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ANO. 8209080463

NO. OF PAGES 2

REASON

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☒ FILMED ON APERTURE CARD NO 8209080463-01 thru 8209080463-02

210.120 We have reviewed Specification No. CNS-1206.02-01-0001, 12/10/79, Revision 2, "Design Specification, ASME III, Class 2 and 3 Piping," Revision 4. Provide a data file for a Class 2 or 3 piping system which uses CNS-1206.02-01-0001 as the design specification. The piping line should have a run pipe of 12" diameter or larger and contain at least one branch connection.

Response:

A problem file for code 2/3 RNE, Revision 1 has been provided. This problem contains piping in the Nuclear Service Water System.

210.121 The staff has reviewed the Class 1 stress report on RCL drain lines (EDS Report No. 01-0093-1159).

Table 1.0-3 indicates a usage factor of 0.032 for "Joint Name" 142. Page E62, first line, shows "Cumul Usage" of 0.032, along with "Maximum S_{alt}" of 210,000 psi. From the Code Figure 1-9-2, the number of allowable design cycles for S_a = 210,000 is about 130. The usage factor of 0.032 implies that the number of anticipated cycles associated with S_a = 210,000 is about 0.032X130=4 cycles. Provide the basis for assuming only 4 cycles for the fatigue analysis.

Please furnish a detailed description of how the usage factor of 0.032 was determined. The description should include, for each of the transients in Table 4.6-1:

(a) The pressure range

(b) Moment ranges due to thermal expansion and OBE (separately)

(c) Fluid temperature changes as a function of time

(d) Ranges of T_1, T_2, and $(T_a - T_b)$

(e) Stress indices used in the evaluation. If not given in the Code, indicate their source.

<u>Response</u>:

See attached response.

Calculation of the fatigue usage factor for AWBW component at DCP 142: [redacted]

a) The input section of the superpipe program;

1. All load cases analysis including the transient loads were run prior to code compliance. They were combined to get proper gravity, thermal and seismic loads for steady state conditions or transient conditions as specified on page E44 of E67.

2. On page E45 of E67, the pressure distributions for all Class 1 pipe run were specified for pressure stress calculations.

3. The temperature distributions were input to find the allowable stresses for piping. See page E46 of E67.

4. The earthquake (OBE) cases were specified with the number of events and cycles per event on page E48 of E67.

5. The steady state load conditions of the transients in Table 4.6-1 were specified with following information shown on page E49 of E67.

   a. Associated transient state
   b. Number of occurence
   c. Pressure distribution for calculation of pressure stress
   d. Temperature distribution for allowable stresses
   e. Thermal load cases made up the steady state conditions
   f. Load-state identifier to show each steady-state load with or without OBE load or thermal transient. The associated OBE load and thermal transients are defined in next two columns.

b) The output of the program;

1. The detailed fatigue damage calculation was provided. It shows the load pairs which have fatigue damage on the system. It also has the values for allowables (S_m), the stress ratio of S_n, the stress ration for EQ.12 and EQ.13 when $S_n > 3S_m$, peak stress, K_e, alternate stress, number of cycles for each load pair and associated allowable cycles, usage factor of each load pair and the cumulative usage factor. See page 77.

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2. The summary of fatigue usage and break location only shows the highest values in each equation (EQ.10, 11, ... etc.). See page E62 of E67.

A hand calculation to check computer code compliance was done in the problem file and was provided here for information.

c) The requested items can be found as follows:

a. Pressure range from page E45 of E67. Example is at mid section of 2nd page of hand calculation.

b. Values of moments of each load cases are on the 1st page of hand calculation.

c. Fluid temperature - time history can be found from attached transient analyses. The envelope of thermal transients was also provided on pages D5, D6 and D7 of D8.

d. ΔT_1, ΔT_2 and $T_a - T_b$ terms are on page D8 of D8.

e. Stress indices are given in the 1974 ASME Code. Values used are on 1st page of hand calculation.

d) Brief summary for the calculation;

The usage factor of 0.032 was calculated as shown on page 77. The computer calculation was verified by hand calculation for the worst load pair, N-1A-0-1 and U-03-1-1. Following is how every load pair gets the number of anticipated cycles. The worst load pair has OBE in each state and the OBE events were evenly used, that is, two cycles for 1st load pair. N-1A has 253 cycles left, U-03 has 78 cycles left and OBE has 1 event left. The 2nd load pair has OBE in U-3 only and OBE only has 1 event left, so 2nd pair load has one anticipated cycle. The third one was conservatively counted for OBE alone. Total number of cycles is the number of events times cycles per event. The Fourth load pair is N-1A and U-03 with transient. At this moment, N-1A has 252 left, OBE has zero event and U-03 has 77 cycles left, so the fourth one has 77 cycles. The fifth one was determined by U-7B's cycles, 20. Since the allowable cycles exceeds one million cycles, the computation stopped here.

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DUKE POWER COMPANY-CATAWBA STATION 1
EDS PROBLEM 0093-101-NC13 CODE COMPLIANCE REV. 0
2 IN RCL DRAIN-LINE FROM XOVER LEG 1D TO OVERLAPPED PIPING OF NC12, NC10
THERMAL TRANSIENT AND CODE COMPLIANCE ANALYSES

