1. **EnGlNEERlNd DATA TRANSMITTAL**

2. **To:** (Receiving Organization)  
   R.N. Anderson/N1E10000/WAVS

3. **From:** (Originating Organization)  
   S.D. Ellingson/SF840000/MECH/HVAC

4. **Related EDT No.:**  
   N/A

5. **Proj./Prog./Dept./Div.:**  
   Nuclear Material Stabilization

6. **Design Authority/Design Agent/Cog. Engr.:**  
   R. Anderson/S. Ellingson/R. Anderson

7. **Purchase Order No.:**  
   N/A

8. **Equip./Component No.:**  
   N/A

9. **System/Bldg./Facility:**  
   22/234-52/PFP

10. **Major Assem. Dwg. No.:**  
    N/A

11. **Permit/Permit Application No.:**  
    N/A

12. **Required Responses Date:**  
    N/A

13. **Receiver Remarks:**  
    This EDT releases the design analysis initiated in support of valve addition into the fan heater steam lines at PFP.

   Reference ECN-657643

   **11A. Design Baseline Document?**  
   ☑ Yes  ☐ No

   **15. DATA TRANSMITTED**

   **(A)**  
   Item No.

   **(B)**  
   Document/Drawing No.

   **(C)**  
   Sheet No.

   **(D)**  
   Rev. No.

   **(E)**  
   Title or Description of Data Transmitted

   **(F)**  
   Approval Designator

   **(G)**  
   Reason for Transmittal

   **(H)**  
   Originator Disposition

   **(I)**  
   Receiver Disposition

   **1.**  
   HNF-6252

   Steam Valve Addition

   **16. KEY**

   **E, G, D OR N/A**  
   (See WKC-CM-3-3, Sec. 12.7)

   1. Approval  
   2. Release  
   3. Information  
   4. Review  
   5. Post-Review  
   6. Dist. (Receipt Acknow. Required)

   1. Approved  
   2. Approved w/comment  
   3. Disapproved w/comment  
   4. Reviewed not/acknowledged

   **17. SIGNATURE/DISTRIBUTION**  
   (See Approval Designator for required signatures)

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   QA

   Safety

   Env.

   **18. Signature of EDT Originator**  
   3/1/00

   **19. Authorized Representative for Receiving Organization**  
   N/A

   **20. Design Authority/ Cognizant Manager**  
   9/7/00

   ☐ Approved  
   ☐ Approved w/comments  
   ☐ Disapproved w/comments

   **21. DOE APPROVAL (if required)**

   Ctrl No.

   ☐ Approved  
   ☐ Approved w/comments  
   ☐ Disapproved w/comments

   BD-7400-172-2 (10/87)
PFP Steam Valve Addition
Design Analysis

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

Fluor Hanford
P.O. Box 1000
Richland, Washington

Approved for public release; further dissemination unlimited
PFP Steam Valve Addition Design Analysis

Scott D Ellingson
Fluor Hanford

Date Published
April 2000

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Total Pages: 33
Status and description of the attached Calculation Sheets.

**Discipline:** Piping

**Project No. & Title:** Plutonium Finishing Plant Contract 5204, Release 22

**Calculations:** Room 321 Steam Valve Addition

These calculations apply to:

- Drawing No. H-2-16455
- Drawing No. 
- Other (Study, CDR) ECN-657643

The status of these calculations is:

- ☒ Final Calculations
- ☐ Void Calculations (reason voided):

Were calculations incorporated into the final drawings?

- ☐ Yes
- ☐ No

Were calculations verified by independent "check" calculations?

- ☐ Yes
- ☐ No

### Original and Revised Calculation Approvals

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**FLUOR DANIEL-NORTHWEST**  
**DESIGN ANALYSIS**

**Calc. No.** S204-22-P-001  
**Revision** 0  
**Contract/Job No.** CONTRACT S204, RELEASE 22  
**Date** 9/8/80  
**Checked By**  
**Page No.** 1 of 14

**Subject** Rm 321 STEAM VALVE ADDITION  
**Originated By** S.D. Ginn  
**Revised By**  
**Date** 5/1/80

**Location** 234-52, PFP

---

**GIVEN**

SECONDARY ISOLATION VALVES ARE REQUIRED WITHIN THE STEAM LINES SUPPLIING THE PFP BUILDING VENTILATION FANS, SEE ENGINEERING CHANGE NOTICE 657643 AND THE APPENDIX ATTACHED TO THIS ANALYSIS FOR LAYOUT. REFERENCE TO MISCELLANEOUS DESIGN REFERENCE AND CRITERIA ARE AS FOLLOWS:

**H-2-16.155**  
ORIGINAL CONSTRUCTION DRAWING  
HWN-3165  
ORIGINAL CONSTRUCTION SPEC./PIPE CODE PH-2  

**FLUID SERVICE**  
20 psig STEAM, TEMPERATURE = 250 °F

**DESIGN CRITERIA**  
ADME 83.1-1998 POWER PIPELINE  
HNF-P60-897: HANFORD DESIGN CRITERIA  
SAFETY DESIGNATION: GENERAL SERVICE

**MATERIALS**  
PIPE: SCH 40, ASTM A53, CS, SEAMLESS  
BOLTS: ASTM A107, CS, FT² = 55 KSI  
HANGERS: 4' CARBON STEEL, FT² = 60 KSI  
PIPE INSULATION: 1/2' THK. ASBESTOS, SEE APPX. PGS. 8  
EXISTING VALVES: 8" CRANIG. NO. 9651/2 (FROM FIELD)  
NEW VALVES: 8" PER HZ-31750, SHT 2; PIPE CODE M2  
NEW PIPE:

