PPG INDUSTRIES, INC. CHEMICAL DIVISION - U.S. P. O. BOX 1000 LAKE CHARLES, LA. 70602

September 8, 1980

Mr. Paul Kelley
Petrocon, Inc.
P. O. Box 3971
Beaumont, TX 77704

SUBJECT: Reliability Study

Dear Paul:

Enclosed are Lamar White's calculations for pressure and temperature limits on the furnace tubes. Also included are the curves and data supplied by Huntington Alloy for INCOLOY alloy 800 H.

Please compare these numbers with yours. If there are still some questions, please give me a call.

Very truly yours,

Walter L Oglesby

Walter L. Oglesby

WLO/bjm

cc: S. L. White

File: 4.47

$$t_s = \frac{P_e D_o}{2S_e + P_e}$$

$$t_s = \frac{P_R D_o}{2S_R + P_R}$$

$D_o = 6.5''$

$t_s = 0.3125''$ A.W.

$D_i = 5.875''$

Condition 280 psig duty

Normal Press. = 158 psig

Max Press = 350 psig

Normal Temp = 1100 °F

Max Temp = 1245 °F @ .25" coke

Corrosion All = 1/16" = 0.062

Design = 1350 °F

		100,000 hr @ 280#	@ 350#
Creep Rupture	t_s =	0.194/.256	0.241/.303
	t_s =	0.124/.186	0.159/.217
*	t_s =	0.009/.152	0.112/.174

* Elastic Stress

@1350°F S_r = 4550

@1245°F S_r = 7200

@1100°F S_e = 10,000

$$(2S_R + P_R)t_s = P_R D_o$$

$$2S_R = \frac{P_R D_o}{t_s} - P_R$$

$$S_r = \left(\frac{(P_R)6.5}{.2175} - P_R\right)\Big/2$$

350#	5054#
	#

≅ 5100

— Min wall (.28) — corr all ( )

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CALCULATED STRESS	API ALLOWABLE STRESS 5100 PSI (CREEP RUPTURE)			
	100,000 hr	60000 hr	40,000 hr	20,000 hr
@ 350 psig (PEAK PRESS.) 5100 psi	1325°F	1345°F	1360°F	1390°F

CALCULATED STRESS	HUNNINGTION ALLOWABLE STRESS 5100 PSI (C…				
	100000 hr	10,000 hr	1000 hr	100 hr	10 hr
@ 350 psig (PEAK PRESS.) 5100 psi	1400°F	1500°F	1590°F	1690°F	1780…

BY API VALUES

EXPECTED LIFE IF START OF RUN TEMP OF 1100°F USED AND MAX. SUSTAINED PRESS OF 280# WITH 6.5" OD × 0.3125 AW TUBE (0.3125" (A.W.) − 12.5% = 0.28" (M.W.)) + (0.28" LESS CORROSION ALLOW OF 0.0625" = 0.2175" WALL)

A.W. / AVG. WALL
MW / MIN. WALL

$$S_R = \left(\frac{(P_R) D_o}{t_s} - P_R\right)/2 = \left(\frac{(280\ \text{psig})(6.5")}{0.2175"} - 280\ \text{psig}\right)/2$$

$$S_R = 4043\ \text{psi}$$

$$L_D = 10^{\left[36.3/(T_D+460)\right]10^3 - 15} = 388814,950\ \text{hr}$$

If 1245°F is used (0.25" ro?ac)

$$L_D = 3,333,336\ \text{hr}$$

If 1350°F is used

$$L_D = 214531\ \text{hr}$$

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Although 280# is the highest pressure that can be o…l…d at design feed flow, it might be …

to get some what higher at reduced rates. 350# is the SRV setting upstream of the FCV & other piping losses. It is impossible for the tubes in the radiant section to ever see a sustained pressure of 350#, but for simplicity, it may be used as the limit.

If 1350°F is used & 350# with our tube

$S_R = 5054$ psi (1-7)

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$L_D = 52\,936$ hr.

It must be pointed out, however, that to make the life drop to 52936 h, the 350# & 1350°F would have to be sustained for the entire life, and the corrosion allowance would have to be gone on the first day. Since these cannot be true, it is safe to say that the life will be much greater than 52,936 h. On the other hand, cycling the tubes will shorten the life. It is true that we cycle the tubes many times in a 100,000 h period (11.5 yr). Thus as a safety factor, if 100,000 hr is the desired design and much cycling will take place, then say 200,000 h will be used as the design value. The normal temp cycle from start of run to end of run can be accounted for. The 200,000 hr design will continue to lose the [illegible] due to the numerous and dramatic cycles the tubes get due to trips, rate changes etc.