LOAD CASE SPECIFICATION

CASE NAME	LOAD TYPE	COMB TYPE	RESULTS SET	SCALE FACTOR	DATE IDENT.	TIME IDENT.	TITLE
GRAV	GRAV		GRV1	1.000	80/05/16.	10.43.18.	GRAVITY ANALYSIS
OBE1	EQIN	ASUM	OBEA ✓	1.000	80/05/15.	18.34.14.	SEISMIC ANALYSIS (INERTIA)
			RPV1 ✓	1.000	80/05/19.	17.06.55.	SAM-RPV (PRIMARY)
OBE2	EQIN	ASUM	OBE1	1.000	EARLIER LOAD CASE		
			RCL1 ✓	1.000	80/05/19.	17.06.55.	SAM-RCL (SECONDARY)
			RB-1 ✓	1.000	80/05/19.	17.06.55.	REACTOR BUILDING SAM (SECONDARY)
SSE1	EQIN	ASUM	OBE1	1.875	EARLIER LOAD CASE		
			LOCA	1.000	80/05/19.	17.06.55.	LOCA
THR1	EXPN	DSUM	T557 ✓	1.000	80/09/23.	10.35.55.	SEGMENT 60@ 557F THE REST @ 70F
			THM3 ✓	1.000	80/05/16.	10.43.18.	FULL POWER THERMAL ANCHOR MOTION
THR2	EXPN	DSUM	T456 ✓	1.000	80/09/23.	10.35.55.	SEGMENT 60 @ 456F THE REST @ 70F
			THM3 ✓	1.000	80/05/16.	10.43.18.	FULL POWER THERMAL ANCHOR MOTION
THR3	EXPN		THM1 ✓	.000	80/05/16.	10.43.18.	NORMAL FULL POWER
U-03	TRNS		U-03 ✓	1.000	80/09/24.	16.38.38.	LOSS OF FLOW IN ONE LOOP.

TABLE E- 3

DUKE POWER COMPANY-CATAWBA STATION 1
EDS PROBLEM 0093-101-NC13 CODE COMPLIANCE REV. 0
2 IN RCL DRAIN-LINE FROM XOVER LEG 1D TO OVERLAPPED PIPING OF NC12, NC10
THERMAL TRANSIENT AND CODE COMPLIANCE ANALYSES

PRESSURE DISTRIBUTIONS FOR PRESSURE STRESSES

DISTRIBUTION NAME	RUN NAME	FIRST DCP	LAST DCP	PRESSURE (PSI)	DISTRIBUTION TITLE
PRED					DESIGN PRESSURE
	ALL RUNS			2485.000	
PRE1					0/0
	ALL RUNS			.000	
PRE2					2235/0
	RUN1	140	151	2235.000	— USED IN U-3
	RUN1	151	157	.000	
	RUN3	COMPLETE	RUN	.000	
PRE3					560/0
	RUN1	140	151	560.000	
	RUN1	151	157	.000	
	RUN3	COMPLETE	RUN	.000	
PRE4					3107/0
	RUN1	140	157	3107.000	
	RUN1	151	157	.000	
	RUN3	COMPLETE	RUN	.000	

TABLE E- 3 CONT'D

TEMPERATURE DISTRIBUTIONS FOR ALLOWABLE STRESSES

DISTRIBUTION NAME	RUN NAME	FIRST DCP	LAST DCP	TEMPERATURE (F)	DISTRIBUTION TITLE
TEMD					DESIGN TEMPERATURE
	ALL RUNS			650.000	
TEM1					70/70
	ALL RUNS			70.000	
TEM2					557/70
	RUN1	140	151	557.000	
	RUN1	151	157	70.000	
	RUN3	COMPLETE RUN		70.000	
TEM3					456/70
	RUN1	140	151	456.000	
	RUN1	151	157	70.000	
	RUN3	COMPLETE RUN		70.000	

TABLE E-3 CONT'D

CONTROL INFORMATION FOR NORMAL CONDITION LOAD STATES

NO. OF EARTHQUAKE CASES = 1

FATIGUE DAMAGE FOR BREAK LOCATION FLAG = .100
SN/SM RATIO FOR BREAK LOCATION FLAG = 2.400

NO. OF HIGHEST SALT VALUES = 0

STRESS FACTOR FOR EQNS 10,12,13 = 3.000

EARTHQUAKE CASES

CASE NAME	NO. OF EVENTS	CYCLES PER EVENT
OBE2	5	40

WARNING NO. 322 ITEM 1 = OBE2 ITEM 2 = EQIN

SEISMIC OBE

TABLE E-3 CONT'D

DUKE POWER COMPANY-CATAWBA STATION 1
EDS PROBLEM 0093-101-NC13 CODE COMPLIANCE REV. 0
2 IN RCL DRAIN-LINE FROM XOVER-LEG 1D TO OVERLAPPED PIPING OF NC12, NC10
THERMAL TRANSIENT AND CODE COMPLIANCE ANALYSES

LOAD-STATES FOR NORMAL CONDITIONS

STEADY STATE	TRANS STATE	NO. OF OCCUR.	EQKE SUPPRESS 1 2 3	PRES DIST	TEMP DIST	STST TRNS	STEADY-STATE LOAD CASES	LOAD-STATE IDENTIFIER	EQKE CASE	THRM TRNS	DYNU CASE	TRANSIENT CASES	TITLE
N-1A		255		PRE1	TEM1		THR3	N-1A- 0-0					
				PRE1	TEM1		THR3 ✓	N-1A- 0-1	OBE2				
N-06		999999		PRE2	TEM2		THR1	N-06- 0-0					
				PRE2	TEM2		THR1	N-06- 0-1	OBE2				
U-03		80		PRE2	TEM2		THR1	U-03- 0-0					
				PRE2	TEM2		THR1	U-03- 0-1	OBE2				
	1	80		PRE	TEM2		THR1	U-03- 1-0		U-03			
				PRE	TEM2		THR1 ✓	U-03- 1-1	OBE2	U-03			
U-7B		20		PRE3	TEM3		THR2	U-7B- 0-0					
				PRE3	TEM3		THR2	U-7B- 0-1	OBE2				
T-2B		55		PRE4	TEM1		THR3	T-2B- 0-0					
				PRE4	TEM1		THR3	T-2B- 0-1	OBE2				

VALUES PROVIDED ON PG. E45

VALUES PROVIDED ON PG. E46.

