TENNESSEE VALLEY AUTHORITY
CHATTANOOGA, TENNESSEE
37401

TVA 40TH ANNIVERSARY OF PEOPLE IN PARTNERSHIP

May 17, 1974

Mr. John F. O'Leary, Director
Directorate of Licensing
Office of Regulation
U.S. Atomic Energy Commission
Washington, DC 20545

Dear Mr. O'Leary:

TENNESSEE VALLEY AUTHORITY - BROWNS FERRY NUCLEAR PLANT UNIT 1 - DOCKET NO. 50-259 - FACILITY OPERATING LICENSE DPR-33 - ABNORMAL OCCURRENCE REPORT BFAO-7427W

The enclosed report is to provide details concerning 58 Hancock 1-inch 600-lb. forged stainless-steel globe valves which are utilized in systems whose design conditions exceed the vendor's pressure-temperature ratings for the valves and is submitted in accordance with Appendix A to Regulatory Guide 1.16, Revision 1, October 1973. This event occurred on Browns Ferry Nuclear Plant unit 1 on May 7, 1974.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

for E. F. Thomas
Director of Power Production

Enclosure
CC (Enclosure):
Mr. Norman C. Moseley, Director
Region II Regulatory Operations Office, USAEC
230 Peachtree Street, NW., Suite 818
Atlanta, Georgia 30303

Docket 50-259

4495

COPY SENT REGION 2

ABNORMAL OCCURRENCE REPORT

Report No.: BFAO-7427W
Report Date: May 17, 1974
Occurrence Date: May 7, 1974
Facility: Browns Ferry Nuclear Plant unit 1

Identification of Occurrence

Fifty-eight Hancock 1-inch 600-lb. forged stainless-steel globe valves are utilized in systems whose design conditions exceed the vendor's pressure-temperature ratings for the valves.

Conditions Prior to Occurrence

Browns Ferry Nuclear Plant unit 1 was in the final phases of the startup testing program. The unit had been operated through the complete power range. On Tuesday, May 7, 1974, while the reactor was being brought up to power, the plant was notified by the TVA Division of Engineering Design of the potential deficiency described in the next paragraph. The decision was made to bring the reactor to a cold shutdown condition to resolve a relief valve problem which was undergoing review as well as to investiage the problem covered by this report.

Description of Occurrence

As a result of a routine procedure by the Division of Construction, a computer identification check of unit 1 valves revealed a discrepancy involving the subject 1-inch globe valves. Investigation of the discrepancy disclosed that the original design conditions as specified by TVA on its purchase order for these valves were 1,250 psi at 575° F. These conditions were never revised to agree with an amendment of the system design condition of 1,146 psi and 562° F. established by the NSSS vendor. This discrepancy was reported to AEC on Tuesday, May 7.

Further investigation of systems to which these valves had been applied revealed that a number of these valves were utilized in systems whose design conditions are 1,326 psi at 562° F. and 1,250 psi at 575° F.

Analysis of Occurrence

When notified of the problem, the Division of Engineering Design tabulated a list of the affected unit 1 valves to determine the number and their location. This tabulation can be found in Appendix A of this report. The valves are installed in the sampling lines of the recirculation and core spray systems and are used as high-point vent valves in the recirculation system.

Corrective Action

It was the opinion of TVA that a stress analysis in accordance with ASME Section III design rules for class 2 valves would permit the vendor and TVA to upgrade the pressure-temperature ratings for the valves in question. The analysis was performed by the vendor (see Appendix C) and by TVA. The required primary pressure rating of the valves for the most severe design conditions of 1,326 psi at 562° F. is P_r = 800 psi (see sheet 1 of Appendix D).

Corrective Action (continued)

The required minimum wall thickness calculated is t_m = .243" (reference sheet 2 of Appendix D).

Minimum valve wall measurements were performed on ten of the 1-inch Hancock globe valves in unit 1 at four locations which had previously been established as the minimum wall areas. All valves are part of a lot. A description and tabulation of the wall thickness measurements are presented in Appendix B of this report. The ten valves measured are identified by an asterisk in Appendix A. Verification that all the valve wall thickness measurements exceed the calculated minimum wall thickness is shown in Appendix D.

The analysis of the valve body, bonnet, and bolting was performed by the valve manufacturer, Dresser Industries, and was verified by TVA, as described in Appendix D.

Recommendation

The engineering verification program undertaken by TVA and Dresser proves conclusively that these valves are capable of being rated to 900 lbs. if care is taken to control the amount of grinding for marking and excessive indentation of the marking tool is prevented. In any case, the valves more than meet the requirement for an 800-lb. rating, which fully satisfies the most severe design conditions to which they are subjected in this plant.

