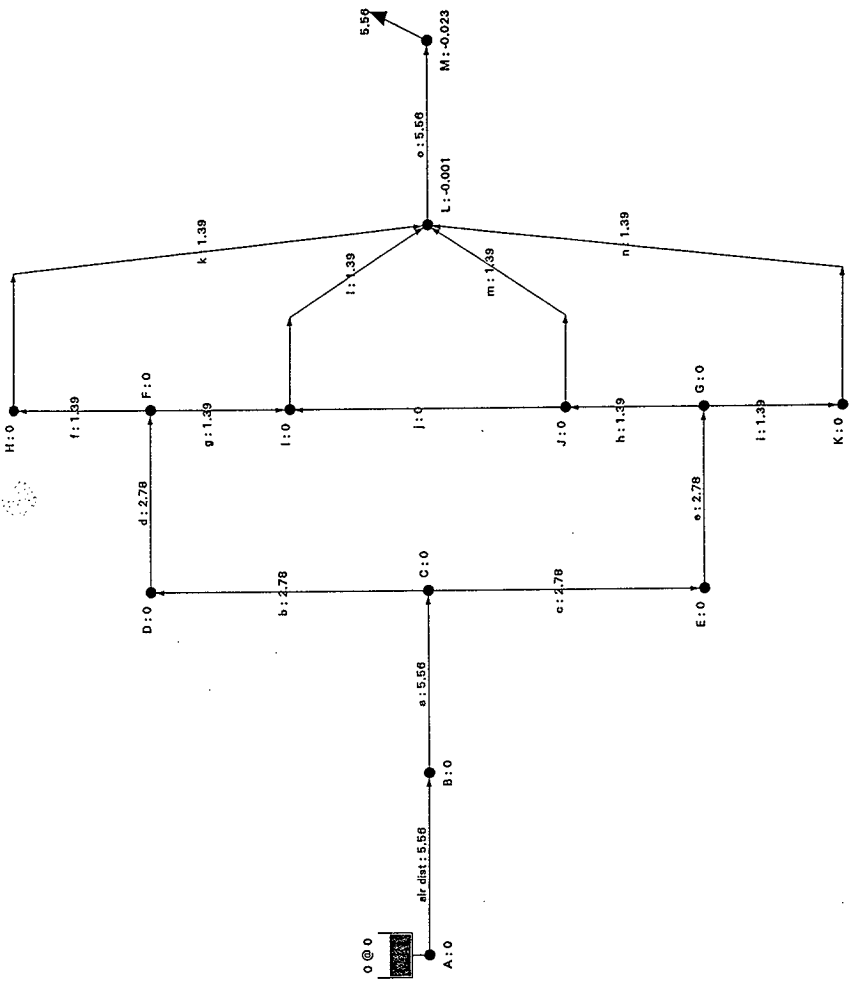
DESIGN ANALYSIS

Client: Numatec
Subject: System Curves for Portable Exhauster Installation
Location: 241-C/241-AY

WO/Job No.: ER4319/W-320
Date: 2/18/98 By: Kelly Hayase
Checked: 3/2/98 By: Ken Cecil
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

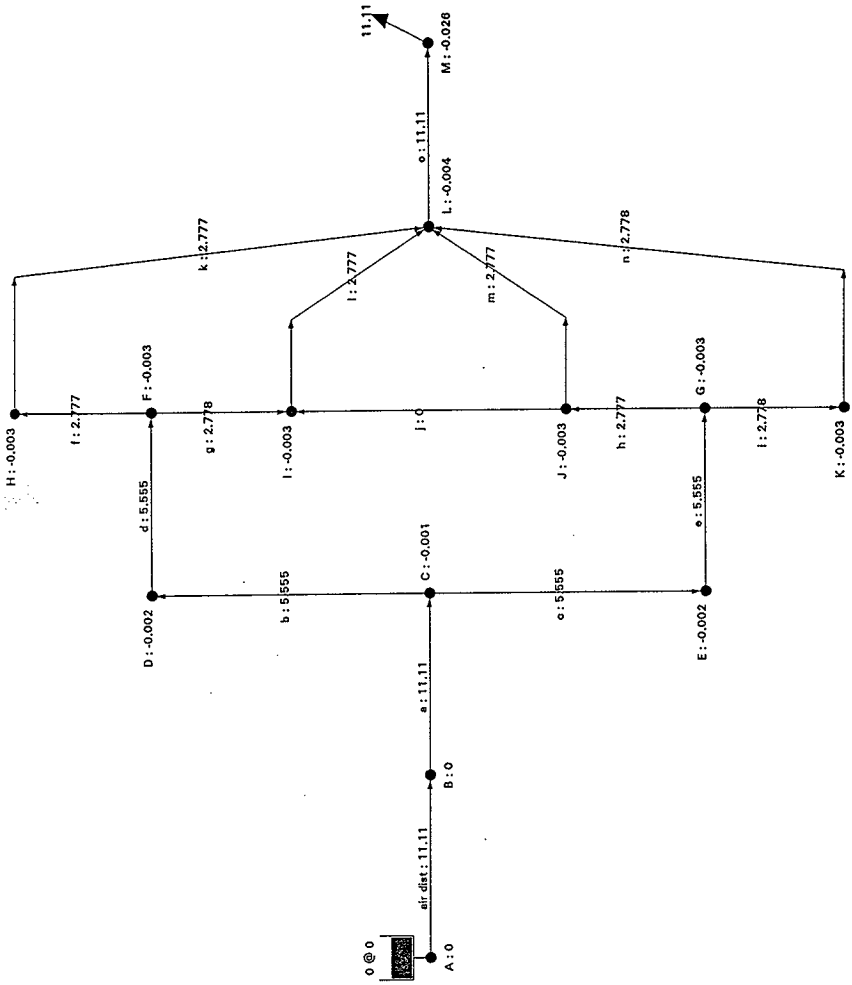


Company:	Fluor Daniel NW
Project:	
by:	Fluor Daniel NW
Comments:	
Version:	PIPE-FLO ver 5.01

02/17/98	9:38 am
Linelist:	ANNULUS2
Lineup:	ANNULUS2
flow rate:	cfm
pressure:	psi_a
level & grade:	ft

Calculation W320-27-054

C-2 of C-13

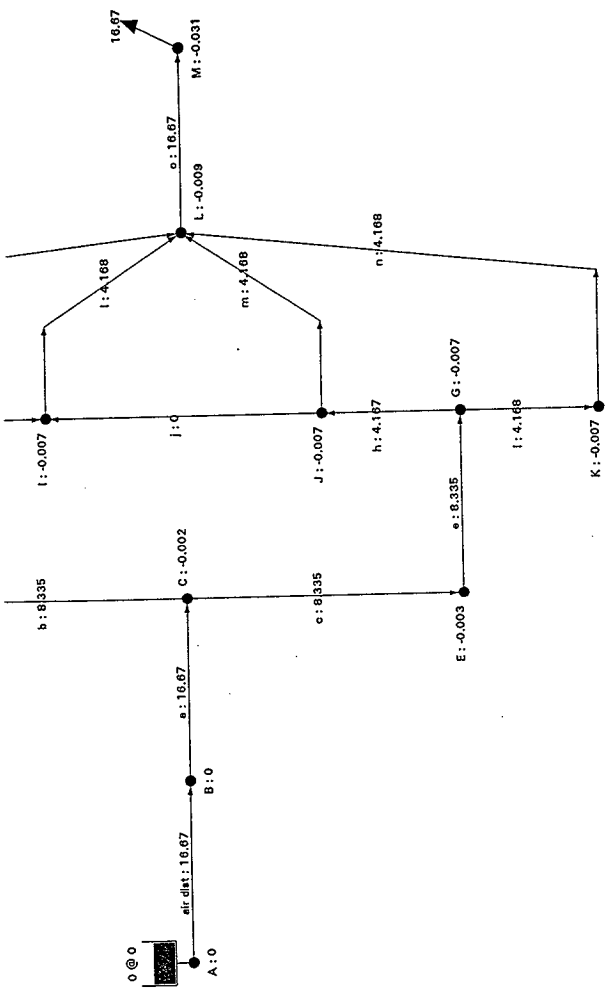


Company:	Fluor Daniel NW
Project:	
by:	Fluor Daniel NW
Comments:	
Version:	PIPE-FLO ver 5.01

02/17/98	9:39 am
Linelist:	ANNULUS2
Lineup:	ANNULUS2
flow rate:	cfm
pressure:	psi_g
level & grade:	ft

Calculation W320-27-054

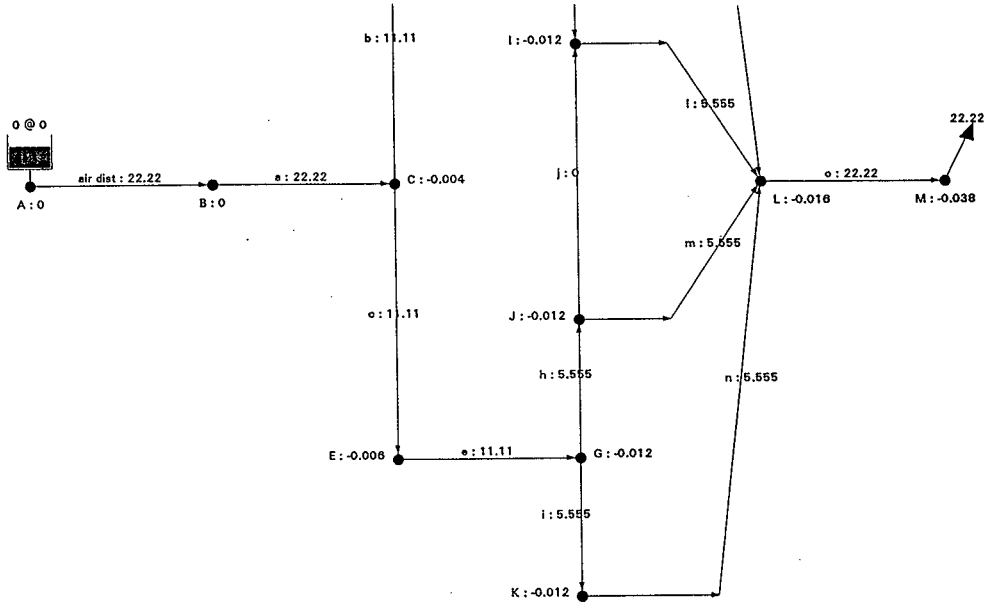
C-3 of C-13



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: psig level & grade: ft

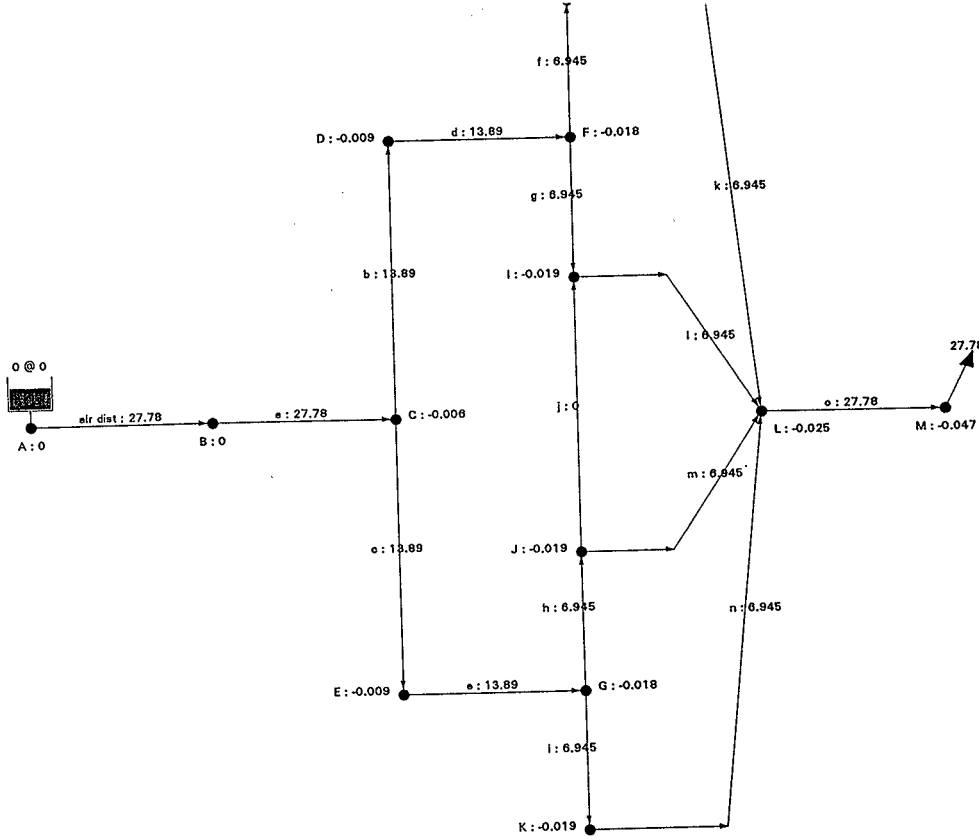
Calculation W320-27-054

Calculation WJ320-27-054



C-4 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:	psi_g
Version:	PIPE-FLO ver 5.01	**level & grade:**	ft

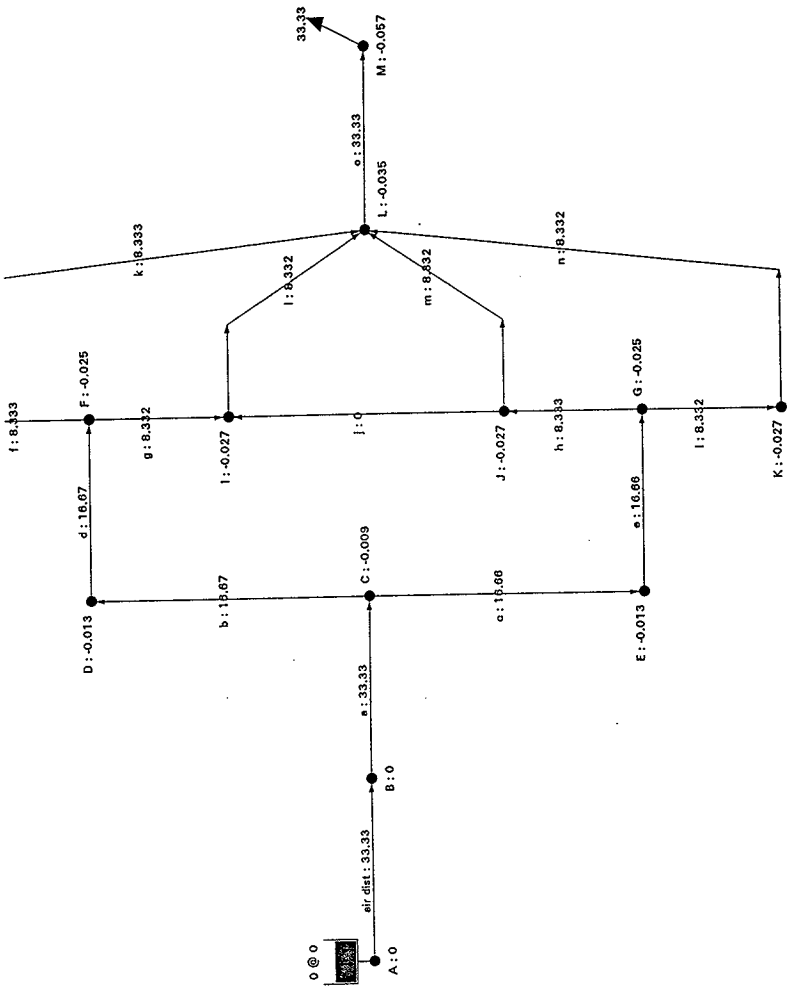


Company:	Fluor Daniel NW	02/17/98	9:40 am
Project:		**Linelist:**	ANNULUS2
by:	Fluor Daniel NW	**Lineup:**	ANNULUS2
Comments:		**flow rate:**	cfm
		pressure:	psi_g
Version:	PIPE-FLO ver 5.01	**level & grade:**	ft

Calculation W320-27-094

C-5 of C-13

C-6 of C-13

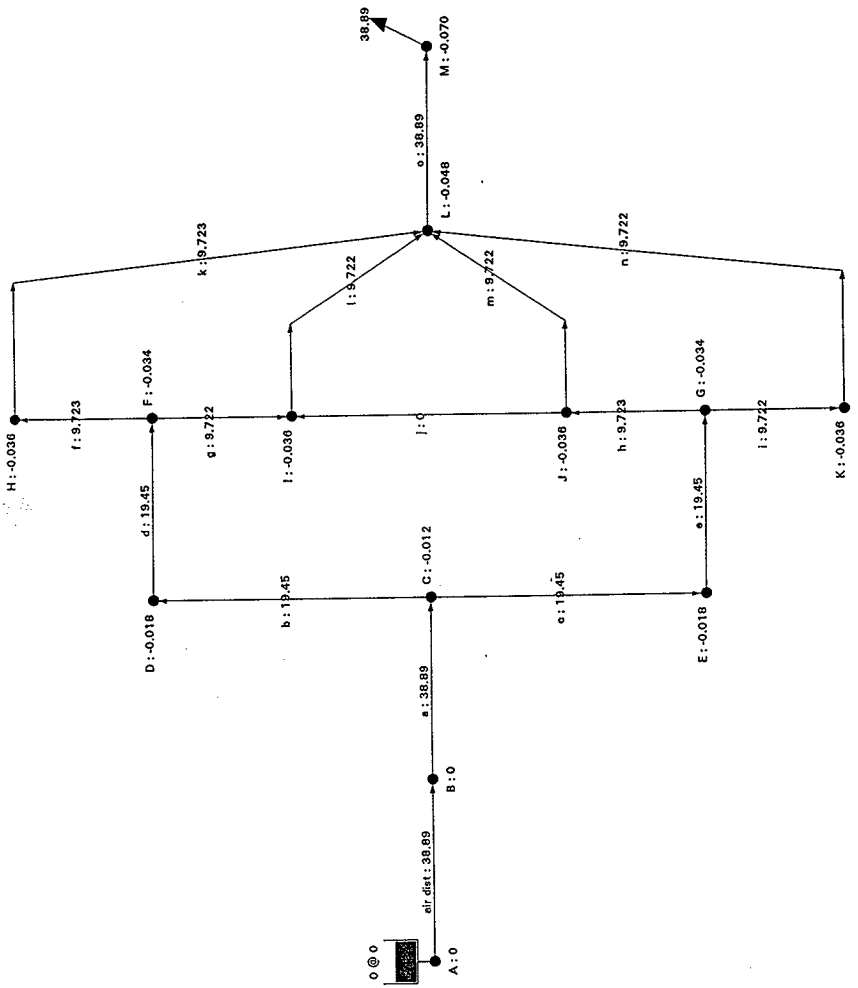


Company:	Fluor Daniel NW
Project:	
by:	Fluor Daniel NW
Comments:	
Version:	PIPE-FLO ver 5.01

02/17/98	9:40 am
Linelist:	ANNULUS2
Lineup:	ANNULUS2
flow rate:	cfm
pressure:	psig
level & grade:	ft

Calculation W320-27-054

C-7 of C-13

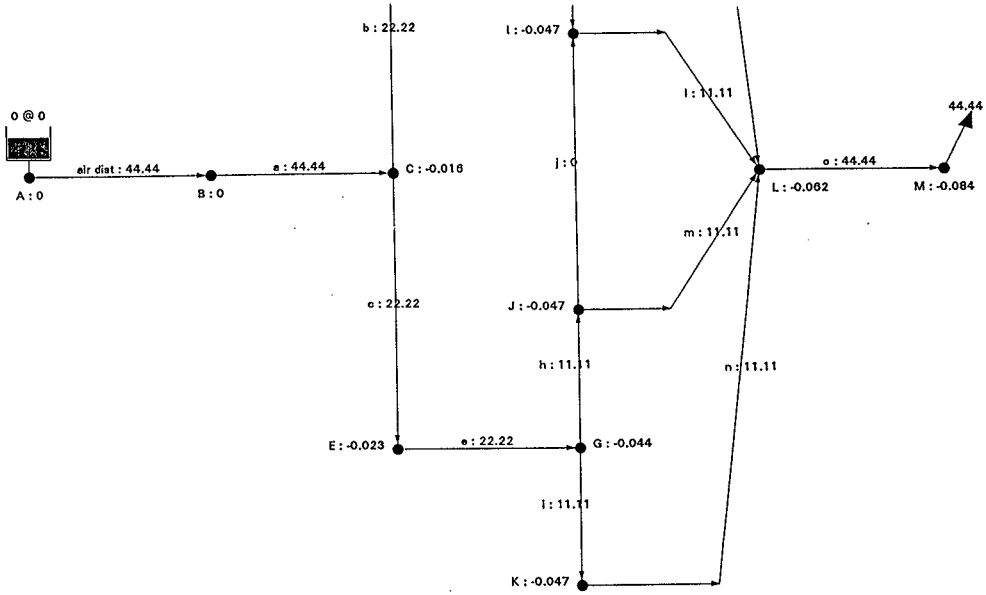


Company:	Fluor Daniel NW
Project:	
by:	Fluor Daniel NW
Comments:	
Version:	PIPE-FLO ver 5.01

02/17/98	9:40 am
Linelist:	ANNULUS2
Lineup:	ANNULUS2
flow rate:	cfm
pressure:	psi_g
level & grade:	ft

Calculation W320-27-054

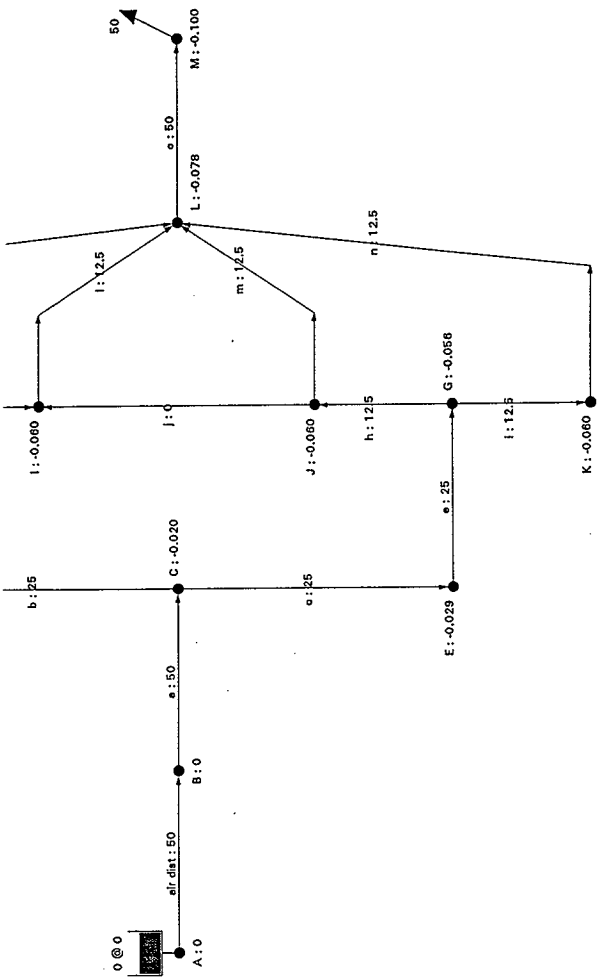
Calculation W320-27-059



Company:	Fluor Daniel NW	02/17/98	9:41 am
Project:		**Linelist:**	ANNULUS2
by:	Fluor Daniel NW	**Lineup:**	ANNULUS2
Comments:		**flow rate:**	cfm
		pressure:	psi_g
Version:	PIPE-FLO ver 5.01	**level & grade:**	ft

C-8 of C-13

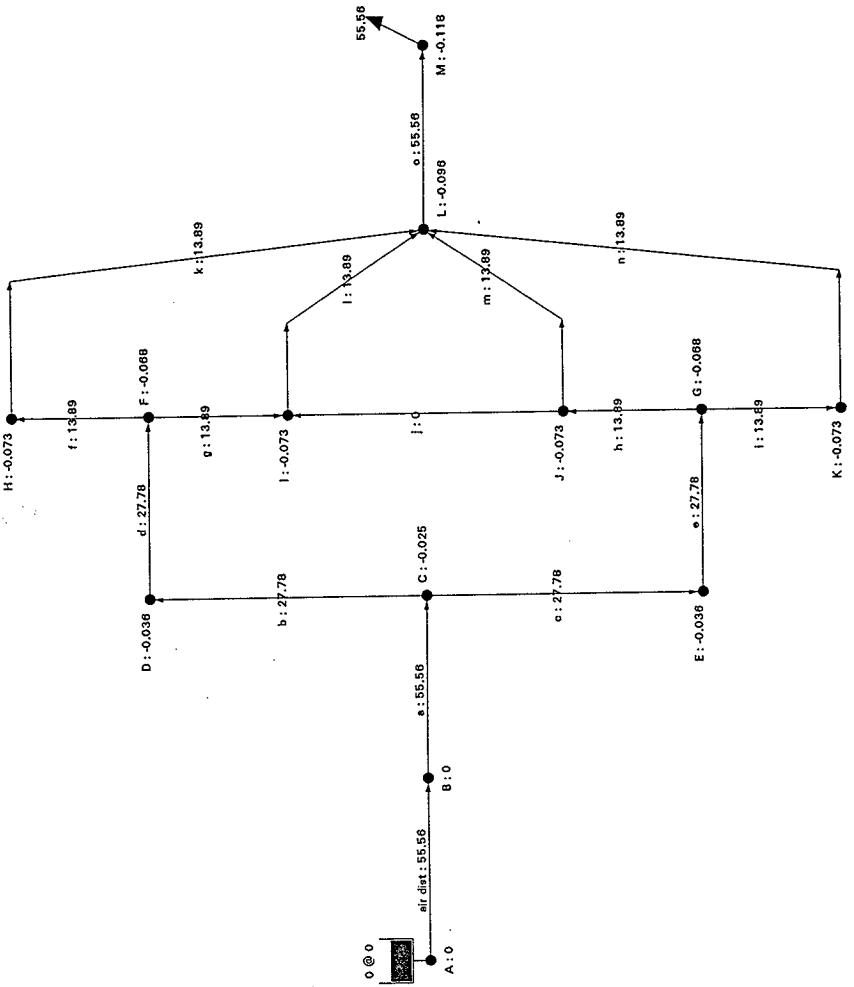
C-9 of C-13



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$_g$ level & grade: ft

Calculation W320-27-054

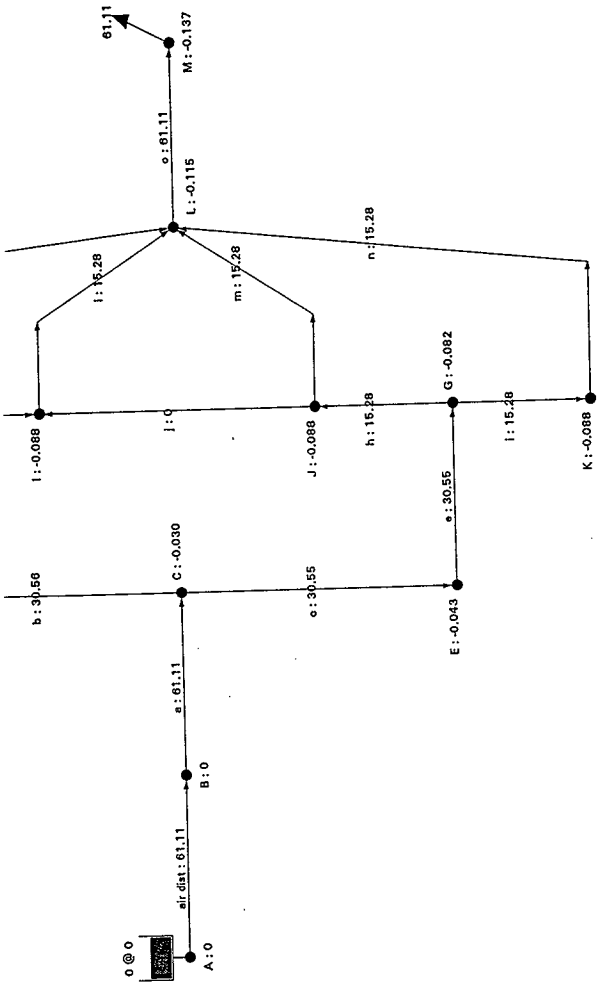
C-10 of C-13



Company: Fluor Daniel NW	02/17/98 9:47 am
Project:	Linelist: ANNULUS2
by: Fluor Daniel NW	Lineup: ANNULUS2
Comments:	flow rate: cfm
	pressure: psi_g
Version: PIPE-FLO ver 5.01	level & grade: ft

Calculation W320-27-054

C-11 of C-13

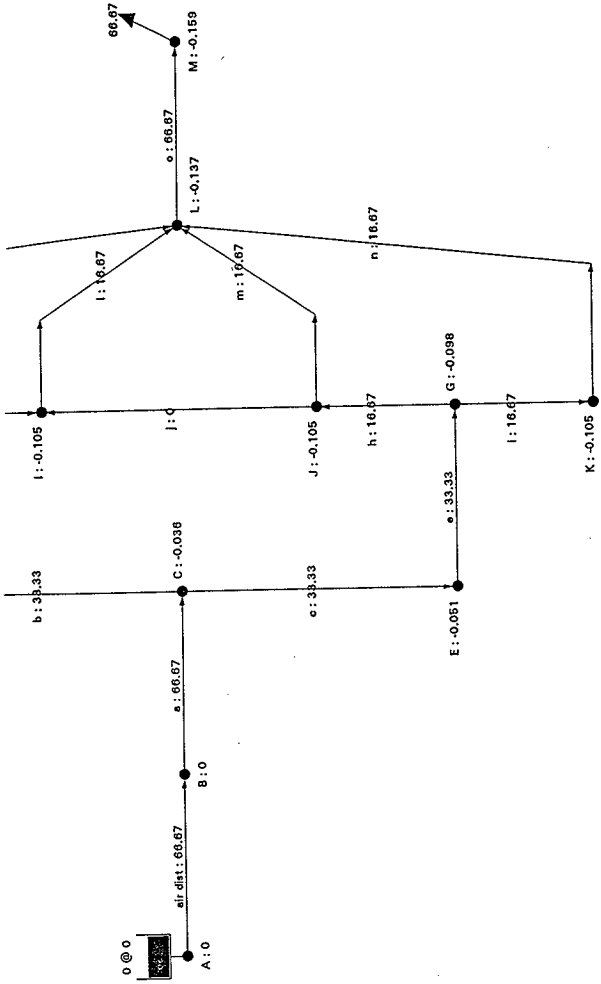


Company:	Fluor Daniel NW
Project:	
by:	Fluor Daniel NW
Comments:	
Version:	PIPE-FLO ver 5.01

02/17/98	9:47 am
Linelist:	ANNULUS2
Lineup:	ANNULUS2
flow rate:	cfm
pressure:	psig
level & grade:	ft

Calculation W320-27-054

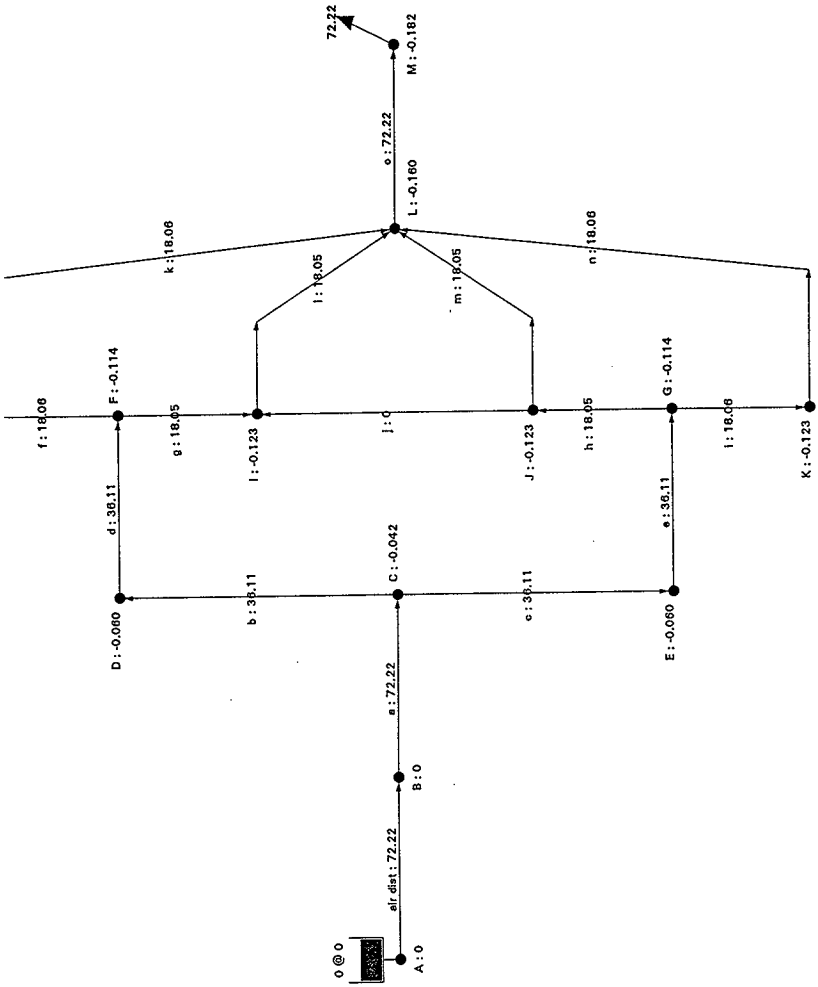
C-12 of C-13



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: psig level & grade: ft

Calculation W320-27-054

C-13 of C-13



02/17/98	9:48 am
Linelist:	ANNULUS2
Lineup:	ANNULUS2
flow rate:	cfm
pressure:	psi_g
level & grade:	ft

Company:	Fluor Daniel NW
Project:	
by:	Fluor Daniel NW
Comments:	
Version:	PIPE-FLO ver 5.01

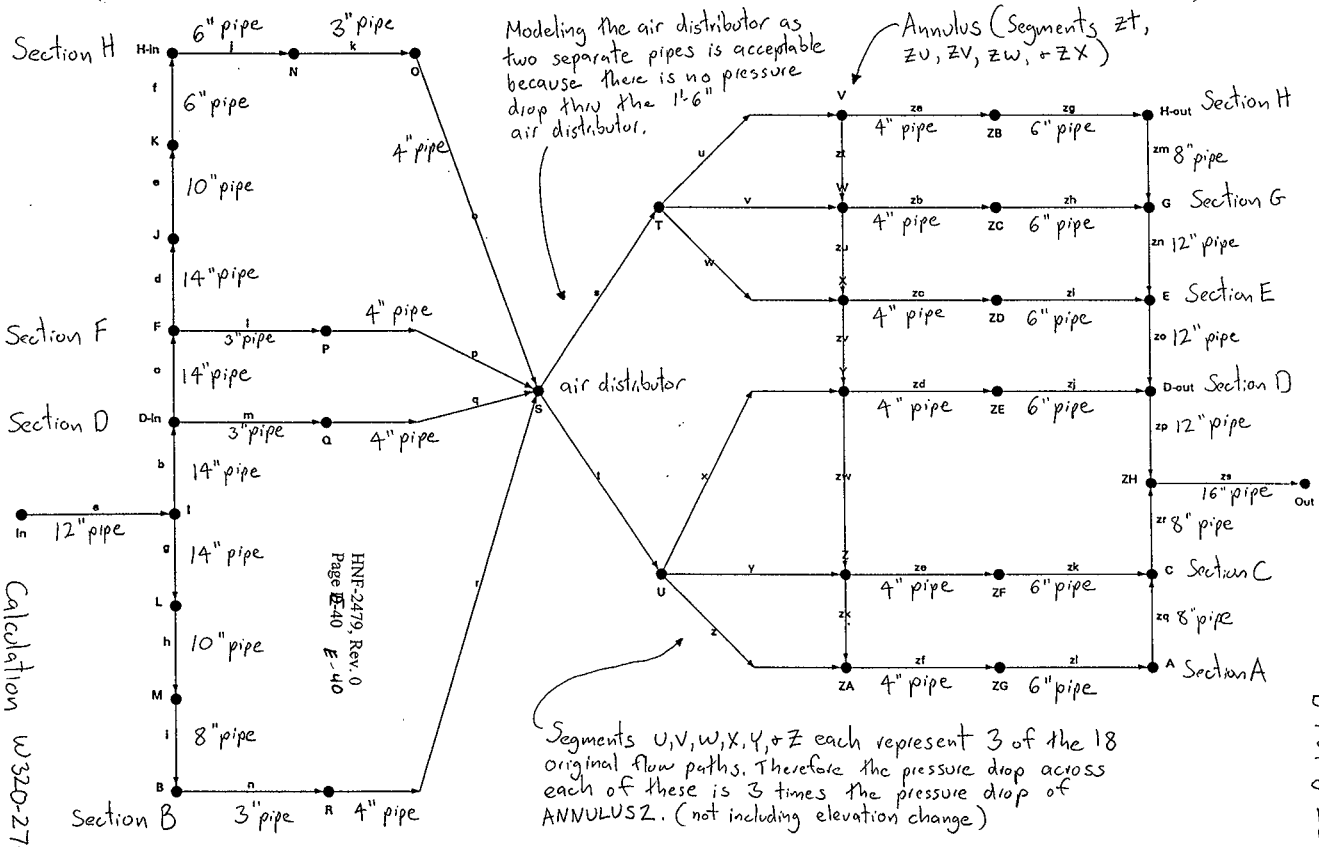
Calculation W320-27-054

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 By: Kelly Hayase
Checked: 3/2/98 By: [illegible]
Revised: By:

Appendix D: Pipe-Flo Model ANNULUS



HNF-2479, Rev. 0
Page E-40 E-40

Calculation W320-27-054

Company:	Fluor Daniel NW	02/17/98	9:52 am
Project:		**Linelist:**	ANNULUS
by:	Fluor Daniel NW	**Lineup:**	
Comments:		**flow rate:**	cfm
		pressure:	psi_g
Version:	PIPE-FLO ver 5.01	**level & grade:**	ft

SYSTEM REPORT

3 am

Pipes: 50
Nodes: 38
Pumps/Comps: 0

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

D-3 of D-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

SYSTEM PIPES

PUMP/COMP

D-4 of D-2

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

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

Created: 01/26/98 11:38 am
Design file:
Pipe Specs: 1

02/17/98 9:52 am
System: ANNULUS
rev: 02/17/98 9:51 am

D-6 of D-20

PIPELIST REPORT

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

Calculation W320-27-054

D-7 of D-20

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

Calculation W320-27-054

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

Created: 01/26/98 9:46 am
Design file:
Pipe Specs: 3

02/17/98 9:36 am
System: ANNULUS2
rev: 01/29/98 10:30 am B-6 of B-11

MATERIALS REPORT

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	

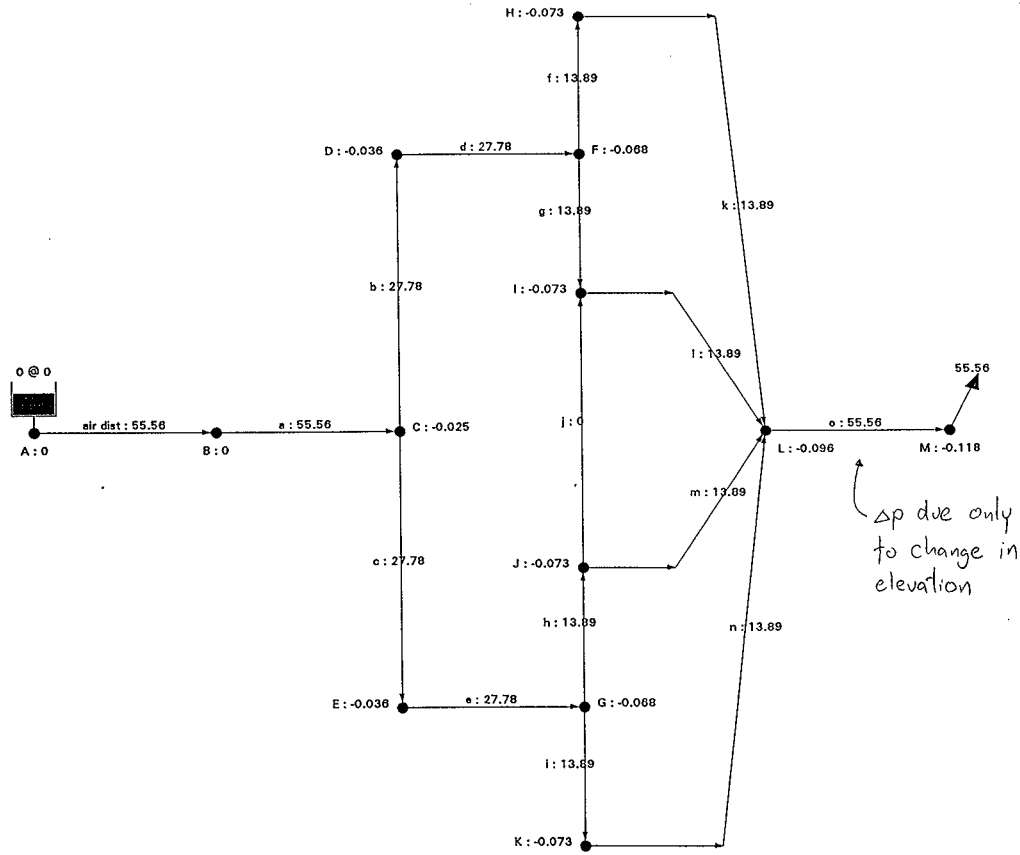
Calculation W320-27-054

PIPE SUMMARY 02/17/98 9:36 am

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



Company: Fluor Daniel NW		02/17/98 9:37 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