DEFINITION ON PG. E44

DUKE POWER COMPANY-CATAWBA STATION 1
EDS PROBLEM 0093-101-NC13 CODE COMPLIANCE REV. 0
2 IN RCL DRAIN-LINE FROM XOVER LEG 1D TO OVERLAPPED PIPING OF NC12, NC10
THERMAL TRANSIENT AND CODE COMPLIANCE ANALYSES

FATIGUE DAMAGE COMPUTATION, SOP NO. 3W

RUN NAME	DCP NAME	COMP NAME	COMP TYPE	SECTION NAME	MATERIAL NAME
RUN1	142		AWBW	AWBW	SA376 TP304

(MATERIAL DEFAULTS TO ADJACENT COMPONENTS)

DETAILED CALC. FOR NO. OF CYCLES & USAGE FACTOR.

STATE A	STATE B	SM (PSI)	SN/(1)SM (EQ10)	SE/(1)SM (EQ12)	S/(1)SM (EQ13)	SP (PSI)	KE	S-ALT (PSI)	NO. OF CYCLES	CYCLES ALLOWED	USAGE FACTOR	CUMUL USAGE
N-1A- 0-1	U-03- 1-1	16830.00	4.306**	.780	.839	171617.72	2.45	210292.96	2	148	.014	.014
N-1A- 0-0	U-03- 1-1	16830.00	2.969**			115365.43	1.00	57682.72	1	10162	.000	.014
OBE2		16830.00	2.690**			113199.86	1.00	56599.93	200	10995	.018	.032
N-1A- 0-0	U-03- 1-0	16830.00	1.661			60330.38	1.00	30165.19	77	309356	.000	.032
U-7B- 0-0	T-28- 0-0	17972.00	1.302			50547.09	1.00	25273.54	20	1000000	0.000	.032

THIS WAS CHECKED BY HAND CALCS.

FATIGUE DAMAGE COMPUTATION, SOP NO. 3R

RUN NAME	DCP NAME	COMP NAME	COMP TYPE	SECTION NAME	MATERIAL NAME
RUN1	142	97	STRP	2S160IN	SA376 TP304

STATE A	STATE B	SM (PSI)	SN/(1)SM (EQ10)	SE/(1)SM (EQ12)	S/(1)SM (EQ13)	SP (PSI)	KE	S-ALT (PSI)	NO. OF CYCLES	CYCLES ALLOWED	USAGE FACTOR	CUMUL USAGE
N-1A- 0-1	U-03- 1-1	16830.00	3.281**	.557	.698	59786.45	1.31	39225.24	2	61454	.000	.000
N-1A- 0-0	U-03- 1-1	16830.00	2.326			43714.37	1.00	21857.19	1	1000000	0.000	.000

FATIGUE DAMAGE COMPUTATION, SOP NO. 4L

RUN NAME	DCP NAME	COMP NAME	COMP TYPE	SECTION NAME	MATERIAL NAME
RUN1	143	97	STRP	2S160IN	SA376 TP304

STATE A	STATE B	SM (PSI)	SN/(1)SM (EQ10)	SE/(1)SM (EQ12)	S/(1)SM (EQ13)	SP (PSI)	KE	S-ALT (PSI)	NO. OF CYCLES	CYCLES	USAGE	CUMUL