In addition, these valves have received a room temperature hydrostatic test at 3,000 psi, which is equivalent to 2,780 psi at 562° F. and would be the required test pressure for an 1,854 design pressure, or more than required for these valves.

Based on the results of the engineering evaluation, TVA takes the position that these valves are fully qualified for the higher design conditions.

System	Valve Number	Use	Service	Flow Medium	Feet From Pipe Tap	Temp. At Location	Design Conditions
Core Spray	75-222A X-27C	Penetration Isol.	Dead End	Water		Room	1250 psi @ 575 F
↓	75-211A X-27D	↓	↓	↓		↓	↓
Recirc	68-205A X-49A	↓	↓	↓		↓	1326 psi @ 562 F
↓	68-207A X-30E	↓	↓	↓		↓	↓
↓	68-209A X-49B	↓	↓	↓		↓	↓
↓	68-211A X-30F	↓	↓	↓		↓	↓
↓	68-212A X-39F	↓	↓	↓		↓	↓
↓	68-210A X-47D	↓	↓	↓		↓	↓
↓	68-208A X-34E	↓	↓	↓		↓	↓
↓	68-206A X-49C	↓	↓	↓		↓	↓
↓ *	68-214A X-33B	↓	↓	↓		↓	↓
↓	68-200A X-32A	↓	↓	↓		↓	↓
↓	68-201A X-32B	↓	↓	↓		↓	↓

Valves indicated by *. have been measured for minimum wall thickness (App. B)

System	Valve Number	Use	Service	Flow Medium	Feet From Pipe Tap	Temp. At Location	Design Conditions
Recirc	68-224A X-32D	Penetration Isol.	Dead End	Water		Room	1326 psi @ 562 F
	68-223A X-32C						
	* 68-221A X-33D						
	68-204A X-27A						1250 psi @ 575 F
	68-202A X-52F						
	68-203A X-27B						
	68-231 X-27A	High Point Vent			10 ft.	200 F	
	68-232 X-27A						
	68-241 X-32A				10 ft		1326 psi @ 562 F
	68-242 X-32A						
	68-243 X-32B				10 ft.		
	68-244 X-32B						
	68-245 X-32C				10 ft		

System	Valve Number	Use	Service	Flow Medium	Feet From Pipe Tap	Temp. At Location	Design Conditions
Recirc	68-246 X-32C	High Point Vent	Dead End	Water		200 F	1326 psi @ 562F
	68-247 X-32D				10 ft.		
	68-248 X-32D						
	68-249 X-33A				29 ft.		
	68-250 X-33A						
*	68-253 X-33C				40 ft.		
*	68-254 X-33C						
	68-257 X-41				65 ft.		
	68-264 X-40A-A	Penetration Isol.				Room	
	68-265 X-40A-B						
	68-266 X-40A-C						
	68-267 X-40A-D						
	68-268 X-40A-E						

System	Valve Number	Use	Service	Flow Medium	Feet. From Pipe Tap	Temp. At Location	Design Conditions
Recirc	68-269 X-40A-F	Penetration Isol.	Dead End	Water		Room	1326 psi @ 562F
↓	68-270 X-40B-A	↓	↓	↓		↓	↓
	68-271 X-40B-B						
	68-272 X-40B-C						
	68-273 X-40B-D						
	68-274 X-40B-E						
	68-275 X-40B-F						
	68-276 X-40C-A						
	68-277 X-40C-B						
	68-278 X-40C-C						
	68-279 X-40C-D						
	68-280 X-40C-E						
↓	68-281 X-40C-F	↓	↓	↓		↓	↓

System	Valve Number	Use	Service	Flow Medium	Feet From Pipe Tap	Temp. At Location	Design Conditions
Recirc	68-282 X-40D-A	Penetration Isol.	Dead End	Water		Room	1326 psi @ 562 F
	68-283 X-40D-B						
	68-284 X-40D-C						
	68-285 X-40D-D						
	68-286 X-40D-E						
	68-287 X-40D-F						
*	68-288	Jet Pump Instr Nozzle Drain			1 ft.	200 F	1146 psi @ 575 F
*	68-289						
*	68-290				1 ft.		
*	68-291						
*	68-251 X-33B	High Point Vent			30 ft		1148 psi @ 562 F
*	68-255 X-33D				28 ft.		1146 psi @ 562 F

5-9-74

TENNESSEE VALLEY AUTHORITY

THICKNESS MEASUREMENT RECORD
ULTRASONIC METHOD

Part identification: INST. VALVE 5500W-18

Manufacturer: DRESSER

Reference code or standard: G-29 P.S.-S.M.-1.1(b)

Minimum design thickness: Body ______ Weld End ______

(b) Material type (CS, SS, etc.) & P No.: SS

Product form (casting, forging, etc.): FORGED

Equipment make and model: KRAUTKRAMER D-METER

Probe type and size: KMR-4, ½" dia.