**NOTE**: THE EXISTING STEAM DISTRIBUTION SYSTEM AT PFP WAS DESIGNED AND BUILT IN 1949. THE SYSTEM WAS DESIGNED FOR DEAD LOADS, LIVE LOADS AND OPERATING LOADS; SEISMIC LOADS WERE NOT CONSIDERED IN THE DESIGN OF THE SYSTEM. CURRENT SITE DESIGN CRITERIA REQUIRES THAT SEISMIC LOAD BE CONSIDERED FOR NEW STRUCTURES, SYSTEMS, OR COMPONENTS (SSCCS) ADDAMS TO SSCS, OR THE MODIFICATION OF SSCS. ADDING A NEW SECONDARY ISOLATION VALVE TO THE EXISTING SYSTEM TO IMPROVE OPERATOR SAFETY IS NOT AN ADDITION TO OR MODIFICATION OF THE SYSTEM, AND THUS UPGRADING THE SYSTEM TO MEET CURRENT SEISMIC REQUIREMENTS IS NOT REQUIRED. AS A CONSERVATIVE SAFETY APPROACH, ADDITIONAL PIPE SUPPORT HANGERS WILL BE INSTALLED AT THE LOCATION OF THE NEW VALVES REGARDLESS OF THE OUTCOME OF THIS ANALYSIS. NO CREDIT IS GIVEN FOR THE NEW SUPPORTS IN THIS ANALYSIS.

**REQUIRED**: DETERMINE IF THE ADDITION OF THE NEW 8" STEAM VALVES WILL INDUCE UNACCEPTABLE STRESSES WITHIN THE SYSTEM OR PROVIDE AN UNSAFE CONDITION.
**DESIGN ANALYSIS**

**Solution:** The basic approach will be to determine the loads on the system, determine inherent stresses on the system using equation (1), paragraph 104.8.1, ASME B31.1, and compare the calculated stresses to that allowable per table A-1, ASME B31.1.

**Path Forward:**

1. **Determine system layout for analysis purposes.** (Pg 3)
2. **Determine loads, stresses, and acceptability of 8" pipe run.** (Pg 4-9)
3. **Determine loads, stresses, and acceptability of 10" pipe run.** (Pg 10-12)
4. **Determine the stresses and acceptability of all pipe hangers.** (Pg 12-4)

**Conclusion:**

1. **8" Pipe Analysis**
   - All loads on the 8" pipe due to the addition of the new valve and existing components are shown on page 8. The worst case loading was found to exist at the 4" branch location on the 8" pipe. The inherent stress at this location was calculated to be 20,920 psi, which is a factor of 5.7 lower than the allowable of 120,000 psi.

2. **10" Pipe Analysis**
   - The loads subjected to the 10" pipe, due to the addition of the new valve on the 8" pipe, are shown on page 13. These loads were found to be less than those calculated on the 8" pipe. Therefore, the stresses are inherently acceptable and were not calculated.

3. **Hangers**
   - Hanger stresses were calculated for the worst case load location and were found to be acceptable. The highest stress was found in the hanger rod, hex nut threads, and was 4657 psi. This is a factor of 2.5 lower than the allowable of 11,800 psi.
1. **SYSTEM LAYOUT**

   From review of the system layout found within the appendix of this analysis, it is found that the location with the greatest hanger spacing and most concentrated loads, is the back-to-back valve application, typical. A plan, and represented by detail III, this will be the area analyzed and shown below for sake of clarity.

   ![Diagram of system layout](image)

   **Typical Branch Tie (C.T.)**

   **Typical Hanger**

   1. 4" GLOBE VALVE, ASSUMED CRANE NO. 143, WT: 134 LBS.
   2. 4" GATE VALVE, ASSUMED CRANE NO. 476/2, WT: 97 LBS.
   3. 4" TEMP. CONT. VALVE, ASSUMED SPENCE TYPE "E", WT: 210 LBS.
   4. 9" Y-STRAINER, ASSUMED ARMSTRONG F169-3, WT: 112 LBS.
   5. SAME AS 6.
   6. 8" GATE VALVE, CRANE NO. 465/8, EXISTING, WT: 280 LBS.
   7. 8" GATE VALVE, STOCKHAM 6-624, NW PER PIPE 3/4, WT: 316 LBS.

   Those items assumed could not be field verified due to pipe insulation.
2. Determine loads, stresses, and acceptability of 8" pipe.

First, determine the influence the 4" pipe header has on the 8" pipe. This load must be accounted for on the 8" pipe.

As a conservative approach, assume a simply supported beam as shown below, where $R_1$ is the support reaction at the coil end of the piping loop, and $R_2$ is the support reaction provided by the 8" header.

See layout on page 3 and vendor data for misc. dimension and weights. See appendix pages A10, A11 & A12 for pipe and insulation weights. Sum moments about $R_1$ to get $R_2$.

\[
\begin{align*}
F_{\text{globe valve}} &= 139 \text{ lbs}, x = 36'' \\
F_{\text{gate valve}} &= 97 \text{ lbs}, x = 17.5'' \\
F_{\text{gate valve}} &= 97 \text{ lbs}, x = 57.5'' \\
F_{\text{temp. valve}} &= 210 \text{ lbs}, x = 28'' \\
F_{\text{y-stripper}} &= 112 \text{ lbs}, x = 4.2'' \\
F_{\text{13.5" pipe with insulation}} &= 11.7 + 6.6 = 18.3 \text{ lbs}, x = 6.5'' \\
F_{\text{13 of 4" pipe with insulation}} &= 11.7 + 6.6 + 18.3 \text{ lbs}, x = 65.1'' \\
F_{\text{30 of 4" pipe with insulation}} &= 270 + 15.5 = 293.8 \text{ lbs}, x = 15'' \\
F_{\text{30 of 4" pipe with insulation}} &= 270 + 15.5 = 423.3 \text{ lbs}, x = 57'' \\
F_{\text{48 of 4" pipe with insulation}} &= 43.2 + 24.4 = 67.6 \text{ lbs}, x = 72''
\end{align*}
\]

See appendix pages A10, A11 & A12 for pipe and insulation weight determination.

