Bechtel Power Corporation

777 East Eisenhower Parkway
Ann Arbor, Michigan

Mail Address: P.O. Box 1000, Ann Arbor, Michigan 48106

May 9, 1978

BLC-5936

THIS DOCUMENT CONTAINS
POOR QUALITY PAGES

Consumers Power Company
Mr. G. S. Keeley,
Project Manager
1945 West Parnall Road
Jackson, Michigan 49201

Midland Units 1 and 2
Consumers Power Company
Bechtel Job 7220
MCAR-19 FINAL REPORT
UNDERSIZED HANGER WELDS PER
VENDOR DRAWING REQUIREMENTS
Files 2417/2801

Dear Mr. Keeley:

Attached is the Final Report covering the deficiency described in MCAR-19. The Final Report includes a description of the discrepancy, a statement of the safety implications, corrective actions to prevent repetition; conclusions, and recommendations.

The analysis of the discrepant shop welds, the results of the destructive loading tests, and the established conservatism of Grinnell's designs confirm that no safety problem exists. This deficiency is now considered nonreportable.

MCAR-19 item 3a required site inspection of the Grinnell hangers shipped on October 31, 1977. The inspection performed found this lot of hangers acceptable.

This Final Report completes scheduled action on MCAR-19.

Very truly yours,

for P. A. Martinez
Project Manager

PAM/WGM/pp

Attachments (1) Final Report by Bechtel, May 3, 1978.
(2) ITT Grinnell's Field Surveyed Welds Stress Analysis For Bechtel Associates Professional Corp., April 20, 1978.

cc: Mr. R. C. Bauman w/o
[redacted]/16
Mr. J. L. Corley w/o
Mr. B. W. Marguglio w/o

8006230751 S

Bechtel Associates Professional Corporation

777 East Eisenhower Parkway
Ann Arbor, Michigan

Mail Address: P.O. Box 1000, Ann Arbor, Michigan 48106

SUBJECT: MCAR #19 (Issued 11/7/77)

FINAL REPORT, Revision 1

DATE: August 1, 1978

PROJECT: Consumers Power Company
Midland Plant Units 1 & 2
Bechtel Job 7220

Description of Discrepancy

Shop welds for various pipe hanger assemblies designed and fabricated by ITT-Grinnell were noted as underfabricated when compared to the sizes required on the design drawings. A sample size of 125 shop welds was selected as representative of the total group of shop welds on the assembles supplied by Grinnell. All 125 shop welds were examined; from this review, 54 welds (i.e., 43%) were identified as underfabricated in size. Generally, this discrepant condition was 1/16-inch or less undersize.

Paragraph K-1310 of Appendix K, ASME Section III, Subsection NA, which supplements Article NF-4000 of Subsection NF on the fabrication and installation of component supports, states that the recommended maximum tolerances for weld sizes is "plus only, no undersize permitted."

The reason for the discrepancy appears to be three-fold:

1) Grinnell's internal weld inspection procedure was a visual technique which allowed shop fillet welds in any single continuous weld to have an underrun from the nominal fillet weld size required of 1/16-inch without correction, provided the underrrun did not exceed 10% of the weld length. This is an accepted industrial standard for welded structural members.

2) Only shop welds that visually appeared suspect were inspected with a gage.

3) Ambiguous and inconsistent criteria in Grinnell's written procedures for measuring and sizing obtuse angle fillet weld.

Safety Implications

Initially, this deficiency was considered a potentially reportable discrepancy because a safety problem could exist if a Q-listed pipe support should fail due to an underfabricated shop weld. However, based on the results of follow-up analysis which established the design conservatism of the support designs, and the results of the full size destructive loading test with both underspecified and underfabricated welds (reference MCAR #18), we conclude a safety problem does not exist.

Grinnell states that although some of the shop welds are underfabricated from the weld sizes specified on the hanger drawings, there is no safety problem as the welds were sized using allowable weld stress levels that were conservative when compared to the code.

To confirm Grinnels's contention that no safety problem exists, Grinnell performed a reanalysis of the 54 discrepant shop welds of the 125 shop welds noted above. The results indicated that the underfabricated shop welds reanalyzed had weld stress levels less than the maximum permitted by the ASME Code, Section III, Subsection NF. The complete details of the reanalysis is set forth in Grinnell's report entitled "Field Surveyed Welds Stress Analysis for Bechtel Associate Professional Corporation," dated April 19, 1978, which is attached to this report.

The reanalysis of the discrepant shop welds, the results of the full size destructive loading tests conducted on underspecified and underfabricated welds associated with MCAR #18, and the established conservatism of Grinnell's designs, confirm that the safety of the plant operation is not jeopardized by underfabricated shop welds. This deficiency is now considered a nonreportable deficiency.

Corrective Action

To prevent the reoccurrence of underfabricated shop welds Grinnell has:

1) Revised its QA/QC procedures 02A001-"Dimensional Tolerance Standard for Component Supports" Rev D dated December 13, 1977, and 02A006-"Visual and Dimensional Acceptance Criteria for Welds" Rev D dated March 17, 1978. These were approved Level 1 by Bechtel on March 1, 1978, and March 28, 1978, to conform to Paragraph K-1310 of Appendix K, ASME, Section III, Subsection NA.

2) Initiated additonal in-house training sessions for its weld inspectors. (Started November 18, 1977 - Completed December 15, 1977.)

3) Initiated a 100% weld inspection program in September, 1977.

PSQR activities were intensified in the Grinnell shop including a shop weld size inspection on 100 percent of Q-listed hangers shipped October 31, 1977. PSQR routine inspections since that period have shown satisfactory results.

An incoming inspection of all hangers at the jobsite has confirmed the effectiveness of Grinnell's corrective actions to date. The inspection of 100 percent of the hangers was initiated on December 22, 1977, and discontinued June 9, 1978, since the last four shipments had no deficiencies noted.

Conclusions and Recommendations

The results of Grinnell's reanalysis of underfabricated shop welds, the results on the full size destructive loading tests conducted on under-specified and underfabricated welds associated with MCAR #18, and the established conservatism of Grinnell's design confirm that no safety problem exists due to an underfabricated shop weld. It is recommended that hangers with existing discrepant shop welds be used "as-is."

Submitted by ______

Approved by ______

Concurrence by ______

RNT/cap
7/31/1

ITT Grinnell Corporation
Executive Offices
260 West Exchange Street
Providence, Rhode Island 02901
Telephone (401) 831-7000

Pipe Hanger Division

April 20, 1978

Bechtel Associates Professional Corp.
P. O. Box 1000
777 Eisenhower Parkway
Ann Arbor, Michigan 48106

Attn: Mr. R. L. Castleberry - Proj. Eng.

Subject: Consumers Pwr. Co.
Midland Plant - Job 7220
P.O. 7220-M-106-AC
GLBH-867

Gentlemen:

In accordance with the agreements reached between Bechtel and ITT Grinnell, we are submitting the attached report entitled "Field Surveyed Welds Stress Analysis for Bechtel Associates Professional Corp.". This report was generated to demonstrate that the welds made in our Warren, Ohio fabrication facility, though not in strict accordance with the design details, are more than adequate for the purpose intended.

In the preparation of this report, several very conservative assumptions were made. First, if any weld deviated from the design drawing for any percentage of the length; we assumed it to be the smaller size for the entire length, when in fact, the average amount of deviation from the design drawings, for all assemblies inspected, was less than 50%. Second, the analysis performed on the support designs was done for loadings which would only be seen during an "emergency" condition, but we did not take credit for the increase in the allowable stress as allowed by the ASME III Subsection NF. Third, for purposes of this report, we assumed that an overstressed shop weld was reason for rejection of an assembly, yet in many cases, a slightly overstressed weld would not adversely affect the function of the support. This is based on extensive testing we have performed on welds which demonstrate the conservatism of the ITT Grinnell allowables.

