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CALCULATION SHEET

CALC. TITLE AUXILIARY SPRAY LINE THERMAL STRATIFICATION CALC. NO 13-MC-ZZ-643

SUBJECT STRATIFIED THERMAL ANALYSIS OF THE 2-INCH DIA. PIPE SHEET NO. 6

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	Rev. Indicator
1	[signature]	9/9/93	KRS	9/9/93						↓

3.0 REFERENCES

1) Chem. Vol. Control Sys. Auxiliary Spray Draw. No. 13 - P - CHF - 107, Rev. 16

2) BPC, Reactor Coolant System - Pressurizer Spray Line Iso. Sketch Sheet 13 -P- RCF - 102, Rev.5, Prob. RC-502, Sheets 11A and 11B.

3) Letter 281-00896-MAR/KMS, dated July 31, 1992 from M. A. Radspinner to File, "CATS Item 41011, IEB 88-08 Thermal Stresses in Piping Connected to the RCS"

4) Letter 161-04571-WFC/JMQ, dated January 15, 1992 from W.F. Conway, APS to NRC, "Response to NRC request for Additional Information on NRC Bulletin 88-08"

5) Calculation No. 13-MC-ZZ-588, Rev. 4, dated 12-15-89. "CVCS Auxiliary Spray Line Class 1 Piping."

6) Calculation No. 13-MC-ZZ-596, Rev. 4, dated 4-27-90. "Pressurizer Spray Lines Class 1 Analysis."

7) "Reduction and Assessment of Surge Line and Auxiliary Spray Line Temperature and Displacement Data," September 1991, prepared by Fatigue Evaluation Services, ABB Combustion Engineering Nuclear Power.

8) 1977 ASME Boiler and Pressure Vessel Code, Section III, Division 1 including Summer 1979 Addenda.

9) ANSYS - Engineering Analysis System Computer Code, Revision 4.4A, 1989.

10) Calculation No. 13-MC-CH-531, Rev. 5, dated 2-18-92. "CVCS Auxiliary Spray Line Class 2 Piping Analysis."

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	Rev. Indicator
1	[signature]	9/8/93	KRS	9/9/93						↓

4.0 AUXILIARY SPRAY LINE TRANSIENT DEFINITIONS

PIPING SYSTEM DESCRIPTION

The function of the Auxiliary Spray Line is to provide the operator with an auxiliary pressurizer spray to control the Reactor Coolant System, RCS, pressure during the final stages of reactor shutdown by allowing cooling of the pressurizer. The Aux. Spray Line is part of the Chemical Volume Control System, CVCS, and is located between the charge line (Loop 2A) and the pressurizer, (RCE-X02). It is a 2-inch Schedule 160 pipe size. The upstream end connects to the charge line where it takes the fluid, (reactor coolant) from this charge line. Note that the section of the charge it connects to is a portion after the regenerative heat exchanger outlet nozzle. The down stream end connects to the 4-inch main spray line, and the main spray line immediately connects to the pressurizer inlet nozzle.

NORMAL START-UP OPERATIONS

The pressure in the line rises from atmospheric pressure to 2250 psig. After equilibrium of the system is attained the flow in the line drops back to zero flow, while the temperature and the pressure in the pipe system remain at 125 F and 2250 psig.

NORMAL OPERATIONS

During Normal Operations of the plant systems such as at full power, step power changes and ramp power changes, there is no flow in the Auxiliary Spray Line. In the system heat-up Operating Condition, circulation starts in the loop with coolant flow and temperature of 44.0 GPM and 120 F.

UPSET OPERATIONS

In normal operations of the plant system an upset condition is assumed where the Auxiliary Spray Line may inadvertently function at full power. For this event the coolant pressure is maintained at 2250 psig and the fluid temperature rises from an initial temperature of 125 F to 460 F in a short time and the flow reaches to 61.6 GPM.

NORMAL SHUTDOWN OPERATIONS

During normal shutdown or reactor cooling, the flow in this pipe system increases from zero flow to 61.6 GPM and the temperature of the fluid increases from 125 F to 225 F. However, the pressure in the line remains the same, 2250 psig. After the pressurizer is cooled the flow will slowly be reduced to zero, the fluid temperature will be reduced to 70 F and pressure will be reduced to atmospheric pressure.

