DISTRIBUTION SHEET

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Design Analysis Report for Compressed Air Piping 241-SY-101 Hydraulic Pump Retrieval Trailer		ECN No. NA

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ENGINEERING DATA TRANSMITTAL

1. EDT 609375

2. To: (Receiving Organization) See Distribution List	3. From: (Originating Organization) Special Projects	4. Related EDT No.: NA
5. Proj./Prog./Dept./Div.: 241-SY-101	6. Cog. Engr.: M. J. Ostrom	7. Purchase Order No.: NA
8. Originator Remarks: See attached Design Analysis report to determine pressure losses in the compressed air piping installed on the hydraulic trailer for the 241SY101 retrieval mission. These calculations apply to drawing H-2-824510. They are routed for your information.		9. Equip./Component No.: NA
		10. System/Bldg./Facility: 241-SY-101
11. Receiver Remarks:		12. Major Assm. Dwg. No.: NA
		13. Permit/Permit Application No.: NA
		14. Required Response Date: ASAP

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(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Impact Level	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition
1.	WHC-SD-WM-DA-183		0	DESIGN ANALYSIS REPORT FOR COMPRESSED AIR PIPING 241-SY-101 HYDRAULIC PUMP RETRIEVAL TRAILER.	SQ	3 1 BFA 12/14/94		

16. KEY

Impact Level (F)	Reason for Transmittal (G)	Disposition (H) & (I)
1, 2, 3, or 4 (see MRP 5.43)	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

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BFA	3 1	1	QA ML McElroy	[signature]	12/21/94	S1-57						
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18. MJ Ostrom [signature] 12/14/94 Signature of EDT Originator Date	19. CE Hanson [signature] 12/15/94 Authorized Representative for Receiving Organization Date	20. CE Hanson [signature] 12/15/94 Cognizant/Project Engineer's Manager Date	21. DOE APPROVAL (if required) Ltr. No. [] Approved [] Approved w/comments [] Disapproved w/comments

RELEASE AUTHORIZATION

Document Number:	WHC-SD-WM-DA-183, REV. 0
Document Title:	~~Design Analysis Report for~~ Compressed Air Piping, 241-SY-101 Hydraulic Pump Retrieval Trailer
Release Date:	12/22/94

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

APPROVED FOR PUBLIC RELEASE

WHC Information Release Administration Specialist:

Niki Solis   12/22/94

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SUPPORTING DOCUMENT

1. Total Pages 13

2. Title

Compressed Air Piping, 241-SY-101 Hydraulic Pump Retrieval Trailer

3. Number

WHC-SD-WM-DA-183

4. Rev No.

0

5. Key Words

Piping
Trailer
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12/22/94 D. Doles

6. Author

Name: Thomas R. Wilson

Signature

Organization/Charge Code 7E620/N2B26

7. Abstract

The following Design Analysis was prepared by the Westinghouse Hanford Company to determine pressure losses in the compressed air piping installed on the hydraulic trailer for the 241-SY-101 pump retrieval mission.

9. Impact Level ~~N/A~~ SQ

10. RELEASE STAMP

OFFICIAL RELEASE BY WHC
DATE DEC 22 1994
35 Station 21

COMPRESSED AIR PIPING
241-SY-101 HYDRAULIC PUMP RETRIEVAL TRAILER

PREPARED BY: [signature] DATE: 12/13/94
T. R. Wilson, Engineer
Mitigation Equipment

REVIEWED BY: R. D. Routh DATE: 12/14/94
R. D. Routh, PE
Mitigation Equipment

APPROVED BY: [signature] DATE: 12/15/94
C. E. Hanson, Manager
Mitigation Equipment