$T_D = 1298°F$ say $1300°F$ w/ $S_R = 5100$ $L_D = 200{,}000$

350" $\pm$ .21" WALL

This design temp is not the max allowable however, it is the equivalent temp. between start of run and end of run. To solve for the end of run temp 1100°F as the start of run temp.

$$T_e = T_{SOR} + f_t\,(T_{eor} - T_{SOR})$$

280

$$1300°F = 1100°F + f_t\,(T_{eor} - 1100°F)$$

$$V = N_0 \left(\frac{\Delta T}{T_a}\right) \ln\left(\frac{A}{S_0}\right)$$

$N_0 = 6.1$ @ 1100°F (1200°F min

$\Delta T = EOR - 1100 = 280$

$$N = N_0 \left(\frac{\Delta t}{t_0}\right)$$

$T_a = 1560°$

$\Delta t = 1.116 \times 10^{-2}$

$$N = 6.1 \left(\frac{1.116 \times 10^{-2}}{0.28}\right) = 0.24$$

$R = 5.58 \times 10^{-3}$ "/yr

$t_0 = 0.28''$ MIN. WALL

$$V = 6.1 \left(\frac{\Delta T}{1560}\right) \ln \frac{1.5 \times 10^7}{3887}$$

$S_0 = 3887$ psi @ .28"

$A = 1.5 \times 10^7$

$$V = \left(\frac{280}{1560}\right) 50.37 = 9.0$$

$$T_{EOR} = 1380°F$$

Corrosion allowance condition

$B = 0.0625/0.2175 = 0.287$

$f \approx 0.5565$

$t_M = (0.2175) + (0.5565)(0.0625)$

$t_M = 0.2522$

$\boxed{\text{Try over}}$!

$B = 0.0625/0.2300 = 0.272$

$f \approx 0.5565$

$\boxed{\text{Try over}}$

$B = 0.0625/0.245 = 0.255$

$f \approx 0.5552$

$t_M = 0.2797$ say 0.28

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Starting over

$S_R = 4467$ psi (36.75)

$T_D = 1348$ say $1350°F$

$T_{EOR} = 1440°F$

$v = 10.9$

$n = 0.24$

$\eta = 0.73$

$N_0 = 6.1$

$\Delta T = EOR - 1100 = 340$

$T_a = 1560$

$\Delta t = 1.116 \times 10^{-2}$

$R = 5.53 \times 10^{-3}$

$t_0 = 0.28$

$S_0 = 3887$

$A = 1.5 \times 10^7$

Thus with the current tubes, the wall thickness should be sufficient to give 11.2 yr. or 100,000 hr of 1/2 to 1 yr runs. The start of each run temp will be 1100°F and the end of run temp can go to 1440°F. (ΔP or product quality may necessitate end of run soon than this, if so the life span for creep rupture failure will increase). During each run, temperature and pressure cycles should be allowable with out affecting the life expectancy below 11.2 yr. The question now remaining is how high can TMT be allowed to cycle with out any danger. API RP 530 states that temperatures up to with in 50°F of the critical temperature may be used of short periods such as decoking. ANSI allows short duration temp & press cycles to go above the allowable stress by 1.3. They have, however, chosen to use about 80% of the 100,000 hr curve as the stress at that temperature. The best insight to this question is gotten by calculating the peak, end of tube life condition. A press of 350 psig can certainly be reached for a very short period if there is a plug or feed flow trip (30 sec to 1 min duration). At this time the corrosion allowance is gone. This results in a calculated stress of 5100 psi. Now the question is, is there a temperature that can cause the tube to rupture in this amount of time. The

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Huntington Alloys manual's data will be used in this case, since it shows creep rupture failure on this order of time magnitude. As can be seen, the life of the tube drops exponentially with temperature. Even pushing the life down to the minimum that can be extrapolated, 1 hr., a temp of about 1900°F would be needed. Even at this, it would take 1 hour for a new tube to fail. In an old tube it would take less since some of the hour would be used up by the many hours at the lower temp. (Remember that creep rupture is cummulative) Since 1 hour at 1900°F is basically equivalent to 200,000 hours at the design temp. and since we have used only about 50% of this (100,000 is end of tube life), we would expect about ½ at 1900°F to be possible. This might be smaller if the furnace has be cycled alot; or it might be greater if the equivalent design TMT has been lower than expected. Thus we should not have any problem with running the TMT up to 1900°F (actually up to 30 to 60 times during the life of the furnace) toward the end of of the tube life since there should be some reasonable safety margin amount of life left in the tube. Furthermore, once the tube does reach 100,000 hours, there is NO guarantee that it will not fail, at any random time, due to creep rupture even at normal conditions.

Now, as to the question of a trip temperature, it would appear it could safely be anywhere between 1450°F (end of run max. TMT) and about 1900°F. Since there is a good margin between these, the trip should be set so that it and an alarm can be provided at a comfortable operating margin above 1450.

70% = 1550 Alarm
80% = 1700 Trip

0% 50% 63% 100%
1275
500 [1100 1450] 2000

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Rupture strength of the alloy is shown by the data plotted in Figure 20. Rupture-strength values for some specific temperatures and times are listed in Table 22.

