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SUBJECT: Forwards response to request for addl info on Bulletin
88-005 re product forms other than fittings & flanges.

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WILLIAM F. CONWAY
EXECUTIVE VICE PRESIDENT
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161-03547-WFC

October 19, 1990

Docket No. STN 528/529/530

Document Control Desk
U. S. Nuclear Regulatory Commission
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- Reference:
- A) Letter from S. R. Petersen, NRC, to W. F. Conway, APS, dated September 12, 1990
Subject: Bulletin 88-05 Regarding Product Forms Other than Fittings and Flanges
 - B) Letter from W. F. Conway to NRC, dated June 8, 1990 (161-3268 dated June 8, 1990)
Subject: Bulletin 88-05 Regarding Product Forms Other Than Fittings and Flanges
 - C) Letter from S. R. Petersen, NRC, to W. F. Conway, APS, dated May 18, 1990
Subject: Bulletin 88-05 Regarding Product Forms Other Than Fittings and Flanges

Dear Sirs:

Subject: Palo Verde Nuclear Generating Station (PVNGS)
Units 1, 2, and 3
Bulletin 88-05 Regarding Product Forms Other than Fittings and Flanges from Piping Supplies Incorporated (PSI) West Jersey Manufacturing (WJM) and Chews Landing Metal Manufacturing (CLM)
File: 90-019-026

Attachment 1 of this letter provides responses to the Reference (A) NRC request for additional information.

Attachment 2 of this letter provides the results of the analysis to demonstrate the adequacy of the lug material as scheduled in Reference (B).

The Reference (B) letter stated that APS is reviewing its records to determine if product forms other than lugs have been procured from PSI, WJM and CLM. APS has completed this review and has determined that the only material supplied to PVNGS was pipe lugs.

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Page Two

The Reference (B) letter also stated APS will provide a plan for future use of PSI, WJM, or CLM material other than fittings and flanges which are in storage. (Item 4 of the Reference C letter.) There is no PSI, WJM, or CLM lug material presently in the PVNGS warehouse. Therefore, there are no plans for future use of stored PSI, WJM, or CLM lug material.

If you have any questions, please contact A. C. Rogers of my staff at (602) 340-4093.

Sincerely,

A handwritten signature in cursive script that reads "James M. Levine for WFC". The signature is written in dark ink and is positioned to the right of the word "Sincerely,".

WFC/JMQ/pmm

Attachments

cc: D. H. Coe
J. B. Martin
A. C. Gehr
A. H. Gutterman

EVALUATION OF LUGS AT PVNGS

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ATTACHMENT 1

RESPONSE TO REQUEST FOR INFORMATION DATED SEPTEMBER 12, 1990

1. What is the design code used for the evaluation of the welded lugs? What is the design code the lugs were originally designed to?

RESPONSE: In both instances, ASME Code Section III, 1974 Edition, with Addenda through Winter 1975, was utilized.

2. In the bounding calculations for the lugs, what is the assumed maximum stress values for the pipe wall and weld? Is this stress assumed to be the maximum pull-out shearing stress where the lug is attached? Are the bounding calculations for lugs attached to pipe elbows? Provide sample bounding calculations.

RESPONSE: The critical part of a welded lug design is the locally induced stress levels in the piping. These stresses govern over the weld and lug stresses. Local pipe wall stresses combined with the stresses generated by the internal piping loading are required to meet the applicable code allowable limits. Limiting the local stresses to be 50% of the basic material (S_h) code allowable will yield a conservative maximum anticipated lug load.

Lugs on Q class piping elbows are not used at PVNGS.

The formulas and analyses specifics are discussed in Attachment 2, Section 4. Specific calculations are available for review if needed.

3. What are the assumptions in the bounding analysis regarding the limiting lug dimensions, stress areas, the stress concentration factors, and the theory of failure. Are Welding Research Council (WRC) Bulletins 107, 198, and 297 used in these bounding calculations?

RESPONSE: The sampling process and the specifics of the analysis are discussed in Attachment 2, Sections 3 and 4. Bechtel Program ME210 was utilized to compute maximum anticipated lug loads. Bechtel Program ME210 is based on the theories and approaches outlined in WRC Bulletin 107 and is consistent with the guidance of WRC Bulletins 198 and 297.

4. Provide the results of sample tensile and chemical tests of the lug material from warehouse stock and sample hardness tests of the installed lugs to demonstrate the adequacy of the bounding lug strength assumption.

RESPONSE: Tensile, chemical, and hardness tests are not warranted based on the results of the analysis provided in Attachment 2. Our assumptions for the mechanical and chemical properties of the steel are consistent with the findings for fittings and flanges as discussed in NUREG-1402.

ATTACHMENT 2

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1.0 INTRODUCTION

NRC Bulletin 88-05 identified a problem with the products supplied by Piping Supplies Incorporated (PSI), West Jersey Manufacturing (WJM), and Chews Landing Metal Manufacturers (CLM). The material issue regarding flanges and fittings was resolved for Palo Verde. However, the issue regarding material other than fittings and flanges required a response per NRC letters dated May 18, 1990, and September 12, 1990. The review of PSI, WJM and CLM products other than fittings and flanges revealed that lugs were the only other product form delivered to PVNGS.

2.0 PURPOSE

This report documents the activities performed to demonstrate that pipe lug material supplied by the suppliers (PSI, WJM, and CLM) identified in the NRC Bulletin 88-05 will perform its intended function without compromising the safety of the Palo Verde pipe support design. Based on industry-wide test results, as documented in NUREG-1402, the lowest strength ASME plate material is considered for this evaluation.

3.0 SCOPE

The lug evaluation is limited to safety related (Q class) piping systems. The initial scope considered for this evaluation was based on Shear Lug Table 4.1 of the Bechtel Power Corporation (BPC) Pipe Support Design Manual for the Palo Verde Project (see Appendix B). However, a survey of the actual lug design showed that lug sizes other than those specified in Table 4.1 were utilized in the pipe support design work. Therefore, a random sample approach to include all possible lug sizes for Palo Verde was deemed necessary.

3.1 Sampling Process

A flow chart of this process is shown in Appendix A. The process is described as follows:

3.1.1 Population Size

Q class and non-Q class piping stress calculations were reviewed and 454 Q class calculations were identified. These calculations comprise the population size.

3.1.2 Sampling Technique

The calculations, comprising the population size, were sequentially numbered from 1 to 454 in order to proceed with the random sampling process. In order to achieve a 95% confidence level sample, a sample size of 55 is required for a total population of 454 calculations (see Appendix A). The random sampling was performed as follows:

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3.1.3 First Sampling

The last three digits of column 7 of the statistical tables for random units (Reference 6.3) were used to select the calculation numbers for the initial sample size of 55. Fifty-five calculations resulted but did not contain any piping greater than 12 inches in diameter. A second sample was necessary to include piping greater than 12 inches in diameter.

3.1.4 Second Sampling

The same random sampling technique was used to select 17 additional calculations addressing piping greater than 12 inches in diameter.

Combining Table 4.1 and the two random samples yielded 72 analyses covering 367 lugs. Sixteen of these lugs were found to be of non-standard (non-rectangular) type. Appendix C shows the various categories for these non-standard lugs.

4.0 ANALYSIS METHODOLOGY

4.1 General Description

The basis for the analytical approach used in this evaluation is the conservatism inherent to PVNGS lug design. Lugs on Q class piping elbows are not used at PVNGS. The critical part of a welded lug design is the locally induced stress levels in the piping. These stresses govern over the weld and lug stresses. Local pipe wall stresses combined with the stresses generated by the internal piping loading are required to meet the applicable code allowable limits. Limiting the local stresses to be 50% of the basic material code allowable will yield a conservative maximum anticipated lug load. Because the welded attachments have acceptable ASME Section III weld inspections and have passed a hydro/functional pressure test, and were conservatively sized during original design, the weld strength is not specifically addressed. Many of the Class 1 and 2 welds are examined on a periodic basis in accordance with the inservice inspection program.

The lowest strength ASME material (tensile strength of 45 ksi) is used for this evaluation and supported by industry-wide test results for blind flanges documented by NUREG-1402. The worst case blind flange (plate) material identified by these tests was similar to the ASME lowest strength material. Since the lugs were also fabricated from plate material, it is appropriate to consider ASME lowest strength material for this evaluation.

NUREG-1402, Section 3, "Conclusions" supports an analytical approach since it states that the analytical procedures used to qualify the nonconforming material and the results of the analyses provide an

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adequate basis for resolving the staff's concerns with respect to demonstrating the adequacy of the material for service.

The evaluation methodology is as follows:

- a) Calculate maximum anticipated lug loadings for each pipe diameter using the pipe wall stress as the governing stress.
- b) Calculate the lug capacities assuming the lowest strength ASME material (45 ksi tensile strength).
- c) Demonstrate that these lug capacities are greater than the maximum anticipated lug loadings.

This whole process is illustrated by the flowchart on page F-1 of Appendix F.

4.2 Maximum Anticipated Lug Load

Using Welding Research Bulletin 107 (Bechtel computer program ME210), the maximum anticipated lug loads are computed limiting the pipe wall stress to 50% of the basic allowable stress (7.5 ksi) for the pipe material.

Appendix E describes the ME210 methodology and Appendix F tabulates the computation results.

4.3 Lug Capacity

The formulas illustrated in Appendix E are used to compute lug capacities assuming an 11.9 ksi allowable stress. This value is equivalent to the lowest strength ASME material allowable stress for a lug at 600°F.

5.0 RESULTS

5.1 Capacity Versus Maximum Load Comparison

Appendix F shows a table and graph for the results of the lug evaluation. Of the 351 rectangular lugs, 343 lugs showed single lug capacities greater than the maximum anticipated lug loads. The other eight lug situations, all from Table 4-1 (Appendix B) of Reference 6.4, required two lugs. Please note that in Table 4-1, the design of lugs is based on two lugs. In addition, in the sampling process all lug designs were found to contain two or more lugs. The 16 non-standard lugs were evaluated on a case-by-case basis. All were acceptable.

5.2 Conclusion

The use of material supplied by PSI, WJM and CLM for lugs has not compromised the integrity of the pipe support design at PVNGS.

6.0 REFERENCES

- 6.1 NUREG-1402, date published May 1990.
- 6.2 Welding Research Council Bulletin 107, March 1979 Revision.
- 6.3 CRC handbook of Tables for Probability and Statistics, Second Edition, William H. Beyer, Editor.
- 6.4 Pipe Support Design Manual for Palo Verde Generating Station.
- 6.5 Special Calculation 13-MC-ZZ-624.

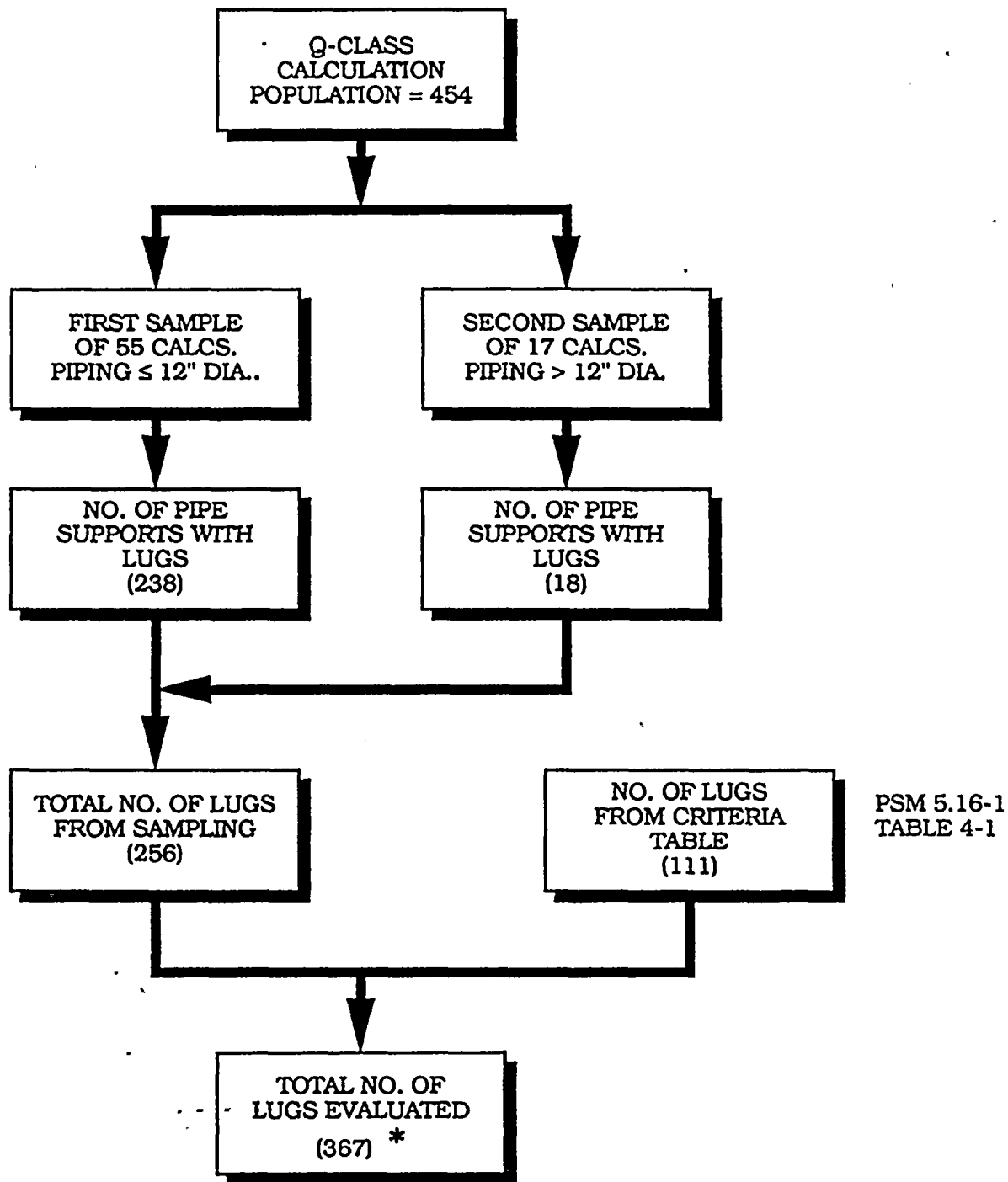
7.0 APPENDICES

- A Flowchart of Random Sampling Process
- B Standard Lug Design Table 4-1
- C Non-Standard Lugs
- D ME210 Methodology
- E Lug Capacity Formulas
- F Maximum Lug Load Versus Lug Capacity Comparison Charts

APPENDIX A

FLOWCHART OF RANDOM SAMPLING PROCESS

RANDOM SAMPLING PROCESS



* NO. OF NON-STANDARD LUGS = 16

APPENDIX B

STANDARD LUG DESIGN TABLE 4.1

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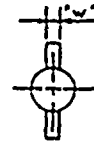
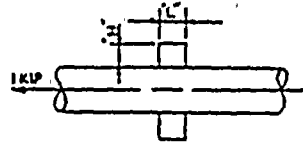
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TABLE 4.1