Note: Weight of normal condensate assumed nil. Weight of flooded condensate or full line test fluid, assumed nil per design authority direction.

\[
\begin{align*}
EMR' &= (134)(36) + (47)(17.5) + (97)(57.5) + (210)(28) + (112)(51) + (18.3)(65.5) \\
&+ (18.3)(65.5) + (18.3)(51) + (92.3)(57) + (67.6)(72) - 0.2\cdot R_2 = 0 \\
R_2 &= \frac{EMR'}{0.2} = 439.2 \text{ lbs}
\end{align*}
\]
DESIGN ANALYSIS

Determine: Final load on the 8" pipe due to the 4" pipe loop and components. Assume the 439.2 lb load at a distance of 2'-8" (32") from the 8" pipe. As shown below and induces a torsional moment of:

\[ M_1 = 439.2 \times 32 = 14054.4 \text{ in.-lbs} \]

*Final reaction on 8" pipe due to 4" pipe loop:*

Point load, \( R_2' = 439.2 \text{ lbs} \). Moment, \( M_1 = 14054.4 \text{ in.-lbs} \). Note: This is conservative since 4" pipe attachment to the existing steam coils was not considered.

Determine all loads on the 8" pipe for final analysis. Assume a simply supported beam as shown below. Where \( R_1 \) is the support reaction at the first ceiling hanger, and \( R_2' \) is the support reaction provided by the 10" pipe.

Where:

\[ R_2' = 439.2 \text{ lbs} \]
\[ F_1 = 2800 \text{ lbs} \]
\[ F_2 = 1360 \text{ lbs} \]
\[ W = 487 \text{ lb/ft pipe/insulation} \]

Notes:

1. The moment on the 8" pipe due to the 4" pipe is not shown. It will be accounted for in the 8311 equation.
2. Normal condensate loading is assumed nil. Flooded condensate loading or full line test fluid is assumed nil per design authority direction.
3. The 42" pipe overhang shown is 1/2 the distance between ceiling hangers. All other dimensions are per page 3.
TO SIMPLIFY ANALYSIS, SEPARATE POINT LOADS FROM UNIFORM LOADS AND
COMBINE RESULTS AT POINTS OF INTEREST FOR FINAL ANALYSIS. BEAM
ANALYSIS FOR POINT LOADS WILL BE ACCOMPLISHED BY AREA UNDER THE SHEAR
DIAGRAM + BEAM ANALYSIS FOR UNIFORM LOADS WILL BE ACCOMPLISHED
BY RISE EQUATIONS.

\[ EY = 0 = (R_1^P)L + (R_2^P)L - 439.2 - 280 - 316 \]
\[ (R_1^P)L + (R_2^P)L = 1035.2 \text{ lbs} \]

\[ EMR1 = 0 = (439.2)(58) + (280)(75.5) + (316)(87) - (R_2^P)(120) \]
\[ (R_2^P)L = (439.2)(58) + (280)(75.5) + (316)(87) \]
\[ 120 \]
\[ (R_2^P)L = 617.5 \text{ lbs} \]
\[ (R_1^P)L = 1035.2 - (R_2^P)L = 417.7 \text{ lbs} \]

AT NEW VALVE:
\[ MA = (617.5)(33) = 20377.5 \text{ in.-lbs} \]

AT EXIST VALVE:
\[ MB = MA + (301.3)(145) = 23844.8 \]

AT 4" BRANCH CONNECTION:
\[ MC = MB + (215)(173) = 24221 \text{ in.-lbs} \]
UNIFORM LOADS:

W = \left(\frac{\text{lbs/ft}}{\text{in}}\right)_{\text{pipe}} + \left(\frac{\text{lbs/ft}}{\text{in}}\right)_{\text{insulation}}

For pipe, W = 28.56 \text{ lbs/ft} = 2.379 \text{ lbs/in} \quad \text{(Appendix Pg A10)}

For insulation, W = 9.7 \text{ lbs/ft} = 0.808 \text{ lbs/in} \quad \text{(Appendix Pg A12)}

W = 2.379 + 0.808 = 3.2 \text{ lbs/in}

From AISC, \( (R_i)_{UL} = \frac{W(1+A)^2}{2L} \)

\[ (R_i)_{UL} = 349.9 \text{ lbs} \]

\[ (R_2)_{UL} = \frac{W(2-L)}{2L} \]

\[ (R_2)_{UL} = 168.5 \text{ lbs} \]

AT NEW VALVE: \( M_4 = \frac{W \times (L^2-A^2 \times L)}{2L} \)

\[ M_4 = 3817.4 \text{ in-lbs} \]

AT EXIST VALVE: \( M_e = \frac{(3.2)(94.5)(120^2-42^2-33)(120)}{2(120)} \)

\[ M_e = 4329.0 \text{ in-lbs} \]

AT 4" BRANCH CONNECTION: \( M_4 = \frac{(3.2)(62)(120^2-42^2-62)(120)}{2(120)} \)

\[ M_4 = 4295.4 \text{ in-lbs} \]
AT CEILING HANGER, (R_i)_{UL}, M_g = W_A \times \frac{R_1}{R_2} = 2822.4 \text{ IN-LBS}

LOAD SUMMARY ON 8" PIPE

AT CEILING HANGER, R_{1''} = (R_i)_e + (R_i)_{UL} = 917.7 + 349.9 = 767.6 \text{ LBS}

AT NEW 10" PIPE, R_{2''} = (R_2')_e + (R_2)_{UL} = 617.5 + 168.5 = 786.0 \text{ LBS}

AT CEILING HANGER, M_2 = M_g = 2822.4 \text{ IN-LBS}

AT 4" BRANCH CONNECT, M_3 = M_c + M_4 = 2422.1 + 4329.4 = 28516.4 \text{ IN-LBS}

AT EXIST VALVE, M_4 = M_b + M_e = 23849.8 + 4329 = 28173.8 \text{ IN-LBS}

AT NEW VALVE, M_5 = M_a + M_d = 20377.5 + 3817.4 = 24194.9 \text{ IN-LBS}
Determine stress within the 8" pipe header.