Calculation W320-27-054

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

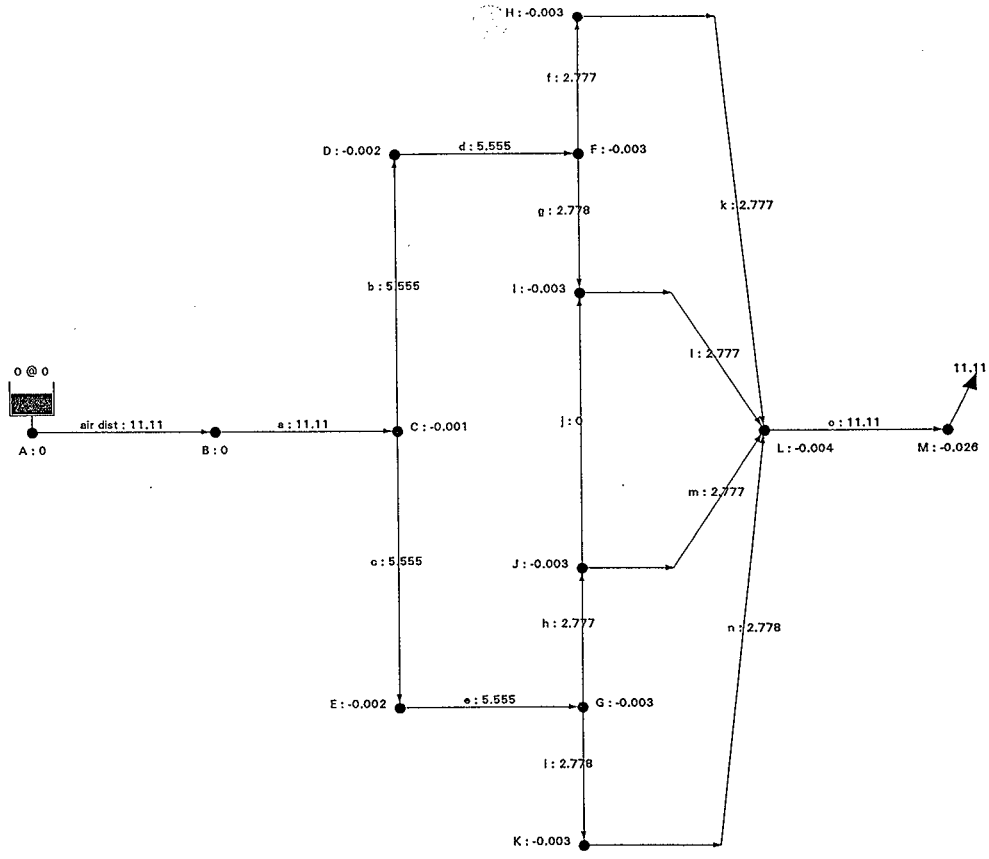
Flows IN: 55.56 cfm
Flows OUT: 0 cfm

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

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

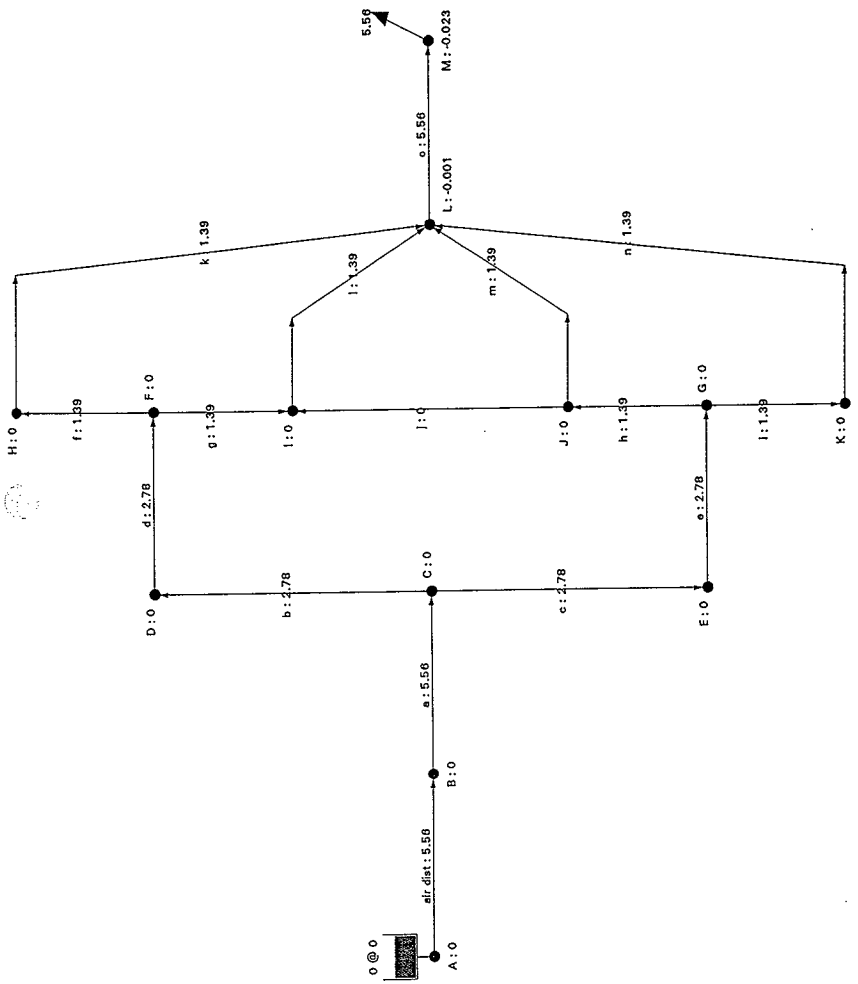


Company:	Fluor Daniel NW	02/17/98	9:39 am
Project:		**Linelist:**	ANNULUS2
by:	Fluor Daniel NW	**Lineup:**	ANNULUS2
Comments:		**flow rate:**	cfm
		pressure:	psi_g
Version:	PIPE-FLO ver 5.01	**level & grade:**	ft

Calculation W320-27-054

C-2 of C-13

C-1 of C-13



Company:	Fluor Daniel NW
Project:	
by:	Fluor Daniel NW
Comments:	
Version:	PIPE-FLO ver 5.01

02/17/98	9:38 am
Linelist:	ANNULUS2
Lineup:	ANNULUS2
flow rate:	cfm
pressure:	psi_g
level & grade:	ft

Calculation W320-27-054

DESIGN ANALYSIS

WO/Job No.: ER4319/W-320

Client: Numatec
Subject: System Curves for Portable Exhauster Installation
Location: 241-C/241-AY

Date: 2/18/98 By: Kelly Hayase
Checked: 3/2/98 By: Ken Clark
Revised: By:

Appendix C: **Pipe-Flo results of ANNULUS2 for different flow rates used as input into Pipe-Flo Model ANNULUS**

D-8 of 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

Calculation W320-27-094

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

Calculation W320-27-054

Company: Fluor Daniel NW
Project:
by: Fluor Daniel NW

Created: 01/26/98 11:38 am
Design file:
Pipe Specs: 1

02/17/98 9:52 am
System: ANNULUS
rev: 02/17/98 9:51 am

D-10 of D-20

MATERIALS REPORT

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
	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

Calculation W320-27-054

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

Calculation W320-27-054

D-12 of D-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

Calculation W320-27-054

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	

PIPE SUMMARY 02/17/98 9:52 am

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

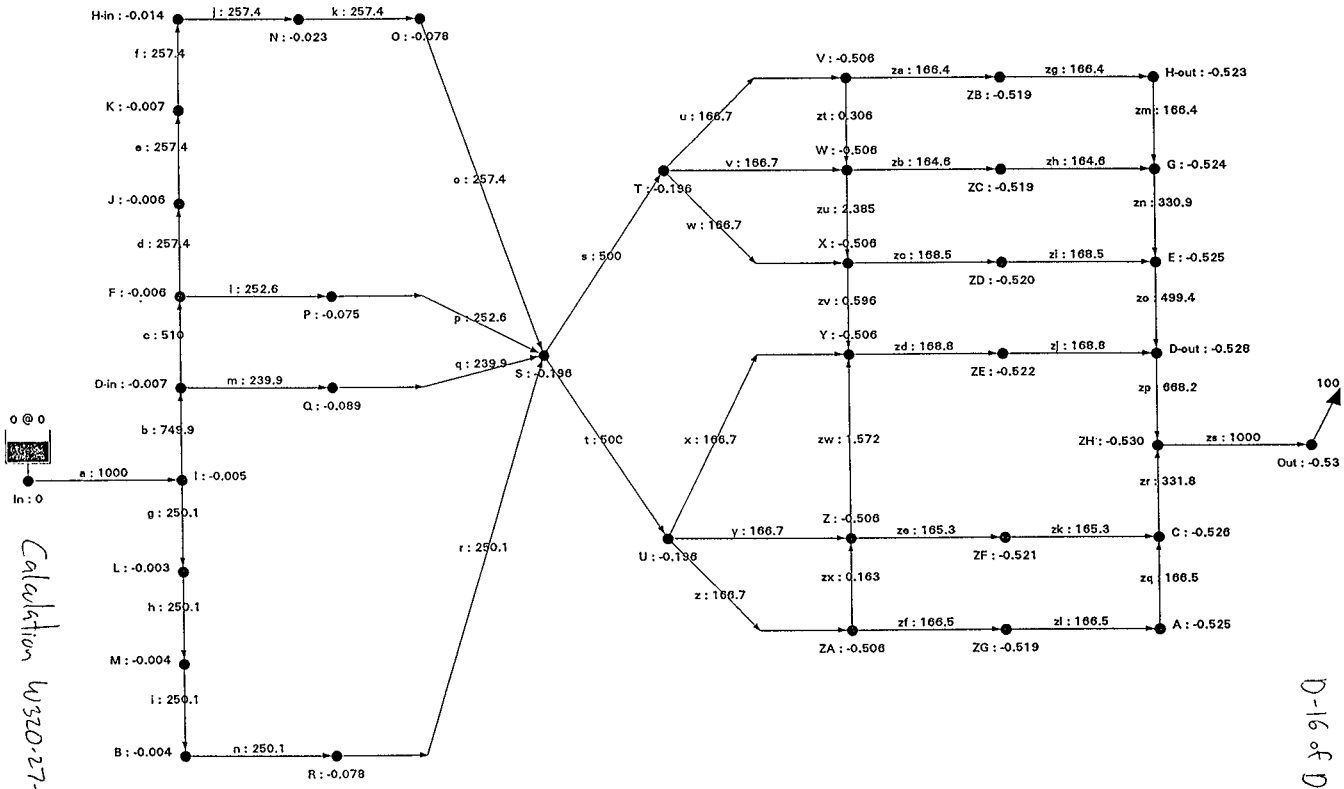
VALVE & FITTING SUMMARY

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°

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

Calculation W320-27-054



Calculation W320-27-054

D-16 of D-20

HNF-2479, Rev. 0
Page E-65

Company:	Fluor Daniel NW	02/17/98	9:54 am
Project:		**Linelist:**	ANNULUS
by:	Fluor Daniel NW	**Lineup:**	ANNULUS
Comments:		**flow rate:**	cfm
		pressure:	psi_g
Version:	PIPE-FLO ver 5.01	**level & grade:**	ft

Company: Fluor Daniel NW
Project:
by: Fluor Daniel NW

02/17/98 9:54 am
Lineup: ANNULUS
rev: 02/17/98 9:53 am

D-17 of D-20

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

Calculation W320-27-054

D-18 of D-20

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

Calculation W320-27-054

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

Calculation W320-27-054

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

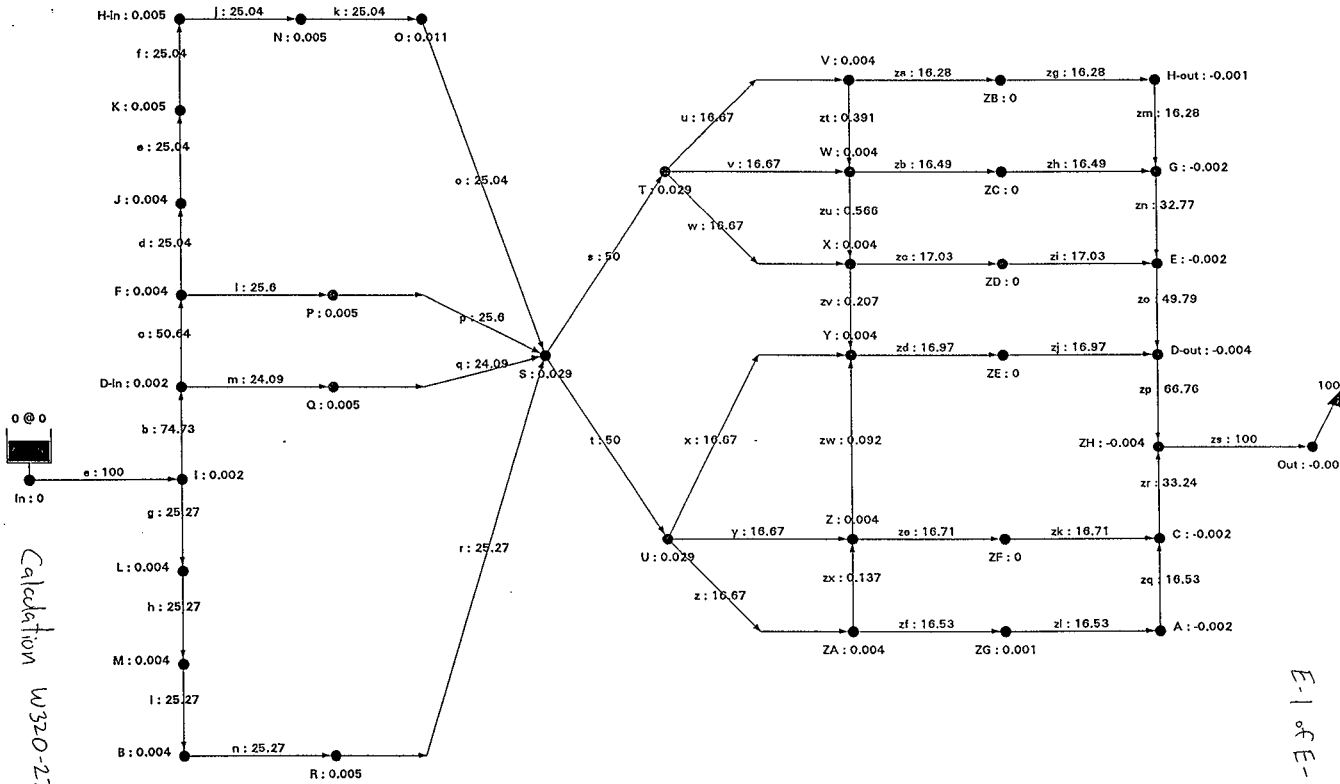
Calculation W320-27-054

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 By: Kelly Hayase
Checked: 3/2/98 By: [illegible]
Revised: By:

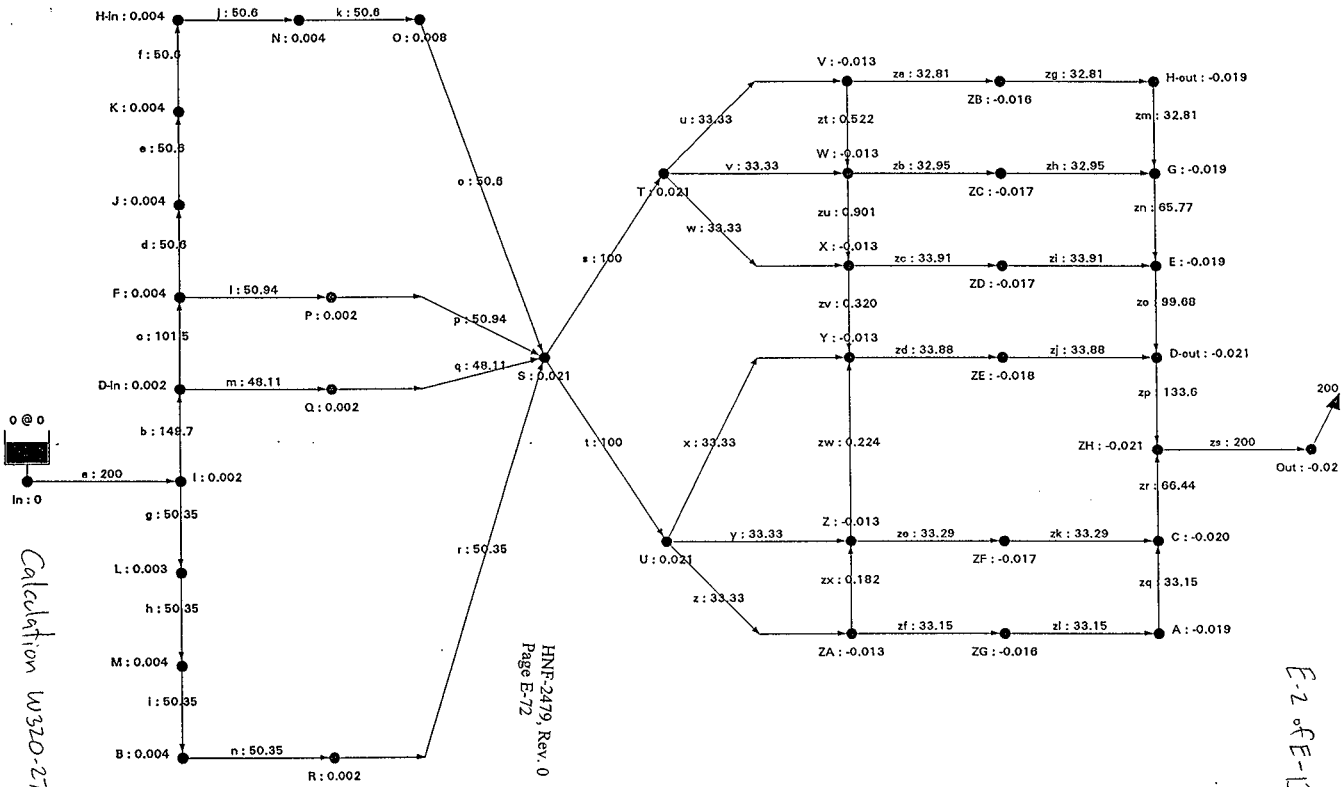
Appendix E: Pipe-Flo results of ANNULUS used to generate the system curve



Calculation W320-27-094

E-1 of E-13

Company:	Fluor Daniel NW	02/17/98	9:56 am
Project:		**Linelist:**	ANNULUS
by:	Fluor Daniel NW	**Lineup:**	ANNULUS
Comments:		**flow rate:**	cfm
		pressure:	psi_g
Version:	PIPE-FLO ver 5.01	**level & grade:**	ft

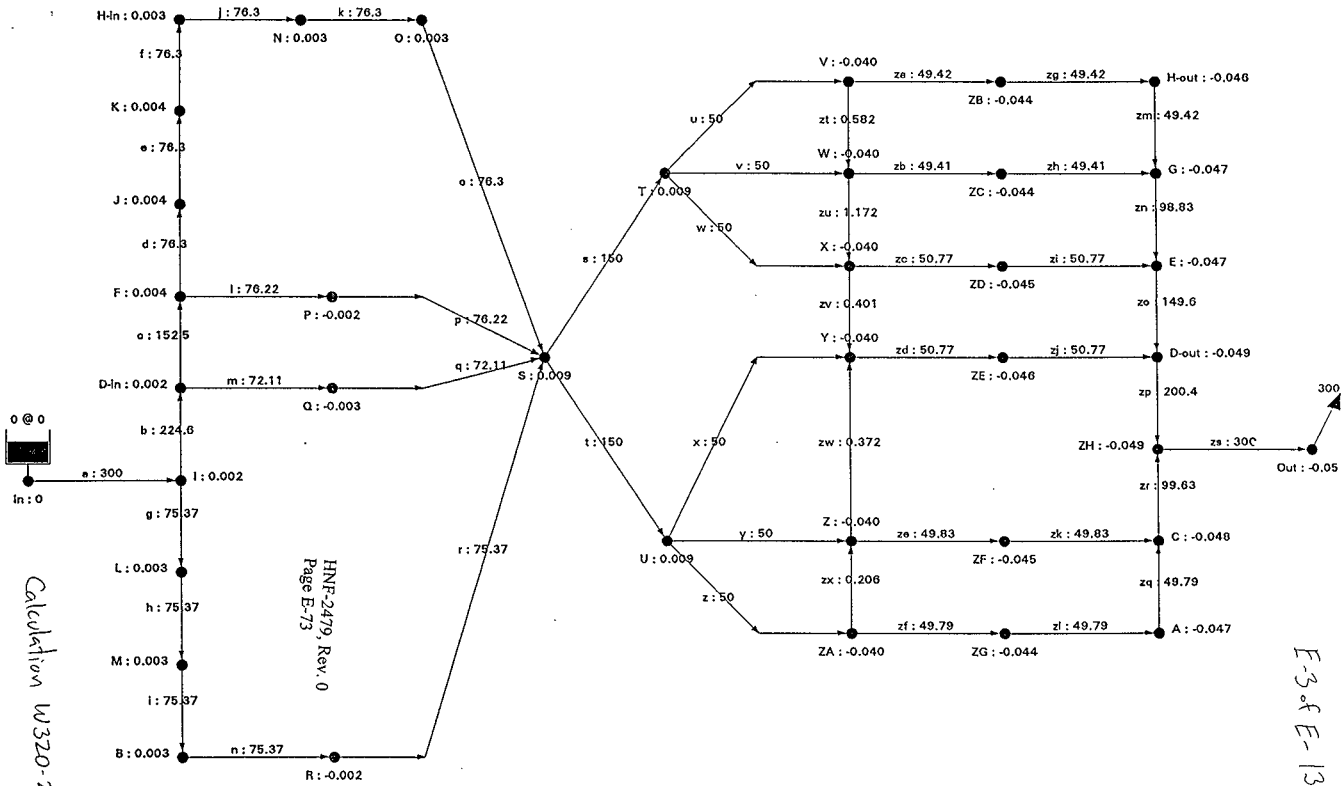


Calculation W320-27-054

HNF-2479, Rev. 0
Page E-72

E-2 of E-13

Company:	Fluor Daniel NW	02/17/98	9:57 am
Project:		**Linelist:**	ANNULUS
by:	Fluor Daniel NW	**Lineup:**	ANNULUS
Comments:		**flow rate:**	cfm
		pressure:	psi_g
Version:	PIPE-FLO ver 5.01	**level & grade:**	ft

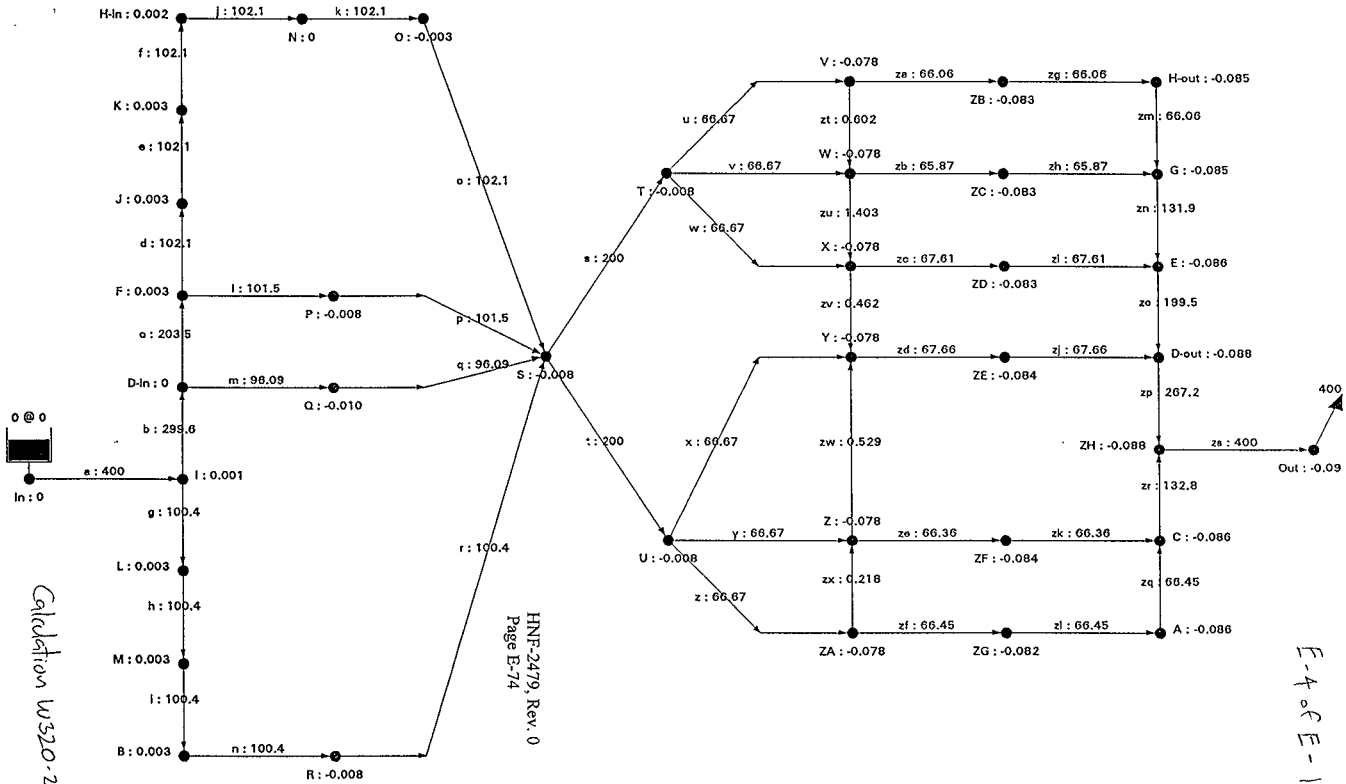


Company:	Fluor Daniel NW		02/17/98 9:59 am
Project:		**Linelist:**	ANNULUS
by:	Fluor Daniel NW	**Lineup:**	ANNULUS
Comments:		**flow rate:**	cfm
		pressure:	psi_g
Version:	PIPE-FLO ver 5.01	**level & grade:**	ft

HNF-2479, Rev. 0
Page E-73

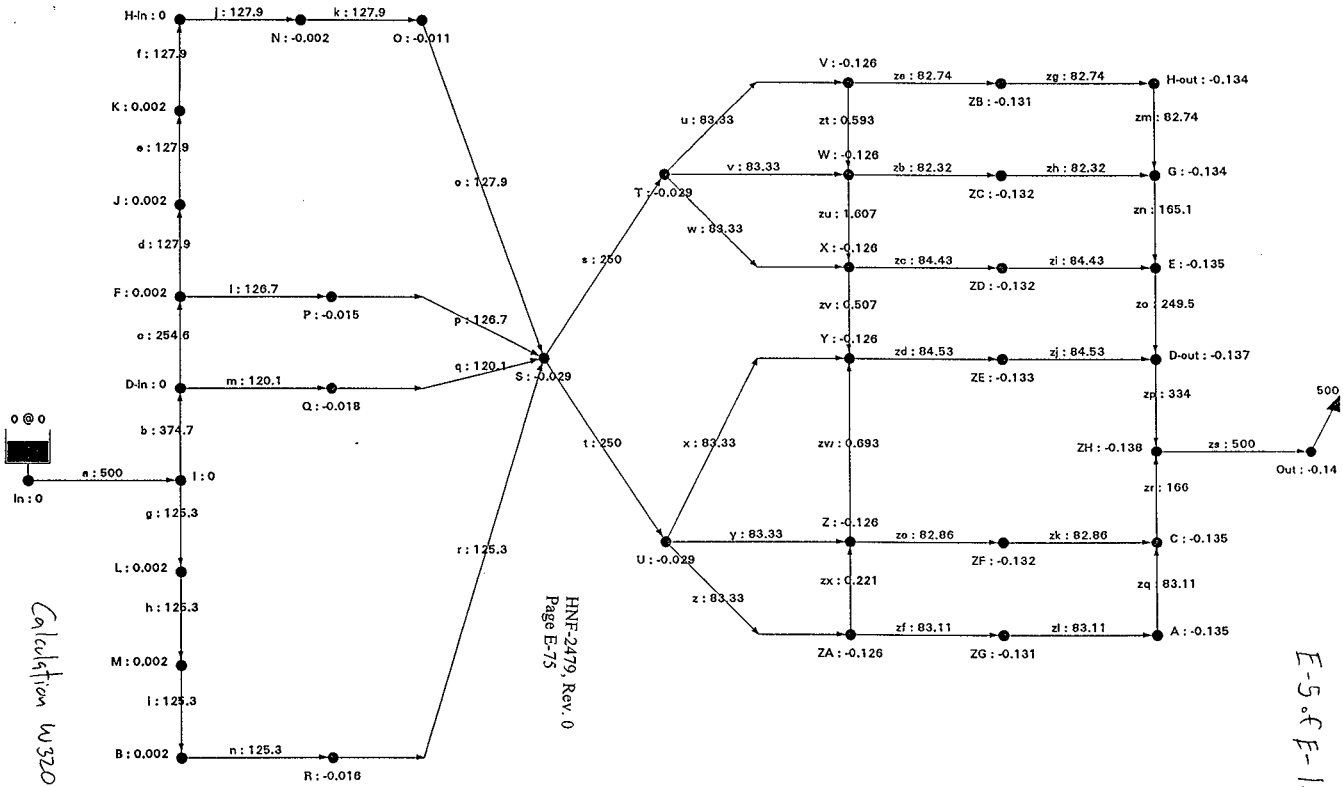
Calculation W320-27-054

E-3 of E-13



Company:	Fluor Daniel NW	02/17/98	9:59 am
Project:		**Linelist:**	ANNULUS
by:	Fluor Daniel NW	**Lineup:**	ANNULUS
Comments:		**flow rate:**	cfm
		pressure:	psi_g
Version:	PIPE-FLO ver 5.01	**level & grade:**	ft

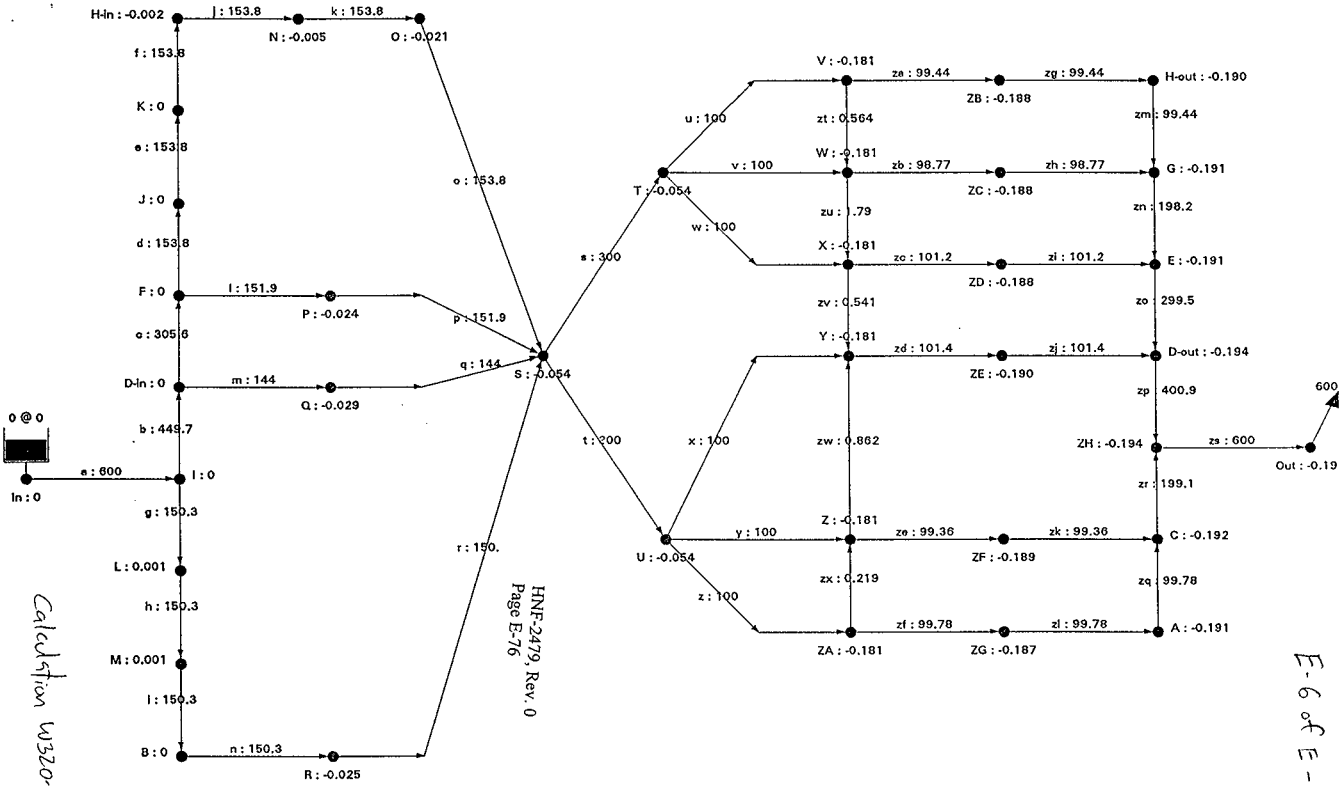
Calculation W320-27-054



Company:	Fluor Daniel NW	02/17/98	10:00 am
Project:		**Linelist:**	ANNULUS
by:	Fluor Daniel NW	**Lineup:**	ANNULUS
Comments:		**flow rate:**	cfm
		pressure:	psi_g
Version:	PIPE-FLO ver 5.01	**level & grade:**	ft

Calculation W320-27-054

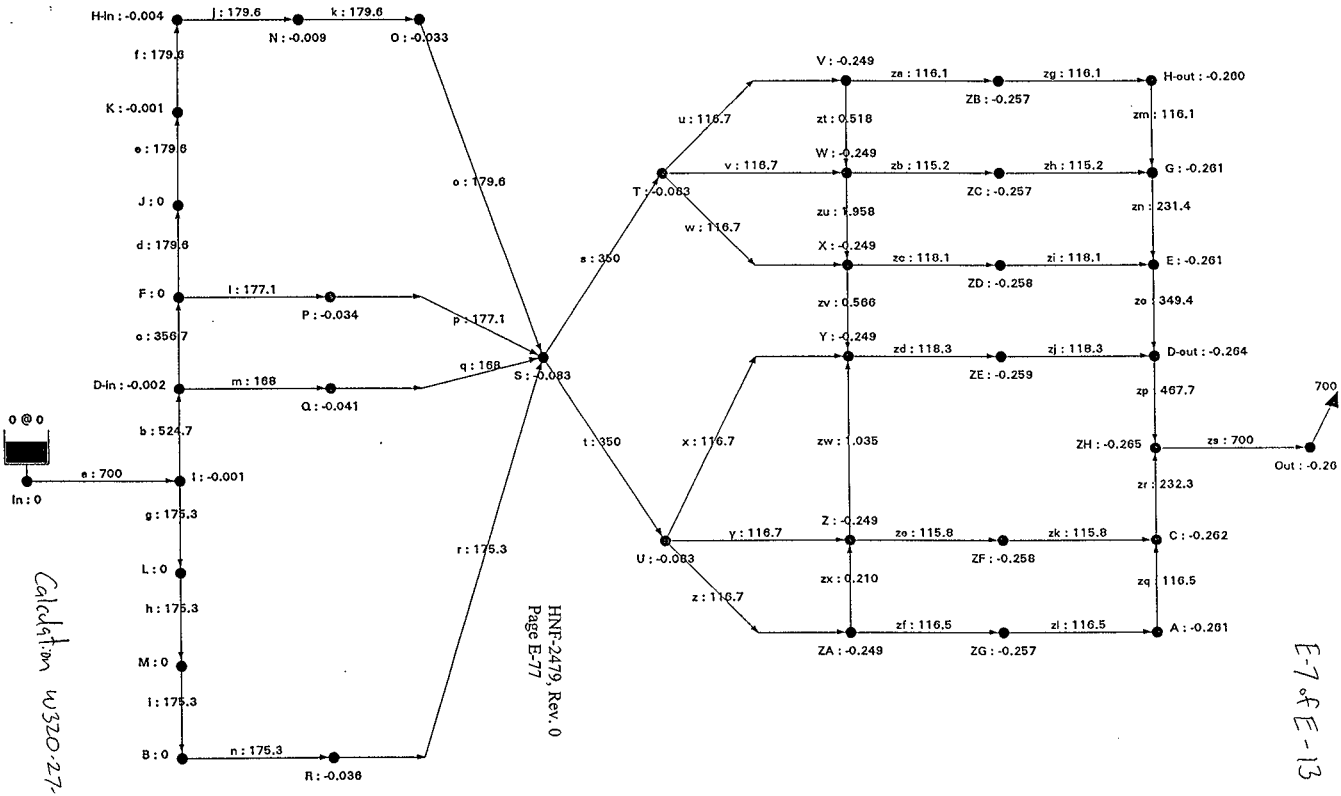
E-5 of E-13



Calculation W320-27-054

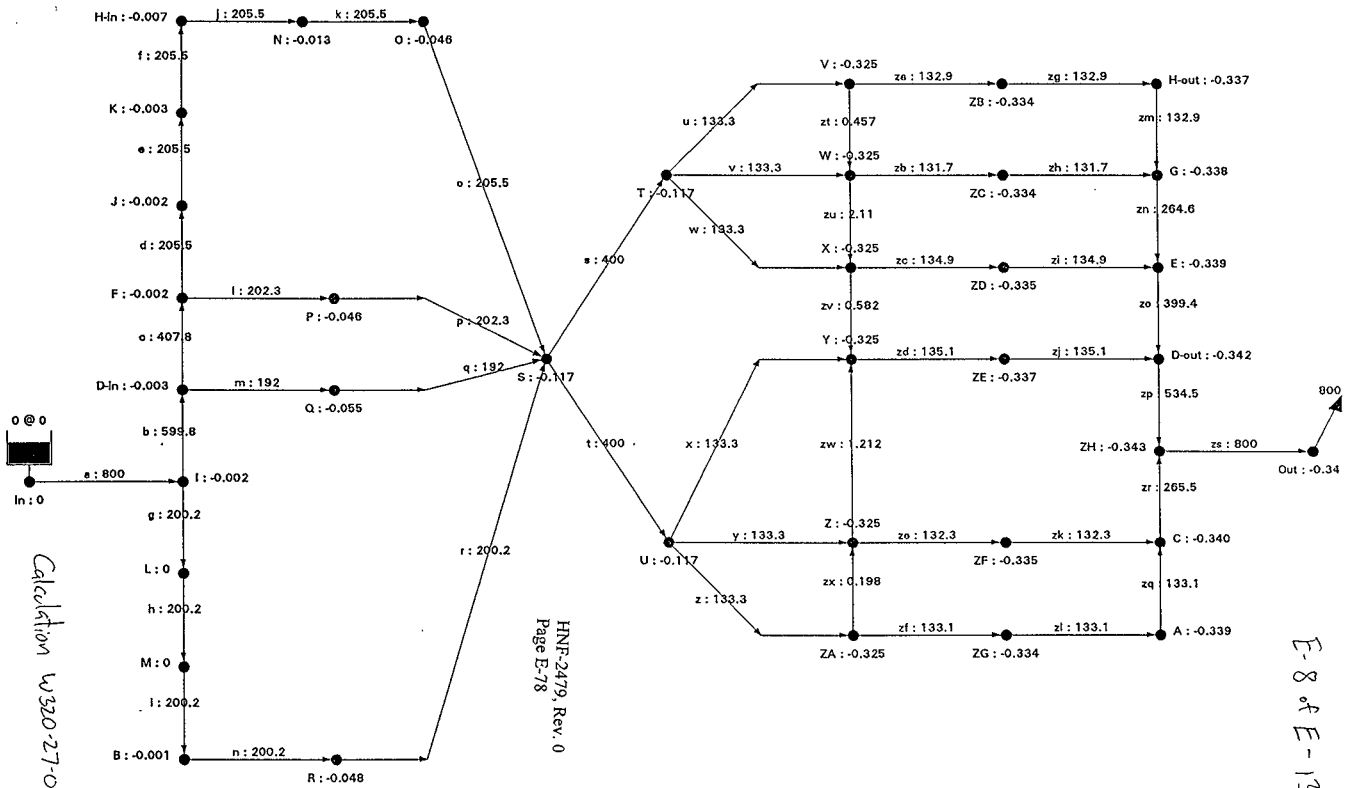
E-6 of E-13

Company:	Fluor Daniel NW	02/17/98	10:02 am
Project:		**Linelist:**	ANNULUS
by:	Fluor Daniel NW	**Lineup:**	ANNULUS
Comments:		**flow rate:**	cfm
		pressure:	psi_g
Version:	PIPE-FLO ver 5.01	**level & grade:**	ft



Company:	Fluor Daniel NW	02/17/98	10:03 am
Project:		**Linelist:**	ANNULUS
by:	Fluor Daniel NW	**Lineup:**	ANNULUS
Comments:		**flow rate:**	cfm
		pressure:	psi_g
Version:	PIPE-FLO ver 5.01	**level & grade:**	ft

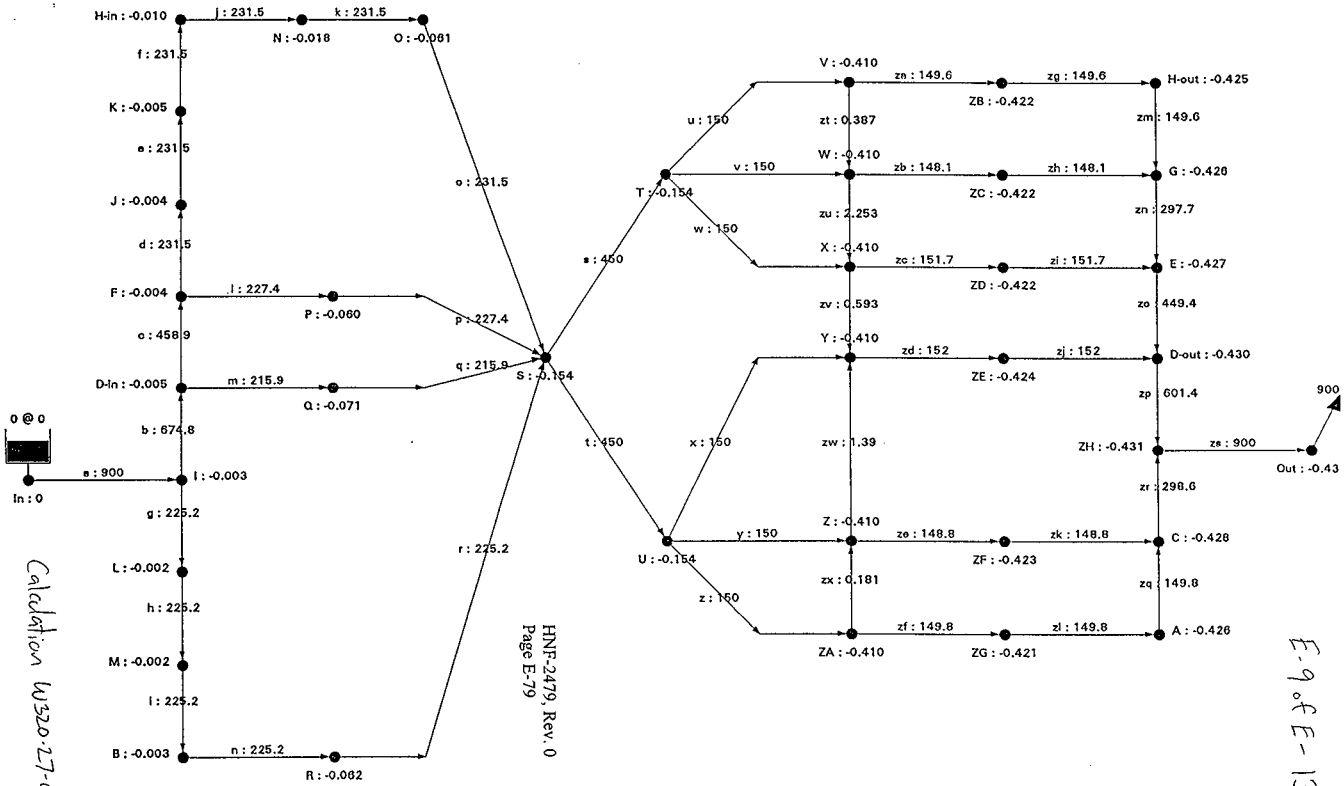
Calculation W320-27-054



Calculation W320-27-054

E-8 of E-13

Company:	Fluor Daniel NW	02/17/98	10:04 am
Project:		**Linelist:**	ANNULUS
by:	Fluor Daniel NW	**Lineup:**	ANNULUS
Comments:		**flow rate:**	cfm
		pressure:	psi_g
Version:	PIPE-FLO ver 5.01	**level & grade:**	ft