Frequency: 4 MHz

Calibration step thickness range: .200" thru .400

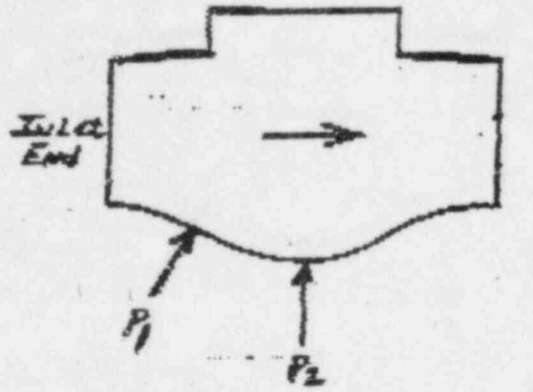
Couplant type: KRAUTKRAMER PASTE

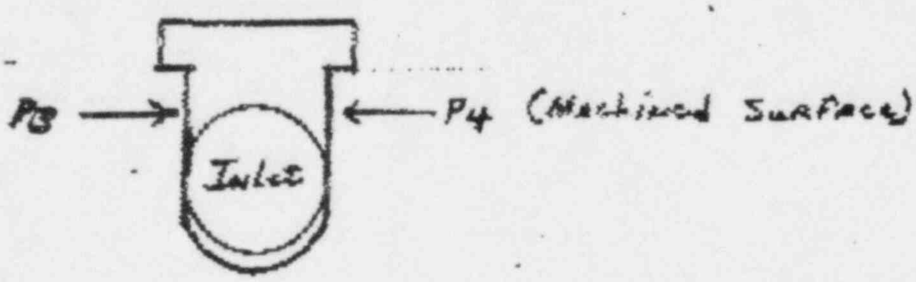
Special equipment attachments: NONE

Measurement location:

		Valves			Pumps			Pipe
		Body	Neck	Weld End	Body	Neck	Weld End	
0°	1							
	2							
90°	1							
	2							
180°	1							
	2							
270°	1							

5-9-74





	Acc.	UT	Corr. Factor
P_1	.384	10.1 mm = .398"	.965
P_2	.330	9.1 mm = .359"	.919
P_3	.320	8.9 mm = .351"	.912
P_4	.292	8.4 mm = .329"	.888

ve. Id.	P_1 (UT)	P_1 (Corr)	P_2 (UT)	P_2 (Corr)	P_3 (UT)	P_3 (Corr)	P_4 (UT)	P_4 (Corr)
68-214A, X-33B	10.1 mm	0.385 in	9.5 mm	.345"	8.6 mm	.309"	8.9 mm	.312"
68-251, X-33B	10.4	0.396	9.6	.347	8.9	.330	9.1	.319
68-253, X-33C	9.8	0.372	8.6	.312	9.1	.327	8.6	.301
68-254, X-33C	9.9	0.376	9.1	.330	8.7	.313	8.6	.301
68-221, X-33D	10.3	0.392	9.2	.333	8.7	.313	8.7	.305
68-255, X-33D	10.3	0.392	9.7	.351	8.9	.320	9.6	.336
68-288	10.1	0.384	9.5	.344	8.5	.306	8.2	.287
68-289	10.3	0.392	9.6	.367	9.3	.334	8.8	.308
68-290	10.0	0.380	9.8	.355	8.5	.306	9.5	.332
68-291	9.9	0.376	9.5	.344	8.5	.306	8.2	.287

VIA TELECOPIER TO - BOB HARRIS - TVA

APPENDIX C

DRESSER

DRESSER INDUSTRIAL VALVE & INSTRUMENT DIVISION

PRODUCT ENGINEERING DEPARTMENT

Check QA package. Were all valves hydro? Yes - All valves received a 3000 psi hydrostatic test. Seat leakage was at 2175 psi. All valves OK. MWB

DRESSER 1"-5500 W VALVE

PER TABLE NB-3542-1, FOR 900 lb VALVE

$d_m = 1" \longrightarrow t_m = 0.28"$ ✓

MEASURED WALL THICKNESSES AS SHOWN IN FIG. 1 ARE ALL EXCEEDING $t_m = 0.28"$. ✓ HENCE, VALVE BODY PRESSURE RATING EXCEEDS 900 lb.