From inspection of the load summary diagram, it is found that the highest magnitude and quantity of loads occur at the 4" branch connection. Therefore, this will be the location of final analysis.

Notes: 1. Stresses within the 4" branch piping itself will not be analyzed. It is assumed that the addition of the new valve in the 8" line will not add loading to the 4" branch, since it is free to move up and down, and that the existing stresses are acceptable.

2. Thermal expansion and hoop stresses will not be analyzed. It is assumed that the addition of the new 8" valves will not effect the existing inherent stresses.

From ASME B31.1, Paragraph 10.4.8.1, stresses due to sustained loads, $S_L$, must satisfy the following:

\[
S_L = \frac{Pd_o + (0.75)lMA}{\sqrt{Z}}
\]

\[
S_L = \frac{(30)(8.625) + (0)(3179.7)}{\sqrt{16.81}} = 20.92 \text{ kips}
\]

This is less than 12000 psi.

OK!
3. Determine loads, stresses, and acceptability of 10" pipe.

Assume a simply supported beam as shown below where $R_1''$ and $R_2''$ are ceiling hanger supports and $R_2''$ is the load imposed by the 8" pipe branch, ref. Pg. 8.

![Diagram of a simply supported beam with loads $R_1''$ and $R_2''$.]

\[
R_2'' = 786 \text{ LBS}
\]

Notes:
1. As before, partial or full pipe condensate loads will not be accounted for.
2. As before, thermal and seismic loads will not be accounted for.
3. The 60" overhangs are \( \frac{1}{2} \) the distance between ceiling hangers.

Use same approach, separate point loads and uniform loads and combine when finished.

Point loads:
\[
\begin{align*}
\Sigma F_Y &= 0 = (R_1'')_{pl} + (R_2'')_{pl} = 786 \\
(R_1'')_{pl} + (R_2'')_{pl} &= 786 \\
\Sigma M_{R_1} &= 0 = (R_2'')_{pl} \cdot 120 - (786)(12) \\
(R_2'')_{pl} &= \frac{(786)(12)}{120} = 78.6 \text{ LBS} \\
(R_1'')_{pl} &= 786 - 78.6 = 707.4 \text{ LBS}
\end{align*}
\]

Moment at $R_2'' = M_h$
\[
M_h = (707.4)(12) = 8,488.8 \text{ IN-LBS}
\]
**FLUOR DANIEL NORTHWEST**

**DESIGN ANALYSIS**

**Subject:** Rm 321 Steam Valve Addition

**FLUOR HANFORD**

**Place:** 234-SF, PFP

**Location:**

**Uniform Loads:**

\[ W = \text{Pipe, Insulation} \text{ Lbs/in.} \]

**FBE Pipe:**

\[ W = 90.98 \text{ Lbs/ft. Approx P8 A10 (R''1)UL} \]

\[ = 3.373 \text{ Lbs/in.} \]

**For Insulation:**

\[ W = 112.2 \text{ Lbs/ft. Approx P8 A12} \]

\[ = 4.49 \text{ Lbs/in.} \]

\[ W = 3.373 + 96.9 = 4.37 \text{ Lbs/in.} \]

\[ \text{From Inspection, (R''1)UL and (R''2)UL equally share the total load} \]

\[ (R''1)UL = (R''2)UL = \frac{W}{2} = \frac{(4.3)(200)}{2} = 516 \text{ Lbs} \]

**Maximum Moment, M6, at each support:**

\[ M6 = \frac{WA^2}{2} = \frac{(7740)(200)^2}{2} = 7740 \text{ in. Lbs} \]

**For ease of calculation, assume this is also the moment at the 8" branch connection (conservative, actual value would be slightly less).**

**Load SUMMARY to Pipe:**

**At Ceiling Hangers:**

\[ R''1 = (R''1)PL + (R''1)UL = 70.7 + 516 = 1223.4 \text{ Lbs} \]

\[ R''2 = (R''2)PL + (R''2)UL = 78.6 + 516 = 594.6 \text{ Lbs} \]

**At 8" Branch connection:**

\[ M7 = M6 + M6 = 8488.8 + 7740 = 16228.8 \text{ in. Lbs} \]

\[ R'' = 1223.4 \text{ Lbs} \]

\[ R'' = 786.9 \text{ Lbs} \]

\[ R'' = 594.6 \text{ Lbs} \]

\[ M6 = 7740 \text{ in. Lbs} \]

\[ M7 = 16228.8 \text{ in. Lbs} \]
Determine stress within the 10" pipe.

From inspection, the loads for the 10" pipe are found to be less than that calculated for the 8" pipe. Since the stress calculated for the 8" pipe was determined acceptable, the stress within the 10" pipe must be acceptable.

4. Determine the stresses and acceptability of all pipe hangers.

For design details of both the 8" and 10" pipe ceiling hangers, see detail, page A4, within the appendix. Determine stresses for the worst case condition, i.e., the 10" pipe hanger. Where Ri" = 1223.9 lbs.