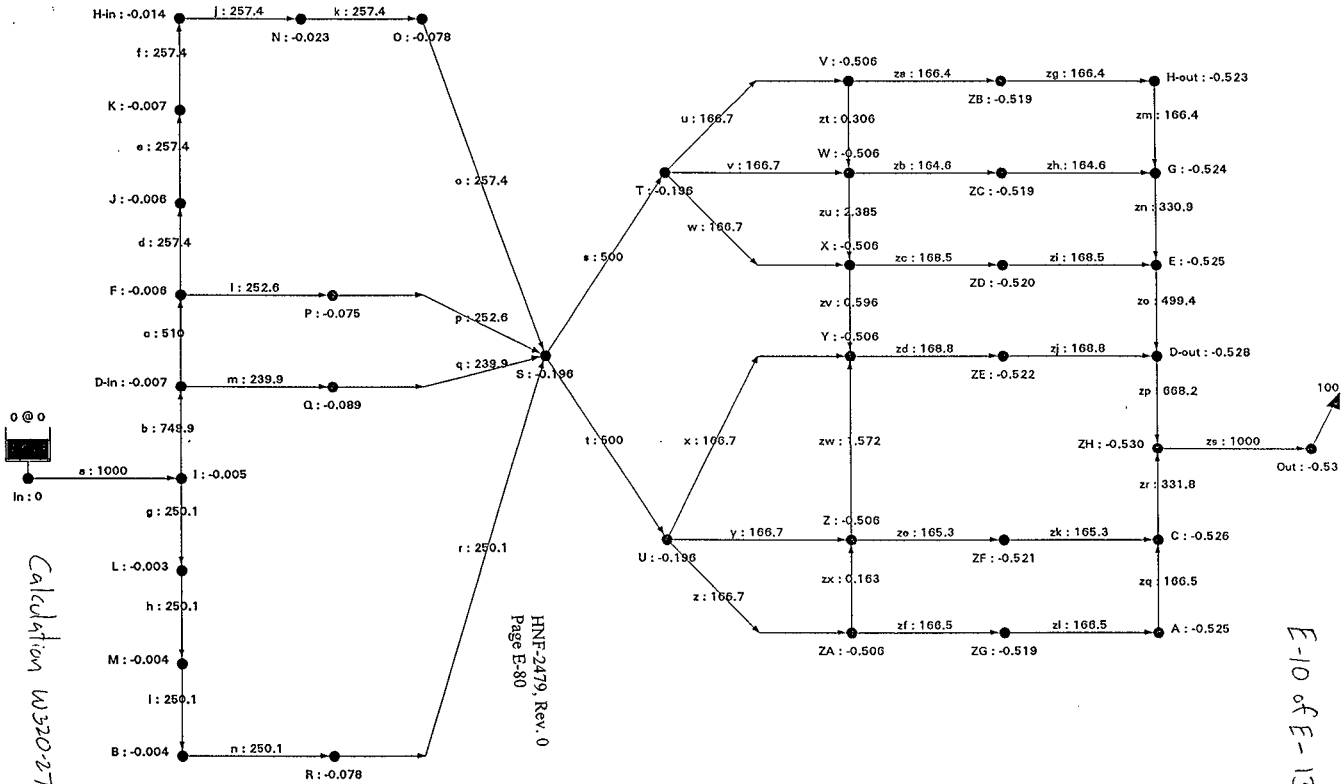


Calculation W320-27-054

HNF-2479, Rev. 0
Page E-79

E-9 of E-13

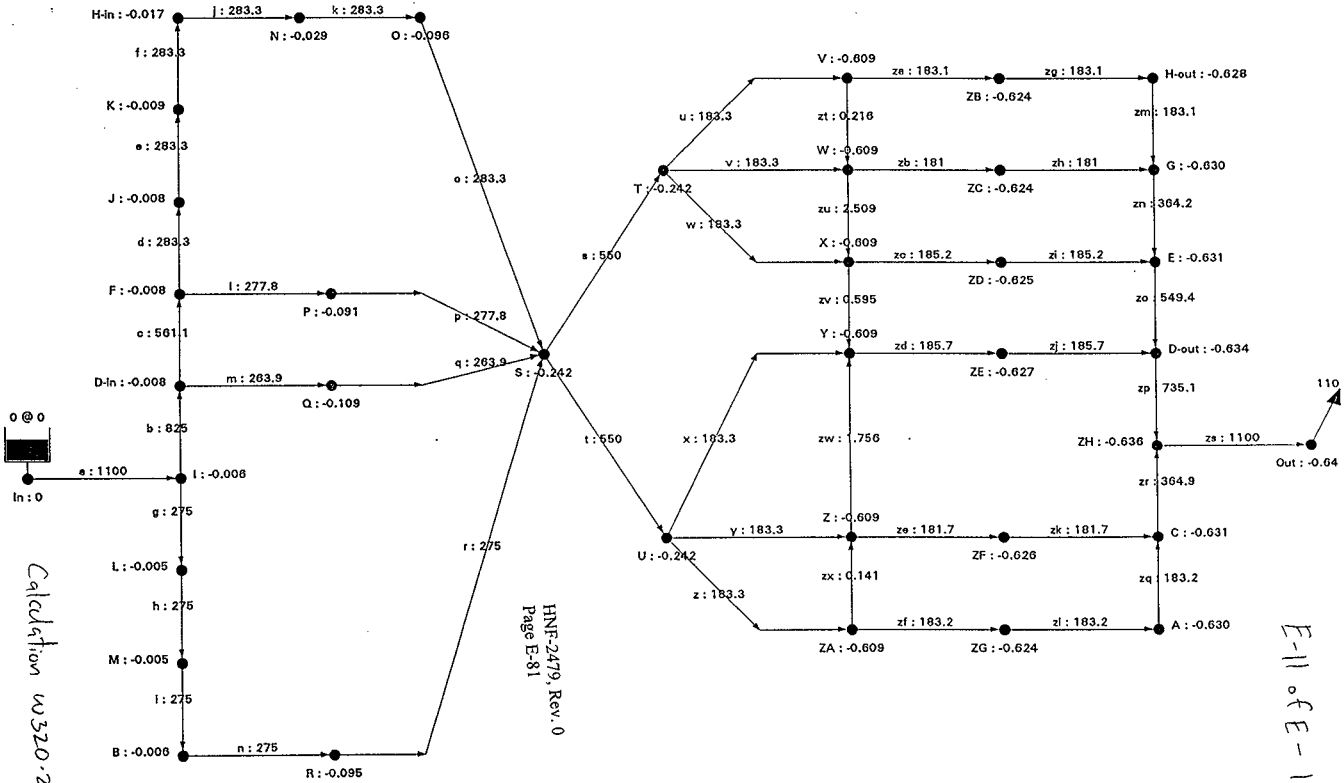
Company:	Fluor Daniel NW	02/17/98	10:06 am
Project:		**Linelist:**	ANNULUS
by:	Fluor Daniel NW	**Lineup:**	ANNULUS
Comments:		**flow rate:**	cfm
		pressure:	psi_g
Version:	PIPE-FLO ver 5.01	**level & grade:**	ft



Calculation W320-27-054

E-10 of E-13

Company:	Fluor Daniel NW	02/17/98	10:09 am
Project:		**Linelist:**	ANNULUS
by:	Fluor Daniel NW	**Lineup:**	ANNULUS
Comments:		**flow rate:**	cfm
		pressure:	psi_g
Version:	PIPE-FLO ver 5.01	**level & grade:**	ft

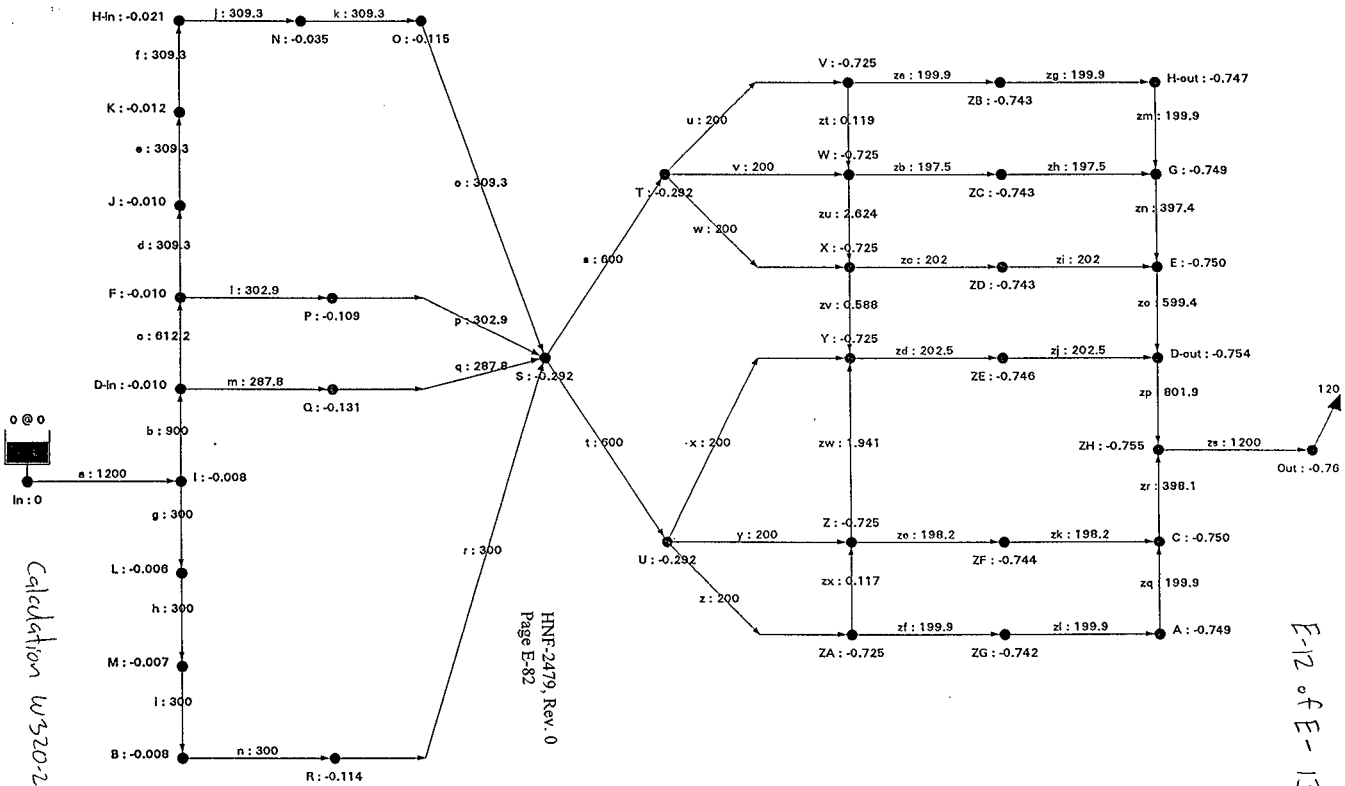


Calculation W320-27054

HNF-2479, Rev. 0
Page E-81

E-11 of E-13

Company:	Fluor Daniel NW	02/17/98	10:11 am
Project:		**Linelist:**	ANNULUS
by:	Fluor Daniel NW	**Lineup:**	ANNULUS
Comments:		**flow rate:**	cfm
		pressure:	psig
Version:	PIPE-FLO ver 5.01	**level & grade:**	ft

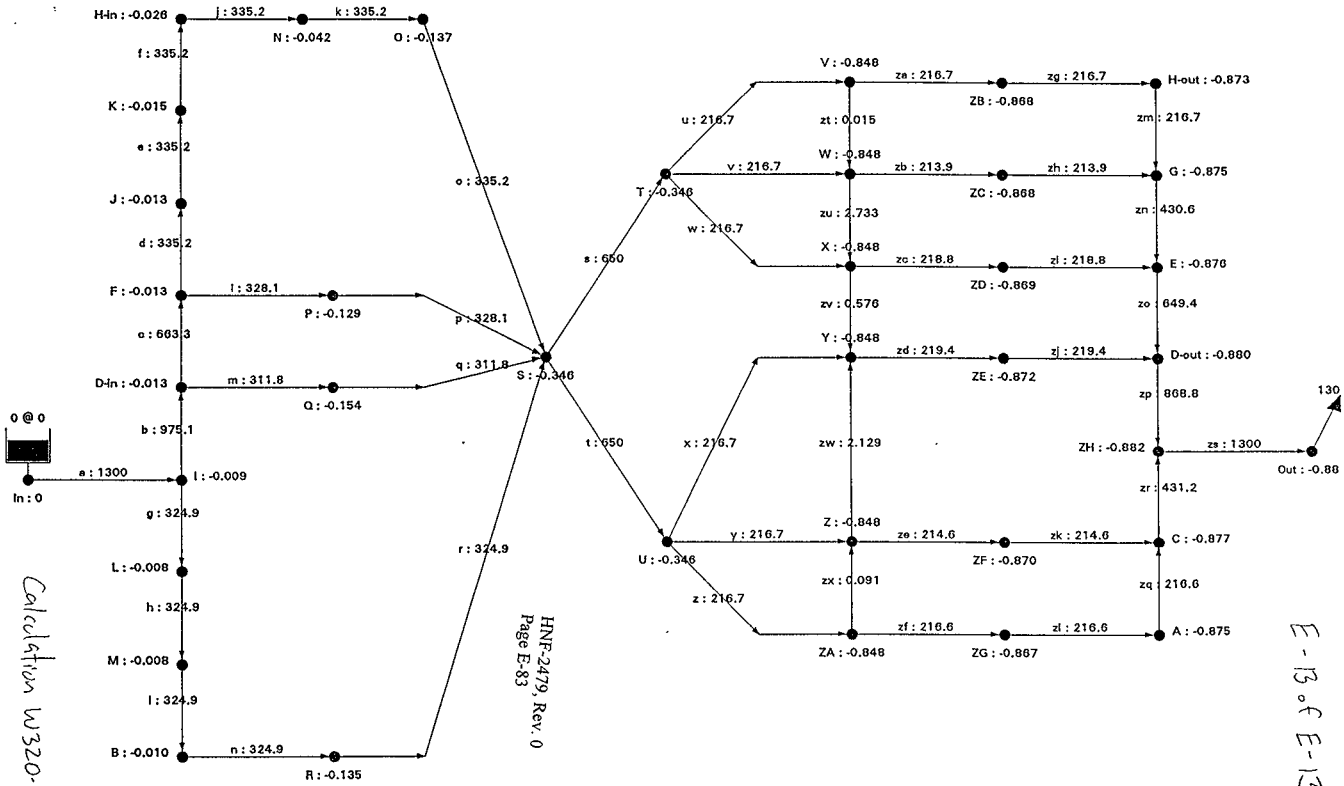


Calculation W320-27-054

HNF-2479, Rev. 0
Page E-82

E-12 of E-13

Company:	Fluor Daniel NW	02/17/98	10:13 am
Project:		**Linelist:**	ANNULUS
by:	Fluor Daniel NW	**Lineup:**	ANNULUS
Comments:		**flow rate:**	cfm
		pressure:	psi_g
Version:	PIPE-FLO ver 5.01	**level & grade:**	ft



Calculation W320-27-054

HNF-2479, Rev. 0
Page E-83

E-13 of E-13

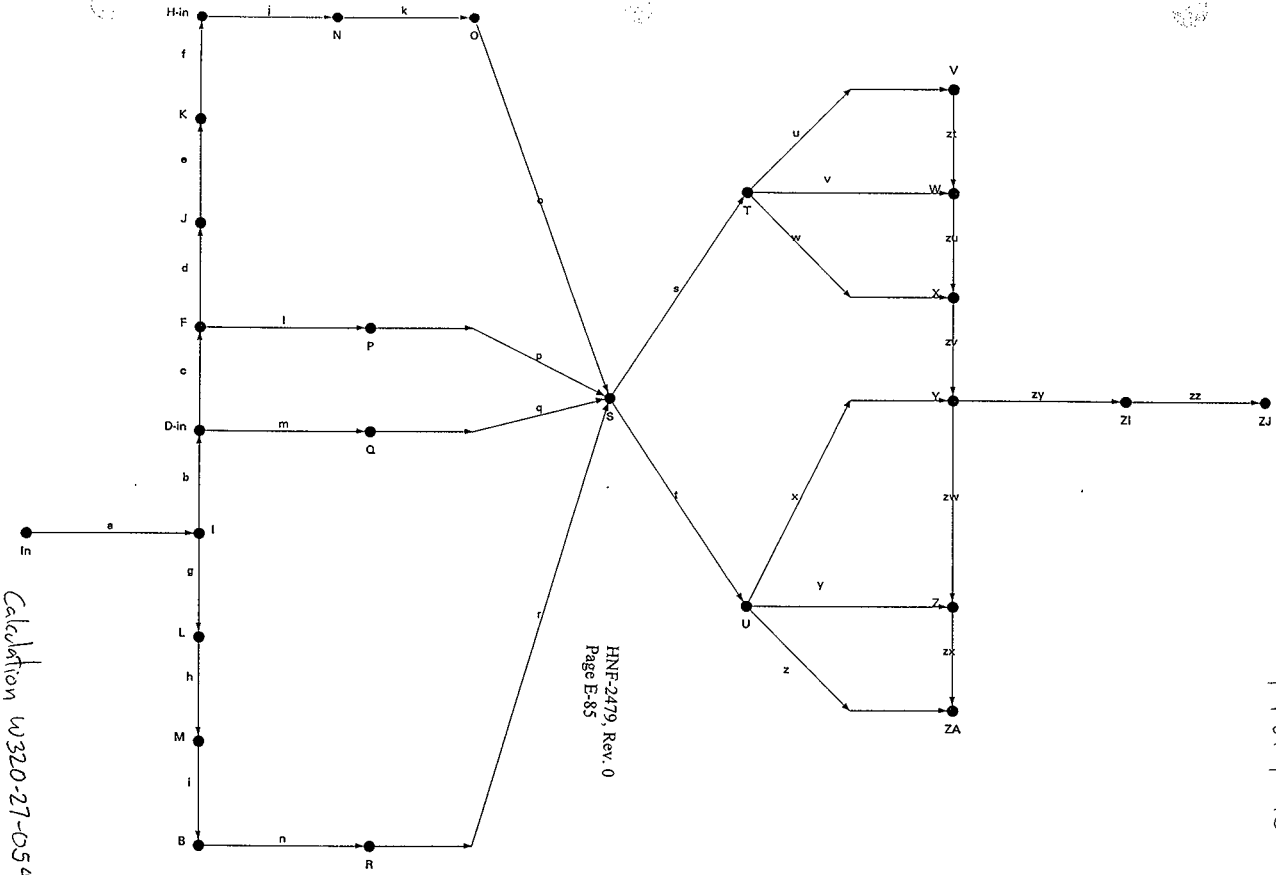
Company:	Fluor Daniel NW	02/17/98	10:14 am
Project:		**Linelist:**	ANNULUS
by:	Fluor Daniel NW	**Lineup:**	ANNULUS
Comments:		**flow rate:**	cfm
		pressure:	psi_g
Version:	PIPE-FLO ver 5.01	**level & grade:**	ft

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 By: Kelly Hayase
Checked: 3/2/98 By: Kai Cl
Revised: By:

Appendix F: Pipe-Flo Model ANNU-PEX



HNF-2479, Rev. 0
Page E-85

Calculation W320-27-054

F-1 of F-15

Company:	Fluor Daniel NW	02/18/98	2:02 pm
Project:		**Linelist:**	ANNU-PEX
by:	Fluor Daniel NW	**Lineup:**	
Comments:		**flow rate:**	cfm
		pressure:	psi_g
Version:	PIPE-FLO ver 5.01	**level & grade:**	ft

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

Calculation W320-27-054

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

Calculation W320-27-054

F-6 of F-15

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

Calculation W320-27-054

F-7 of 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

Calculation W320-27-054

Company: Fluor Daniel NW
Project:
by: Fluor Daniel NW

Created: 01/26/98 11:38 am
Design file:
Pipe Specs: 1

02/18/98 2:03 pm
System: ANNU-PEX
rev: 02/18/98 2:02 pm F-8 of F-15

MATERIALS REPORT

Pipes: 33
Nodes: 26
Pumps/Comps: 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 [illegible]

Calculation W320-27-054

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

Calculation W320-27-059

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

Calculation W320-27-054

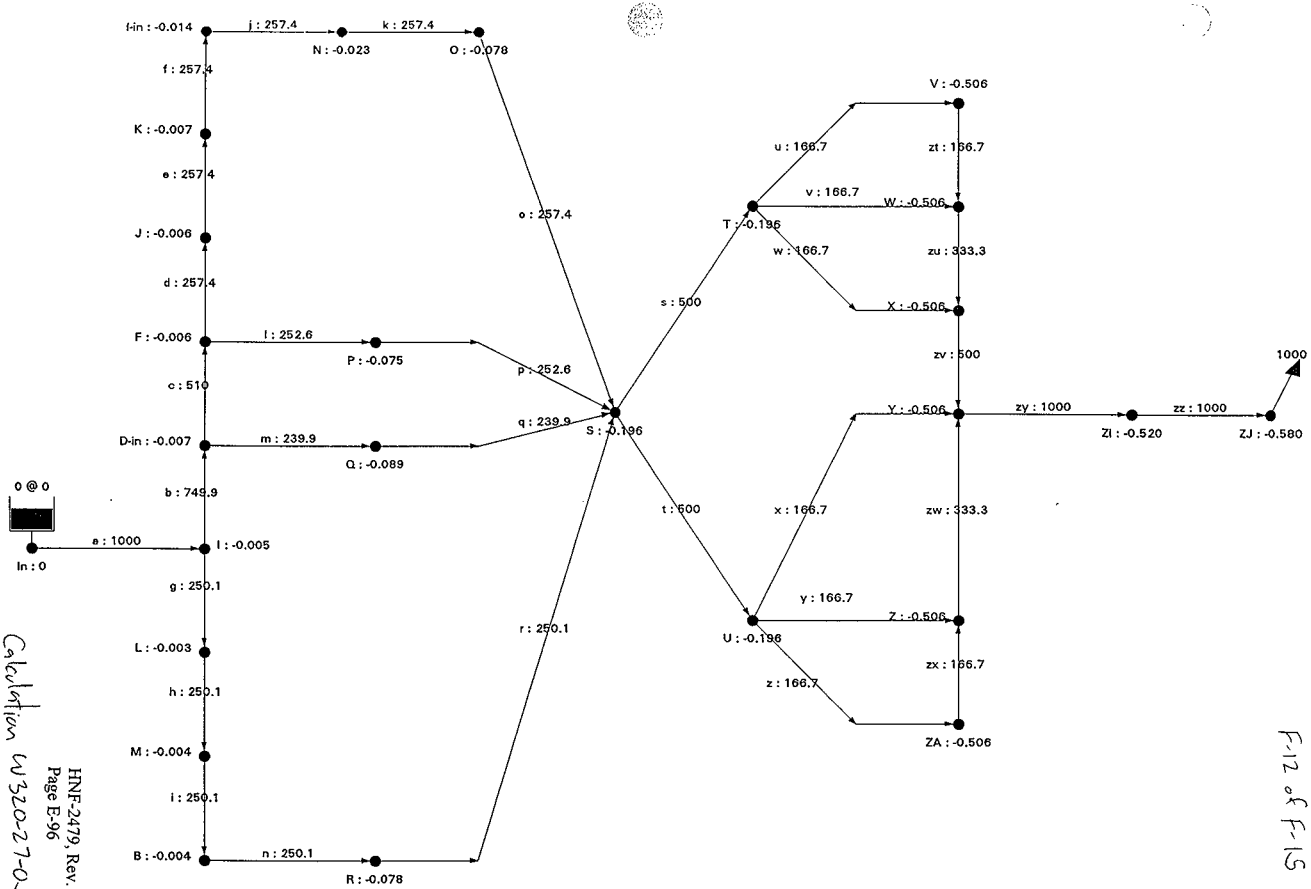
F-11 of F-15

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

Calculation W320-27-054



Company:	Fluor Daniel NW	02/18/98	2:04 pm
Project:		**Linelist:**	ANNU-PEX
by:	Fluor Daniel NW	**Lineup:**	ANNU-PEX
Comments:		**flow rate:**	cfm
		pressure:	psi_g
Version:	PIPE-FLO ver 5.01	**level & grade:**	ft

Calculation W320-27-054

Company: Fluor Daniel NW
Project:
by: Fluor Daniel NW

02/18/98 2:04 pm
Lineup: ANNU-PEX
rev: 02/18/98 2:04 pm F-13 of F-15

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

Calculation W320-27-054

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

Calculation W320-27-054

PIPELINE	FROM		TO	FLOW cfm	VEL ft/sec	dP psi g	HL ft
b	In		I	1000	21.46	0.005	12.86
	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
	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
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

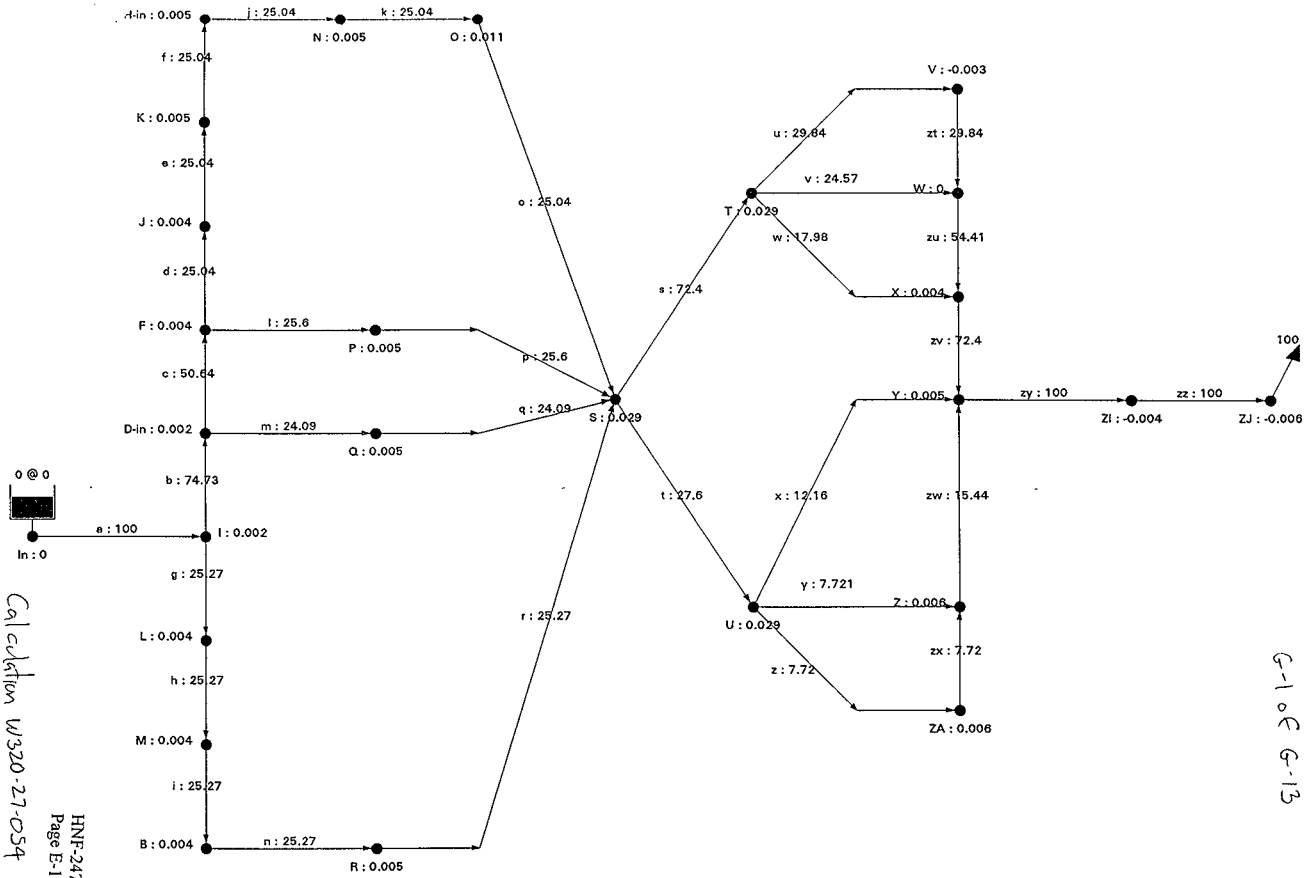
Calculation W320-27-054

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 By: Kelly Hayase
Checked: 3/2/98 By: Ken Clark
Revised: By:

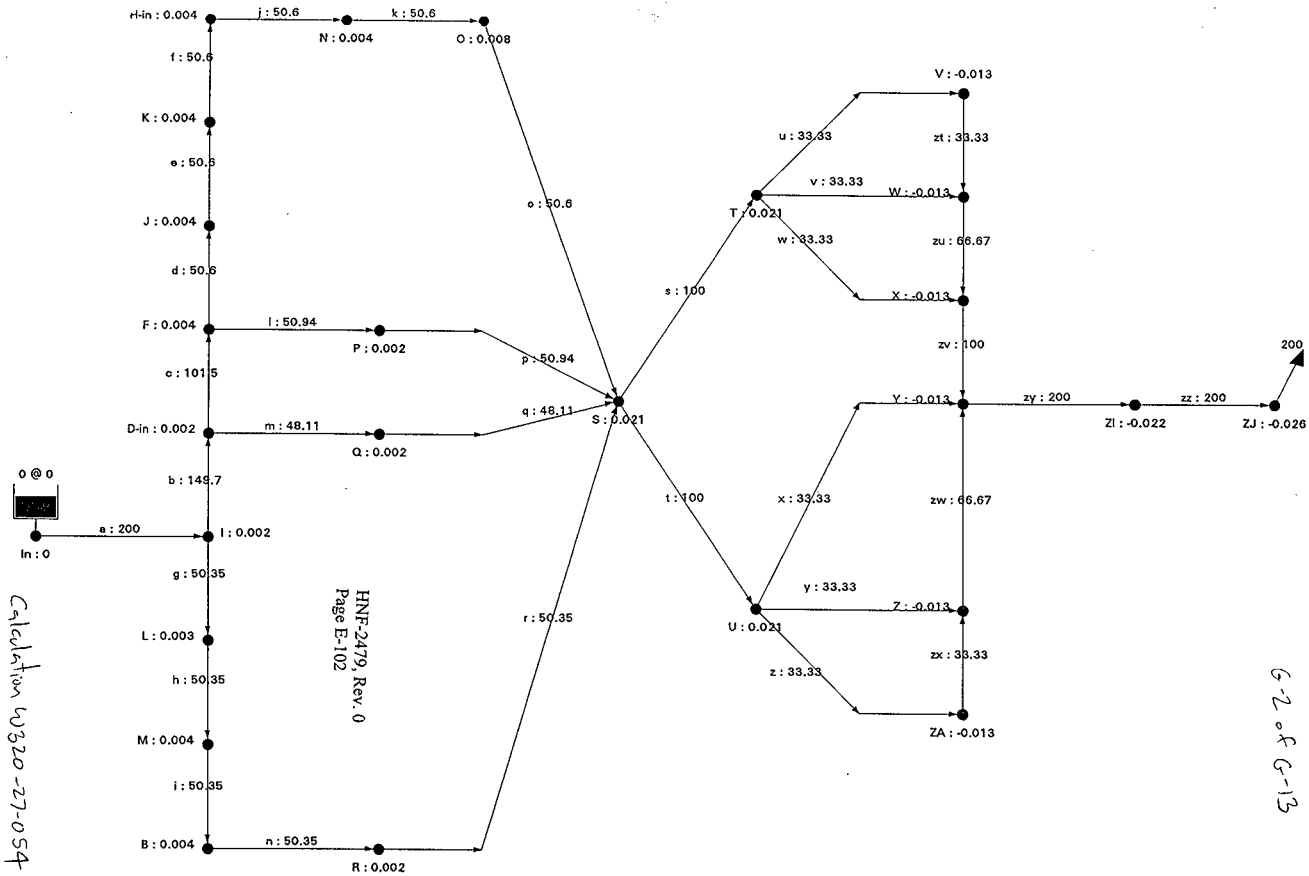
Appendix G: Pipe-Flo results of ANNU-PEX used to generate the system curve



Company:	Fluor Daniel NW	02/18/98	2:06 pm
Project:		**Linelist:**	ANNU-PEX
by:	Fluor Daniel NW	**Lineup:**	ANNU-PEX
Comments:		**flow rate:**	cfm
		pressure:	psi_g
Version:	PIPE-FLO ver 5.01	**level & grade:**	ft

Calculation W320-27-054

G-1 of G-13

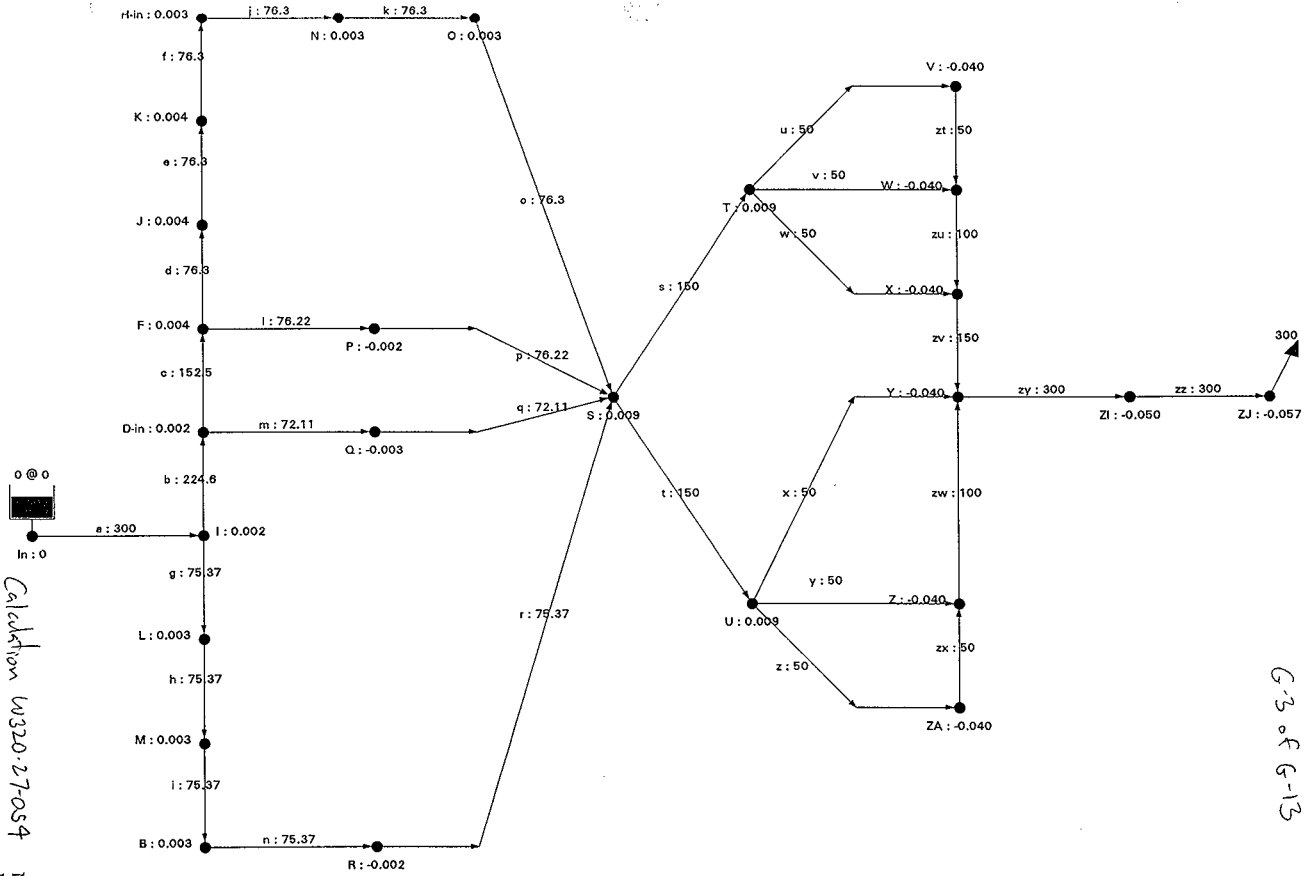


Calculation W320-27-054

HNF-2479, Rev. 0
Page E-102

G-2 of G-13

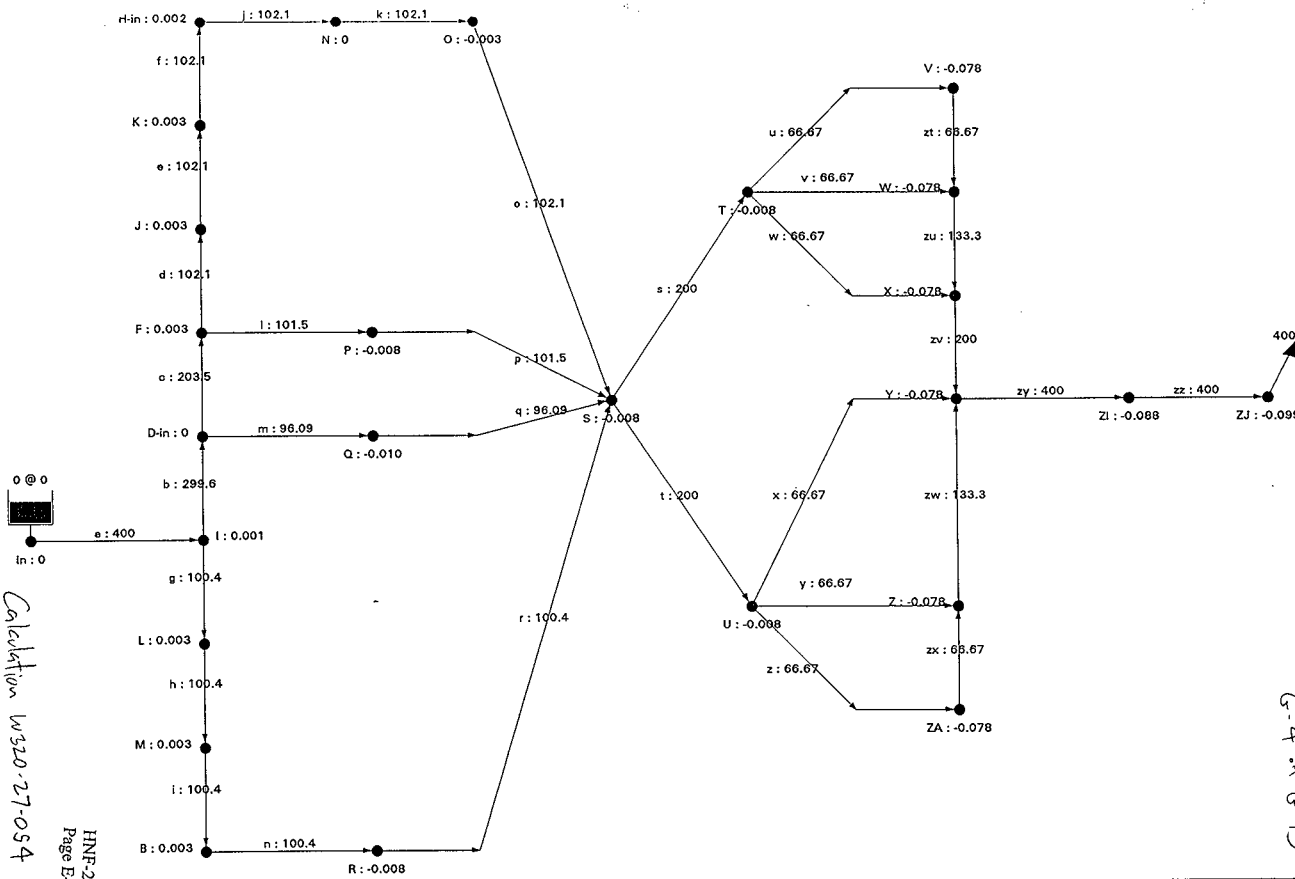
Company:	Fluor Daniel NW	02/18/98	2:07 pm
Project:		**Linelist:**	ANNU-PEX
by:	Fluor Daniel NW	**Lineup:**	ANNU-PEX
Comments:		**flow rate:**	cfm
		pressure:	psi_g
Version:	PIPE-FLO ver 5.01	**level & grade:**	ft