PER TABLE NB-3531-5, FOR 900 lb, 316 S.S., WELDING END VALVE, ALLOWABLE DESIGN PRESSURE AT 600°F IS 1510 PSIG WHICH IS HIGHER THAN ACTUAL DESIGN CONDITION

BONNET-BODY JOINT -

BOLTING: $4 - \frac{1}{2}"\phi$ ($A_b = 0.126\ in^2$)

GASKET: $1\frac{9}{16} \times 1\frac{31}{32}$ FLEXITALLIC → $G = 1.7656"$ ✓, $b = 0.1015"$ ✓

$N = \frac{1.9687 - 1.5625}{2} = \frac{.4062}{2} = .2031$

$b_o = .1015 \quad b = b_o \text{ for } b_o \le \frac{1}{4}$

$G = GOD - 2b = 1.9687 - .203 = 1.7657$

STEM THRUST = 1,801. lbs ✓

$W_{m1} = (0.785 G^2 P + 6.28 b G m P) + (1801)$

$= [.785 (1.7656^2)(1326) + 6.28 (.1015)(1.7656)(3)(1326)] + [1801]$

$= 9,523$ lbs ✓

BOLT STRESS $= \dfrac{9523}{4(.126)} = 18,895$ psi ✓

OK mmb

PER TABLE I-7.3, FOR SA193-B7, S = 25,000 psi AT 600°F

BONNET DIMENSIONS IS SHOWN IN FIG. 2. CONSERVATIVELY ASSUME THE BONNET BEING A BOLTED BLIND FLANGE OF FOLLOWING DIMENSIONS (PER SECTION VIII, APPENDIX II):

$A = 2.938"$ ✓

$B = 0.753"$ ✓

$C = 2.625"$ ✓

$g_o = 0.36"$ ✓

$t = 0.5"$ ✓

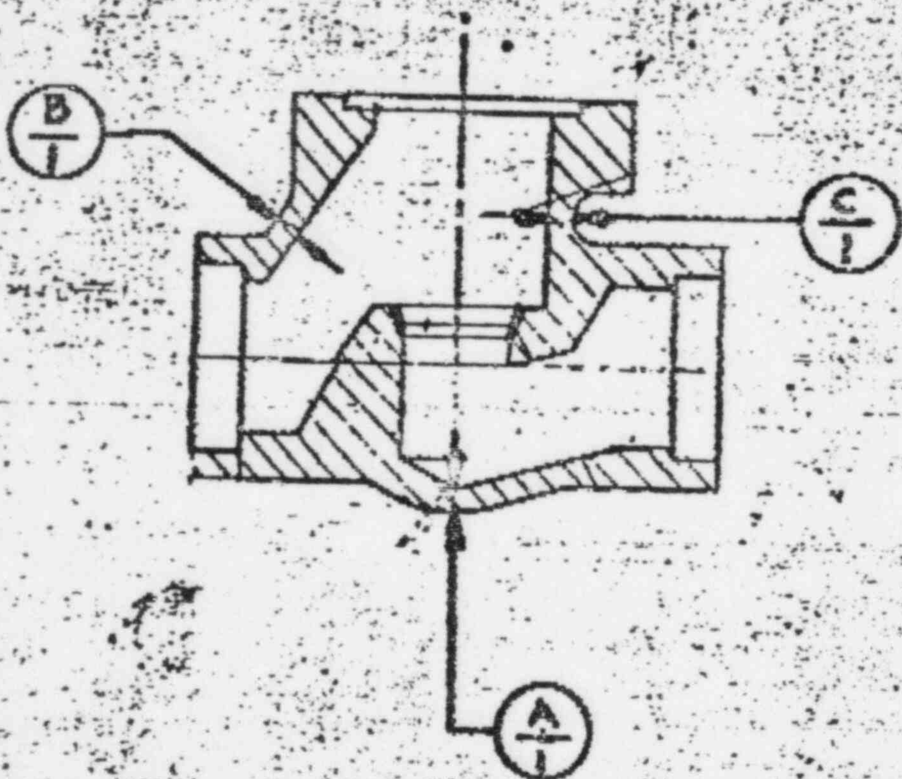
$G = 1.7656$ ✓

$b = 0.1015$ ✓

$m = 3.0$ ✓

$g_1 = g_0$ ✓ mmb

DIMENSIONAL EXAMINATION		
	VALVE 1	VALVE 2
A/T	.330	.330
B/T	.500	.460
C/T	.720	.730



1" 5500W BODY

FIGURE 1

THE STRESSES IN BONNET UNDER 1326 psi PRESSURE PER ASME CODE FLANGE DESIGN PROCEDURES:

S_H = 11,819 psi < 1.5S = 25,500 psi ✓

S_R = 19,569 psi < 1.5S = 25,500 psi ✓

S_T = 10,511 psi < 1.5S = 25,500 psi ✓

OK [initials]

FOR SA-182 GRADE 316, ALLOWABLE S AT 600°F IS 17,000 psi.