TO Mr. R. L. Castleberry April 20, 1978

In the conclusions of the attached report, you will note that, based on the sample size and the fact that no supports were found with overstressed shop welds, we state with a high degree of confidence that there is an extremely low probability that any overstressed welds exist. However, due to the conservatism in our method of analysis as outlined above, we feel confident the actual "acceptance rate" would be much higher than stated in the report. Therefore, based on the extremely low probability of detecting a support with an overstressed shop weld due to fabrication tolerances, we advise that supports shipped from our Warren plant to the Midland jobsite be accepted as is.

Further, based on the results of this report, we feel that reasonable fabrication tolerances be established for future work processed at our Warren facility. In the subject report, we have demonstrated a very conservative design approach and have proven with a high degree of confidence that the probability of finding an overstressed shop weld, even though fabricated at 1/16" below its design value for up to 100% of the weld length, is very low.

Since ASME Section III, Subsection NF does not specifically address weld tolerances for component supports, the fabrication tolerances normally imposed are those as listed in the American Welding Society's Structural Welding Code which allows 1/16" underrun for 10% of the weld length. Based on testing we have performed and on the results of the subject report, we feel that even this tolerance is overly conservative. We feel that a more reasonable tolerance would be 1/16" underrun for 30% of the weld length. In conclusion, we feel confident that this report provides adequate justification for the use of supports previously shipped to the Midland jobsite and that in the future reasonable fabrication tolerances can be established in line with the result of this report. We trust this meets with your approval, and look forward to discussing any comments you may have.

Very truly yours,

R. J. Masterson, P.E.
Manager of Research,
Development & Engineering
Pipe Hanger Division

RJM/ecm

Att.

cc: M. Rothwell-(Bechtel/AA)
J. F. Newgen -(Bechtel/M)
D. Riat -(Bechtel/AA)
R. Riblet - Cleveland
H. Brennan - Taylor
D. Panoff - (Bechtel/AA)
R. Tomlin - (Bechtel/AA)
K. Brafford - (Bechtel/Prov)
H. Thielsch - Prov.
Paul Milman - Prov.
J. Meiss - Prov.
M. Grosso - Prov.
P. Stanish - Prov.
N. DeCristofaro - Prov.
F. Bigos - Prov.

THIS COPY FO

Field Surveyed Welds

Stress Analysis

For

Bechtel Associates Professional Corp.

Midland Power Station Units 1 & 2

Midland, Michigan

By R. Vandeputte/D.T. David Turnquist Date 4-19-78

R. Vandeputte/D. Turnquist
Proj. Mgr. Engineer

Reviewed By F. Bigos Date 4-19-78

F. Bigos
Project Supervisor

Approved By P. Stanish Date 4-19-78

P. Stanish
Project Manager

Date 4-19-78

R. Masterson, P.E.
Mgr., Research, Development and Engineering

CONTENTS

ABSTRACT

The results of a field survey of supports with shop welds, made by ITT Grinnell's Warren, Ohio facility, conducted by Bechtel Associates Professional Corp., are analyzed to verify the adequacy of the supports on the Midland Project fabricated by ITT Grinnell in the fulfillment of Purchase Order #7220-M-106-AC Rev. 5

In accordance with MIL-STD-105D representative sampling guidelines, 125 ASME Nuclear Code Class 2 and 3 supports are surveyed and 17 supports are found to have portions of shop welds below the size specified on the ITT Grinnell support detail. These welds are analyzed for the "as-built" stress levels using the smallest weld section found along the particular weld.

The results of this analysis show that all surveyed supports meet weld stress requirements of ASME Boiler and Pressure Vessel Code, Section III, Subsection NF.

Based on the above analysis, it is determined with a high level of confidence that there is an extremely low probability of finding any supports with overstressed shop welds.

INTRODUCTION

An agreement between Bechtel Associates Professional Corp. (Bechtel) and ITT Grinnell (ITT-G) was reached on 11/16/77, in which Bechtel established a representative sample size to conduct a field survey of ITT-G shop fabricated assemblies. ITT-G agreed to compile and analyze each shop weld questioned on the subject assemblies, based on the smallest section of weld. The basis of this report intended to justify the acceptability of the questioned assemblies, by showing that none of the assemblies has a weld that would be overstressed in the "as-built" condition, as well as to give a reasonable assurance that supports with overstressed welds due to fabrication tolerances, have an extremely low probability of occurence. The ASME Boiler and Pressure Vessel Code, Section III, Sub-Section NF, Paragraph 4222 entitled Tolerances for Linear Type Supports advised that "tolerances....may be as recommended in Non-Mandatory Appendix K, unless specified in the design specifications". Since specific tolerances are not required by Subsection NF, or the Design Specification, hangers fabricated with shop welds below the tolerance of Appendix K are acceptable provided that no shop welds are overstressed in the "as-built" condition.

METHOD OF SURVEY

Bechtel conducted a survey which consisted of a representative sample of 125 supports fabricated for use on ASME Nuclear Code Class 2 and 3 systems. This survey encompassed supports installed in various buildings as well as the Warehouse/Q.C. "holds" area. The supports found with portions of any shop weld below the size specified on the support detail were tabulated and forwarded to ITT-G for analysis. The results of this survey are included as Appendix II of this report.

The basis for the sample size was the military standard for sampling procedures, MIL-STD-105D, dated April 29, 1963. A maximum lot size of 3200 supports was used in conjunction with inspection level II, on Table I. From this a code letter "K" was used to determine a sample size from Table II-A. This table also identified the number of rejects per lot acceptable for various quality levels. For the purpose of this report a reject is defined as a support that has any shop weld that is overstressed in the "as-built" or "as-fabricated" configuration.

METHOD OF ANALYSIS

Weld stress calculations were performed for each support to verify that none of the shop welds were overstressed in the "as-built" condition. These calculations were performed using the smallest section found, carried the full length of the weld. This represents a conservative approach, since most welds questioned were undersized for 5 to 25% of the weld length.

Forces on the welds were determined using tables identical to those shown by O. Blodgett in Design of Welded Structures table 4 (Appendix IV), and table 5 (Appendix V), pages 7.4-6, and 7.4-7.

All forces due to tension or compression, shear, bending and twisting, were combined vectorially. The resultant load per linear inch was then calculated and compared to the maximum allowable stress per linear inch as specified in ASME Section III, Subsection NF-3000, Table 3292.1-1. Consideration for through plate loading was given in accordance with paragraph NF-3226.5 and Appendix XVII-2211C.

Using the data provided by the weld calculations and test sample, we applied Poissons Distribution. This equation (Appendix VI) approximated a point on characteristic curve for determining percent confidence vs. sample number.

ANALYSIS OF RESULTS

Listed below are the "as-built" weld stresses for the shop welds in question on the surveyed assemblies, the Section III code allowable for the "as-built" size, and the "α ratio" which is the allowable stress divided by the actual calculated stress.

All welds analyzed, as listed in Appendices II and III, meet the maximum stress requirements of ASME Boiler and Pressure Vessel Code, Section III, Subsection NF, Summer 1974 Addenda.

Sk. #	S.W. #	Stress (#/in.)	Allow (#/in.)	α
1-610-6-7	1	1854	2380	1.3
2-611-5-20	1	323	2380	7.4
	2	145	2380	16
2-611-6-7	3	150	2380	16
	4	76	1591	21
2-611-6-8	2	163	1190	7.3
1-619-6-15	1	130	2380	18
1-616-6-14	1 & 2	1756	2380	1.4
	3 - 10	286	2380	8
2-617-9-10	2,3,5,7	51	2380	47
	1,4,6,8	9	1591	177
1-610-3-12	2 & 4	58	2784	48
1-610-3-27	1	805	2784	3.5
1-617-8-10	1 & 2	1535	2380	1.6
1-616-7-9	1	482	1190	2.5
	2	909	1190	1.3
0-614-8-12	1 - 4	65	1190	18
2-619-3-31	1	57	2380	42
2-612-3-18	4 - 11	57	2380	42

Sk. #	S.W. #	Stress (#/in.)	Allow (#/in.)	α
2-617-6-12	3 - 6	91	2380	26
0-616-8-23	3 & 4	767	2380	3.1
1-619-6-16	1	15	1190	79
	2 & 3	283	2380	8.4

The 54 welds analyzed all maintained a certain safety margin (α ratio) which ranged from 1.3 to 177. The reason for this wide variation in safety margin is that many of the welds questioned were designed with a size that we consider to be minimal for fabrication (3/16" - 1/4) regardless of loading.