PIPE SIZE	LUG SIZE HxWxL	WELD SIZE	UNIT LOCAL STRESS	ALLOWABLE LOAD FOR .5Sh=6ksi	WELD SIZE	UNIT LOCAL STRESS	ALLOWABLE LOAD FOR .5Sh=6ksi	WELD SIZE	UNIT LOCAL STRESS	ALLOWABLE LOAD FOR .5Sh=6ksi	FORCE ON WELD
in.	in.	in.	ksi	kip	in.	ksi	kip	in.	ksi	kip	kip/in.
①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫
Sch. 40											
2 1/2	1/2 x 1/2 x 2	3/16	4.71	1.21	3/16	3.67	1.68	3/16	2.96	2.03	0.38
2 1/2	1/2 x 1/2 x 4	3/16	1.93	3.11	3/16	1.60	3.75	3/16	1.42	4.23	0.15
3	1/2 x 1/2 x 2	3/16	2.97	1.21	3/16	3.72	1.61	3/16	2.94	2.04	0.38
3	1/2 x 1/2 x 4	3/16	2.14	2.80	3/16	1.77	3.51	3/16	1.44	4.17	0.15
4	3/4 x 3/4 x 2	1/4	6.12	0.98	1/4	5.29	1.82	1/4	2.23	2.62	0.50
4	3/4 x 3/4 x 4	1/4	2.83	2.12	1/4	1.57	3.82	1/4	1.17	5.13	0.17
6	3/4 x 3/4 x 2	1/4	4.91	1.22	1/4	3.97	1.89	1/4	2.23	2.69	0.50
6	3/4 x 3/4 x 4	1/4	2.42	2.48	1/4	1.18	1.80	1/4	1.15	5.22	0.17
8	1 x 1 x 2	5/16	3.27	1.86	5/16	1.68	1.19	5/16	1.20	5.00	0.30
8	1 x 1 x 4	5/16	1.48	4.05	5/16	0.92	6.52	5/16	0.62	9.68	0.11
10	1 x 1 x 2	5/16	2.90	2.07	5/16	1.72	3.49	5/16	1.20	5.00	0.30
10	1 x 1 x 4	5/16	1.42	4.21	5/16	0.87	6.90	5/16	0.60	10.00	0.11
Sch. 80											
12	1 x 1 x 2	5/16	2.95	2.03	5/16	1.57	8.82	5/16	1.20	5.00	0.30
12	1 x 1 x 4	5/16	1.50	4.00	5/16	0.82	7.32	5/16	0.58	10.34	0.11
14	1 x 1 x 2	5/16	3.01	1.59	5/16	1.48	4.05	5/16	1.20	5.00	0.30
14	1 x 1 x 4	5/16	1.55	3.87	5/16	0.79	7.59	5/16	0.58	10.34	0.11
16	1 x 1 x 2	5/16	3.11	1.93	3/8	1.07	5.61	3/8	0.77	7.79	0.25
16	1 x 1 x 4	5/16	2.13	2.82	3/8	0.74	8.11	3/8	0.50	12.00	0.13
16	1 x 1 x 6	5/16	1.16	3.85	3/8	0.55	10.91	3/8	0.38	15.79	0.09
18	1 x 1 x 2	5/16	3.20	1.83	3/8	1.00	6.00	3/8	0.77	7.79	0.25
18	1 x 1 x 4	5/16	2.22	2.70	3/8	0.70	8.57	3/8	0.60	12.00	0.13
18	1 x 1 x 6	5/16	1.51	3.65	3/8	0.53	11.32	3/8	0.37	16.22	0.09
20	1 x 1 x 2	5/16	3.27	1.83	3/8	0.93	6.45	3/8	0.77	7.79	0.25
20	1 x 1 x 4	5/16	2.29	2.62	3/8	0.66	9.09	3/8	0.50	12.00	0.13
20	1 x 1 x 6	5/16	1.70	3.53	3/8	0.50	12.00	3/8	0.37	16.22	0.09
24	1 x 1 x 2	5/16	3.36	1.9	3/8	0.84	7.14	1/2	0.77	7.79	0.25
24	1 x 1 x 4	5/16	2.38	2.72	3/8	0.60	10.00	1/2	0.50	12.00	0.13
24	1 x 1 x 6	5/16	1.80	3.33	3/8	0.46	13.04	1/2	0.37	16.22	0.09
Sch. 160											
26	1 1/2 x 1 1/2 x 4	5/16	3.38	1.79	5/16	2.30	2.61	3/8	1.28	4.69	0.25
26	1 1/2 x 1 1/2 x 6	5/16	2.42	2.48	5/16	1.51	3.66	3/8	0.92	6.52	0.13
26	1 1/2 x 1 1/2 x 8	5/16	1.83	3.20	5/16	1.25	4.80	3/8	0.70	8.57	0.09
28	1 1/2 x 1 1/2 x 4	5/16	3.40	1.76	5/16	2.31	2.60	3/8	1.29	4.65	0.25
28	1 1/2 x 1 1/2 x 6	5/16	2.44	2.46	5/16	1.68	3.57	3/8	0.93	6.45	0.13
28	1 1/2 x 1 1/2 x 8	5/16	1.86	3.23	5/16	1.26	4.76	3/8	0.71	8.45	0.09
30	1 1/2 x 1 1/2 x 4	5/16	3.42	1.75	5/16	2.32	2.59	3/8	1.29	4.65	0.25
30	1 1/2 x 1 1/2 x 6	5/16	2.46	2.44	5/16	1.67	3.59	3/8	0.93	6.45	0.13
30	1 1/2 x 1 1/2 x 8	5/16	1.88	3.19	5/16	1.28	4.69	3/8	0.72	8.33	0.09
Sch. 20											
30	1 1/2 x 1 1/2 x 4	5/16	3.42	1.75	5/16	2.32	2.59	3/8	1.29	4.65	0.25
30	1 1/2 x 1 1/2 x 6	5/16	2.46	2.44	5/16	1.67	3.59	3/8	0.93	6.45	0.13
30	1 1/2 x 1 1/2 x 8	5/16	1.88	3.19	5/16	1.28	4.69	3/8	0.72	8.33	0.09

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SHEAR LUG TABLE

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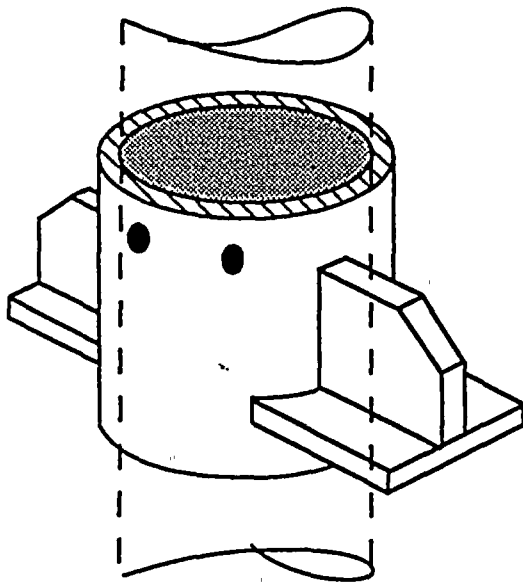
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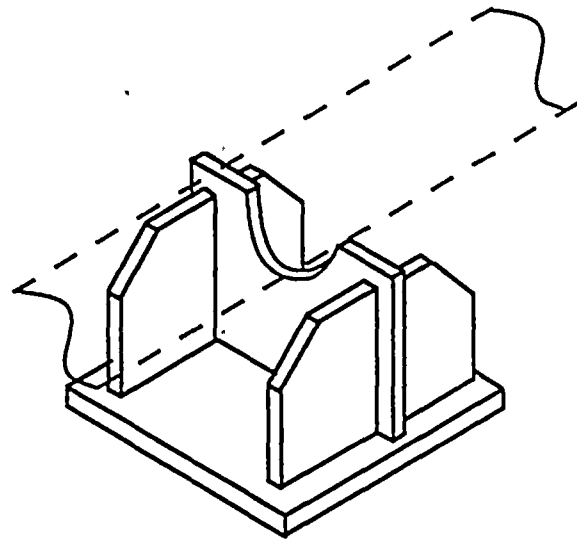
APPENDIX C
NON-STANDARD LUGS

LUG ANALYSIS REPORT
LISTING OF NON-STANDARD LUGS
Page No. 1
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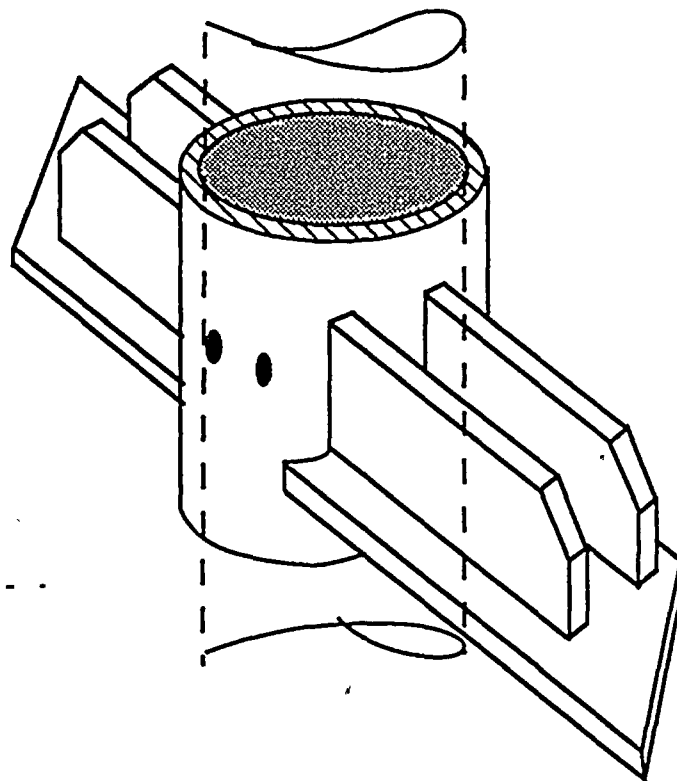
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RC-504	*13-RC-002-H-030	69B					X	
SI-501A	*13-CH-142-H-002	579			X			
SI-501A	*13-CH-424-H-006	176				X		
SP-501A	*13-SP-068-H-002	120A						X
SP-501A	*13-SP-079-H-002	35A						X
SP-501B	*13-SP-025-H-002	35B						X
SP-501B	*13-SP-030-H-002	120B						X
SI-503C	*13-SI-070-H-001	526					X	
SI-502A	*13-CH-149-H-008	626					X	
SI-501A	*13-SI-307-H-015	30			X			
SI-502A	*13-SI-308-H-003	36		X				
FW-501A	*13-SG-005-H-001	124					X	
SI-502A	*13-SI-308-H-001	31	X					
SG-501B	*13-SG-045-H-016	40B						X
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CATEGORY I



CATEGORY II

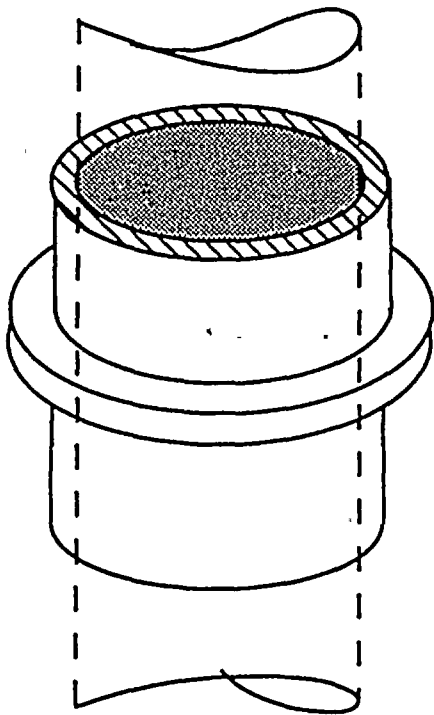


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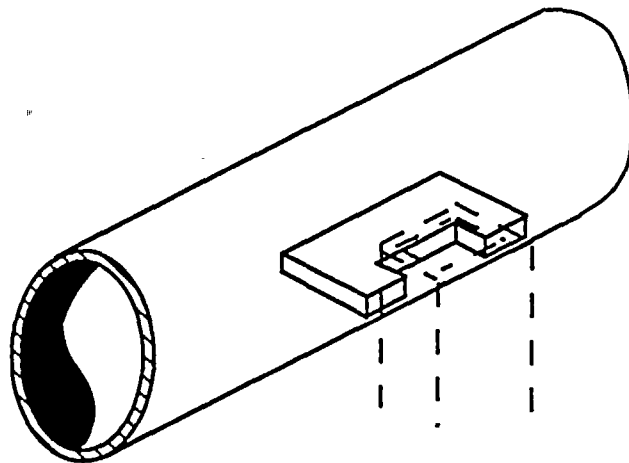
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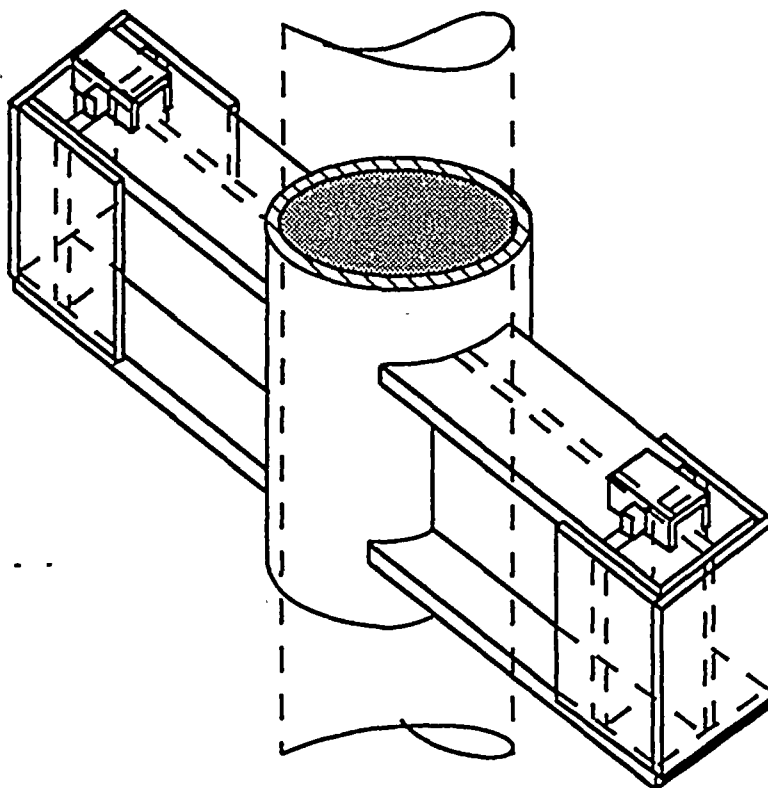
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CATEGORY IV



CATEGORY V



CATEGORY VI

APPENDIX D

ME210 METHODOLOGY

[illegible]

Bechtel Power Corporation's ME210 computer program is based on a paper entitled "Local Stresses in Spherical and Cylindrical Shells Due to External Loadings" by Wichman, Hopper and Mershon, published in Welding Research Council Bulletin Number 107, August 1965 and March 1979 Revision. This program presents a method of analyzing and determining local stresses in cylindrical shells due to external moments and forces acting on rigid attachments of circular or rectangular shape.

APPENDIX E

LUG CAPACITY CALCULATION FORMULA

**CALCULATION OF MAXIMUM CAPACITY
AND MAXIMUM LOAD ON LUG**
pg. 1 of 2

The maximum allowable load on the lug in order to prevent lug failure (1) and pipe failure (2) is calculated as follows:

DEFINITION OF TERMS: (see diagram of lug)

| | | |
|--------------------|---|--|
| P_x | = | Load on lug in the longitudinal direction |
| P_z | = | Load on lug in the lateral direction |
| P_L | = | Longitudinal load on the lug |
| P_{L1} | = | Maximum longitudinal load on the lug without causing lug to fail |
| P_{L2} | = | Maximum longitudinal load on the lug without causing pipe to fail |
| P_f | = | Lateral load on the lug due to friction |
| μ | = | Frictional coefficient = 0.3 |
| M_{xx} | = | Moment at base of lug about X axis |
| M_{zz} | = | Moment at base of lug about Y axis |
| H | = | Height of lug |
| W | = | Width of lug |
| L | = | Length of lug |
| F | = | Weld dimension |
| δ | = | Distance from top of lug to load application point (Conservatively assumed = .1"). |
| e | = | Distance from load application point to centerline of pipe wall. |
| f_{SHEAR} | = | Shear stress in lug |
| f_{TEN} | = | Tensile stress in lug |
| f_{TOTAL} | = | Total stress in lug |
| f_{a1} | = | Max allowable stress in lug for lowest rated ASME material = 11.9 ksi |
| f_{a2} | = | Max allowable stress in pipe = 7.5 ksi |
| f_{PIPE} | = | Stress in pipe |
| f_{ME210} | = | Max stress in pipe due to applied unit load of 1 kip (from ME210 output) |

**CALCULATION OF MAXIMUM CAPACITY
AND MAXIMUM LOAD ON LUG**

pg. 2 of 2

CALCULATION OF P_{L1} (LUG CAPACITY):

$$P_x = P_L$$

$$P_z = P_f = \mu P_L$$

$$M_{xx} = \mu P_L (H-F-\delta)$$

$$M_{zz} = P_L (H-F-\delta)$$

$$f_{TEN} = 6M_{xx}/(W^2L) + 6M_{zz}/(WL^2) = 6(\mu)(P_L)(H-F-\delta)/(W^2L) + 6(P_L)(H-F-\delta)/(WL^2)$$