* Determine the stress within the 3/4" Ø collar bolt. Assume direct shear on one plane.

\[ \tau = \frac{R_i}{A} \]

Where \( A \) = cross sectional area of bolt, from Appendix A, \( A = 0.302 \text{ in}^2 \).

\[ \tau = \frac{1223.9}{0.302} = 4051 \text{ psi} \]

\[ \text{Allowable} = 80\% \text{ Sh. per ASME B31.1, Paragraph 102.3.1 B} \]

\[ \text{Note: ASTM A197 could not be found in Table A.1 of B31.1. Since the construction spec stated Ft. = 55 ksi min., assume material is ASTM A36 Bar with } Sh = 14.5 \text{ksi.} \]

\[ \text{Allowable} = (.8)(14500) = 11600 \text{ psi} \]

\[ \tau (4051) < \text{Allowable (11600)} \text{ OK!} \]
Determine the normal stress in the 3/4" dia. bar due to tension. Assume ASTM A36 material as before:

\[ \sigma = \frac{R_{\text{m}}}{A} \]

Where \( A \) = tensile stress area at threads = 0.334 in.\(^2\) (Pg. A13, Appendix).

\[ \sigma = \frac{1233.4}{0.334} = 3652.8 \text{ psi} \]

\[ \sigma \text{ (allowable)} = 14500 \text{ psi} \]

\[ \frac{\sigma}{\sigma \text{ (allowable)}} = \frac{3652.8}{14500} < 1 \text{ (14500)} \text{ OK!} \]

Determine the average shear stress in the 3/4"-10 UNC hex nut threads which holds up the hanger rod. Assume shear at the major diameter:

\[ \tau = \frac{2 \times R_{\text{m}}}{\pi \times d \times h} \]

Ref. Shigley, 3rd Edition, Ch. 6, Eq. 6.8

Where: \( d \) = major diameter = 0.75", Pg. A13, Appendix

\[ h = \text{nut height} = 0.446 \text{ in. (ref. "Alwin" screw data)} \]

\[ \tau = \frac{2 \times 1233.4}{3.14 \times 0.75 \times 0.446} = 4656.8 \text{ psi} \]

\[ \frac{\tau}{\tau \text{ (allowable)}} = \frac{4656.8}{11600} < 1 \text{ (11600)} \text{ OK!} \]

Determine the stress in the 1/2" x 3/4" x 3" angle weld due to bending. Assume shear at the weld throat and material is ASTM A36 as before:

\[ \sigma = \frac{M \times c}{I} \]

Where \( c = \frac{3}{2} = 1.5 \text{ in.} \)

\[ I = \frac{0.707 \times h \times t^3}{12} = \frac{0.707 \times 0.75 \times 3^3}{12} = 1707 \text{ in.}^4 \]

\[ M = R_{\text{m}} \times c = (1233.4) \times (1.5) = 1849.7 \text{ in.} \times \text{lbs} \]

Ref. Pg. A14, Appendix
\[ \Delta = \frac{(24.46 \times 10^5)}{79.5} = 9616.6 \text{ psi} \quad \left( \frac{9616.6}{14500} \right) \leq 0.6 \quad \text{OK!} \]

Notes:
1. By engineering inspection, it is concluded the 1/2" x 3" flat bar pipe collar is not overstressed and is acceptable.
2. By engineering inspection, it is concluded the 1/2" x 3" angle bracket is not overstressed and is acceptable.
3. By engineering inspection, it is concluded all bearing stresses are within limits and are acceptable.
5204-22-P-001

Rev 0

Appendix
DETAIL I

CUT PIPE 2 PLACES AND INSTALL NEW 8" GATE VALVE, EXIST VALVE, PIPE AND FITTINGS PER PIPE CODE WITH SLIP-ON FLANGE EXCEPTON

DETAIL II

EXIST 4" BRANCH W/45° ELBOW

EXIST 8" BRANCH W/45° ELBOW
NOTES

1. INSTALL NEW 4" GATE VALVES WITH STEM'S VERTICAL AND UPRIGHT.

2. INSTALL NEW 6" GATE VALVES WITH STEM'S VERTICAL AND UPRIGHT WITH EXCEPTION TO FAN #7 LOCATION.
   ROTATE VALVE 1-BOLT HOLE FROM VERTICAL TO ALLOW VALVE STEM CLEARANCE.

DETAIL III

5. REPLACE EXIST 8" GATE VALVE WITH NEW VALVE. CUT PIPE 1 PLC AND RELOCATE EXIST VALVE

5. EXIST 8" BRANCH W/45° ELBOW

4" AND 6" VALVE ADDITION LOADS ARE ASSUMED NIL AND NOT ADDRESSED IN THIS ANALYSIS.

NEW VALVE LOCATION
PIPING CODE - P-12

ASA Primary Pressure Service Rating: 150

Test Press: Two times the operating pressure but not to exceed 350 psi. See column 150, Table 6, ASA Blåe (reproduced on page 38) for temperature range with permissible operating pressures.

<table>
<thead>
<tr>
<th>PIPE SIZES</th>
<th>1/4&quot; to 2&quot;</th>
<th>2-1/2&quot; and Larger</th>
</tr>
</thead>
<tbody>
<tr>
<td>PIPE JOINTS</td>
<td>Welded, or screwed</td>
<td>Welded or ASA 150# steel std. slip-on, welding neck, screwed, or Van Stone Flanges.</td>
</tr>
<tr>
<td>*PIPE ASTM A53</td>
<td>Sched. 40 (Screw nipples 8&quot; lg. or less Sch. 80)</td>
<td>2-1/2&quot; to 12&quot; Schedule 40. 14&quot; and larger, Schedule 20.</td>
</tr>
<tr>
<td>FITTINGS</td>
<td>Welding or steel screwed on drips &amp; drains, inst. &amp; other small conn. beyond shut-off valve at main, use ASA 2000# forged fittings.</td>
<td>welding, or ASA 150# Std. Steel flanged.</td>
</tr>
<tr>
<td>UNIONS</td>
<td>Steel Rockwood with bronze inserts or equal.</td>
<td>ASA 150# Std. steel flanges</td>
</tr>
</tbody>
</table>

Rev. VALVES:

#5 Gate G 1.5 S 426; G 2 S 652
Globe G1.5 S 429; G 1.2 S 653
Angle A 1.5 S 444; A 2 S 655
Check C 2 S 656

BOLTS & NUTS None

GASKETS None

Carbon Steel hex heads & nuts.