A Poissons Distribution applied to the results of the survey indicates that it can be stated with a 95% level of confidence that less than 2½% of the supports may have an overstressed shop weld.

CONCLUSION

Of the 125 supports surveyed, in accordance with a representative sample as determined by MIL-STD-105D, 17 were found to have welds that were shallower than the size specified on the support detail. These welds were recorded, subsequently analyzed, and the actual stresses in the "as-built" condition were compared against code allowables. The calculated safety margins (α ratio) ranged from 1.3 to 177. Through observation, it was seen that all welds were below code allowables; therefore, none of the surveyed supports have any shop welds which are overstressed.

A Poissons Distribution indicates, with a confidence level exceeding 95%, that less than 2.5% of the supports may have an overstressed shop weld.

REFERENCES

ASME Boiler and Pressure Vessel Code. Section III, Subsection NF. Component Supports. New York, N.Y.: United Engineering Center, 1977.

Blodgett, O.W. Design of Welded Structures. Cleveland: The James F. Lincoln Arc Welding Foundation, 1976.

Smith, Lee H. and Donald R. Williams. Statistical Analysis for Business: A Conceptual Approach. 2nd Ed. Belmont, California: Wadsworth Publishing Company, Inc., 1976.

Kreyszig, Erwin. Advanced Engineering Mathematics. 3rd. Ed. New York, New York; John Wiley and Sons, Inc., 1972.

Military Standard, MIL-STD-105D. Sampling Procedures and Tables for Inspection by Attributes. Dept. of Defense, April 29, 1963.

APPENDIX I

LETTER OF AUTHORIZATION OF REPORT

GRINNELL CORPORATION OUTGOING MESSAGE BLANK

PRIORITY: ☒ URGENT ☐ REGULAR

SECURITY: (GRINNELL POLICY CF. I. 5/1)
☐ SYSTEM CONFIDENTIAL - CODED
☐ PERSONAL AND CONFIDENTIAL - CODED
☒ UNCLASSIFIED - NOT CODED

Originator MUST complete sections on left, otherwise message will be returned to originator.

Send original to Communications Dept.

ORIGINATOR'S SIGNATURE ____

CHARGE TO: P.H.E. (Department)

DATE 12-30-77

MESSAGE TEXT SHOULD BE TYPED ONLY.

TO:
R. L. Castleberry (Name)
Bechtel Assoc. Prof. Corp. (Company)
Ann Arbor, Michigan 48106 (Location)
TELEX/TWX: 23-0101 Bechtel (ARB)

COPIES TO:
J.F. Newgen - Midland - (mailed)
E. Spumberg - Bechtel
R. Riblet - Grinnell- (mailed)
D. Panoff - Bechtel
R. Tomlin - Bechtel
M. Grosso - Prov. (mailed)
P. Milman - Prov. (mailed)

TEXT: (BE BRIEF, BUT EXPLICIT)

GTBH-735

Re: Midland Units 1 & 2 - Bechtel 7220-M-106-AC

Please refer to your letters BGH-532 dated 11-23-77 and BGH 539 dated 12-6-77. These letters contained a total of thirty-six (36) shop welds inspected by your field forces and found to have portions below size specified on the hanger sketch.

Per our agreement on 11-16-77, ITT-Grinnell has compiled calculations for each weld based on the smallest weld section and has found these welds within NF Code allowable stresses. If any additional welds are questioned, ITT-Grinnell looks forward to the opportunity to verify their safety.

Three weeks after the receipt of the last "undersized" weld, ITT Grinnell will have a report including all detailed calculations along with an analysis of stresses.

If we can be of further assistance, please contact P. Stanish or myself.

R. Vandeputte

APPENDIX II

LIST OF SUPPORTS WITH UNDERSIZE WELDS

AND ACCOMPANYING COVER LETTER

Bechtel Associates Professional Corporation

777 East Eisenhower Parkway
Ann Arbor, Michigan

Mail Address: P.O. Box 1000, Ann Arbor, Michigan 48106

December 6, 1977

ITT Grinnell Corporation
Pipe Hanger Division
260 W. Exchange Street
Providence, Rhode Island 02901

Attention: Mr. P. Stanish

Subject: Consumers Power Company
Midland Plant - Job 7220
Pipe Hangers, Supports,
and Restraints
P.O. 7220-M-106
File: M-106
BGH-539

Gentlemen:

Attached please find eight field inspection reports on hanger in the field that have undersized from the weld sizes designated on the Grinnell hanger sketches.

IS THERE MORE COMING?

These reports are in addition to those sent under BGH-532 (11/23/77). The question of code minimum weld size was not addressed or considered in these reports.

Very truly yours,

for R. L. Castleberry
Project Engineer

RNT/pw
12/6/6

Attachments

RECEIVED
DEC 8 1977
PIPE HANGER ENGR.

HANGER# 16-2WDC-135-112 SKETCH# 2-617-8-10

SHOP WELD #	WELD SIZE CALLED FOR	WELD SIZE MEASURED	REMARKS
1 & 2	1/4" all around	3/16 - 5/16 all around	no field welding done

(See Calculations page 44, Appendix III)

HANGER# 8"-OHCC-4-H1 SKETCH# 0-614-8-12

SHOP WELD #	WELD SIZE CALLED FOR	WELD SIZE MEASURED	REMARKS
1	1/4 ALL AROUND	3/16 ALL around	
2	1/4 " "	" " "	
3	1/4 " "	" " "	
4	1/4 " "	" " "	
5	3/16 ALL AROUND	1/2 " "	
6	1/8 ALL AROUND	3/32 " "	
		11/25/77	

(See calculations page 4J, Appendix III)

HANGER # 2HFC-102-H14 SKETCH # 2-C19-3-31

SHOP WELD #	WELD SIZE CALLED FOR	WELD SIZE MEASURED	REMARKS
✓ 1	1/4" all around	4/16 TO 5/16	Field Welds not started

(See calculations page 48, Appendix III)

HANGER# 8-1-GCB-16-117 SKETCH# 1-612-3-18

SHOP WELD #	WELD SIZE CALLED FOR	WELD SIZE MEASURED	REMARKS
1-3	1/4" all around	1/4 TO 5/16	field welds not started
4-11	1/4" all around	3/16 TO 1/4	

(See calculations page 49, Appendix III)

HANGER# 12-2HBC-124-H2 SKETCH# 2-617-6-12

SHOP WELD #	WELD SIZE CALLED FOR	WELD SIZE MEASURED	REMARKS
1	3/16 ALL AROUND	1 & 2 3/16" - 1/4" all around	FIELD WELDS NOT STARTED
2	3/16 " "		
√3	1/4 " "	3-6 3/16" - 5/16" all around	
√4	1/4 " "		
√5	1/4 " "		
√6	1/4 " "		

(See calculations page 50, Appendix III)

HANGER# 16-OHAC-51: #4 SKETCH# 0-616-8-23

SHOP WELD #	WELD SIZE CALLED FOR	WELD SIZE MEASURED	REMARKS
-2 ✓	3/16" all around	1 & 2 not accessible	No field welding done
-4	1/4" all around	3 & 4 from 3/16" to 1/4"	

(See calculations page 51, Appendix III)

HANGER# 10"-1HBC-100-H2 SKETCH# 1-C19-6-16

SHOP WELD #	WELD SIZE CALLED FOR	WELD SIZE MEASURED	REMARKS
√ 1,2,3	1/4 ALL AROUND	3/16 - 5/16 all around	FIELD WELDS NOT STARTED

(See calculations page 53, Appendix III)

Bechtel Associates Professional Corporation

777 East Eisenhower Parkway
Ann Arbor, Michigan

Mail Address: P.O. Box 1000, Ann Arbor, Michigan 48106

November 23, 1977

ITT Grinnell Corporation
Pipe Hanger Division
260 W. Exchange Street
Providence, Rhode Island 02901

Attention: Mr. P. Stanish

Subject: Consumers Power Company
Midland Plant - Job 7220
Pipe Hangers, Supports,
and Restraints
P.O. 7220-M-106
File: M-106
BGH-532

Gentlemen:

Attached please find nine field inspection reports on Grinnell hanger shop welds. These nine reports are for nine hangers existing in the field on which there were ~~twenty-eight shop~~ welds that were undersized from the sizes designated on ~~the individual~~ hanger sketches. The question of code minimum weld size was not addressed or considered in these reports.