Calculation W320-27-054

G-3 of G-13

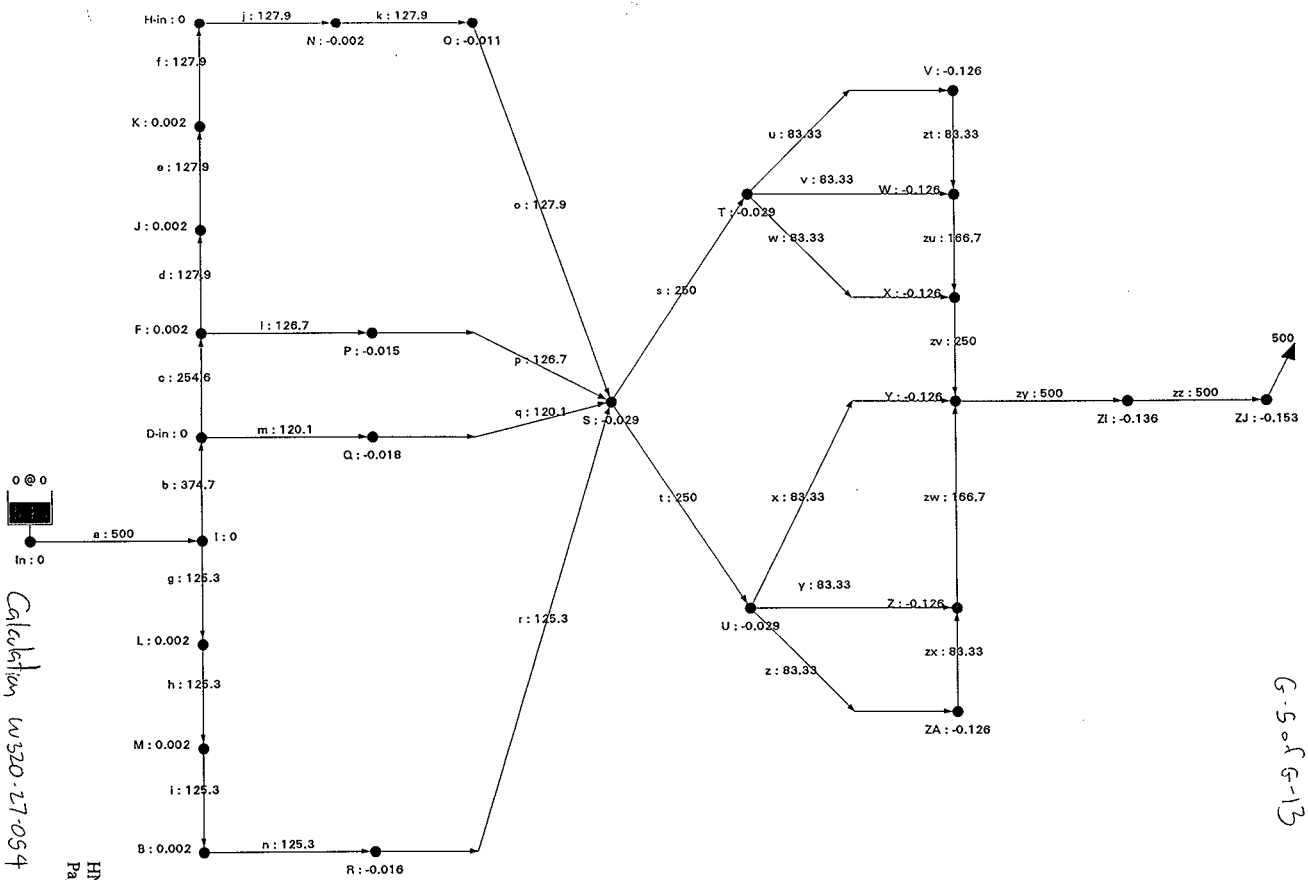
Company:	Fluor Daniel NW	02/18/98	2:08 pm
Project:		**Linelist:**	ANNU-PEX
by:	Fluor Daniel NW	**Lineup:**	ANNU-PEX
Comments:		**flow rate:**	cfm
		pressure:	psi_g
Version:	PIPE-FLO ver 5.01	**level & grade:**	ft



Company:	Fluor Daniel NW	02/18/98	2:28 pm
Project:		**Linelist:**	ANNU-PEX
by:	Fluor Daniel NW	**Lineup:**	ANNU-PEX
Comments:		**flow rate:**	cfm
		pressure:	psi_g
Version:	PIPE-FLO ver 5.01	**level & grade:**	ft

Calculation W320-27-054

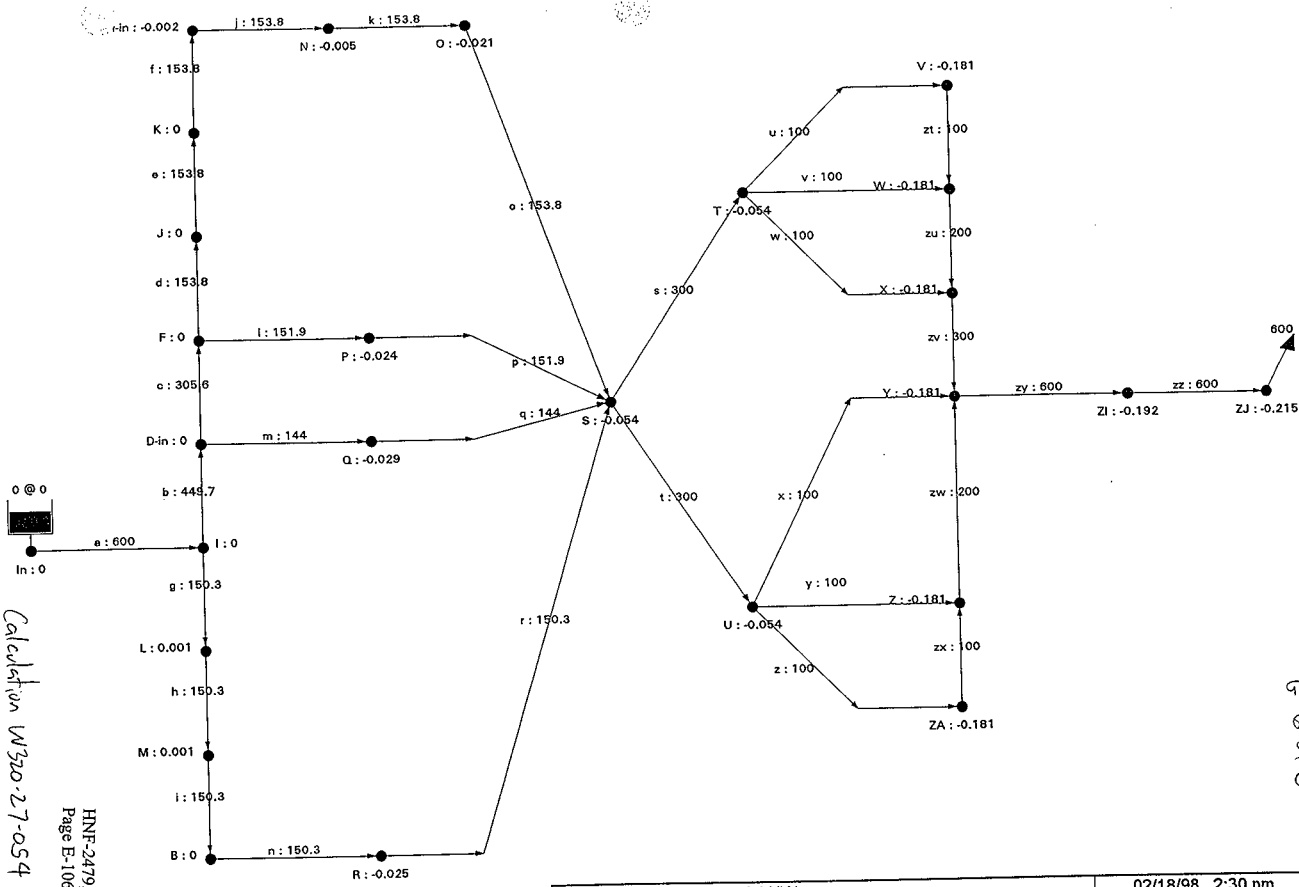
G-4 of G-13



Company:	Fluor Daniel NW	02/18/98	2:28 pm
Project:		**Linelist:**	ANNU-PEX
by:	Fluor Daniel NW	**Lineup:**	ANNU-PEX
Comments:		**flow rate:**	cfm
		pressure:	psi_g
Version:	PIPE-FLO ver 5.01	**level & grade:**	ft

Calculation W320-27-054

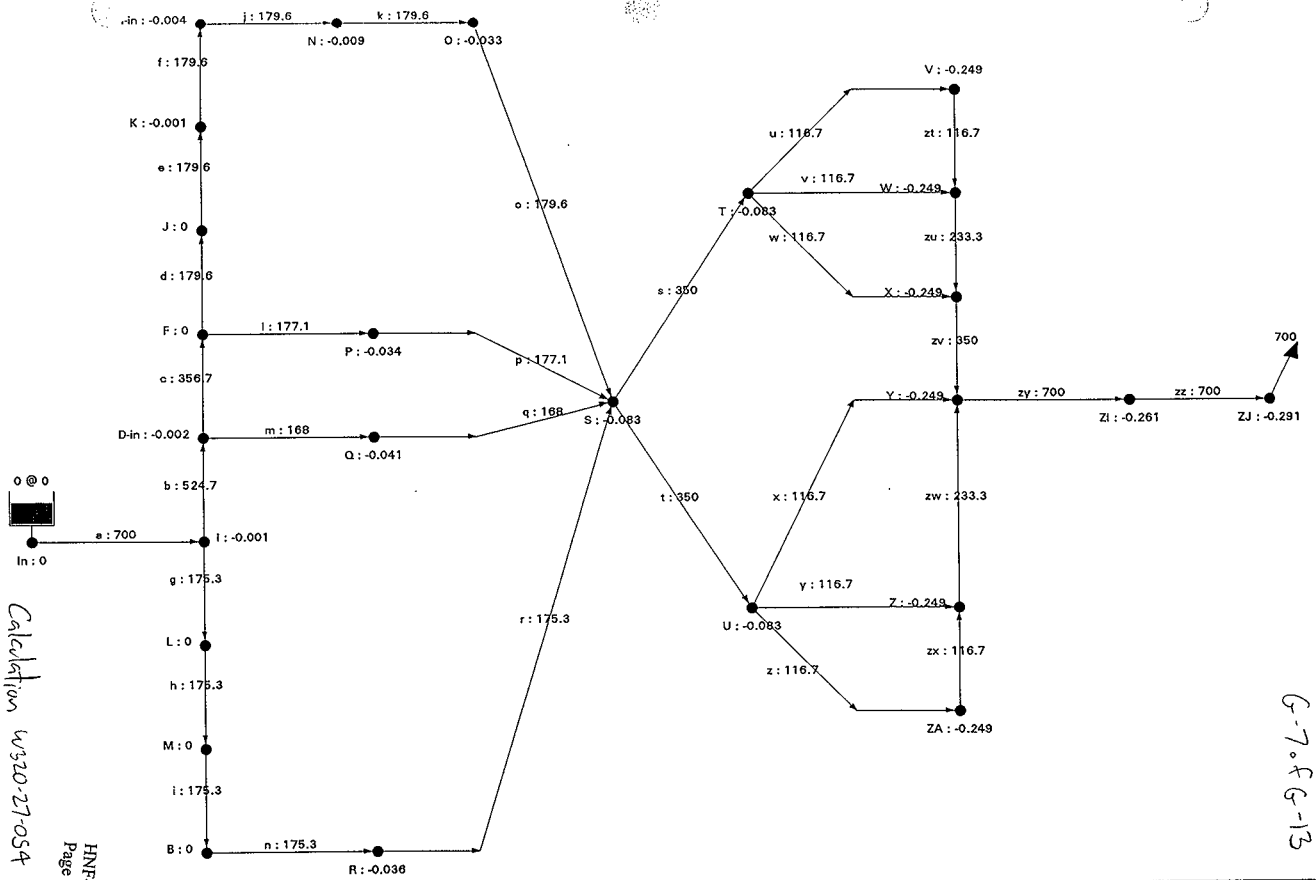
G-5 of G-13



Company:	Fluor Daniel NW	02/18/98	2:30 pm
Project:		**Linelist:**	ANNU-PEX
by:	Fluor Daniel NW	**Lineup:**	ANNU-PEX
Comments:		**flow rate:**	cfm
		pressure:	psi_g
Version:	PIPE-FLO ver 5.01	**level & grade:**	ft

Calculation W320-27-054

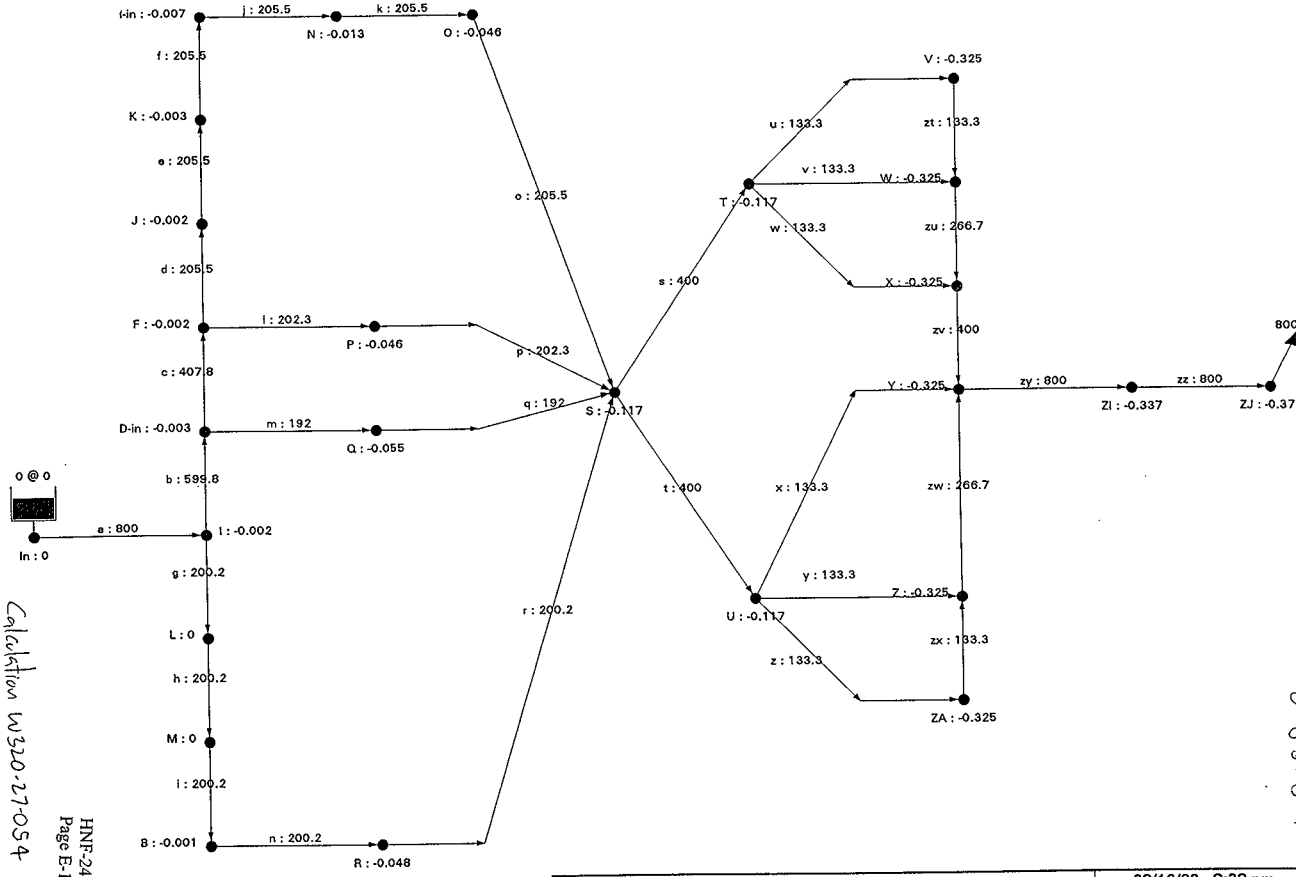
G-6 of G-13



Company:	Fluor Daniel NW	02/18/98	2:31 pm
Project:		**Linelist:**	ANNU-PEX
by:	Fluor Daniel NW	**Lineup:**	ANNU-PEX
Comments:		**flow rate:**	cfm
		pressure:	psi_g
Version:	PIPE-FLO ver 5.01	**level & grade:**	ft

Calculation W320-27-054

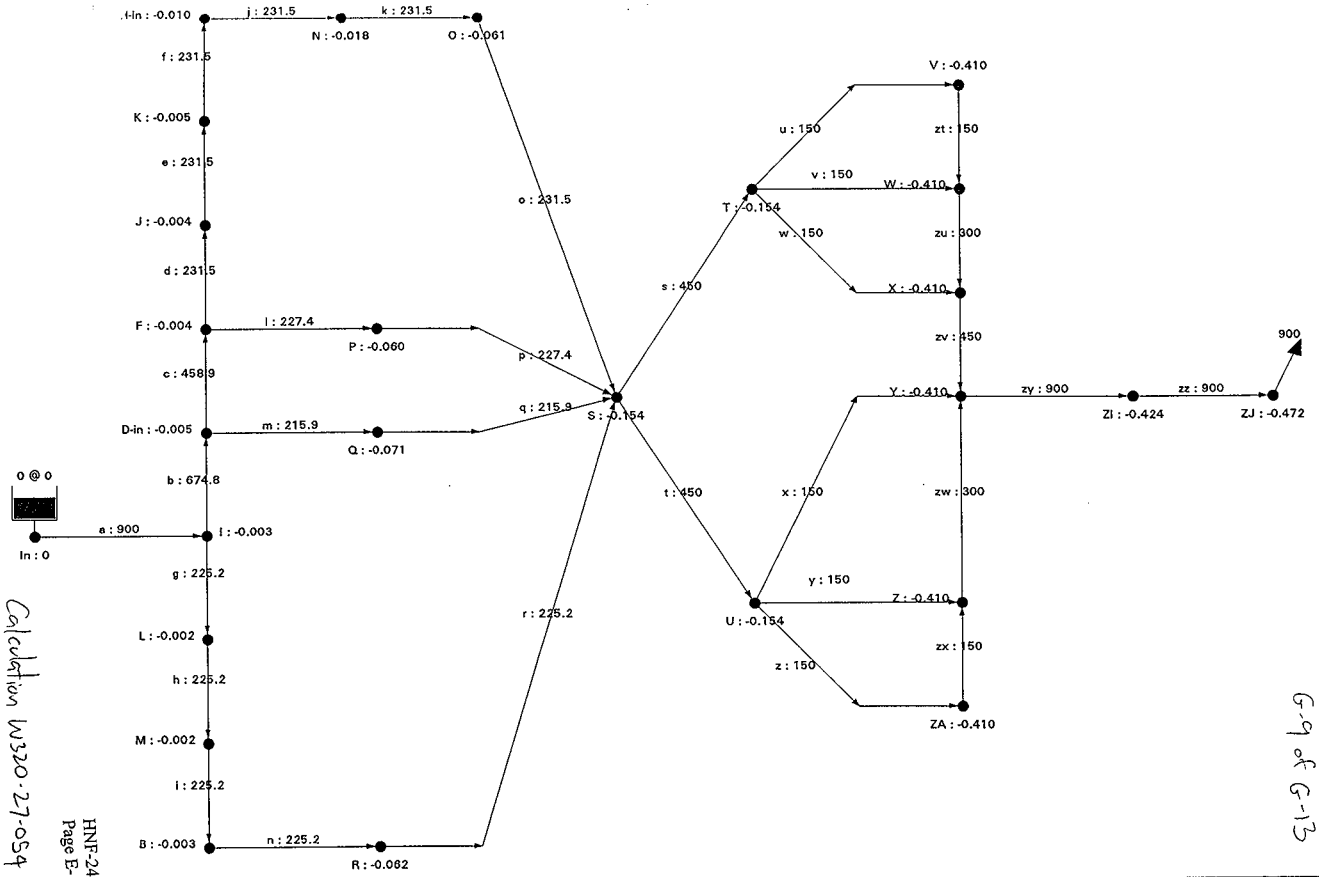
G-7 of G-13



Company:	Fluor Daniel NW	02/18/98	2:32 pm
Project:		**Linelist:**	ANNU-PEX
by:	Fluor Daniel NW	**Lineup:**	ANNU-PEX
Comments:		**flow rate:**	cfm
		pressure:	psi_g
Version:	PIPE-FLO ver 5.01	**level & grade:**	ft

Calculation W320-27-054

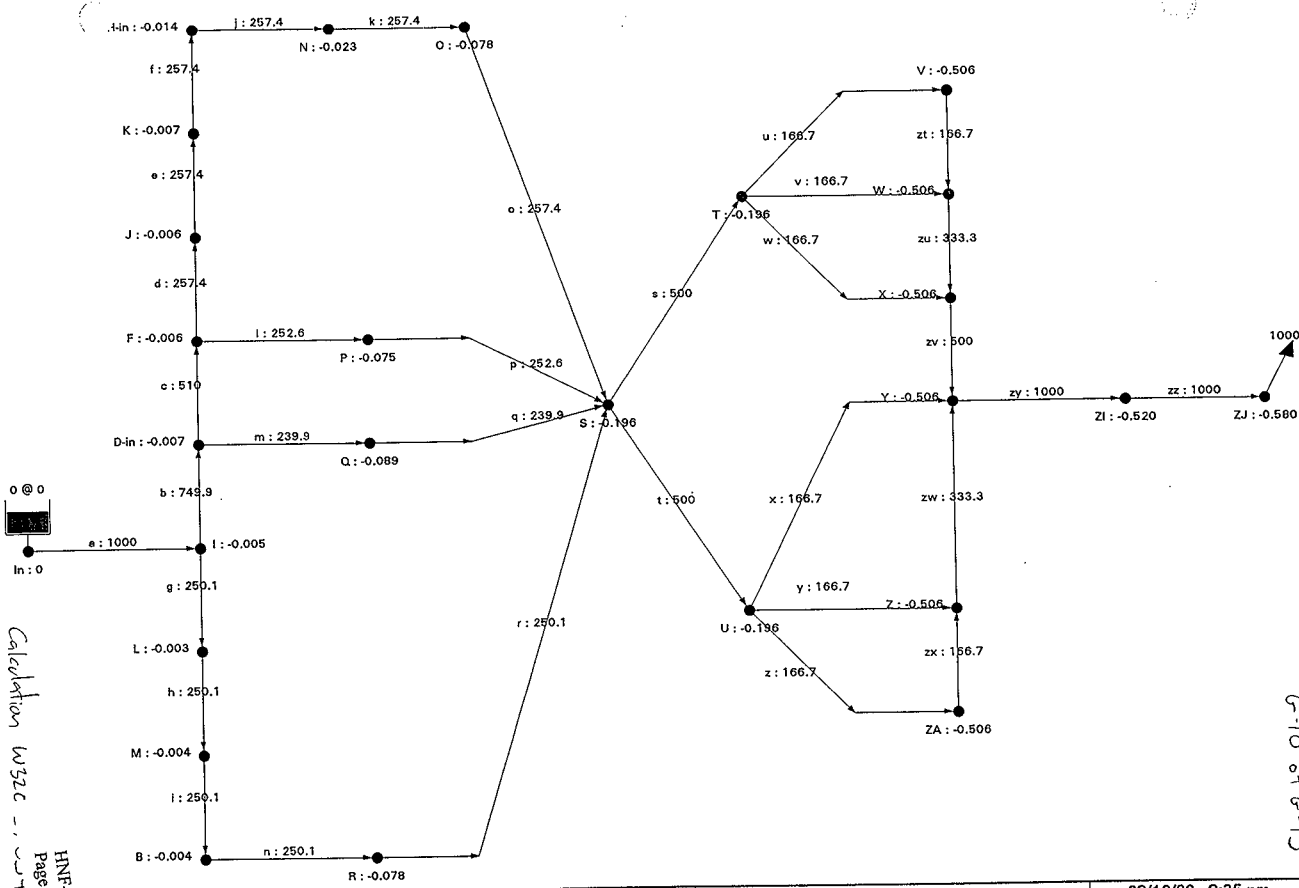
G-8 of G-13



Company:	Fluor Daniel NW	02/18/98	2:34 pm
Project:		**Linelist:**	ANNU-PEX
by:	Fluor Daniel NW	**Lineup:**	ANNU-PEX
Comments:		**flow rate:**	cfm
		pressure:	psi_g
Version:	PIPE-FLO ver 5.01	**level & grade:**	ft

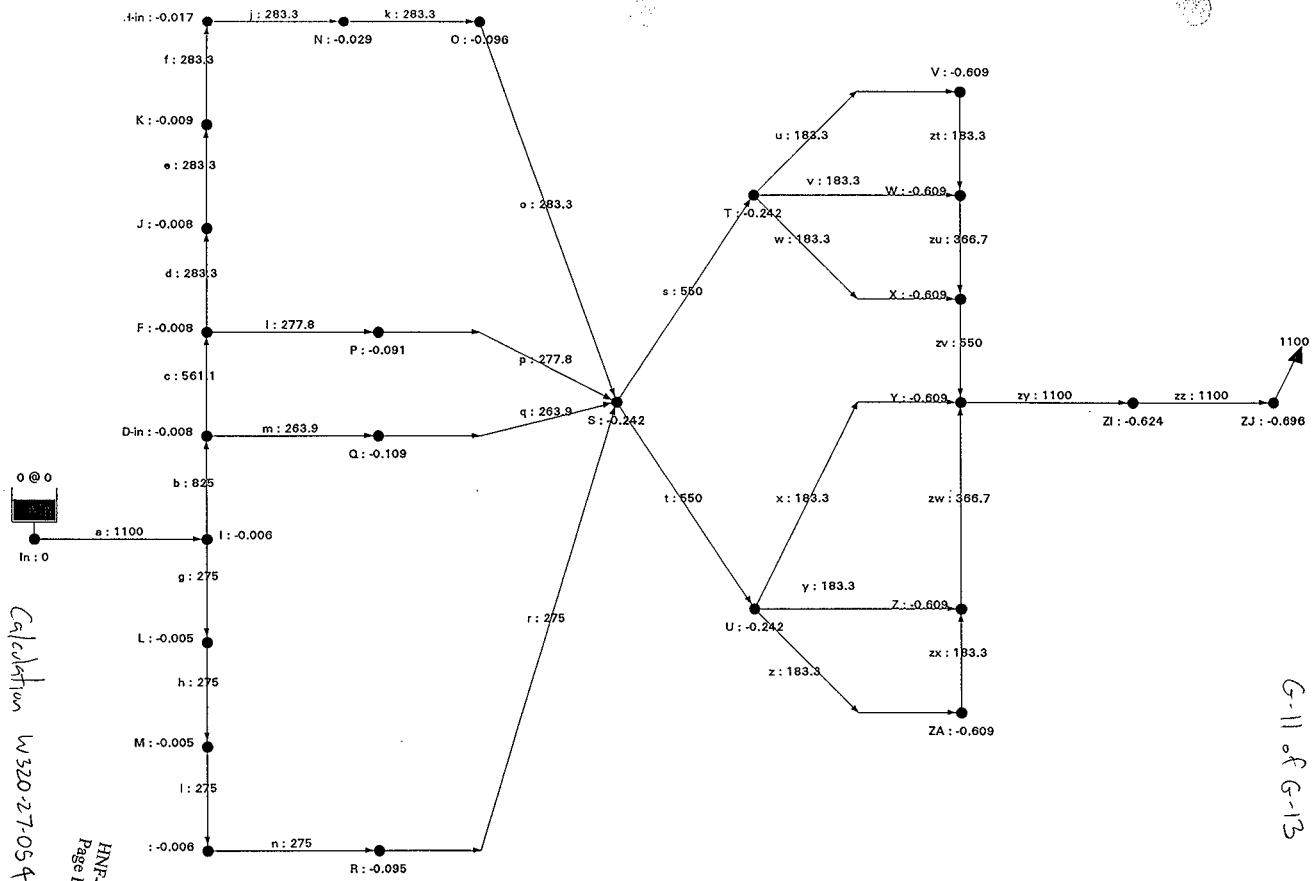
Calculation W320-27-054

G-9 of G-13



Company:	Fluor Daniel NW	02/18/98	2:35 pm
Project:		**Linelist:**	ANNU-PEX
by:	Fluor Daniel NW	**Lineup:**	ANNU-PEX
Comments:		**flow rate:**	cfm
		pressure:	psi_g
Version:	PIPE-FLO ver 5.01	**level & grade:**	ft

Calculation W32C - 001



Calculation W320-27-054

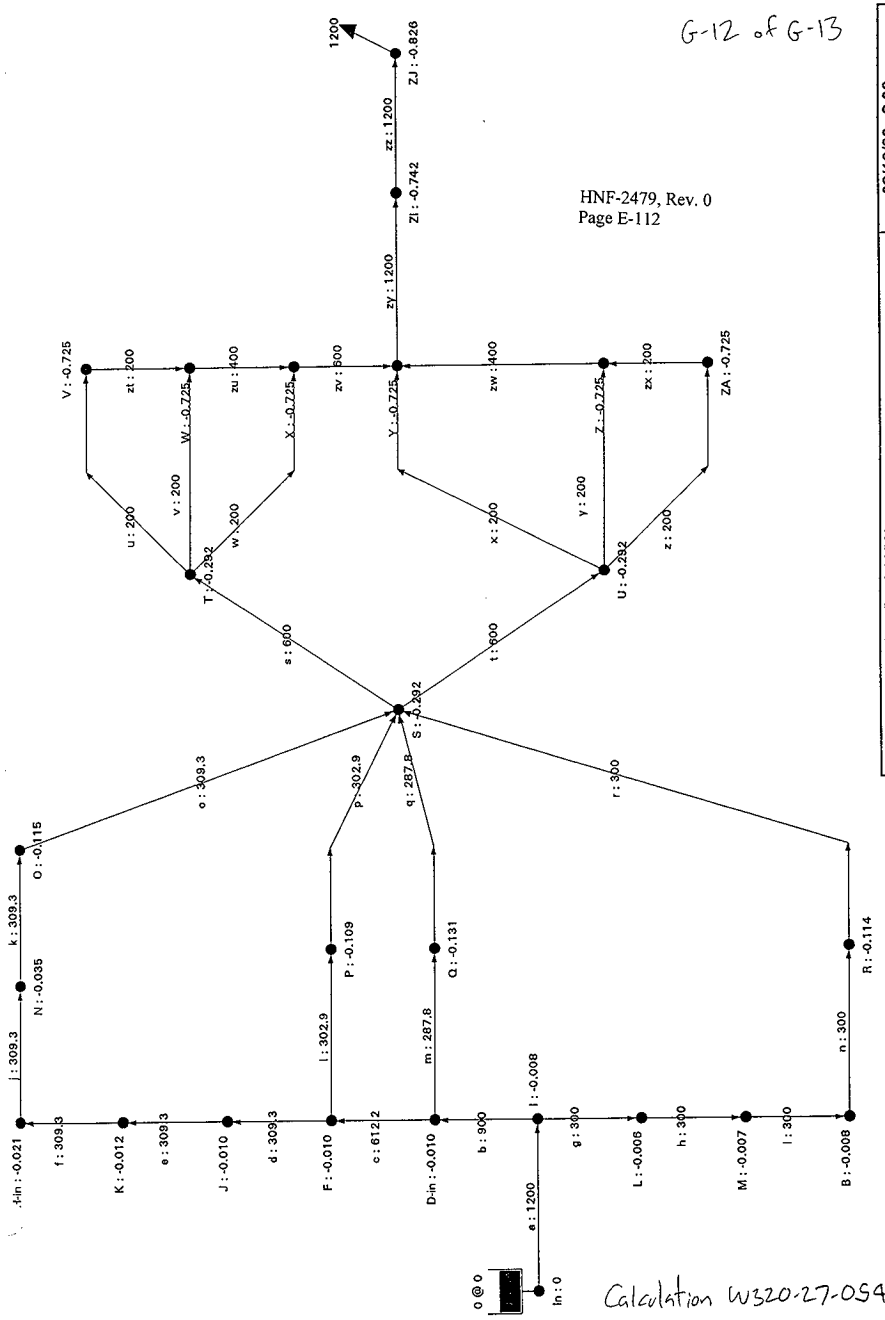
HNF-2479, Rev. 0
Page E-111

G-11 of G-13

Company:	Fluor Daniel NW	02/18/98	2:36 pm
Project:		**Linelist:**	ANNU-PEX
by:	Fluor Daniel NW	**Lineup:**	ANNU-PEX
Comments:		**flow rate:**	cfm
		pressure:	psi_g
Version:	PIPE-FLO ver 5.01	**level & grade:**	ft

G-12 of G-13

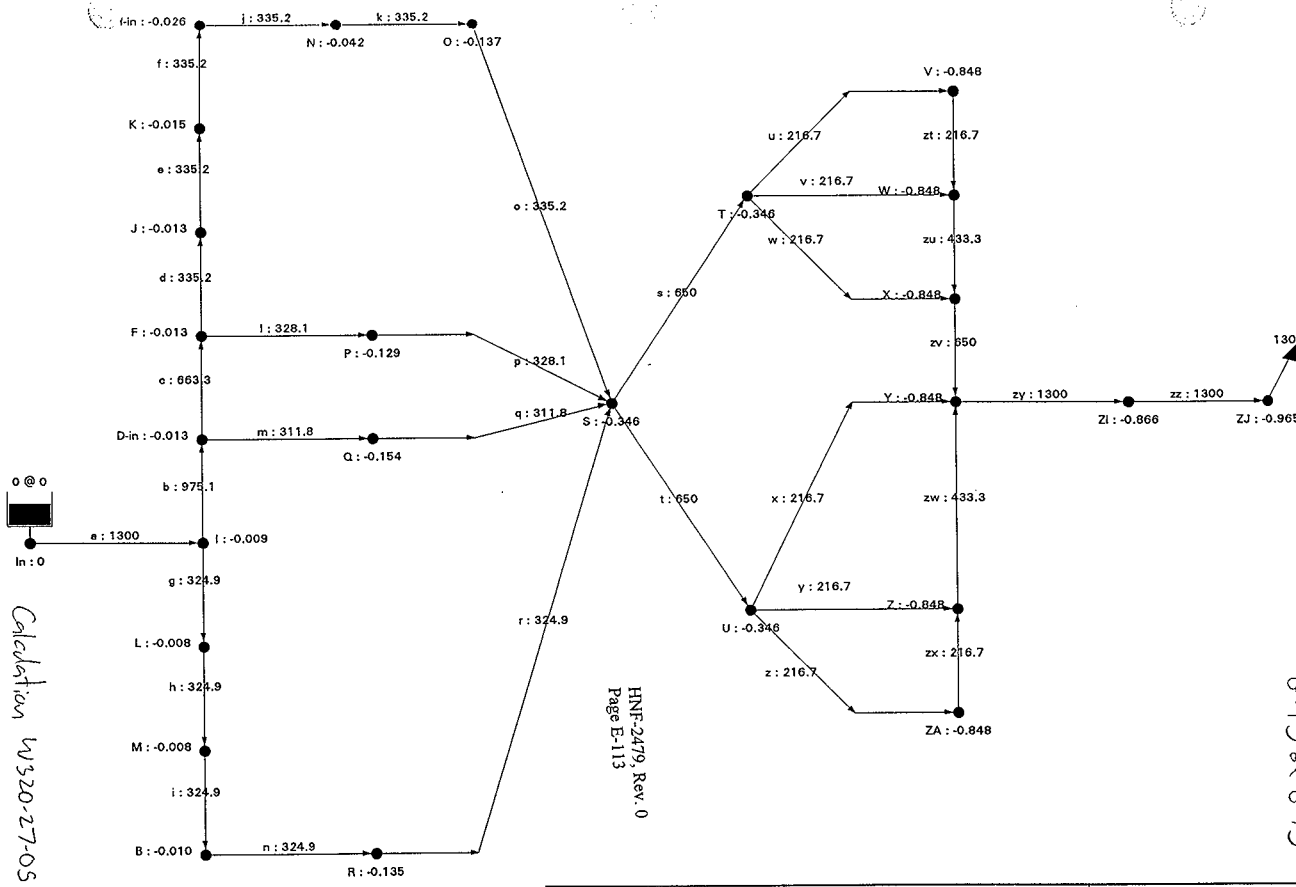
HNF-2479, Rev. 0
Page E-112



Calculation W320-27-054

Company:	Fluor Daniel NW
Project:	
by:	Fluor Daniel NW
Comments:	
Version:	PIPE-FLO ver 5.01

02/18/98	2:38 pm
Linelist:	ANNU-PEX
Lineup:	ANNU-PEX
flow rate:	cfm
pressure:	psig
level & grade:	ft



Calculation W320-27-054

HNF-2479, Rev. 0
Page E-113

G-13 of G-13

Company:	Fluor Daniel NW	02/18/98	2:40 pm
Project:		**Linelist:**	ANNU-PEX
by:	Fluor Daniel NW	**Lineup:**	ANNU-PEX
Comments:		**flow rate:**	cfm
		pressure:	psi_g
Version:	PIPE-FLO ver 5.01	**level & grade:**	ft

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-AY 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.

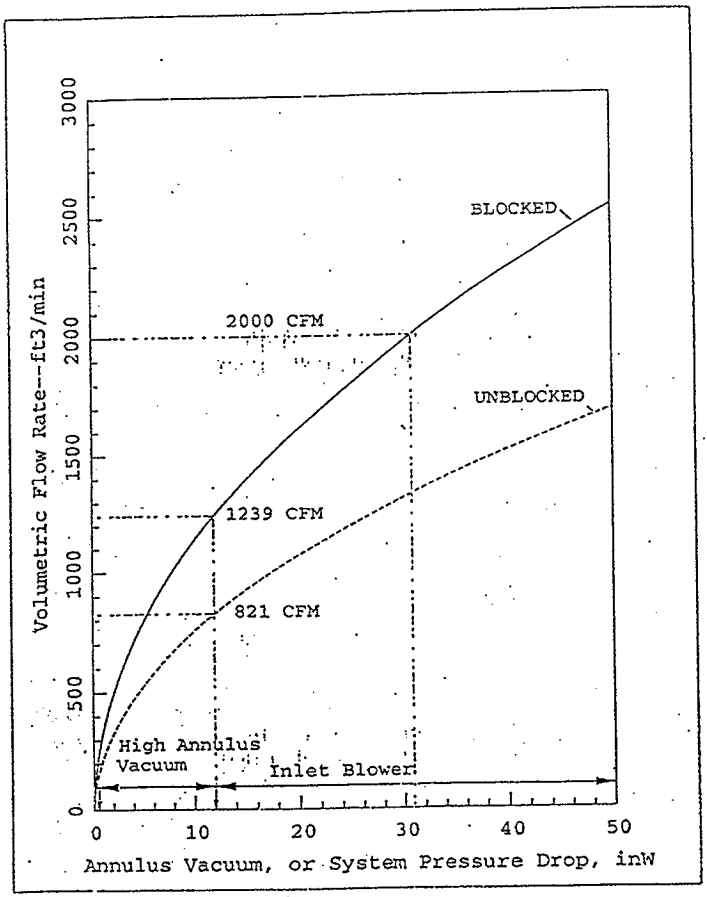
However, due to an ommision in the OTP, we were not able to operate the radial inlet damper to the fan. At this point 1000 FPM flow velocities through the annulus will not be obtainable. What we would hope to obtain by operation of the radial inlet damper would be to stabilize the flow at something less then 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

H-2 of H-2

Figure 2-11. Floor Volumetric Flow vs. Annulus Vacuum or System Pressure Drop—6-Inch Annulus Inlet Lines Blocked and Unblocked.



Calculation W320-27-054

HNF-2479, Rev. 0.
Page E-116

W320-27-055

Nozzle Plate & Encasement Plate Analysis

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:

o Preliminary Calculations

x Final Calculations

o Check Calculations (On Calculation Dated)

o Void Calculation (Reason Voided)

Incorporated in Final Drawings? x Yes o No

This calculation verified by independent "check" calculation? o Yes x 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	Danny L. Evans 7/23/98		
Checked Against Approved Vendor Data	7.23.98		

INDEX

Design Analysis Page No.	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

Subject Calculation Revision No.	Superceded 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
		Calcualtion/Document No.	Revision. No.	Calcualtion/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	Danny L. Evans 7/23/88
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	
	X	1. Does the design or design change involved meet the established criteria to be considered Safety Class?
	X	2. Does this design or design change cause or permit changes to Safety Class instrument or alarm setpoints outside of previously approved operational limits?
	X	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?
	X	4. Does this design or design change involve or change design that has previously undergone formal design verification?

L. Ahmed — Assigned Lead Engineer — 7.17.98 Date

D.R. Evans — 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	WO/Job No.	Filename: W320plts
Subject	Project W-320, Waste retrieval for Tank 241-C-106 Nozzle Plate & Encasement Plate Analysis	Date: July 17, 98	By: M. M. Ahmed
		Checked 7/10/98	By: S. Fargo
Location	200W.	Revised	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).

DESIGN ANALYSIS

Client	Numatec Hanford Inc	WO/Job No.	Filename: W320plt
Subject	Project W-320, Waste retrieval for Tank 241-C-106 Nozzle Plate & Encasement Plate Analysis	Date:July 17, 98	By: M. M. Ahmed MA
		Checked 7/19/98	By: S. Fargo SAF
Location	200W.	Revised	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:!) criteria for allowable stresses as outlined below is used to check actual plate stresses.

$S_h = S_c = 20{,}000$ psi for ASTM 240 SST plate from Appendix-A, Table-1A

DESIGN ANALYSIS

Client	Numatec Hanford Inc	WO/Job No.	Filename: W320plt
Subject	Project W-320, Waste retrieval for Tank 241-C-106 Nozzle Plate & Encasement Plate Analysis	Date: July 17, 98 Checked 7/19/98	By: M. M. Ahmed By: S. Fargo
Location	200W.	Revised	By:

Case-1: Gr + Pr + Th

Sustained Stress (Gr + Pr) =	S_L	<	S_h	Para 302.3.5©
Thermal (Displacement) Stress	S_A	<	$f(1.25\ S_c + 0.25\ S_h)$	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 psi	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.

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
Nozzl-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 Node-B12
	Total GR+P+TH	-508	798	812	530	2720	384	
	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:

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 straigth 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 Ref:3

Fa (thermal) = 120 X 23.18 = 2856 lbs

Fa (seismic) = 120 X 24.48 = 2938 lbs

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	GR+P+TH	AXIAL	VERTICA	LATERAL				
Sluice Pit								Ref:2
	Primary Pipe	378	-45	30	24	-288	36	Autopipe: TRAN-SP
AutoPipe orientation								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:

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 straigth 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 Ref:3

Fa (thermal) = 201.6 X 23.18 = 4673 lbs

Fa (seismic) = 201.6 X 24.48 = 4935 lbs

PIT WALL PIPING LOAD CONSOLIDATION SUMMARY

NOZZLE/LOCATION PIPE ORIENTATION	LOAD CASES	Fx	Fy	Fz	Mx	My	Mz	REF CALC NO
Nozzl-U9 / 241-C-06	GR+P+TH	AXIAL	VERTICA	LATERAL				
Pump Pit								Ref:2
	Primary							Autopipe:
AutoPipe Orientation	Pipe	990	156	-564	223	-1317	-437	TRAN-SL
								Node-A00
	Jumper							Ref:4
	Pipe	-212	-321	-137	-167	2	-249	AutoPipe:
								MA-C06A
	Total							Node-A00
	GR+P+TH	778	-165	-701	56	-1315	-686	
	Seismic							
	Primary							Ref:2
	Pipe	57	0	74	0	173	0	Autopipe:
								TRAN-SL
	Jumper							Ref:4
	Pipe	320	128	261	133	196	151	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 straigth 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 Ref:3

Fa (thermal) = 216 X 23.18 = 5007 lbs

Fa (seismic) = 216 X 24.48 = 5288 lbs

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 Node-A00
	Total GR+P+TH	-478	-468	242	26	-1040	71	
	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 Node-A00
	Total Seismic	90	102	205	27	206	209	

Encasement Pipe Loads:

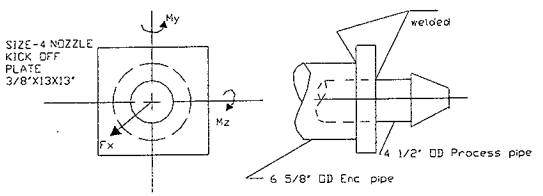
Encasemnet pipe is subjected to soil frictional force along the pipe axis when pipe translates due to thermal or seismic movements. These frictional forces are calculated by the product of the length of straigth pipe run from pitwall to first bend and the friction force per unit length obtained from 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 Ref:3

Fa (thermal) = 138 X 23.18 = 3199 lbs

Fa (seismic) = 138 X 24.48 =3378 lbs

NOZZLE KICK OFF PLATE ANALYSIS:



NOZZLE KICK OFF PLATE

$a \equiv \frac{6.625}{2} \cdot in$ $\quad a = 3.313 \cdot in$

$b \equiv \frac{4.5}{2} \cdot in$ $\quad b = 2.25 \cdot in$

$\frac{b}{a} = 0.679$

$t \equiv 0.375 \cdot in$

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.