BONNET FOR GLOBE VALVES

DIMENSIONAL EXAMINATION TYPE 5500 ___

A -.360
A -.365

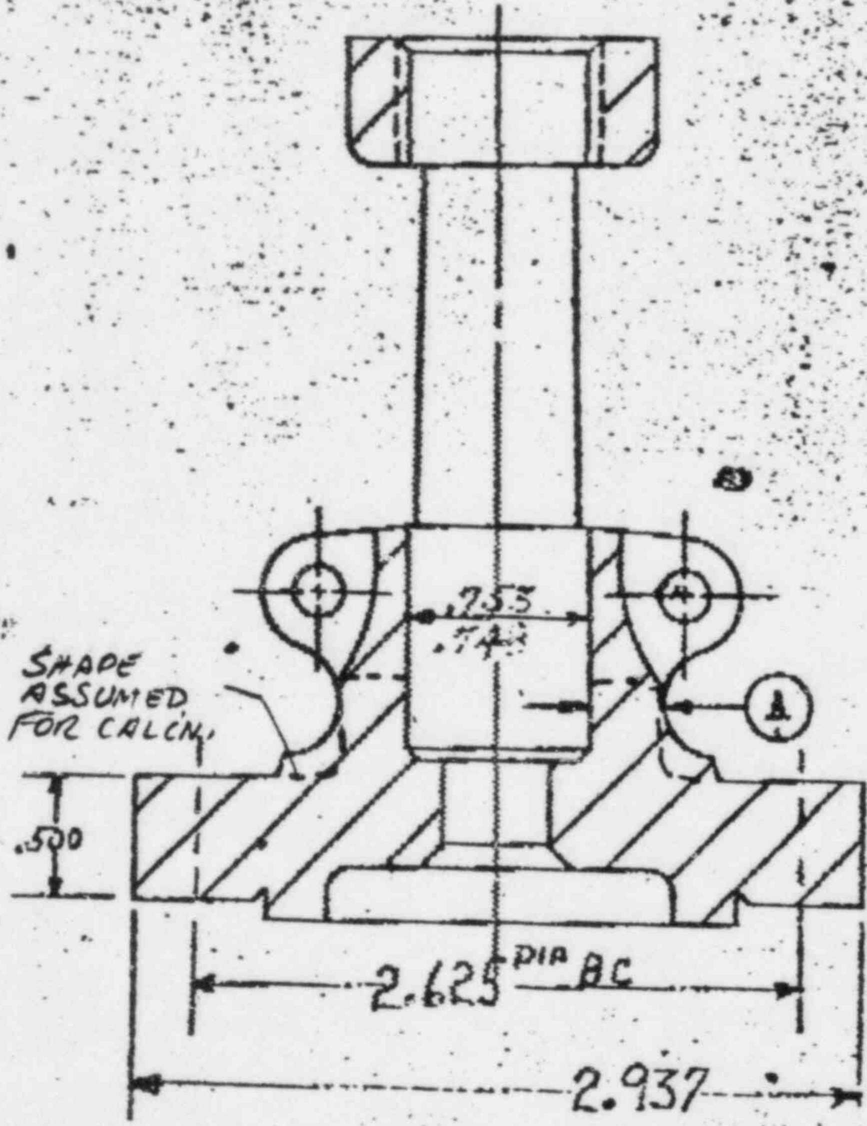


FIG. 2

SUBJECT ______ PROJECT ______

COMPUTED BY ______ DATE ______ CHECKED BY ______ DATE ______

APPENDIX D

We, the undersigned Registered Professional Engineers with experience in stress analysis and flange design, have performed and verified the calculations shown in this document.

We certify that these valves meet the requirements of NB-3500, ASME Section III for Class 2 valves for 600 lb rating.

MARCUS N. BRESSLER PROFESSIONAL ENGINEER TENNESSEE No. 9411 AGRICULTURE COMMERCE

Marcus N. Bressler

MARCUS N. BRESSLER, PE

DATE: 5/10/74

JOHN S. G. WILLIAMS REGISTERED ENGINEER AGRICULTURE COMMERCE No. 8944 STATE OF TENNESSEE

John S. G. Williams

JOHN S. G. WILLIAMS, PE

DATE: 5/11/74

APPENDIX D

SUBJECT 1" HANCOCK SW 600# GLOBE VALVES PROJECT BROWNS FERRY NP

COMPUTED BY M.N. BRESSLER DATE 5/10/74 CHECKED BY JBW DATE 5/11/74

SECTION III ANALYSIS. VALVES ARE CLASS 2

1.0 DESIGN CONDITIONS

RECIRC SYSTEM	1326 psi	@ 562 F ✓
CORE SPRAY	1250	@ 575
RECIRC SYSTEM	1146	@ 562

∴ PERFORM CALCULATIONS FOR RECIRC SYSTEM HIGH VALUES TO SATISFY ALL SYSTEMS.