NOT SO
SHOULD BE 25

Very truly yours,

R. L. Castleberry
Project Engineer

We do not consider 1/4" undersized

RV.

RNT/pw
12/6/5

Attachments

RECEIVED
DEC 12 1977
PIPE HANGER ENGR.

HANGER# 1HCB-2-H12 SKETCH# 1-610-3-12

SHOP WELD #	WELD SIZE CALLED FOR	WELD SIZE MEASURED	REMARKS
1	1/4" fillet - All around.	1/4" fillet - All around.	Lower stanchion weld to clamp.
✓ 2	1/4" fillet - All around.	50% - 1/4" 50% - 1/4-" 7/32 Appears to have been ground in shop.	Lower stanchion weld to flat plate.
3	1/4" fillet - All around.	1/4" fillet - All around.	Upper stanchion weld to clamp.
✓ 4	1/4" fillet - All around.	50% - 1/4-" 50% - 1/4" 7/32 Appears to have been ground in shop.	Upper stanchion weld to flat plate.

(See calculations, page 42, Appendix III)

HANGER# 1GCB-25-H6 SKETCH# 1-610-3-27

SHOP WELD #	WELD SIZE CALLED FOR	WELD SIZE MEASURED	REMARKS
✓ 1	1/4" fillet - all around	90% - 1/4" fillet 10% - 1/4-" fillet 7/32	

(See calculations page 43 Appendix III)

HANGER# 1FCB-35-H7 SKETCH# 1-610-6-7

SHOP WELD #	WELD SIZE CALLED FOR	WELD SIZE MEASURED	REMARKS
✓ 1	1/4" fillet - all around.	3/16" fillet - welded all around.	

(See calculations page 31, Appendix III)

HANGER# 2HCB-1-H12 SKETCH# 2-611-5-20

SHOP WELD #	WELD SIZE CALLED FOR	WELD SIZE MEASURED	REMARKS
1	1/4" fillet - 2 sides	3/16" fillet	Additional weld across face of flange.
2	1/4" fillet - 2 sides	3/16" fillet	Additional weld across face of flange.
5	1/4" fillet - outerface on flanges both sides on web.	1/4" fillet - all around	

(See calculations page 33 Appendix III)

HANGER# 2FCB-35-H7 SKETCH# 2-611-6-7

SHOP WELD #	WELD SIZE CALLED FOR	WELD SIZE MEASURED	REMARKS
1	1/4" fillet - all around.	75% - 1/4" fillet 25% - 1/4-" fillet	
2	1/4" fillet - all around.	1/4"fillet - all around.	Approximately 25% inaccessible due to grouting. Bottom side in grout top side 1/4" fillet
✓ 3	1/4" fillet - outer face of flanges and both sides of web.	95% - 1/4" fillet 5% - 3/16" fillet	
✓ 4	1/4" fillet - outer face of flanges and both sides of web.	1/8" fillet top of flange 1/4" fillet bottom of flange 75% - 3/16" on web 25% - 1/4" on web	

(See calculations page 34 appendix III)

HANGER# 2FCB-35-H8   SKETCH# 2-611-6-8

SHOP WELD #	WELD SIZE CALLED FOR	WELD SIZE MEASURED	REMARKS
1	1/4" fillet - Outer face on flange both sides on web.	1/4" fillet - All around.	Size of weld in obtuse angle indeterminate.
2	1/4" fillet - all around.	95% - 1/4" fillet 5% - 3/16" fillet	Fillet weld member #3 to base plate. Size of weld in obtuse angl indeterminate.
3	1/4" fillet - All around.	1/4" fillet - all around.	Fillet weld member #2 to base plate.

(See calculations page 36 Appendix III)

HANGER# 1HBC-100-H1 SKETCH# 1-619-6-15

SHOP WELD #	WELD SIZE CALLED FOR	WELD SIZE MEASURED	REMARKS
✓ 1	1/4" fillet - all around.	3/16" and 1/4"(50/50) fillet.	Size of weld in obtuse angle indeterminate.
2	1/4" fillet - all around.	1/4+" fillet welded all around.	Center weld as installed.
3	1/4" fillet - all around.	1/4+" fillet welded all around.	Top weld as installed.

(See calculations page 37 Appendix III)

HANGER# 1-HBC-136-H1 SKETCH# 1-616-6-14

SHOP WELD #	WELD SIZE CALLED FOR	WELD SIZE MEASURED	REMARKS
✓ 1	1/4" fillet - All around.	3/16" fillet - 10% length 1/4" fillet - 90% length Bottom leg up to 3/8" (40%)	South stanchion as installed.
✓ 2	1/4" fillet - All around.	3/16" fillet - 10% length 1/4" fillet - 90% length Bottom leg up to 3/8" (40%)	South stanchion as installed.
✓ 3	1/4" fillet - All around.	3/16" fillet - Random scattered 5%. 1/4" +fillet - Remaining 95%	Welds associated with clamp assembly.
✓ 4	1/4" fillet - All around.	3/16" fillet - Random scattered 5%. 1/4" +fillet - Remaining 95%.	Welds associated with clamp assembly.
✓ 5	1/4" fillet - All around.	3/16" fillet - Random scattered 5%. 1/4" +fillet - Remaining 95%.	Welds associated with clamp assembly.
✓ 6	1/4" fillet - All around.	3/16" fillet - Random scattered 5%. 1/4" +fillet - Remaining 95%.	Welds associated with clamp assembly.
✓ 7	1/4" fillet - All around.	3/16" fillet - Random scattered 5%. 1/4" +fillet - Remaining 95%.	Welds associated with clamp assembly.
✓ 8	1/4" fillet - All around.	3/16" fillet - Random scattered 5%. 1/4" +fillet - Remaining 95%.	Welds associated with clamp assembly.
✓ 9	1/4" fillet - All around.	3/16" fillet - Random scattered 5%. 1/4" +fillet - Remaining 95%.	Welds associated with clamp assembly.
✓ 10	1/4" fillet - All around.	3/16" fillet - Random scattered 5%. 1/4" +fillet - Remaining 95%.	Welds associated with clamp assembly.

(See calculations page 38 Appendix III)

HANGER#2HBC-145-H2 SKETCH# 2 617-9-10

SHOP WELD #	WELD SIZE CALLED FOR	WELD SIZE MEASURED	REMARKS
1	1/4" fillet - all around.	3/16" fillet generally except 50% of the upper most weld (#6) is 1/8" fillet	Pipe to plate per detail.
2	1/4" fillet - all around.	Fillet all around. 15% - 3/16"fillet 85% - 1/4" fillet	Pipe to clamp weld.
3	1/4" fillet - all around.	Fillet all around. 15% - 3/16"fillet 85% - 1/4" fillet	Pipe to clamp weld.
4	1/4" fillet - all around.	3/16" fillet generally except 50% of the upper most weld (#6) is 1/8" fillet	Pipe to plate per detail.
5	1/4" fillet - all around.	Fillet all around. 15% - 3/16" fillet 85% - 1/4" fillet	Pipe to clamp weld.
6	1/4" fillet - all around.	3/16" fillet generally except 50% of the upper most weld (#6) is 1/8" fillet	Pipe to plate per detail.
7	1/4" fillet - all around.	Fillet all around. 15% - 3/16" fillet 85% - 1/4" fillet	Pipe to clamp weld.
8	1/4" fillet - all around.	3/16" fillet generally except 50% of the upper most weld (#6) is 1/8" fillet.	Pipe to plate per detail.