$F_x \equiv 812 \cdot lb$

$K_{mrb} \equiv 0.147$ $\quad$ Prorating for b/a=0.68

$w \equiv \frac{F_x}{2 \cdot \pi \cdot b}$ $\quad w = 57.437 \cdot \frac{lb}{in}$ $\quad M \equiv K_{mrb} \cdot w \cdot a$ $\quad M = 27.968 \cdot lb$

$\sigma_{axial} \equiv \frac{6 \cdot M}{t^2}$ $\quad \sigma_{axial} = 1193.316 \cdot \frac{lb}{in^2}$

PRESSURE LOADING:

Table-24, Case-2f (Ref:6): Annular plate subjected to internal design pressure of 325 psi, end conditions being same as above.

$q \equiv 325 \cdot \frac{lb}{in^2}$ $\quad K_{mrb} \equiv 0.0175$ $\quad M \equiv K_{mrb} \cdot q \cdot a^2$ $\quad M = 62.407 \cdot lb$

$\sigma_{pressure} \equiv \frac{6 \cdot M}{t^2}$ $\quad \sigma_{pressure} = 2662.698 \cdot \frac{lb}{in^2}$

MOMENT LOADING:

Table-24, Case-21 (Ref:6) Central couple on a plate with a fixed edge (trunnion loading)

$M_y \equiv 2720 \cdot ft \cdot lb$ $\quad M_z \equiv 384 \cdot ft \cdot lb$

$M_r \equiv \left(M_y^2 + M_z^2\right)^{0.5}$ $\quad M_r = 32963.666 \cdot in \cdot lb$

$\beta \equiv 0.523$ $\quad \alpha \equiv 0.02$ prorating for b/a = 0.68

$\sigma_{moment} \equiv \frac{\beta \cdot M_r}{t^2 \cdot a}$ $\quad \sigma_{moment} = 37009.973 \cdot \frac{lb}{in^2}$

TOTAL PLATE STRESS DUE TO SUSTAINED & THERMAL LOADS:

$\sigma_{total} \equiv \sigma_{axial} + \sigma_{pressure} + \sigma_{moment}$

$\sigma_{total} = 40865.987 \cdot \frac{lb}{in^2}$

Allowable Stresses per ASME Code B31.3(Ref:I): $f \equiv 1$ $S_h \equiv 20000 \cdot \frac{lb}{in^2}$ $S_c \equiv 20000 \cdot \frac{lb}{in^2}$

For Sustained loads(GR+P) "SI": $S_L \equiv S_h$ Para 302.3.5(c)

For Thermal loads: $S_a \equiv f \cdot (1.25 \cdot S_c + 0.25 \cdot S_h)$ Eqn: (1a) $S_a = 30000 \cdot \frac{lb}{in^2}$

Allowable Stress for GR+P+TH loads: $S_L + S_a = 50000 \cdot \frac{lb}{in^2}$ > $\sigma_{total} = 40865.987 \cdot \frac{lb}{in^2}$

SEISMIC LOAD CASE:

Seismic loads at nozzle U-9 are critical

$F_x \equiv 377 \cdot lb$

$M_y \equiv 369 \cdot ft \cdot lb$

$M_z \equiv 151 \cdot ft \cdot lb$

$M_r \equiv (M_y^2 + M_z^2)^{0.5}$

$M_r = 4784.405 \cdot in \cdot lb$

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.

$K_{mrb} \equiv 0.147$ Prorating for b/a=0.68

$w \equiv \frac{F_x}{2 \cdot \pi \cdot b}$ $w = 26.667 \cdot \frac{lb}{in}$ $M \equiv K_{mrb} \cdot w \cdot a$ $M = 12.985 \cdot lb$

$\sigma_{axial} \equiv \frac{6 \cdot M}{t^2}$ $\sigma_{axial} = 554.04 \cdot \frac{lb}{in^2}$

MOMENT LOADING:

Table-24, Case-21 (Ref:6)

Central couple on a plate with a fixed edge (trunnion loading)

$\beta \equiv 0.523$ $\alpha \equiv 0.02$ prorating for b/a = 0.68

$\sigma_{moment} \equiv \frac{\beta \cdot M_r}{t^2 \cdot a}$ $\sigma_{moment} = 5371.693 \cdot \frac{lb}{in^2}$

Total Plate seismic stress:

$\sigma_{seismic} \equiv \sigma_{axial} + \sigma_{moment}$

$\sigma_{seismic} = 5925.733 \cdot \frac{lb}{in^2}$ < $S_{occ} \equiv 1.33 \cdot S_h$ $S_{occ} = 26600 \cdot \frac{lb}{in^2}$ Ref:1

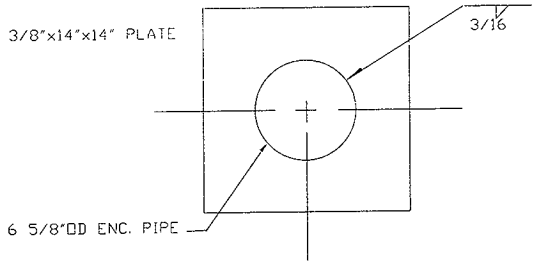
ENCASEMENT PLATE ANALYSIS:

Table-26, Case-1a: Rectangular plate simply supported on all four edges and load applied uniformly.

Critical encasement pipe load is at Nozzle-U9:

$F_{thermal} = 5007 \cdot lb$

$F_{seismic} = 5288 \cdot lb$



ENCASEMENT PIPE PLATE

$a = 14 \cdot in$ $\quad t = 0.375 \cdot in$

$b = 14 \cdot in$ $\quad \frac{a}{b} = 1$ $\quad \beta = 0.2874$

$$q_t \equiv \frac{F_{thermal}}{a \cdot b} \qquad q_t = 25.546 \cdot \frac{lb}{in^2}$$

$$q_s \equiv \frac{F_{seismic}}{a \cdot b} \qquad q_s = 26.98 \cdot \frac{lb}{in^2}$$

Thermal Stress:

$$\sigma_t \equiv \frac{\beta \cdot q_t \cdot b^2}{t^2}$$

$$\sigma_t = 10232.973 \cdot \frac{lb}{in^2} \quad < \quad S_a = 30000 \cdot \frac{lb}{in^2}$$

Seismic Stress:

$$\sigma_s \equiv \frac{\beta \cdot q_s \cdot b^2}{t^2}$$

$$\sigma_s = 10807.262 \cdot \frac{lb}{in^2} \quad < \quad S_{occ} = 26600 \cdot \frac{lb}{in^2}$$

Calc : W320-27-055

APPENDIX - A

SUPPORT FORCES

Point/ Supp. ID	Connect/ Type	Load Combination	LOCAL Dirn	LOCAL Force	LOCAL Deform	GLOBAL Dirn	GLOBAL Force	GLOBAL Deform
						Z		-0.096
		RESP	back		0.000	X		0.000
						Y		0.000
						Z		0.000
		TOTAL	back	79	0.000	X		0.240
						Y	79	0.000
						Z		0.096

RESTRAINT. REACTIONS

Point name	Load combination	FORCES (lb) X	Y	Z	Result	MOMENTS (ft-lb) X	Y	Z	Result
A00	Anchor								
	GR	0	-45	0	45	24	0	36	43
	T1	372	0	27	373	0	-294	0	294
NOZ-6	P1	6	0	3	7	0	6	0	6
	SUM	378	-45	30	382	24	-288	36	291
C-06C	RESP	264	0	207	336	0	452	0	452
Sluice Pit	TOTAL	642	45	237	686	24	740	36	741
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

REF # 2

RESTRAINT REACTIONS

Point name	Load combination	FORCES (lb) X	Y	Z	Result	MOMENTS (ft-lb) X	Y	Z	Result
A166	Inclined								
	GR	0	-79	0	79	0	0	0	0
	T1	0	0	0	0	0	0	0	0
	P1	0	0	0	0	0	0	0	0
	SUM	0	-79	0	79	0	0	0	0
	RESP	0	0	0	0	0	0	0	0
	TOTAL	0	79	0	79	0	0	0	0
A167	Anchor								
	GR	0	-67	0	67	-81	0	-3	81
	T1	-622	0	946	1132	0	2738	0	2738
NOZ-U2	P1	-11	0	19	21	0	45	0	45
	SUM	-633	-67	964	1156	-81	2783	-3	2784
AY-02E	RESP	0	0	0	0	0	0	0	0
	TOTAL	633	67	964	1156	81	2783	3	2784

SLUICE PIT

ASME B31.3c (1992) CODE COMPLIANCE

Point name	Load combination	(Moments in ft-lb) In-Pl. Moment	Out-Pl. Moment	Torsion Moment	S.I.F In	S.I.F Out	Eq. no.	(Stress in psi) Load type	Code Stress	Code Allow.
*** Segment A begin ***										
A00	Max P						(3a)	HOOP	4844	16700
	GR + Max P	36	6		1.00	1.00	(18)	SUST	2238	16700
	Cold to T1	0	294	0	1.00	1.00	(17)	DISP	1098	25050
	SRSS	0	326		1.00	1.00	(18)	OCC	1565	22211
A01	Max P						(3a)	HOOP	4844	16700
	GR + Max P	123	13		1.00	1.00	(18)	SUST	2655	16700
	Cold to T1	0	472	0	1.00	1.00	(17)	DISP	1764	25050
	SRSS	0	663		1.00	1.00	(18)	OCC	3183	22211
A02	Max P						(3a)	HOOP	4844	16700
	GR + Max P	18	13		1.00	1.00	(18)	SUST	2169	16700
	Cold to T1	0	880	0	1.00	1.00	(17)	DISP	3285	25050
	SRSS	0	519		1.00	1.00	(18)	OCC	2491	22211
A03 N-	Max P						(3a)	HOOP	4844	16700
	GR + Max P	18	13		1.00	1.00	(18)	SUST	2169	16700
	Cold to T1	0	899	0	1.00	1.00	(17)	DISP	3355	25050
	SRSS	0	533		1.00	1.00	(18)	OCC	2556	22211
A03 N+	Max P						(3a)	HOOP	4844	16700
	GR + Max P	13	18		1.00	1.00	(18)	SUST	2169	16700
	Cold to T1	899	0	0	1.00	1.00	(17)	DISP	3355	25050
	SRSS	533	0		1.00	1.00	(18)	OCC	2556	22211
A03 M	Max P						(3a)	HOOP	4844	16700
	GR + Max P	15	37		1.00	1.00	(18)	SUST	2256	16700
	Cold to T1	1003	0	0	1.00	1.00	(17)	DISP	3746	25050
	SRSS	625	0		1.00	1.00	(18)	OCC	3001	22211
A03 F-	Max P						(3a)	HOOP	4844	16700
	GR + Max P	14	81		1.00	1.00	(18)	SUST	2457	16700
	Cold to T1	904	0	0	1.00	1.00	(17)	DISP	3373	25050
	SRSS	599	0		1.00	1.00	(18)	OCC	2876	22211
A03 F+	Max P						(3a)	HOOP	4844	16700
	GR + Max P	81	14		1.00	1.00	(18)	SUST	2457	16700
	Cold to T1	0	904	0	1.00	1.00	(17)	DISP	3373	25050
	SRSS	0	599		1.00	1.00	(18)	OCC	2876	22211

RESTRAINT REACTIONS

Point name	Load combination	FORCES (lb) X	Y	Z	Result	MOMENTS (ft-lb) X	Y	Z	Result
A00	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

C-106A PUMP PIT NOZ-119

HNF-2479, Rev. 0
Page F-20

RESTRAINT REACTIONS

Point name	Load combination	FORCES (lb) X	Y	Z	Result	MOMENTS (ft-lb) X	Y	Z	Result
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

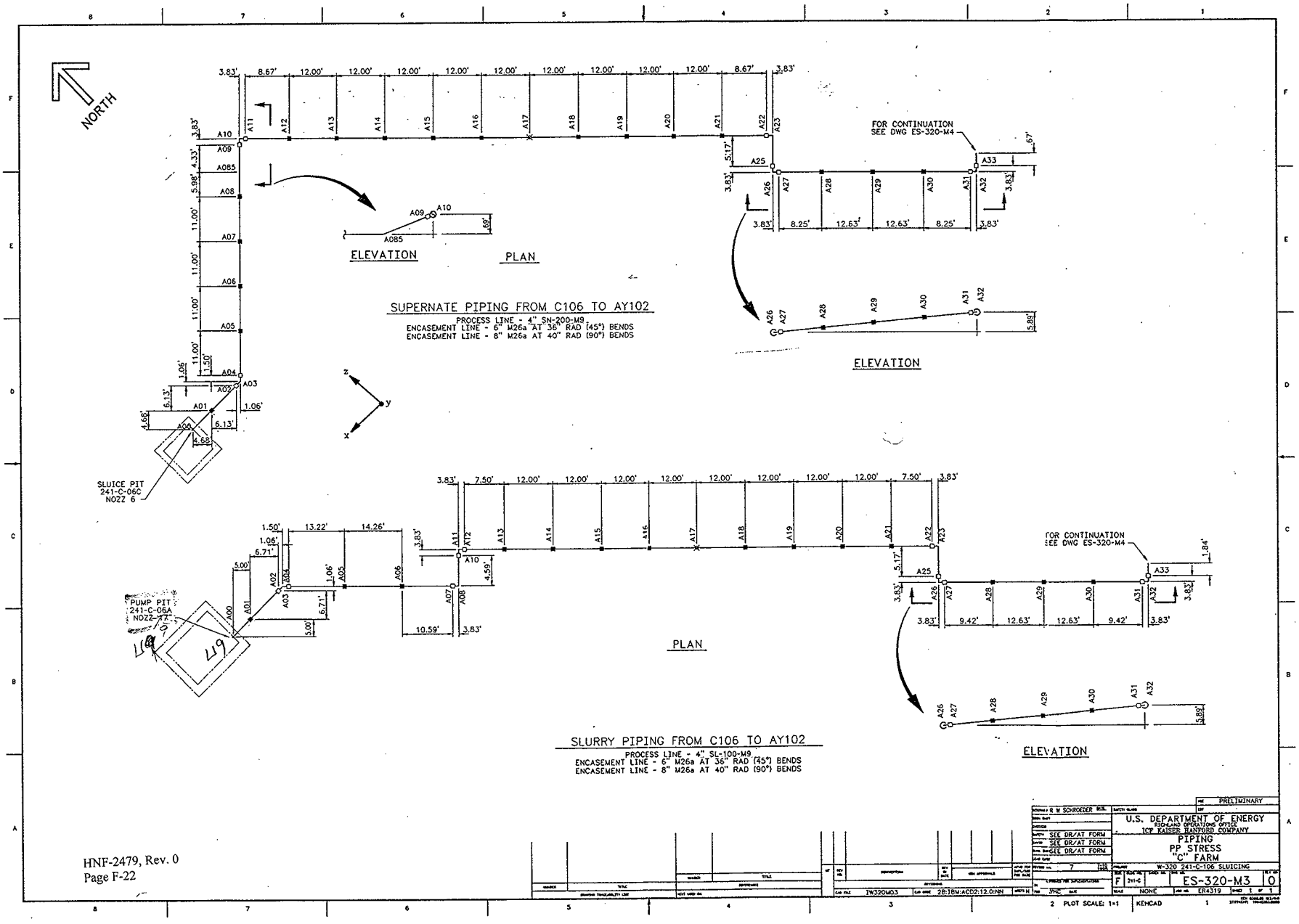
RESTRAINT REACTIONS

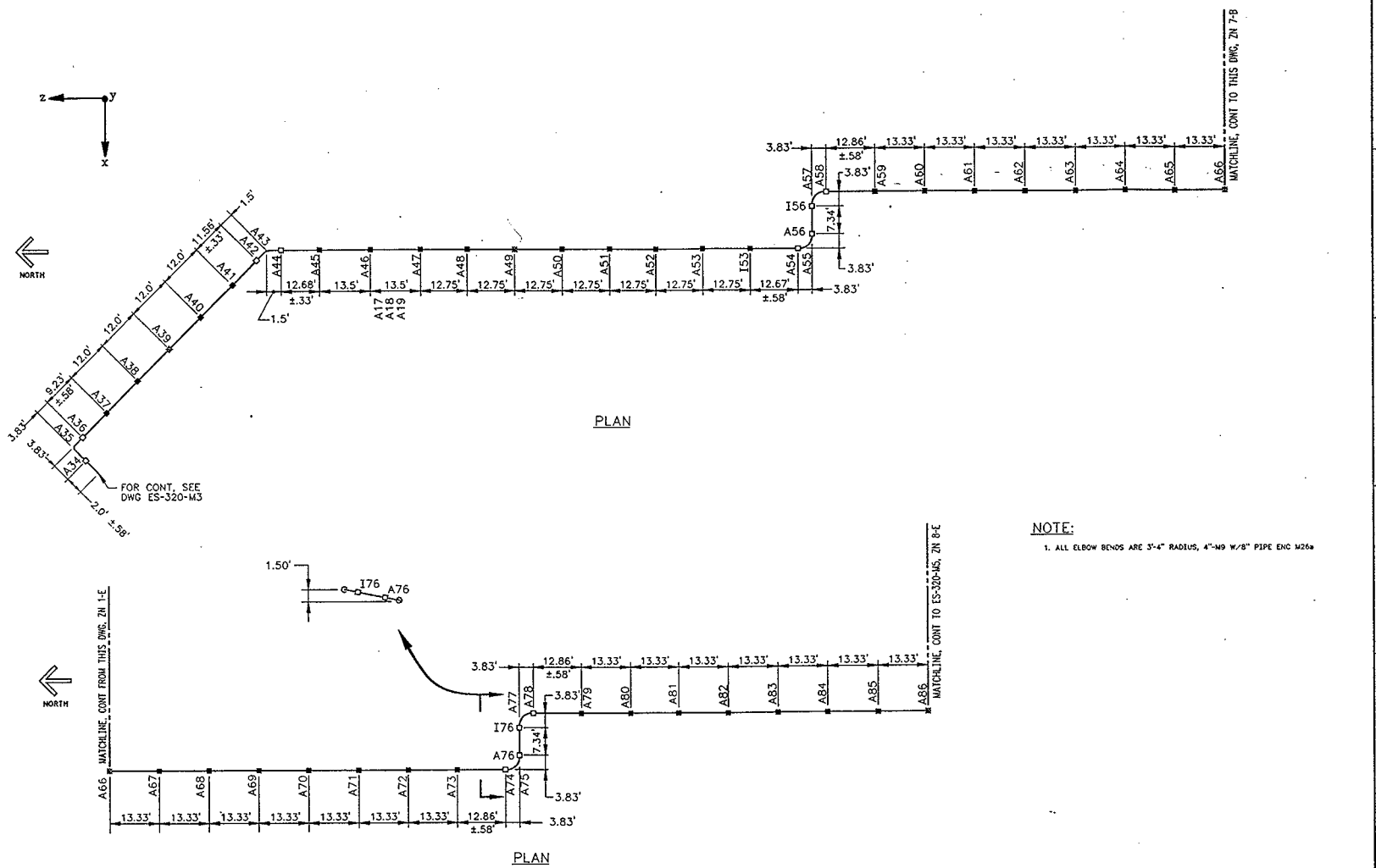
Point name	Load combination	FORCES (lb) X	Y	Z	Result	MOMENTS (ft-lb) X	Y	Z	Result
A164	Guide								
	GR	0	-197	0	197	0	0	0	0
	T1	0	0	-407	407	0	0	0	0
	P1	0	0	-6	6	0	0	0	0
	SUM	0	-197	-412	457	0	0	0	0
	RESP	0	0	0	0	0	0	0	0
	TOTAL	0	197	412	457	0	0	0	0
A165	Inclined								
	GR	0	-143	0	143	0	0	0	0
	T1	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
A168	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
	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
A170	Inclined								
	GR	0	-109	0	109	0	0	0	0
	T1	0	0	0	0	0	0	0	0
	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
A171	Anchor								
	GR	0	-78	0	78	-9	0	-112	112
	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

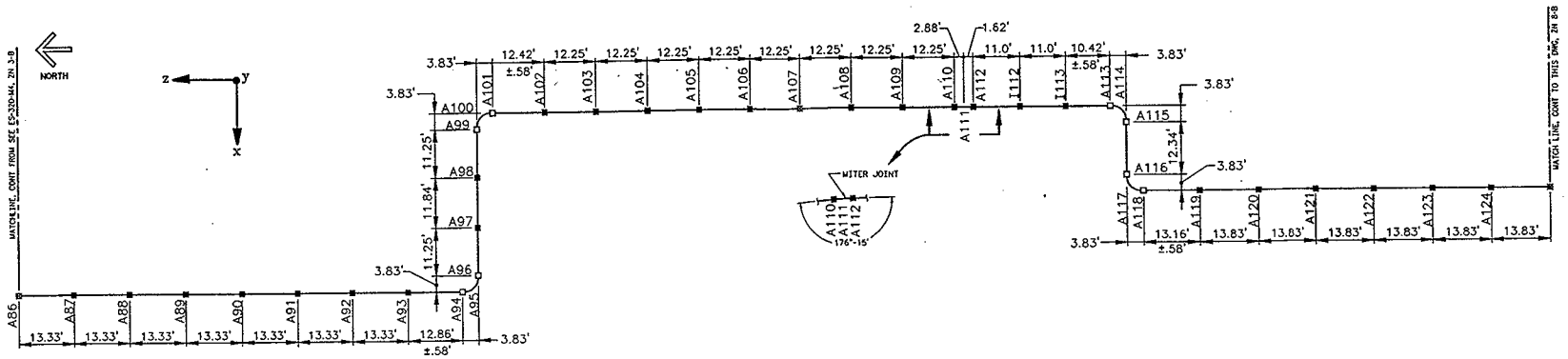
PUMPIT
241-AY-02A

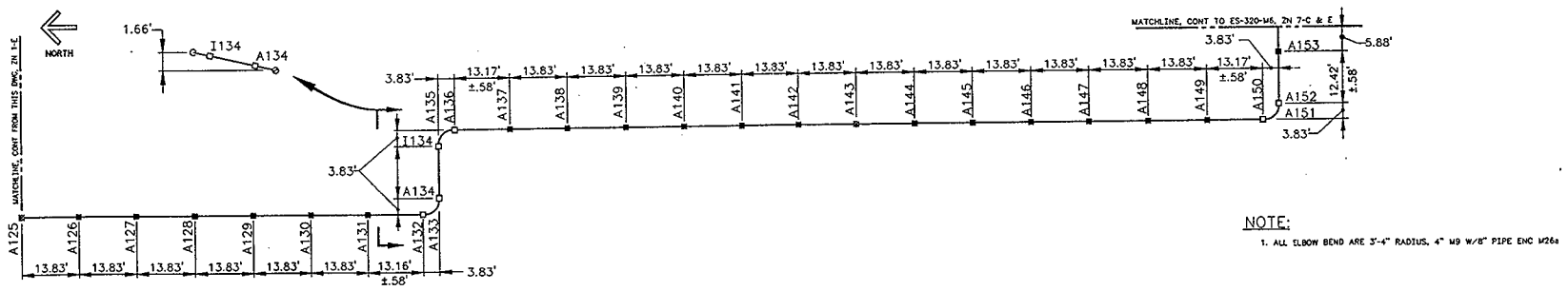
ASME B31.3c (1992) CODE COMPLIANCE

Point name	Load combination	(Moments in ft-lb) In-Pl. Moment	Out-Pl. Moment	Torsion Moment	S.I.F In	S.I.F Out	Eq. no.	(Stress in psi) Load type	Code Stress	Code Allow.
*** 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	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	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	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	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	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	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	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	1.00	(17)	DISP	9369	25050
	SRSS	0	284		1.00	1.00	(18)	OCC	1364	22211


NORTH
FOR CONTINUATION SEE DWG ES-320-M4
ELEVATION
PLAN
SUPERNATE PIPING FROM C106 TO AY102
PROCESS LINE - 4" SN-200-M9
ENCASEMENT LINE - 6" M26a AT 36" RAD (45°) BENDS
ENCASEMENT LINE - 8" M26a AT 40" RAD (90°) BENDS
SLUICE PIT 241-C-06C NOZZ 6
PUMP PIT 241-C-06A NOZZ 17
SLURRY PIPING FROM C106 TO AY102
PROCESS LINE - 4" SL-100-M9
ENCASEMENT LINE - 6" M26a AT 36" RAD (45°) BENDS
ENCASEMENT LINE - 8" M26a AT 40" RAD (90°) BENDS
PRELIMINARY
U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
ICF KAISER HANFORD COMPANY
PIPING
PP STRESS
"C" FARM
W-320 241-C-106 SLUICING
ES-320-M3
0
NONE
ER4319
PLOT SCALE: 1=1
KEHCAD


NORTH
PLAN
FOR CONT, SEE DWG ES-320-M3
MATCHLINE, CONT TO THIS DWG, ZN 7-B
MATCHLINE, CONT FROM THIS DWG, ZN 1-E
MATCHLINE, CONT TO ES-320-M5, ZN 8-E
NOTE:
1. ALL ELBOW BENDS ARE 3'-4" RADIUS, 4"-M9 W/8" PIPE ENC M26a
U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
TCP KAISER HANFORD COMPANY
PIPING
TRANSFER LINE PLAN
W-320 TANK 241-C-106 SLUICING
ES-320-M4
PRELIMINARY
PLOT SCALE: 1=10
KENCAD





NOTE:

1. ALL ELBOW BEND ARE 3'-4" RADIUS, 4" M9 W/8" PIPE ENC M26a

U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
FOR KAISER HANFORD COMPANY

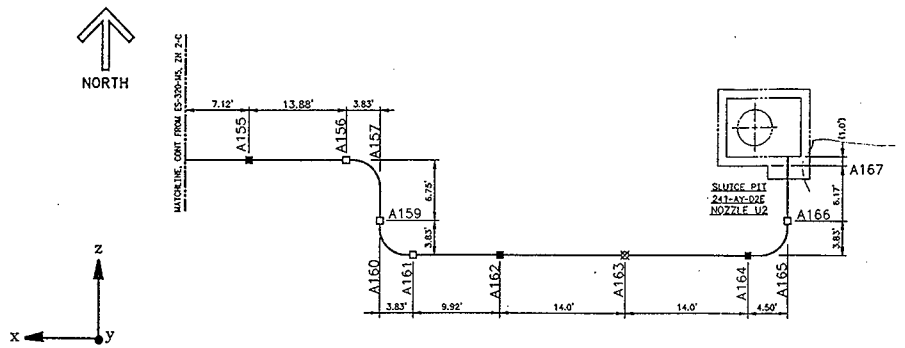
PIPING
TRANSFER LINE PLAN

W-320 TANK 241-C-106 SLUICING

ES-320-M5

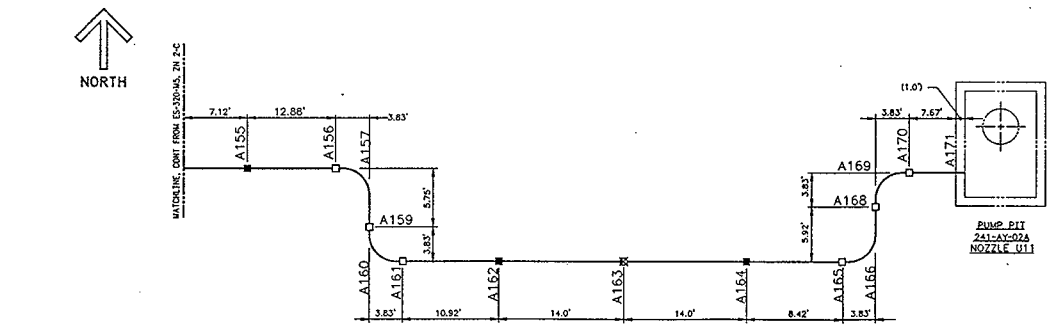
PRELIMINARY

PLOT SCALE: 1=10 KEMCAD



PLAN

SUPERNATE PIPING FROM C106 TO AY102



PLAN

SLURRY PIPING FROM C106 TO AY102

NOTE:

1. ALL ELBOW BENDS ARE 3'-4" RADIUS, 4" M9 W/8" PIPE ENC M26a.

PRELIMINARY	
U.S. DEPARTMENT OF ENERGY RICHLAND OPERATIONS OFFICE ICP KAISER HANFORD COMPANY	
PIPING PLAN TANK 241-AY-102	
W320, TANK 241-C-106 SLUICING	
F 241-AY	ES-320-M6 0
1"= 5'-0"	ER4319
1W320M06	2B:TBM:ACD2:12.0:NN
PLOT SCALE: 1=5	KENCAD

ICF KAISER
HANFORD COMPANY

Calc No. W320-27-029
Revision No. 03
Page No. 10 of 10

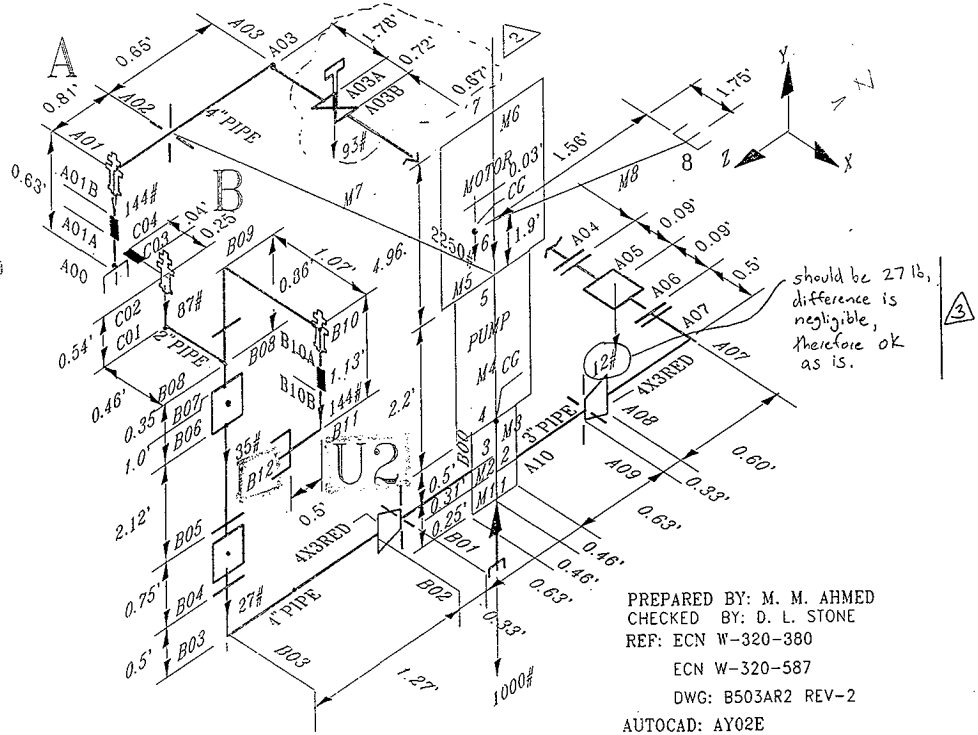
DESIGN ANALYSIS

Client	WESTINGHOUSE HANFORD COMPANY	WO/Job No. ER4319	Filename: AY02E.WP
Subject	AY FARM- JUMPER STRESS ANALYSIS	Date 8/31/95	By: M. M. Ahmed
	PROJECT W-320 WASTE RETRIEVAL FOR TANK C-106	Checked 9/11/95	By: M. K. Pal
Location	C TANK FARM - 200W.	Revised	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



should be 27 lb, difference is negligible, therefore ok as is.

PREPARED BY: M. M. AHMED
CHECKED BY: D. L. STONE
REF: ECN W-320-380
ECN W-320-587
DWG: B503AR2 REV-2
AUTOCAD: AY02E
AUTOPIPE: AY02E-R2

Valve at A03A should be closer to A04, however, the overall length between A03 & A07 is correct, therefore ok as is.

REF #5

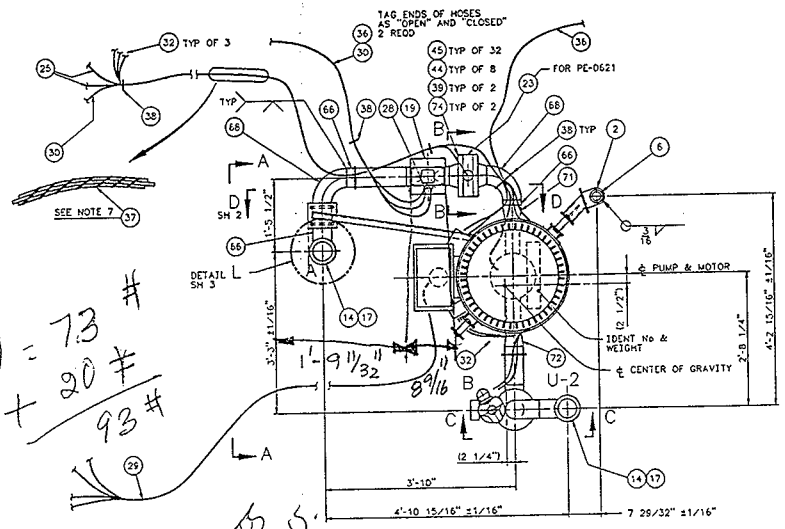
SUPPORT FORCES

Point/ Supp. ID	Connect/ Type	Load Combination	LOCAL Dirn	LOCAL Force	LOCAL Deform	GLOBAL Dirn	GLOBAL Force	GLOBAL Deform
		GR+T1	down	3379	0.000	X		-0.020
			rght		0.020	Y	-3379	0.000
						Z		-0.005
		RESPONSE	down	714	0.000	X	284	0.000
			left	284	0.000	Y	714	0.000
						Z		0.011
		TOTAL	down	4093	0.000	X	284	0.020
			left	284	0.020	Y	4093	0.000
						Z		0.016
1		GR	down	3248	0.000	X		-0.001
1 1	Y - Stop					Y	-3248	0.000
Stiff	:RIGID					Z		-0.001
		T1	up	2031	0.000	X		0.005
						Y	2031	0.000
						Z		-0.018
		GR+T1	down	1217	0.000	X		0.005
						Y	-1217	0.000
						Z		-0.019
		RESPONSE	down	1161	0.000	X		0.001
						Y	1161	0.000
						Z		0.012
		TOTAL	down	2378	0.000	X		0.005
						Y	2378	0.000
						Z		0.031

RESTRAINT REACTIONS

Point name	Load combination	FORCES (lb) X	Y	Z	Result	MOMENTS (ft-lb) X	Y	Z	Result
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	388	-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

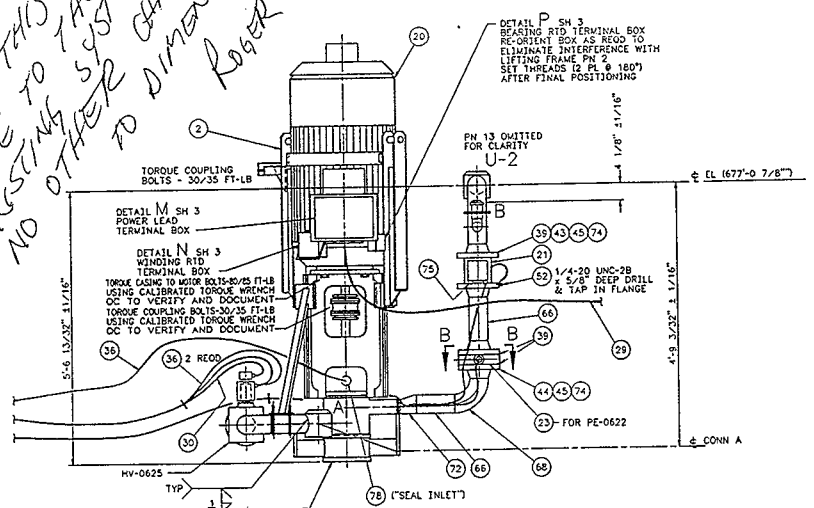
U-2



PLAN

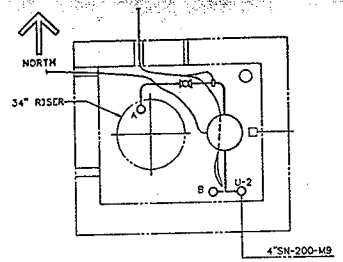
W = 73 #
+ 20 #
93 #

NO, I ADDED THIS VALVE TO THE EXISTING SYSTEM NO OTHER CHANGES TO DIMENSIONS. ROGER

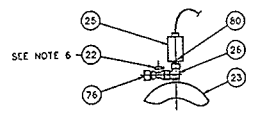


VIEW A-A

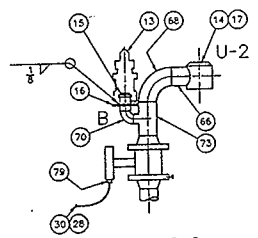
1 ASSEMBLY
SCALE: 1"= 1'-0"



241-AY-02E
SLUICE PIT
KEY PLAN
SCALE: NONE



SECTION B-B
SCALE: NONE



VIEW C-C
SCALE: NONE

ECN: W-320-587

QUANTITY REQUIRED			PART/DASH NUMBER	NOMENCLATURE/DESCRIPTION	MATERIAL/REFERENCE	SHEET	ITEM NO.
		X	-010	ASSEMBLY			1
	X	1	-020	LIFTING FRAME SUB-ASSY		2	2
X		1	-030	PUMP BASE SUB-ASSY		2	3
							4
	1		-001	PLATE, 3/8" THK	ASTM A 36	3	5
		1	-002	PLATE, 3/8" THK	ASTM A 36	3	6
	1		-003	PLATE, 3/8" THK	ASTM A 36	3	7
	4		-004	PLATE, 3/8" THK	ASTM A 36	3	8
1			-005	PLATE, 1" THK	ASTM A 240 304L	3	9
1			-006	PLATE, 1" THK x 11 5/8" DIA	ASTM A 240 304L		10
							11
							12
		1	H-2-818509-1	JUMPER FLUSH BLANK HEAD			13
		2	H-2-32440-2	CONN, VERT, 4"			14
		1	H-2-90185-2	NOZZLE, MALE, 2"			15
		1	H-2-3194-6	KICKOFF PLATE, 2" ROUND			16
		2	H-2-3997-8	GASKET 4" TYPE III			17
							18
		1	HV-0625 SEE NOTE 10	BALL VALVE 4" -2 WAY	PBM INC		19
		1	P-0622	PUMP, IN-LINE 3" INLET & 3" OUTLET	PROCUREMENT SPEC W-320-P17		20
		1	FE-0621	FLOWMETER, 4"	CONSTRUCTION SPEC W-320-C7		21
		2	SS-43M4	BALL VALVE 1/4"	WHITEY		22
		2	PE-0621 & PE-0622 SEE NOTE 5 & 6	PRESSURE SENSOR, 4"	RED VALVE CO, INC.		23
		1	RB350-250	CONDUIT RED BUSHING, 3 1/2" x 2 1/2"	APPLETON ELECTRIC		24
		2	PE-0621 & PE-0622 SEE NOTE 5	PRESSURE TRANSDUCER, (PE) 1/4" NPT	CONSTR SPEC W-320-C7		25
		2	SS-4-ST	STREET TEE, 1/4" NPT	CAJON		26
		1	CGFP7917	CORD CONNECTOR, 2 1/2"	CROUSE-HINDS		27
		2	CGB196-SG	CGB FITTING, 1/2" NPT, x .625/.750 DIA	CROUSE-HINDS		28
		1	XHHW P62-0504	CABLE, 3C-500 KCM W/ GROUND, RATED FOR 90°C x 30' L	ROCKBESTOS FIREWALL III		29
		2	I46-5700	CABLE, 2 TW SH PR #16 AWG W/ OVERALL SHIELD PR x 25' L	ROCKBESTOS		30
					ROCKBESTOS		31
		3	I46-0031	CABLE, 3C #16 AWG W/ OVERALL SHIELD x 25' L	ROCKBESTOS		32
		3	CGB293	CGB FITTING, 3/4" NPT x .250/.375 DIA	CROUSE-HINDS		33
		1	RB75-50	REDUCING BUSHING, 3/4" x 1/2"	APPLETON		34
							35
		3	Y1GT0404MC04MC-300	HOSE ASSY 1/4" ID FLEX x 25' L	IMPERIAL EASTMAN		36

(CONT ON SHEET 2)

NOTES:

1. FABRICATION AND TESTING SHALL BE IN ACCORDANCE WITH HANFORD SPECIFICATION HS-BS-0064, REV B.
2. HYDROSTATIC TEST AT 480 PSIG.
3. JUMPER WEIGHT IS 4170 LB APPROX.
4. ROUTE CABLES APPROXIMATELY AS SHOWN AND SECURE TO SUPPORT STEEL W/PN 38. AVOID IMPACT WRENCH AND LIFTING BAIL AREAS.
5. PRESSURE SENSOR (PN 23) SHALL BE SERIES 40, FOR CLASS 300 FLANGES 316 SST, EPDM SLEEVES WITH 1/4" NPT PRESSURE TAP. FURNISH WITH 100 ML OF SILICONE OIL IN SEPARATE CONTAINER.
6. SEE CONSTRUCTION SPEC W-320-C7, SECTION 13440 FOR FILLING INSTRUCTION AFTER ASSEMBLY. AFTER FILLING, REMOVE HANDLE FROM BALL VALVE (PN 22).
7. TIE EACH END OF TEFLON SPIRAL WRAPPING (PN 37) WITH NYLON CABLE TIES (PN 38).
8. TRIM CABLES FURNISHED WITH PN 25 TO 25' LONG PRIOR TO INSTALLATION.
9. USE (1) COAT OF AMERLOCK 400 IN PLACE OF AMERCOAT 187 PRIMER AND AMERCOAT 33, WHERE REQUIRED BY JUMPER FABRICATION SPECIFICATION.
10. VALVE SHALL BE 4"-2 WAY PBM SP SERIES, 4" SCHED 40 BW END FITTINGS, SST, #4" SP-H-40SW-2/59 W/MODEL DDA-50-84 PNEUMATIC ACTUATORS, 90° ROTATION AND A DAL-50 SERIES VALVE POSITION INDICATORS, 2-POSITION "OPEN & CLOSED", IN AN EXPLOSION PROOF HOUSING (NEMA 7). ASSEMBLED AS (1) UNIT OR AN APPROVED SUBSTITUE.

