ATTACHMENT 19, CALCULATION COVER SHEET

ESP No.:	ES199501352	Supp No.:	—	Rev. No.:	0	Page 1 of 18

INITIATION (Control Doc Type - DCALC)

DCALC No.: CA00027 | REVISION NO.: 0

VENDOR CALCULATION (CHECK ONE): ☐ YES ☑ NO

RESPONSIBLE GROUP: PDSU

RESPONSIBLE ENGINEER: JOHN F BASHOR

CALCULATION

ENGINEERING DISCIPLINE:

- ☐ Civil
- ☐ Instr & Controls
- ☐ Nuc Engrg
- ☐ Electrical
- ☑ Mechanical
- ☐ Diesel Gen Project
- ☐ Life Cycle Mngmt
- ☐ Reliability Engrg
- ☐ Nuc Fuel Mngmt
- ☐ Other:

Title: UNIT-1 SALTWATER 1" HALF COUPLING WELD FAILURE

Unit: ☑ UNIT 1 ☐ UNIT 2 ☐ COMMON

Proprietary or Safeguards Calculation ☐ YES ☐ NO

Comments:

Vendor Calc No.: | REVISION NO.:

Vendor Name:

Safety Class (Check one): ☑ SR ☐ AQ ☐ NSR

There are assumptions that require Verification during walkdown: AIT #

This calculation **SUPERSEDES**:

CALCULATION REVIEW:

RESPONSIBLE ENGINEER: [signature] DATE: 7-25-95

INDEPENDENT REVIEWER: John R. Sponsel [signature] DATE: 7/25/95

OR (for Vendor Calcs)

OWNER ACCEPTANCE REVIEWER: N/A DATE: N/A

BGE

CALCULATION

1.0 Purpose

The purpose of the calculation is to perform an analyses on the 1" half coupling leak on the common discharge pipe in the Unit 1 Service Water Pump room. This calculation provides the technical justification for continued operation and determination of operability for issue report number IR5028461 (ES199501352).

2.0 References

2.1. UFSAR Chapter 9, Rev 15

2.2 Operations Drawing OM-49 (60708E) Sheet 2 of 2, Rev 64

2.3. FSK-MP-4498 Rev 3

2.4. FSK-MP-4498-2001

2.5. USAS B31.1, Power Piping, 1967 edition through 1972 addenda (B31.1d)

2.6 Crane technical paper 410, page 2-14, A-6

2.7. Bechtel Calculation C-1007.3, Intake Structure Updated Seismic Analysis from Job No. 6750

2.8. Bechtel Calculation C-1007.1, Auxiliary Building Updated Seismic Analysis from Job No. 6750

2.9. NIBCO Bronze & Iron valves catalog 5-100-E

2.10 ASTM B-43-84a SEAMLESS RED BRASS PIPE, STANDARD SIZES

2.11 VOGT catalog F-14, forged steel valves and fittings

2.12 BG&E Calc. V-94-002 Rev 0, Autopipe validation calculation.

2.13 M-600 sheet LJ-1, rev 44

2.14 ANSI B16.11-1973 Table 4.

2.15 _Design of Welded Structures_, O. Blodgett , Cleavland Ohio 1982.

2.16 Non-Destructive Examination report 95-UT-F-3.

2.17 Saltwater system flow model simulation, Node junction 33 pressure results dated 7/24/95.

3.0 Inputs

3.1 The applicable code for the saltwater branch piping is USAS B31.1. Allowables are per Table A-2 of B31.1. are:

Materials	Hot Allowable	Cold Allowable

A-106 GRB	15,000 psi	15,000 psi	B31.1 1971 addenda
B-43	8,000 psi	8,000 psi	B31.1 1971 addenda

3.2 The seismic accelerations used to evaluate the half coupling loads were taken from the Intake Structure Response Spectra. Although the Saltwater piping is located throughout the Intake structure and Auxiliary Building the Intake Structure curves are bounding for the entire Saltwater System for all elevations and zones. All assemblies have fundamental 'Natural' frequencies greater than or equal to 20 Hz.. A review of the Auxiliary Building and Intake Structure spectra revealed that all assemblies lie within the ZPA range.

The 1% damping curves for horizontal and vertical acceleration for all elevations in the Intake structure were reviewed. For conservatism the maximum acceleration value was chosen for the OBE case, multiplied by 1.875 to obtain the DBE case, then generically applied in the X, Y, and Z directions as the static earthquake load case. The specific value used was for vertical acceleration (.4 g's * 1.875 = 0.75 g's).

N-411 prescribes that 5% damping be used for natural frequencies less than 10 Hz and 2% damping be used for frequencies greater than 20 Hz. Between 10 Hz and 20 Hz linear interpolation is to be used to find intermediate accelerations. This evaluation used 1% damping for all locations and frequencies. Use of lower damping values produces higher accelerations and higher piping loads. Therefore, the damping values are conservative.

All of these approximations of seismic curves are conservative.