(See calculations page 40 Appendix III)

APPENDIX III

LIST OF STRESS CALCULATIONS

SK# 1-610-6-7 { SHOP WELD #1 }

WELD STRESS DUE TO F_x LOADING (EQUALLY DIVIDED BETWEEN TWO VERTICAL MEMBERS)

$$F_x \cdot \frac{M}{S_w}, \quad M = \frac{F_x}{2}(\ell) = \frac{1478}{2}(12'')$$

$$S_w = 2\left(bd + \frac{d^2}{6}\right) \text{ (SEE APPENDIX V)}$$

$$F_x = \frac{(1478)(12)}{2\left[(1.584)4 + \frac{4^2}{6}\right)2\right]} = \frac{17736}{36} = 493\ \#/\text{IN.}$$

WELD STRESS DUE TO FRICTION ($\mu = .3$) $F_z = \mu(F_y)$ EQUALLY DIVIDED BETWEEN 2 VERTICAL MEMBERS

$$F_z = \frac{.3(2177)}{2}$$

$$F_z = \frac{F_z L}{S_w} = \quad L = 12'', \quad S_w = \frac{d^2(2b+d)}{3(b+d)} \text{ (SEE APPENDIX V)}$$

$$F_z = \frac{(.3)(2177)(12)}{2\left[\frac{1.584(2(4)+1.584)}{3(4+1.584}\right]2}$$

$$F_z = \frac{7837.2}{5.76} = 1361\ \#/\text{IN}$$

$$F_t = F_x + F_z = 1854\ \#/\text{IN.}$$

WELD STRESS DUE TO SHEAR FORCES

$$F_s = \frac{P}{A_w}, \quad A_w = 22'' \text{ (TOTAL 2 WELDS)}$$

$$F_s = \frac{(.3)(2177)}{22} = 30\ \#/\text{IN}$$

$$F_{RESULTANT} = \sqrt{F_t^2 + F_s^2} = 1854\ \#/\text{IN} < 2380\ \#/\text{IN}$$

3/16" WELD O.K.

NOTE:

2380 #/IN = ALLOWABLE LOAD PER LINEAR INCH FOR E70XX ELECTRODES AS CALCULATED BY THE FOLLOWING

$$.707 \times 18000\text{ PSI} \times 3/16 \cong 2380\ \#/\text{IN}$$

18000 PSI IS ALLOWED UNDER ASME SECTION III SUBSECTION NF-3000 TABLE 3292.1-1

ITT Grinnell Corporation PIPE HANGER ENGINEERING DIVISION

BY: [signature] DATE: 4-12-78 SUBJECT: BECHTEL PWR. CORP. P. O. #7220-M-106-AC SHEET NO. 3 OF 23

CHKD. BY: D.T. DATE: 4-12-78 CUSTOMER: MIDLAND PLT. UNITS 1 & 2 SYSTEM: R.H.

PROJECT: HANGER MATERIAL PROJECT NO.

K# 2-611-5-20

SHOP WELD #1 (ASSUMING TENSILE / COMPRESSIVE LOAD RESISTED BY WELD DIRECTLY BELOW ITEM #4)

$F_T = \frac{P}{A_W}$, $P = 6075^{\#}$ (MAX.) $A_W = (10.5)(2)$ $F_T = \frac{6075}{21} = 289.3^{\#}/IN$

SHEAR STRESS - ASSUMING SHEAR FORCE IS EQUALLY RESISTED BY WELD #1 + #2

$F_s = \frac{P}{A_W}$, $P = 6075$ (MAX.) $A_W = (21)(2)$ $F_s = \frac{6075}{42} = 144.6^{\#}/IN$

$F_{RESULTANT}$ (SHOP WELD #1) $= \sqrt{F_T^2 + F_s^2} = 323^{\#}/IN < 2380^{\#}/IN$

3/16" WELD O.K.

SHOP WELD #2: STRESS IN WELD #2 IS EQUAL TO THE SHEAR STRESS IN WELD #1

$F_s = F_{RESULTANT} = 144.6 < 2380^{\#}/IN$

3/16" WELD O.K.

NOTE:

SEE NOTE ON PAGE 3.1 FOR DEFINITION OF ALLOWABLE STRESS

SK# 2-611-6-7

SHOP WELD #3 : ASSUMING F_x LOAD EQUALLY RESISTED BY ALL FOUR WELDS, FIXED CONNECTIONS

$$F_t = \frac{M}{S_W}, \quad M = \frac{\left(\frac{F_x}{4}\right)L}{8} \quad \text{(PER AISC pg. 203)}$$

$$S_W \text{ (FROM APPENDIX V)} = \frac{d^2}{6}$$

$$F_t = \frac{\left(\frac{F_x}{4}\right)L}{8\left[\frac{d^2}{6}\right]} = \frac{\left(\frac{850}{4}\right)(15)}{8\left(\frac{4^2}{6}\right)} = \frac{3187.5}{21.33} = \underline{149} \ \#/\text{IN}$$

SHEAR STRESS : ASSUMING LOAD EQUALLY DIVIDED AT 4 WELDS

$$F_s = \frac{P}{A_W} \qquad P = \frac{850}{4}, \quad A_W = 12''$$

$$F_s = \frac{850}{(4)(12)} = 18\#$$

$$F_{RESULTANT} = \sqrt{F_t^2 + F_s^2} = 150\#/\text{IN} < 2380\#/\text{IN}$$

3/16" WELD O.K

SHOP WELD #4 : USING SAME ARGUMENTS AS FOR SHOP WELD #3

$$F_t = \frac{M}{S_W} \qquad S_W = 2\left(\frac{d^2}{6}\right) \quad \text{(SEE APPENDIX V)}$$

$$F_t = \frac{\left(\frac{F_x}{4}\right)L}{8\left(\frac{d^2}{3}\right)} = \frac{3187.5}{42.67} = 75\#/\text{IN}$$

$$F_s = \frac{P}{A_W}, \quad A_W = 16''$$

$$F_s = \frac{850}{(4)(16)} = 13.3\#/\text{IN}$$

$$F_{RESULTANT} = \sqrt{F_t^2 + F_s^2} = 76\#/\text{IN} < 1591\#/\text{IN}$$

1/8" WELD O.K.

NOTES:

1.) FOR 3/16" WELD ALLOWABLE DEFINITION SEE PAGE 3'
2.) 1591#/IN = ALLOWABLE LOAD PER LINEAR INCH FOR E70XX ELECTRODES AS CALCULATED BY:
$.707 \times 18000 \times 1/8'' \cong 1591\#/\text{IN}$

18 KSI IS ALLOWED UNDER ASME SECTION III, SUBSECTION

ITT Grinnell Corporation — PIPE HANGER ENGINEERING DIVISIC

BY ... DATE 4-12-78 SUBJECT BECHTEL PWR. CORP. P. O. #7220-M-106-AC SHEET NO. 5 OF 2

CHKD. BY D.T. DATE 4-12-78 CUSTOMER MIDLAND PLT. UNITS 1 & 2 SYSTEM RH

PROJECT HANGER MATERIAL PROJECT NO.

NF-3000 TABLE NF 3292.1-1

SK# 2-611-6-8

SHOP WELD #2 : MAXIMUM LOAD ON WELD EQUALS

F_y -2299#, F_z (SHEAR) 2299#

$F_{RESULTANT} = \frac{P}{A_W}$ $A_W = 20'$ $P = \sqrt{2299^2 + 2299^2}$

$F_R = \frac{3251}{20}$

$F_R = 163^{\#}/IN < 1190^{\#}/IN$ 3/16" WELD O.K.

NOTE: FOR DEFINITION OF 3/16" WELD ALLOWABLE SEE PAGE 31.