REV	DESCRIPTION	REV BY DATE	REA APPROVALS	APVD FOR FAB DATE
2	REV TO INCORP ECN W-320-587			
1	W-320-439,-414 & -380 REV TO INCORP ECNS			

REVISIONS

USE	CONSTRUCTION
DWG	606537
SHEET	3
DESIGNED Ea MEYER sr	
DRWN CHKD C D JONES	
CHECKED ROGER SCHOENIG	
SUPTN SEE DR/AT FORM	
SHOP SEE DR/AT FORM	
QUAL CHKD SEE DR/AT FORM	
LEAD CHKD C D JONES	
KEYED NO. 19	
PROJECT	W-320 TANK 241-C-106 SLUICING
SIZE F	SCALE 241-AY 8405
DWG NO.	B503AR2
REV NO.	2
SCALE	SHOWN
CAD NO.	EP4319
SHEET	1 OF 3

U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
ICF KAISER HANFORD COMPANY

JUMPER ASSEMBLY
SLUICE PIT
AY-02E-U2-A-(B)

THOMAS H MAY
W-HC 5-22-95

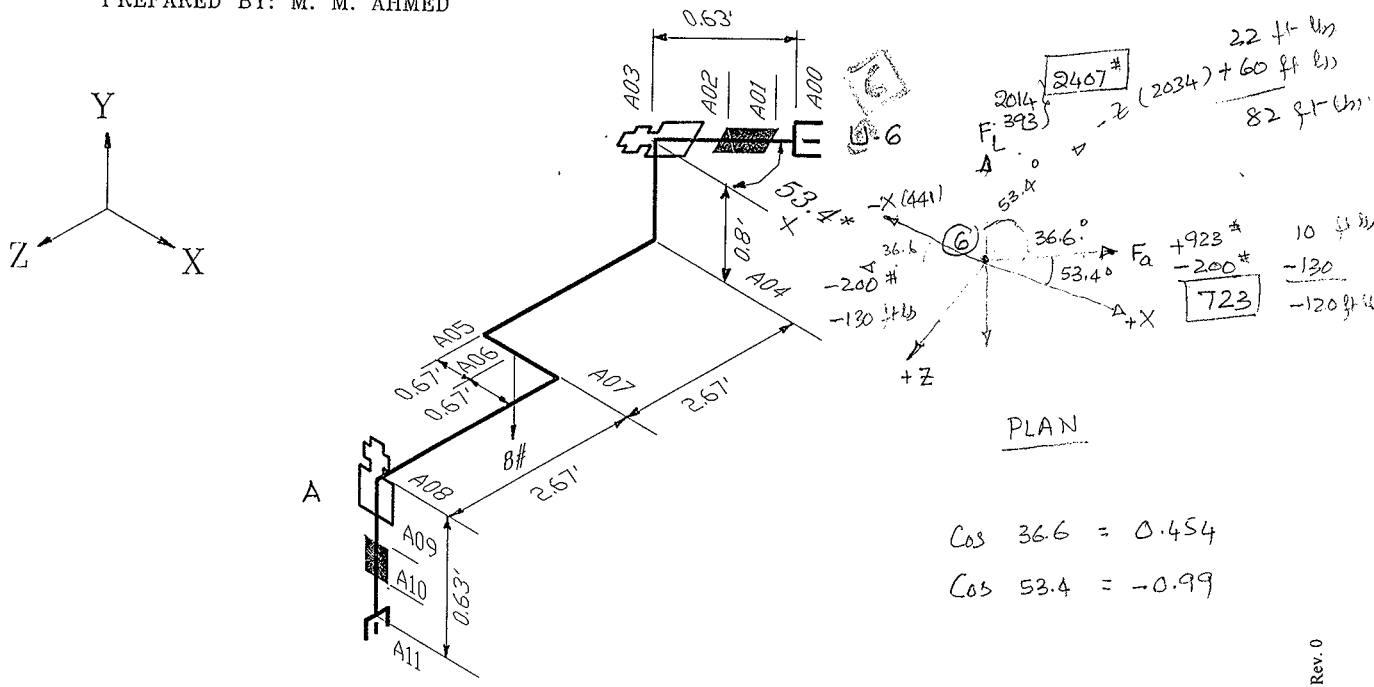
B503AR2 | W3N55:ACD2:12 C:SS | 2 PLOT SCALE: 1=12 | KEHCAD

NUMBER	TITLE
H-2-818423 SH 6	DRAWING LIST
H-2-818545	

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



S U P P O R T F O R C E S

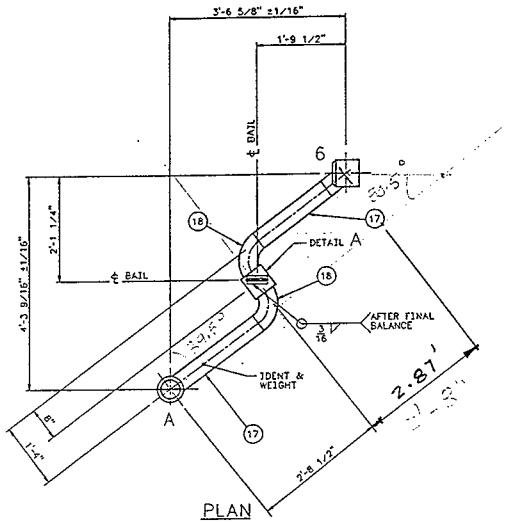
Point/ Supp. ID	Connect/ Type	Load Combination	L O C A L Dirn	L O C A L Force	L O C A L Deform	G L O B A L Dirn	G L O B A L Force	G L O B A L Deform

*** End of system , no supports encountered. ***

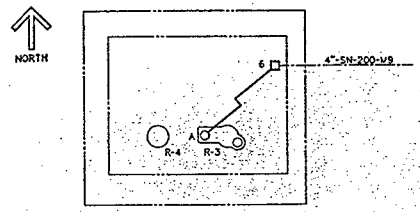
R E S T R A I N T R E A C T I O N S

Point name	Load combination	FORCES (lb) X	Y	Z	Result	MOMENTS (ft-lb) X	Y	Z	Result
A00	Anchor								
	GR	6	-222	29	224	55	7	38	67
	T1	-447	427	-2062	2153	76	-588	-60	596
	R1	9	1	7	12	4	5	3	7
	R2	1	0	1	1	0	1	0	1
	R3	0	0	0	0	0	0	0	0
	GR+T1	-441	205	-2034	2091	131	-581	-22	596
	SEIS	10	1	8	13	4	6	4	8
	TOTAL	451	206	2042	2101	135	586	26	602
A11	Anchor								
	GR	-6	-208	-29	210	-27	0	12	30
	T1	447	-427	2062	2153	458	8	-175	491
	R1	10	1	7	12	3	1	0	3
	R2	1	0	1	1	0	0	0	0
	R3	0	0	0	0	0	0	0	0
	GR+T1	441	-635	2034	2175	431	7	-163	461
	SEIS	11	1	8	14	3	2	0	3
	TOTAL	452	636	2042	2186	434	9	164	464

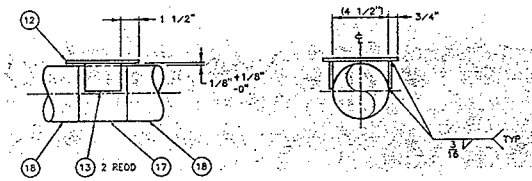
QTY REQD	PART/DASH NUMBER	NOMENCLATURE/DESCRIPTION	MATERIAL/REFERENCE	SHEET	ITEM NO.
X	-010	ASSEMBLY			1
					2
					3
					4
1	H-2-32440-1	CONN, HORIZ 4"			5
1	H-2-32440-2	CONN, VERT, 4"			6
2	H-2-3997-8	GASKET 4" TYPE III			7
1	H-2-90161-3	LIFTING BAIL			8
					9
					10
					11
1		PLATE 1/4" THK x 6" x 6"	ASTM A 36		12
2		BAR 1/4" THK x 2 1/4" x 3"	ASTM A 240 304L		13
					14
					15
					16
AR		PIPE, 4" SCHED 40S	ASTM A 312 GR TP 304L		17
3		ELBOW, 90° LR 4" SCHED 40S BW	ASTM A 403 WP-S 304L		18
					19
					20



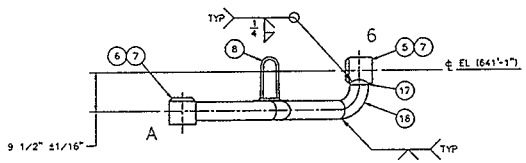
PLAN



241-C-06C
SLUICE PIT
KEY PLAN
SCALE: NONE



DETAIL A
SCALE: 3"= 1'-0"



ELEVATION

1 ASSEMBLY
SCALE: 1"= 1'-0"

NOTE:

1. FABRICATION AND TESTING SHALL BE IN ACCORDANCE WITH HANFORD SPECIFICATION HS-BS-0084 REV B.
2. HYDROSTATIC TEST AT 480 PSIG.
3. JUMPER WEIGHT IS 325 LB APPROX.
4. USE (1) COAT OF AMERLOCK 400 IN PLACE OF AMERCOAT 187 PRIMER AND AMERCOAT 33, WHERE REQUIRED BY JUMPER FABRICATION SPECIFICATION.

CARROLL J. MEYER
STATE OF WASHINGTON
11532
REGISTERED
PROFESSIONAL ENGINEER
(2)PIECE 5-3-96

USE: CONSTRUCTION
DESIGNED Bs MEYER SR. ENGR. SAFETY CLASS 3
CHECKED
SAFETY SEE DR/AT FORM
CHECK SEE DR/AT FORM
PLANT SHOP SEE DR/AT FORM

U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
JCP KAISER HANFORD COMPANY

JUMPER ASSEMBLY
SLUICE PIT
C-06C-6-A

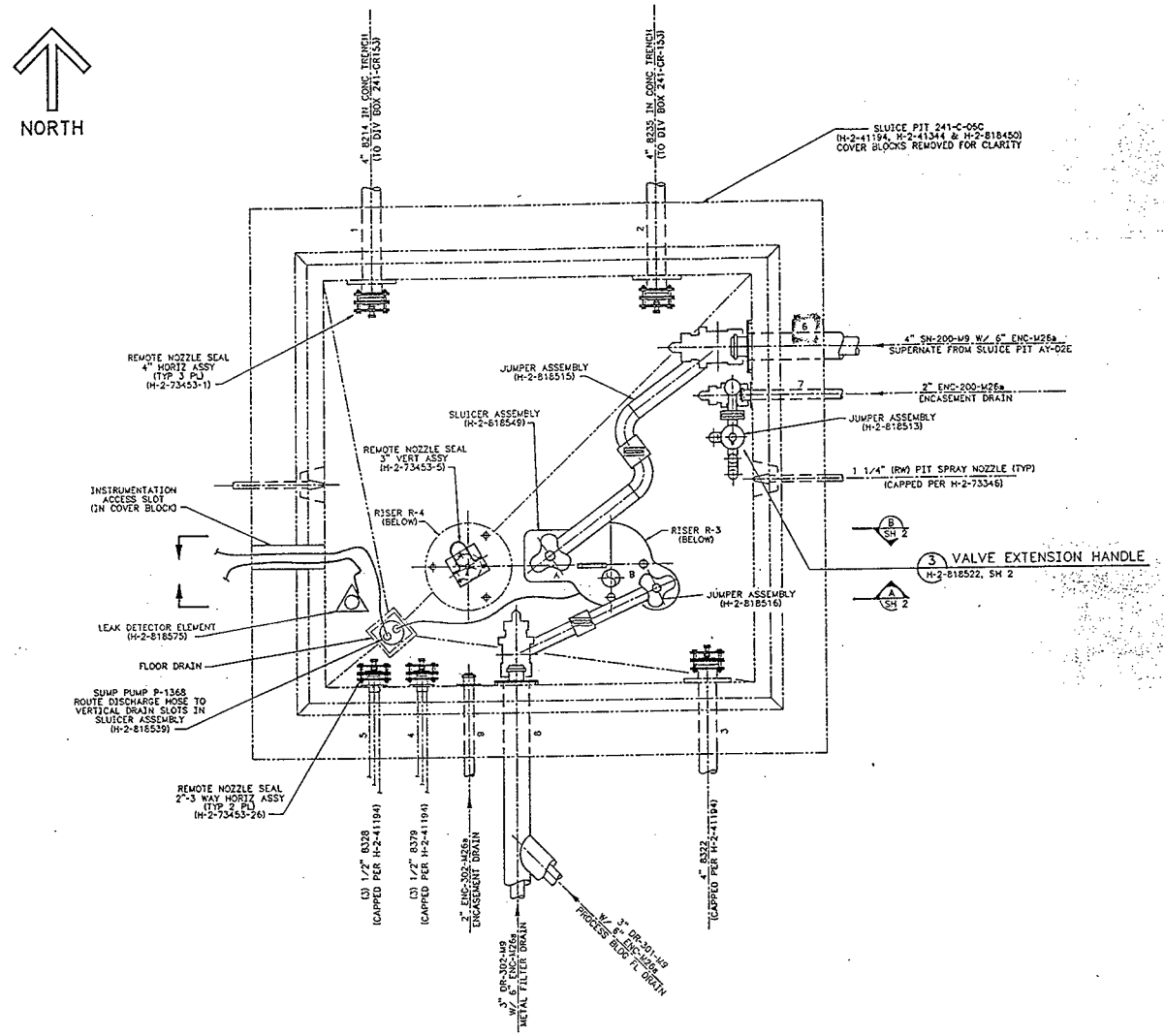
REVISION NO. 3 | PROJECT W-320 TANK 241-C-106 SLUICING
APPROVED FOR IMPLEMENTATION | SYSTEM F | BLDG. NO. 241-C | SHEET NO. 8-05 | DWG. NO. H-2-818515 | REV. NO. 0
PLANT WHC | DATE SHOWN | JOB NO. ER4319 | SHEET 1 OF 1

H-2-818423 SH 7 DRAWING LIST
MARKER TITLE REFERENCES
NEXT USED IN H-2-818526

REV NO. | DESCRIPTION | REV BY DATE | CEN APPROVALS | APPD FOR IMPLEMENT FOR DATE

CAD FILE B818515A CAD SYSTEM 2B:TBM:ACD2:12.0:NN SHEET N

2 PLOT SCALE: 1=12 KEHCAD 1



PLAN
SLUICE PIT
241-C-06C

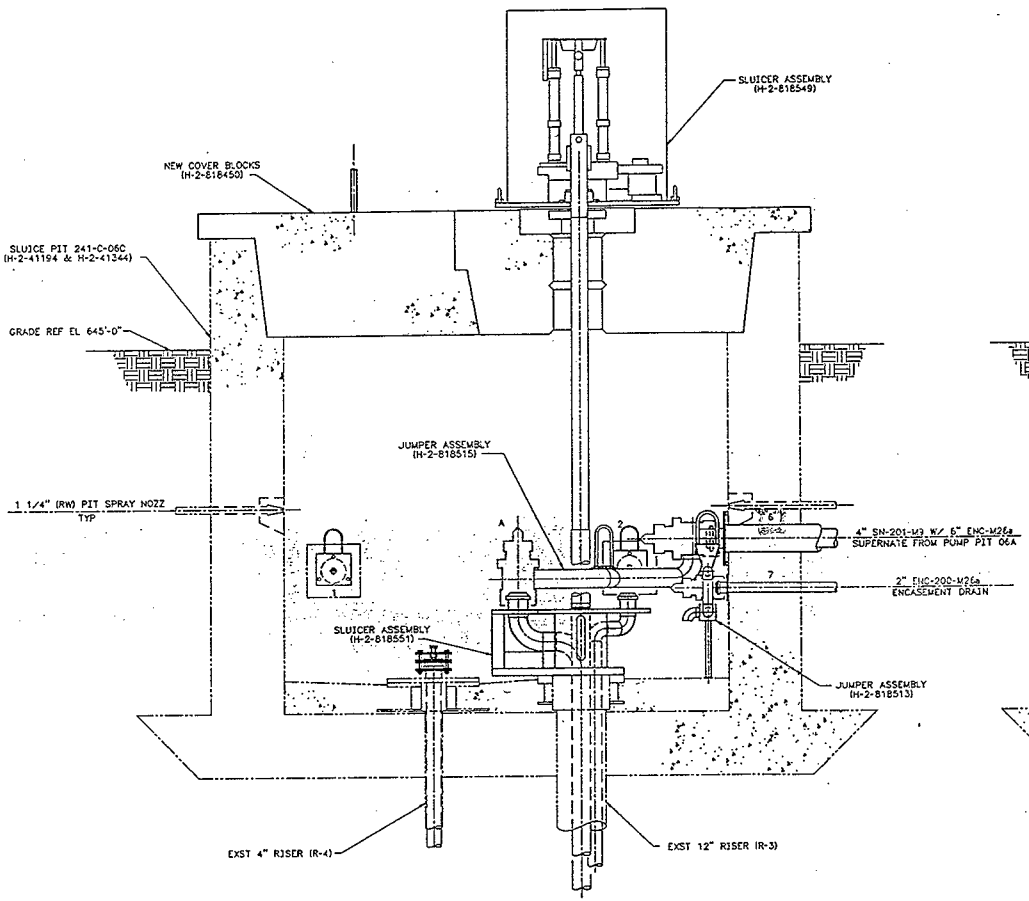
NOTES:

1. FOR GENERAL NOTES, LEGEND AND KEY PLAN SEE H-2-818518.

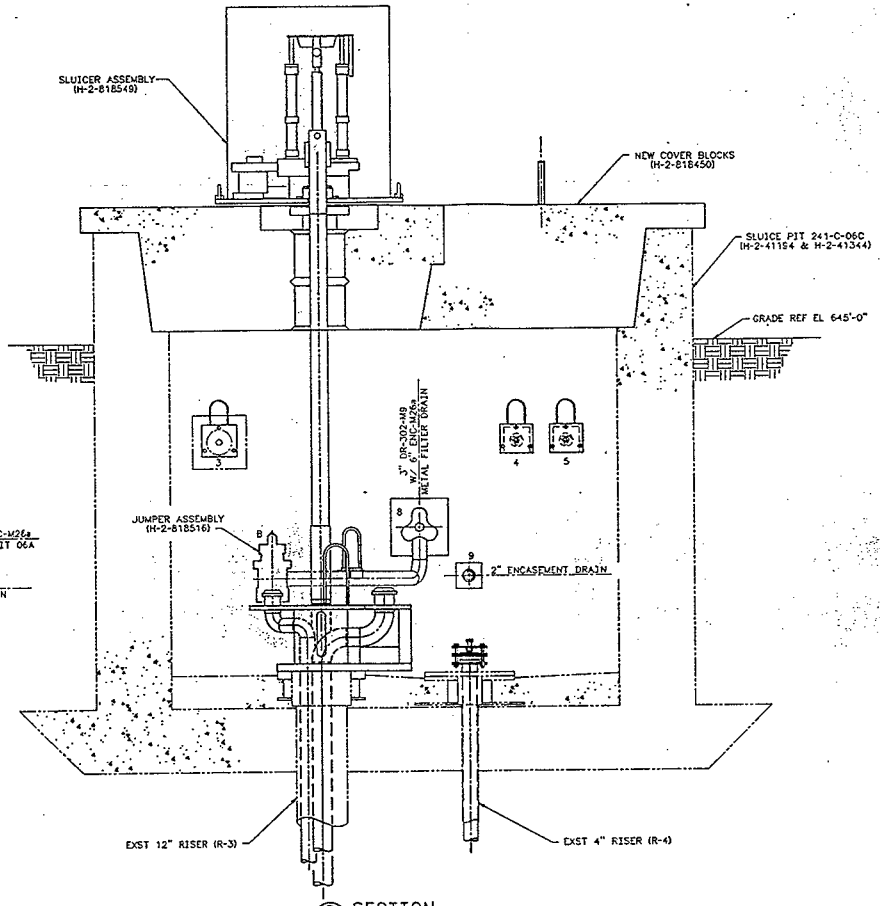
H-2-818423 SH 7	DRAWING LIST		

B818526A	2B:TBM:ACD2:12.0:NN	W/HC	2 PLOT SCALE: 1=12

DESIGNED R W SCHROEDER	SAFETY CLASS 3	CONSTRUCTION	
SAFETY SEE DR/AT FORM	U.S. DEPARTMENT OF ENERGY RICHLAND OPERATIONS OFFICE ICF KAISER HANFORD COMPANY		
SAFETY SEE DR/AT FORM	PIPING JUMPER ARRANGEMENT SLUICE PIT 241-C-06C		
SAFETY SEE DR/AT FORM	W-320 TANK 241-C-106 SLUICING		
F 241-C 8404	H-2-818526	0	
SCALE 1"=1'-0"	ER4319	SHEET 1 of 2	
KEHCAD			



A SECTION
SH. 1



B SECTION
SH. 1

NOTES:

1. FOR NOTES, SEE SHEET 1.

CHARLES B. SHUMAN 11483 REGISTERED PROFESSIONAL ENGINEER

EXPIRES 5-3-96

DESIGNED R W SCHROEDER	SAFETY CLASS 3	USE CONSTRUCTION	
DRAWN BY		CAT	
CHECKED	U.S. DEPARTMENT OF ENERGY RICHLAND OPERATIONS OFFICE WCF KAISER HANFORD COMPANY		
SUPERV SEE DR/AT FORM	PIPING JUMPER ARRANGEMENT SLUICE PIT 241-C-06C		
DATE SEE DR/AT FORM			
DUR. DATE SEE DR/AT FORM			
LAB CHIEF	REVISION NO. 10	PROJECT W-320 TANK 241-C-106 SLUICING	
SIZE F	BLDG. NO. 241-C	PROJ. NO. 6404	DWG. NO. H-2-818526 REV. NO. 0
SCALE 1"=1'-0"			ER4319 SHEET 2 OF 2

B818526B 2B:IBM:ACD2:12.0/NN WHC

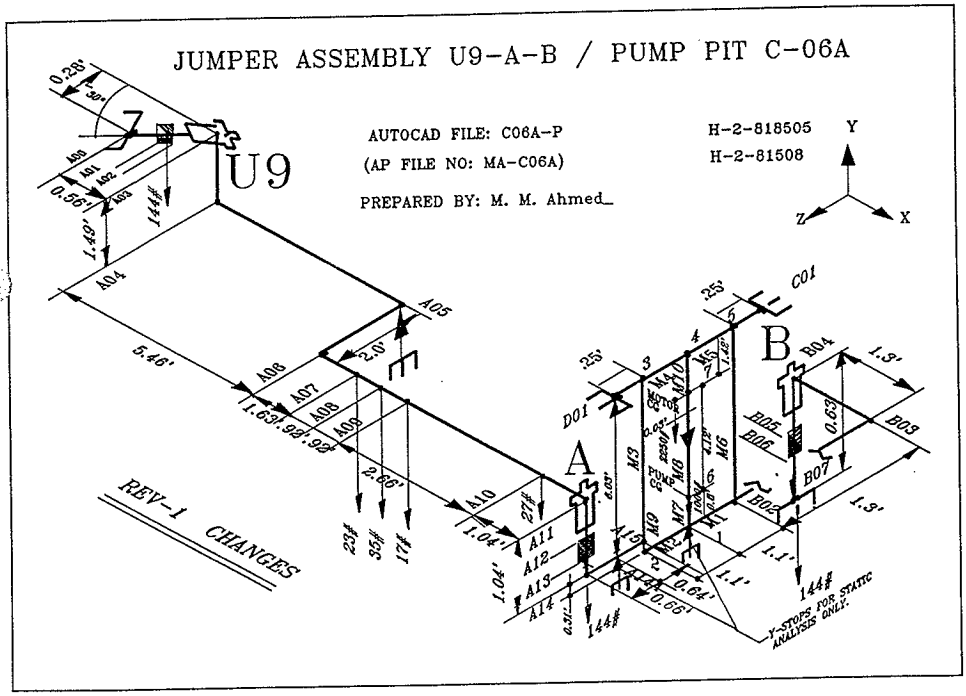
PLOT SCALE: 1=12 KEMCAD

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
Date 9-11-95
Checked 9/11/95
Revised / /

Filename: C06A.WP
By: M.M. Ahmed
By: M.K. Pal
By:

Rev-1: By: M. Ahmed 6-28-96
Checked By: M.K. Pal 7-1-96



REF -4

RESTRAINT REACTIONS

Point name	Load combination	FORCES (lb) X	Y	Z	Result	MOMENTS (ft-lb) X	Y	Z	Result
A00	Anchor								
	GR	57	-358	9	362	-28	-39	-186	193
	T1	-290	37	-32	294	-11	41	-80	91
U-9	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

SEISMIC:

$F_a = 295 \cos 30 + 132 \cos 60 = 320$ #

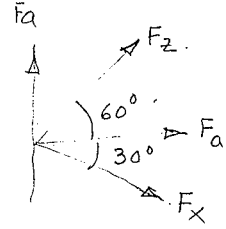
$M_a = 79 \cos 30 + 129 \cos 60 = 133$ ft #

$F_l = 295 \sin 30 + 132 \sin 60 = 261$ #

$M_l = 79 \sin 30 + 129 \sin 60 = 151$ ft #

RESTRAINT REACTIONS

Point name	Load combination	FORCES (lb) X	Y	Z	Result	MOMENTS (ft-lb) 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 + TH:

$F_a = -233 \cos 30 - 23 \cos 60 = -212$ #

$F_l = -233 \sin 30 - 23 \sin 60 = -137$ #

$M_a = -39 \cos 30 - 266 \cos 60 = -167$ ft #

$M_l = -39 \sin 30 - 266 \sin 60 = -249$ ft #

Client WESTINGHOUSE HANFORD COMPANY
Subject AY FARM- JUMPER STRESS ANALYSIS
PROJECT W-320 WASTE RETRIEVAL FOR TANK C-106
Location C TANK FARM - 200W.

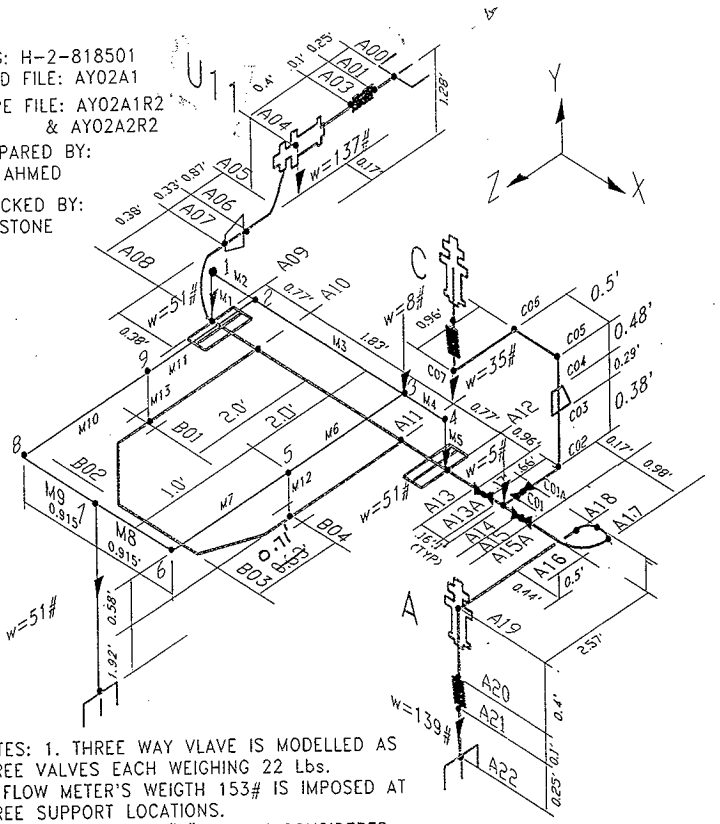
WO/Job No. ER4319
Date 8/31/95
Checked 9/11/95
Revised

Filename: AY02E.WP
By: M. M. Ahmed
By: M. K. Pal
By:

Rev-2, By: M. 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 WEIGTH 153# IS IMPOSED AT THREE SUPPORT LOCATIONS.
3. Y-STOP AT NODE "7" IS NOT CONSIDERED FOR DYNAMIC ANALYSIS.

REF #5

SUPPORT FORCES

Point/ Supp. ID	Connect/ Type	Load Combination	LOCAL Dirn	LOCAL Force	LOCAL Deform	GLOBAL Dirn	GLOBAL Force	GLOBAL Deform
B01	9	GR	down	26	0.000	X		-0.013
B01 1	Guide		rght		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
			rght		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
			rght		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		GR	down	146	0.000	X		0.016
7 1	Y - Stop		-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

RESTRAINT REACTIONS

Point name	Load combination	FORCES (lb) X	Y	Z	Result	MOMENTS (ft-lb) X	Y	Z	Result
A00	Anchor								
	GR	19	-424	0	424	191	54	-33	201
U-11	T1	-82	33	-52	102	-8	-34	-2	35
	GR+T1	-63	-390	-52	399	183	20	-35	187
AY-02A									
A22	Anchor								
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

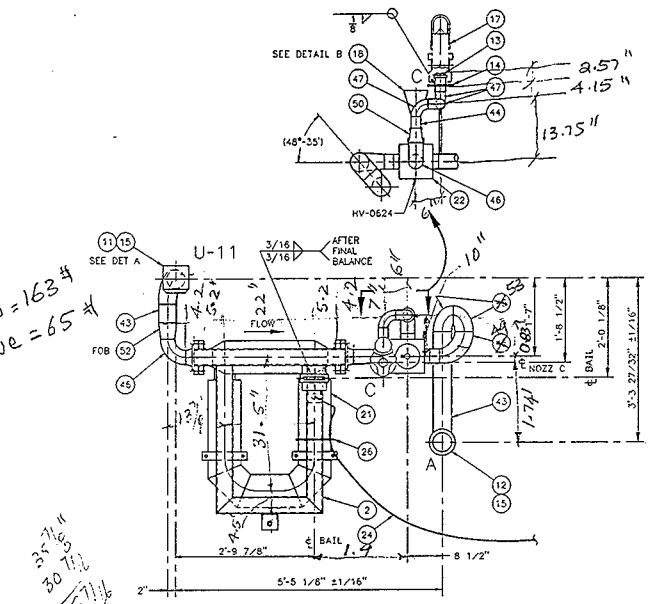
Point name	Load combination	FORCES (lb) X	Y	Z	Result	MOMENTS (ft-lb) X	Y	Z	Result
A00	Anchor								
	R1	189	48	46	201	100	173	26	202
	R2	73	83	42	118	180	93	6	202
	R3	29	36	65	80	39	37	4	54
	RESPONSE	205	102	90	246	209	200	27	291
A22	Anchor								
	R1	80	59	30	104	52	31	38	72
	R2	29	130	51	143	94	9	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

U-11

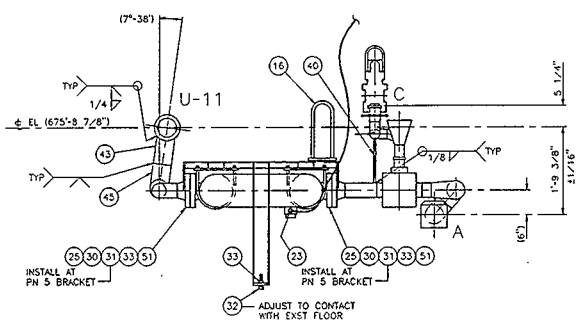
AY-02A PUMP PIT

LOCAL FORCES & MOMENTS

Point name	Load combination	FORCES (lb) X	Y	Z	Result	MOMENTS (ft-lb) X	Y	Z	Result
*** 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	252
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

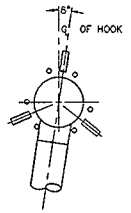


PLAN

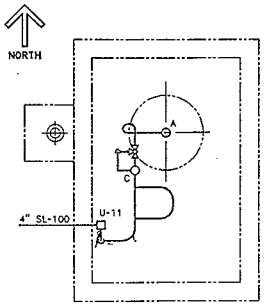


ELEVATION

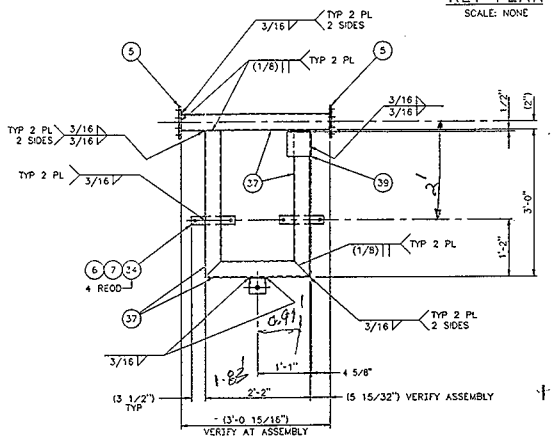
1 ASSEMBLY
SCALE: 1"= 1'-0"



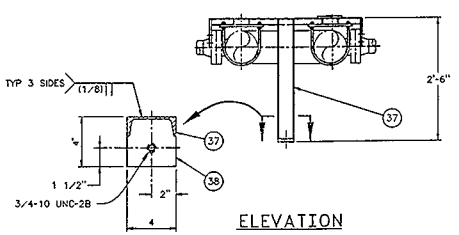
DETAIL A
SCALE: NONE



241-AY-02A
PUMP PIT
KEY PLAN
SCALE: NONE



PLAN



ELEVATION

2 SUPPORT FRAME SUB-ASSY
SCALE: 1"= 1'-0"

PARTS/MATERIAL LIST

QUANTITY REQUIRED		PART/DASH NUMBER	NOMENCLATURE/DESCRIPTION	MATERIAL/REFERENCE	SHEET	ITEM NO.
	X	-010	ASSEMBLY			1
X	1	-020	SUPPORT FRAME SUB-ASSEMBLY		1	2
						3
						4
2		-001	BRACKET, PLATE 1/2" THK	ASTM A 36	2	5
2		-002	BRACKET, PLATE 1/2" THK	ASTM A 36	2	6
2		-003	U-BOLT, BAR Ø1/2"	ASTM A 36	2	7
						8
						9
						10
	1	H-2-32440-1	CONN, HORIZ 4"			11
	1	H-2-32440-2	CONN, VERT, 4"			12
	1	H-2-90185-2	NOZZLE, MALE 2"			13
	1	H-2-3194-2	KICKOFF PLATE, 2" ROUND			14
	2	H-2-3697-8	GASKET 4" TYPE III			15
	1	H-2-90161-15	LIFTING BAIL			16
	1	H-2-818509-1	JUMPER FLUSHING BLANK HEAD			17
	1	H-2-50171-5	FUNNEL ASSEMBLY			18
						19
						20
	1	MODEL CMF300M356NU	DENSITY/FLOW/TEMPERATURE SENSOR (UE)	FISHER-ROSEMOUNT MICRO-MOTION		21
	1	HV-0624, SEE NOTE 5	BALL VALVE, 3"-3 WAY	PBM		22
	1	UE-0621	CGB FITTING, 3/4" NPT, W/FLAX PACKING BUSHING & CABLE CLAMP	COMMERICAL		23
	AR		INSTRUMENT CABLE	SEE LEGEND		24
	2	BLUE GARD STYLE 3700	GASKET, 3" 300# RAISED FACE, 1/8" THK COMPRESSED FIBER	GARLOCK		25
						26
	AR		CABLE TIE, 18" LG, NYLON	COMMERICAL		27
						28
						29

PARTS/MATERIAL LIST (CONTINUED TO SHEET 2)

LEGEND:

(ITRS-XX-XX) WIRING RUN NUMBER. SEE ELECTRICAL DRAWING H-2-81899 FOR CABLE TYPE, WIRE NUMBERS AND DESTINATION.

NOTE:

1. FABRICATION AND TESTING SHALL BE IN ACCORDANCE WITH HANFORD SPECIFICATION HS-BS-0084, REV B.
2. HYDROSTATIC TEST AT 480 PSIG.
3. JUMPER WEIGHT IS 775 LB APPROX.
4. USE (1) COAT OF AMERLOCK 400 IN PLACE OF AMERCOAT 187 PRIMER AND AMERCOAT 33, WHERE REQUIRED BY JUMPER FABRICATION SPECIFICATION.
5. VALVE SHALL BE 3"-3 WAY PBM MULT-PORT SERIES, T-PORT 180° TURN, FLOW PATTERN #5, 3" SCHED 40 BW END FITTING, SST, #3" MP-H-39-BW-2/P0C059 OR APPROVED SUBSTITUTE.

EXPIRES 5-24-97

USE	CONSTRUCTION
DESIGNED Ba MEYER sr	SAFETY CLASS 3
DRAWN CHKR C D JONES	
CHECKED ROGER SCHROEDER	
SAFETY SEE DR/AT FORM	
CNTR SEE DR/AT FORM	
CIVIL CHKR SEE DR/AT FORM	
LEAD CHKR C D JONES	
REVIEW NO. 15	

U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
ICF KAISER HANFORD COMPANY

JUMPER ASSEMBLY
PUMP PIT
AY-02A-U11-A-(C)

PROJECT W-320 TANK 241-C-106 SLUICING
SIZE F | SUBC NO. 241-AY | INDEX NO. 8405 | DWG NO. H-2-818501 | REV NO. 2
SCALE SHOWN | JOB NO ER4319 | SHEET 1 OF 2

REV	DESCRIPTION	REV DATE	ECN APPROVALS
2	REV TO INCORP ECN W-320-XXX		
1	REV TO INCORP ECN W-320-401		

APPD FOR SUBC USE FOR SAFE

APPROVED FOR SUBMITTAL BY THOMAS H MAY
WHC DATE 6-22-95

END FILE B501AR2 | CAD CODE W1N95:ACD2:12.0:SS | SHEET N

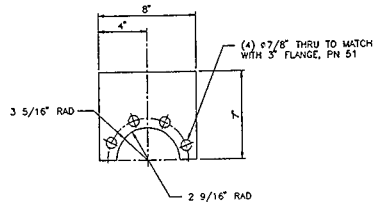
H-2-818423 DRAWING LIST

NEXT USED ON H-2-818544

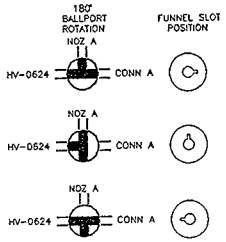
2 PLOT SCALE: 1=12 | KEHCAD

PARTS/MATERIAL LIST (CONTINUED FROM SHEET 1)

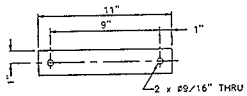
QUANTITY REQUIRED		PART/DASH NUMBER	NOMENCLATURE/DESCRIPTION	MATERIAL/REFERENCE	SHEET	ITEM NO.
			(CONT FROM SHEET 1)			
	X		ASSEMBLY		1	1
X	1		SUPPORT FRAME SUB-ASSEMBLY		1	2
	8		STUD BOLT, 3/4"-10UNC-2A x 6" LG	ASTM A 193 GR B8 304		30
	8		STUD BOLT, 3/4"-10UNC-2A x 6 1/2" LG	ASTM A 193 GR B8 304		31
1			MACHING SCREW, 3/4"-10UNC-2A x 3" L HEX HD	ANSI B18.2.1 CS		32
1	64		HEAVY HEX NUT, 3/4"-10UNC-2B	ASTM A 194 GR 8F 303		33
	4		HEX NUT, 1/2"-13UNC-2B	ANSI B18.2.2 CS		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
	3		ELBOW, 90° LR 2" SCHED 40S BW	ASTM A 403 WP-S 304L		47
	1		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
	1		CONC RDCR 3" x 2" SCHED 40S BW	ASTM A 403 WP-S 304L		50
	2		FLANGE, 3" 300# 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



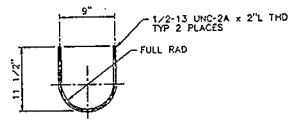
5 BRACKET
SCALE: 3"= 1'-0"



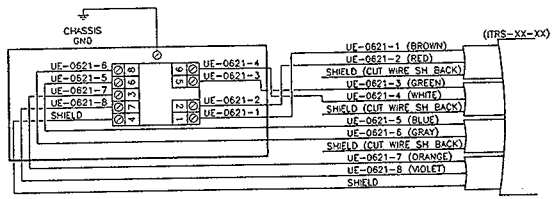
DETAIL B
SCALE: NONE



6 BRACKET
SCALE: 3"= 1'-0"



7 U-BOLT
SCALE: 1 1/2"= 1'-0"



WIRING CONNECTION DIAGRAM
UE-0621

EXPIRES 3-24-97

DRAWN BY BA MEYER Sr	SAFETY CLASS 3	REVIEW NO. 2 DATE 02/18/97	USE CONSTRUCTION
SAFETY SEE DR/AT FORM	U.S. DEPARTMENT OF ENERGY Richland Operations Office FLUOR DANIEL NORTHWEST, INC		
SCHE SEE DR/AT FORM	JUMPER ASSEMBLY PUMP PIT AY-02A-U11-A-(C)		
DWG ENGR SEE DR/AT FORM	PROJECT W-320 TANK 241-C-106 SLUICING		
	SCALE SHOWN	INST 606537	SHEET 2 OF 2

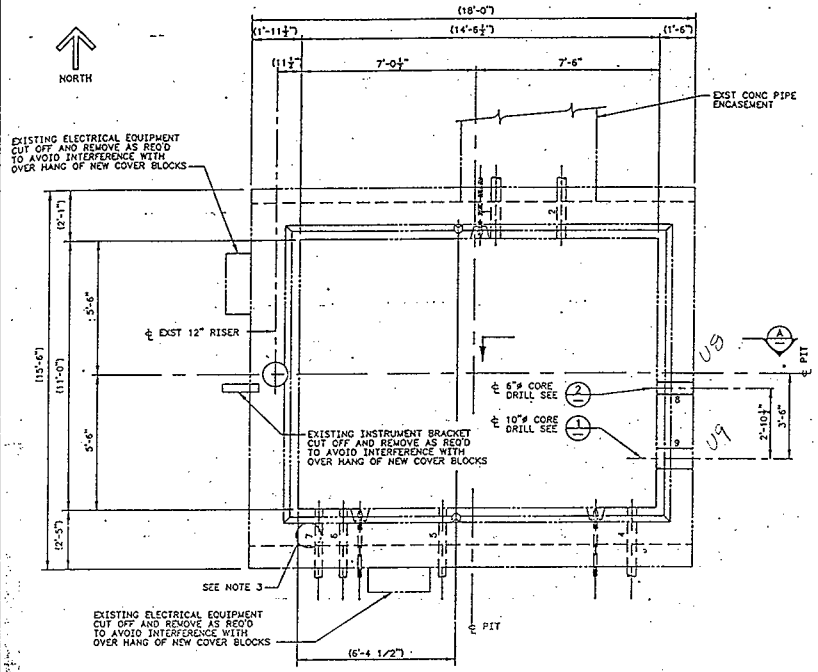
DWG NO	TITLE	REF NUMBER	TITLE
DRAWING TRACEABILITY LIST		REFERENCES	
		NEXT USED ON	

REVISIONS

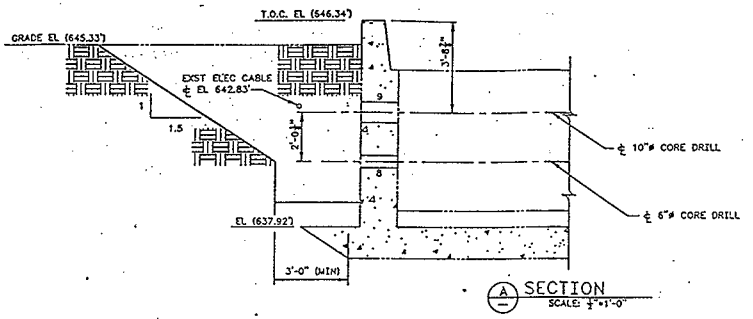
CADFILE B501B CADCODE WIN95:ACD2:12.0:SS

2 PLOT SCALE: 1=12

DWG NO H-2-818501 REV 0 SH 2 OF 2



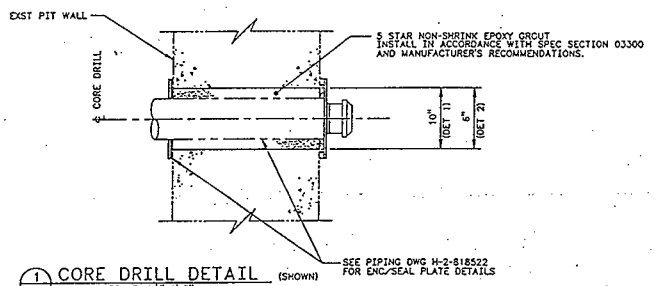
PLAN-EXST PUMP PIT
SCALE: ¼"=1'-0"



SECTION
SCALE: ½"=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 EXCAVATED MATERIAL QUANTITIES.
3. SEE H-2-818524 SH1 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.