3.3 Design and Operating Conditions for the Saltwater Piping at the half coupling location are obtained from M-601 Class LJ-1 are:

	Design	Operating
Pressure	50 psi	35 psi
Temperature	95° F	95° F

3.4 The internal pressure of the saltwater pipe in the location of the half coupling was taken as 20 psi. Even though the stated design pressure of the system is 50 psi the half coupling location is downstream of the Service Water Heat Exchanger in the common discharge pipe. This is a once through system that discharges back to the Chesapeak Bay, therefore, the local pipe internal pressure at the half coupling is substantially less than the normal operating pressure of 35 psi. To accurately determine the pressure at this junction point a simulation was run with the approved and verified Saltwater system flow model in all possible lineups. The required junction node point pressure (point 33), which corresponds to the tee in question, was printed out for all possible lineups. The highest pressure found in the simulation run was 19.6 psi, therefore a value of 20 psi was conservatively used in the calculation of the blowdown rate into the room and the minimum wall determination.

3.5 BGE calculation M-90-169, *"Maximum flood height resulting from a pipe break in the service water pump rooms"* determined the maximum allowable flooding rate into the Service Water Pump room from the Saltwater system to be 447 gal/min..

3.6 The Stress Intensification Factor for threaded joints is 2.3.

3.7 The pipe data utilized in this analysis, except for material allowables, is taken from AutoPipe Plus 386 ver 4.5 ANSI B31.1 1967 library.

3.8 The allowables for DBE were taken as 1.2*Sh (OBE allowable). This is conservative since the DBE allowable approaches Sy (yield strength).

3.9 The design temperature of the Saltwater system is 95°F. Since $Q \propto 1/\sqrt{\rho}$ and ρ decreases with increasing temperature ρ at 95°F will be used. Since saltwater is more dense than water this is conservative. Saltwater density used in the determination of the discharge into the room will be 62.0 lbs/ft^3 (Crane technical paper 410 page A-6)

4.0 Assumptions

4.1 Seismic Anchor Movement (SAM) for this analysis is negligible, and as such are not included on this evaluation. This piping is anchored directly to the Saltwater system main piping run, which is 24" and extremely rigid.

4.2 Valve weights were selected based on nominal values obtained from NIBCO catalog 5-100-E for bronze and iron valves. For 1 inch valves, 5 lbs was used which is 48% higher than the value listed for 1 inch class 125 bronze globe valve style T-211.

4.3 For determination of the Saltwater discharge rate into the Service Water Pump room the opening was modeled as a sharp edged orifice. For the purpose of this calculation β was conservatively assumed to be 0.2 which is the smallest tabulated value shown on page A-20 of Crane technical paper 410.

4.4 The Reynolds number is required to look up tabulated values of C_0. However, for fully turbulent flow ($Re > 2x10^4$) 'C_0' is relatively constant with increasing Re. A value of 0.60 was used for C_0 with $\beta = 0.2$ and $Re > 2x10^4$.

5.0 Method of Analysis

The piping configurations shown in attachment 1 has been modeled using AutoPipe Plus 386 ver 4.5. The piping has been evaluated for deadweight, thermal, pressure, and seismic loads. The code option used is Power Piping B31.1, 1967. The stress ratios in section 8.0 are computed using the following limits: (Symbols as defined by the AutoPipe Manual Appendix 10.)

Sustained Stress:

$$S_L = Pd^2/(D^2-d^2)+S_{B,sus} \leq 1.0S_H$$

Occasional Stress:

$$S_{LO} = S_{SUS} + S_{B,OCC} \leq 1.2S_H$$

Thermal Stress:

$$S_E = (S_b^2 + 4\ S_t^2)^{1/2} \leq S_A$$

The forces and moments generated at point B00 as a result of the above stated AutoPipe run were used to determine the required weld size for the 1" half-coupling. This weld size determination was done in accordance with ref. 2.15 and is contained in attachment 2.

A separate calculation was performed in accordance with ref. 2.6 to determine the maximum discharge rate into the Servicewater room assuming the half-coupling was to fail completely. This discharge rate was then compared to the maximum analyzed flooding rate into the room from the Saltwater system. This calculation is contained in attachment 3.

Finally, an unreinforced opening evaluation was performed, assuming the half coupling was completely removed. The methodology described in ANSI B31.1 1967 section104.3 was used. Based on the lowest minimum wall reading from UT report 95-UT-F-3, and a pipe internal pressure of 20 psi the minimum required area of reinforcement was calculated for the 30" main pipe run. This required area of reinforcement was then multiplied by a factor of 2.0 to account for inaccuracy in the UT measurement. This conservative area of reinforcement and a corrosion rate of .15"/yr was then used to determine the maximum number of months of continued operation the pipe section can sustain before the remaining area of reinforcement provided by the excess run wall falls below the required area of reinforcement. This calculation of the number of months of continued operation immediately follows the attached AutoPipe run.

6.0 Identification of Computer Codes and Computer

Program Used:

Name:	AutoPipe Plus 386
Version:	4.5
Computer:	PC# B027

Piping Information:

System No.:	LJ-1
Material:	Carbon Steel, Brass
Size:	3/4" to 2"

Computer Results:

Input File:	SWDRAINS.DAT., SWELLDRS.DAT, ASSY3.DAT
Output File:	SWDRAINS.OUT., SWELLDRS.OUT, ASSY3.OUT

7.0 Conclusions

Based on the unreinforced opening calculation the number of months until the opening no longer meets the code requirements is < 13.