ASME boiler and pressure vessel code

INCOLOY alloy 800H is approved under the Boiler and Pressure Vessel Code of the American Society of Mechanical Engineers. The alloy is approved under Section I (Power Boilers), Section III (Nuclear Vessels), and Section VIII (Pressure Vessels). Section I coverage is provided by Code Case 1325; Section III design values are contained in Code Case 1592.

Design stresses specified for alloy 800H by Section I and Section VIII, Division 1, of the Code (1977 edition) are listed in Table 23. Stress-intensity values for Class 1 components of nuclear vessels

Table 22 – Representative Rupture-Strength Values for INCOLOY alloy 800H

Temperature		Stress to Produce Rupture in							
		10,000 h		30,000 h		50,000 h		100,000 h	
°F	°C	psi	MPa	psi	MPa	psi	MPa	psi	MPa
1200	650	17,500	121	15,000	103	14,000	97	13,000	90
1300	705	11,000	76	9,500	66	8,800	61	8,000	55
1400	760	7,300	50	6,300	43	5,800	40	5,300	37
1500	815	5,200	36	4,400	30	4,100	28	3,700	26
1600	870	3,500	24	3,000	21	2,800	19	2,500	17
1700	925	1,900	13	1,600	11	1,400	10	1,200	8.3
1800	980	1,200	8.3	1,000	6.9	900	6.2	800	5.5

Table 23 – INCOLOY alloy 800H Design Stresses from ASME Boiler and Pressure Vessel Code, Section I and Division 1 of Section VIII

Maximum Metal Temperature		Maximum Allowable Stress in Tension			
		Standard		Conditional[a]	
°F	°C	psi	MPa	psi	MPa
100	38	16,200	111.6	16,200	111.6
200	93	15,400	106.1	16,200	111.6
300	149	14,500	99.9	16,200	111.6
400	204	13,500	93.0	16,200	111.6
500	260	12,900	88.9	16,000	110.3
600	316	12,200	84.1	16,000	110.3
650	343	11,900	82.0	16,000	110.3
700	371	11,700	80.6	15,700	108.2
750	399	11,400	78.6	15,400	106.1
800	427	11,100	76.5	15,300	105.4
850	454	10,900	75.1	15,100	104.1
900	482	10,700	73.7	14,800	102.0
950	510	10,500	72.3	14,600	100.6
1000	538	10,300	71.0	14,400	99.2
1050	566	10,100	69.6	13,700	94.4
1100	593	10,000	68.9	13,500	93.0
1150	621	9,800	67.5	11,200	77.2
1200	649	8,400	57.9	8,400	57.9
1250	677	6,900	47.5	6,900	47.5
1300	704	5,400	37.2	5,400	37.2
1350	732	4,500	31.0	4,500	31.0
1400	760	3,600	24.8	3,600	24.8
1450	788	3,000	20.6	3,000	20.6
1500	816	2,500	17.2	2,500	17.2

[a] These higher stress values of up to 90% of yield strength at temperature may be used where slightly greater deformation is acceptable. The stresses may result in dimensional changes due to permanent strain and are not recommended for applications such as flanges of gasketed joints.