1 CORE DRILL DETAIL (SHOWN)
SCALE: 1½"=1'-0"

2 CORE DRILL DETAIL (AS NOTED)
SCALE: 1½"=1'-0"

REV	DATE	DESCRIPTION	BY	CHK	APPROVALS
RS 2		W-320 PROJECT TURNOVER PER ECN W-320-727, INC ECN W-320-646	SS	SS	
RS 1		GEN DWG REV PER ECNS W-320-156, W-320-205, W-320-290, W-320-411, W-320-429, W-320-493 & W-320-565.	PB 2/97	RWD 3/97	RWD JJH 3/97 JB 3/97

DRAWING	TITLE
H-2-41343	STRL CONC PLAN & SECT PUMP PIT
H-2-73346	PIPING WASTE TANK ISOLATION
H-2-73305 SH 2	DRAWING LIST

DRAWING	TITLE
H-2-73346	PP WST TK ISOL TK-241-C-106
H-2-41343	STRL-CONC PL & SECT PMP PT
H-2-818423	DRAWING LIST

DRAWING TRACEABILITY LIST — REFERENCES

CAD FILE 8818448A CAD SIZE WIN 95:ACD2:12.0:NN PLOT N

PREPARED PC BRINKMAN — SAFETY CLASSIFICATION SC — ERT 606541
DSIGN J R BOOTH — CHKD R W DAVIDSON
SAFETY AW CLARKSON JR 9/95
DFTR DL FORT 9/95
PROJ ENGR JJ HUSTON 9/95
CAD SUPR R W DAVIDSON
REVISION NO. 5 — PROJECT W-320 TANK 241-C-106 SLUICING

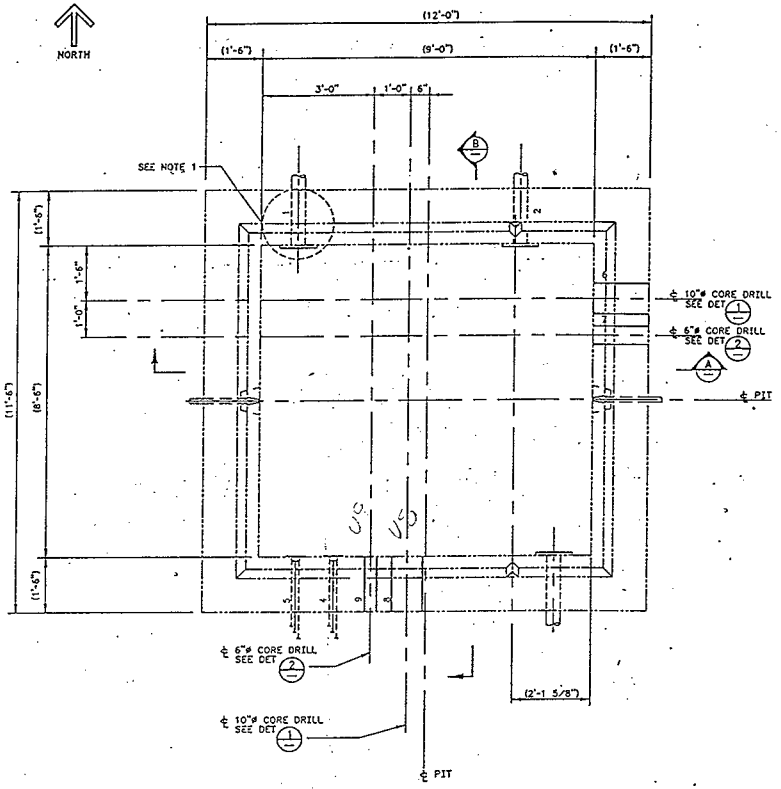
U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
ICF KAISER HANFORD COMPANY

STRUCTURAL
241-C-06A PUMP PIT MOD
PLAN, SECTION & DETAILS

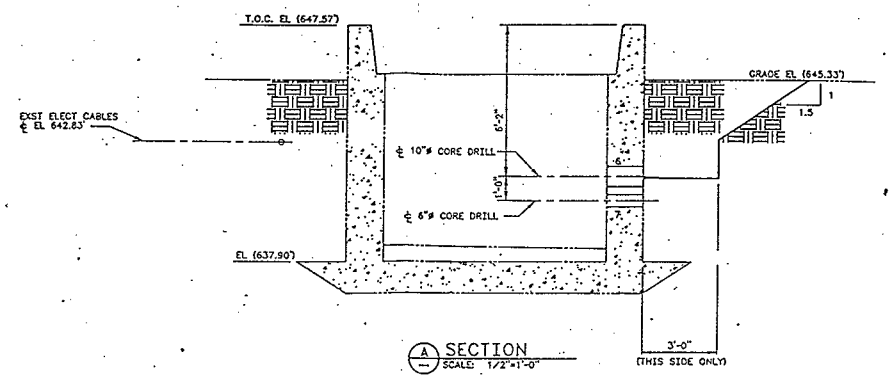
APPROVED FOR CONSTRUCTION BY THOMAS H MAY — DATE 09/12/95
SYM WHC

SYSTEM	SUBSYSTEM	DWG NO.	SHEET NO.	REV NO.
F	241-C	0901	H-2-818448	2

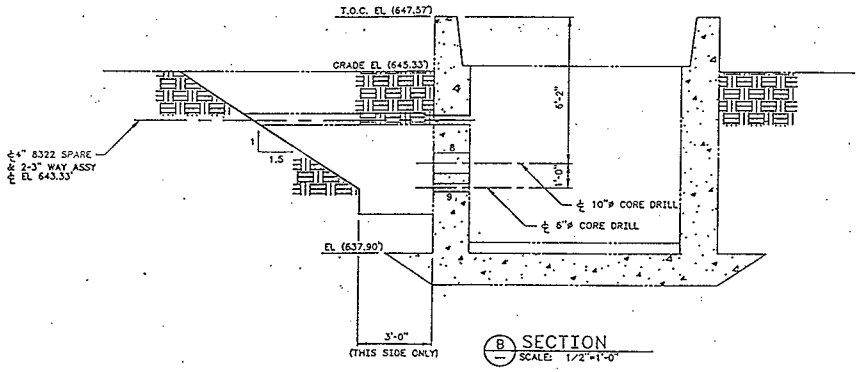
SCALE SHOWN — ARCHIVE NO. ER4319 — SHEET 1 OF 5



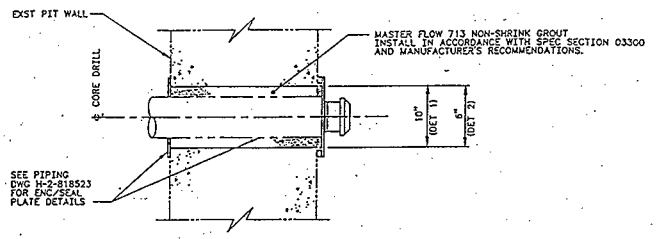
PLAN-EXST SLUICE PIT
SCALE: 1/2"=1'-0"



A SECTION
SCALE: 1/2"=1'-0"



B SECTION
SCALE: 1/2"=1'-0"



1 CORE DRILL DETAIL (SHOWN)
SCALE: 1 1/2"=1'-0"

2 CORE DRILL DETAIL (AS NOTED)
SCALE: 1 1/2"=1'-0"

NOTES:

1. SEE H-2-818526, SH1 FOR EXISTING PIPING DESCRIPTION, REFERENCE & NUMBER DESCRIPTION.
2. FOR ADDITIONAL NOTES SEE H-2-818448, SH1.

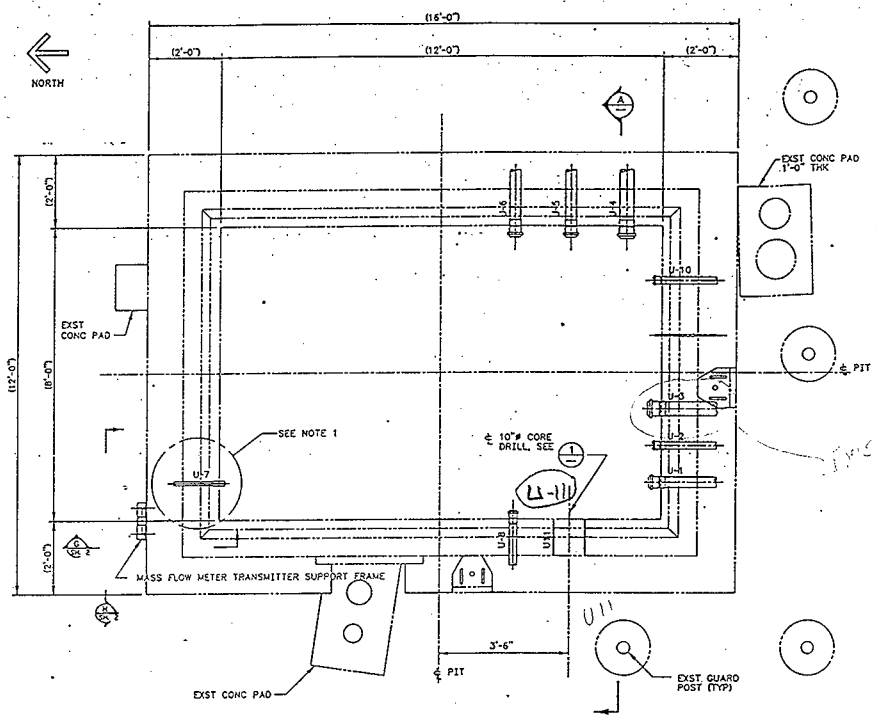
HNF-2479, Rev. 0
Page F-42

H-2-41344	STRL-CONC PL SLUICING PT	H-2-41344	STRL-CONC PL SLUICING PT		
H-2-73051 SH 2	DRAWING LIST	H-2-818423	DRAWING LIST		

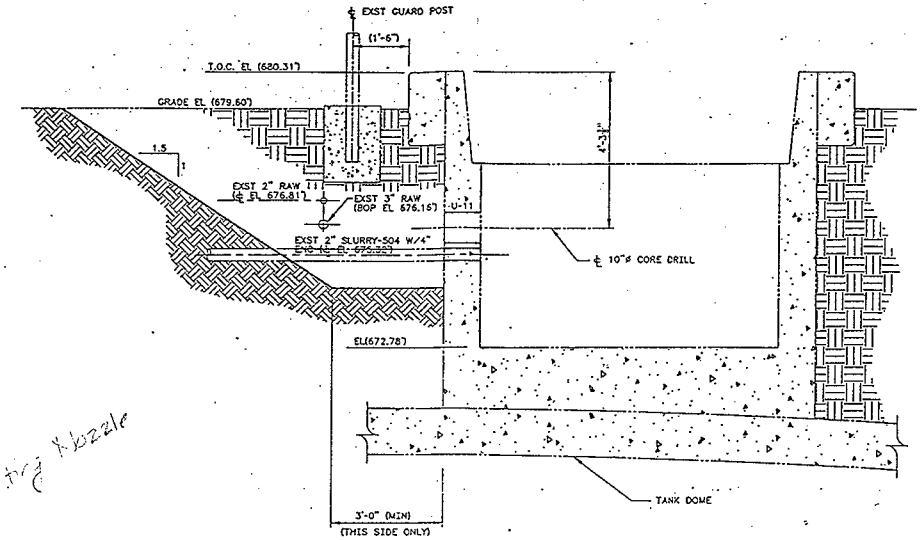
REV NO	DESCRIPTION	REV BY / DATE	APPROVALS
RS 2	W-320 PROJECT TURNOVER PER ECN W-320-727. INC ECN W-320-646	SB 2/98	
RS 1	GEN DWG REV PER ECNS W-320-156, W-320-203, W-320-290, W-320-411 & W-320-565.	PB 2/97	RWD JJH 3/97 / JB 3/97

DESIGNED PC BRINKMAN	SAFETY CLASSIFICATION SC
DRAWN BY J R BOOTH	
CHECKED R W DAVIDSON	U.S. DEPARTMENT OF ENERGY RICHLAND OPERATIONS OFFICE ICF KAISER HANFORD COMPANY
APPROVED AW CLARKSON JR	
DRAWN DL FORT	STRUCTURAL 241-C-06C SLUICE PIT MOD PLAN, SECTIONS & DETAILS
DWG CHKR JJ HUSTON	
DWG CHKR R W DAVIDSON	
REVISION NO. 3	PROJECT W-320 TANK 241-C-106 SLUICING
ENGINEERING ORGANIZATION THOMAS H MAY	SIZE F / SYS 241-C / SHED 0901 / SHEET NO. H-2-818450 / REV NO. 2
CAD FILE B818450A / CAD SYM WIN 95:ACD2:12.0:NN / SHEET N	PLAN WHC / DATE 09/12/95 / SCALE SHOWN / JOB NO. ER4319 / SHEET 1 OF 3

2 PLOT SCALE: 1=16 KEYCAD



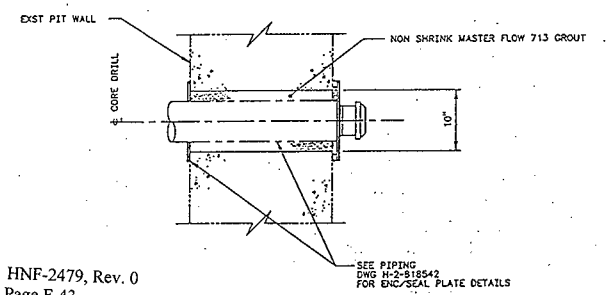
PLAN-EXST PUMP PIT
SCALE: 1/4"=1'-0"



A SECTION
SCALE: 1/4"=1'-0"

NOTES

1. SEE H-2-818544 FOR EXISTING PIPING DESCRIPTION, REFERENCE & NUMBER DESCRIPTION.
2. EXCAVATE, BACKFILL AND COMPACT FOR CORE DRILLS IN ACCORDANCE WITH SPECIFICATION SECTION 02200.
3. EXCAVATION PROFILES SHALL BE AS SHOWN ON DRAWINGS OR AS REQUIRED TO MINIMIZE EXCAVATED MATERIAL QUANTITIES.
4. UPON COMPLETION OF CORE DRILLING ACTIVIES, RESTORE EXISTING PIPING, CONDUITS, AND STRUCTURES TO OPERATIONAL CONFIGURATION/CONDITION.
5. CORE DRILL SHALL BE IN ACCORDANCE WITH SPECIFICATION SECTION 03300.
6. EXISTING CONCRETE PITS/COVER BLOCKS ARE CLASSIFIED AS SAFETY CLASS. OTHER ITEMS SHOWN ON DRAWINGS ARE GENERAL SERVICES UNLESS NOTED OTHERWISE.



1 CORE DRILL DETAIL
SCALE: 1 1/2"=1'-0"

DATE 03-31-00

ESSENTIAL DRAWING

H-2-64313	STR CONC SLUICING PT PL & SECT	H-2-64314	STR CONC SLUICING PT PL & SECT
H-2-64300	DRAWING LIST	H-2-818423	DRAWING LIST

REV NO.	DESCRIPTION	DRAWN	CHKD	APPROVED	CHG NO.
2	W-320 PROJECT TURNOVER PER ECN W-320-727 INC ECN W-320-596	SB 2/98			
1	GEN DWG REV PER ECNS W-320-216, W-320-290 & W-320-565.	PS 2/97	RWD 2/97	AWC 2/97	RWD JJH 2/97 JB 2/97

REVISIONS

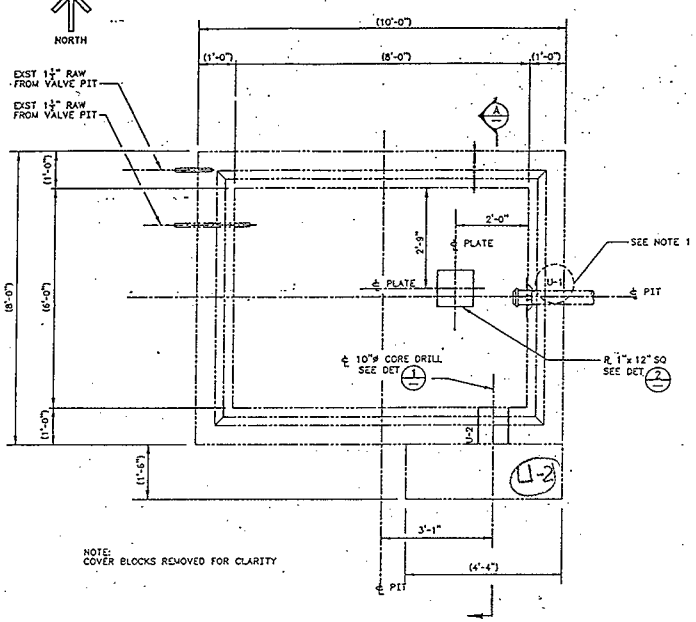
SCALE	SHOWN	DWG NO.	H-2-818453
REV	2	SHEET	1 OF 3

U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
ICF KAISER HANFORD COMPANY

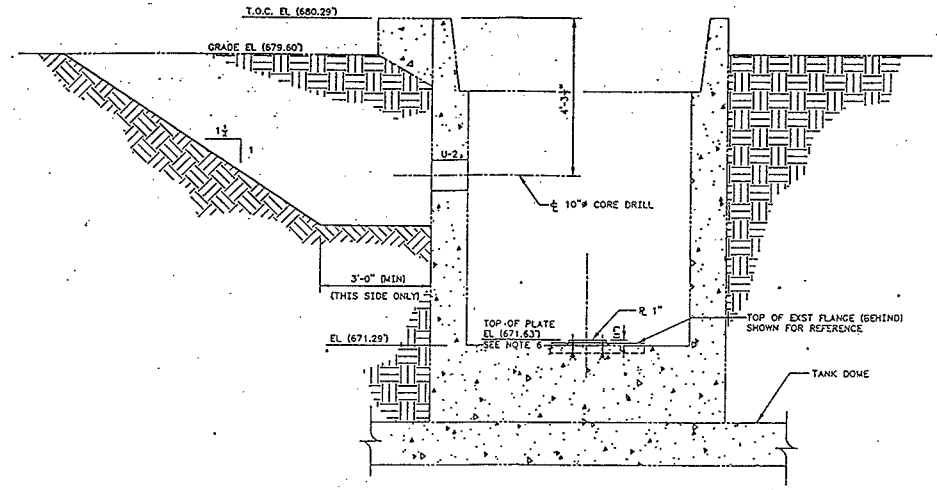
STRUCTURAL
241-AY-02A PUMP PIT MOD
PLAN, SECTION & DETAIL

W-320 TANK 241-C-106 SLUICING

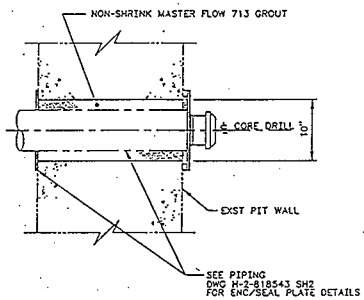
PLOT SCALE: 1=16 | KEHCAD



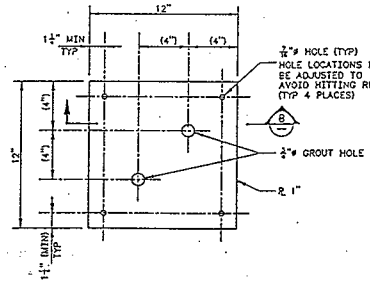
PLAN-EXST SLUICE PIT
SCALE: ¼"=1'-0"



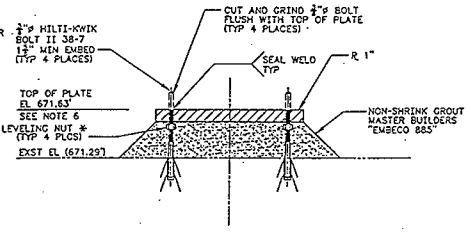
A SECTION
SCALE: ¼"=1'-0"



1 CORE DRILL DETAIL
SCALE: 1½"=1'-0"



2 DETAIL
SCALE: 3"=1'-0"



B SECTION
SCALE: 3"=1'-0"

* STEEL SHIM STOCK MAY BE ADDED AS REQ'D

NOTES:

1. SEE H-2-818545 FOR EXISTING PIPING DESCRIPTION, REFERENCE & NUMBER DESCRIPTION.
2. EXCAVATE, BACKFILL AND COMPACT FOR CORE DRILLS IN ACCORDANCE WITH SPECIFICATION, SECTION 02200.
3. EXCAVATION PROFILES SHALL BE AS SHOWN ON DRAWINGS OR AS REQUIRED TO MINIMIZE EXCAVATED MATERIAL QUANTITIES.
4. CORE DRILLING SHALL BE IN ACCORDANCE WITH SPECIFICATION, SECTION 03300.
5. HILTI-KWIK BOLT II INSTALLATIONS FOR SAFETY CLASS 1 WORK SHALL BE IN ACCORDANCE WITH SPECIFICATION, SECTION 05055.
6. TOP OF 1" PLATE TO BE AS-BUILT FOR JUMPER INTERFACE. SEE H-2-818543, SH 1.
7. ASSUMED CONCRETE COMPRESSIVE STRENGTH (f'c) IS TAKEN AS 3000psi.
8. EXISTING CONCRETE PITS ARE CLASSIFIED AS SAFETY CLASS. OTHER ITEMS SHOWN ON DRAWINGS ARE GENERAL SERVICES UNLESS NOTED OTHERWISE.

ESSENTIAL DRAWING

	2	W-320 PROJECT TURNOVER PER ECN W-320-727 INC ECN W-320-596	SB 2/98						
RS	1	GEN DWG REV PER ECNS W-320-497, W-320-123, W-320-216, W-320-260, W-302-307 W-320-362 & W-320-565.	PB 2/97	RWD 2/97	SDC AWC 2/97	RWD JJH 2/97	JB 2/97		
REV NO.		DESCRIPTION	REV BY DATE	REV APPROVALS					

H-2-64314	STR CONC SLUICING PT PL & SECT	H-2-64314	STR CONC SLUICING PT PL & SECT
H-2-64300	DRAWING LIST	H-2-818423	DRAWING LIST
DRAWING	TITLE	DRAWING	TITLE
SIM FOR TRANSMITTAL USE		NOT USED BY	REFERENCES

DESIGNED S SMITH — SAFETY CLASSIFICATION SC — CAT 606537
DRN BY J R BOOTH — CHECKED R W DAVIDSON — SAFETY AW CLARKSON JR — DATE DAVID L. FORT — SUBM. BY CE NORTON — CAR BY R W DAVIDSON — REVISION 6

U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
ICF KAISER HANFORD COMPANY

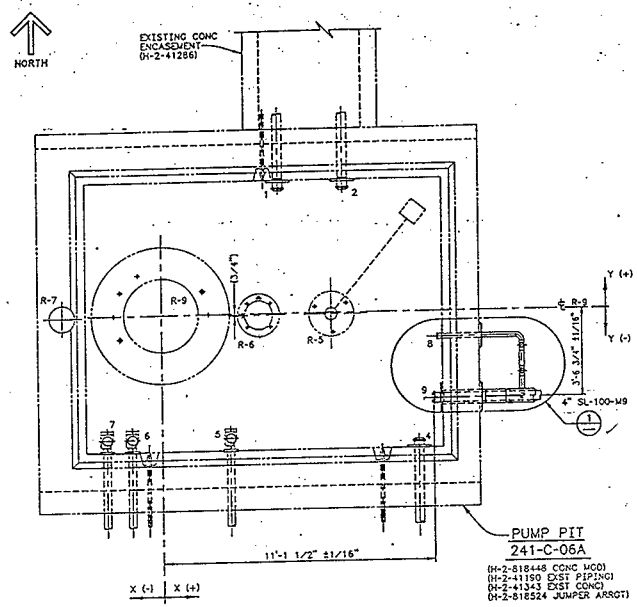
STRUCTURAL
241-AY-02E SLUICE PIT MOD
PLAN, SECTIONS & DETAILS

PROJECT W-320 TANK 241-C-106 SLUICING

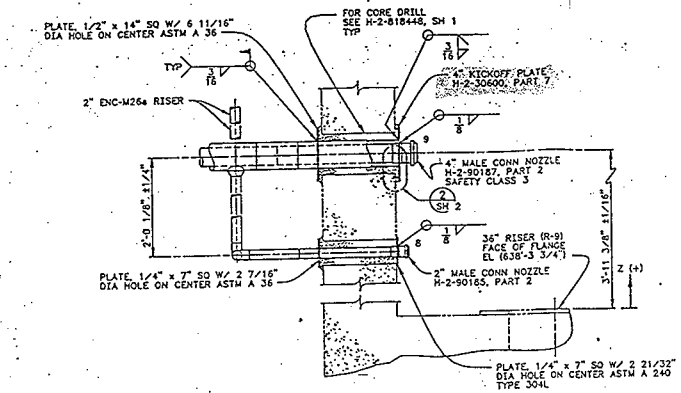
SIZE	SCALE NO.	DWG NO.	SHT NO.	REV NO.
F	241-AY	0901	H-2-818454	2

CONTRACTOR DWG NO. — BY THOMAS H MAY — DATE 08/22/95 — SCALE SHOWN — CAD NO. ER4319 — SHEET 1 OF 4

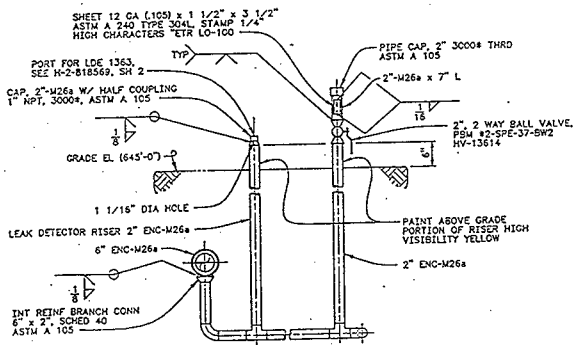
CAD FILE E818454A — CAD SYSTEM WIN 95:ACD2:12.0:NN — SHEET N — 2 PLOT SCALE: 1=16 — KEHCAD



PLAN
SCALE: 1/2"=1'-0"



SECTION
SCALE: 1"=1'-0"



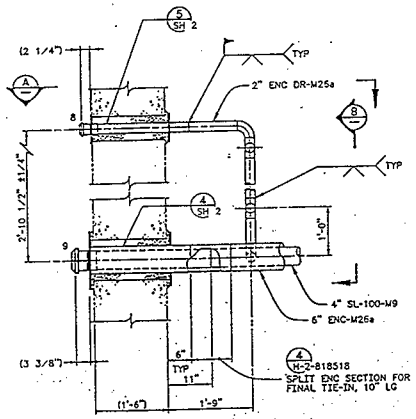
SECTION
SCALE: 1"=1'-0"

AS-BUILT DIMENSIONS			
NOZZLE	X	Y	Z
8			
9			

DIMENSIONS SHALL BE LISTED TO THE CLOSEST 1/64 OF AN INCH

NOTE:

1. FOR GENERAL NOTES, LEGEND AND KEY-PLAN, SEE DWG H-2-818518.
2. ALL "SL" M-9 PIPING, INCLUDING IT'S CONTAINMENT AND ATTACHMENT WELDS, SHALL BE SAFETY CLASSIFICATION (SS). ALL OTHER WORK SHALL BE SAFETY CLASSIFICATION (GS).



PLAN

DETAIL
SCALE: 1"=1'-0"

H-2-73344	TANK ISOLATION C-106		
H-2-73051 SHEET 2	DRAWING LIST		
H-2-41190	PIPING CASCADE PUMP PIT	H-2-818423	DRAWING LIST
H-2-41343	CONC PUMP PIT		

DRAWING PACKAGE LIST

REV NO.	DESCRIPTION	REVISION
1	W-320 PROJECT TURNOVER PER ECN W-320-783 INC ECN'S W-320-205 & 429	

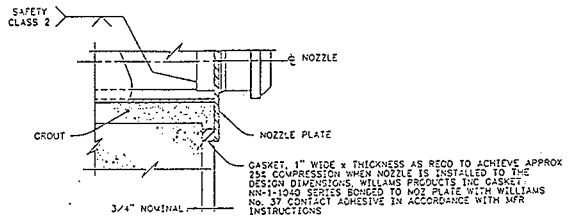
DESIGNED	B.A. MEYER
DRAWN	NENITO J JURO
CHECKED	C D JONES
SAFETY	A W CLARKSON
APPR	D L FORT
CAL. ENGR	J J HUSTON
CAD ENGR	C D JONES
SAFETY CLASSIFICATION	SS
PROJECT	W-320 TANK 241-C-106 SLUICING
REVISION NO.	15
REVISED BY	THOMAS H MAY
DATE	5-12-95
CAD FILE	8818522A
CAD DWG	WIN95:ACD2;12.0;SS
SCALE	SHOWN
DATE	3-21-94
SAFETY CLASSIFICATION	SS
CAD	606541

U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
ICF KAISER HANFORD COMPANY

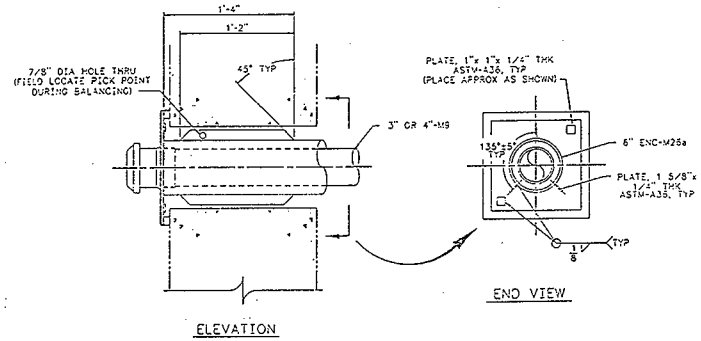
PIPING
PUMP PIT C-06A
PLAN, SECTIONS & DETAIL

F	241-C	0403	H-2-818522
REV NO.	1		
JOB NO.	ER4319	SHEET	1 OF 2

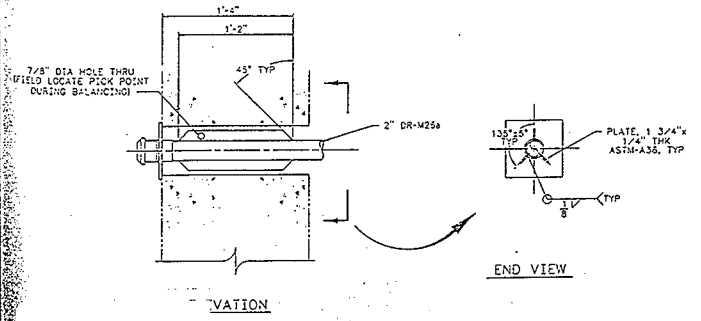
2 PLOT SCALE: 1=24 KEHCAD



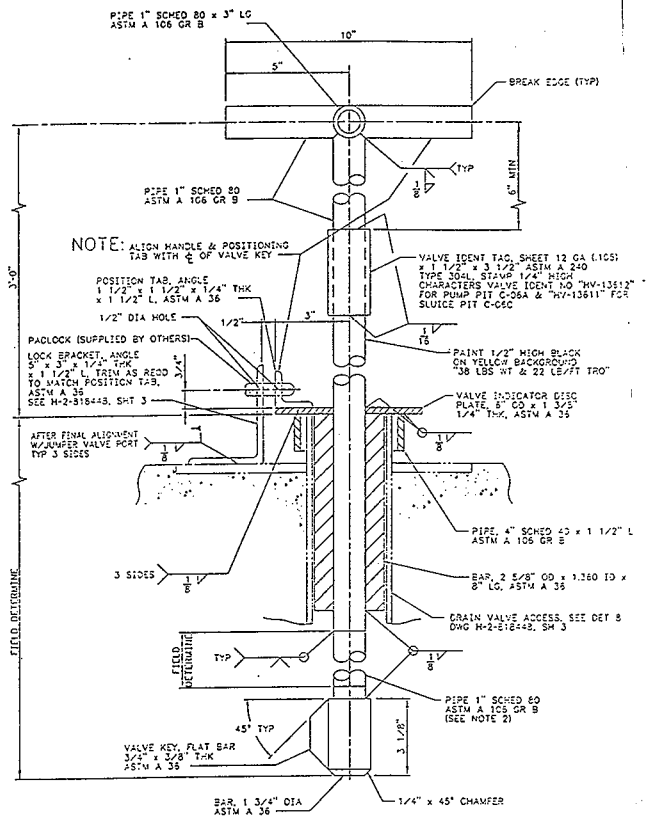
2 SH 1 DETAIL
SCALE: 3"= 1'-0"

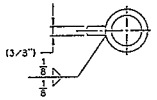


4 SH 1 DETAIL
SCALE: 2"= 1'-0"



5 SH 1 DETAIL
SCALE: 2"= 1'-0"





3 DETAIL (VALVE EXTENSION HANDLE)
H-2-818524, SH 1
SCALE: 1/2"= 1'-0"

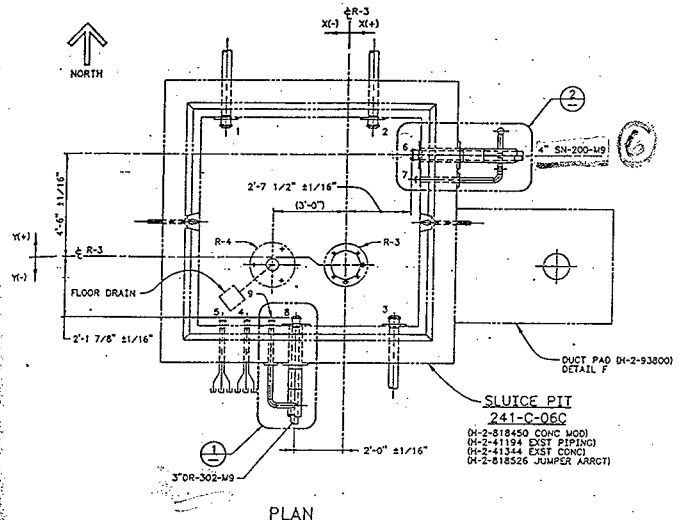
NOTE:

1. FOR NOTES, SEE SHEET 1.
2. ASSEMBLE SECTION SUCH THAT THE VALVE KEY IS CONCENTRIC (±1/4") TO VALVE EXTENSION HANDLE.
3. SEE H-2-818423 NOTE 1 FOR SPECIFIC INFORMATION CONCERNING SAFETY CLASSIFICATION OF COMPONENTS.

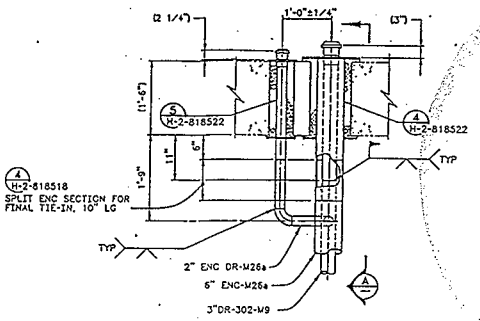
EXPIRES 7-31-19

DESIGNED BY B MEYER	SS		626541
DRAWN BY J JUPLO		U.S. DEPARTMENT OF ENERGY RICHLAND OPERATIONS OFFICE ICF KAISER HANFORD COMPANY	
CHECKED CD JONES		PIPING PUMP PIT C-06A DETAILS	
APPROVED AM CLARKSON			
DATE CL FORT			
DWG CHK JJ HUSTON			
DWG CHK CD JONES			
12		W-320 TANK 241-C-106 SLUICING	
		F 241-C 0403	H-2-818522 1

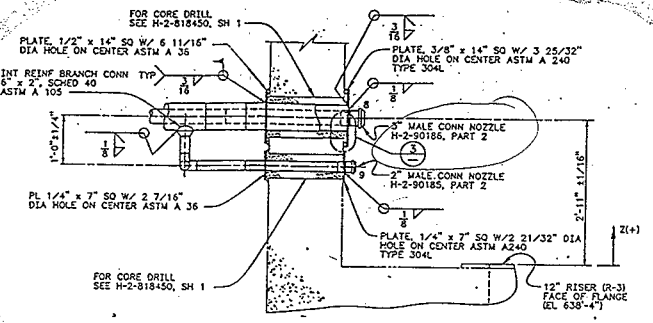
1 INC ECN W320-205, 510, 582, 583, 612 UPDATED PER PARTIAL FIELD VERIFICATION ECN W320-778 AS-BUILT FOR PROJECT W-320



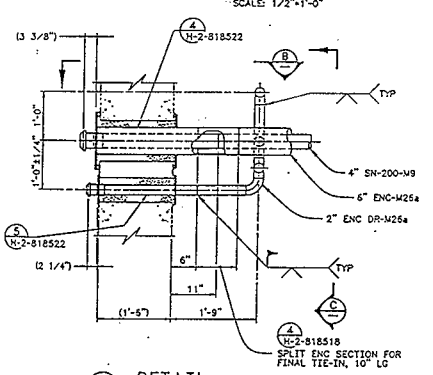
PLAN
SCALE: 1/2"=1'-0"



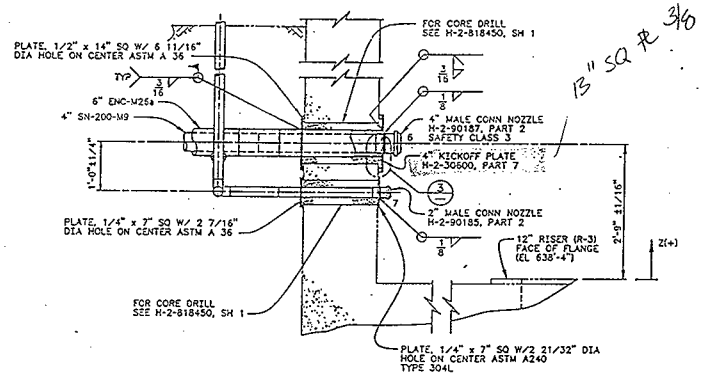
1 DETAIL
SCALE: 1"=1'-0"



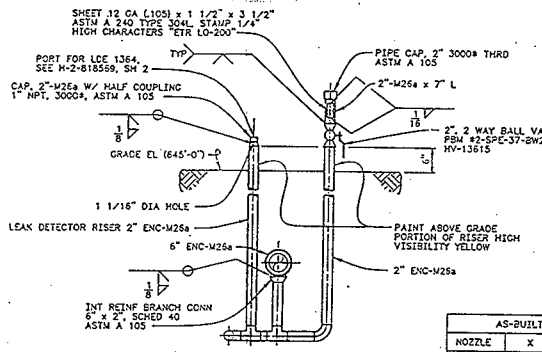
A SECTION
SCALE: 1"=1'-0"



2 DETAIL
SCALE: 1"=1'-0"



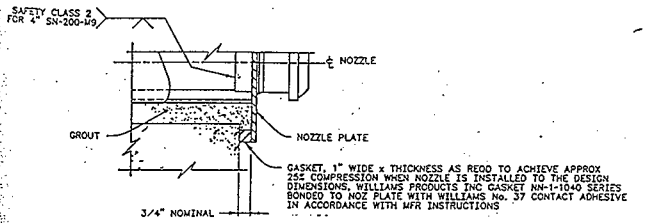
8 SECTION
SCALE: 1"=1'-0"



C SECTION
SCALE: 1"=1'-0"

AS-BUILT DIMENSIONS			
NOZZLE	X	Y	Z
6			
7			
8			
9			

DIMENSIONS SHALL BE LISTED TO THE CLOSEST 1/64 OF AN INCH



3 DETAIL
SCALE: 3"=1'-0"

NOTE:

1. FOR GENERAL NOTES, LEGEND AND KEY PLAN, SEE DWG H-2-818516.
2. ALL "SN" M-9 PIPING, INCLUDING IT'S CONTAINMENT AND ATTACHMENT WELDS, SHALL BE SAFETY CLASSIFICATION (SS). ALL OTHER WORK SHALL BE SAFETY CLASSIFICATION (GS).