Based on the forces and moments acting on the half-coupling attachment weld only 3.7% of the existing weld is required to provide adequate structural integrity.

Assuming the half-coupling completely fails the blowdown rate of the saltwater system into the Servicewater room will be 246 gpm which is << than the maximum analyzed flooding rate of 447 gpm.

8.0 Computations

See following AutoPipe Runs, unreinforced opening calculation and attachments.

```
****************************************************************
**                                                            **
**              AUTOPIPE SYSTEM DATA LISTING                  **
**                                                            **
****************************************************************
```

SYSTEM NAME : LEAK195

PROJECT ID : NEW REVISION TO FSK-MP-4498

PREPARED BY : ____________________
J. BASHOR

CHECKED BY : ____________________
TODD CONNER

PIPING CODE : B31.1-67

AMBIENT TEMP. (deg F) : 70.0

COMPONENT LIBRARY : AUTOPIPE

MATERIAL LIBRARY : AUTO1967

MODEL REVISION NUMBER : 1

LEAK195 NEW REVISION TO FSK-MP-4498
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P O I N T   D A T A   L I S T I N G

POINT NAME	TYPE	-----OFFSETS (ft)----- X	Y	Z	PIPE ID	DESCRIPTION
*** SEGMENT B						
B00	Run	0	0	-2.00	1CS40	
B01	Bend	0	-0.42	0		Short Elbow, Radius = 0.75 inch Bend angle change = 90.00 deg SIF - In = 2.08, Out = 2.08
B02	Run	0.44	0	0		
B03	Valv	0.19	0	0		Weight = 5 lb Surface factor = 1.00, SIF = 2.30
B04	Run	0.50	0	0	1BR80	
B05	Run	0.15	0	0		

Total weight of empty pipes : 2 lb

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

POINT NAME	---COORDINATE(ft)--- X	Y	Z	DATA TYPE	DESCRIPTION
*** SEGMENT B					
B00	0.00	0.00	-2.00	ANCHOR	Rigid
					Thermal movements : None
B01 N	0.00	-0.35	-2.00	USRFLX	In = 2.30, Out = 2.30, Flex = Automatic
B01	0.00	-0.42	-2.00	TI	
B01 F	0.06	-0.42	-2.00	USRFLX	In = 2.30, Out = 2.30, Flex = Automatic
B02	0.44	-0.42	-2.00	WEIGHT	3 lb , No offsets
				USRFLX	In = 2.30, Out = 2.30, Flex = Automatic
B03	0.63	-0.42	-2.00		
B04	1.13	-0.42	-2.00		
B05	1.27	-0.42	-2.00	WEIGHT	1 lb , No offsets
				USRFLX	In = 2.30, Out = 2.30, Flex = Automatic

Number of points in the system : 8

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

Pipe ID/ Material	Nom/ Sch	O.D. inch	Thickness(inch) W.Th.	Corr	Mill	Insu	Ling	Spec Grav	Weight(lb/ft) Pipe	Other	Total
1CS40 A106-B	1.000 40	1.315	0.133	0	0.02	0	0	1.00	1.68	0	2.05
1BR80 BR	NS	1.315	0.182	0	0.02	0	0	1.00	2.38	0	2.69

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03/14/95 AutoPIPE+4.50 MODEL PAGE 5

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

Material Name	Pipe ID	Density lb/cu.ft	Pois. Ratio	Temper. deg F	Modulus E6 psi	Expans. in/100ft	Allow. psi
A106-B	1CS40	489.0	0.30	70.0	27.90		15000.0
				95.0		0.1904	15000.0
BR	1BR80	529.0	0.30	70.0	14.00		8000.0
				95.0		0.2923	8000.0

TEMPERATURE AND PRESSURE DATA

POINT NAME	CASE 1 PRESS. psi	CASE 1 TEMPER deg F	CASE 1 EXPAN. in/100ft	CASE 2 PRESS. psi	CASE 2 TEMPER deg F	CASE 2 EXPAN. in/100ft	CASE 3 PRESS. psi	CASE 3 TEMPER deg F	CASE 3 EXPAN. in/100ft
*** SEGMENT B									
B00	50.00	95.00	0.190						
B04	50.00	95.00	0.292						
B05	50.00	95.00	0.292						

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

```
Current model revision number : 1

  Static - Date and Time of analysis ............. Mar 14, 1995   3:31 PM
           Model Revision Number .................. 1
           Number of load cases ................... 3
           Load cases analyzed .................... GR T1 E1
           Gaps/Friction/Yielding considered ...... No
           Hanger design run ...................... No
           Cut short included ..................... No
           Weight of contents included ............ Yes
           Pressure stiffening case ............... 0
           Water elevation for buoyancy loads .... Not considered
```

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03/14/95 AutoPIPE+4.50 RESULT PAGE 2