ALLOWABLE LOAD IS MULTIPLIED BY ONE-HALF IN ACCORDANCE WITH THROUGH PLATE REQUIREMENTS AS STATED IN NF 3226.5

K# 1-619-6-15

SHOP WELD #1: (BRACE TO PLATE) MAXIMUM FORCE
$F_x = 2598^{\#}$

$F = \frac{P}{A_W}$ $A_W \cong 20"$ $F = \frac{2598}{20} = 130^{\#}/\text{IN} < 2380^{\#}/\text{IN}$

3/16" WELD O.K

NOTE:

FOR DEFINITION OF ALLOWABLE STRESS OF 3/16" WELD SEE PAGE 31.

\# 1-616-6-14

SHOP WELDS 1 & 2 :

STRESS DUE TO F_X LOAD (EQUALLY RESISTED BY TWO WELDS)

$F_{BX} = \frac{M}{S_{WX}}$, $S_{WX} = 2bd + \frac{d^2}{3}$ (SEE APPENDIX V)

$F_{BX} = \frac{(1360)(24)}{2\left[(2)(4)(4) + \frac{16}{3}\right]} = \frac{32640}{74.66} = 437^{\#}/\text{IN}$

STRESS DUE TO FRICTION FORCE ($\mu = .3$)

$F_{BZ} = \frac{\mu F_Y}{2}$

$F_{BZ} = \frac{F_B L}{S_{WZ}}$; $S_{WZ} = \frac{2d^2}{3}$ (APPENDIX V)

$L = 14.5"$

$F_{BZ} = \frac{(.3)(6470)(14.5)}{2\left[(2)\frac{4^2}{3}\right]} = \frac{28144.5}{21.33} = 1319^{\#}/\text{IN}$

AXIAL & BENDING

$F = F_{BX} + F_{BZ} = 1755^{\#}/\text{IN}$

SHEAR FORCE EQUALS VECTOR SUM $\vec{F_X} + \vec{F_Z}$ DIVIDED BY 2. (2 WELDS)

$F_S = \frac{F_S}{A_W}$; $A_W \cong 20"$ $F_S = \frac{2370}{2} = 1185^{\#}$

$F_S = \frac{1185}{20} = 59.25^{\#}/\text{IN}$

$F_{RESULTANT} = \sqrt{F_B^2 + F_S^2} = 1756^{\#}/\text{IN} < 2380^{\#}/\text{IN}$

3/16" WELD O.K.

SHOP WELDS 3 THRU 10

CALCULATION FOR STAN. TO PLATE WELDS (TYP) FOR CLAMP TO STAN. WELDS

$F_B = \frac{M}{S_W}$ $M = \mu F_Y L$, $\mu = .3$
$L = 2.06$
$F_Y = 6470$

$S_W = \frac{\pi d^2}{4}$ (SEE APPENDIX V)

$F_B = \frac{.3(6470)(2.06)(4)}{(\pi)(4.5)^2} = 251\#/IN$

$F_S = \frac{F_a}{A_W}$ $A_W = (\pi)(4.5)$
$F_a = \mu F_Y$

$F_S = \frac{(.3)(6470)}{(\pi)(4.5)}$

$F_S = 137\#/IN$

$F_{RESULTANT} = \sqrt{F_B^2 + F_S^2}$ $F_R = 286\#/IN < 2380\#/IN$

3/16" WELD OK.

NOTE:

FOR ALLOWABLE STRESS FOR 3/16" WELD SEE PAGE 31.

ITT Grinnell Corporation — PIPE HANGER ENGINEERING DIVISION

BY ... DATE 4-12-78 SUBJECT BECHTEL PWR. CORP. P. O. #7220-M-106-AC SHEET NO. 10 OF 23

CHKD. BY D.T. DATE 4-12-78 CUSTOMER MIDLAND PLT. UNITS 1 & 2 SYSTEM C.C.

PROJECT HANGER MATERIAL PROJECT NO.

SK# 2-617-9-10

SHOP WELDS # 2, 3, 5, 7

FRICTION FORCE ONLY LOAD ON WELD ($\mu = .3$)

$F_B = \frac{M}{S_W}$ $S_W = \frac{\pi d^2}{4}$ (SEE APPENDIX V)

$M = \mu F_Y (L)$

$L = 1.875''$

$$F_B = \frac{.3(120)(1.875)}{\frac{\pi (1.313)^2}{4}} = \frac{270}{5.42} = 50\#/\text{IN}$$

$F_S = \frac{F}{A_W}$ $A_W = \pi d$

$F = \mu F_Y$

$$F_S = \frac{.3(120)}{\pi(1.313)} = 9\#/\text{IN}$$

$$F_{RESULTANT} = \sqrt{F_B^2 + F_S^2} = 51\#/\text{IN} < 2380\#/\text{IN}$$

3/16" WELD O.K

NOTE:

FOR ALLOWABLE STRESS FOR 3/16" WELD SEE PAGE 31

HOP WELDS # 1, 4, 6, 8

FRICTION FORCE ONLY LOAD ON WELD ($\mu = .3$)

$$F_S = \frac{\mu F_Y}{A_W} \qquad A_W = \pi d$$

$$F_S = \frac{.3\,(120)}{\pi\,(1.313)} = 8.7\ \#/\text{IN} < 1591\ \#/\text{IN}$$

1/8" WELD O.K.

NOTE:

FOR ALLOWABLE STRESS FOR 1/8" WELD SEE PAGE 34

SK# 1-610-3-12

SHOP WELDS #2 & #4

FRICTION FORCE ONLY ($\mu = .3$)

$$F_s = \frac{F_Y \mu}{A_W} ; \quad A_W = \pi d$$

$$F_s = \frac{.3(4038)}{\pi(6.625)} = 58.2 \text{ \#/IN} < 2784 \text{ \#/IN}$$

7/32" WELD O.K.

NOTE:

2784 #/IN = ALLOWABLE LOAD PER LINEAR INCH FOR E70XX ELECTRODES AS CALCULATED BY

$$.707 \times 18000 \times 7/32 \cong 2784 \text{ \#/IN}$$

18000 PSI IS ALLOWED PER ASME SECTION III SUBSECTION NF-3000, TABLE 3292.1-1.

SK# 1-610-3-27

SHOP WELD #1 :

BEAM LOADED BY MOMENT INDUCED AT FIXED CONNECTION

$$M = \frac{Pa^2 b}{L^2}$$ (AISC MANUAL pg. 2-203)

$$M = \frac{(8116)(15)^2(12)}{27^2} = 30059.3$$

$$F_B = \frac{M}{S_W} \qquad S_W = 2db + \frac{d^2}{3}$$ (SEE APPENDIX V)

$$F_B = \frac{30059.3}{2(4)(4) + \frac{4^2}{3}} = \frac{30059.3}{37.33} = 805\#/\text{IN}$$

SHEAR IS NEGLIGIBLE

$$F_{total} = 805\#/\text{IN} < 2784\#/\text{IN}$$

7/32" WELD O.K.

Note:

2784#/IN. = ALLOWABLE LOAD PER LINEAR INCH FOR E70XX ELECTRODES AS CALCULATED BY

$$.707 \times 18000 \times 7/32 \cong 2784\#/\text{IN}$$

18000 PSI IS ALLOWED PER ASME SECTION III SUBSECTION NF-3000, TABLE 3292.1-1

SK# 2-617-8-10
SHOP WELDS # 1 & 2

STRESS DUE TO FRICTION IN X-DIRECTION ($\mu = .3$)
(EQUALLY RESISTED BY 2 WELDS)

$F_{Bx} = \frac{M}{S_W}$ $\quad M = \mu F_Y L, \quad L = 10"$

$S_W = 2\left[2bd + \frac{d^2}{3}\right]$ (SEE APPENDIX V)

$F_{Bx} = \frac{.3(8319)(10)}{2\left[(2)(4)(4) + \frac{4^2}{3}\right]} = \frac{25173}{74.66}$ $\quad F_{Bx} = 337 \#/IN$

STRESS DUE TO FRICTION IN THE Z-DIRECTION

$F_{Bz} = \frac{M}{S_W}$ $\quad$ M (SEE ABOVE)

$S_W = 2(2)\frac{b^2}{3}$

$F_{Bz} = \frac{25173}{21.32} = 1181 \#/IN$

AXIALLY STRESS (2 WELDS)

$F_x = \frac{F}{A_W}$ $\quad A_W \cong 24"$

$F_x = \frac{496}{(2)(24)} = 10 \#/IN$

ITT Grinnell Corporation — PIPE HANGER ENGINEERING DIVISION

BY: [signature] DATE: 4-12-78 SUBJECT: BECHTEL PWR. CORP. P. O. #7220-M-106-AC SHEET NO. 15 OF 23

CHKD. BY: DT DATE: 4-12-78 CUSTOMER: MIDLAND PLT. UNITS 1 & 2 SYSTEM: C.C.