THERMAL STRATIFICATION

As a part of APS response to NRC, Reference (4), NED assessed Unit 3 Auxiliary Pressurizer Spray System temperature data. This data was recorded to evaluate the potential for thermal stratification in the Auxiliary Spray Line. The data reduction performed by ABB-CE focused primarily on plant heat-up and cooldown operations.In Reference (4) APS concluded that the Auxiliary Spray Line did not exhibit thermal stratification due to leakage as described in IE Bulletin 88-08. However the line did exhibit a top-to-bottom temperature differential of up to 115 F in the portion of the pipe system between Valve V-431 and

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CALCULATION SHEET

CALC. TITLE AUXILIARY SPRAY LINE THERMAL STRATIFICATION CALC. NO 13-MC-ZZ-643

SUBJECT STRATIFIED THERMAL ANALYSIS OF THE 2-INCH DIA. PIPE SHEET NO. 9

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	Rev. Indicator
1	[signature]	9/8/93	KRS	9/9/93						↓

5.0 CALCULATIONS

Calculations were performed by using ANSYS Version 4.4A computer code because this code allows the input of the variable pipe wall temperatures experienced during stratification. The input is shown in Section 6.0 based on Histograms per the existing Class 1 design basis calculations (References 5 and 6). Although the monitored temperatures were in the range of 400 F at top to about 285 F on bottom of pipe, the thermal load cases were input with the Main Spray operating temperature on the top less 115 F for the bottom temperature. This was done for conservatism as the higher temperature values yield a larger differential expansion top to bottom due to their larger mean coefficients. The stratified section is Section I as described on the following sheets and shown on the sketch on sheet 40.

The input and stress summaries for each individual load case output are shown in Attachments 1 and 2. The maximum stresses in the output are in terms of maximum stress intensity which is conservative compared to the bending stress as it is equal to twice the maximum shear stress and includes the effects of internal pressure. Maximum stresses occur at the 4"x4"x2" Tee (Data Point 7) and at the 2" Check Valve Taper Transition Joints (Data Points 51 and 52). The results of the load case runs for expansion stress at these locations are shown in Tables 1 and 2 in Section 7.

The stratified load conditions affect only Primary Plus Secondary Stress Intensity Range, Eqtn. (10) and Peak Stress Intensity Range, Eqtn. (11) for calculating Usage Factors. Moment stresses from the ANSYS analyses are substituted for the second term in both equations. The through wall temperature gradient terms in both equations can be taken from the existing stress calculations, references 5 and 6. The moments due to dead weight, seismic inertia and seismic anchor movement are not affected by thermal stratification and were taken from the exisitng flexibility analysis, reference 10.

Equation (10) and Equation (11), Sp, is recalculated as follows for the Tee and Taper Transition Joints by using the unintensified moment stress from Table 1 included in the second term of both equations. The maximum stress for all thermal load conditions in Table 1 is conservatively used to calculate the moment stresses in all calculations below:

For both locations, the Tee and Taper Transition Joints, the maximum Equation 10 stress is compared to 3 Sm. Equation 11 peak stresses for each transient are then calculated and the resulting Cumulative Usage Factors for both locations are compared with the 1.0 allowable.

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	Rev. Indicator
1		9/9/93	KRS	9/9/93						↓

CODE COMPLIANCE EVALUATION:

$$S_m = C_1 \frac{P_o D_o}{2t} + C_2 \frac{D_o M_i}{2I} + C_3 E\alpha |T_a - T_b|$$

CONSIDER TAPERED TRANSITION AT VALVE V431 (NODE 8)

$|T_a - T_b|$ IS GOVERNED BY INADVERTENT SPRAY ACTUATION EVENT PER SHEET B-27 OF REF. 5.