CODE COMPLIANCE COMBINATIONS

Combination	Category	Method	Load	Factor	Allowable	Remarks
GR + Max P	Sustain	Sum	Gravity	1.00	Automatic	Default
			Max Long	1.00		
Cold to T1	Expansion	Sum	Thermal 1	1.00	Automatic	Default
Sus. + E1	Occasion	Abs sum	Earth 1	1.00	Automatic	Default
			Max Sus	1.00		
Max P	Hoop		Max Hoop	1.00	Automatic	Default

OTHER USER COMBINATIONS

Combination	Method	Load	Factor	Remarks
GR	Sum	Gravity	1.00	Default
T1	Sum	Thermal 1	1.00	Default
E1	Sum	Earth 1	1.00	Default

CODE COMPLIANCE

Y - Factor 0.00
Weld efficiency factor 1.00
Range reduction factor 1.00
Design Pressure Factor 1.00
Minimum stress ratio used in reports... 0.00
Include corrosion in stress calcs. .... Y
Include torsion in code stress .... Y
Include axial force in code stress .... N
Longitudinal pressure calculation ..... AxF/area
Include rigorous pressure .... Not analyzed

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--------------------------------------------------------------------------------
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```

EARTHQUAKE LOAD CASES :

Number of load cases analysed : 1

Load case 1 - E1

X-Multiplier= 0.750 Y-Multiplier= 0.750 Z-Multiplier= 0.750

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

Point name	Load combination	FORCES (lb) X	Y	Z	Result	MOMENTS (ft-lb) X	Y	Z	Result
B00	Anchor								
	GR	0	-12	0	12	0	0	-8	8
	T1	0	0	0	0	0	0	0	0
	E1	9	9	9	15	-4	-6	10	12

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ASME / ANSI B31.1 (1967) CODE COMPLIANCE

Point name	Load combination	In-Pl. Moment	Out-Pl. Moment	Torsion Moment	S.I.F In	S.I.F Out	Eq. no.	Load type	Code Stress	Code Allow.
		(Moments in ft-lb)					(Stress in psi)			
*** Segment B begin ***										
B00	Max P							HOOP	283	15000
	GR + Max P	0	8	0	1.00	1.00		SUST	810	15000
	Cold to T1	0	0	0	1.00	1.00	(8)	DISP	0	22500
	Sus. + E1	4	18	6	1.00	1.00		OCC	1873	18000
B01 N-	Max P							HOOP	283	15000
	GR + Max P	0	8	0	1.00	1.00		SUST	810	15000
	Cold to T1	0	0	0	2.30	2.30	(8)	DISP	0	22500
	Sus. + E1	1	14	6	2.30	2.30		OCC	2269	18000
B01 N+	Max P							HOOP	283	15000
	GR + Max P	8	0	0	2.30	2.30		SUST	1748	15000
	Cold to T1	0	0	0	2.30	2.30	(8)	DISP	0	22500
	Sus. + E1	14	1	6	2.30	2.30		OCC	3208	18000
B01 F-	Max P							HOOP	283	15000
	GR + Max P	7	0	0	2.30	2.30		SUST	1608	15000
	Cold to T1	0	0	0	2.30	2.30	(8)	DISP	0	22500
	Sus. + E1	13	5	0	2.30	2.30		OCC	3221	18000
B01 F+	Max P							HOOP	283	15000
	GR + Max P	7	0	0	1.00	1.00		SUST	749	15000
	Cold to T1	0	0	0	2.30	2.30	(8)	DISP	0	22500
	Sus. + E1	13	5	0	2.30	2.30		OCC	2361	18000
B02 -	Max P							HOOP	283	15000
	GR + Max P	3	0	0	1.00	1.00		SUST	398	15000
	Cold to T1	0	0	0	2.30	2.30	(8)	DISP	0	22500
	Sus. + E1	6	3	0	2.30	2.30		OCC	1156	18000
B02 +	Max P							HOOP	283	15000
	GR + Max P	3	0	0	1.00	1.00		SUST	398	15000
	Cold to T1	0	0	0	2.30	2.30	(8)	DISP	0	22500
	Sus. + E1	6	3	0	2.30	2.30		OCC	1156	18000
B03	Max P							HOOP	283	15000
	GR + Max P	2	0	0	1.00	1.00		SUST	283	15000
	Cold to T1	0	0	0	2.30	2.30	(8)	DISP	0	22500
	Sus. + E1	4	2	0	2.30	2.30		OCC	761	18000

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ASME / ANSI B31.1 (1967) CODE COMPLIANCE

Point name	Load combination	In-Pl. Moment (Moments in ft-lb)	Out-Pl. Moment	Torsion Moment	S.I.F In	S.I.F Out	Eq. no.	Load type	Code Stress (Stress in psi)	Code Allow.
B04	Max P							HOOP	207	8000
	GR + Max P	0	0	0	1.00	1.00		SUST	68	8000
	Cold to T1	0	0	0	2.30	2.30	(8)	DISP	0	12000
	Sus. + E1	0	0	0	2.30	2.30		OCC	99	9600
B05	Max P							HOOP	207	8000
	GR + Max P	0	0	0	1.00	1.00		SUST	55	8000
	Cold to T1	0	0	0	2.30	2.30	(8)	DISP	0	12000
	Sus. + E1	0	0	0	2.30	2.30		OCC	55	9600