FATIGUE USAGE AND BREAK LOCATION SUMMARY

RUN NAME = RUN1

SOP NO.	DCP NAME	COMP NAME	COMP TYPE	SECTION NAME	MATERIAL NAME	MAX E10 SN/(1)SM	BREAK LOC.	MAX E12 SE/(1)SM	MAX E13 S/(1)SM	MAXIMUM SP (PSI)	MAXIMUM SALT (PSI)	CUMUL USAGE	BREAK LOC.
3W	142		AWBW	AWBW	SA376 TP304	4.306	***	.780	.852	171617.72	210292.96	.032	SUMMARY
3R	142	97	STRP	2S160IN	SA376 TP304	3.281	***	.557	.698	59786.45	39225.24	.000	
4L	143	97	STRP	2S160IN	SA376 TP304	3.072	***	.552	.680	56277.28	30403.90	.000	
4R	143	C35	CRVP	2S160IN	SA376 TP304	4.388	***	.828	.855	84641.42	107595.85	.002	
5L	144	C35	CRVP	2S160IN	SA376 TP304	2.635	***			55130.78	27565.39	.000	
5R	144	98	STRP	2S160IN	SA376 TP304	1.916				36817.10	18409.05	0.000	
6L	144A	98	STRP	2S160IN	SA376 TP304	1.658				32464.28	16232.14	0.000	
6W	144A		AWBW	AWBW	SA376 TP304	1.658				65112.99	32556.49	.000	
6R	144A	98A	STRP	2S160IN	SA376 TP304	1.283				25146.64	12573.32	0.000	
7L	145	98A	STRP	2S160IN	SA376 TP304	2.170				41202.39	20601.20	0.000	
7R	145	C36	CRVP	2S160IN	SA376 TP304	3.051	***	.217	.727	61769.45	30884.72	.000	
8L	146	C36	CRVP	2S160IN	SA376 TP304	1.811				42153.37	21076.68	0.000	
8R	146	99	STRP	2S160IN	SA376 TP304	1.344				28125.00	14062.50	0.000	
9L	146A	99	STRP	2S160IN	SA376 TP304	.977				21786.49	10893.25	0.000	
10L	146B	99	STRP	2S160IN	SA376 TP304	.863				19687.30	9843.65	0.000	
10W	146B		AWBW	AWBW	SA376 TP304	1.062				40970.31	20485.15	0.000	
11L	146C	99A	STRP	2S160IN	SA376 TP304	.761				17739.80	8869.90	0.000	
12L	147	99A	STRP	2S160IN	SA376 TP304	.879				20118.08	10059.04	0.000	
12R	147	C37	CRVP	2S160IN	SA376 TP304	1.101				30142.99	15071.49	0.000	
13L	147A	C37	CRVP	2S160IN	SA376 TP304	2.405	***			50824.26	25412.13	0.000	
13R	147A	100A	STRP	2S160IN	SA376 TP304	1.739				33905.60	16952.80	0.000	
14L	147B	100A	STRP	2S160IN	SA376 TP304	1.128				22661.50	11330.75	0.000	
14W	147B		AWBW	AWBW	SA376 TP304	1.433				56415.00	28207.50	.000	
15L	147C	1001	STRP	2S160IN	SA376 TP304	.832				17328.90	8664.45	0.000	
16L	148	1001	STRP	2S160IN	SA376 TP304	1.016				20636.65	10318.32	0.000	
16R	148	C38A	CRVP	2S160IN	SA376 TP304	1.306				30926.99	15463.49	0.000	
17L	148A	C38A	CRVP	2S160IN	SA376 TP304	2.051				43927.26	21963.63	0.000	
17R	148A	100	STRP	2S160IN	SA376 TP304	1.503				29303.50	14651.75	0.000	
18L	148B	100	STRP	2S160IN	SA376 TP304	1.221				24331.13	12165.56	0.000	
18W	148B		AWBW	AWBW	SA376 TP304	1.563				62258.68	31129.34	.000	
19L	148C	1002	STRP	2S160IN	SA376 TP304	.923				18971.87	9485.94	0.000	
19W	148C		AWBW	AWBW	SA376 TP304	1.145				43501.30	21750.65	0.000	
20L	149	1002	STRP	2S160IN	SA376 TP304	1.107				22281.94	11140.97	0.000	
20R	149	C38B	CRVP	2S160IN	SA376 TP304	1.443				33394.93	16697.47	0.000	
21L	149A	C38B	CRVP	2S160IN	SA376 TP304	1.090				27036.23	13518.11	0.000	
21R	149A	100B	STRP	2S160IN	SA376 TP304	.871				18042.81	9021.40	0.000	
22L	149B	100B	STRP	2S160IN	SA376 TP304	.992				20218.04	10109.02	0.000	
23L	149C	100B	STRP	2S160IN	SA376 TP304	.897				18508.40	9254.20	0.000	
23W	149C		AWBW	AWBW	SA376 TP304	1.111				41879.13	20939.56	0.000	
24L	150	1003	STRP	2S160IN	SA376 TP304	.882				19534.64	9767.32	0.000	
24R	150	C39	CRVP	2S160IN	SA376 TP304	1.119				29267.82	14633.91	0.000	

TABLE E- 3 CONT'D

HAND CALCULATION TO
CHECK COMPUTER CODE COMPLIANCE:

* DATA POINT (142) : AWBW AT NOZZLE. 2" SCH 160.

OD	T_S	B_1	C_1	K_1	F_{1A}	B_2	C_2	K_2	K_3	C_3	C_3'
2.375	0.343	.50	1.10	1.20	1.40	1.0	1.40	2.50	1.7	1.0	.50

- LOAD CASE MOMENTS

		MX (FT.LB)	MY (FT-LB)	MZ (FT-LB)
	GRAVITY	-42.56	-4.03	89.11
	SEISMIC	54.39	31.66	52.37
	SAM RPV	108.49	-144.14	37.63
	SAM RCL	586.79	-798.77	214.18
	SAM RB	27.06	-43.26	12.94
	LOCA	390.30	-525.74	139.02
(Thermal)	THM3 $E_C/E_H = 1.127$	-727.17	361.09	59.48
"	T537 $E_C/E_H = 1.101$	165.28	13.30	-34.16
"	TA56 $E_C/E_H = 1.075$	131.64	11.02	-27.31

- DESIGN PRESSURE = 2485 PSIG = P_o — $I = 1.163 \text{ in}^4$
- DESIGN TEMPERATURE = 650°F.
- CHECKING FOR DESIGN & FAULTED CONDITIONS EQ. 9 & 9F.

$$\text{EQ. 9} : S = B_1 \frac{P_o D_o}{2t} + B_2 \frac{D_o M_i}{2I} \quad \} M_i = \text{GRAV} + \text{SEIS} + \text{SAM}_{RPV}$$

$$M_i = (205.44^2 + 179.83^2 + 179.11^2)^{1/2} = 326.53 \text{ ft-lbs}$$

$$S = .5 \times \frac{2485 \times 2.375}{2 \times 0.343} + 1.0 \times \frac{2.375 \times 326.53 \times 12}{2 \times 1.163}$$

$$= 4301.66 + 4000.90 = 8302.56 \text{ Psi}$$

COMPUTER SHOWED: 8304.98 Psi OK

REV	BY	DATE	CHECKED	DATE			
0	T Mikkelsen	10/10/80	[illegible]	10/17/80	eds nuclear	DUKE/CATAWBA #1	
						JOB NO 0093-101	PAGE 1 OF 3
						CALC NO NC-13	

EQ. 9F : $S = B_1 \frac{P_o D_o}{2t} + B_2 \frac{D_o M_i}{2I}$ { M_i = GRAV + SSE (SEISMIC + SAM GRAV) + LOCA

$M_i = (738.26^2 + 859.40^2 + 396.88^2)^{1/2} = 1200.46$ ft-lbs

$S = .5 \times \frac{2485 \times 2.375}{2 \times 0.343} + 1.0 \times \frac{2.375 \times 1200.46 \times 12}{2 \times 1.163}$

$= 4301.66 + 14708.97 = 19010.63$ Psi

COMPUTER SHOWED 19019.27 Psi OK ◄

– CHECKING FOR NORMAL & UPSET CONDITIONS :

EQ. 10 : $S_n = C_1 \frac{P_o D_o}{2t} + C_2 \frac{M_i D_o}{2I} + \frac{1}{2(1-\nu)} E \alpha \Delta T_1 + C_3 E \alpha |T_a - T_b|$

. CHECK RANGE OF STEADY STATES N-1A-01 AND U-03-1-1

– PRESSURE RANGE : 2235 Psi.