2.0 REQUIRED RATING

VALVE MATERIAL - SA-182 F316 ✓

ALLOWABLE STRESS (TABLE I-7.2) AT 562 F ✓

$S_{600} = 17.0$ kpsi, $S_{500} = 18.0$ kpsi $S = 17380$ psi ✓

FROM TABLE NB-3531-5 (SUMMER 73 Addenda), FOR 316 S.S.

$P_{r_{600F}} = 1510$ psi ✓ $P_{r_{500F}} = 1595$ psi ✓

$P_{r_{562F}} = 1542$ psi ✓ FOR CLASS 900.

FROM TABLE NB-3531-4 (S '73 Addenda), FOR 316 S.S.

$P_{r_{600F}} = 1005$ psi ✓ $P_{r_{500F}} = 1065$ psi ✓

$P_{r_{562F}} = 1027$ psi ✓ FOR CLASS 600

INTERPOLATED PRIMARY PRESSURE RATING, FROM NB-3543(c)

$$p_r = p_{r_1} + \frac{(p_d - p_1)}{(p_2 - p_1)} \times (P_{r_2} - P_{r_1})$$ ✓

2 = 900 ✓
1 = 600 ✓

$$p_r = 600 + \left(\frac{1362 - 1027}{1542 - 1027}\right)(900 - 600)$$

$p_r = 796$ ✓, SAY 800 ✓ psi NON-STANDARD PRESSURE RATING

SUBJECT ______ PROJECT ______

M.N. BRESSLER 5/10/74
COMPUTED BY DATE CHECKED BY [signature] DATE 5/11/74

3.0 REQUIRED MINIMUM WALL THICKNESS

FROM NB-3543 (b)

$$t_m = t_1 + \frac{(p_d - p_1)}{(p_2 - p_1)} \times (t_2 - t_1)$$

FROM NB-3641.1, REQUIRED PIPE WALL THICKNESS IS

FOR 1" NOM PIPE SIZE $D_o = 1.315$ ✓

$$t_m = \frac{PD_o}{2(S_m + yP)} + a \quad P = 1326,\ a = 0,\ S_m = 17380,\ y = 0.4$$

$$t_m = \frac{1326 \times 1.315}{2(17380 + 0.4 \times 1326)}$$

$t_m = .049"$ ✓

PIPE USED IS SCH 80, $t_{nom} = .179$

$ID = 1.315 - 2 \times .179 = .957$ ✓

∴ ASSUME $d_m = 1"$ ✓

FROM TABLE NB-3542-1, FOR $d_m = 1$

$t_1 = t_{600} = .19"$ $t_2 = t_{900} = .28$

$$t_m = .19 + \frac{(1326 - 1027)}{(1542 - 1027)}(.28 - .19)$$

$t_m = .243"$ .148

SUBJECT ______ PROJECT ______

M. N. Bressler 5/10/74
COMPUTED BY DATE CHECKED BY JSM DATE 5/11/74

4.0 MEASURED WALL THICKNESSES

Reference Appendix A, valve list for unit 1

There are 53 valves involved whose design conditions are 1326 psi @ 562F, and 5 valves at 1250 psi and 575F for unit 1. For units 2 & 3 the numbers are 55 and 5. From Table IV-B of MIL-STD-105A, for a lot size of 41 to 65 units, the first sample size should be 7. A total of 10 valves were measured on unit 1 at four locations which had previously been established as the minimum wall areas. All thicknesses were or exceeded 0.287" which occurred at an area along the side of the branch which has been ground to provide a flat for marking. The maximum depth of marking does not exceed .012". Assuming 0.015" as an absolute extreme, the minimum wall is

$$0.287 - 0.015 = 0.272''$$

which is in excess of the required 0.243".

Appendix B describes the locations where the measurements were made, and tabulates the measured dimensions for the unit valves.

5.0 VERIFICATION OF VENDORS CALCULATIONS

The calculations submitted by Dresser Industrial Valves have been checked. They are shown in Appendix C, pages 1-5.

The valves on page 1 can be verified from page 1 of this Appendix. They indicate that these valves can be certified to 900# class.