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

CHECKLIST FOR INDEPENDENT REVIEW

Document Reviewed WHC-SD-WM-DA-183, Rev. 0

Author T. R. Wilson

Yes	No	NA	
[X]	[ ]	[ ]	Problem completely defined.
[X]	[ ]	[ ]	Necessary assumptions explicitly stated and supported.
[ ]	[ ]	[X]	Computer codes and data files documented.
[X]	[ ]	[ ]	Data used in calculations explicity stated in document.
[X]	[ ]	[ ]	Data checked for consistency with original source information as applicable.
[X]	[ ]	[ ]	Mathematical derivations checked including dimensional consistency of results.
[X]	[ ]	[ ]	Models appropriate and used within range of validity or use outside range of established validity justified.
[ ]	[ ]	[X]	Hand calculations checked for errors.
[ ]	[ ]	[X]	Code run streams correct and consistent with analysis documentation.
[ ]	[ ]	[X]	Code output consistent with input and with results reported in analysis documentation.
[X]	[ ]	[ ]	Acceptability limits on analytical results applicable and supported. Limits checked against sources.
[X]	[ ]	[ ]	Safety margins consistent with good engineering practices.
[X]	[ ]	[ ]	Conclusions consistent with analytical results and applicable limits.
[X]	[ ]	[ ]	Results and conclusions address all points required in the problem statement.

If software analysis performed,

MANDATORY Software QA Log Number N/A

R. D. Rouch (signature)
Reviewer

12/14/94
Date

DESIGN VERIFICATION METHOD

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

___X___ Independent Review

_______ Alternative Calculations

_______ Qualification Testing

_______ Formal Design Review

C. E. Hanson [signature] 12/15/94
Cognizant/Project/Design Manager

SD # WHC-SD-WM-DA-183, Rev. 0

ECN #______

DWG(S) #H-2-824510

CONTENTS

DESIGN ANALYSIS REPORT FOR COMPRESSED AIR PIPING, 241-SY-101 HYDRAULIC PUMP RETRIEVAL TRAILER

1.0 INTRODUCTION

The purpose of this analysis is to determine the pressure losses in the compressed air piping installed on the WHC 100-ton Hydraulic Trailer, a component of the 241-SY-101 Equipment Removal System. Compressed air is used to operate the pneumatic vibrators installed on the Hydraulic Trailer and Strongback. To operate effectively, each of the six (6) vibrators must be supplied with compressed air at the same pressure. Regulators are installed at the inlet to each vibrator to control air pressure to the same pressure requirement. The compressed air supply pressure minus the compressed air piping losses must be greater than the regulated pressure requirement at all of the vibrators. This analysis calculates the pressure losses in the longest, hence worst case, piping run only. Pressure losses in shorter piping runs will be less, therefore air pressure at all of the regulators will be adequate if the worst case condition is satisfied.

2.0 SUMMARY OF RESULTS

The pressure losses in the compressed air piping installed on the WHC 100-ton Hydraulic Trailer are small based on the air consumption requirements of the vibrators. Adequate air pressure will be available at all of the regulators if the compressed air supply pressure is greater than approximately 100 psig. Pressure losses will vary with the temperature and humidity of the ambient air, however the compressed air supply pressure noted will more than accommodate these variances.

3.0 DISCUSSION

Each vibrator requires a compressed air flowrate of 93 standard cubic feet per minute, delivered at 80 psig. The compressed air piping is fabricated from nominal 2-inch black steel pipe and fittings. A short piece of hose connects the compressed air piping on the Strongback to the compressed air piping on the Hydraulic Trailer to allow the Strongback to be raised and lowered. The pressure losses through the hose are considered to be negligible. The compressed air piping is routed back to a manifold with a single-point connection for the compressed air supply. Valves are installed to isolate the front, left side, and right side pairs of vibrators. The configuration of the compressed air piping is shown on Drawing H-2-824510. The pressure loss calculations are included in Appendix A.

4.0 REFERENCES

DRAWINGS

H-2-824510 Vibrator Air Piping Installation

OTHER

Hicks, Tyler G., *Standard Handbook of Engineering Calculations*

APPENDIX A - CALCULATIONS

ANALYTICAL CALCULATIONS

Page ____ of ____

Subject AIR LINE SIZING · PRESSURE DROPS

Originator S. L. TAYLOR Date 12/1/94

Checker R. D. ROUTH Date 12/1/94

SEE ATTACHED MATHCAD CALCULATIONS AND REFERENCES

BD-6400-060.1 (07/93)