– THERMAL RANGE : (TES7 + THM3) — ZERO.

– ΔT_1 RANGE : 21.87 + 12.35 = 34.22 °F.

– $M_i = (2191.01^2 + 2457.25^2 + 663.66^2)^{1/2} = 3358.43$ ft-lbs

$S_n = 1.1 \times \frac{2235 \times 2.375}{2 \times 0.343} + 1.4 \times \frac{3358.43 \times 12 \times 2.375}{2 \times 1.163} + \frac{1}{1.4} \times 257.81 \times 34.22$

$= 8511.57 + 57610.21 + 6301.61 = 72423.39$

COMPUTER SHOWED : 4.306 × 16830 = 72469.98 OK ◄

EQ. 12 : $S_e = C_2 M_i \frac{D_o}{2I}$ { M_i = THERMAL RANGE.

$M_i = (637.55^2 + 421.59^2 + 29.42^2)^{1/2} = 764.90$ ft-lbs.

$S_e = 1.4 \times \frac{764.9 \times 12 \times 2.375}{2 \times 1.163} = 13121.05$ Psi

COMPUTER SHOWED 13127.40 Psi OK ◄

REV	BY	DATE	CHECKED	DATE			
0	TMIYALIAN	10/10/80	M.E.S./A.P.	10/17/80	eds nuclear	DUKE / CATAWBA #1; JOB NO 0393-101; CALC NO NC-13	PAGE 6 OF 3

$$EQ. 13: S = C_1\frac{P_0 D_0}{2t} + C_2\frac{M_i D_0}{2I} + C_3' E\alpha |T_a - T_b|_{max}$$

M_i = EQ 9 m_i = 326.53 ft-lbs.

$$S = 1.1 \times \frac{2835 \times 2.375}{2 \times 0.343} + 1.4 \times \frac{326.53 \times 12 \times 2.375}{2 \times 1.163}$$

$$= 8511.57 + 5601.27 = 14112.84\ Psi.$$

COMPUTER SHOWED : 14120.37 Psi OK

$$EQ. 11 \quad S_p = K_1 C_1 \frac{P_0 D_0}{2t} + K_2 C_2 \frac{M_i D_0}{2t} + \frac{K_3}{2(1-\nu)} E\alpha \Delta T_1 + \frac{1}{1-\nu} E\alpha \Delta T_2$$

M_i = M_i EQ 10 = 3358.43 ft-lbs / ΔT_2 = 6.73°F

$$S_p = 1.1 \times 1.68 \times \frac{2835 \times 2.375}{2 \times 0.343} + 1.4 \times 2.5 \times \frac{3358.43 \times 12 \times 2.375}{2 \times 1.1623}$$

$$+ 1.7 \times \frac{257.81}{1.4} \times 34.22 + \frac{1}{0.7} \times 257.81 \times 6.73$$