SUBSTITUTING FOR S_m, USING 4821 PSI FROM TABLE 2 & $|T_a - T_b|$ FROM REF. 6:

$$= 1.59 \frac{2250 \times 2.375}{2 \times 0.343} + \left\{ 1.97 \frac{2.375 \times 2670}{2 \times 1.163} + 1.97 \times 4821 \right\}$$

$$+ 1.26 \times 28.3 \times 10^{6} + 8.55 \times 10^{-6} |383 - 348|$$

$$= 39449 < 3S_m \quad (3S_m = 53760 \Rightarrow S_m = 17920)$$

$$S_p = K_1 C_1 \frac{P_o D_o}{2t} + K_2 C_2 \frac{D_o M_i}{2I} + \frac{1}{2(1-\nu)} K_3 E\alpha |\Delta T_1|$$

$$+ K_3 C_3 E\alpha |T_a - T_b| + \left(\frac{1}{1-\nu}\right) E\alpha |\Delta T_2|$$

SUBSTITUTING FOR S_p, USING $|T_a - T_b|$, ΔT_1, ΔT_2 PER REF. 5

$$= 1.2 \times 1.59 \frac{2250 \times 2.375}{2 \times 0.343} + 1.8 \left\{ 1.97 \left(\frac{2.375 \times 2670}{2 \times 1.163} + 4821 \right) \right\}$$

$$+ \frac{1}{2(1-0.3)} 1.7 \times 28.3 \times 8.55 \times 228 + 1.7 \times 1.26 \times 28.3 \times 8.55 \times |388 - 348|$$

$$+ \frac{1}{(1-0.3} \times 8.55 \times 28.3 \times 99$$

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CALCULATION SHEET

CALC. TITLE AUXILIARY SPRAY LINE THERMAL STRATIFICATION CALC. NO 13-MC-ZZ-643

SUBJECT STRATIFIED THERMAL ANALYSIS OF THE 2-INCH DIA. PIPE SHEET NO. 11

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	Rev. Indicator
1	DRG	9/5/93	ICLS	9/9/93						↓

$S_p = 14863 + 26763 + 66990 + 20732 + 34221$

$= 163569$

$S_{alt} = \frac{S_p}{2} = 81785$

AT $S_{alt} = 81785$ PSI $\Rightarrow N = 2760$ (FIG I-9-1)

CONSERVATIVELY, CONSIDER ALL 1505 CYCLES (FROM DESIGN CALC. REF. 5) HAVE SAME STRESS LEVEL:

$U_1 = \frac{1505}{2760} = 0.545$

USAGE FROM ORIGINAL DESIGN CALC @ TTJ = 0.0953

TOTAL USAGE = 0.545 + 0.0953

= 0.641

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CALCULATION SHEET

CALC. TITLE AUXILIARY SPRAY LINE THERMAL STRATIFICATION CALC. NO 13-MC-ZZ-643

SUBJECT STRATIFIED THERMAL ANALYSIS OF THE 2-INCH DIA. PIPE SHEET NO. 12

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	Rev. Indicator
1	[signature]	9/9/93	KRS	9/9/93						↓

- FOR AUSTENITIC STEEL, $m = 1.7$, $n = 0.3$

$3S_m = 48450$ PSI

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

$$= \underline{1.257}$$

- MODIFIED $S_p = 102740 + (2723 \times 2 \times 1)$

($C_{2r} = C_{2b}$, K_2)

$$= \underline{108186 \text{ PSI}}$$

- $$S_{alt} = \frac{K_e S_p}{2} = \frac{108186 \times 1.257}{2}$$

$$= 67995 \text{ PSI}$$

@ $S_{alt} = 67995 \Rightarrow N_{ALLOW} = 5625$

- CONSIDER ALL 1505 CYCLES EXPERIENCE THE ABOVE STRESS LEVEL. (CONSERVATIVE SEE NOTE IN SECTION 6.0 TABLE)

$$U_1 = \frac{1505}{5625} = 0.2676$$

- $U_{TOTAL} = 0.0366 + 0.2676 = \underline{0.304}$

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CALCULATION SHEET

CALC. TITLE AUXILIARY SPRAY LINE THERMAL STRATIFICATION CALC. NO 13-MC-ZZ-643

SUBJECT STRATIFIED THERMAL ANALYSIS OF THE 2-INCH DIA. PIPE SHEET NO. 13

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	Rev. Indicator
1	[signature]	9/9/93	KRS	9/9/93						↓