Steam - 1/16" Hanford Code S-2 or G-2.
Air - 1/16" ring, Hanford G-2, S-2 Compressor to receiver; Hanford G-4, S-4 beyond receiver.

Rev. #5 TRAPS

Steam - Trane inverted bucket or equal.
Air - Armstrong 1/2" float-operated, snap action type or equal.

STRAINERS Strong Fig. LXS, or equal.

*SMALL AIR PIPING Sizes below 3/4" I.P.S. shall be soft annealed copper tubing with fittings per Piping Code P-33.
POWER & PROCESS PIPING FOR MANUFACTURING & SERVICE AREAS

PART I - MATERIALS AND STANDARDS

1. PIPE - GENERAL

All pipe shall be round in section, free from flaws of any kind, reasonably straight and manufactured within the tolerances specified by American Society for Testing Materials, and American Water Works Association for steel and cast iron pipe, respectively. All piping not covered by these classifications shall be manufactured within the tolerance dictated by best American practice, or within the limits of the American Standards Association Pipe Code B31.1, 1942.

Fabricated pipe, flanges, and fittings shall comply with Sects. 1 & 6 ASA B31.1 - 1942 unless otherwise specified herein or on drawings.

2. Deleted

3. STEEL PIPE

Unless otherwise indicated on drawings all pipe for power and process piping shall be preferably seamless; a first choice acceptable alternate will be lap welded pipe; a second choice acceptable alternate will be electric fusion butt welded pipe.

Steel pipe shall conform to the ASTM designation, latest revision, stated in each piping code.

Where ASTM designation A-106 is specified, the following alternates will be acceptable:

(a) ASTM designation A-83 Type A seamless tubes made of killed steel.
(b) ASTM designation A-155 Grade C electric fusion welded steel pipe.
(c) ASTM designation A-161 low carbon seamless steel tubes.

Where ASTM designation A-53 is specified, the following alternates will be acceptable:

(a) ASTM designation A-106 and all alternates for A-106.
(b) American Petroleum Institute 5L seamless open hearth or electric furnace steel pipe. The Bessemer grade of API 5L will not be acceptable.

Neither furnace nor automatic butt welded pipe will be accepted under this Power and Process Piping specification except that electric fusion butt welded pipe will be acceptable. Lap welded pipe otherwise conforming to A-53 will be acceptable as an alternate where pipe conforming to A-53 is specified.

All underground steel pipe, unless otherwise specified, shall have a protective coating applied as specified in the applicable piping code.
The American Standard Code for Pressure Piping, ASA B-31.1 and supplements thereto, shall be considered as the minimum requirements for acceptable materials, parts and installation details. Each application should be considered on the basis of its ultimate use, installation requirements, and maintenance practices. In all cases the best possible field practice shall be followed.

Where steel flanges or fittings are specified in the Service classification section of this Specification forged steel shall be used. Flange quality steel shall be furnished for use in field fabrication.

All Van Stone joints, regardless of service or pressure, shall be comprised of forged or rolled steel.

Steel welding neck, screwed, and slip-on flanges shall be of material equal in chemical and physical properties to that of the pipe to which they are to be welded.

Flanges for use in service classification 600 psi shall have a 1/4" raised face with smooth finish.

Unless otherwise specified, flanges for use in service classification 150, and 300 psi shall have a 1/16" raised face, and in accordance with ASA B16e.

Flanges for use in classification 150 psi and less shall be finished smooth full face, and in accordance with ASA B16e.

24. ALLOY STEEL BOLTS & NUTS

Alloy steel bolts shall conform to the latest ASTM designation A-193, Grade B-7. Nuts shall conform to the latest designation A-194, Class 2.

All alloy steel bolts shall be bolt studs threaded their entire length and long enough to extend completely through the nuts. Each stud shall be furnished with two semi-finished nuts of American National Form, heavy dimensions, chamfered and trimmed, and finished of American National Form Coarse-thread Series for sizes 1" and smaller, eight-pitch thread Series for sizes 1-1/8" and larger.

25. CARBON STEEL BOLTS AND NUTS

Carbon steel bolts and bolt studs shall conform to the latest ASTM Specification A-107 which covers Commercial Quality Hot-rolled Bar steels and shall have a tensile strength of not less than 55,000 lbs. per square inch.

Carbon steel bolts and nuts shall be furnished with true machine cut threads of American National Form Coarse-thread Series for sizes 1" and smaller 8-pitch thread Series for sizes 1-1/8" and larger.

Carbon steel bolts 1" and smaller shall be furnished with hexagonal heads and hexagonal nuts. All bolts shall be finished under the head.
Carbon steel bolts 1-1/8" and larger shall be bolt studs threaded their entire length with true machine cut threads and shall be furnished with two carbon steel hexagonal nuts.

All carbon steel nuts shall be semi-finished cold pressed with true machine cut threads and finished on the face.

26. GASKETS

Unless otherwise noted under details of "Service Classifications," all gaskets shall be furnished in accordance with Hanford Gasket Code, Part IV of this Specification.

Unless otherwise called for, ring gaskets shall be used throughout except where required on cast iron full face 125# fittings.

27. PIPE HANGERS

Steel hangers shall be fabricated from commercial steel having an ultimate strength of not less than 60,000 lbs. per square inch. Refer to standards B-4-1 through B-4-5, B-4-7, and B-4-17 through B-4-35 in appendix for details.