$$= 14299.44 + 144112.27 + 10712.74 + 2478.66$$

$$= 171603.11\ Psi$$

COMPUTER SHOWED 171617.72 Psi OK

$$EQ\ 14: S_{ALT} = K_e \frac{S_p}{2}$$

$$K_e = 1 + \frac{1-n}{n(m-1)}\left(\frac{S_n}{3S_m} - 1\right)$$

$$= 1 + \frac{1}{.3}\left(\frac{72423.39}{3 \times 16830} - 1\right) = 2.448$$

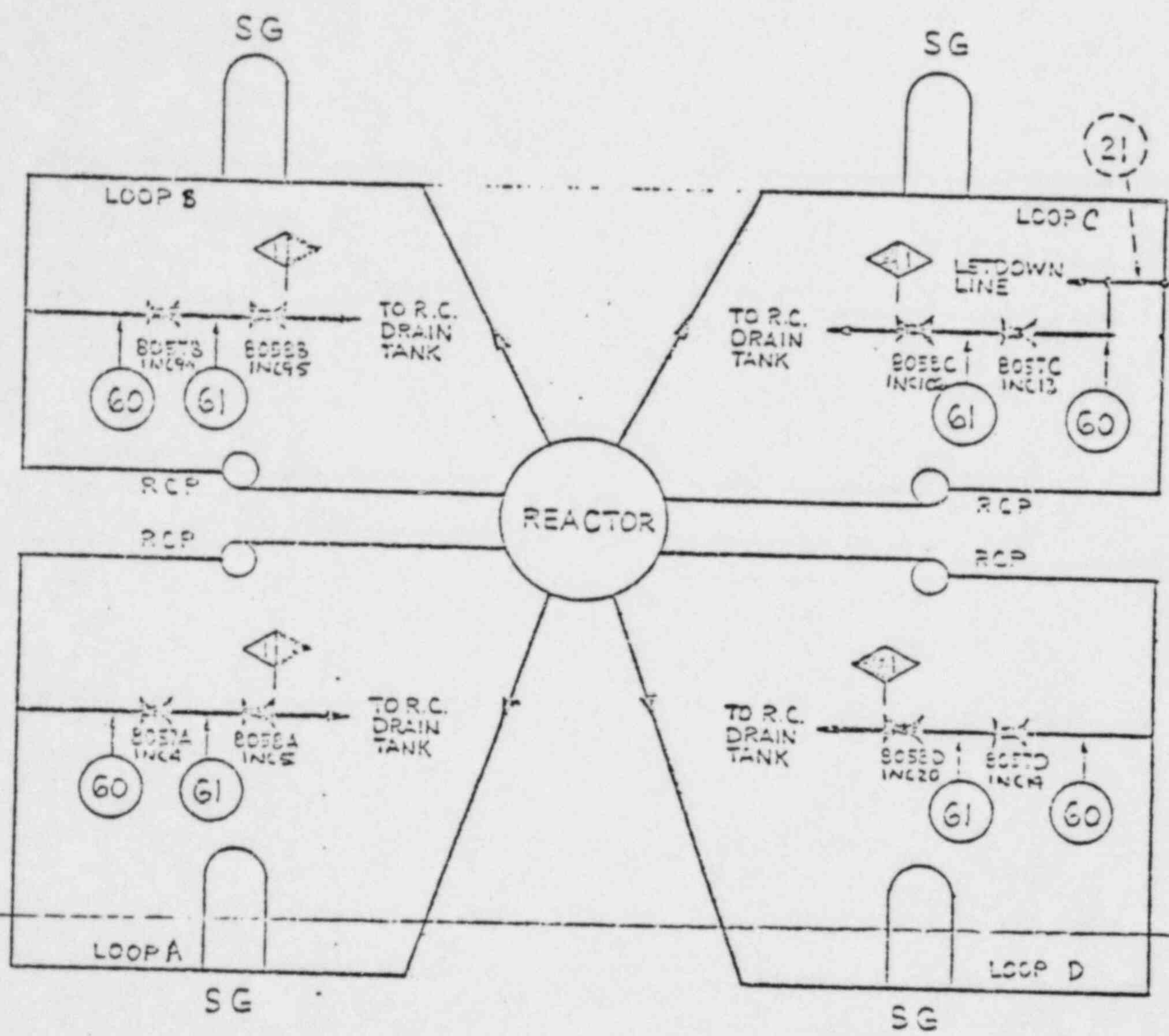
$$S_{ALT} = 2.448 \times \frac{171603.11}{2} = 210042.21\ Psi.$$

COMPUTER SHOWED : 210292.96 Psi OK

REF: NC-13 LOAD CASE REV. 2
NC-13 CODE COMPLIANCE REV. 0 80/09/24 16.38.38 . +THERMAL: 80/09/23 10.35.55

REV	BY	DATE	CHECKED	DATE		
0	T. Nguyen	10/10/80	[illegible]	10/17/80	eds nuclear	DUKE/CATAWBA 1; JOB NO 0093-101; CALC NO NC-13; PAGE 3 OF 3

REACTOR COOLANT DRAIN LINES



POINT IDENTIFICATION

POINTS	AREA CONSIDERED
60	From crossover leg connection to first drain line isolation valve
61	Line between two drain line isolation valves.

NC p [illegible] 13

PROJECT: Containment Parameter Analysis	BY: RCB
TITLE: Reactor Coolant Drain Lines	DATE: 8/4/78
Calculation No. 25-? ? 3.1.7	CHECKED: [illegible]

NORMAL CONDITIONS

Rev. 0

	N-1 HEATUP	N-2 COOLDOWN	N-3 STEP LOAD INCREASE OF 10% OF FULL POWER
EVENTS	200	200	2,000
60 P	0 AMB / 10 385 / 8280 385 / 17532 2235	0 2235 / 9000 385 / 17532 385 / 17542 AMB	0 2235 / 50 2170 / 175 2295 / 300 2255
T	0 70 / 17532 557	0 557 / 70	0 558 / 50 544 / 300 561
F	0	0	0

	N-4 STEP LOAD DECREASE OF 10% OF FULL POWER	N-5 LARGE STEP LOAD DECREASE	N-6 STEADY STATE FLUCTUATIONS
EVENTS	2,000	200	INFINITE
60 P	0 2235 / 30 2310 / 150 2160 / 300 2235	0 2235 / 50 2375 / 75 2160 / 450 1960 / 1200 2195	0 2185 / 60 2285 / 120 2185
T	0 558 / 150 572 / 300 556	0 558 / 60 571 / 1200 546	0 555 / 60 561 / 120 555
F	0	0	0

	N-7 UNIT LOADING AT 5% PER MINUTE	N-8 UNIT UNLOADING AT 5% PER MINUTE
EVENTS	18,300	18,300
60 P	2235	2235
T	0 557 / 1020 558	0 558 / 1020 557
F	0	0

PROJECT: [illegible]	BY: ECB
TITLE: Reactor Coolant Drain Lines	DATE: 6/11/78
Calculation No. 05-[illegible] Pg. 7	CHECKED: [illegible]

UPSET CONDITIONS

Rev. 0

	U-1	U-2	U-3
	REACTOR TRIP FROM FULL POWER	LOSS OF LOAD WITHOUT IMMEDIATE TURBINE OR REACTOR TRIP	LOSS OF FLOW IN ONE LOOP (TEMPS FOR THE LOOP THAT LOST FLOW)
EVENTS	400	60	80 (NOTE 4)
60 P	0: 2235; 60: 1855; 100: 1855	0: 2235; 9: 2435; 31: 2435; 54: 1765; 100: 1585	0: 2235; 15: 1985; 75: 1885; 144: 1860
T	0: 558; 10: 561; 60: 548; 100: 548	0: 558; 27: 590; 31: 592; 100: 560	0: 558; 15: 513; 45: 558; 120: 546; 144: 546
F	0	0	0