CONSIDER 4" x 4" x 2" TEE (NODE 188)

- THERMAL EXPANSION STRESS AT THE TEE COMPONENT WITHOUT STRATIFICATION:
  - FROM THERMAL EXPANSION ANALYSIS, THE TEE COMPONENT STRESS = 13095 PSI. (ME101 COMPUTER RUN SNUM; NE-194, 9-3-87)
- THERMAL STRATIFICATION FROM 2" A-UX. SPRAY LINE:
  THERMAL EXPANSION PLUS THERMAL STRATIFICATION STRESS AT TEE COMPONENT = 15818 PSI PER TABLE 1
- STRATIFICATION CONTRIBUTION FROM BRANCH SIDE:

$$(15818 - 13095) = 2723 \text{ PSI}$$

~~DESIGN REPORT: S_n = 46740 PSI & $3S_m$ = 48450 PSI~~
(REF. 6) S_p = 102740 PSI, U_i = 0.0366

- MODIFIED $S_n = 46740 + (2723 \times 2)$ ($C_{2r} = C_{2b}$)

$$= \underline{52186} \text{ PSI}$$

$S_n > 3S_m < m\,3S_m$

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	Rev. Indicator
1	DBaig	9/9/93	KRS	9/9/93						↓

STRESS INDICES EVALUATION

TAPERED TRANSITION AT CHECK VALVE V431

$$C_1 = 1.3 + 0.003\,(D_o/t) + 1.5\,(\delta/t) \Rightarrow \delta = 1/16 \text{ ASSUME}$$

$$= 1.3 + 0.003\,(2.375/0.343) + 1.5\,(0.0625/0.343)$$

$$= \underline{1.59}$$

$$C_2 = 1.4 + 0.004\,(2.375/0.343) + 3\,(0.0625/0.343)$$

$$= \underline{1.97}$$

$$C_3 = 1.2 + 0.008\,(D_o/t)$$

$$= 1.2 + 0.008\,(2.375/0.343)$$

$$= \underline{1.26}.$$

$K_1 = 1.2$ $\quad C_1 = 1.59$

$K_2 = 1.8$ $\quad C_2 = 1.97$

$K_3 = 1.7$ $\quad C_3 = 1.26$

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CALCULATION SHEET

CALC. TITLE AUXILIARY SPRAY LINE THERMAL STRATIFICATION CALC. NO 13-MC-ZZ-643

SUBJECT STRATIFIED THERMAL ANALYSIS OF THE 2-INCH DIA. PIPE SHEET NO. 15

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	Rev. Indicator
1	[signature]	9/9/93	KRS	9/9/93						↓

4"x 4" x 2" TEE. (INDICES CONT'D)

$$C_{2b} = C_{2r} = 0.67 \left[R_m / T_r \right]^{2/3} \text{ BUT NOT LESS THAN 2.0.}$$

$$= 0.67 \left[(4.5 - 0.531) / 0.531 \right]^{2/3}$$

$$= 1.61 \Rightarrow \text{USE } 2.0$$

FOR THE ABOVE TEE, THE OTHER INDICES ARE NOT REQUIRED FOR THIS ANALYSIS.

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CALC. TITLE AUXILIARY SPRAY LINE THERMAL STRATIFICATION CALC. NO 13-MC-ZZ-643

SUBJECT STRATIFIED THERMAL ANALYSIS OF THE 2-INCH DIA. PIPE SHEET NO. 15 A

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	Rev. Indicator
1	D Berg	9/9/93	KRS	9/9/93						↓

CONCLUSION:

The Auxiliary Spray line is able to withstand the effects of Stratified Flow, as monitored by the PVNGS monitoring program, for a 40 year life.

The calculations incorporating Stratified Flow effects reflected increased Usage Factors at both 4"x4"x2" Tee and the Tapered Transition Joint at valve V431. The increased Usage Factors required mandatory breaks at these locations. However, there are breaks postulated at these locations. (Reference: Figure 3 . 6-23, UFSAR) and therefore there is no impact due to increased Usage Factors at these locations.)