PROJECT: HANGER MATERIAL PROJECT NO.

AXIAL BENDING

$F = F_x + F_{Bx} + F_{Bz}$

$F = 10 + 337 + 1181 = 1528\ \#/\text{IN}$

SHEAR DUE TO FRICTION $A_W \cong 24"$

$$F_{st} = \frac{\sqrt{(\mu F_Y)^2 + (\mu F_Y)^2}}{A_W} = \frac{\sqrt{2}\ \mu F_Y}{24} = \frac{3559.5}{24} = 148.3\ \#/\text{IN}$$

$$F_{RESULTANT} = \sqrt{F^2 + F_{st}^2}$$

$F_{RESULTANT} = 1535\ \#/\text{IN} < 2380\ \#/\text{IN}$

3/16" WELD O.K.

NOTE:

FOR ALLOWABLE STRESS FOR 3/16" WELD SEE PAGE 31.

SK# 1-616-7-9

SHOP WELD #1

$F_s = \frac{F}{A_W}$ $A_W \cong 36"$

$F_s = \frac{17360}{36} = 482^{\#}/IN < 1190^{\#}/IN$

3/16" WELD O.K.

SHOP WELD #2

$F_s = \frac{F}{A_W}$ $A_W = 27.5"$

$F \sqrt{F_X^2 + F_Y^2}$

$F = \sqrt{17360^2 + 17360^2}$

$F_s = \frac{\sqrt{2}\ 17360}{27} = 909^{\#}/IN < 1190^{\#}/IN$

3/16"-WELD O.K.

NOTES:

1.) 36" = LENGTH OF WELD AROUND W6X15.5
27.5 = " " " " M4X13 @ 45° ∡

2.) ALLOWABLE FOR 3/16" WELD WITH THROUGH PLATE REDUCTION SEE PAGE 36

SK# 0-614-8-12

SHOP WELDS #3 #4 (TYPICAL TO #1, 2#)

(SHOP WELD #1 & #2 - LOCATED AT TOP OF BRACKET)
HIGHEST STRESS

$F_S = \frac{F}{A_W}$ A_W = LENGTH OF WELD AROUND 3" CHANNELS ≅ 22" (FOR 2 CHANNELS)

$F_S = \frac{\sqrt{2}\ 1015}{22}$ $F = \sqrt{F_T^2 + F_S^2}$

$F_S = 65^{\#}/\text{IN} < 1190^{\#}/\text{IN}$ 3/16" WELD O.K.

NOTE:

ALLOWABLE STRESS FOR 3/16" WELD WITH THROUGH PLATE REDUCTION SEE PAGE 36

SK# 2-619-3-31

SHOP WELD #1 (STANCHION TO BASE PLATE)

FRICTION FORCES ONLY ($\mu = .3$)

$F_S = \frac{\mu F_Z}{A_W}$; $A_W = \pi d$

$F_S = \frac{.3(2073)}{\pi(3.5)} = 57^{\#}/\text{IN} < 2380^{\#}/\text{IN}$

3/16" WELD O.K.

NOTE:

FOR ALLOWABLE STRESS FOR 3/16" WELD SEE PAGE 31

SK# 2-612-3-18

SHOP WELD #4 - STAN. TO BASE PLATE - TYPICAL FOR WELDS 5 THRU 11

ONLY FORCE DUE TO FRICTION ($\mu = .3$)

$$F_B = \frac{.3\,F_Y L}{S_W}, \quad L = 3.375'' = \text{LENGTH OF STAN.}$$

$$S_W = \frac{\pi d^2}{4} \quad \text{(SEE APPENDIX V)}$$

$$F_B = \frac{.3\,(521)(3.375)}{\frac{\pi\,(3.5)^2}{4}} = \frac{527.5}{9.62} = 55^{\#}/\text{IN}$$

$$F_S = \frac{\mu F_Y}{A_W} \qquad A_W = \pi d = \text{LENGTH OF WELD}$$

$$F_S = \frac{.3\,(521)}{\pi\,(3.5)} = 14.2^{\#}/\text{IN}$$

$$F_{RESULTANT} = \sqrt{55^2 + 14.2^2} = 57^{\#}/\text{IN} < 2380^{\#}/\text{IN}$$

<u>3/16" WELD O.K.</u>

NOTE:

FOR ALLOWABLE STRESS FOR 3/16" WELD SEE PAGE 31

ITT Grinnell Corporation

PIPE HANGER ENGINEERING DIVISION

BY ... DATE 4-12-78 SUBJECT BECHTEL PWR. CORP. P. O. #7220-M-106-AC SHEET NO. 20 OF 23

CHKD. BY D.T. DATE 4-12-78 CUSTOMER MIDLAND PLT. UNITS 1 & 2 SYSTEM CC

PROJECT HANGER MATERIAL PROJECT NO.

SK# 2-617-6-12 (ORIGINAL DESIGN)

SHOP WELD #3 (TYPICAL FOR #4 THRU #6)

ONLY STRESS IN WELD DUE TO FRICTION ($\mu = .3$

$F_B = \frac{\mu F_Y L}{S_W}$, L = LENGTH OF STAN. = 3.25'

$S_W = \frac{\pi d^2}{4}$ (SEE APPENDIX V)

$$F_B = \frac{(.3)(1411)(3.25)}{\frac{\pi (4.5)^2}{4}} = \frac{1375.7}{15.9} \qquad F_B = 86^{\#}/IN$$

$A_W = \pi d$ = LENGTH OF WELD

$$F_S = \frac{\mu F_Y}{A_W}$$

$$F_S = \frac{(.3)(1411)}{\pi (4.5)} = 30^{\#}/IN$$

$$F_{RESULTANT} = \sqrt{F_S^2 + F_B^2} = 91^{\#}/IN < 2380$$

3/16" WELD O.K.

NOTE:

FOR ALLOWABLE STRESS FOR 3/16" WELD SEE PAGE 31

SK# 3-616-8-23

SHOP WELDS #3 & #4 (TYPICAL)

LOADS EQUALLY DEVIDED BETWEEN 2 WELDS

STRESS DUE TO F_X

$$F_{BX} = \frac{\frac{F_X}{2} L}{S_W} \qquad L = 17.5 \qquad S_W = 2db + \frac{d^2}{3} \text{ (SEE APPENDIX V)}$$

$$F_{BX} = \frac{\frac{2213}{2}(17.5)}{(2)(4)(4) + \frac{4^2}{3}} = \frac{19364}{37.33} = 518\#/\text{IN}$$

$$F_{SX} = \frac{\frac{F_X}{2}}{A_W}, \qquad A_W = \text{LENGTH OF WELD} \cong 24''$$

$$F_{SX} = \frac{\frac{2213}{2}}{24} = 46\#/\text{IN}$$

STRESS DUE TO F_Y

$$F_{BY} = \frac{\frac{F_Y}{4} L}{S_W}, \qquad S_W = 2\frac{d^2}{3} \text{ (SEE APPENDIX V)}$$

$$F_{BY} = \frac{\frac{604}{4}(17.5)}{2\left(\frac{4^2}{3}\right)} = \frac{2643}{10.66} = 248\#/\text{IN}$$

$$F_{SY} = \frac{\frac{F_Y}{4}}{A_W}$$

A_W = LENGTH OF WELD = 24"

$F_{SY} = 6^{\#}/IN$

STRESS DUE TO FRICTION

$$F_{SF} = \frac{\frac{.3 F_Y}{4}}{A_W} = .3 F_{SY} = 1.8^{\#}/IN \quad (NEG.)$$

AXIAL AND BENDING

$F_t = F_{BX} + F_{BY}$

$F_t = 518 + 248 = 766^{\#}/IN$

SHEAR

$F_S = \sqrt{F_{SX}^2 + F_{SY}^2} = 40^{\#}/IN$

$F_{RESULTANT} = \sqrt{F_t^2 + F_S^2} = 767^{\#}/IN < 2380^{\#}/IN$

3/16" WELD O.K.