Pipe hangers and supports for piping 3" diameter and over in Power House and Service Buildings, and for all size outside lines shall be of steel, per hanger detail drawings. Hangers for lines 2-1/2" diameter and smaller in Power House and Service Buildings are to be provided in the field.

28. UNIONS

Use of screwed unions shall be limited as far as practical to relatively small sizes. Such unions shall be steel ground joint, with trim as hereinafter specified. In general, ASA standard flanges are preferred. Galvanized malleable iron may be used for plumbing. Gasket unions shall not be used.

29. VALVES

All valves shall be as specified under the respective Piping Code, Part III of this Specification. Refer to Part V for Hanford Valve Code information. Complete specifications for valves are given in Hanford Works Specification HW 3450.

30. HANDRAILING

For pipe handrailings see Master Architectural Specification, HW 3372, page 14-6, and Hanford Architectural Standards c-4-1 and c-4-10.

30. SPECIFIED MAKES OF EQUIPMENT

Except where one Vendor only is definitely specified, any equivalent valve shown on Hanford Mechanical Standards B-3-38, B-3-39, B-3-40, B-3-41, B-3-42 will be acceptable.

In reference to all other material except valves, equipment of other makes of equal quality and construction and which are approved by the Purchaser as such will be acceptable unless one Vendor only is definitely specified. Such limitation to the product of a specific Vendor will be based upon specific requirements which preclude the use of other equipment.
## PIPE DATA — cont.

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<th></th>
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<th></th>
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<tr>
<td>3 1/2</td>
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<td>3.834</td>
<td>114.51</td>
<td>393.62</td>
<td>122.00</td>
<td>6.56</td>
<td>15.94</td>
<td>7.3</td>
<td>1330.47</td>
</tr>
<tr>
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<td>4.500</td>
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<td>0.016</td>
<td>3.834</td>
<td>114.51</td>
<td>393.62</td>
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<tr>
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<td>393.62</td>
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<td>6.56</td>
<td>15.94</td>
<td>7.3</td>
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<td>122.00</td>
<td>6.56</td>
<td>15.94</td>
<td>7.3</td>
<td>1330.47</td>
</tr>
</tbody>
</table>

Identification, wall thickness and weights are extracted from ANSI B36.10 and B36.19. The notations STD, XS, and XXS indicate Standard, Extra Strong, and Double Extra Strong pipe respectively. Transverse internal area values listed in "square feet" also represent volume in cubic feet per foot of pipe length.
3.3 MILITARY SPECIFICATIONS

MIL-A-3316 Adhesives, Fire Resistant, Thermal Insulation

MIL-C-19565 Coating Compounds, Thermal Insulation Pipe Covering - Fire and Water-Resistant, Vapor-Barrier, and Weather Resistant

MIL-C-20079 Cloth, Glass; Tape, Textile, Glass; and Thread, Glass

4.0 INSULATION MATERIALS

Insulation shall be furnished in the Thickness, Material Type, and Jacket (Finish) Class specified in the Procurement Document or on the drawings. Tables I, II, and III define the thickness requirements (Table I), Material Type (Table II), Jacket (Finish) Class (Table III) which are established as Standard at Hanford.

4.1 INSULATION THICKNESS REQUIREMENTS

TABLE I
Insulation Thickness Requirements

<table>
<thead>
<tr>
<th>Service</th>
<th>Temp. F</th>
<th>Thickness in Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steam or High Pressure Water</td>
<td>Max 1000</td>
<td>3-1/2</td>
</tr>
<tr>
<td>Steam or High Pressure Water</td>
<td>Max 600</td>
<td>3</td>
</tr>
<tr>
<td>Steam or High Pressure Water</td>
<td>Max 350</td>
<td>2-1/2</td>
</tr>
<tr>
<td>Condensate</td>
<td>Max 212</td>
<td>1-1/2</td>
</tr>
<tr>
<td>Cold Water</td>
<td>Min 55</td>
<td>1/2</td>
</tr>
<tr>
<td>Chilled Water</td>
<td>Min 35</td>
<td>1-1/2</td>
</tr>
</tbody>
</table>
## X2.4 Standard Pipe Insulation

The following library of pipe insulation materials is contained in the files AUTOPIPE.LIB, AUTODIN.LIB, AUTOJIS.LIB and AUTOGRPP.LIB. Refer to Section M1.12 of the User Reference for details.

<table>
<thead>
<tr>
<th>Menu Window OPTION</th>
<th>Insulation Material</th>
<th>Density (lb/ft²)</th>
</tr>
</thead>
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<tr>
<td>Asb</td>
<td>amosite asbestos</td>
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<tr>
<td>Calc</td>
<td>calc-silicate Thermobestos</td>
<td>11.00</td>
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<td></td>
<td>85% magnesium calcium silicate</td>
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</tr>
<tr>
<td>Fib</td>
<td>fiberglass</td>
<td>7.00</td>
</tr>
<tr>
<td></td>
<td>Owens-Corning 25ASJ</td>
<td></td>
</tr>
<tr>
<td>Glas</td>
<td>cellular glass foam-glass</td>
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<td>High</td>
<td>high temp</td>
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<tr>
<td>Kay</td>
<td>Kaylo 10&quot;</td>
<td>12.50</td>
</tr>
<tr>
<td>Peri</td>
<td>perlite</td>
<td>13.00</td>
</tr>
<tr>
<td></td>
<td>Celotemp™ 1500</td>
<td></td>
</tr>
<tr>
<td>Sty</td>
<td>styro-foam</td>
<td>1.80</td>
</tr>
<tr>
<td>Temp</td>
<td>Careytemp™</td>
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<td>poly-urethane</td>
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<tr>
<td>Wool</td>
<td>mineral wool</td>
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</tr>
<tr>
<td>X-sup</td>
<td>super-X</td>
<td>25.00</td>
</tr>
</tbody>
</table>

*NOTE:* Other is also listed in the Menu Window. However, this option does not provide a library supplied density. Its purpose is to allow the user to define any other pipe insulation material which is not contained in the library.