AIR LINE SIZING - PRESSURE DROPS

BASIS: (2) 2-inch lines down length of trailer from compressor tie-in to rear of strong back.
upstream pressure is 125 psig from compressor output.
flow required (each line) = 186 cfm @ 80 psi.
pipe is 2-inch carbon steel inside diameter is: $d := 2.067$ in

length of each pipe.. $l := 60$ ft
equivalent length of (2) 90 degree elbows: (pg 3-355). $\theta := 3.5$ft......... $E := 2 \cdot \theta$
equivalent length of (1) tee: (pg 3-355)... $t := 12$ ft
total equivalent of pipe:........................... $L := l + E + t$ .... $L = 79$ ft

volume flow rate: $Q := 186$ scfm
(atmospheric pressure = 14.7)

pressure: $P := (125 + 14.7)$

volume: $v := 144$

temperature: $T := 60 + 460$

gas constant: $R := 53.33$

compressed air density: (pg 3-390) $\rho := \frac{P \cdot v}{R \cdot T}$ $\rho = 0.73$

standard air density $\tau := .075$

weight flow rate: (pg 3-390) $W := \tau \cdot Q \cdot 60$ $W = 837$

velocity: (pg 3-390) $V := \frac{183.4 \cdot W}{3600 \cdot d^2 \cdot \rho}$ $V = 13.76$

viscosity of air at 80 F is : (pg 3-390) $z := 0.0186$ cp

Reynolds number: (pg 3-390) $R := \frac{6.32 \cdot W}{d \cdot z}$ $R = 1.38 \cdot 10^5$

on curve 6 (pg 3-389) for 2 inch carbon steel pipe friction factor is: $\xi := 0.021$

pressure loss in the pipe: (pg 3-391) $\Delta P := \frac{3.36 \cdot 10^{-6} \cdot \xi \cdot L \cdot W^2}{d^5 \cdot \rho}$ $\Delta P = 0.14$ psi

* all formulas are found in "Standard Handbook of Engineering Calculations", Tyler G.Hicks

AIR LINE SIZING - PRESSURE DROPS

BASIS: (2) 2-inch lines on each side of strongback from tie-in at rear for rear vibrators at front of strongback.
upstream pressure is (125 - 5.34) = 119.66 psig from compressor output.
flow required (each line) = 93 cfm @ 80 psi.
pipe is 2-inch carbon steel inside diameter is: $d := 2.067$ in

length of each pipe.. $l := 30$ ft
equivalent length of (2) 90 degree elbows: (pg 3-355).$\theta := 3.5$ft......... $E := 2 \cdot \theta$
equivalent length of (1) 2-inch -1-inch reducer: (pg 3-355).................. $t := 2.0$ ft
total equivalent of pipe:............................ $L := l + E + t$ .... $L = 39$ ft

volume flow rate: $Q := 93$scfm
(atmospheric pressure = 14.7)

pressure: $P := (119.66 + 14.7)$

volume: $v := 144$

temperature: $T := 60 + 460$

gas constant: $R := 53.33$

air density: (pg 3-390) $\rho := \frac{P \cdot v}{R \cdot T}$ $\rho = 0.7$

standard air density: $\tau := .075$

weight flow rate: (pg 3-390) $W := \tau \cdot Q \cdot 60$ $W = 418.5$

velocity: (pg 3-390) $V := \frac{183.4 \cdot W}{3600 \cdot d^2 \cdot \rho}$ $V = 7.15$

viscosity of air at 80 F is : (pg 3-390) $z := 0.0186$ cp

Reynolds number: (pg 3-390) $R := \frac{6.32 \cdot W}{d \cdot z}$ $R = 68795.36$

on curve 6 (pg 3-389) for 2 in carbon steel pipe friction factor is: $\xi := .022$

pressure loss in the pipe: (pg 3-391) $\Delta P := \frac{3.36 \cdot 10^{-6} \cdot \xi \cdot L \cdot W^2}{d^5 \cdot \rho}$ $\Delta P = 0.02$ psi

* all formulas are found in "Standard Handbook of Engineering Calculations", Tyler G.Hicks