5100 psi
CALCULATED STRESS
@350°

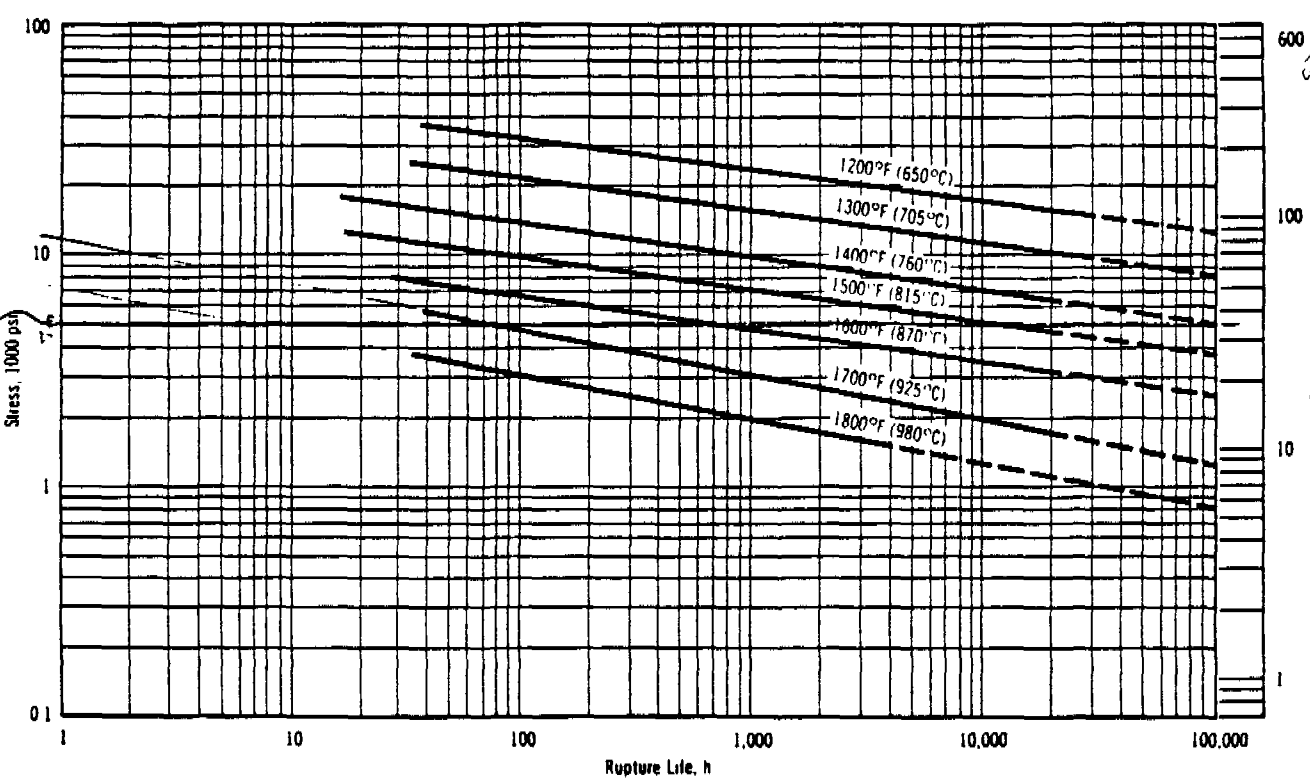

Figure 20. Typical rupture strength of INCOLOY alloy 800H

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Fatigue strength

Low-cycle fatigue strength of alloy 800H at room temperature and 1400°F (760°C) is shown in Figure 16.[14] Low-cycle fatigue data for alloys 800 and 800H are compared at 1000°F (538°C) and 1200°F (649°C) in Figures 17 and 18.

Creep and rupture properties

The outstanding characteristic of INCOLOY alloy 800H is its high creep and rupture strength. The alloy's carbon content and annealing treatment are designed to produce optimum creep-rupture properties in material having the standard INCOLOY alloy 800 composition. Figure 19 shows creep strength of alloy 800H at various temperatures.

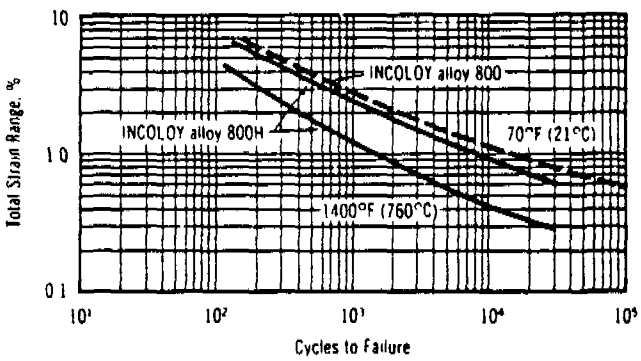

Figure 16. Low-cycle fatigue strength of INCOLOY alloy 800H. Bending strain was used for alloy 800; axial strain was used for alloy 800H.

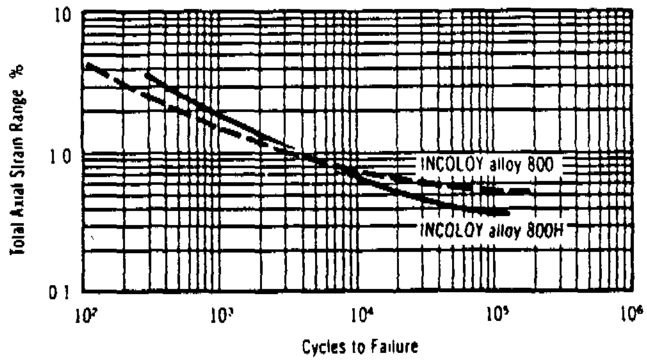

Figure 17. Low-cycle fatigue strengths of INCOLOY alloys 800 and 800H at 1000°F (540°C).

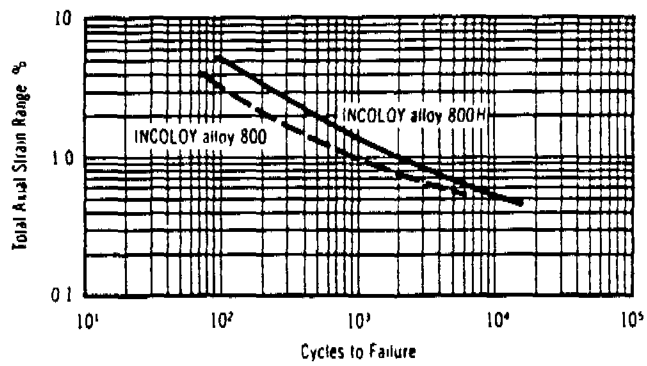

Figure 18. Low-cycle fatigue strengths of INCOLOY alloys 800 and 800H at 1200°F (650°C).