- 4' PIPE, 12" LONG, 21/2" THK, VOL = \( \frac{1}{4} \left( \left( \frac{2}{12} \right)^2 \left( \frac{21}{12} \right) \right) \frac{1}{12} = 0.43 \text{ ft}^3 \) @ 16 \( \frac{\text{lb}}{\text{ft}^3} \) => 6.6 LBs
- 4' PIPE, 36" LONG, 21/2" THK, VOL = \( \frac{1}{4} \left( \left( \frac{3}{12} \right)^2 \left( \frac{21}{12} \right) \right) \frac{30}{12} = 9.54 \text{ ft}^3 \) @ 16 \( \frac{\text{lb}}{\text{ft}^3} \) => 153.4 LBs
- 4' PIPE, 48" LONG, 21/2" THK, VOL = \( \frac{1}{4} \left( \left( \frac{4}{12} \right)^2 \left( \frac{21}{12} \right) \right) \frac{48}{12} = 1.527 \text{ ft}^3 \) @ 16 \( \frac{\text{lb}}{\text{ft}^3} \) => 24.4 LBs
- 8' PIPE, 12" LONG, 21/2" THK, VOL = \( \frac{1}{4} \left( \left( \frac{2}{12} \right)^2 \left( \frac{21}{12} \right) \right) \frac{12}{12} = 1.606 \text{ ft}^3 \) @ 16 \( \frac{\text{lb}}{\text{ft}^3} \) => 9.7 LBs
- 10' PIPE, 12" LONG, 21/2" THK, VOL = \( \frac{1}{4} \left( \left( \frac{2}{12} \right)^2 \left( \frac{21}{12} \right) \right) \frac{10}{12} = 0.723 \text{ ft}^3 \) @ 16 \( \frac{\text{lb}}{\text{ft}^3} \) => 11.5 LBs/FT
MECHANICAL ENGINEERING DESIGN 3rd EDITION

BY J. E. SHIGLEY

DESIGN OF MECHANICAL ELEMENTS

Figure 6-2
(a) American National or Unified thread; (b) square thread; (c) Acme thread.

Table 6-2 Diameters and Areas of Unified Screw Threads UNC and UNF

<table>
<thead>
<tr>
<th>Size designation</th>
<th>Nominal major diameter, in</th>
<th>Threads per inch, N</th>
<th>Tensile-stress area, $A_t$, in²</th>
<th>Minor-diameter area, $A_m$, in²</th>
<th>Threads per inch, N</th>
<th>Tensile-stress area, $A_t$, in²</th>
<th>Minor-diameter area, $A_m$, in²</th>
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<td>0.256</td>
<td>0.240</td>
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<tr>
<td>4.5</td>
<td>0.7500</td>
<td>10</td>
<td>0.334</td>
<td>0.302</td>
<td>16</td>
<td>0.373</td>
<td>0.351</td>
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<tr>
<td>5</td>
<td>0.8750</td>
<td>9</td>
<td>0.462</td>
<td>0.419</td>
<td>14</td>
<td>0.509</td>
<td>0.480</td>
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<tr>
<td>6</td>
<td>1.0000</td>
<td>8</td>
<td>0.606</td>
<td>0.551</td>
<td>12</td>
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<td>0.625</td>
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<tr>
<td>7</td>
<td>1.2500</td>
<td>7</td>
<td>0.569</td>
<td>0.890</td>
<td>12</td>
<td>1.073</td>
<td>1.024</td>
</tr>
<tr>
<td>8</td>
<td>1.5000</td>
<td>6</td>
<td>1.405</td>
<td>1.294</td>
<td>12</td>
<td>1.315</td>
<td>1.260</td>
</tr>
</tbody>
</table>
# Mechanical Engineering Design 3rd Edition

**By J.E. Shigley**

WELDED, BRAZED, AND BONDED JOINTS 285

Table 7.2 Bending Properties of Fillet Welds: The unit moment of inertia $J_{u}$ is taken about a horizontal axis through the centroid of the weld group $G$; the weld size is given by $h$.

<table>
<thead>
<tr>
<th>Weld</th>
<th>Throat area $A$</th>
<th>Location of $G$</th>
<th>Unit moment of Inertia $I_u$</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="" alt="Weld Diagram" /></td>
<td>$A = 0.707hd$</td>
<td>$x = 0$</td>
<td>$I_u = \frac{d^3}{12}$</td>
</tr>
<tr>
<td><img src="" alt="Weld Diagram" /></td>
<td>$A = 1.414hd$</td>
<td>$x = b/2$</td>
<td>$I_u = \frac{d^3}{6}$</td>
</tr>
<tr>
<td><img src="" alt="Weld Diagram" /></td>
<td>$A = 1.414hb$</td>
<td>$x = b/2$</td>
<td>$I_u = \frac{bd^3}{2}$</td>
</tr>
<tr>
<td><img src="" alt="Weld Diagram" /></td>
<td>$A = 0.707h(2b + d)$</td>
<td>$x = \frac{b^2}{2b + d}$</td>
<td>$I_u = \frac{d^3}{12} (2b + d)$</td>
</tr>
<tr>
<td><img src="" alt="Weld Diagram" /></td>
<td>$A = 0.707h(b + 2d)$</td>
<td>$x = b/2$</td>
<td>$I_u = \frac{2d^3}{3} - 2d^3 y + (b + 2d)^2$</td>
</tr>
<tr>
<td><img src="" alt="Weld Diagram" /></td>
<td>$A = 1.414h(b + d)$</td>
<td>$x = b/2$</td>
<td>$I_u = \frac{d^3}{6} (3b + d)$</td>
</tr>
</tbody>
</table>

(continued)