$$f_{SHEAR} = (P_x^2 + P_z^2)^{1/2}/(LW) = P_L(1 + \mu^2)^{1/2}/(LW)$$

$$f_{TOTAL} = (f_{TEN}^2 + f_{SHEAR}^2)^{1/2}$$

$$= (P_L/WL) [[6(H-F-\delta)(\mu/W + 1/L)]^2 + [1 + \mu^2]]^{1/2}$$

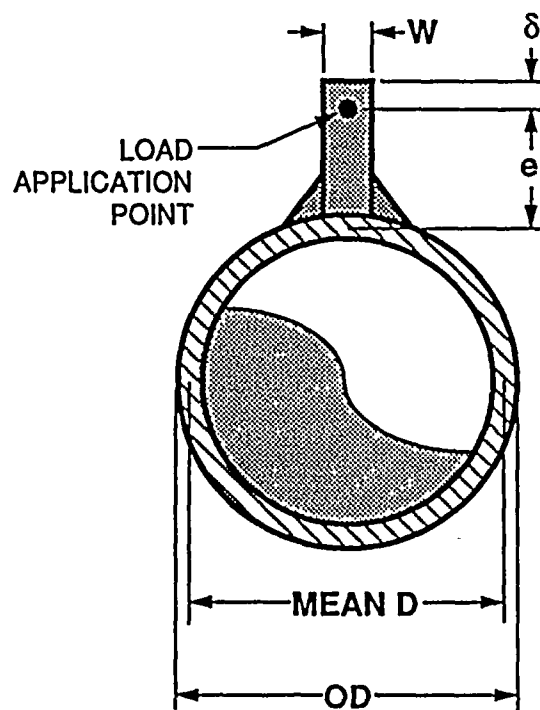
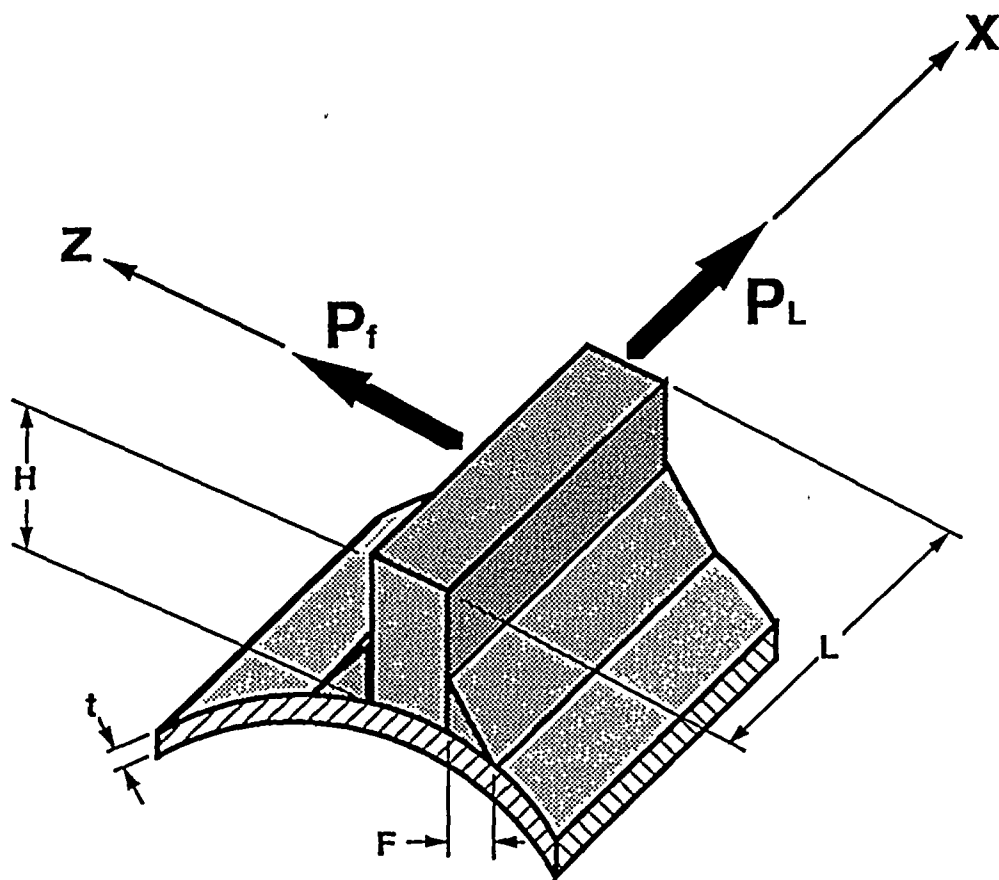
Considering $f_{a1}/f_{TOTAL} = 1$

$$P_{L1} = f_{a1}(WL)/[[6(H-F-\delta)(\mu/W + 1/L)]^2 + [1 + \mu^2]]^{1/2}$$

CALCULATION OF P_{L2} (MAXIMUM LUG LOAD):

Considering $f_{a2}/f_{PPE} = 1$

$$P_{L2} = f_{a2}/f_{ME210}$$

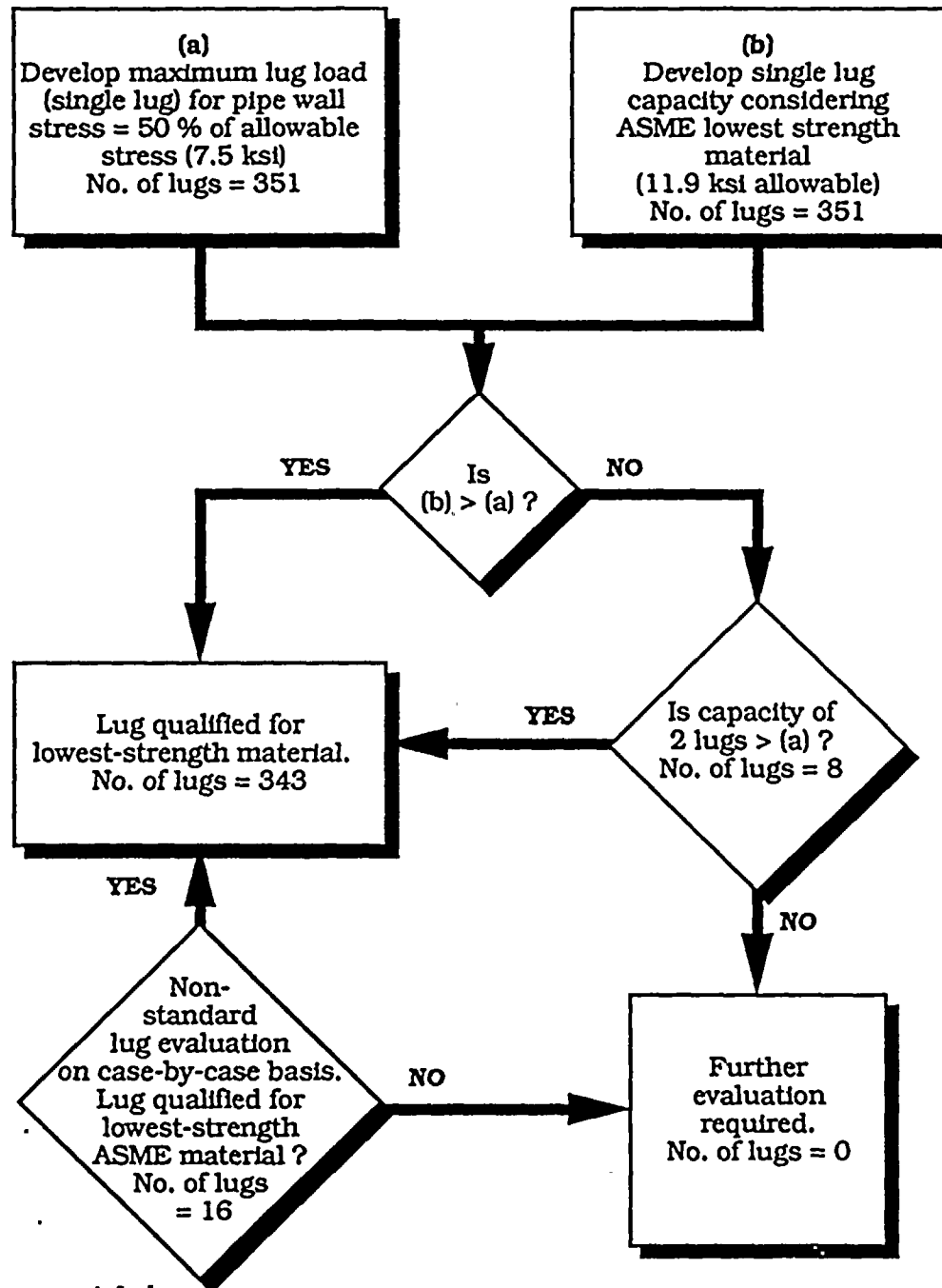


Note: One lug shown for clarity. The actual lug design consists of two lugs.

APPENDIX F

MAXIMUM LUG LOAD VERSUS LUG CAPACITY
COMPARISON CHARTS

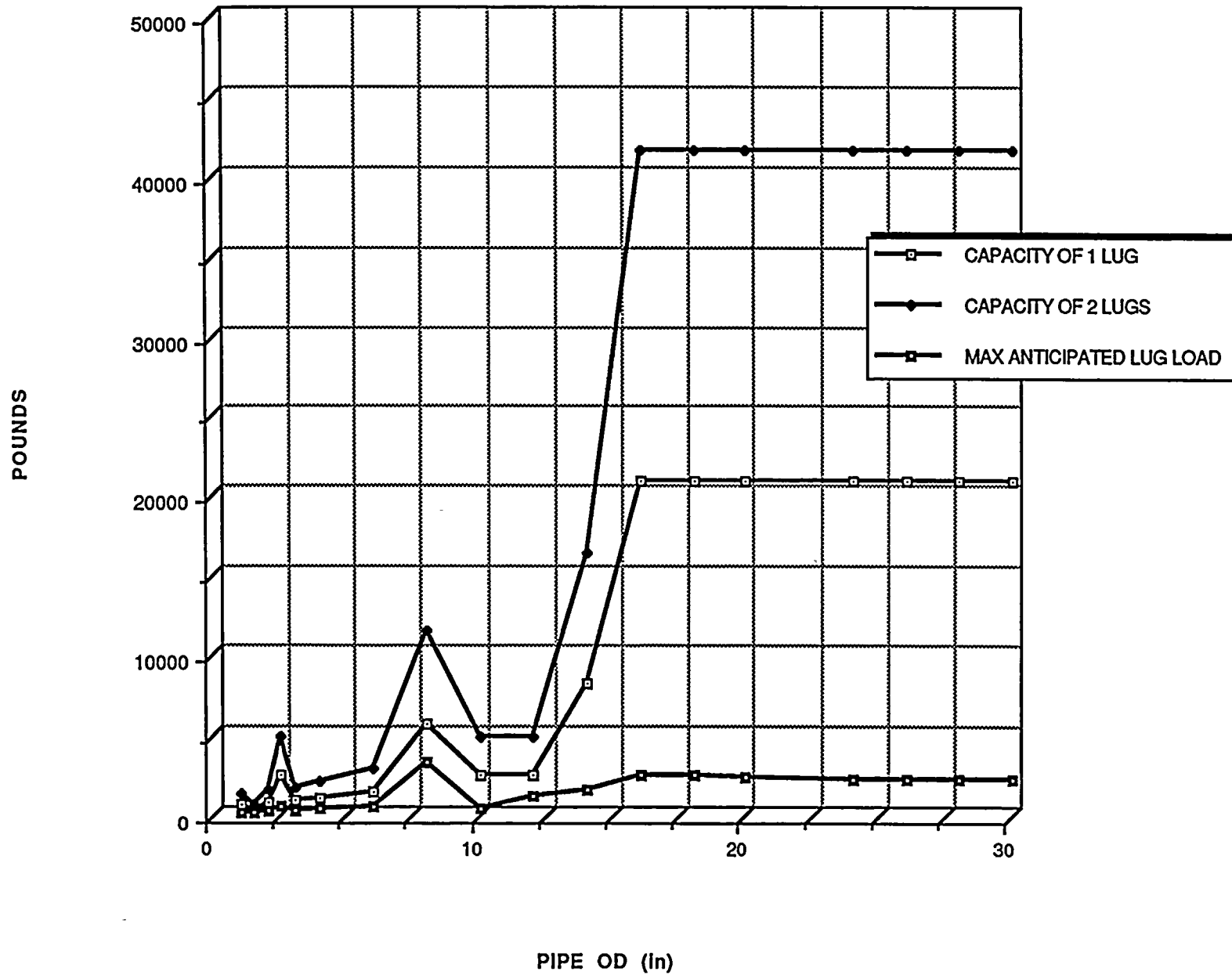
LUG QUALIFICATION

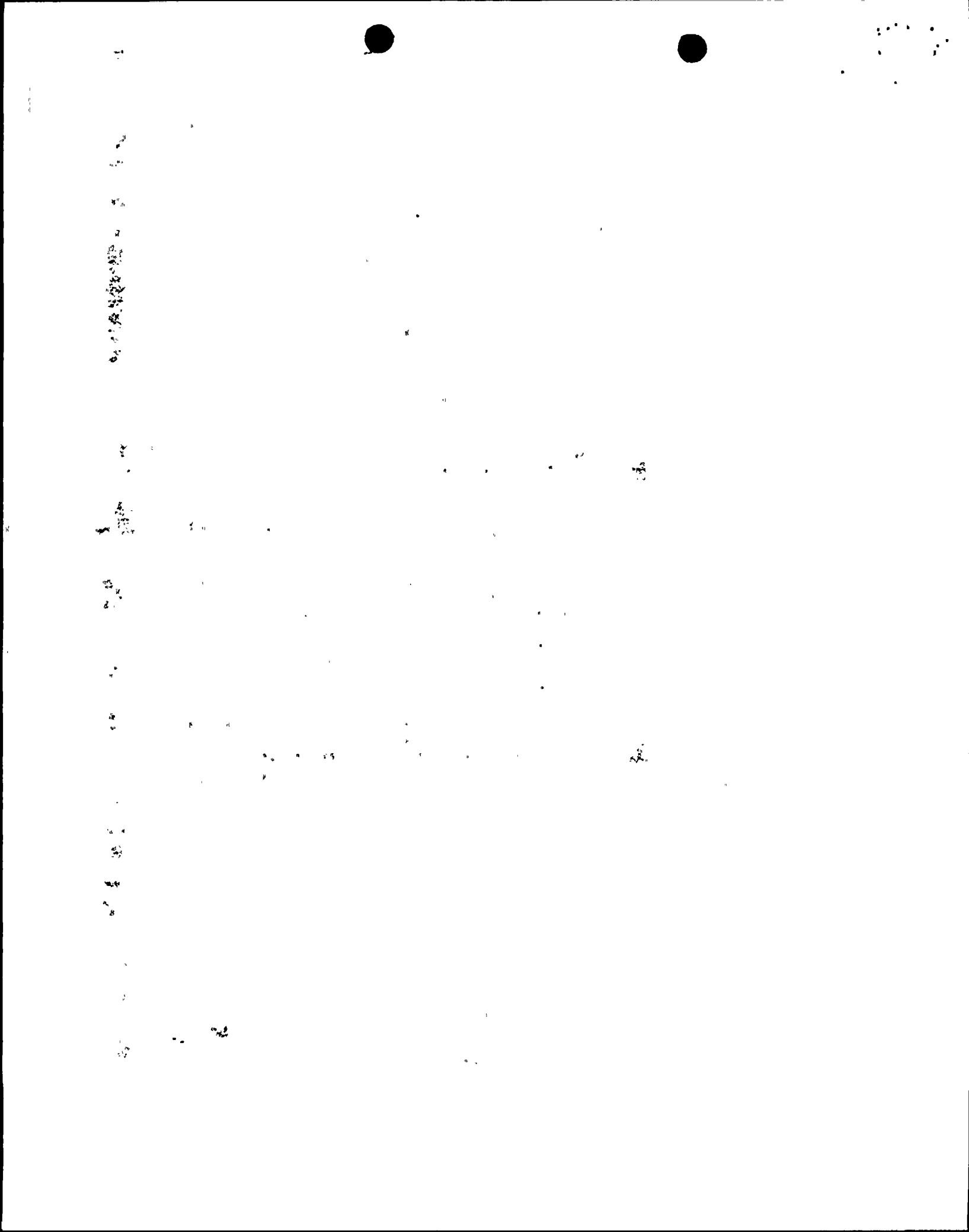


Summary:

- (1) A total of 343 out of 351 standard lugs are qualified based on a single lug capacity.
- (2) 8 standard lugs are qualified based on 2 lug capacity.
- (3) All 16 non-standard lugs are qualified on a case by case basis.