	U-4	U-5
	LOSS OF FLOW IN ONE LOOP (AVG MIXED TEMPS OF ALL LOOPS)	LOSS OF POWER (BLACKOUT WITH NATURAL CIRCULATION)
EVENTS	80 (NOTE 4)	60
60 P	0: 2235; 35: 1985; 75: 1885; 140: 1860	0: 2235; 120: 2055; 1500: 2435; 3000: 2435; 4620: 2335; 9900: 2235
T	0-15: 558; 21: 568; 25: 574; 30: 573; 35: 574; 105: 548; 140: 548	0: 558; 60: 570; 300: 556; 9900: 556
F	0	0

TEST CONDITIONS

	T-1	T-2	T-3
	TURBINE ROLL TEST	PRIMARY SIDE HYDROSTATIC TEST	PRIMARY SIDE LEAK TEST
EVENTS	10	5	50
60 P	0: 2235; 1680: 1905	0: AMB; 3107	0: AMB; 2485
T	0: 557; 1680: 475	AMB	AMB
F	0	0	0

(7)

PROJECT: Transient Parameter Analysis	BY: LCB
TITLE: Reactor Coolant Drain Lines	DATE: 8/4/78
Calculation No. CS-20 5 of 7	CHECKED: [illegible]

Rev 0

UPSET CONDITIONS

	U-6 REACTOR TRIP WITH COOLDOWN AND INADVERTENT SI ACTUATION					U-7 INADVERTENT RCS DEPRESSURIZATION				
EVENTS	10					20				
P	2235 (0)	1280 (25)		2235 (300)	2235 (1200)	2235 (0)	1455 (60)	1175 (83)	791 (204)	560 (600)
60 T	558 (0)	547 (10)	498 (85)	488 (300)	482 (1200)	558 (0)	564 (35)	555 (60)		456 (600)
F	0					0				

INFORMATION BELOW VOIDED BY REVISION 1

~~EMERGENCY CONDITIONS~~

	SMALL STEAM BREAK					SMALL LOCA				
EVENTS	5					5				
P	2235 (0)	1845 (665)	2235 (1000)		2235 ([illegible])	2235 (040)	2035 (115)	1455 (135)	935 (300)	345 (1000)
60 T	558 (0)	423 (300)	378 ([illegible])	318 (1600)	298 (4000)	558 (0)	558 (100)	563	562 (75)	511 (300)	374 (7000)
F	0	(NOTE 2)				0	(NOTE 2)			

REV 1 By: LCBuey 2/12/79
Checked: [illegible] 2/13/79

FAULTED CONDITIONS

	LARGE STEAM BREAK					LARGE LOCA			
EVENTS	1					1			
P	2235 (0)		773 (12)	773 (190)	2485 (360)	2235 (0)	1200	260	45
60 T	557 (0)	415	376 (20)	270 / 260	212 (360)	558 (0)			100 (9)
F	0					0			

By: [signature] 2/12
Checked: [signature] 2/12

General

a. All pressure valves are PSIG; time is in seconds, flow is gpm, temperature is °F.

b. All upset conditions (plus the turbine roll test and heatup) are followed by a return to hot shutdown conditions: P returns to 2235 psig at a rate consistent with Tsat returning to 653 F at 100 F/hr. (Except for Loss of Power: P returns at a rate consistent with Tsat returning to 653 @ 200 F/hr).

Specific Notes

1. Point 61 is at ambient temperature and pressure with no flow for all plant conditions considered.

2. ~~Following the small steam break, the plant is returned toward the cold shutdown conditions as follows:~~

	4000	11764	25204	25214
P	2335	385	385	0
	4000	12208		
T	298	70		

3. ~~Following the small LOCA, the plant is returned toward the cold shutdown condition as follows:~~

	3000	15960	15970
P	345	345	AMB
	3000	15944	
T	374	70	

NOTES 2 & 3 DELETED PER REVISION 1

4. The total number of occurences of loss of flow in one loop is 80, i.e. the 80 occurrence for the two cases of loss of flow are one in the same. The more limiting of the conditions should be used for each individual line segment.

eds nuclear

Catawba Nuclear Station, Unit 1

RCL DRAIN LINES

ASME BPVC SECTION III CLASS 1 STRESS REPORT

EDS Report No. 01-0093-1159

Revision: 0

TABLE D-3-1
(Problems NC-10, -11, -13)

TRANSIENT EVENT IDENTIFICATION

Load State	Seg. 60		Seg. 61		Seg.		Seg.		No. of Occur.	Trans. Data	Remarks
	Press.	Temp.	Press.	Temp.	Press.	Temp.	Press.	Temp.			
N-1A	0	70	0	70					200	None	Run this Case
N-1B	2235	557	0	70					200	"	Envl. by N-06
N-2A	2235	557	0	70					200	"	Same as N-1B.
N-2B	0	70	0	70					200	"	Same as N-1A.
N-03	2235	557	0	70					2000	"	Envl. by N-06
N-04	2235	557	0	70					2000	"	Envl. by N-06
N-05	2235	558	0	70					200	"	Envl. by N-06
N-06	2185	555	0	70					∞	"	Run this Case
N-07	2235	557	0	70					18300	"	Envl. by N-06.
N-08	2235	557	0	70					18300	"	Envl. by N-06.
U-01	2235	558	0	70					400	"	Envl. by N-06.
U-2A	2235	558	0	70					80	"	Envl. by N-06.