The bonnet-to-body joint has been checked by various methods. First an approximation was made assuming the bonnet to be a blind flange as shown on the next page.

SUBJECT ______ PROJECT ______

M.N. BRESSLER 5/10/74
COMPUTED BY DATE CHECKED BY DATE

SECOND, THE VENDOR ASSUMED THE BONNET TO BE A HUBBED FLANGE WITH A UNIFORM THICKNESS HUB.

THE CALCULATIONS ARE SHOWN ON THE FORM IN PAGE 6. THE CORRESPONDENCE OF STRESSES IS GOOD.

6.0 CONCLUSION

THE VALVES ARE CAPABLE OF MEETING THE HIGHER DESIGN CONDITIONS OF 1326 psi AT 562 F.

Marcus N. Bressler
MARCUS N. BRESSLER, PE

COMPUTED [illegible] DATE 5/9/74
CHECKED MHB DATE 5/9/74

BONNET CHECK SEC VIII UG-34

$$t = d\sqrt{\frac{CP}{S} + \frac{1.78\,Wh_g}{Sd^3}}$$

$$\frac{t^2}{d^2} = \frac{CP}{S} + \frac{1.78\,Wh_g}{Sd^3} \quad \therefore \quad t^2 d = \frac{CPd^3}{S} + \frac{1.78\,Wh_G}{S}$$

$$S = \frac{CPd^3 + 1.78\,Wh_G}{t^2 d}$$

h_G 1.3125 − .828125 = .484375"

d = 1.76563"

t = 0.5"

C = 0.3

P = 1386 psig

W FORMULA (4) UA-49(c) = 9523# previous calc.

$A_b = A_m$ = 4(0.126) =

S_a = 25000 psi W_{m_1} = 9523

16570
4960
21530

$\therefore$

2189

$$S_{op} = \frac{.3(1386)(1.76563)^3 + 1.78(9563)(.484375)}{.25(1.76563)} = \underline{\underline{21530}} \text{ psi} \le 1.5\,S$$

25,500
OK

17672
17.633

ULTRA CONSERVATIVE CHECK —

S = 1.78(12600).4297 ... = 21,1[illegible] ≤ 1.5S = 25,500

WELDING NECK FLANGE DESIGN

DESIGN CONDITIONS		GASKET and BOLTING CALCULATIONS		(From Design Tables 2 and 3)	
Design Pressure, P	1326	Gasket Details: 1.96875 ✓, 1.5625 ✓	Facing Details: 1.379", 1.96875"	N =	0.203 ✓
Design Temperature	562 ✓			b =	0.1015 ✓
Flange Material	SA 182 F316 ✓			y =	4500 ✓
Bolting Material	SA 193 B7 ✓	H_S = STEM THRUST = 1801 ✓		m =	3.0 ✓
Corrosion Allowance	0 ✓	$W_{m2} = b\pi Gy$ = 2534 ✓	A_m = greater of W_{m2}/S_a or W_{m1}/S_b = 0.381 ✓		

Stresses				
Flange	Design Temp., S_{fo}	17380 ✓	$H_p = 2b\pi GmP$ = 1479 ✓	A_b = 4(.126) = 0.504 ✓
Flange	Atm. Temp., S_{fa}	18750	$H = G^2\pi P/4$ = 3247 ✓	$W = .5(A_m + A_b)S_a$ = 11063 ✓
Bolting	Design Temp., S_b	25000 ✓	$W_{m1} = H_p + H + H_S$ = 9526 ✓✓	W_{m1} = 9526 ✓
Bolting	Atm. Temp., S_a	25000 ✓	Gasket Width Check (Raised Face ONLY): $N_{min} = A_bS_a/2y\pi G$ = N/A ✓	

CONDITION	LOAD	X	LEVER ARM	=	MOMENT
Operating	$H_D = \pi B^2P/4$ = 591 ✓		$h_D = R + .5g_1$ = .756 ✓		$M_D = H_Dh_D$ = 446 ✓
	$H_G = H_p$ = 1479 ✓		$h_G = .5(C - G)$ = .4297 ✓		$M_G = H_Gh_G$ = 1925 ✓
	$H_T = H - H_D$ = 2656 ✓		$h_T = .5(R + g_1 + h_G)$ = ~~.6629~~ .6829		$M_T = H_Th_T$ = ~~1760~~ 1811
					M_o = ~~4132~~ 4182
Gasket Seating	$H_G = W$ = 11063 ✓		$h_G = .5(C - G)$ = .4297 ✓		M_g = 4754 ✓