MAXIMUM ANTICIPATED LUG LOAD vs. LUG CAPACITY





LUG ANALYSIS REPORT

Page No. 1

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| RUN NO | PROB | HANGER | DATA PT | NOM OD
(in.) | THICK
(in.) | H
(in.) | W
(in.) | L
(in.) | ACT OD
(in.) | MEAN D
(in.) | ECC
(in.) | LUG LIMIT
(lb.) | ME210
(ksi) | PIPE LIM
(lb.) | COMMENT |
|------------------------|-------------------|-----------------|-------------------------|-----------------------------------|--------------------------------|---------------|--------------|---------------|-------------------------------------|--------------------------|-----------------------------|---|----------------------------------|---|---------|
| ME210
RUN
NUMBER | PROBLEM
NUMBER | HANGER NUMBER | DATA
POINT
NUMBER | NOMINAL
PIPE
OUTER
DIAM. | PIPE
WALL
THICK-
NESS | LUG
HEIGHT | LUG
WIDTH | LUG
LENGTH | ACTUAL
PIPE
OUTER
DIAMETER | MEAN
PIPE
DIAMETER | ECCEN-
TRICITY
OF LUG | FORCE TO
CAUSE LUG
FAILURE
(1) | MAX
PIPE
STRESS
(ME210) | FORCE TO
CAUSE
PIPE
FAILURE
(2) | |
| 3 | DF-501A | 13-DG-012-H-00H | 45 | 1.00 | 0.1790 | 0.5000 | 0.5000 | 1.0000 | 1.316 | 1.137 | 0.4895 | 2596.397 | 15.68 | 478.316 | |
| 3 | DF-502A | 13-DG-002-H-00H | 40 | 1.00 | 0.1790 | 0.5000 | 0.5000 | 1.0000 | 1.316 | 1.137 | 0.4895 | 2596.397 | 15.68 | 478.316 | |
| 3 | DF-502C | 13-DG-001-H-00A | 95 | 1.00 | 0.1790 | 0.5000 | 0.5000 | 1.0000 | 1.316 | 1.137 | 0.4895 | 2596.397 | 15.68 | 478.316 | |
| 3 | DF-502C | 13-DG-001-H-00D | 80 | 1.00 | 0.1790 | 0.5000 | 0.5000 | 1.0000 | 1.316 | 1.137 | 0.4895 | 2596.397 | 15.68 | 478.316 | |
| 3 | DF-502C | 13-DG-001-H-00J | 55 | 1.00 | 0.1790 | 0.5000 | 0.5000 | 1.0000 | 1.316 | 1.137 | 0.4895 | 2596.397 | 15.68 | 478.316 | |
| 3 | DF-502C | 13-DG-001-H-00M | 40 | 1.00 | 0.1790 | 0.5000 | 0.5000 | 1.0000 | 1.316 | 1.137 | 0.4895 | 2596.397 | 15.68 | 478.316 | |
| 3 | DF-502C | 13-DG-001-H-00Q | 25 | 1.00 | 0.1790 | 0.5000 | 0.5000 | 1.0000 | 1.316 | 1.137 | 0.4895 | 2596.397 | 15.68 | 478.316 | |
| 3 | GA-501C | 13-GA-011-H-00E | 246 | 1.00 | 0.1790 | 0.5000 | 0.5000 | 1.0000 | 1.316 | 1.137 | 0.4895 | 2596.397 | 15.68 | 478.316 | |
| 3 | GA-501C | 13-GA-011-H-00G | 252 | 1.00 | 0.1790 | 0.5000 | 0.5000 | 1.0000 | 1.316 | 1.137 | 0.4895 | 2596.397 | 15.68 | 478.316 | |
| 3 | GA-501C | 13-GA-011-H-00K | 259 | 1.00 | 0.1790 | 0.5000 | 0.5000 | 1.0000 | 1.316 | 1.137 | 0.4895 | 2596.397 | 15.68 | 478.316 | |
| 3 | GA-501C | 13-GA-011-H-00U | 230 | 1.00 | 0.1790 | 0.5000 | 0.5000 | 1.0000 | 1.316 | 1.137 | 0.4895 | 2596.397 | 15.68 | 478.316 | |
| 3 | GA-501C | 13-GA-012-H-00G | 188 | 1.00 | 0.1790 | 0.5000 | 0.5000 | 1.0000 | 1.316 | 1.137 | 0.4895 | 2596.397 | 15.68 | 478.316 | |
| 3 | GA-501C | 13-GA-012-H-00L | 360 | 1.00 | 0.1790 | 0.5000 | 0.5000 | 1.0000 | 1.316 | 1.137 | 0.4895 | 2596.397 | 15.68 | 478.316 | |
| 3 | GA-501C | 13-SG-140-H-0AB | 278 | 1.00 | 0.1790 | 0.5000 | 0.5000 | 1.0000 | 1.316 | 1.137 | 0.4895 | 2596.397 | 15.68 | 478.316 | |
| 3 | GA-501C | 13-SG-140-H-0AE | 270 | 1.00 | 0.1790 | 0.5000 | 0.5000 | 1.0000 | 1.316 | 1.137 | 0.4895 | 2596.397 | 15.68 | 478.316 | |
| 3 | GA-501C | 13-SG-140-H-00A | 332 | 1.00 | 0.1790 | 0.5000 | 0.5000 | 1.0000 | 1.316 | 1.137 | 0.4895 | 2596.397 | 15.68 | 478.316 | |
| 3 | GA-501C | 13-SG-140-H-00E | 344 | 1.00 | 0.1790 | 0.5000 | 0.5000 | 1.0000 | 1.316 | 1.137 | 0.4895 | 2596.397 | 15.68 | 478.316 | |
| 3 | GA-501C | 13-SG-140-H-00H | 328 | 1.00 | 0.1790 | 0.5000 | 0.5000 | 1.0000 | 1.316 | 1.137 | 0.4895 | 2596.397 | 15.68 | 478.316 | |
| 3 | GA-501C | 13-SG-140-H-00R | 306 | 1.00 | 0.1790 | 0.5000 | 0.5000 | 1.0000 | 1.316 | 1.137 | 0.4895 | 2596.397 | 15.68 | 478.316 | |
| 3 | GA-501C | 13-SG-140-H-00U | 300 | 1.00 | 0.1790 | 0.5000 | 0.5000 | 1.0000 | 1.316 | 1.137 | 0.4895 | 2596.397 | 15.68 | 478.316 | |
| 3 | GA-501C | 13-SG-140-H-00V | 298 | 1.00 | 0.1790 | 0.5000 | 0.5000 | 1.0000 | 1.316 | 1.137 | 0.4895 | 2596.397 | 15.68 | 478.316 | |
| 3 | GA-501C | 13-SG-140-H-00Z | 284 | 1.00 | 0.1790 | 0.5000 | 0.5000 | 1.0000 | 1.316 | 1.137 | 0.4895 | 2596.397 | 15.68 | 478.316 | |
| 1 | SG-509C | 13-SG-194-H-00H | 35C | 1.00 | 0.2500 | 0.5000 | 0.5000 | 1.0000 | 1.316 | 1.066 | 0.5250 | 2596.397 | 13.43 | 558.451 | |
| 6 | SP-502C | 13-SP-383-H-00A | 255 | 1.00 | 0.1330 | 0.5000 | 0.5000 | 1.0000 | 1.316 | 1.183 | 0.4665 | 2596.397 | 20.51 | 365.675 | |
| 6 | SP-502C | 13-SP-381-H-00A | 270 | 1.00 | 0.1330 | 0.5000 | 0.5000 | 1.0000 | 1.316 | 1.183 | 0.4665 | 2596.397 | 20.51 | 365.675 | |
| 6 | SP-502C | 13-SP-382-H-00A | 260 | 1.00 | 0.1330 | 0.5000 | 0.5000 | 1.0000 | 1.316 | 1.183 | 0.4665 | 2596.397 | 20.51 | 365.675 | |
| 4 | 310A | 13-SI-349-H-00C | 306 | 1.00 | 0.1790 | 0.5000 | 0.5000 | 2.0000 | 1.316 | 1.137 | 0.4895 | 6806.107 | 10.45 | 717.703 | |
| 2 | 421 | 13-CH-003-H-00Z | 315 | 1.00 | 0.2500 | 1.0000 | 0.5000 | 1.0000 | 1.316 | 1.066 | 1.0250 | 859.924 | 25.75 | 291.262 | |
| 5 | 421 | 13-EV-102-H-00H | 335 | 1.00 | 0.1790 | 1.0000 | 0.5000 | 1.0000 | 1.316 | 1.137 | 0.9895 | 859.924 | 30.32 | 247.361 | |
| 5 | 421 | 13-NC-036-H-00C | 260 | 1.00 | 0.1790 | 1.0000 | 0.5000 | 1.0000 | 1.316 | 1.137 | 0.9895 | 859.924 | 30.32 | 247.361 | |
| 5 | 421 | 13-NC-081-H-00J | 485 | 1.00 | 0.1790 | 1.0000 | 0.5000 | 1.0000 | 1.316 | 1.137 | 0.9895 | 859.924 | 30.32 | 247.361 | |
| 5 | 421 | 13-NC-082-H-00R | 515 | 1.00 | 0.1790 | 1.0000 | 0.5000 | 1.0000 | 1.316 | 1.137 | 0.9895 | 859.924 | 30.32 | 247.361 | |
| 5 | 421 | 13-NC-087-H-00G | 420 | 1.00 | 0.1790 | 1.0000 | 0.5000 | 1.0000 | 1.316 | 1.137 | 0.9895 | 859.924 | 30.32 | 247.361 | |
| 5 | 421 | 13-NC-092-H-00M | 450 | 1.00 | 0.1790 | 1.0000 | 0.5000 | 1.0000 | 1.316 | 1.137 | 0.9895 | 859.924 | 30.32 | 247.361 | |
| 7 | 421 | 13-SI-091-H-00D | 285 | 1.00 | 0.1333 | 1.0000 | 0.5000 | 1.0000 | 1.316 | 1.183 | 0.9667 | 859.924 | 39.99 | 187.547 | |
| 7 | 421 | 13-SI-257-H-00D | 395 | 1.00 | 0.1333 | 1.0000 | 0.5000 | 1.0000 | 1.316 | 1.183 | 0.9667 | 859.924 | 39.99 | 187.547 | |
| 8 | SI-516C | 13-SI-359-H-AAC | 3 | 1.00 | 0.1330 | 2.0000 | 0.3750 | 2.0000 | 1.316 | 1.183 | 1.9665 | 666.132 | 50.22 | 149.343 | |

(1) LUG REACHING 11.9 ksi STRESS LIMIT FOR THE LOWEST-STRENGTH ASME MATERIAL

(2) STRESS IN PIPE WALL REACHING 7.5 ksi (50% OF THE ALLOWABLE LIMIT) WITH SINGLE LUG.

(3) ONE LUG INSUFFICIENT TO PROVIDE LUG STRENGTH GREATER THAN THE FORCE IN (2). MINIMUM TWO LUGS REQUIRED.

LUG ANALYSIS REPORT

Page No. 2

08/24/90

| RUN NO | PROB | HANGER | DATA PT | NOM OD
(in.) | THICK
(in.) | H
(in.) | W
(in.) | L
(in.) | ACT OD
(in.) | MEAN D
(in.) | ECC
(in.) | LUG LIMIT
(lb.) | ME210
(ksi) | PIPE LIM
(lb.) | COMMENT |
|--------|---------|-----------------|---------|-----------------|----------------|------------|------------|------------|-----------------|-----------------|--------------|--------------------|----------------|-------------------|---------|
| 8 | SI-5160 | 13-SI-360-H-OAZ | 55 | 1.00 | 0.1330 | 2.0000 | 0.3750 | 2.0000 | 1.316 | 1.183 | 1.9665 | 666.132 | 50.22 | 149.343 | |
| 16 | ZC-512B | 13-SI-436-H-OAA | 343 | 1.50 | 0.1450 | 0.5000 | 0.5000 | 1.5000 | 1.900 | 1.755 | 0.4725 | 4641.000 | 12.52 | 599.042 | |
| 16 | ZC-512B | 13-SI-439-H-OAA | 468 | 1.50 | 0.1450 | 0.5000 | 0.5000 | 1.5000 | 1.900 | 1.755 | 0.4725 | 4641.000 | 12.52 | 599.042 | |
| 16 | ZC-512B | 13-SI-441-H-OAA | 540 | 1.50 | 0.1450 | 0.5000 | 0.5000 | 1.5000 | 1.900 | 1.755 | 0.4725 | 4641.000 | 12.52 | 599.042 | |
| 13 | ZC-513B | 13-SI-414-H-OAA | 497 | 1.50 | 0.2000 | 0.5000 | 0.5000 | 1.5000 | 1.900 | 1.700 | 0.5000 | 4641.000 | 8.78 | 854.214 | |
| 13 | ZC-513B | 13-SI-415-H-OOC | 562 | 1.50 | 0.2000 | 0.5000 | 0.5000 | 1.5000 | 1.900 | 1.700 | 0.5000 | 4641.000 | 8.78 | 854.214 | |
| 13 | ZC-513B | 13-SI-416-H-OOG | 670 | 1.50 | 0.2000 | 0.5000 | 0.5000 | 1.5000 | 1.900 | 1.700 | 0.5000 | 4641.000 | 8.78 | 854.214 | |
| 13 | ZC-513B | 13-SI-418-H-OOC | 795 | 1.50 | 0.2000 | 0.5000 | 0.5000 | 1.5000 | 1.900 | 1.700 | 0.5000 | 4641.000 | 8.78 | 854.214 | |
| 13 | ZC-513B | 13-SI-419-H-OAA | 815 | 1.50 | 0.2000 | 0.5000 | 0.5000 | 1.5000 | 1.900 | 1.700 | 0.5000 | 4641.000 | 8.78 | 854.214 | |
| 13 | ZC-513B | 13-SI-420-H-OAA | 867 | 1.50 | 0.2000 | 0.5000 | 0.5000 | 1.5000 | 1.900 | 1.700 | 0.5000 | 4641.000 | 8.78 | 854.214 | |
| 13 | ZC-513B | 13-SI-421-H-OAA | 915 | 1.50 | 0.2000 | 0.5000 | 0.5000 | 1.5000 | 1.900 | 1.700 | 0.5000 | 4641.000 | 8.78 | 854.214 | |
| 13 | ZC-513B | 13-SI-421-H-OOC | 950 | 1.50 | 0.2000 | 0.5000 | 0.5000 | 1.5000 | 1.900 | 1.700 | 0.5000 | 4641.000 | 8.78 | 854.214 | |
| 13 | ZC-513B | 13-SI-422-H-OOC | 25 | 1.50 | 0.2000 | 0.5000 | 0.5000 | 1.5000 | 1.900 | 1.700 | 0.5000 | 4641.000 | 8.78 | 854.214 | |
| 13 | ZC-513B | 13-SI-423-H-OOB | 80 | 1.50 | 0.2000 | 0.5000 | 0.5000 | 1.5000 | 1.900 | 1.700 | 0.5000 | 4641.000 | 8.78 | 854.214 | |
| 13 | ZC-513B | 13-SI-424-H-OAA | 112 | 1.50 | 0.2000 | 0.5000 | 0.5000 | 1.5000 | 1.900 | 1.700 | 0.5000 | 4641.000 | 8.78 | 854.214 | |
| 13 | ZC-513B | 13-SI-425-H-OOB | 173 | 1.50 | 0.2000 | 0.5000 | 0.5000 | 1.5000 | 1.900 | 1.700 | 0.5000 | 4641.000 | 8.78 | 854.214 | |
| 13 | ZC-513B | 13-SI-426-H-OAA | 205 | 1.50 | 0.2000 | 0.5000 | 0.5000 | 1.5000 | 1.900 | 1.700 | 0.5000 | 4641.000 | 8.78 | 854.214 | |
| 13 | ZC-513B | 13-SI-427-H-OAA | 271 | 1.50 | 0.2000 | 0.5000 | 0.5000 | 1.5000 | 1.900 | 1.700 | 0.5000 | 4641.000 | 8.78 | 854.214 | |
| 76 | SI-514B | 13-SI-176-H-OAA | 25 | 1.50 | 0.3440 | 0.7500 | 0.5000 | 2.0000 | 2.375 | 2.031 | 0.8220 | 3688.658 | 5.25 | 1428.570 | |
| 17 | CH-504 | 13-CH-443-H-OAA | 297 | 1.50 | 0.1450 | 1.0000 | 0.2500 | 1.0000 | 1.900 | 1.755 | 0.9725 | 314.390 | 56.82 | 131.996 | |
| 17 | CH-504 | 13-CH-443-H-OOC | 360 | 1.50 | 0.1450 | 1.0000 | 0.2500 | 1.0000 | 1.900 | 1.755 | 0.9725 | 314.390 | 56.82 | 131.996 | |
| 11 | EC-505A | 13-EC-020-H-OAA | 145 | 1.50 | 0.2000 | 1.0000 | 0.3750 | 2.0000 | 1.900 | 1.525 | 1.0000 | 1578.329 | 14.63 | 512.645 | |
| 11 | EC-505A | 13-EC-020-H-OAB | 155 | 1.50 | 0.2000 | 1.0000 | 0.3750 | 2.0000 | 1.900 | 1.525 | 1.0000 | 1578.329 | 14.63 | 512.645 | |
| 11 | EC-505A | 13-EC-020-H-OAC | 160 | 1.50 | 0.2000 | 1.0000 | 0.3750 | 2.0000 | 1.900 | 1.525 | 1.0000 | 1578.329 | 14.63 | 512.645 | |
| 11 | EC-505A | 13-EC-022-H-OAB | 45 | 1.50 | 0.2000 | 1.0000 | 0.3750 | 2.0000 | 1.900 | 1.525 | 1.0000 | 1578.329 | 14.63 | 512.645 | |
| 11 | EC-505A | 13-EC-022-H-OAC | 55 | 1.50 | 0.2000 | 1.0000 | 0.3750 | 2.0000 | 1.900 | 1.525 | 1.0000 | 1578.329 | 14.63 | 512.645 | |
| 11 | EC-505A | 13-EC-022-H-OAD | 60 | 1.50 | 0.2000 | 1.0000 | 0.3750 | 2.0000 | 1.900 | 1.525 | 1.0000 | 1578.329 | 14.63 | 512.645 | |
| 18 | 100B | 13-DW-069-H-OOE | 145 | 1.50 | 0.1450 | 1.0000 | 0.5000 | 1.0000 | 1.900 | 1.755 | 0.9725 | 859.924 | 38.69 | 193.849 | |
| 18 | 100B | 13-DW-078-H-OOK | 50 | 1.50 | 0.1450 | 1.0000 | 0.5000 | 1.0000 | 1.900 | 1.755 | 0.9725 | 859.924 | 38.69 | 193.849 | |
| 18 | CH-504 | 13-CH-276-H-OOC | 185 | 1.50 | 0.1450 | 1.0000 | 0.5000 | 1.0000 | 1.900 | 1.755 | 0.9725 | 859.924 | 38.69 | 193.849 | |
| 9 | EC-505A | 13-EC-020-H-OOT | 180 | 1.50 | 0.2000 | 1.0000 | 0.5000 | 1.0000 | 1.900 | 1.400 | 1.0000 | 859.924 | 24.73 | 303.275 | |
| 14 | EC-505 | 13-EC-020-H-OAA | 30 | 1.50 | 0.2000 | 1.0000 | 0.5000 | 1.5000 | 1.900 | 1.700 | 1.0000 | 1618.394 | 16.06 | 466.999 | |
| 14 | EC-505 | 13-EC-022-H-OAA | 14 | 1.50 | 0.2000 | 1.0000 | 0.5000 | 1.5000 | 1.900 | 1.700 | 1.0000 | 1618.394 | 16.06 | 466.999 | |
| 15 | 215 | 13-WC-026-H-OOH | 221 | 1.50 | 0.2000 | 1.0000 | 0.5000 | 2.0000 | 1.900 | 1.700 | 1.0000 | 2470.416 | 11.87 | 631.845 | |
| 15 | 215 | 13-WC-019-H-OOK | 446 | 1.50 | 0.2000 | 1.0000 | 0.5000 | 2.0000 | 1.900 | 1.700 | 1.0000 | 2470.416 | 11.87 | 631.845 | |
| 10 | EC-505A | 13-EC-022-H-OOT | 80 | 1.50 | 0.2000 | 1.0000 | 0.5000 | 2.0000 | 1.900 | 1.400 | 1.0000 | 2470.416 | 13.53 | 554.324 | |
| 12 | EC-505A | 13-EC-019-H-OOC | 110 | 1.50 | 0.2000 | 1.5000 | 0.3750 | 2.0000 | 1.900 | 1.525 | 1.5000 | 937.997 | 21.04 | 356.464 | |
| 12 | EC-505A | 13-EC-022-H-OOC | 10 | 1.50 | 0.2000 | 1.5000 | 0.3750 | 2.0000 | 1.900 | 1.525 | 1.5000 | 937.997 | 21.04 | 356.464 | |
| 81 | 449 | 13-CH-058-H-OAA | 127 | 2.00 | 0.1540 | 0.5000 | 0.5000 | 1.0000 | 2.375 | 2.221 | 0.4770 | 2596.397 | 19.26 | 389.408 | |
| 81 | 449 | 13-CH-058-H-OOC | 121 | 2.00 | 0.1540 | 0.5000 | 0.5000 | 1.0000 | 2.375 | 2.221 | 0.4770 | 2596.397 | 19.26 | 389.408 | |
| 81 | 449 | 13-CH-058-H-OOD | 115 | 2.00 | 0.1540 | 0.5000 | 0.5000 | 1.0000 | 2.375 | 2.221 | 0.4770 | 2596.397 | 19.26 | 389.408 | |
| 81 | 449 | 13-CH-059-H-OOD | 112 | 2.00 | 0.1540 | 0.5000 | 0.5000 | 1.0000 | 2.375 | 2.221 | 0.4770 | 2596.397 | 19.26 | 389.408 | |
| 81 | 449 | 13-CH-073-H-OOB | 240 | 2.00 | 0.1540 | 0.5000 | 0.5000 | 1.0000 | 2.375 | 2.221 | 0.4770 | 2596.397 | 19.26 | 389.408 | |

(1) LUG REACHING 11.9 ksi STRESS LIMIT FOR THE LOWEST-STRENGTH ASME MATERIAL

(2) STRESS IN PIPE WALL REACHING 7.5 ksi (50% OF THE ALLOWABLE LIMIT) WITH SINGLE LUG.