NOTE:
FOR ALLOWABLE STRESS FOR 3/16" WELD SEE PAGE 31

1-619-6-16

SHOP WELD # 1

TENSILE STRESS + F_Y

$$F_B = \frac{F_Y}{A_W} \qquad A_W = \text{LENGTH OF WELD}$$

$$F_B = \frac{354}{24} = 15^{\#}/\text{IN} < 1190^{\#}/\text{IN}$$

3/16" WELD O.K.

SHOP WELD # 2 (TYPICAL FOR WELD # 3) (LOAD EQUALLY DIVIDED BETWEEN 2 WELDS)

STRESS DUE TO F_X

$$f_X = \frac{\frac{F_X}{2}}{A_W} = \frac{843}{10} = 84^{\#}/\text{IN} \qquad A_W = \text{LENGTH OF WELD} = 10''$$

BENDING DUE TO F_Y

$$f_{BY} = \frac{\frac{F_Y (A)(B)}{2(L)^2}}{Z_W}(A+L) = \frac{\frac{(1857)(5.365)(29.625)}{2(35)^2}}{18}(5.365+35) = 270^{\#}/\text{IN}$$

$$F = \sqrt{f_X^2 + f_{BY}^2} = 283^{\#}/\text{IN} < 1190^{\#}/\text{IN.}$$

<u>3/16" WELD O.K</u>

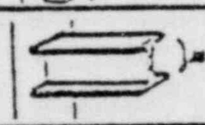
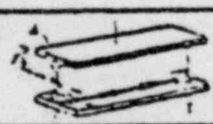
NOTE:

FOR ALLOWABLE STRESS FOR 3/16" WELD WITH THROUGH PLATE REDUCTION SEE PAGE 36

APPENDIX IV

DETERMINING FORCE ON WELD

Determining Force on Weld

Type of Loading		standard design formula stress lbs/in^2	treating the weld as a line force lbs/in
	PRIMARY WELDS transmit entire load at this point		
	tension or compression	$\sigma = \frac{P}{A}$	$f = \frac{P}{A_w}$
	vertical shear	$\sigma = \frac{V}{A}$	$f = \frac{V}{A_w}$
	bending	$\sigma = \frac{M}{S}$	$f = \frac{M}{S_w}$
	twisting	$\sigma = \frac{TC}{J}$	$f = \frac{TC}{J_w}$
	SECONDARY WELDS hold section together - low stress		
	horizontal shear	$\tau = \frac{VAy}{It}$	$f = \frac{VAy}{In}$
	torsional horizontal shear*	$\tau = \frac{T}{2At}$	$f = \frac{T}{2A}$

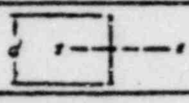
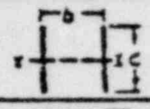
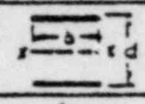
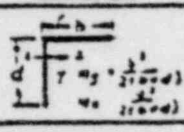
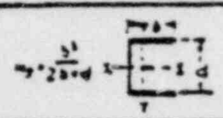
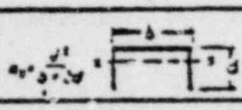
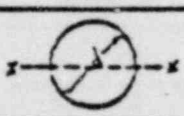
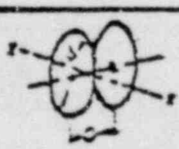
A = area contained within median line.
(*) applies to closed tubular section only.

APPENDIX V

PROPERTIES OF WELD TREATED AS LINE

Determining Weld Size

Properties of Weld Treated as Line

Outline of Welded Joint b = width d = depth	Bending (about horizontal axis x-x)	Twisting
	$S_w = \frac{d^2}{6}$ in.^{2}	$J_w = \frac{d^3}{12}$ in.^{3}
	$S_w = \frac{d^2}{3}$	$J_w = \frac{d(3b^2+d^2)}{6}$
	$S_w = bd$	$J_w = \frac{b^3+3bd^2}{6}$
	$S_w = \frac{4bd+d^2}{6} = \frac{d^2(4b+d)}{6(2b+d)}$ top bottom	$J_w = \frac{(b+d)^4 - 6b^2d^2}{12(b+d)}$
	$S_w = bd + \frac{d^2}{6}$	$J_w = \frac{(2b+d)^3}{12} - \frac{b^2(b+d)^2}{(2b+d)}$
	$S_w = \frac{2bd+d^2}{3} = \frac{d^2(2b+d)}{3(b+d)}$ top bottom	$J_w = \frac{(b+2d)^3}{12} - \frac{d^2(b+d)^2}{(b+2d)}$
	$S_w = bd + \frac{d^2}{3}$	$J_w = \frac{(b+d)^3}{6}$
	$S_w = \frac{2bd+d^2}{3} = \frac{d^2(2b+d)}{3(b+d)}$ top bottom	$J_w = \frac{(b+2d)^3}{12} - \frac{d^2(b+d)^2}{(b+2d)}$
	$S_w = \frac{4bd+d^2}{3} = \frac{4bd^2+d^3}{6b+3d}$ top bottom	$J_w = \frac{d^3(4b+d)}{6(b+d)} + \frac{b^3}{6}$
	$S_w = bd + \frac{d^2}{3}$	$J_w = \frac{b^3+3bd^2+d^3}{6}$
	$S_w = 2bd + \frac{d^2}{3}$	$J_w = \frac{2b^3+6bd^2+d^3}{6}$
	$S_w = \frac{\pi d^2}{4}$	$J_w = \frac{\pi d^3}{4}$
	$I_w = \frac{\pi d}{2}\left(D^2 + \frac{d^2}{2}\right)$ $S_w = \frac{I_w}{c}$ where $c = \frac{\sqrt{D^2+d^2}}{2}$	

APPENDIX VI

POISSONS DISTRIBUTION CALCULATION

ITT Grinnell Corporation BECHTEL PWR. CORP. PIPE HANGER ENGINEERING DIVISION

BY DT DATE 4-12-78 SUBJECT P. O. #7220-M-106-AC SHEET NO. .... OF ....

CHKD. BY [initials] DATE 4-12-78 CUSTOMER MIDLAND PLT. UNITS 1 & 2 SYSTEM ....

PROJECT HANGER MATERIAL PROJECT NO. ....

POISSON'S DISTRIBUTION

$$P(x;\theta) = \frac{\mu^x}{x!} e^{-\mu} = e^{-\mu} \sum_{x=0}^{c} \frac{\mu^x}{x!} \quad (1)$$

θ = 2.5% DEFECTIVE

n = 125 HANGER DESIGNS TESTED

c = 0 DEFECTS

$\mu = n\theta = 3.125$

$$P(x;\theta) = e^{-3.125} \sum_{x=0}^{0} \frac{3.125^0}{x!}$$

$$\sum_{x=0}^{0} \frac{3.125^0}{x!} = 1$$

$$P(x;\theta) = e^{-3.125}(1) = .043937$$

CONFIDENCE LEVEL = $1 - P(x;\theta)$ = 95.61%

(1) ERWIN KREYSZIG, ADVANCED ENGINEERING MATHEMATICS, 3RD ED. NEW YORK, NEW YORK: JOHN WILEY AND SONS, INC. 1972, PAGE 731.

PHE No. 4

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