NOTES:

Load State	Seg. 60		Seg.61		Seg.		Seg.		No. of Occur.	Trans. Data	Remarks
	Press.	Temp.	Press.	Temp.	Press.	Temp.	Press.	Temp.			
U-2B	1585	560	0	70					80	None	Envl. by N-06
U-03	2235	558	0	70					80	U-03	Run this Case.
U-04	2235	558	0	70					80	None	Envl. by N-06
U-0	2235	558	0	70					40	"	Envl. by N-06
U-06	2235	558	0	70					10	"	Envl. by N-06
U-7A	2235	558	0	70					20	"	Envl. by N-06
U-7B	560	456	0	70					20	"	Run this Case.
T-01	2235	557	0	70					10	"	Envl. by N-06
T-2A	0	70	0	70					5	"	Envl. by N-1A
T-2B	3107	70	0	70					5	"	Run this Case.
T-3A	0	70	0	70					50	"	Envl. by N-1A
T-3B	2485	70	0	70					50	"	Envl. by T-2B

NOTES: Segment 61 is always at ambient for all plant conditions.

TRANSIENT EVENT IDENTIFICATION

TABLE D-3-1 (cont'd)
(Problems NC-10, -11, -13)

TRANSIENT EVENT IDENTIFICATION

TABLE D-3-1 (cont'd)
(Problems NC-10, -11, -13)

Load State	Seg. 60		Seg.61		Seg.		Seg.		No. of Occur.	Trans. Data	Remarks
	Press.	Temp.	Press.	Temp.	Press.	Temp.	Press.	Temp.			
U-2B	1585	560	0	70					80	None	Envl. by N-06
U-03	2235	558	0	70					80	U-03	Run this Case.
U-04	2235	558	0	70					80	None	Envl. by N-06
U-05	2235	558	0	70					40	"	Envl. by N-06
U-06	2235	558	0	70					10	"	Envl. by N-06
U-7A	2235	558	0	70			...		20	"	Envl. by N-06
U-7B	560	456	0	70					20	"	Run this Case.
T-01	2235	557	0	70					10	"	Envl. by N-06
T-2A	0	70	0	70					5	"	Envl. by N-1A
T-2B	3107	70	0	70					5	"	Run this Case.
T-3A	0	70	0	70					50	"	Envl. by N-1[illegible]
T-3B	2485	70	0	70					50	"	Envl. by T-2B

NOTES: Segment 61 is always at ambient for all plant conditions.

Load State	Seg. 60 Press.	Seg. 60 Temp.	Seg.61 Press.	Seg.61 Temp.	Seg. Press.	Seg. Temp.	Seg. Press.	Seg. Temp.	No. of Occur.	Trans. Data	Remarks
N-1A	0	70	0	70					255*	None	
N-06	2235	557	0	70					∞	"	
U-03	2235	558	0	70					80	U-03	
U-7B	560	456	0	70					20	None	
T-2B	3107	70	0	70					55	"	

NOTES: This is the envelope of all the load states for NC-10, -11, and -13.

*NC-10 conservatively used 455 cycles including 200 cycles from transient event N-2B

SIGNIFICANT TRANSIENT EVENTS

TABLE D-3-2
(Problems NC-10, -11, -13)

Item (d)

Table: THERMAL TRANSIENT RESULTS*

Loading: U-3 (Loss of flow in one loop, temperature for loop that lost flow)

Segment 60

Section Name / Adjacent Section	Indices C_3	Indices K_3	Time (sec)	ΔT_1 (°F)	ΔT_2 (°F)	T_{avg} (°F) T_a	T_{avg} (°F) T_b		Stress (PSI)
1. 2" Sch160 Butt-Welded Nozzle	1.0	1.7	15.0	21.87	4.35			Sa	4358
(1-1)			15.0	21.87	4.35			Sn	4155
			45.0	-12.35	-2.38			Sa	2449
			45.0	-12.35	-2.38			Sn	2345
2. 2 Sch160 Strp.	1.0	1.0	15.0	21.87	4.35			Sa	2904
(1-1)			15.0	21.87	4.35			Sn	4155
			45.0	-12.35	-2.38			Sa	1624
			45.0	-12.35	-2.38			Sn	2345
3. 2" Sch160 5-D Bend	1.0	1.0	15.0	31.63	7.72			Sa	4471
(1-2)			15.5	31.72	6.66			Sn	6025
			45.0	-16.22	-3.92			Sa	2286
			45.5	-16.34	-3.53			Sn	3104
Max (Ta-Tb)									
								Sa	
								Sn	
Max (Ta-Tb)									
								Sa	
								Sn	
Max (Ta-Tb)									
								Sa	
								Sn	
Max (Ta-Tb)									

Ref. Computer Seq. Number					
1. AAWQAIG	2. →	3. →	4.	5.	6.
7.	8.				

NOTES: StrP = Straight Pipe

* OUTPUT OF TRANSZA PROGRAM.

TRANSIENT RESULTS

TABLE D-4
(Problems NC-10, -11, -13)

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Catawba Nuclear Station, Unit 1

RCL DRAIN LINES

ASME BPVC SECTION III CLASS 1 STRESS REPORT

EDS Report No. 01-0093-1159

Revision: 0

4.6 Analysis Combination of Conditions

For analysis purposes, the defined normal, upset, and testing conditions are enveloped by specific combinations of steady-state conditions of temperatures and pressures, transient conditions of rapid temperature changes, and seismic (OBE) effects. These load states are chosen to represent all significant stress cycles. A load fluctuation is considered significant when the total excursion of load stress intensity exceeds the value of the alternating stress intensity obtained from the applicable design fatigue curve for 10^6 cycles. A summary of the enveloped load states is shown below in Table 4.6-1.

TABLE 4.6-1
CONDITIONS ANALYZED

Transient Event Name	Transient Event Description	Equivalent No. of Occurrences
N-1A	Heatup	255 (See Note 1)
N-06	Steady-State Fluctuations	infinite
U-03	Loss of Flow in One Loop	80
U-7B	Inadvertent RCS Depressurization	20
T-2B	Primary Side Hydrostatic Test	55

NOTES:
1. For problem NC-10, 455 cycles were used conservatively including 200 cycles from transient event N-2B.