(3) ONE LUG INSUFFICIENT TO PROVIDE LUG STRENGTH GREATER THAN THE FORCE IN (2). MINIMUM TWO LUGS REQUIRED.

LUG ANALYSIS REPORT

Page No. 3

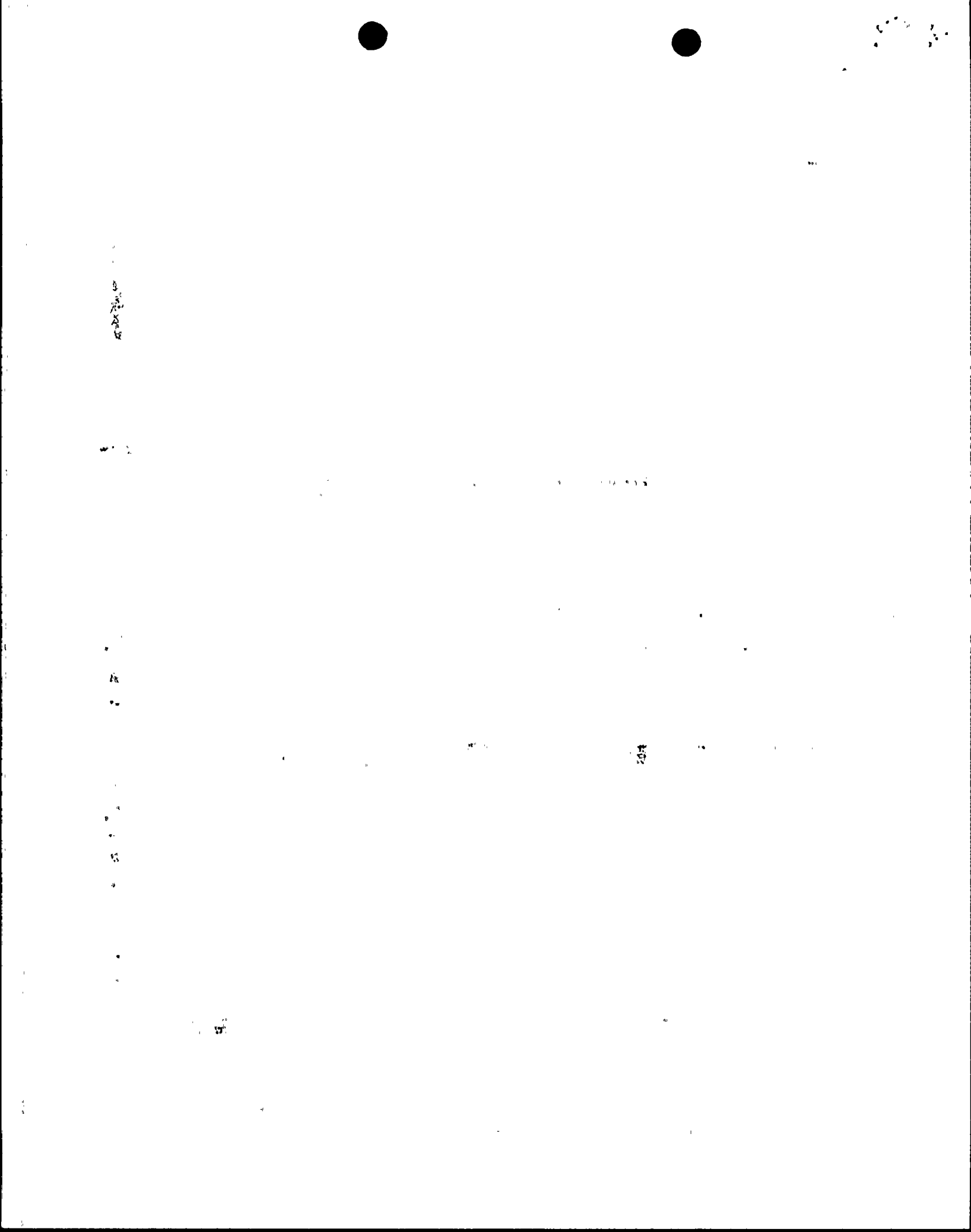
08/24/90

| RUN NO | PROB | HANGER | DATA PT | NOM OD
(in.) | THICK
(in.) | H
(in.) | W
(in.) | L
(in.) | ACT OD
(in.) | MEAN D
(in.) | ECC
(in.) | LUG LIMIT
(lb.) | ME210
(ksi) | PIPE LIM
(lb.) | COMMENT |
|--------|---------|-----------------|---------|-----------------|----------------|------------|------------|------------|-----------------|-----------------|--------------|--------------------|----------------|-------------------|---------|
| 81 | 449 | 13-CH-074-H-000 | 224 | 2.00 | 0.1540 | 0.5000 | 0.5000 | 1.0000 | 2.375 | 2.221 | 0.4770 | 2596.397 | 19.26 | 389.408 | |
| 81 | 1A-502B | 13-1A-070-H-00N | 250 | 2.00 | 0.1540 | 0.5000 | 0.5000 | 1.0000 | 2.375 | 2.221 | 0.4770 | 2596.397 | 19.26 | 389.408 | |
| 81 | 1A-502B | 13-1A-070-H-00P | 264 | 2.00 | 0.1540 | 0.5000 | 0.5000 | 1.0000 | 2.375 | 2.221 | 0.4770 | 2596.397 | 19.26 | 389.408 | |
| 82 | 687 | 13-HP-001-H-0AK | 165 | 2.00 | 0.1540 | 0.5000 | 0.5000 | 2.0000 | 2.375 | 2.221 | 0.4770 | 6806.107 | 9.08 | 825.991 | |
| 82 | 687 | 13-HP-001-H-0AM | 200 | 2.00 | 0.1540 | 0.5000 | 0.5000 | 2.0000 | 2.375 | 2.221 | 0.4770 | 6806.107 | 9.08 | 825.991 | |
| 82 | 687 | 13-HP-002-H-00M | 34 | 2.00 | 0.1540 | 0.5000 | 0.5000 | 2.0000 | 2.375 | 2.221 | 0.4770 | 6806.107 | 9.08 | 825.991 | |
| 82 | 687 | 13-HP-002-H-00P | 47 | 2.00 | 0.1540 | 0.5000 | 0.5000 | 2.0000 | 2.375 | 2.221 | 0.4770 | 6806.107 | 9.08 | 825.991 | |
| 82 | 1A-502A | 13-1A-070-H-0AP | 33 | 2.00 | 0.1540 | 0.5000 | 0.5000 | 2.0000 | 2.375 | 2.221 | 0.4770 | 6806.107 | 9.08 | 825.991 | |
| 75 | SI-514B | 13-SI-102-H-00A | 60 | 2.00 | 0.3440 | 0.5000 | 0.5000 | 2.0000 | 2.375 | 2.031 | 0.5720 | 6806.107 | 3.92 | 1913.260 | |
| 83 | ZC-501E | 13-SI-326-H-00B | 505 | 2.00 | 0.1540 | 0.7500 | 0.2500 | 1.5000 | 2.375 | 2.221 | 0.7270 | 844.504 | 28.10 | 266.904 | |
| 78 | EC-505 | 13-EC-003-H-00C | 62 | 2.00 | 0.2180 | 0.7500 | 0.5000 | 2.0000 | 2.375 | 2.157 | 0.7590 | 3688.658 | 8.49 | 883.392 | |
| 84 | ZC-504F | 13-SI-336-H-00M | 300 | 2.00 | 0.1540 | 0.7500 | 0.5000 | 2.5000 | 2.375 | 2.221 | 0.7270 | 5017.035 | 10.07 | 744.786 | |
| 79 | EC-503A | 13-EC-017-H-00C | 116 | 2.00 | 0.2180 | 1.0000 | 0.3750 | 2.0000 | 2.375 | 2.157 | 1.0090 | 1578.329 | 13.07 | 573.833 | |
| 79 | EC-503C | 12-EC-008-H-00C | 166 | 2.00 | 0.2180 | 1.0000 | 0.3750 | 2.0000 | 2.375 | 2.157 | 1.0090 | 1578.329 | 13.07 | 573.833 | |
| 85 | 100B | 13-DW-065-H-00B | 101 | 2.00 | 0.1540 | 1.0000 | 0.5000 | 1.0000 | 2.375 | 2.221 | 0.9770 | 859.924 | 37.42 | 200.428 | |
| 85 | 100B | 13-DW-078-H-00G | 35 | 2.00 | 0.1540 | 1.0000 | 0.5000 | 1.0000 | 2.375 | 2.221 | 0.9770 | 859.924 | 37.42 | 200.428 | |
| 85 | CH-518C | 13-CH-127-H-00L | 270 | 2.00 | 0.1540 | 1.0000 | 0.5000 | 1.0000 | 2.375 | 2.221 | 0.9770 | 859.924 | 37.42 | 200.428 | |
| 85 | CH-518C | 13-CH-127-H-00R | 245 | 2.00 | 0.1540 | 1.0000 | 0.5000 | 1.0000 | 2.375 | 2.221 | 0.9770 | 859.924 | 37.42 | 200.428 | |
| 85 | CH-518C | 13-CH-127-H-00X | 215 | 2.00 | 0.1540 | 1.0000 | 0.5000 | 1.0000 | 2.375 | 2.221 | 0.9770 | 859.924 | 37.42 | 200.428 | |
| 85 | CH-518C | 13-CH-127-H-00Y | 210 | 2.00 | 0.1540 | 1.0000 | 0.5000 | 1.0000 | 2.375 | 2.221 | 0.9770 | 859.924 | 37.42 | 200.428 | |
| 85 | CH-518C | 13-CH-127-H-00Z | 205 | 2.00 | 0.1540 | 1.0000 | 0.5000 | 1.0000 | 2.375 | 2.221 | 0.9770 | 859.924 | 37.42 | 200.428 | |
| 80 | EC-505 | 13-EC-012-H-00C | 58 | 2.00 | 0.2180 | 1.2500 | 0.5000 | 2.0000 | 2.375 | 2.157 | 1.2590 | 1848.480 | 13.18 | 569.044 | |
| 77 | SI-514G | 13-SI-112-H-00C | 212 | 2.00 | 0.3430 | 1.7500 | 0.3750 | 2.0000 | 2.375 | 2.032 | 1.8215 | 779.124 | 12.24 | 612.745 | |
| 77 | SI-514G | 13-SI-112-H-00D | 223 | 2.00 | 0.3430 | 1.7500 | 0.3750 | 2.0000 | 2.375 | 2.032 | 1.8215 | 779.124 | 12.24 | 612.745 | |
| 77 | SI-514G | 13-SI-112-H-00G | 237 | 2.00 | 0.3430 | 1.7500 | 0.3750 | 2.0000 | 2.375 | 2.032 | 1.8215 | 779.124 | 12.24 | 612.745 | |
| 90 | 042 | 13-FP-112-H-004 | 39 | 2.50 | 0.2030 | 0.5000 | 0.5000 | 2.0000 | 2.875 | 2.672 | 0.5015 | 6806.107 | 6.95 | 1079.130 | |
| 90 | | | | 2.50 | 0.2030 | 0.5000 | 0.5000 | 2.0000 | 2.875 | 2.672 | 0.5015 | 6806.107 | 6.95 | 1079.130 | |
| 88 | | | | 2.50 | 0.2760 | 0.5000 | 0.5000 | 2.0000 | 2.875 | 2.599 | 0.5380 | 6806.107 | 4.83 | 1552.790 | |
| 86 | | | | 2.50 | 0.3750 | 0.5000 | 0.5000 | 2.0000 | 2.875 | 2.500 | 0.5875 | 6806.107 | 3.45 | 2173.910 | |
| 91 | | | | 2.50 | 0.2030 | 0.5000 | 0.5000 | 4.0000 | 2.875 | 2.672 | 0.5015 | 15815.737 | 3.63 | 2066.110 | |
| 89 | | | | 2.50 | 0.2760 | 0.5000 | 0.5000 | 4.0000 | 2.875 | 2.599 | 0.5380 | 15815.737 | 2.70 | 2777.770 | |
| 87 | | | | 2.50 | 0.3750 | 0.5000 | 0.5000 | 4.0000 | 2.875 | 2.500 | 0.5875 | 15815.737 | 2.14 | 3504.670 | |
| 92 | ZC-505 | 13-EC-020-H-002 | 20 | 2.50 | 0.2000 | 1.0000 | 0.5000 | 2.0000 | 2.875 | 2.675 | 1.0000 | 2470.416 | 12.65 | 592.885 | |
| 92 | EC-505 | 13-EC-022-H-005 | 4 | 2.50 | 0.2000 | 1.0000 | 0.5000 | 2.0000 | 2.875 | 2.675 | 1.0000 | 2470.416 | 12.65 | 592.885 | |
| 135 | 323 | 13-CH-393-H-022 | 20 | 3.00 | 0.2160 | 0.5000 | 0.5000 | 1.0000 | 3.500 | 3.284 | 0.5080 | 2596.397 | 12.58 | 596.184 | |
| 136 | 245 | 13-CT-025-H-011 | 155 | 3.00 | 0.2160 | 0.5000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 0.5080 | 6806.107 | 6.76 | 1109.460 | |
| 136 | 245 | 13-CT-025-H-029 | 100 | 3.00 | 0.2160 | 0.5000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 0.5080 | 6806.107 | 6.76 | 1109.460 | |
| 136 | DG-502A | 13-DG-009-H-003 | 15 | 3.00 | 0.2160 | 0.5000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 0.5080 | 6806.107 | 6.76 | 1109.460 | |
| 136 | DG-502A | 13-DG-009-H-007 | 35 | 3.00 | 0.2160 | 0.5000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 0.5080 | 6806.107 | 6.76 | 1109.460 | |
| 136 | DG-502A | 13-DG-009-H-009 | 45 | 3.00 | 0.2160 | 0.5000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 0.5080 | 6806.107 | 6.76 | 1109.460 | |
| 136 | ZY-504 | 13-CH-143-H-018 | 55 | 3.00 | 0.2160 | 0.5000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 0.5080 | 6806.107 | 6.76 | 1109.460 | |
| 136 | ZY-526A | 13-CH-131-H-004 | 21 | 3.00 | 0.2160 | 0.5000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 0.5080 | 6806.107 | 6.76 | 1109.460 | |
| 136 | | | | 3.00 | 0.2160 | 0.5000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 0.5080 | 6806.107 | 6.76 | 1109.460 | |

(1) LUG REACHING 11.9 ksi STRESS LIMIT FOR THE LOWEST-STRENGTH ASME MATERIAL

(2) STRESS IN PIPE WALL REACHING 7.5 ksi (50% OF THE ALLOWABLE LIMIT) WITH SINGLE LUG.

(3) ONE LUG INSUFFICIENT TO PROVIDE LUG STRENGTH GREATER THAN THE FORCE IN (2). MINIMUM TWO LUGS REQUIRED.