*** Segment B end ***

$$t_{mh} = \frac{P \cdot D_o}{2 \cdot (SE + P \cdot y)} + A$$

P	20	Design Pressure (psi)
Do	12.75	Outside diameter (in)
SE	15000	Allowable Stress (psi)
y	0.4	Coefficient for ferritic steel
Life	*13*	*Service life (months)*
rate	*0.15*	*Corrosion Rate (in/yr)*
A	0.1625	Corrosion allowance (in)
t_{mh}	**0.1710**	**Required min wall IAW Eqn (3) 104.1.2 (in)**

Evaluation of Reinforcment Requirements

The required reinforcement is:

$$A_7 = t_{mh} \cdot d_1$$

t_{mh}	0.17	Required min wall IAW Eqn (3) 104.1.2 (in)
d	0.96	I.D. of 1" sch 80 pipe (in)
	2.00	uncertainty correction factor
d1	1.914	
A7	**0.33**	**Required reinforcement area (in^2)**

Area available for reinforcement

$$A_1 + A_2 + A_3 + A_4 + A_5 \geq A_7$$

$$A_1 = (2 \cdot d_2 - d_1) \cdot (T_h - t_{mh})$$

d2 is the greater of d1 or (tb-A)+Th +d1/2

tb	0	Thickness of branch (in)
A	0.1625	Corrosion allowance (in)
Th	0.36	Actual wall in header (in)
d2'	1.1545	(in)
d2"	1.914	(in)
d2	1.914	half width reinforcing zone (in)
A1	**0.36**	**area provided by excess run wall (in)**

In this instance A2 through A5 are zero since the branch connection is assumed to fail

Excess reinforcement

A1-A7 0.03 Therefore this is acceptable.

ULTRASONIC THICKNESS MEASUREMENT

NDE-5400-CC
REV 0

1.NDE Report No.: 95-UT-F-3 2.Date: 03/15/95 3. Unit: 1 4. Sys. No. 012

5. M.O. No.: IRO-028-461 6. RFO/PM: N/A 7. ISO/DWG.No. N/A

8.Examiner: EDDIE HOUSTON 9.Certification Level: I-T 10.Initials: EH

Examiner: N/A Certification Level: N/A Initials: N/A

11.Component: SERVICE WATER HX / SALT WATER COMMON RETURN LINE.

12.Configuration: TEE 13.Location: 12' TB , SERVICE WATER ROOM

14.Material: STEEL 15.Material Temp.: 54.2 °F 16.Cal Block Temp.: 56.6 °F

17.Couplant Type/Batch No.: SONOTRACE 40 , BATCH # 093104

EQUIPMENT DATA

Transducer: 18.Size: 0.312" 19.Freq.: 5MHZ 20.Style: DUAL 21.Serial No.: 129219

Instrument: 22.Brand/Model: PANAMETRICS 26 DL PLUS 23.Serial No.: 91037108

COMPONENT

24.Nominal Diameter: 30" 25.Nominal Thickness: 0.375" 26.Grid Size: 0.5"

27.Datum Location: N/A

Grid: 28.*Start*:Row 001 Column A 29.*Finish*:Row 016 Column O

Test Equipment Used: Digital Thermometer:

30.Brand/Model: OMEGA 873F

31.Serial No.: T-136995 32.Cal. Due Date: 06/03/95

33.CALIBRATION

BLOCK SN CCU-07						
ACTUAL	0.500"	N/A	N/A	0.100"	TIME	+/- < 2% of Initial Conditio
INITIAL	0.500"	N/A	N/A	0.100"	1539	N/A
CAL CHECK	N/A	N/A	N/A	N/A	N/A	N/A
FINAL	0.499"	N/A	N/A	0.100"	1620	YES

34.Remarks: GRID DATA SHEET NUMBER: 95-UT-F-3B

DATA SHEET NUMBER: 95-UT-F-3A

READING TAKEN AS PER ENGINEERING.