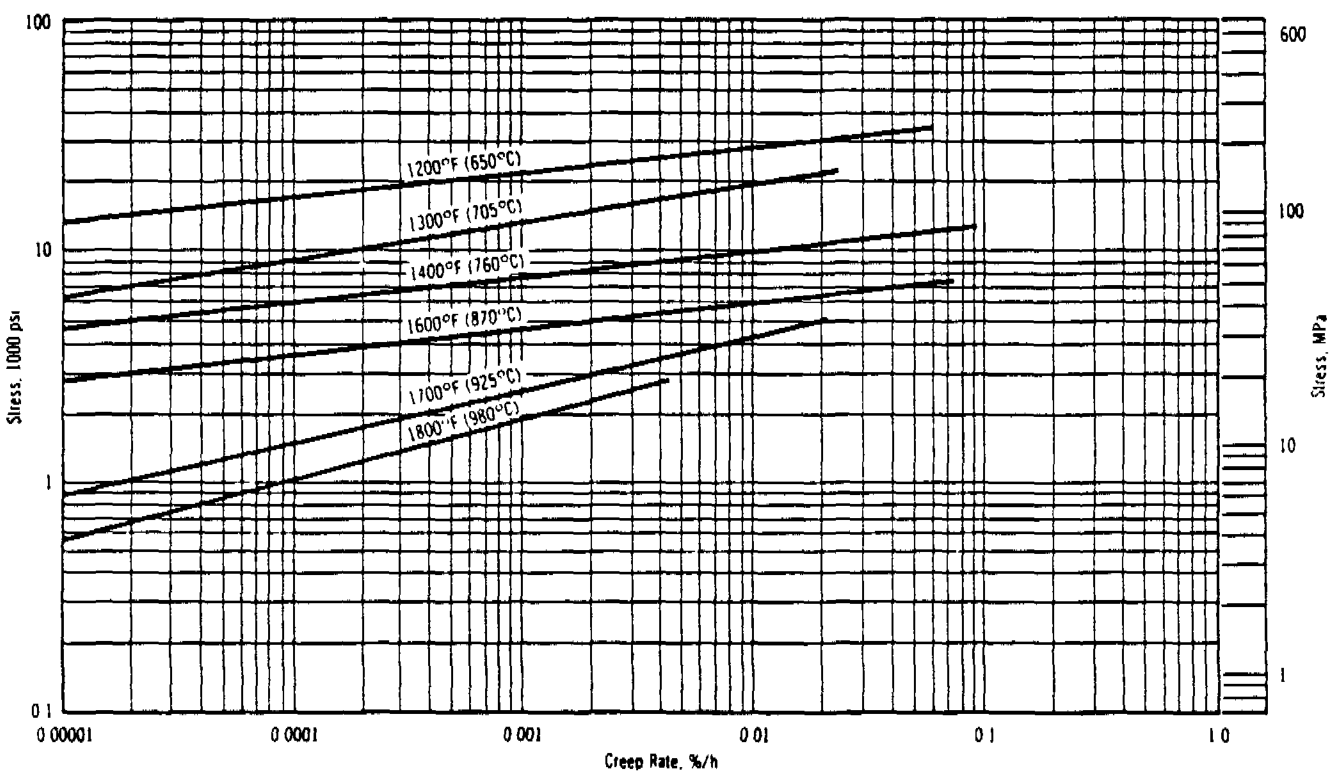

Figure 19. Typical creep strength of INCOLOY alloy 800H

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ponents shall be furnished in nominal thicknesses. Unless limited elsewhere in this Code, such components may be rated for the same allowable pressures as seamless pipe of the same nominal thickness, as determined in 304.1 for material having the same allowable stress.

Piping components such as pipe, for which allowable stresses have been developed in accordance with 302.3, but which do not have established pressure ratings may be rated by rules for pressure design in 304, modified as applicable by other provisions of this Code.

302.2.3 *Normal Operating Conditions*

Normal operating conditions are those in which the design pressure and design temperature apply. In selecting components the following limitations apply:

(a) The rated pressure of components at the design temperature shall be equal to or greater than the design pressure.

(b) For components without ratings the design pressure shall not produce a stress exceeding the allowable stress for the material at design temperature.

302.2.4 *Allowances for Variations from Normal Operating Conditions*

Variations in the temperature or pressure, or both, from normal operating conditions are characteristic of certain services. If the duration of these variations is greater than permitted by (a) and (b) below, as in cyclic operations, the most severe combination of pressure and temperature shall be regarded as normal operation. If these variations are infrequent and of short duration, however, the pressure-temperature ratings or the allowable stresses of the piping components may be exceeded as indicated in (a) and (b) below. Application of pressures exceeding pressure-temperature ratings of valves may under certain conditions cause a loss of seat tightness or difficulty of operation. Such application is the owner's responsibility. These allowances shall not be applied to: 1) materials whose allowable stresses have not been reduced as specified in Note 3 in 302.3.2(b), nor 2) cast iron or similar non-ductile materials.