LUG ANALYSIS REPORT

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| RUN NO | PROB | HANGER | DATA PT | NOM OD
(in.) | THICK
(in.) | H
(in.) | W
(in.) | L
(in.) | ACT OD
(in.) | MEAN D
(in.) | ECC
(in.) | LUG LIMIT
(lb.) | ME210
(ksi) | PIPE LIM
(lb.) | COMMENT |
|--------|---------|-----------------|---------|-----------------|----------------|------------|------------|------------|-----------------|-----------------|--------------|--------------------|----------------|-------------------|---------|
| 133 | | | | 3.00 | 0.3000 | 0.5000 | 0.5000 | 2.0000 | 3.500 | 3.200 | 0.5500 | 6806.107 | 4.49 | 1670.370 | |
| 131 | | | | 3.00 | 0.4370 | 0.5000 | 0.5000 | 2.0000 | 3.500 | 3.063 | 0.6185 | 6806.107 | 2.89 | 2595.150 | |
| 137 | | | | 3.00 | 0.2160 | 0.5000 | 0.5000 | 4.0000 | 3.500 | 3.284 | 0.5080 | 15815.737 | 3.54 | 2118.640 | |
| 134 | | | | 3.00 | 0.3000 | 0.5000 | 0.5000 | 4.0000 | 3.500 | 3.200 | 0.5500 | 15815.737 | 2.53 | 2964.420 | |
| 132 | | | | 3.00 | 0.4370 | 0.5000 | 0.5000 | 4.0000 | 3.500 | 3.063 | 0.6185 | 15815.737 | 1.78 | 4213.480 | |
| 138 | CH-510 | 13-CH-077-H-003 | 15 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 1.0000 | 3.500 | 3.284 | 1.0080 | 859.924 | 23.63 | 317.393 | |
| 138 | CH-510 | 13-CH-077-H-008 | 40 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 1.0000 | 3.500 | 3.284 | 1.0080 | 859.924 | 23.63 | 317.393 | |
| 138 | CH-504 | 13-CH-282-H-004 | 85 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 1.0000 | 3.500 | 3.284 | 1.0080 | 859.924 | 23.63 | 317.393 | |
| 139 | CH-518D | 13-CH-319-H-001 | 410 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 1.5000 | 3.500 | 3.284 | 1.0080 | 1618.394 | 16.08 | 466.418 | |
| 139 | CH-518D | 13-CH-319-H-003 | 400 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 1.5000 | 3.500 | 3.284 | 1.0080 | 1618.394 | 16.08 | 466.418 | |
| 139 | CH-518D | 13-CH-319-H-005 | 390 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 1.5000 | 3.500 | 3.284 | 1.0080 | 1618.394 | 16.08 | 466.418 | |
| 139 | CH-518D | 13-CH-590-H-012 | 285 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 1.5000 | 3.500 | 3.284 | 1.0080 | 1618.394 | 16.08 | 466.418 | |
| 139 | CH-518D | 13-CH-590-H-015 | 295 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 1.5000 | 3.500 | 3.284 | 1.0080 | 1618.394 | 16.08 | 466.418 | |
| 139 | CH-518D | 13-CH-590-H-019 | 310 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 1.5000 | 3.500 | 3.284 | 1.0080 | 1618.394 | 16.08 | 466.418 | |
| 140 | 248 | 13-CT-023-H-013 | 250 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 1.0080 | 2470.416 | 12.05 | 622.407 | |
| 140 | 248 | 13-CT-023-H-032 | 200 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 1.0080 | 2470.416 | 12.05 | 622.407 | |
| 140 | 278 | 13-CT-023-H-0AD | 186 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 1.0080 | 2470.416 | 12.05 | 622.407 | |
| 140 | 278 | 13-CT-023-H-0AJ | 196 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 1.0080 | 2470.416 | 12.05 | 622.407 | |
| 140 | 278 | 13-CT-023-H-0AZ | 209 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 1.0080 | 2470.416 | 12.05 | 622.407 | |
| 140 | 278 | 13-CT-023-H-0OD | 138 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 1.0080 | 2470.416 | 12.05 | 622.407 | |
| 140 | 278 | 13-CT-023-H-0OP | 158 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 1.0080 | 2470.416 | 12.05 | 622.407 | |
| 140 | 278 | 13-CT-023-H-0OV | 170 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 1.0080 | 2470.416 | 12.05 | 622.407 | |
| 140 | 278 | 13-CT-025-H-0AE | 96 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 1.0080 | 2470.416 | 12.05 | 622.407 | |
| 140 | 278 | 13-CT-025-H-0OJ | 46 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 1.0080 | 2470.416 | 12.05 | 622.407 | |
| 140 | 278 | 13-CT-025-H-002 | 86 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 1.0080 | 2470.416 | 12.05 | 622.407 | |
| 140 | 278 | 13-CT-025-H-023 | 8 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 1.0080 | 2470.416 | 12.05 | 622.407 | |
| 140 | 278 | 13-CT-025-H-025 | 12 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 1.0080 | 2470.416 | 12.05 | 622.407 | |
| 140 | 278 | 13-CT-025-H-036 | 1 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 1.0080 | 2470.416 | 12.05 | 622.407 | |
| 140 | 278 | 13-CT-033-H-006 | 22 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 1.0080 | 2470.416 | 12.05 | 622.407 | |
| 140 | 278 | 13-EW-002-H-009 | 104 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 1.0080 | 2470.416 | 12.05 | 622.407 | |
| 140 | CH-510 | 13-CH-077-H-005 | 25 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 1.0080 | 2470.416 | 12.05 | 622.407 | |
| 140 | CH-510 | 13-CH-077-H-010 | 70 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 1.0080 | 2470.416 | 12.05 | 622.407 | |
| 140 | CH-510 | 13-CH-077-H-012 | 55 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 1.0080 | 2470.416 | 12.05 | 622.407 | |
| 140 | CH-510 | 13-CH-077-H-014 | 45 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 1.0080 | 2470.416 | 12.05 | 622.407 | |
| 140 | CH-510 | 13-CH-078-H-002 | 120 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 1.0080 | 2470.416 | 12.05 | 622.407 | |
| 140 | CH-510 | 13-CH-078-H-004 | 135 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 1.0080 | 2470.416 | 12.05 | 622.407 | |
| 140 | CH-510 | 13-CH-087-H-002 | 480 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 1.0080 | 2470.416 | 12.05 | 622.407 | |
| 140 | CH-510 | 13-CH-087-H-004 | 380 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 1.0080 | 2470.416 | 12.05 | 622.407 | |
| 140 | CH-510 | 13-CH-087-H-007 | 365 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 1.0080 | 2470.416 | 12.05 | 622.407 | |
| 140 | CH-510 | 13-CH-087-H-019 | 440 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 1.0080 | 2470.416 | 12.05 | 622.407 | |
| 140 | CH-510 | 13-CH-088-H-005 | 360 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 1.0080 | 2470.416 | 12.05 | 622.407 | |
| 140 | CH-510 | 13-CH-088-H-007 | 310 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 1.0080 | 2470.416 | 12.05 | 622.407 | |
| 140 | CH-510 | 13-CH-091-H-005 | 109 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 1.0080 | 2470.416 | 12.05 | 622.407 | |

- (1) LUG REACHING 11.9 ksi STRESS LIMIT FOR THE LOWEST-STRENGTH ASME MATERIAL.
 (2) STRESS IN PIPE WALL REACHING 7.5 ksi (50% OF THE ALLOWABLE LIMIT) WITH SINGLE LUG.
 (3) ONE LUG INSUFFICIENT TO PROVIDE LUG STENGTH GREATER THAN THE FORCE IN (2). MINIMUM TWO LUGS REQUIRED.

LUG ANALYSIS REPORT

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| RUN NO | PROB | HANGER | DATA PT | NOM OD
(in.) | THICK
(in.) | H
(in.) | W
(in.) | L
(in.) | ACT OD
(in.) | MEAN D
(in.) | ECC
(in.) | LUG LIMIT
(lb.) | ME210
(ksi) | PIPE LIM
(lb.) | COMMENT |
|--------|---------|-----------------|---------|-----------------|----------------|------------|------------|------------|-----------------|-----------------|--------------|--------------------|----------------|-------------------|---------|
| 140 | CH-510 | 13-CH-206-H-002 | 275 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 1.0080 | 2470.416 | 12.05 | 622.407 | |
| 140 | CH-510 | 13-CH-206-H-004 | 265 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 1.0080 | 2470.416 | 12.05 | 622.407 | |
| 140 | CH-510 | 13-CH-206-H-009 | 245 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 1.0080 | 2470.416 | 12.05 | 622.407 | |
| 140 | CH-510 | 13-CH-206-H-012 | 225 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 1.0080 | 2470.416 | 12.05 | 622.407 | |
| 140 | CH-510 | 13-CH-206-H-019 | 205 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 1.0080 | 2470.416 | 12.05 | 622.407 | |
| 140 | CH-510 | 13-CH-207-H-001 | 80 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 1.0080 | 2470.416 | 12.05 | 622.407 | |
| 140 | CH-510 | 13-SI-001-H-002 | 455 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 1.0080 | 2470.416 | 12.05 | 622.407 | |
| 140 | CH-510 | 13-SI-001-H-003 | 460 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 1.0080 | 2470.416 | 12.05 | 622.407 | |
| 140 | CH-510 | 13-SI-041-H-007 | 305A | 3.00 | 0.2160 | 1.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 1.0080 | 2470.416 | 12.05 | 622.407 | |
| 140 | CH-525 | 13-CH-293-H-009 | 322 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 1.0080 | 2470.416 | 12.05 | 622.407 | |
| 140 | CH-525 | 13-CH-293-H-019 | 302 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 1.0080 | 2470.416 | 12.05 | 622.407 | |
| 140 | CH-525 | 13-CH-305-H-028 | 200 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 1.0080 | 2470.416 | 12.05 | 622.407 | |
| 140 | CH-525 | 13-CH-305-H-033 | 86 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 1.0080 | 2470.416 | 12.05 | 622.407 | |
| 140 | ZC-504G | 13-SI-325-H-003 | 322 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 1.0080 | 2470.416 | 12.05 | 622.407 | |
| 141 | CH-510 | 13-CH-087-H-011 | 400 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 3.0000 | 3.500 | 3.284 | 1.0080 | 4327.975 | 7.78 | 964.010 | |
| 141 | CH-525 | 13-CH-293-H-011 | 338 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 3.0000 | 3.500 | 3.284 | 1.0080 | 4327.975 | 7.78 | 964.010 | |
| 141 | CH-525 | 13-CH-293-H-026 | 342 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 3.0000 | 3.500 | 3.284 | 1.0080 | 4327.975 | 7.78 | 964.010 | |
| 141 | CH-525 | 13-CH-293-H-028 | 348 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 3.0000 | 3.500 | 3.284 | 1.0080 | 4327.975 | 7.78 | 964.010 | |
| 141 | CH-525 | 13-CH-293-H-031 | 356 | 3.00 | 0.2160 | 1.0000 | 0.5000 | 3.0000 | 3.500 | 3.284 | 1.0080 | 4327.975 | 7.78 | 964.010 | |
| 142 | EC-506A | 13-EC-055-H-001 | 36 | 3.00 | 0.2160 | 2.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 2.0080 | 1048.401 | 22.65 | 331.126 | |
| 142 | EC-506A | 13-EC-064-H-003 | 34 | 3.00 | 0.2160 | 2.0000 | 0.5000 | 2.0000 | 3.500 | 3.284 | 2.0080 | 1048.401 | 22.65 | 331.126 | |
| 145 | SI-514B | 13-SI-176-H-003 | 117 | 4.00 | 0.4380 | 0.5000 | 0.5000 | 3.0000 | 4.500 | 4.062 | 0.6190 | 11275.583 | 2.16 | 3472.220 | |
| 153 | | | | 4.00 | 0.2370 | 0.7500 | 0.7500 | 2.0000 | 4.500 | 4.263 | 0.7685 | 6594.170 | 6.76 | 1109.460 | |
| 151 | | | | 4.00 | 0.3370 | 0.7500 | 0.7500 | 2.0000 | 4.500 | 4.163 | 0.8185 | 6594.170 | 4.24 | 1768.860 | |
| 143 | | | | 4.00 | 0.5310 | 0.7500 | 0.7500 | 2.0000 | 4.500 | 3.969 | 0.9155 | 6594.170 | 2.36 | 3177.960 | |
| 154 | | | | 4.00 | 0.2370 | 0.7500 | 0.7500 | 4.0000 | 4.500 | 4.263 | 0.7685 | 17129.615 | 3.18 | 2358.490 | |
| 152 | | | | 4.00 | 0.3370 | 0.7500 | 0.7500 | 4.0000 | 4.500 | 4.163 | 0.8185 | 17129.615 | 2.20 | 3409.090 | |
| 144 | | | | 4.00 | 0.5310 | 0.7500 | 0.7500 | 4.0000 | 4.500 | 3.969 | 0.9155 | 17129.615 | 1.35 | 5555.550 | |
| 155 | EC-503A | 13-EC-016-H-001 | 54 | 4.00 | 0.2370 | 1.0000 | 0.3750 | 2.0000 | 4.500 | 4.263 | 1.0185 | 1578.329 | 13.00 | 576.923 | |
| 155 | EC-503A | 13-EC-016-H-007 | 88 | 4.00 | 0.2370 | 1.0000 | 0.3750 | 2.0000 | 4.500 | 4.263 | 1.0185 | 1578.329 | 13.00 | 576.923 | |
| 155 | EC-503A | 13-EC-016-H-014 | 68 | 4.00 | 0.2370 | 1.0000 | 0.3750 | 2.0000 | 4.500 | 4.263 | 1.0185 | 1578.329 | 13.00 | 576.923 | |
| 155 | EC-503C | 13-EC-001-H-007 | 58 | 4.00 | 0.2370 | 1.0000 | 0.3750 | 2.0000 | 4.500 | 4.263 | 1.0185 | 1578.329 | 13.00 | 576.923 | |
| 155 | EC-503C | 13-EC-007-H-004 | 107 | 4.00 | 0.2370 | 1.0000 | 0.3750 | 2.0000 | 4.500 | 4.263 | 1.0185 | 1578.329 | 13.00 | 576.923 | |
| 155 | EC-503C | 13-EC-007-H-007 | 117 | 4.00 | 0.2370 | 1.0000 | 0.3750 | 2.0000 | 4.500 | 4.263 | 1.0185 | 1578.329 | 13.00 | 576.923 | |
| 156 | 100 | 13-DW-048-H-049 | 7 | 4.00 | 0.2370 | 1.0000 | 0.5000 | 1.5000 | 4.500 | 4.263 | 1.0185 | 1618.394 | 14.45 | 519.031 | |
| 156 | 100 | 13-DW-048-H-051 | 15 | 4.00 | 0.2370 | 1.0000 | 0.5000 | 1.5000 | 4.500 | 4.263 | 1.0185 | 1618.394 | 14.45 | 519.031 | |
| 156 | 100 | 13-DW-048-H-053 | 20 | 4.00 | 0.2370 | 1.0000 | 0.5000 | 1.5000 | 4.500 | 4.263 | 1.0185 | 1618.394 | 14.45 | 519.031 | |
| 157 | 042 | 13-FP-049-H-008 | 140 | 4.00 | 0.2370 | 1.0000 | 0.5000 | 2.0000 | 4.500 | 4.263 | 1.0185 | 2470.416 | 11.01 | 681.199 | |
| 157 | EC-505 | 13-EC-001-H-013 | 36 | 4.00 | 0.2370 | 1.0000 | 0.5000 | 2.0000 | 4.500 | 4.263 | 1.0185 | 2470.416 | 11.01 | 681.199 | |
| 157 | EC-505 | 13-EC-001-H-014 | 38 | 4.00 | 0.2370 | 1.0000 | 0.5000 | 2.0000 | 4.500 | 4.263 | 1.0185 | 2470.416 | 11.01 | 681.199 | |
| 157 | EC-505 | 13-EC-010-H-017 | 48 | 4.00 | 0.2370 | 1.0000 | 0.5000 | 2.0000 | 4.500 | 4.263 | 1.0185 | 2470.416 | 11.01 | 681.199 | |
| 157 | EC-505 | 13-EC-010-H-018 | 34 | 4.00 | 0.2370 | 1.0000 | 0.5000 | 2.0000 | 4.500 | 4.263 | 1.0185 | 2470.416 | 11.01 | 681.199 | |
| 158 | EC-503A | 13-EC-010-H-009 | 43 | 4.00 | 0.2370 | 1.0000 | 0.7500 | 2.0000 | 4.500 | 4.263 | 1.0185 | 4477.461 | 8.69 | 863.061 | |

(1) LUG REACHING 11.9 ksi STRESS LIMIT FOR THE LOWEST-STRENGTH ASME MATERIAL

(2) STRESS IN PIPE WALL REACHING 7.5 ksi (50% OF THE ALLOWABLE LIMIT) WITH SINGLE LUG.

(3) ONE LUG INSUFFICIENT TO PROVIDE LUG STENGTH GREATER THAN THE FORCE IN (2). MINIMUM TWO LUGS REQUIRED.