35.Number of Attached Data Sheets: 1 Number of Attached Grid Data Sheets: 1

ORIGINALLY REVIEWED IE
EP 7-5

36.Prepared By: E. Houston Certification Level: I-T Date: 6-28-95

37.Reviewed By: B [illegible] Certification Level: UT III Date: 6-28-95

38.Received By:(Print) A.L. Simpson Signature: [signature] Date: 7-5-95

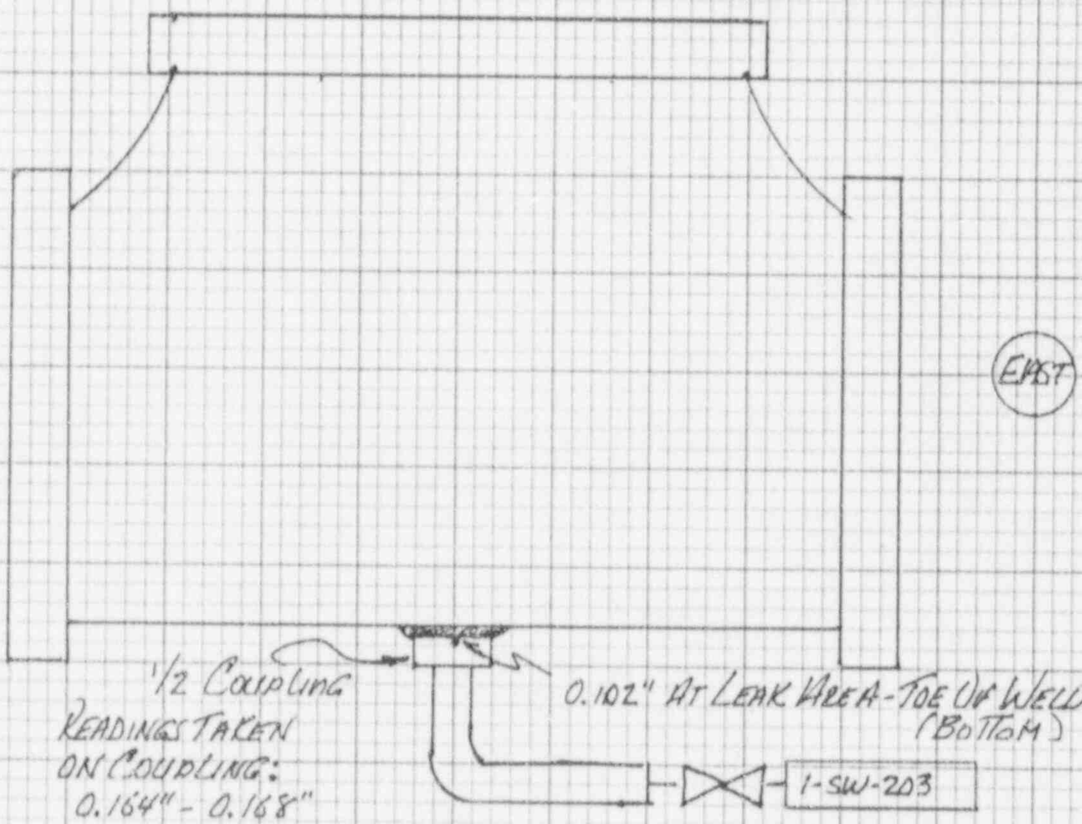
DATA SHEET No. 95-UT-F-3A

TOP

NOTE: PAINTED SURFACE

WEST

EAST



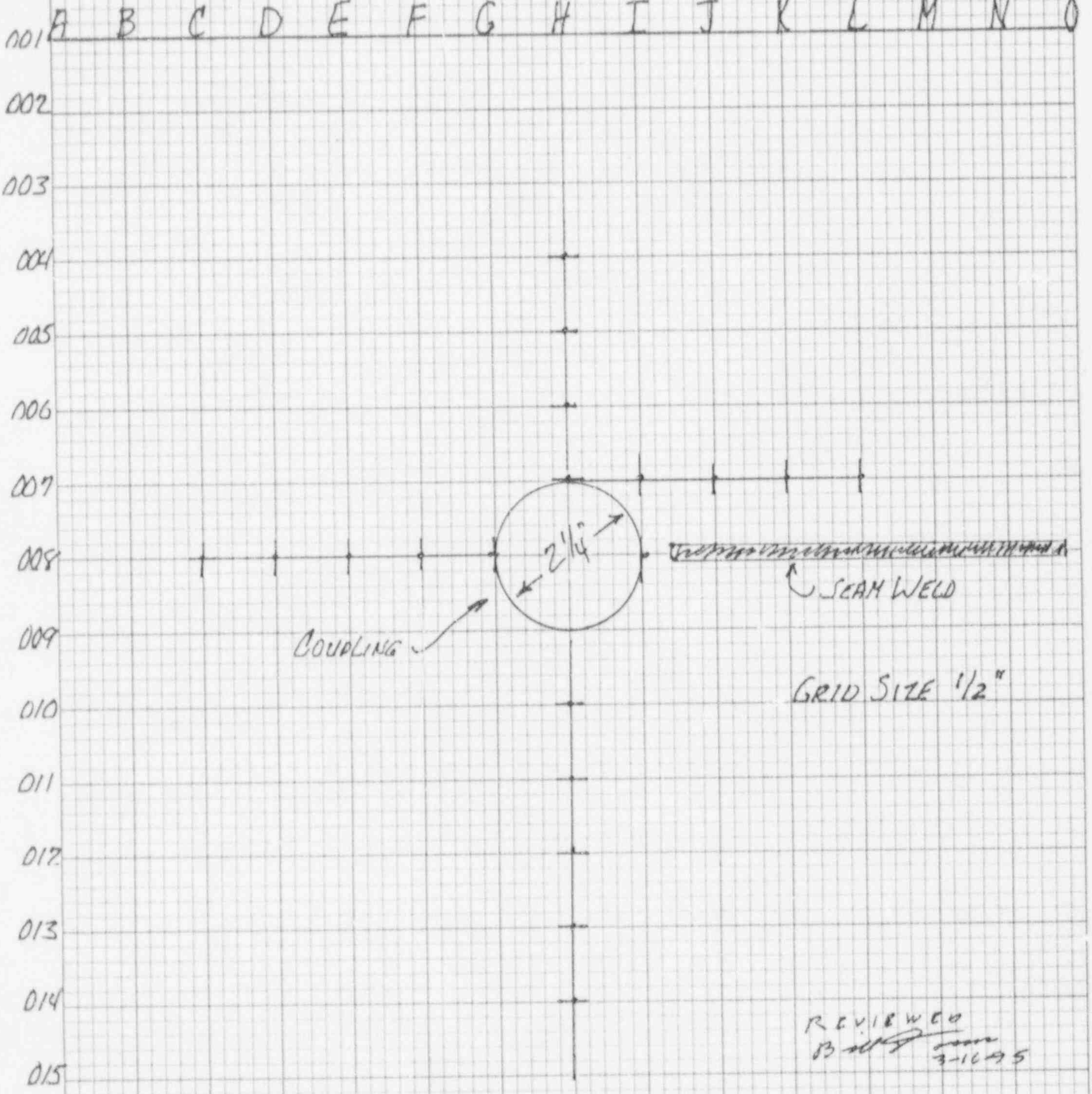
READINGS WERE TAKEN IN A 6" SQUARE AREA AROUND THE COUPLING.
SEE GRID DATA SHEET No. 95-UT-F-3A