(a) If the increased operating condition will not last more than 10 hours at any one time and will not total more than 100 hours per year, it is permissible to exceed the pressure rating or the allowable stress at the temperature existing in the increased operating condition by up to 33 percent.

(b) If the increased operating condition will not last more than 50 hours at any one time and will not total more than 500 hours per year, it is permissible to exceed the pressure rating or the allowable stress at the temperature existing in the increased operating condition by up to 20 percent.

302.2.5 *Ratings at Junction of Different Services*

When two services that operate at different pressure-temperature conditions are connected, the valve segregating the two services shall be rated for the more severe service condition. If the valve will operate at a reduced temperature due to its remoteness from a high temperature header or piece of equipment, this valve (and any mating flanges) may be rated at the reduced temperature provided it can withstand the hydrostatic tests required on each side of the valve. Piping on either side of the valve, however, shall be designed for the conditions of the service to which it is connected.

302.3 Allowable Stresses and Other Stress Limits for Metallic Components

302.3.1 *General*

Appendix A contains allowable stresses (SE) in tension for metals and design stresses (S) for bolting materials which shall be used in design calculations unless modified by other provisions of this Code. For materials not subject to a specified quality or joint factor (E), the allowable stresses in Appendix A are numerically equal to basic allowable stresses (S) determined in accordance with the bases stated in 302.3.2(b). For certain castings, a casting quality factor (E) has been applied as defined in 302.3.3. For components containing longitudinal or spiral welds, a joint factor (E) has been applied as defined in 302.3.4. For steels of structural grade, a quality factor (E) of 0.92 has been applied. For bolting materials, the design stresses in Appendix A were determined in accordance with the bases stated in 302.3.2(a).

The tabulated allowable and design stresses are grouped by material and product form, and are listed for stated temperatures up to the limit provided for the material in 323.2.1. Straight line interpolation between temperatures is permissible. The temperature intended is the design temperature.

(a) *Shear and Bearing:* Allowable stresses in shear shall be 0.80 times the basic allowable stress in tension derived from tabulated values in Appendix A in accordance with Note 16. Allowable stress in bearing shall be 1.60 times the basic allowable stress in tension.

(b) *Compression:* Allowable stresses in compression shall be no greater than the basic allowable stresses in tension as tabulated in Appendix A. Consideration shall be given to structural stability.

302.3.2 *Bases for Allowable Stresses*

The bases for establishing design stress values for bolting materials and allowable stress values for other materials in this Code are as follows:

(a) *Bolting Materials:* Design stress values at temperature for bolting materials shall not exceed the lowest of the following:

(1) 1/4 of the specified minimum tensile strength at room temperature. (If the bolting material is heat treated, see Note 1.)

(2) 1/4 of the "tensile strength at temperature." (See Note 2.)

(3) 5/8 of the specified minimum yield strength at room temperature. (If the bolting material is heat treated, see Note 1.)

(4) 5/8 of the "yield strength at temperature." (See Note 2.)

(5) 100 percent of the average stress for a creep rate of 0.01 percent per 1000 hours.

(6) 67 percent of the average stress for rupture at the end of 100,000 hours.

(7) 80 percent of minimum stress for rupture at the end of 100,000 hours.

(b) *Other Materials:* Basic allowable stress values at temperature for materials other than bolting materials shall not exceed the lowest of the following:

(1) 1/3 of the specified minimum tensile strength at room temperature.

(2) 1/3 of the "tensile strength at temperature." (See Note 2.)

(3) 2/3 of the specified minimum yield strength at room temperature.

(4) 2/3 of the "yield strength at temperature" (see Note 2), except that for austenitic stainless steels and for certain of the nickel alloys, this factor may be as large as 90 percent (see Note 3) of the "yield strength at Temperature" (but never more than 2/3 of the specified minimum yield strength at room temperature).

(5) 100 percent of the average stress for a creep rate of 0.01 percent per 1000 hours.

(6) 67 percent of the average stress for rupture at the end of 100,000 hours.

(7) 80 percent of the minimum stress for rupture at the end of 100,000 hours.

Note 1: For heat treated bolting materials the design stress shall be further limited to the lower of 1/5 of the specified minimum tensile strength at room temperature or 1/4 of the specified minimum yield strength at room temperature.

Note 2: For an unlisted material, the "tensile (or yield) strength at temperature" shall be derived by multiplying the average expected tensile (or yield) strength at temperature by the ratio of the specified minimum tensile (or yield) strength at room temperature to the average (expected) tensile (or yield) strength at room temperature.