LUG ANALYSIS REPORT

Page No. 6

08/24/90

| RUN NO | PROB | HANGER | DATA PT | NOM OD
(in.) | THICK
(in.) | H
(in.) | W
(in.) | L
(in.) | ACT OD
(in.) | MEAN D
(in.) | ECC
(in.) | LUG LIMIT
(lb.) | ME210
(ksi) | PIPE LIM
(lb.) | COMMENT |
|--------|---------|-----------------|---------|-----------------|----------------|------------|------------|------------|-----------------|-----------------|--------------|--------------------|----------------|-------------------|---------|
| 159 | EC-506A | 13-EC-054-H-011 | 10 | 4.00 | 0.2370 | 2.0000 | 0.5000 | 2.0000 | 4.500 | 4.263 | 2.0185 | 1048.401 | 20.66 | 363.020 | |
| 159 | EC-506A | 13-EC-063-H-015 | 12 | 4.00 | 0.2370 | 2.0000 | 0.5000 | 2.0000 | 4.500 | 4.263 | 2.0185 | 1048.401 | 20.66 | 363.020 | |
| 146 | SI-513L | 13-SI-100-H-026 | 200 | 4.00 | 0.4380 | 2.0000 | 0.5000 | 3.0000 | 4.500 | 4.062 | 2.1190 | 1850.381 | 5.74 | 1306.620 | |
| 146 | SI-513L | 13-SI-100-H-018 | 189 | 4.00 | 0.4380 | 2.0000 | 0.5000 | 3.0000 | 4.500 | 4.062 | 2.1190 | 1850.381 | 5.74 | 1306.620 | |
| 147 | SI-513L | 13-SI-100-H-017 | 186 | 4.00 | 0.4380 | 2.0000 | 0.5000 | 4.0000 | 4.500 | 4.062 | 2.1190 | 2705.797 | 4.36 | 1720.180 | |
| 148 | SI-513L | 13-SI-100-H-021 | 193 | 4.00 | 0.4380 | 2.0000 | 0.5000 | 4.5000 | 4.500 | 4.062 | 2.1190 | 3145.338 | 3.89 | 1928.020 | |
| 149 | SI-513L | 13-SI-100-H-019 | 190 | 4.00 | 0.4380 | 4.0000 | 0.5000 | 4.0000 | 4.500 | 4.062 | 4.1190 | 1255.108 | 7.84 | 956.633 | |
| 150 | SI-514H | 13-SI-107-H-004 | 328 | 4.00 | 0.3430 | 4.0000 | 0.5000 | 4.0000 | 4.500 | 4.157 | 4.0715 | 1255.108 | 10.94 | 685.558 | |
| 166 | 731B | 13-SP-008-H-001 | 620 | 6.00 | 0.2800 | 0.7500 | 0.7500 | 2.0000 | 6.625 | 6.345 | 0.7900 | 6594.170 | 5.83 | 1286.440 | |
| 166 | 731B | 13-SP-014-H-001 | 600 | 6.00 | 0.2800 | 0.7500 | 0.7500 | 2.0000 | 6.625 | 6.345 | 0.7900 | 6594.170 | 5.83 | 1286.440 | |
| 166 | 741 | 13-LR-001-H-004 | 3 | 6.00 | 0.2800 | 0.7500 | 0.7500 | 2.0000 | 6.625 | 6.345 | 0.7900 | 6594.170 | 5.83 | 1286.440 | |
| 166 | 741 | 13-LR-001-H-005 | 7 | 6.00 | 0.2800 | 0.7500 | 0.7500 | 2.0000 | 6.625 | 6.345 | 0.7900 | 6594.170 | 5.83 | 1286.440 | |
| 166 | 741 | 13-LR-001-H-008 | 18 | 6.00 | 0.2800 | 0.7500 | 0.7500 | 2.0000 | 6.625 | 6.345 | 0.7900 | 6594.170 | 5.83 | 1286.440 | |
| 166 | 741 | 13-LR-011-H-005 | 73 | 6.00 | 0.2800 | 0.7500 | 0.7500 | 2.0000 | 6.625 | 6.345 | 0.7900 | 6594.170 | 5.83 | 1286.440 | |
| 166 | 741 | 13-LR-011-H-006 | 77 | 6.00 | 0.2800 | 0.7500 | 0.7500 | 2.0000 | 6.625 | 6.345 | 0.7900 | 6594.170 | 5.83 | 1286.440 | |
| 166 | 741 | 13-LR-012-H-006 | 43 | 6.00 | 0.2800 | 0.7500 | 0.7500 | 2.0000 | 6.625 | 6.345 | 0.7900 | 6594.170 | 5.83 | 1286.440 | |
| 166 | 741 | 13-LR-012-H-007 | 47 | 6.00 | 0.2800 | 0.7500 | 0.7500 | 2.0000 | 6.625 | 6.345 | 0.7900 | 6594.170 | 5.83 | 1286.440 | |
| 166 | 741 | 13-LR-012-H-009 | 56 | 6.00 | 0.2800 | 0.7500 | 0.7500 | 2.0000 | 6.625 | 6.345 | 0.7900 | 6594.170 | 5.83 | 1286.440 | |
| 166 | | | | 6.00 | 0.2800 | 0.7500 | 0.7500 | 2.0000 | 6.625 | 6.345 | 0.7900 | 6594.170 | 5.83 | 1286.440 | |
| 162 | | | | 6.00 | 0.4320 | 0.7500 | 0.7500 | 2.0000 | 6.625 | 6.193 | 0.8660 | 6594.170 | 3.13 | 2396.160 | |
| 160 | | | | 6.00 | 0.7180 | 0.7500 | 0.7500 | 2.0000 | 6.625 | 5.907 | 1.0090 | 6594.170 | 1.56 | 4807.690 | |
| 167 | | | | 6.00 | 0.2800 | 0.7500 | 0.7500 | 4.0000 | 6.625 | 6.345 | 0.7900 | 17129.615 | 2.97 | 2525.250 | |
| 163 | | | | 6.00 | 0.4320 | 0.7500 | 0.7500 | 4.0000 | 6.625 | 6.193 | 0.8660 | 17129.615 | 1.79 | 4189.940 | |
| 161 | | | | 6.00 | 0.7180 | 0.7500 | 0.7500 | 4.0000 | 6.625 | 5.907 | 1.0090 | 17129.615 | 0.98 | 7653.060 | |
| 164 | AF-501A | 13-AF-003-H-004 | 210 | 6.00 | 0.4320 | 1.0000 | 0.5000 | 2.0000 | 6.625 | 6.193 | 1.1160 | 2470.416 | 4.80 | 1562.500 | |
| 168 | ZC-504G | 13-SI-333-H-001 | 142 | 6.00 | 0.2800 | 1.0000 | 0.5000 | 2.5000 | 6.625 | 6.345 | 1.0400 | 3380.191 | 7.53 | 996.016 | |
| 169 | ZC-504C | 13-SI-330-H-036 | 344 | 6.00 | 0.2800 | 1.0000 | 0.5000 | 4.0000 | 6.625 | 6.345 | 1.0400 | 6295.032 | 4.92 | 1524.390 | |
| 165 | ZY-520A | 13-AF-009-H-015 | 130 | 6.00 | 0.4320 | 1.0000 | 0.7500 | 2.0000 | 6.625 | 6.193 | 1.1160 | 4477.461 | 3.90 | 1923.070 | |
| 170 | 215 | 13-WC-023-H-022 | 107 | 6.00 | 0.2800 | 1.5000 | 0.5000 | 2.0000 | 6.625 | 6.345 | 1.5400 | 1474.540 | 12.99 | 577.367 | |
| 170 | 215 | 13-WC-002-H-017 | 425 | 6.00 | 0.2800 | 1.5000 | 0.5000 | 2.0000 | 6.625 | 6.345 | 1.5400 | 1474.540 | 12.99 | 577.367 | |
| 171 | ZC-504G | 13-SI-088-H-036 | 43 | 6.00 | 0.2800 | 1.5000 | 1.0000 | 2.0000 | 6.625 | 6.345 | 1.5400 | 4025.097 | 9.32 | 804.721 | |
| 172 | EC-503A | 13-EC-010-H-023 | 11 | 6.00 | 0.2800 | 1.5000 | 1.5000 | 3.0000 | 6.625 | 6.345 | 1.5400 | 13327.495 | 4.65 | 1612.900 | |
| 178 | SP-502C | 13-SP-049-H-001 | 52 | 8.00 | 0.3220 | 1.0000 | 1.0000 | 3.0000 | 8.625 | 8.303 | 1.0610 | 12302.626 | 3.70 | 2027.020 | |
| 178 | ZC-501E | 13-SI-321-H-002 | 645 | 8.00 | 0.3220 | 1.0000 | 1.0000 | 3.0000 | 8.625 | 8.303 | 1.0610 | 12302.626 | 3.70 | 2027.020 | |
| 180 | ZC-504G | 13-SI-331-H-002 | 70 | 8.00 | 0.2500 | 1.0000 | 1.0000 | 3.0000 | 8.625 | 8.375 | 1.0250 | 12302.626 | 5.36 | 1399.250 | |
| 180 | | | | 8.00 | 0.3220 | 1.0000 | 1.0000 | 3.0000 | 8.625 | 8.303 | 1.0610 | 12302.626 | 5.36 | 1399.250 | |
| 176 | | | | 8.00 | 0.5000 | 1.0000 | 1.0000 | 3.0000 | 8.625 | 8.125 | 1.1500 | 12302.626 | 1.99 | 3768.840 | |
| 173 | | | | 8.00 | 0.9060 | 1.0000 | 1.0000 | 3.0000 | 8.625 | 7.719 | 1.3530 | 12302.626 | 0.89 | 8426.960 | |
| 179 | | | | 8.00 | 0.3220 | 1.0000 | 1.0000 | 6.0000 | 8.625 | 8.303 | 1.0610 | 31709.775 | 1.81 | 4143.640 | |
| 177 | | | | 8.00 | 0.5000 | 1.0000 | 1.0000 | 6.0000 | 8.625 | 8.125 | 1.1500 | 31709.775 | 1.09 | 6880.730 | |
| 174 | | | | 8.00 | 0.9060 | 1.0000 | 1.0000 | 6.0000 | 8.625 | 7.719 | 1.3530 | 31709.775 | 0.55 | 13636.300 | |
| 175 | ZC-504G | 13-SI-377-H-008 | 12A | 8.00 | 0.6250 | 1.5000 | 1.0000 | 2.5000 | 8.625 | 8.000 | 1.7125 | 5722.894 | 2.28 | 3289.470 | |
| 30 | DF-501A | 13-DG-012-H-00R | 10 | 10.00 | 0.1790 | 0.5000 | 0.5000 | 1.0000 | 10.750 | 10.571 | 0.4895 | 2596.397 | 19.71 | 380.518 | |

(1) LUG REACHING 11.9 ksi STRESS LIMIT FOR THE LOWEST-STRENGTH ASME MATERIAL

(2) STRESS IN PIPE WALL REACHING 7.5 ksi (50% OF THE ALLOWABLE LIMIT) WITH SINGLE LUG.

(3) ONE LUG INSUFFICIENT TO PROVIDE LUG STENGTH GREATER THAN THE FORCE IN (2). MINIMUM TWO LUGS REQUIRED.

LUG ANALYSIS REPORT

Page No. 7

08/24/90

| RUN NO | PROB | HANGER | DATA PT | NOM OD (in.) | THICK (in.) | H (in.) | W (in.) | L (in.) | ACT OD (in.) | MEAN D (in.) | ECC (in.) | LUG LIMIT (lb.) | ME210 (ksi) | PIPE LIM (lb.) | COMMENT |
|--------|---------|-----------------|---------|--------------|-------------|---------|---------|---------|--------------|--------------|-----------|-----------------|-------------|----------------|---------|
| 22 | NC-504B | 13-NC-081-H-017 | 160 | 10.00 | 0.3650 | 1.0000 | 0.5000 | 2.0000 | 10.750 | 10.385 | 1.0825 | 2470.416 | 6.17 | 1215.550 | |
| 23 | NC-504B | 13-NC-082-H-007 | 65 | 10.00 | 0.3650 | 1.0000 | 0.5000 | 3.5000 | 10.750 | 10.385 | 1.0825 | 5302.048 | 4.16 | 1802.880 | |
| 24 | 215 | 13-NC-040-H-001 | 35 | 10.00 | 0.3650 | 1.0000 | 0.7500 | 3.0000 | 10.750 | 10.385 | 1.0825 | 8103.142 | 3.71 | 2021.560 | |
| 24 | 215 | 13-NC-041-H-001 | 335 | 10.00 | 0.3650 | 1.0000 | 0.7500 | 3.0000 | 10.750 | 10.385 | 1.0825 | 8103.142 | 3.71 | 2021.560 | |
| 25 | WC-501B | 13-NC-034-H-010 | 155 | 10.00 | 0.3650 | 1.0000 | 1.0000 | 3.0000 | 10.750 | 10.385 | 1.0825 | 12302.626 | 3.22 | 2329.190 | |
| 25 | | | | 10.00 | 0.3650 | 1.0000 | 1.0000 | 3.0000 | 10.750 | 10.385 | 1.0825 | 12302.626 | 3.22 | 2329.190 | |
| 20 | | | | 10.00 | 0.5930 | 1.0000 | 1.0000 | 3.0000 | 10.750 | 10.157 | 1.1965 | 12302.626 | 1.61 | 4658.380 | |
| 181 | | | | 10.00 | 1.1250 | 1.0000 | 1.0000 | 3.0000 | 10.750 | 9.625 | 1.4625 | 12302.626 | 0.66 | 11363.600 | |
| 26 | NC-504B | 13-NC-081-H-015 | 185 | 10.00 | 0.3650 | 1.0000 | 1.0000 | 3.5000 | 10.750 | 10.385 | 1.0825 | 15352.750 | 2.79 | 2688.170 | |
| 27 | WC-501B | 13-NC-034-H-004 | 55 | 10.00 | 0.3650 | 1.0000 | 1.0000 | 6.0000 | 10.750 | 10.385 | 1.0825 | 31709.775 | 1.68 | 4464.280 | |
| 27 | ZY-501 | 13-NC-092-H-013 | 35 | 10.00 | 0.3650 | 1.0000 | 1.0000 | 6.0000 | 10.750 | 10.385 | 1.0825 | 31709.775 | 1.68 | 4464.280 | |
| 27 | ZY-501 | 13-NC-092-H-021 | 55 | 10.00 | 0.3650 | 1.0000 | 1.0000 | 6.0000 | 10.750 | 10.385 | 1.0825 | 31709.775 | 1.68 | 4464.280 | |
| 27 | | | | 10.00 | 0.3650 | 1.0000 | 1.0000 | 6.0000 | 10.750 | 10.385 | 1.0825 | 31709.775 | 1.68 | 4464.280 | |
| 21 | | | | 10.00 | 0.5930 | 1.0000 | 1.0000 | 6.0000 | 10.750 | 10.157 | 1.1965 | 31709.775 | 0.92 | 8152.170 | |
| 182 | | | | 10.00 | 1.1250 | 1.0000 | 1.0000 | 6.0000 | 10.750 | 9.625 | 1.4625 | 31709.775 | 0.43 | 17441.800 | |
| 28 | WC-502A | 13-NC-003-H-002 | 40 | 10.00 | 0.3650 | 1.7500 | 1.2500 | 5.0000 | 10.750 | 10.385 | 1.8325 | 18595.307 | 2.70 | 2777.770 | |
| 29 | ZY-510 | 13-NC-082-H-015 | 35 | 10.00 | 0.3650 | 2.0000 | 1.0000 | 3.0000 | 10.750 | 10.385 | 2.0825 | 5416.709 | 5.86 | 1279.860 | |
| 29 | ZY-510 | 13-NC-082-H-017 | 45 | 10.00 | 0.3650 | 2.0000 | 1.0000 | 3.0000 | 10.750 | 10.385 | 2.0825 | 5416.709 | 5.86 | 1279.860 | |
| 19 | ZC-504A | 13-SI-088-H-037 | 120 | 10.00 | 0.6250 | 3.0000 | 1.5000 | 4.0000 | 10.750 | 10.125 | 3.2125 | 9651.530 | 2.24 | 3348.210 | |
| 35 | 215 | 13-NC-001-H-001 | 352 | 12.00 | 0.3750 | 0.7500 | 0.7500 | 2.0000 | 12.750 | 12.375 | 0.8375 | 6594.170 | 4.06 | 1847.290 | |
| 36 | 215 | 13-NC-023-H-010 | 75 | 12.00 | 0.3750 | 1.0000 | 0.5000 | 2.0000 | 12.750 | 12.375 | 1.0875 | 2470.416 | 6.03 | 1243.780 | |
| 37 | 215 | 13-NC-023-H-008 | 92 | 12.00 | 0.3750 | 1.0000 | 0.7500 | 3.0000 | 12.750 | 12.375 | 1.0875 | 8103.142 | 3.65 | 2054.790 | |
| 38 | | | | 12.00 | 0.3750 | 1.0000 | 1.0000 | 3.0000 | 12.750 | 12.375 | 1.0875 | 12302.626 | 3.17 | 2365.930 | |
| 33 | | | | 12.00 | 0.6870 | 1.0000 | 1.0000 | 3.0000 | 12.750 | 12.063 | 1.2435 | 12302.626 | 1.32 | 5681.810 | |
| 31 | | | | 12.00 | 1.3120 | 1.0000 | 1.0000 | 3.0000 | 12.750 | 11.438 | 1.5560 | 12302.626 | 0.54 | 13888.800 | (3) |
| 39 | | | | 12.00 | 0.3750 | 1.0000 | 1.0000 | 6.0000 | 12.750 | 12.375 | 1.0875 | 31709.775 | 1.72 | 4360.460 | |
| 34 | | | | 12.00 | 0.6870 | 1.0000 | 1.0000 | 6.0000 | 12.750 | 12.063 | 1.2435 | 31709.775 | 0.79 | 9493.670 | |
| 32 | | | | 12.00 | 1.3120 | 1.0000 | 1.0000 | 6.0000 | 12.750 | 11.438 | 1.5560 | 31709.775 | 0.35 | 21428.500 | |
| 44 | | | | 14.00 | 0.3750 | 1.0000 | 1.0000 | 3.0000 | 14.000 | 13.625 | 1.0875 | 12302.626 | 3.23 | 2321.980 | |
| 42 | | | | 14.00 | 0.7500 | 1.0000 | 1.0000 | 3.0000 | 14.000 | 13.250 | 1.2750 | 12302.626 | 1.17 | 6410.250 | |
| 40 | | | | 14.00 | 1.4060 | 1.0000 | 1.0000 | 3.0000 | 14.000 | 12.594 | 1.6030 | 12302.626 | 0.49 | 15306.100 | (3) |
| 45 | | | | 14.00 | 0.3750 | 1.0000 | 1.0000 | 6.0000 | 14.000 | 13.625 | 1.0875 | 31709.775 | 1.78 | 4213.480 | |
| 43 | | | | 14.00 | 0.7500 | 1.0000 | 1.0000 | 6.0000 | 14.000 | 13.250 | 1.2750 | 31709.775 | 0.71 | 10563.300 | |
| 41 | | | | 14.00 | 1.4060 | 1.0000 | 1.0000 | 6.0000 | 14.000 | 12.594 | 1.6030 | 31709.775 | 0.33 | 22727.200 | |
| 46 | PC-501B | 13-PC-021-H-013 | 194 | 14.00 | 0.3120 | 2.0000 | 0.5000 | 10.0000 | 14.000 | 13.688 | 2.0560 | 8186.708 | 4.78 | 1569.030 | |
| 54 | | | | 16.00 | 0.3750 | 1.5000 | 1.5000 | 4.0000 | 16.000 | 15.625 | 1.5875 | 20778.795 | 2.95 | 2542.370 | |
| 51 | | | | 16.00 | 0.8430 | 1.5000 | 1.5000 | 4.0000 | 16.000 | 15.157 | 1.8215 | 20778.795 | 0.87 | 8620.690 | |
| 47 | | | | 16.00 | 1.5930 | 1.5000 | 1.5000 | 4.0000 | 16.000 | 14.407 | 2.1965 | 20778.795 | 0.35 | 21428.500 | (3) |
| 50 | SG-502 | 13-SG-122-H-011 | B4X | 16.00 | 1.2180 | 1.5000 | 1.5000 | 6.0000 | 16.000 | 14.782 | 2.0090 | 37388.278 | 0.38 | 19736.800 | |
| 55 | | | | 16.00 | 0.3750 | 1.5000 | 1.5000 | 6.0000 | 16.000 | 15.625 | 1.5875 | 37388.278 | 1.96 | 3826.530 | |
| 52 | | | | 16.00 | 0.8430 | 1.5000 | 1.5000 | 6.0000 | 16.000 | 15.157 | 1.8215 | 37388.278 | 0.62 | 12096.700 | |
| 48 | | | | 16.00 | 1.5930 | 1.5000 | 1.5000 | 6.0000 | 16.000 | 14.407 | 2.1965 | 37388.278 | 0.27 | 27777.700 | |
| 56 | | | | 16.00 | 0.3750 | 1.5000 | 1.5000 | 8.0000 | 16.000 | 15.625 | 1.5875 | 55249.866 | 1.45 | 5172.410 | |