Allowable Stress	STRESS CALCULATION — ~~Operating~~ Conditions (use ~~M_o~~)			
1.5 S_{fo}	Long. Hub, $S_H = fM_o/\lambda g_1^2$	~~17533~~ ~~17709~~	25500	11819
1.5 S_{fo}	Radial Flg., $S_R = \beta M_o/\lambda t^2$	~~19408~~	25500	19569
1.5 S_{fo}	Tang. Flg., $S_T = (M_oY/t^2) - ZS_R$	~~10357~~	25500	10511
1.5 S_{fo}	greater of $.5(S_H + S_R)$ or $.5(S_H + S_T)$	18358	25500	*15694 (* BY TVA)

Allowable Stress	STRESS CALCULATION — Gasket Seating (use M)		
1.5 S_{fa}	Long. Hub, $S_H = fM/\lambda g_1^2$	19915 ✓	28125
1.5 S_{fa}	Radial Flg., $S_R = \beta M/\lambda t^2$	22330 ✓	28125
1.5 S_{fa}	Tang. Flg., $S_T = (MY/t^2) - ZS_R$	11917 ✓	28125
1.5 S_{fa}	greater of $.5(S_H + S_R)$ or $.5(S_H + S_T)$	21122 ✓	28125

SHAPE CONSTANTS (From Design Table 4 and Design Charts 1, 2 and 3)

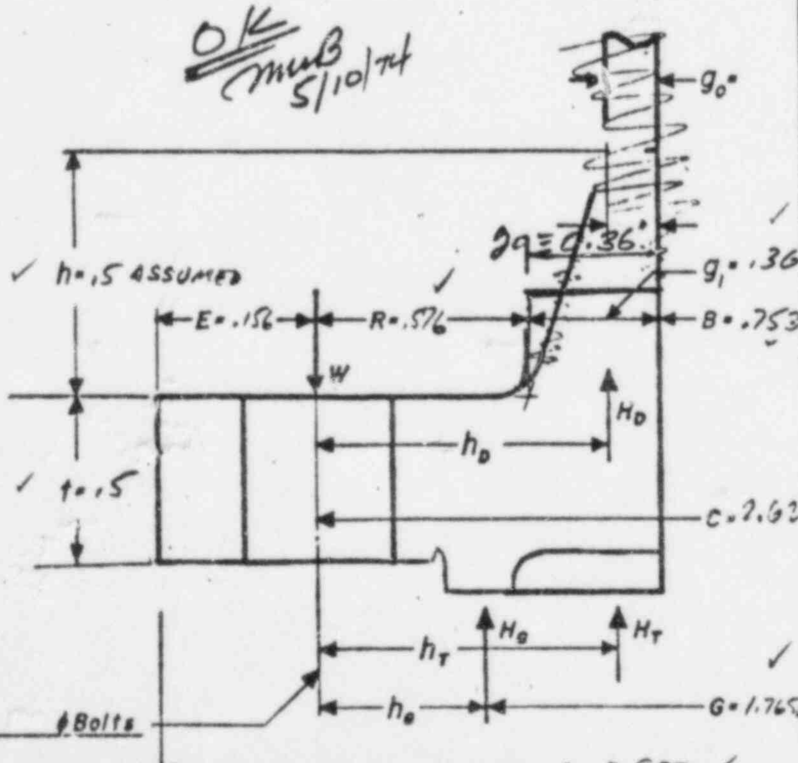
K = A/B	= 3.9	h/h_o	= .960
T	= 1.03	F	= .9077 ✓
Z	= 1.14 ✓	V	= .5501 ✓
Y	= 1.48	f	= 1.0 ✓
U	= 1.62	$e = F/h_o$	= 1.745 ✓
g_1/g_o	= 1.0	$d = \frac{U}{V}h_og_o^2$	= 0.199 ✓
$h_o = \sqrt{Bg_o}$	= .521 ✓		

OTHER STRESS FORMULA FACTORS

t (assumed)	.5
$\alpha = te + 1$	1.873 ✓
$\beta = 4/3\,te + 1$	2.163 ✓
$\gamma = \alpha/T$	1.818 ✓
$\delta = t^3/d$	.628 ✓
$\lambda = \gamma + \delta$	2.446 ✓
$M = M_o/B$	~~5487~~ 5552
$M = M_g/B$	6313 ✓

If bolt spacing exceeds 2a + t, multiply M_o and M_g in above equations by: $\sqrt{\frac{\text{Bolt spacing}}{2a + t}}$

OK MWB 5/10/74



[redacted]
MARCUS N. BRESSLER PROFESSIONAL ENGINEER AGRICULTURE COMMERCE TENNESSEE No. 94..

Computed M.N. Bressler Date 5-10-74

Checked J.S.G. Williams 5/11/74 Number PG 6 OF APPENDIX D