Note 3: The use of these stress values (approaching 90 percent of yield strength at temperature) is not recommended for flanges or gasketed joints or other applications where slight amounts of deformation can cause leakage or malfunction. Where possiblity of such deformation is present, an allowable stress value of either 75 percent of the allowable stress listed in Appendix A or 2/3 of yield strength value as published in ASME Section VIII, Division 2 should be used.

302.3.3 *Casting Quality Factor (E)*

(a) *General:* The casting quality factors (E) defined herein shall be used for cast components not having pressure-temperature ratings established by standards listed in Appendix E, Table 1. Allowable stresses (SE) for cast materials listed in Appendix A contain appropriate factors, as noted.

(b) *Basic Quality Factors:* Static castings which conform to basic requirements of the material specification and have received a visual examination in accordance with MSS SP-55 shall be assigned a basic casting quality factor (E) of 0.80. Centrifugal castings which conform to specification requirements only to the extent of chemical analysis, tensile, hydrostatic and flattening tests and visual examination shall be assigned a basic casting quality factor of 0.80.

(c) *Increased Quality Factors:* Casting quality factors may be increased when supplementary examinations are performed on each casting. Table 302.3.3C states the increased casting quality factors (E) which may be used for various combinations of supplemenatry examination. Quality factors higher than those shown in Table 302.3.3C do not result from combining tests 2a and 2b, or 3a and 3b. In no case shall the quality factor exceed 1.00.

Several of the specifications listed in Appendix A require machining of all surfaces and/or one or more of these supplementary examinations. In such cases, the appropriate increased quality factor is shown in the stress table and has been incorporated in the tabulated allowable stress for such materials.

Table 302.3.3C
Increased Casting Quality Factors (E)

Supplementary Examination in Accordance with Note(s)	Factor, E
1	0.85
2a or 2b	0.85
3a or 3b	0.95
1 and 2(a or b)	0.90
1 and 3(a or b)	1.00
2(a or b) and 3(a or b)	1.00

PROCESS NO.	EQUIPMENT NAME	MATERIAL CONST	CAPACITY GALS.	DIAMETER	HEIGHT	PRESSURE OPERATING	PRESSURE DESIGN	TEMP	COMMENTS
T-110	PB-CHLORIDE STORAGE	C.S.	3000	8	10	.5-1	1.5	150	USE TETRA CL_2 SURGE TK 60-1126
T-120	FRESH EDA STORAGE	C.S.	8000	10.5	13.5	.5-1	1.5	AMB	
T-210	SOLVENT STORAGE	C.S.	30,000	16	20	.5-1		AMB	
T-220	BUTANOL STORAGE	C.S.	3,000	8	10	.5-1		AMB	
T-230	CAUSTIC STORAGE	C.S.	3,000	8	10	.5-1		AMB	
T-240	STRONG CAUSTIC	C.S.	1,000	5	7				USE EXISTING STG TK. 60-855
T-250	WASTE STORAGE								
T-310	CRUDE PB-EDA STORAGE	C.S.	15,000	13	16	.5-1			
T-320	PB-EDA PRODUCT STORAGE	C.S.	165,000	30	33	.5-1			
D-310	#1 DAY TANK STORAGE	C.S	5500	9.5	12				
D-320	#2 DAY TANK STORAGE	C.S.	5500	9.5	12				
T-330	VACUUM SYSTEM SOLVENT STG	C.S.							

PUMP EQUIPMENT LIST

PROCESS NO.	EQUIPMENT NAME	MATERIAL	GPM NOR	GPM DES	ΔP PSI		DENSITY #/GAL @ FLOW	KINEMATIC VISCOSITY - C.S.	BHP	
P-110	PB-CHLORIDE FEED	C.S.	2.3	5	90	193#	6.94	190	1.0	
P-120	FRESH EDA FEED	C.S.	.2	1	20	52#	7.35	.85	.09	
P-130	EDA FLASH RECEIVER	C.S.	.6	1	100	260#	7.35	.85	.80	
P-140	PB-EDA WASH FEED	HASTELLOY	2.8	5	45	133#	6.47	100	1.0	
P-150	EDA FLASH VACUUM	C.S.							5	W.A.G
P-210	SOLVENT FEED	C.S.	1.5	5	35	93#	7.2	.9	.45	
P-220	BUTANOL FEED	C.S.	1.2gph	1	35	100#	6.7	20	.15	
P-230	CAUSTIC FEED	C.S.	.1	1	35	53	12.65	60	.2	
P-240	EDA-WATER	HASTELLOY	1.4	5	30	79	7.27	.85	.4	
P-250	EDA RECOVERY	C.S.	.13	1	20	52#	7.38	.85	.1	
P-260	WASTE WATER	C.S.	1gph	1	10	26#	7.38	.85	.07	
P-270	EDA-CAUSTIC CIRCULATION	NICKEL	12.5	15	40	72#	13.32		1.5	
P-280	STRONG CAUSTIC ADDITION	NICKEL	.23	1	20	28#	13.5		.09	
P-290	EDA RECOVERY VACUUM	C.S.								