(1) LUG REACHING 11.9 ksi STRESS LIMIT FOR THE LOWEST-STRENGTH ASME MATERIAL

(2) STRESS IN PIPE WALL REACHING 7.5 ksi (50% OF THE ALLOWABLE LIMIT) WITH SINGLE LUG.

(3) ONE LUG INSUFFICIENT TO PROVIDE LUG STRENGTH GREATER THAN THE FORCE IN (2). MINIMUM TWO LUGS REQUIRED.

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LUG ANALYSIS REPORT

Page No. 8

08/24/90

| RUN NO | PROB | HANGER | DATA PT | NOM OD
(in.) | THICK
(in.) | H
(in.) | W
(in.) | L
(in.) | ACT OD
(in.) | MEAN D
(in.) | ECC
(in.) | LUG LIMIT
(lb.) | ME210
(ksi) | PIPE LIM
(lb.) | COMMENT |
|--------|------|--------|---------|-----------------|----------------|------------|------------|------------|-----------------|-----------------|--------------|--------------------|----------------|-------------------|---------|
| 53 | | | | 16.00 | 0.8430 | 1.5000 | 1.5000 | 8.0000 | 16.000 | 15.157 | 1.8215 | 55249.866 | 0.49 | 15306.100 | |
| 49 | | | | 16.00 | 1.5930 | 1.5000 | 1.5000 | 8.0000 | 16.000 | 14.407 | 2.1965 | 55249.866 | 0.22 | 34090.900 | |
| 63 | | | | 18.00 | 0.3750 | 1.5000 | 1.5000 | 4.0000 | 18.000 | 17.625 | 1.5875 | 20778.795 | 3.06 | 2450.980 | |
| 60 | | | | 18.00 | 0.9370 | 1.5000 | 1.5000 | 4.0000 | 18.000 | 17.063 | 1.8685 | 20778.795 | 0.75 | 10000.000 | |
| 57 | | | | 18.00 | 1.7810 | 1.5000 | 1.5000 | 4.0000 | 18.000 | 16.219 | 2.2905 | 20778.795 | 0.30 | 25000.000 | (3) |
| 64 | | | | 18.00 | 0.3750 | 1.5000 | 1.5000 | 6.0000 | 18.000 | 17.625 | 1.5875 | 37388.278 | 2.06 | 3640.770 | |
| 61 | | | | 18.00 | 0.9370 | 1.5000 | 1.5000 | 6.0000 | 18.000 | 17.063 | 1.8685 | 37388.278 | 0.55 | 13636.300 | |
| 58 | | | | 18.00 | 1.7810 | 1.5000 | 1.5000 | 6.0000 | 18.000 | 16.219 | 2.2905 | 37388.278 | 0.23 | 32608.600 | |
| 65 | | | | 18.00 | 0.3750 | 1.5000 | 1.5000 | 8.0000 | 18.000 | 17.625 | 1.5875 | 55249.866 | 1.53 | 4901.960 | |
| 62 | | | | 18.00 | 0.9370 | 1.5000 | 1.5000 | 8.0000 | 18.000 | 17.063 | 1.8685 | 55249.866 | 0.44 | 17045.400 | |
| 59 | | | | 18.00 | 1.7810 | 1.5000 | 1.5000 | 8.0000 | 18.000 | 16.219 | 2.2905 | 55249.866 | 0.19 | 39473.600 | |
| 72 | | | | 20.00 | 0.3750 | 1.5000 | 1.5000 | 4.0000 | 20.000 | 19.625 | 1.5875 | 20778.795 | 3.15 | 2380.950 | |
| 69 | | | | 20.00 | 1.0310 | 1.5000 | 1.5000 | 4.0000 | 20.000 | 18.969 | 1.9155 | 20778.795 | 0.66 | 11363.600 | |
| 66 | | | | 20.00 | 1.9680 | 1.5000 | 1.5000 | 4.0000 | 20.000 | 18.032 | 2.3840 | 20778.795 | 0.26 | 28846.100 | (3) |
| 73 | | | | 20.00 | 0.3750 | 1.5000 | 1.5000 | 6.0000 | 20.000 | 19.625 | 1.5875 | 37388.278 | 2.14 | 3504.670 | |
| 70 | | | | 20.00 | 1.0310 | 1.5000 | 1.5000 | 6.0000 | 20.000 | 18.969 | 1.9155 | 37388.278 | 0.48 | 15625.000 | |
| 67 | | | | 20.00 | 1.9680 | 1.5000 | 1.5000 | 6.0000 | 20.000 | 18.032 | 2.3840 | 37388.278 | 0.20 | 37500.000 | (3) |
| 74 | | | | 20.00 | 0.3750 | 1.5000 | 1.5000 | 8.0000 | 20.000 | 19.625 | 1.5875 | 55249.866 | 1.60 | 4687.500 | |
| 71 | | | | 20.00 | 1.0310 | 1.5000 | 1.5000 | 8.0000 | 20.000 | 18.969 | 1.9155 | 55249.866 | 0.39 | 19230.700 | |
| 68 | | | | 20.00 | 1.9680 | 1.5000 | 1.5000 | 8.0000 | 20.000 | 18.032 | 2.3840 | 55249.866 | 0.17 | 44117.600 | |
| 101 | | | | 24.00 | 0.3750 | 1.5000 | 1.5000 | 4.0000 | 24.000 | 23.625 | 1.5875 | 20778.795 | 3.25 | 2307.690 | |
| 97 | | | | 24.00 | 1.2180 | 1.5000 | 1.5000 | 4.0000 | 24.000 | 22.782 | 2.0090 | 20778.795 | 0.52 | 14423.000 | |
| 93 | | | | 24.00 | 2.3430 | 1.5000 | 1.5000 | 4.0000 | 24.000 | 21.657 | 2.5715 | 20778.795 | 0.21 | 35714.200 | (3) |
| 102 | | | | 24.00 | 0.3750 | 1.5000 | 1.5000 | 6.0000 | 24.000 | 23.625 | 1.5875 | 37388.278 | 2.24 | 3348.210 | |
| 98 | | | | 24.00 | 1.2180 | 1.5000 | 1.5000 | 6.0000 | 24.000 | 22.782 | 2.0090 | 37388.278 | 0.39 | 19230.700 | |
| 94 | | | | 24.00 | 2.3430 | 1.5000 | 1.5000 | 6.0000 | 24.000 | 21.657 | 2.5715 | 37388.278 | 0.16 | 46875.000 | (3) |
| 103 | | | | 24.00 | 0.3750 | 1.5000 | 1.5000 | 8.0000 | 24.000 | 23.625 | 1.5875 | 55249.866 | 1.70 | 4411.760 | |
| 96 | | | | 24.00 | 2.2180 | 1.5000 | 1.5000 | 8.0000 | 24.000 | 21.782 | 2.5090 | 55249.866 | 0.15 | 50000.000 | |
| 95 | | | | 24.00 | 2.3430 | 1.5000 | 1.5000 | 8.0000 | 24.000 | 21.657 | 2.5715 | 55249.866 | 0.14 | 53571.400 | |
| 110 | | | | 26.00 | 0.3750 | 1.5000 | 1.5000 | 4.0000 | 26.000 | 25.625 | 1.5875 | 20778.795 | 3.30 | 2272.720 | |
| 107 | | | | 26.00 | 0.5000 | 1.5000 | 1.5000 | 4.0000 | 26.000 | 25.500 | 1.6500 | 20778.795 | 2.09 | 3588.510 | |
| 104 | | | | 26.00 | 0.7500 | 1.5000 | 1.5000 | 4.0000 | 26.000 | 25.250 | 1.7750 | 20778.795 | 1.07 | 7009.340 | |
| 111 | | | | 26.00 | 0.3750 | 1.5000 | 1.5000 | 6.0000 | 26.000 | 25.625 | 1.5875 | 37388.278 | 2.28 | 3289.470 | |
| 108 | | | | 26.00 | 0.5000 | 1.5000 | 1.5000 | 6.0000 | 26.000 | 25.500 | 1.6500 | 37388.278 | 1.48 | 5067.560 | |
| 105 | | | | 26.00 | 0.7500 | 1.5000 | 1.5000 | 6.0000 | 26.000 | 25.250 | 1.7750 | 37388.278 | 0.77 | 9740.260 | |
| 112 | | | | 26.00 | 0.3750 | 1.5000 | 1.5000 | 8.0000 | 26.000 | 25.625 | 1.5875 | 55249.866 | 1.74 | 4310.340 | |
| 109 | | | | 26.00 | 0.5000 | 1.5000 | 1.5000 | 8.0000 | 26.000 | 25.500 | 1.6500 | 55249.866 | 1.15 | 6521.730 | |
| 106 | | | | 26.00 | 0.7500 | 1.5000 | 1.5000 | 8.0000 | 26.000 | 25.250 | 1.7750 | 55249.866 | 0.62 | 12096.700 | |
| 119 | | | | 28.00 | 0.3750 | 1.5000 | 1.5000 | 4.0000 | 28.000 | 27.625 | 1.5875 | 20778.795 | 3.36 | 2232.140 | |
| 116 | | | | 28.00 | 0.5000 | 1.5000 | 1.5000 | 4.0000 | 28.000 | 27.500 | 1.6500 | 20778.795 | 2.12 | 3537.730 | |
| 113 | | | | 28.00 | 0.7500 | 1.5000 | 1.5000 | 4.0000 | 28.000 | 27.250 | 1.7750 | 20778.795 | 1.09 | 6880.730 | |
| 120 | | | | 28.00 | 0.3750 | 1.5000 | 1.5000 | 6.0000 | 28.000 | 27.625 | 1.5875 | 37388.278 | 2.30 | 3260.870 | |
| 117 | | | | 28.00 | 0.5000 | 1.5000 | 1.5000 | 6.0000 | 28.000 | 27.500 | 1.6500 | 37388.278 | 1.49 | 5033.550 | |

(1) LUG REACHING 11.9 ksi STRESS LIMIT FOR THE LOWEST-STRENGTH ASME MATERIAL

(2) STRESS IN PIPE WALL REACHING 7.5 ksi (50% OF THE ALLOWABLE LIMIT) WITH SINGLE LUG.

(3) ONE LUG INSUFFICIENT TO PROVIDE LUG STRENGTH GREATER THAN THE FORCE IN (2). MINIMUM TWO LUGS REQUIRED.

LUG ANALYSIS REPORT

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| RUN NO | PROB | HANGER | DATA PT | NOM OD
(in.) | THICK
(in.) | H
(in.) | W
(in.) | L
(in.) | ACT OD
(in.) | MEAN D
(in.) | ECC
(in.) | LUG LIMIT
(lb.) | ME210
(ksi) | PIPE LIM
(lb.) | COMMENT |
|-------------------------------|------|--------|---------|-----------------|----------------|------------|------------|------------|-----------------|-----------------|--------------|--------------------|----------------|-------------------|---------|
| 114 | | | | 28.00 | 0.7500 | 1.5000 | 1.5000 | 6.0000 | 28.000 | 27.250 | 1.7750 | 37388.278 | 0.78 | 9615.380 | |
| 121 | | | | 28.00 | 0.3750 | 1.5000 | 1.5000 | 8.0000 | 28.000 | 27.625 | 1.5875 | 55249.866 | 1.77 | 4237.280 | |
| 118 | | | | 28.00 | 0.5000 | 1.5000 | 1.5000 | 8.0000 | 28.000 | 27.500 | 1.6500 | 55249.866 | 1.17 | 6410.250 | |
| 115 | | | | 28.00 | 0.7500 | 1.5000 | 1.5000 | 8.0000 | 28.000 | 27.250 | 1.7750 | 55249.866 | 0.63 | 11904.700 | |
| 128 | | | | 30.00 | 0.3750 | 1.5000 | 1.5000 | 4.0000 | 30.000 | 29.625 | 1.5875 | 20778.795 | 3.40 | 2205.880 | |
| 125 | | | | 30.00 | 0.5000 | 1.5000 | 1.5000 | 4.0000 | 30.000 | 29.500 | 1.6500 | 20778.795 | 2.14 | 3504.670 | |
| 122 | | | | 30.00 | 0.7500 | 1.5000 | 1.5000 | 4.0000 | 30.000 | 29.250 | 1.7750 | 20778.795 | 1.10 | 6818.180 | |
| 129 | | | | 30.00 | 0.3750 | 1.5000 | 1.5000 | 6.0000 | 30.000 | 29.625 | 1.5875 | 37388.278 | 2.33 | 3218.880 | |
| 126 | | | | 30.00 | 0.5000 | 1.5000 | 1.5000 | 6.0000 | 30.000 | 29.500 | 1.6500 | 37388.278 | 1.51 | 4966.880 | |
| 123 | | | | 30.00 | 0.7500 | 1.5000 | 1.5000 | 6.0000 | 30.000 | 29.250 | 1.7750 | 37388.278 | 0.79 | 9493.670 | |
| 130 | | | | 30.00 | 0.3750 | 1.5000 | 1.5000 | 8.0000 | 30.000 | 29.625 | 1.5875 | 55249.866 | 1.79 | 4189.940 | |
| 127 | | | | 30.00 | 0.5000 | 1.5000 | 1.5000 | 8.0000 | 30.000 | 29.500 | 1.6500 | 55249.866 | 1.19 | 6302.520 | |
| 124 | | | | 30.00 | 0.7500 | 1.5000 | 1.5000 | 8.0000 | 30.000 | 29.250 | 1.7750 | 55249.866 | 0.64 | 11718.700 | |
| TOTAL NUMBER OF RECORDS = 351 | | | | | | | | | | | | | | | |

- (1) LUG REACHING 11.9 ksi STRESS LIMIT FOR THE LOWEST-STRENGTH ASME MATERIAL
 (2) STRESS IN PIPE WALL REACHING 7.5 ksi (50% OF THE ALLOWABLE LIMIT) WITH SINGLE LUG.
 (3) ONE LUG INSUFFICIENT TO PROVIDE LUG STENGTH GREATER THAN THE FORCE IN (2). MINIMUM TWO LUGS REQUIRED.

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