BOTTOM

REVIEWED
[signature] 3-16-95

[signature] 3-15-95

GRID DATA SHEET No. L 95-UT-F-3B

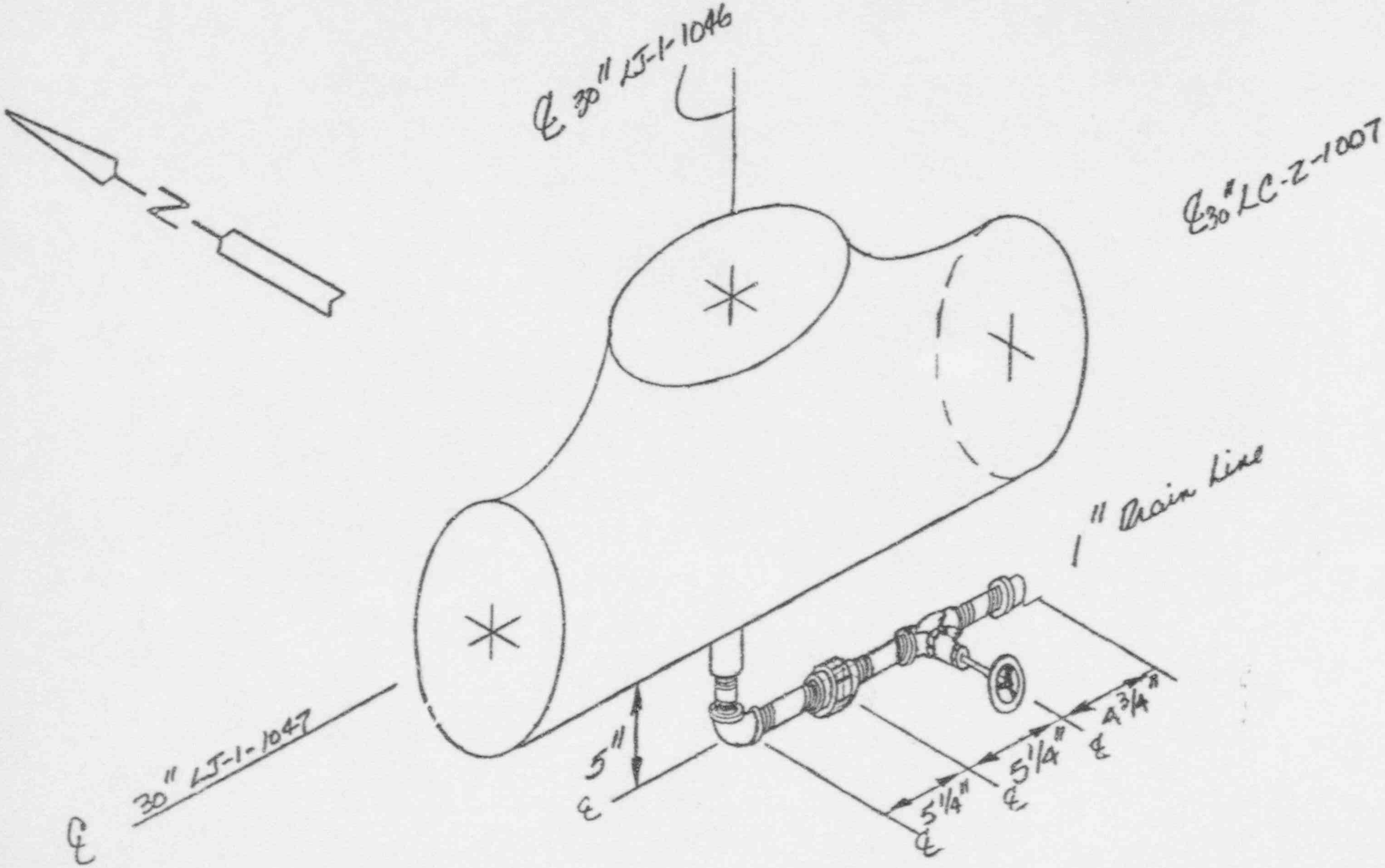


REVIEWED
3-16-95

C008	0.615	H004	0.562	H011	0.533	I007	0.528
D008	0.589	H005	0.532	H012	0.530	I008	0.558
E008	0.612	H006	0.533	H013	0.537	J007	0.524
F008	0.615	H007	0.523	H014	0.531	K007	0.537
G008	0.582	H010	0.526			L007	0.536