CONFIDENTIAL:
Subject to Protective Order
of 14th Judicial District Court
No. 91-1145

PROCESS NO.	EQUIPMENT NAME	MATERIAL CONST.	HEAT DUTY MBTU/H	AREA ft²	PRESSURE SHELL OP/DES.	PRESSURE TUBE OP/DES	TEMP SHELL OP/DES	TEMP TUBE OP/DES	STEAM REQUIRED #/HR	COMMENTS
E-110	PB-CHLORIDE PREHEATER	C.S.	150	125	12[illegible]150	[illegible]/75	350/400	300/350	173	
E-120	EDA-FLASHER PREHEATER	HASTELLOY ON PROCESS	60	127	175/225	.8/FV	375/400	350/400	70	
E-130	EDA-FLASHER CONDENSER	C.S.	63	90	50/75	.8/FV	36/36	325/350	–	6GPM CTW OR 19GPM BRINE
E-210	WASH WATER ECONOMIZER	C.S.	49	134	14.7/50	50/75	260/300	250/300	-	
E-220	EDA-WATER PREHEATER	C.S.	49	33	150/175	50/75	365/400	250/300	58	
E-230	WASH WATER HEATER	Ni ON PROCESS	492	468	175/225	50/75	365/400	250/300	580	
E-240	EDA RECOVERY CONDENSER	C.S.	99	72	50/75	1/50	100/150	220/275	–	10 GPM CTW
E-310	PRODUCT STRIPPER FEED ECONOMIZER	C.S.	136	489	50/150	50/150	280/325	280/325		
E-320	PRODUCT STRIPPER REBOILER	C.S.	300	1536	125[illegible]75	[illegible]/150	350/400	306/350	346	
E-330	PRODUCT STRIPPER CONDENSER	C.S.	138	350	50/75	.5/FV	110/150	219/300		14GPM CTW
E-340	PRODUCT COOLER	C.S.	120	125	50/75	50/75	110/150	170/200		12 GPM CTW

PROCESS NO.	EQUIPMENT NAME	MATERIAL CONST	DIAMETER	HEIGHT	PRESSURE OPERATING	PRESSURE DESIGN	TEMP OPERATING	TEMP DESIGN	COMMENTS
V-100	CCl_4 FLASH DRUM	C.S.	1	5					
V-110	EDA REACTOR #1	GLASS LINED	5	6.25	33	150	300	375	JACKETED 76 #/HR STEAM USAGE
V-120	EDA REACTOR #2	GLASS LINED	5	6.25	33	150	300	375	
V-130	EDA FLASH RECEIVER	C.S	3'	8	.5	50/FV			
V-210	PHASE SEPARATOR	C.S.	4	30	50	75	170	250	
V-220	EDA RECOVERY ACCUMULATOR	C.S.	2	5	1	50	250	300	
V-230	WASH WATER EVAPORATOR	Ni	2	7	3 psia	50/FV	250	300	
V-240	SALT CONCENTRATOR	Ni							
V-310	PRODUCT STRIPPER ACCUMLATOR	C.S.	3 1.5	6.5 3	2 psia	50/FV	218	250	
C-110	EDA VACUUM FLASH	HASTELLOY	2	9	.8 psia	50/FV	350	400	
C-210	EDA RECOVERY COLUMN	Ni	5.5 2	6 POT 20 COL	[illegible]	5[illegible]	250	300	
C-310	PRODUCT STRIPPER	C.S.	2	46	2 psia	50/FV	300	350	18 TRAYS, 24"

PUMP
EQUIPMENT LIST

PROCESS NO.	EQUIPMENT NAME	MATERIAL	GPM NOR.	GPM DES	ΔP		DENSITY	KINEMATIC VISCOSITY	B.H.P.
P-310	PRODUCT STRIPPER FEED	C.S.	4.2	5	50	125 ft	7.2	30	1.0
P-320	PRODUCT STRIPPER BOTTOM	C.S.	232	250	30	100 ft	6.61	8	15
P-330	AQUEOUS PHASE	C.S.	2	2	20	46	8.3	1	.11
P-340	SOLVENT RECYCLE	C.S.	.83	1	35	96	6.94	1	.15
P-350	PRODUCT STRIPPER VACUUM	C.S.							
P-360	PRODUCT DAY TANK	C.S	100	100	30	80	7.2	45	5
P-370	PRODUCT LOADING	C.S.	166	200	40	53	7.2	45	15
P-380	VACUUM SEAL	C.S.	5	5	50		7.2	.7	.5

ADDITIONAL MOTORS

PROCESS NO	NAME	HP	
M-1	EDA REACTOR MIXER V-110	10	ESTIMATE !
M-2	EDA REACTOR MIXER V-120	10	
M-3	V-210 DRIVE	25	