H-2-73051 SHEET 2	DRAWING LIST
H-2-41344	CONC SLUICE PIT
H-2-41194	PIPING CASCADE SLUICE PIT
H-2-818423	DRAWING LIST

REV NO.	DESCRIPTION
1	W-320 PROJECT TURNOVER PER ECN W-320-783 INC ECN'S W-320-255 & 475

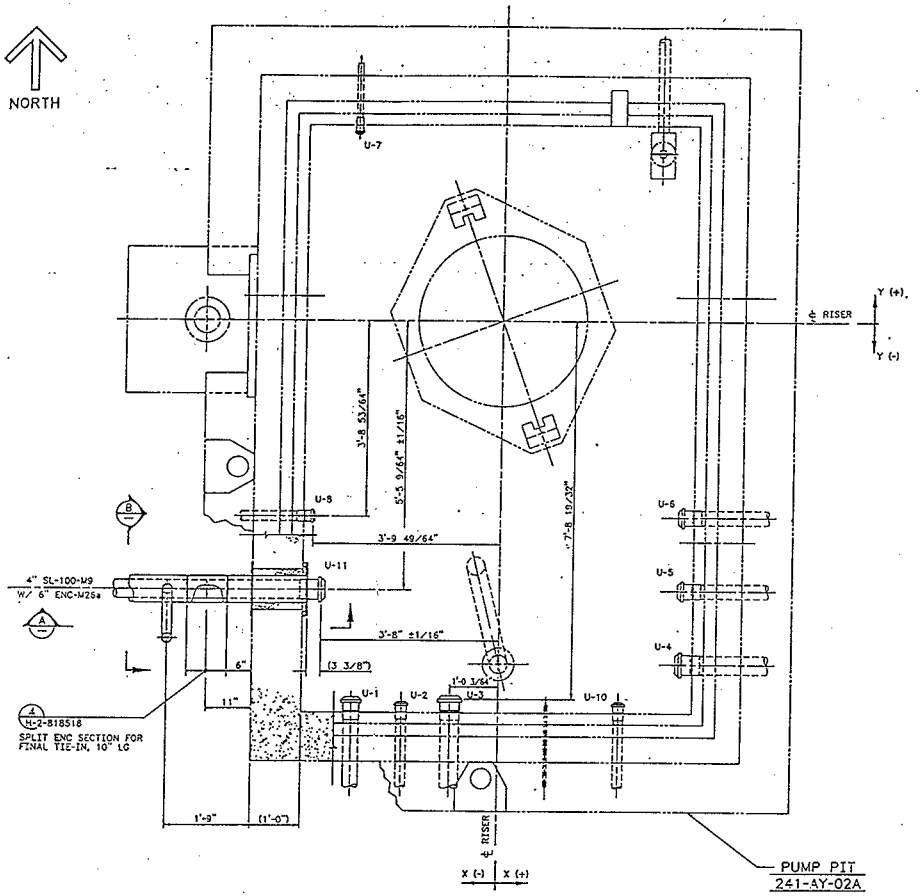
U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
ICF KAISER HANFORD COMPANY

PIPING
SLUICE PIT C-06C
PLAN, SECTIONS & DETAILS

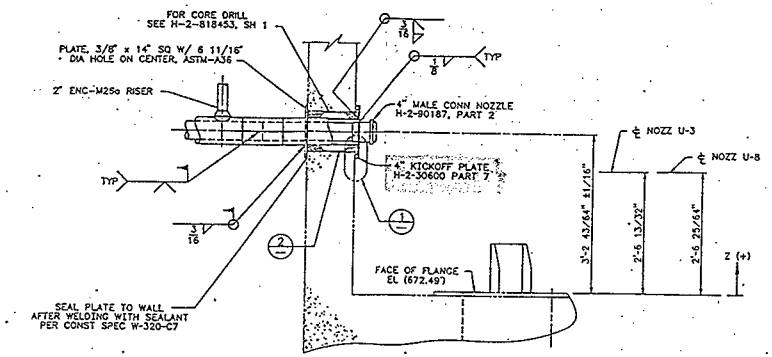
W-320 TANK 241-C-105 SLUICING

F 241-C 0403 H-2-818523 1

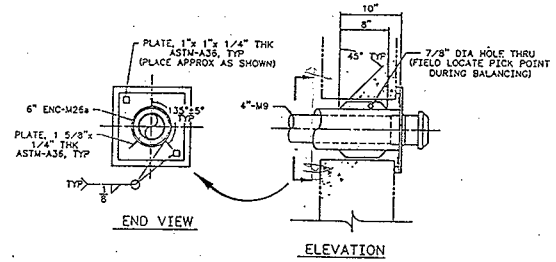
SCALE SHOWN



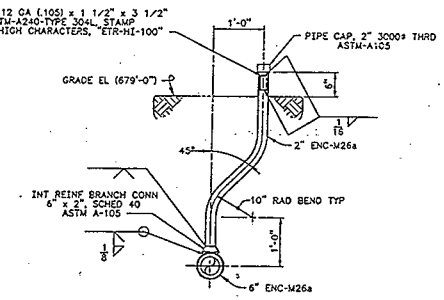
PLAN
SCALE: 1"=1'-0"



A SECTION
SCALE: 1"=1'-0"



2 DETAIL
SCALE: 1 1/2"=1'-0"



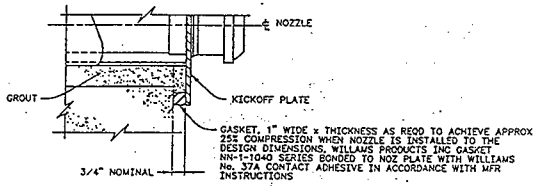
B SECTION
SCALE: 1"=1'-0"

AS-BUILT DIMENSIONS			
NOZZLE	X	Y	Z
U-11	- 3'-8"	- 5'-5 9/64"	13'-2 43/64"
U-8	- 3'-8 49/64"	- 3'-8 53/64"	12'-6 25/64"
U-3	- 1'-0 3/64"	- 7'-8 19/32"	12'-6 13/32"

DIMENSIONS SHALL BE LISTED TO THE CLOSEST 1/64 OF AN INCH

NOTE:

1. FOR GENERAL NOTES, LEGEND AND KEY PLAN, SEE H-2-818518.
2. ALL "SL" M-9 PIPING SHALL BE SAFETY CLASSIFICATION (SS). ALL OTHER WORK SHALL BE SAFETY CLASSIFICATION (GS).



1 DETAIL
SCALE: 3"=1'-0"

ESSENTIAL DRAWING

EXPIRES 7-21-16

H-2-64300	DRAWING LIST	H-2-818423	DRAWING LIST
H-2-64313	STRUCT CONC SLUICE-PIT		

REV		DESCRIPTION	REV BY DATE	REV APPROVED
RS	2	W-320 PROJECT TURNOVER PER ECN W-320-781		
RS	1	GEN DWG REV PER ECN W-320-571, 205 & 119 REV TO INCORP ECNS		

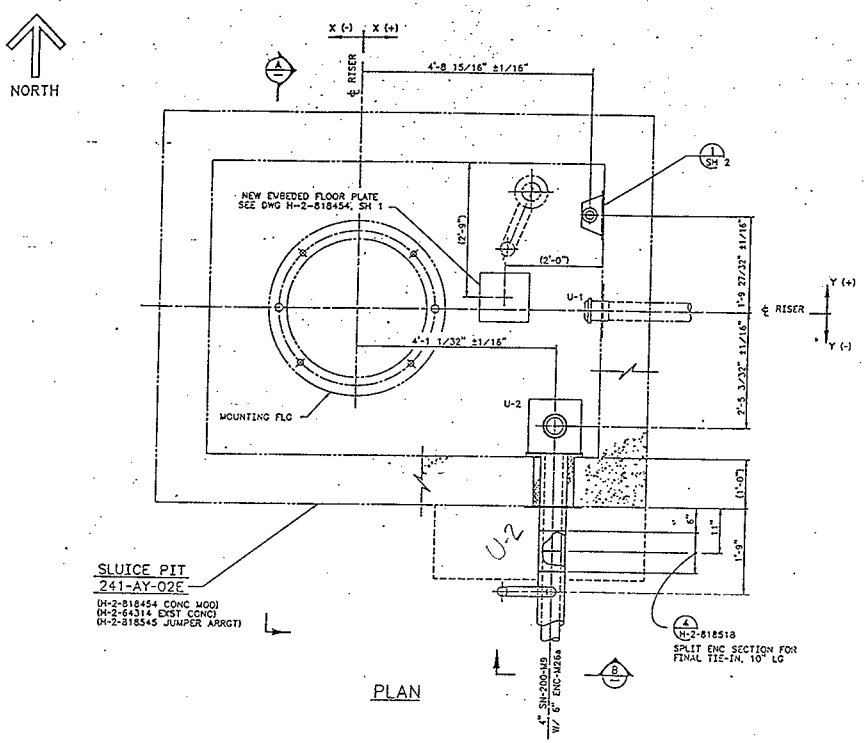
DESIGNED B. MEYER SF
DRAWN C D JONES
CHECKED ROGER SCHROEDER
SUPVR A W CLARKSON
DSGN ENGR D L FORT
DRAFTSMAN C E NORTON
LEAD ENGR C D JONES
REVISION NO. 16

SAFETY CLASSIFICATION SS
SET 606537

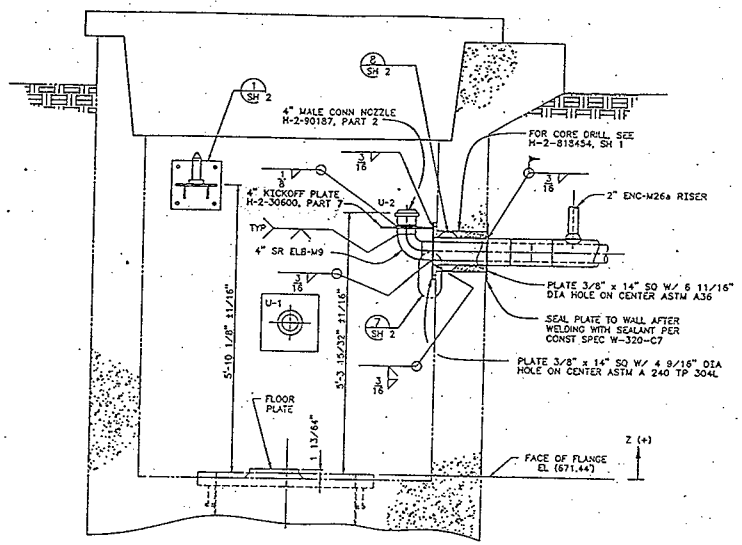
U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
ICF KAISER HANFORD COMPANY

PIPING ---
PUMP PIT AY-02A
PLAN, SECTIONS & DETAIL

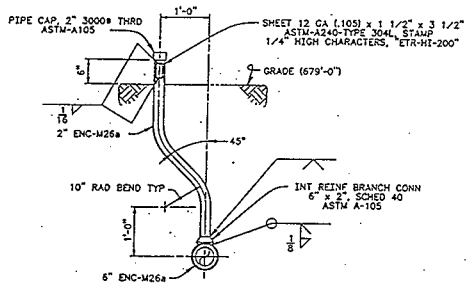
PROJECT W-320 TANK 241-C-106 SLUICING



PLAN



A SECTION



B SECTION

AS-BUILT DIMENSIONS			
NOZZLE	X	Y	Z
U-2	+ 4'-1 1/32"	- 2'-5 3/32"	+ 5'-3 15/32"
DET 1	+ 4'-8 15/16"	+ 1'-9 27/32"	+ 5'-10 1/8"
FLOOR PL	———	———	+ 8'-1 13/64"

DIMENSIONS SHALL BE LISTED TO THE CLOSEST 1/64 OF AN INCH

NOTE:

1. FOR GENERAL NOTES, LEGEND AND KEY PLAN, SEE H-2-818518.
2. ALL "SN" M-9 PIPING SHALL BE SAFETY CLASSIFICATION (SS). ALL OTHER WORK SHALL BE SAFETY CLASSIFICATION (GS).

ESSENTIAL DRAWING

EXPIRES 7-31-98

H-2-64300	DRAWING LIST	H-2-818423	DRAWING LIST
H-2-64314	STRUCT CONC SLUICE PIT		

RS	2	W-320 PROJECT TURNOVER PER ECN W-320-781		
RS	1	GEN DWG REV PER ECN W-320-001 -371, -272, -205 & -119 REV TO INCORP ECNS W-320		

DESIGNED	B. MEYER
DWN CHK	C O JONES
APPROVED	ROGER SCHROEDER
SUPERV	A W CLARKSON
CHKD	D L FORT
DWN CHK	C E NORTON
DWN CHK	C O JONES
SAFETY CLASSIFICATION	SS
UNIT	
REF	606537

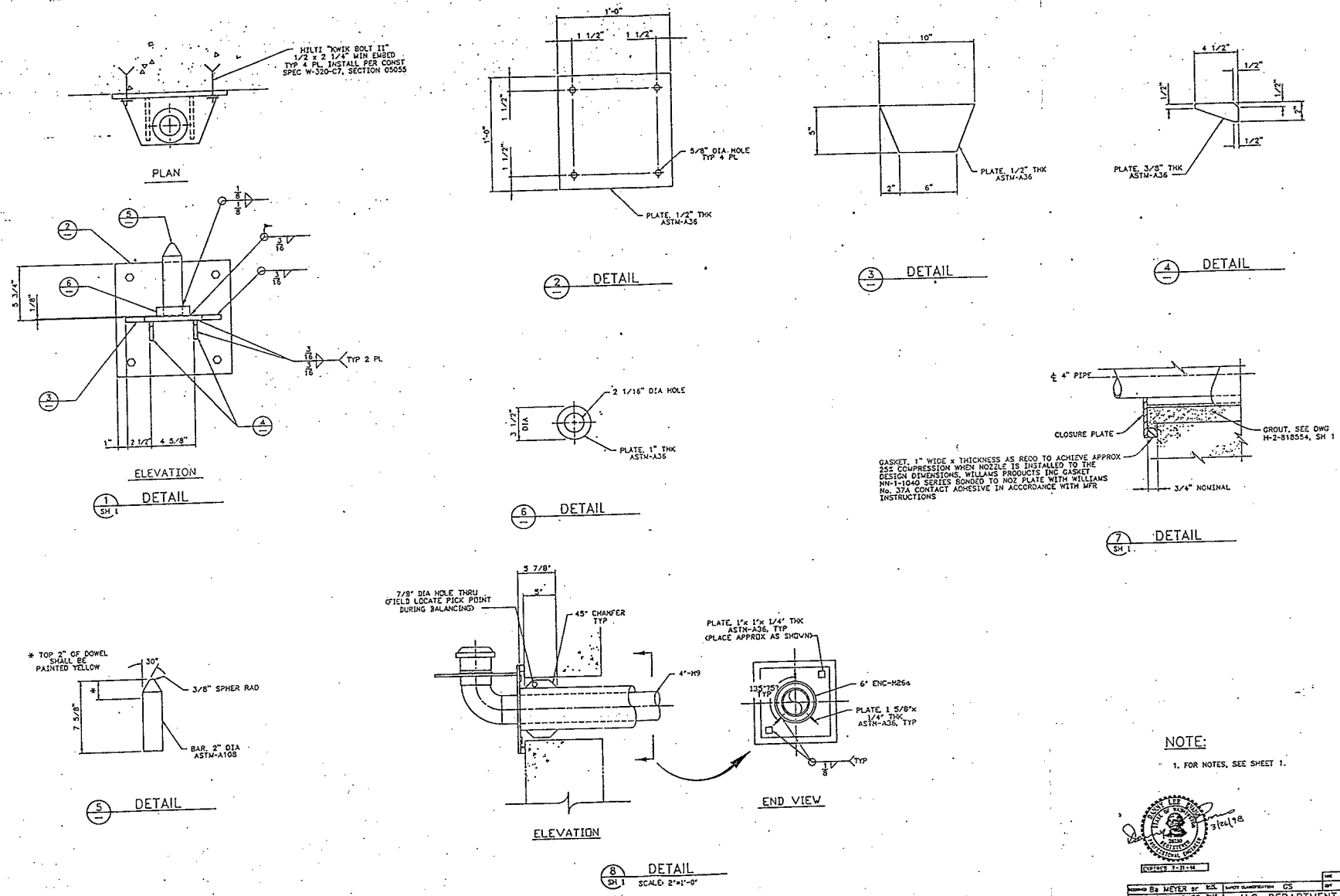
U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
ICF KAISER HANFORD COMPANY

PIPING
SLUICE PIT AY-02E
PLAN & SECTIONS

W-320 TANK 241-C-106 SLUICING

F 241-AY 0403 H-2-818543 2

CAD FILE B818543A WIN95:ACD2:12.0-SS



NOTE:

1. FOR NOTES, SEE SHEET 1.

3/26/98

EXPIRES 7-21-98

RS	2	W-320 PROJECT TURNOVER PER ECN W-320-781	
RS	1	W-320-255 AND -119 REV TO INCORP ECNS	

DRAWN	Ba MEYER		
CHKD BY	C D JONES		
APPD	ROGER SCHROEDER		
SAFETY	A W CLARKSON		
DESIGN	D C FORT		
ELEC DWG	C E NORTON		
CIVIL DWG	C D JONES		
REVISION NO.	11		
PROJECT ENGINEER	THOMAS H MAY		
DATE	8-22-95		

SAFETY CLASSIFICATION GS

606537

U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
ICF KAISER HANFORD COMPANY

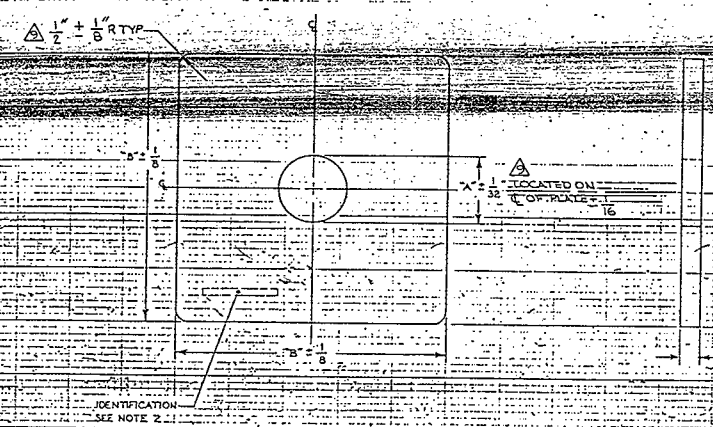
PIPING
SLUICE PIT AY-02E
DETAILS

W-320 TANK 241-C-106 SLUICING

SIZE F	SYM 241-AY	SHEET NO. 0403	DWG NO. H-2-818543
SCALE 3"=1'-0"		DWG NO. ER4319	SHEET 2 OF 2

WTN95:ACD2:12.0:SS

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 25/32"	6 1/4"	3/8"
3,4	2"	2 21/32"	6 1/4"	3/8"
5,6	3"	3 33/32"	11"	3/8"
7,8	4"	4 27/32"	13"	3/8"

(1) (2) (3) (4) (5) (6) (7) (8) STANDARD SQUARE KICK-OFF PLATE

GENERAL NOTES

1. BREAK ALL SHARP EDGES AND CORNERS
2. IDENTIFY PNT THRU 8 PER HS-BS-0015 TYPE 5 WITH DWG NO., PART NO. AND DRAWING REVISION NO. IN LOCATION INDICATED, USING .09 MIN. HIGH CHARACTERS

									INC. ECN 106830, 113558	10
									a) REV'D NOTE 2	9
									ADDED TYPE 5	8
									ADDED TYPE 5 (D) P-100 IDENT CALLOUT (E) C.O. REVISED NOTE 2 (5/01/92) B) Q.A. WAS LEVEL A) DIRECT DWG CHANGE. D.T.	7
									(B.3-G) (5) ADDED PARTS LIST (A) DIRECT DWG CHANGE-DI 11-24-76 INCORP FCN 52293 REPLACES REV. 5-DATED REDRAWN WITH CHANGES	6
										5
										4
										3
										2
										1

REVISION APPROVALS — REVISIONS — PROCESS SPEC

COMMENT PKT ISSUE NO. — CHECK PKT. ISSUE NO. — 5-27-80

REFERENCE DRAWINGS — NEXT USED ON AS ALLOCATED — DRAWING STATUS

STANDARD PART

DRAWING APPROVALS	DATE
J.M. KESEL	11-5-80
E.M. JOHNSTON	11-6-80
R.C.B.	
R.C. BRESCH	
R. CAMPBELL	11-24-80

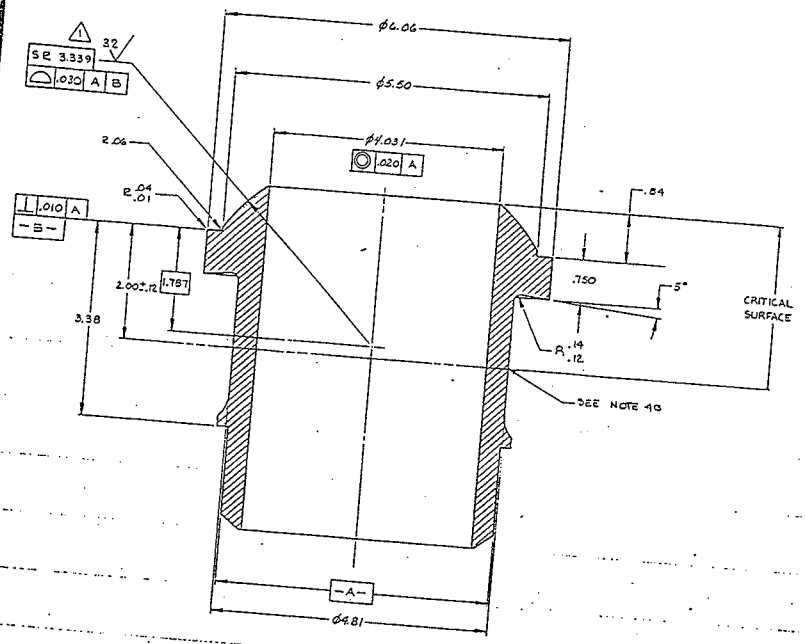
U.S. Department of Energy — Richland Operations Office

Rockwell Hanford Operations — Richland, Washington 99352

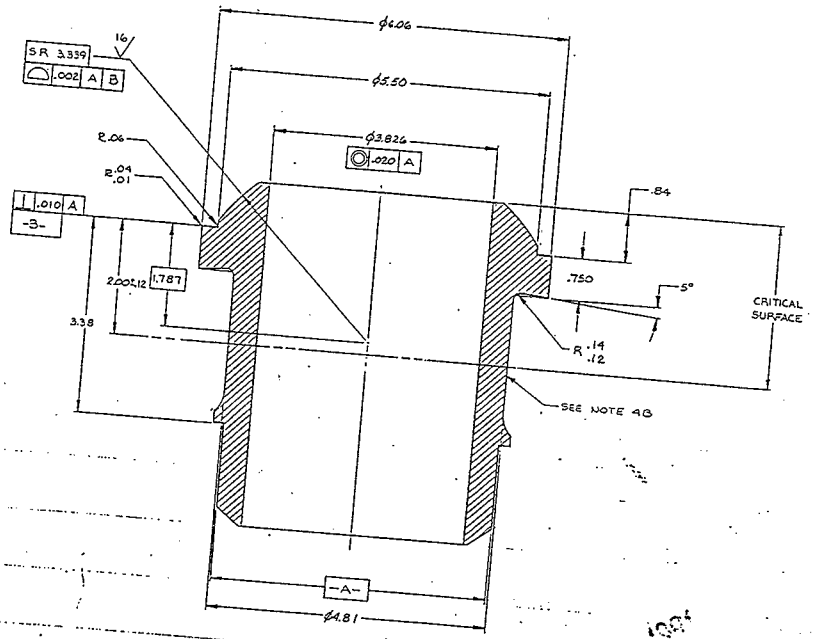
STANDARD SQUARE KICK-OFF PLATE FOR MALE CONNECTORS

NONE — NOT REQ'D — H-2-30600 — 1 — 1 OF 1

CAUTION
NOT COMPLETE WITHOUT
CURRENT STATUS OF OUTS
ECNS FROM DATA BASE
54 NOV 18 1991



(2) NOZZLE SCHED 40
AS MACHINED



(3) NOZZLE SCHED 80
AS MACHINED

54

CAUTION
NOT COMPLETE WITHOUT
CURRENT STATUS OF OUTSTANDING
ECNS FROM DATA BASE

STANDARD PART

DRAWING APPROVALS	DATE
R. YEATS	

U. S. Department of Energy
Richland Operations Office
Rockwell Hanford Operations
Richland, Washington 99352

MALE NOZZLE
4" PUREX

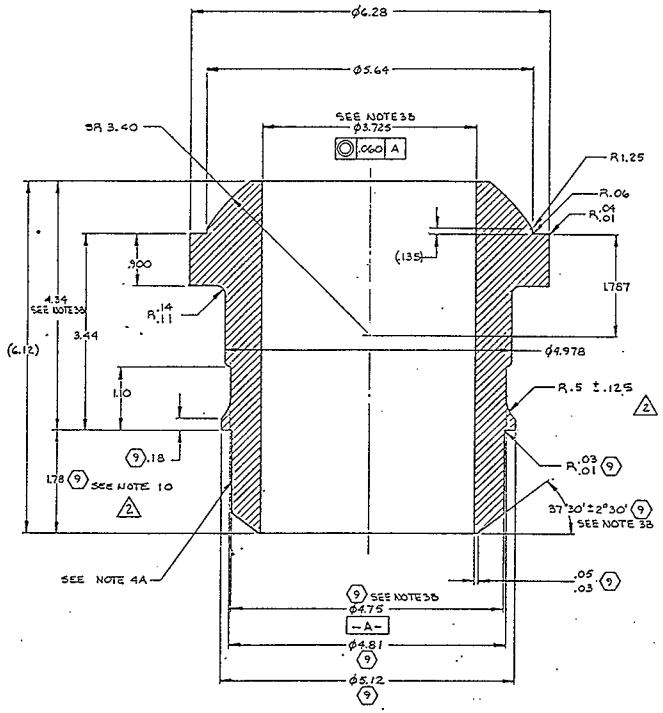
NONE	NOT REQD	FULL SIZE	2CC: GEN	4500	
		H-2-90187		2	2

						INC ECN-118040	1
						DESCRIPTION	

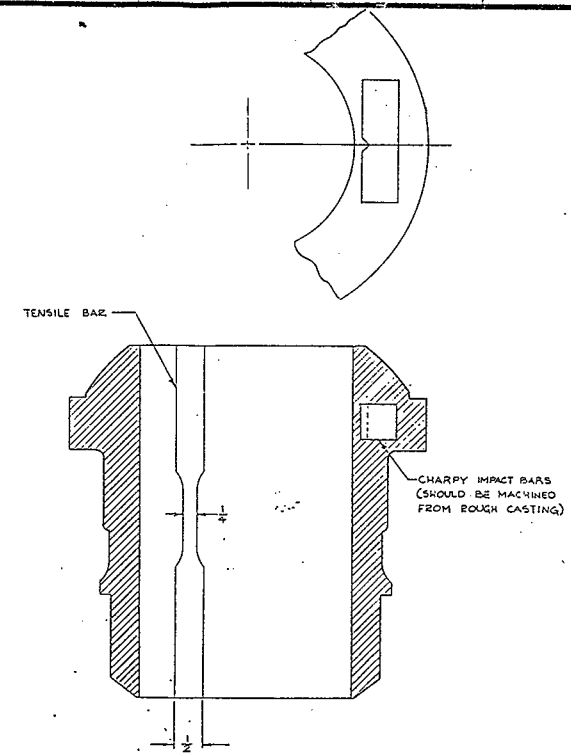
REVISION APPROVALS
REVISIONS
DRAWING STATUS

REFERENCE DRAWINGS
NEXT USED ON H-2-40187 SH 1

PT No	DESCRIPTION	MATERIAL/REMARKS
1	NOZZLE, INVESTMENT CASTING	SEE NOTE 1
2	NOZZLE, SCHED 40 AS MACHINED	H-2-90187-1
3	NOZZLE, SCHED 80 AS MACHINED	H-2-90187-1



1 NOZZLE INVESTMENT CASTING



TYPICAL SECTION FOR OBTAINING TEST SPECIMENS

GENERAL NOTES

1. INVESTMENT CASTINGS MATERIAL AND QUALITY SHALL CONFORM TO THE REQUIREMENTS OF HS-SP-0018.
2. CASTING FILLETS AND CORNER RADII SHALL BE 0.1 MAX. UNLESS OTHERWISE SPECIFIED.
3. DIMENSIONAL INSPECTION OF CASTING (PN 1) SHALL BE:
   A) FIRST ARTICLE INSPECTION OF CASTING FROM NEW TOOLING (NO PREVIOUS PRODUCTION RUNS) SHALL INCLUDE ALL DIMENSIONS. PRODUCTION RUN INSPECTION SHALL FOLLOW THE REQUIREMENTS OF STEP "B".
   B) INSPECTION OF SUBSEQUENT FIRST ARTICLE OR PRODUCTION RUN CASTING FROM PREVIOUSLY APPROVED TOOLING SHALL BE TO DIMENSIONS DESIGNATED.
4. IDENTIFY PER HS-PS-0015 IN LOCATIONS INDICATED:
   A) CAST PART, MARK WITH DRAWING NUMBER AND PART NUMBER TYPE 5, .09 MIN. HEIGHT CHARACTERS.
   B) MACHINED PART: MARK WITH DRAWING NUMBER, PART NUMBER AND DRAWING REVISION NUMBER TYPE 3, .09 MIN. HEIGHT CHARACTERS.
5. REMOVE BURRS AND BREAK SHARP EDGES.
6. MACHINE RADII SHALL BE 1010 R MAXIMUM
7. MACHINE SURFACE FINISH SHALL BE 125√ MAXIMUM.
8. ~~REGRAN CHG PER ECN-305025 AND MACHINE NOTES THAT MEET THE MACHINE CHG PER ECN-305025 AND CAPABILITIES OF RECENT INVESTMENT INSPECTION~~ 2
9. WHEN NOZZLE IS PURCHASED AS A COMPLETED UNIT (CAST AND MACHINED), CASTING DIMENSIONS MAY VARY TO SUIT VENDORS NEEDS. COMPLETED PARTS MUST MEET THE DIMENSIONAL REQUIREMENTS OF THE MACHINED NOZZLE AND THE DESIGNATED (9) CASTING DIMENSIONS.
10. THIS DIMENSION IS A CASTING DIMENSION THAT NEED NOT BE MET AFTER THE PART IS MACHINED.

54

NOV 18 1991

CAUTION
NOT COMPLETE WITHOUT
CURRENT STATUS OF OUTSTANDING
ECNS FROM DATA BASE

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON:
DECIMALS ANGLES FRACTIONS
XX±.03 ±0°30' ±
XXX±.010
DO NOT SCALE PRINT

THIS DRAWING REPLACES H-2-32446 REV 14

STARDARD PART

								AND 148343	2
								INC ECN 107536, 113574	
								PNC CHANGES PER ECN-305025	1
								2-65 INCORP ECO-345574 & DIRECT DRAW.	

REVISIONS

DRAWING APPROVALS	DATE
	1/6
	1/6
	1/6
	1/6
	1/6
	1/6
	1/6
	1/6

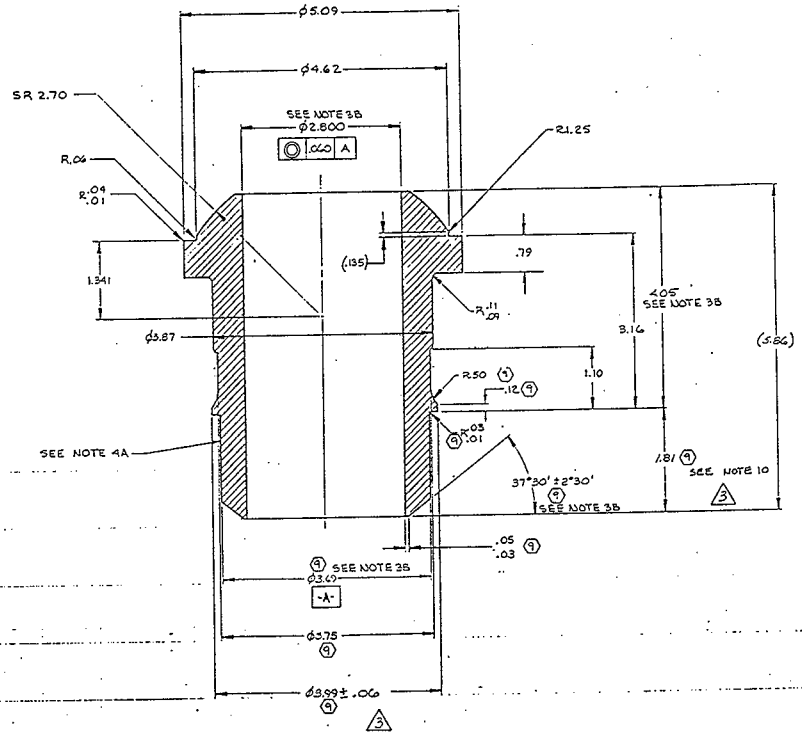
U. S. Department of Energy
Richland Operations Office
Rockwell Hanford Operations
Richland, Washington 99352

MALE NOZZLE
4" PUREX

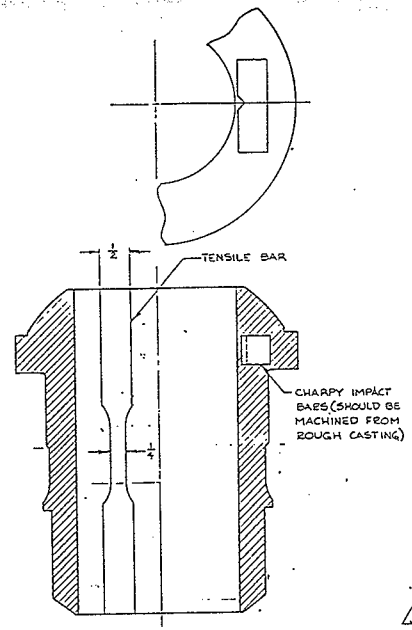
2	NONE	FULL SIZE	200 GEN 4500
		H-2-90187	1 2

REFERENCE DRAWINGS
NEXT USED ON 43 ALLOCATED
COMMENT PPT ISSUE NO
CHECK PPT. ISSUE NO.
DRAWING STATUS YOOZ

PT. NO	DESCRIPTION	MATERIAL / REMARKS
1	NOZZLE, INVESTMENT CASTING	SEE NOTE 1
2	NOZZLE, SCHED 40 AS MACHINED	H-2-90186-1
3	NOZZLE, SCHED 80 AS MACHINED	H-2-90186-1



(1) NOZZLE INVESTMENT CASTING



TYPICAL-SECTION FOR OBTAINING TEST SPECIMENS

GENERAL NOTES

1. INVESTMENT CASTINGS MATERIAL AND QUALITY SHALL CONFORM TO THE REQUIREMENTS OF HS-PP-0018.
2. CASTING FILLETS AND CORNER RADII SHALL BE 0.1 MAX. UNLESS OTHERWISE SPECIFIED.
3. DIMENSIONAL INSPECTION OF CASTING (PN 1) SHALL BE:
   A) FIRST ARTICLE INSPECTION OF CASTING FROM NEW TOOLING (NO PREVIOUS PRODUCTION RUNS) SHALL INCLUDE ALL DIMENSIONS. PRODUCTION RUN INSPECTION SHALL FOLLOW THE REQUIREMENTS OF STEP "B".
   B) INSPECTION OF SUBSEQUENT FIRST ARTICLE OR PRODUCTION RUN CASTING FROM PREVIOUSLY APPROVED TOOLING SHALL BE TO DIMENSIONS DESIGNATED.
4. IDENTIFY PER HS-PS-0013 IN LOCATIONS INDICATED:
   A) CAST PART, MARK WITH DRAWING NUMBER AND PART NUMBER TYPE 5, .09 MIN. HEIGHT CHARACTERS.
   B) MACHINED PART: MARK WITH DRAWING NUMBER, PART NUMBER AND DRAWING REVISION NUMBER TYPE 5, .09 MIN. HEIGHT CHARACTERS.
5. REMOVE BURRS AND BREAK SHARP EDGES.
6. MACHINE RADII SHALL BE .010 R MAXIMUM
7. MACHINE SURFACE FINISH SHALL BE 125 √ MAXIMUM.
8. [illegible]
9. WHEN NOZZLE IS PURCHASED AS A COMPLETED UNIT (CAST AND MACHINED), CASTING DIMENSIONS MAY VARY TO SUIT VENDORS NEEDS. COMPLETED PARTS MUST MEET THE DIMENSIONAL REQUIREMENTS OF THE MACHINED NOZZLE AND THE DESIGNATED (9) CASTING DIMENSIONS.
10. (3) THIS DIMENSION IS A CASTING DIMENSION THAT NEED NOT BE MET AFTER THE PART IS MACHINED.

54

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON:
DECIMALS ANGLES FRACTIONS
XX-±.03 ±0°30' ±
XXX-±.010
DO NOT SCALE PRINT

NOV 18 1991 CAUTION NOT COMPLETE WITHOUT CURRENT STATUS OF OUTSTANDING ECNS FROM DATA BASE

THIS DRAWING REPLACES H-2-32446 REV 14

STANDARD PART

REV	DESCRIPTION	
3	INC ECN 148343	
2	REV PER ECN-113574	
1	CLWNSS CHANGES PER ECN-505026, 2-55 INCORP ECO-245576 DAED DRAW.	

DRAWING APPROVALS / DATE

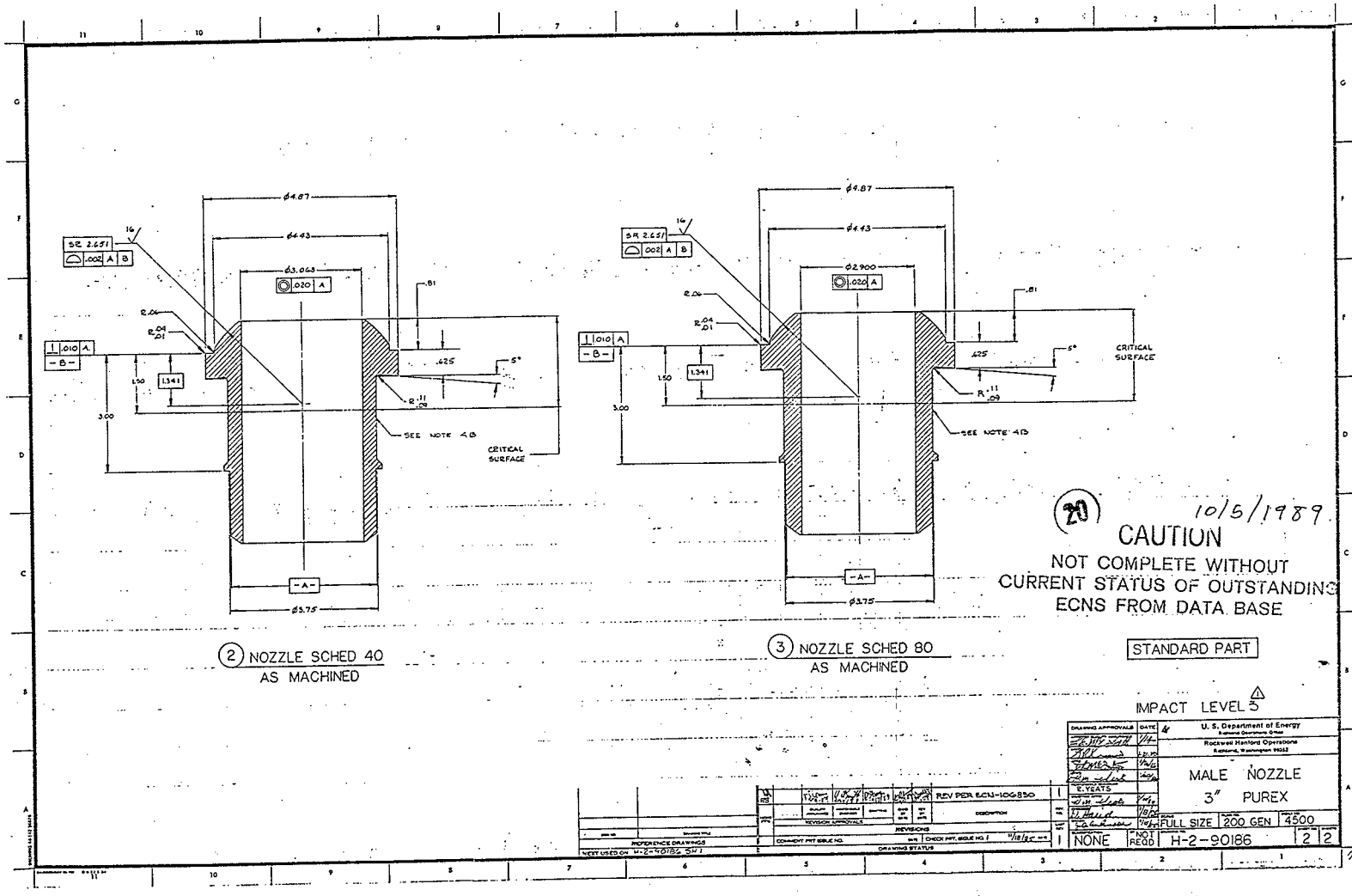
U. S. Department of Energy
Richland Operations Office
Rockwell Hanford Operations
Richland, Washington 99352

MALE NOZZLE
3" PUREX

SCALE FULL SIZE | PLOT NO. 200 GEN | PLOT NO. 4500
CAD/CAM NONE | NOT REQD | DRAWING NO. H-2-90186 | SHEET NO. 1 | 2

REFERENCE DRAWINGS
NEXT USED ON A.S. ALLOCATED
DRAWING STATUS

HNF-2479, Rev. 0


SR 2.651
.002 A B
16
ϕ4.87
ϕ4.43
ϕ3.063
.020 A
.81
R.06
R .04/.01
.625
5°
R .11/.09
SEE NOTE 4B
CRITICAL SURFACE
.010 A
-B-
1.50
1.341
3.00
-A-
ϕ3.75
ϕ2.900
(20)
10/5/1989
CAUTION
NOT COMPLETE WITHOUT
CURRENT STATUS OF OUTSTANDING
ECNS FROM DATA BASE
STANDARD PART
IMPACT LEVEL 5
(2) NOZZLE SCHED 40
AS MACHINED
(3) NOZZLE SCHED 80
AS MACHINED
U. S. Department of Energy
Rockwell Hanford Operations
MALE NOZZLE
3" PUREX
FULL SIZE
200 GEN
4500
NONE
H-2-90186
REV PER ECN-106830
REFERENCE DRAWINGS
NEXT USED ON H-2-90186 SH 1

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				