AIR LINE SIZING - PRESSURE DROPS

BASIS: inlet to (2) vibrators.
upstream pressure is 125 psig from compressor output.
flow required (each line) = 186 cfm @ 80 psi.
pipe is 2-inch carbon steel inside diameter is: $d := 2.067$ in

length of each pipe.. $l := 27$ ft
equivalent length of 90 degree elbows: (pg 3-355).............................. $E := 3.5$ ft
equivalent length of (1) tee: (pg 3-355).. $t := 12$ ft
total equivalent of pipe:........................... $L := l + E + t$ .... $L = 42.5$ ft

volume flow rate: $Q := 186\,\text{scfm}$

pressure: $P := (125 + 14.7)$

volume: $v := 144$

temperature: $T := 60 + 460$

gas constant: $R := 53.33$

compressed air density: (pg 3-390) $\rho := \dfrac{P \cdot v}{R \cdot T}$ $\rho = 0.73$

standard density $\tau := .075$

weight flow rate: (pg 3-390) $W := \tau \cdot Q \cdot 60$ $W = 837$

velocity: (pg 3-390) $V := \dfrac{183.4 \cdot W}{3600 \cdot d^2 \cdot \rho}$ $V = 13.76$

viscosity of air at 80 F is : (pg 3-390) $z := 0.0186\,\text{cp}$

Reynolds number: (pg 3-390) $R := \dfrac{6.32 \cdot W}{d \cdot z}$ $R = 1.38 \cdot 10^5$

on curve 6 (pg 3-389) for 2 inch carbon steel pipe friction factor is: $\xi := 0.021$

pressure loss in the pipe: (pg 3-391) $\Delta P := \dfrac{3.36 \cdot 10^{-6} \cdot \xi \cdot L \cdot W^2}{d^5 \cdot \rho}$ $\Delta P = 0.08$ psi

* all formulas are found in "Standard Handbook of Engineering Calculations", Tyler G.Hicks

AIR LINE SIZING - PRESSURE DROPS

BASIS: inlet to floor penetration

neglect inlet air line diameter to trailer air line diameter change.
assume ball valve has the same equivalent length of pipe as a globe valve.
flow required (each line) = 186 cfm @ 80 psi.
pipe is 2-inch carbon steel inside diameter is: $d := 2.067$ in

equivalent length of (1) globe valve: (pg 3-355).................................. $gv := 50$ ft
length of each pipe.. $l := 71$ ft
equivalent length of (2) 45 degree elbows: (3-355) $\phi := 2.5$ ft........... $E1 := 4 \cdot \phi$
equivalent length of (4) 90 degree elbows: (pg 3-355). $\theta := 3.5$ft......... $E2 := 4 \cdot \theta$
equivalent length of (1) tee: (pg 3-355)........... $\omega := 12$ ft .... $t := 2 \cdot \omega$ ft
total equivalent of pipe:............................ $L := gv + l + E1 + E2 + t$ $L = 169$ ft

volume flow rate: $Q := 186$ scfm

pressure: $P := (125 + 14.7)$
atmospheric pressure = 14.7

volume: $v := 144$

temperature: $T := 60 + 460$

gas constant: $R := 53.33$

compressed air density: (pg 3-390) $\rho := \dfrac{P \cdot v}{R \cdot T}$ $\rho = 0.7$

standard density $\tau := .075$

weight flow rate: (pg 3-390) $W := \tau \cdot Q \cdot 60$ $W = 837$

velocity: (pg 3-390) $V := \dfrac{183.4 \cdot W}{3600 \cdot d^2 \cdot \rho}$ $V = 13.76$

viscosity of air at 80 F is : (pg 3-390) $z := 0.0186$ cp

Reynolds number: (pg 3-390) $R := \dfrac{6.32 \cdot W}{d \cdot z}$ $R = 1.38 \cdot 10^5$

on curve 6 (pg 3-389) for 2 inch carbon steel pipe friction factor is: $\xi := 0.021$

pressure loss in the pipe: (pg 3-391) $\Delta P := \dfrac{3.36 \cdot 10^{-6} \cdot \xi \cdot L \cdot W^2}{d^5 \cdot \rho}$ $\Delta P = 0.31$ psi

* all formulas are found in "Standard Handbook of Engineering Calculations:", Tyler G. Hicks