NOTE: READINGS TAKEN AT RANDOM OF THE REMAINING AREA. ALL READINGS ABOVE 0.520"

3-15-95



N
℄ 30" LJ-1-1046
℄ 30" LC-Z-1007
1" Drain Line
5"
℄
5 1/4"
5 1/4"
4 3/4"
℄
℄
℄
30" LJ-1-1047
℄

Attachment 2 Calculation CA00027

REQUIRED WELD SIZE DETERMINATION FOR 1" HCPLG

Forces and Moments from AutoPipe run:

$Fx := 9$ Shear lbf

$Fy := 21$ Tension lbf

$Fz := 9$ Shear lbf

$Mx := 48$ Bending in-lbf

$My := 72$ Tortion in-lbf

$Mz := 216$ Bending in-lbf

Treating the weld as a line in accordance with Blodgett section 7.4-7

$d := 1.75$ diamater of a 1" 3000 lb half-coupling is 1.75"

$Sw := \frac{\pi \cdot d^2}{4}$ $Sw = 2.405$

$Jw := \frac{\pi \cdot d^3}{4}$ $Jw = 4.209$

$Aw := \pi \cdot d$ $Aw = 5.498$

$M := \left(Mx^2 + Mz^2\right)^{\frac{1}{2}}$ $M = 221.269$ Resultant moment acting on weld

$V := \left(Fx^2 + Fz^2\right)^{\frac{1}{2}}$ $V = 12.728$ Resultant shear acting on weld

$P := 21$ Tension force acting on weld

$T := My \cdot .875$ $T = 63$ Torque acting on weld

$fb := \frac{M}{Sw}$ $fb = 91.993$ Bending stress acting on weld

$fv := \frac{V}{Aw}$ $fv = 2.315$ Shear stress acting on weld

$fp := \frac{P}{Aw}$ $fp = 3.82$ Longitudinal stress acting on weld

$ft := \frac{T}{Jw}$ $ft = 14.967$ Tortional stress acting on weld

$$fweld := \left(fb^2 + fv^2 + fp^2 + ft^2\right)^{\frac{1}{2}}$$ $fweld = 93.31$ Combined stress acting on weld

The minimum strength weld rod BGE will allow for a carbon steel to carbon steel weld is E60xx series
Therefore, the minimum allowable is $\tau := 13600$

Thus, the allowable stress per inch for the weld is $fa := .707\cdot\tau$ $fa = 9.615\cdot10^3$

The required weld size is: $w := \frac{fweld}{fa}$ $w = 0.0097$

Since USAS B31.1 requires the minimum throat on the cover fillet weld to be 3/16":

$$wactual := \frac{\frac{3}{16}}{.707}$$ $wactual = 0.265$

By taking credit for the cover fillet only the percentage of weld required to carry the forces and moments is:

$\frac{w}{wactual} = 0.037$ <u>Only 3.7 percent of the existing weld is required</u>

Attachment 3 Calculation CA00027

SALTWATER SYSTEM BLOWDOWN RATE INTO THE SERVICEWATER ROOM

Flow from a square edged orifice:

where: $d1 := 1.75$ diamater of 1" half-coupling. Ref. ANSI B16.11-1973 Table 4.

$C := 0.6$ Ref. Crane technical paper 410 page 2-14: "...For nozzles & orifices discharging to atmosphere C values may be taken from page A-20 if P is taken as upstream pressure."

Since d2 is the diameter of the straight run of pipe, which is >>d1 β is approx. 0. As β increases C increases which results in an increase in flow. In order to facilitate calculations β will be conservatively assumed to be 0.2 (smallest tabulated value).

The Re number is required to look up tabulated values of C. However, for fully turbulent flow (Re> 2x10^4), C is relatively constant with increasing Re. A value of .60 will be used for C with β = 0.2 and Re 2x10^4.

$\rho := 62.0$ The design temperature of the saltwater system is 95 degrees F. Since Q is proportional to 1/ ρ, and ρ decreases with increasing temperature, ρ @ 95 degrees F will be used. (since saltwater is more dense than water this is conservative)

$P := 20$ P is taken as 20 psi as stated in the calculation input 3.4

$$Q := 236 \cdot d1^2 \cdot C \cdot \sqrt{\frac{P}{\rho}}$$

From Crane technical paper 410 Equation 3-21 page 3-5

$Q = 246.297$ gpm

Since the calculated discharge rate from the 1" half-coupling (assuming it completely fails) is less than the maximum analyzed flooding rate of 447 gpm this size hole at this location is accectable from a room flooding standpoint.