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CALCULATION SHEET

CALC. TITLE AUXILIARY SPRAY LINE THERMAL STRATIFICATION CALC. NO 13-MC-ZZ-643

SUBJECT STRATIFIED THERMAL ANALYSIS OF THE 2-INCH DIA. PIPE SHEET NO. 15 B

6.0 THERMAL INPUT DATA SUMMARY

			OPER. TEMP. / REF. TEMP.					
			AUX / MAIN		AUX. SPRAY		MAIN SPRAY	
FILE	LOAD CASE NAME	CYCLES	FLOW RATE	INTERN. PRESS.	SECT. I TEMP.	SEC, J,K TEMP.	SECT. A TEMP.	SEC. B-F TEMP.
inp 14	NORMAL START UP	500	10/0	2250	495*/70	495/70	495/70	495/70
inp 18	COOLDOWN (A)	40	10/62	400/2250	435*/60	60/60	435/60	435/60
inp 19	COOLDOWN (B)	92	10/62	400/2250	435*/110	110/110	435/110	435/70
inp 20	COOLDOWN (C)	368	10/62	400/2250	435*/160	160/160	435/160	435/70
inp 12	NORMAL -10%	200,000	290/0	2250	570*/495	120/120	570/495	570/495
inp 13	NORMAL +10%	200,000	290/0	2250	565*/495	120/120	565/495	565/495
inp 15	UPSET LD REJECT.	85	220/0	2250	575*/495	120/120	575/495	575/495
inp 16	UPSET INAD. AUX.	5	10/62	2250	460/450	370/160	495/495	495/495
inp 17	UPSET SPUR. EVENT	355	437/62	2250	573/495	573/120	573/495	573/495
NOTES: THE +/- 10% POWER CHANGE 200,000 CYCLES COULD BE CONSIDERED AS INSIGNIFICANT FROM FATIGUE POINT OF VIEW SINCE THE PRESSURE FLUCTUATIONS AND TEMPERATURE CHANGES ARE INSIGNIFICANT PER REF. 5. REMAINING CYCLES TOTAL 1445 PER ABOVE. 1505 USED IN CALC. IS CONSERVATIVE.								
* INDICATES SECTION STRATIFIED AT DELTA-T OF 115F. (INDICATED TEMP. AT TOP. INDICATED LESS 115F AT BOTTOM.)								

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	Rev. Indicator
1	[signature]	2/9/93	KAS	2/9/93						←

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CALCULATION SHEET

CALC. TITLE AUXILIARY SPRAY LINE THERMAL STRATIFICATION CALC. NO 13-MC-ZZ-643

SUBJECT STRATIFIED THERMAL ANALYSIS OF THE 2-INCH DIA. PIPE SHEET NO. 23

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	Rev. Indicator
1	JRM	9/6/93	KLS	9/9/93						↓

inp18

PIPE TEMPERATURES FOR TRANSIENT HISTOGRAMS – AUXILIARY SPRAY PIPE SYSTEM

NORMAL PLANT COOLDOWN (A): During Normal Plant Cooldown Operations there is intermittent flow in the auxiliary spray line. At this time the auxiliary spray pipe has a flow condition of 62 GPM for two, (2), minutes and shuts down for twenty, (20), minutes to zero flow. Stratification in pipe section is conservatively assumed to exist for this operation in the pipe section I, CH-E-009-BCAA-2". There is a possibility that the regenerative heat exchanger is not operating so various temperatures are assumed and accounted for by PLANT COOLDOWN (A), (B), and (C) Conditions

Number of Cycles: COOLDOWN CONDITION (A) – 40 cycles

Pipe Section	A	B	C	D	E	F	I	J	K
Reference Temp. F	60	70	70	70	70	70	60	60	60
System Temp. F	435	435	435	435	435	435	435	60	60
Delta Temp. F	375	365	365	365	365	365	375	0	0
	THERMAL STRATIFICATION IS TO BE INCLUDED IN PIPE SECTION I								
Pressure psig	400	400	400	400	400	400	2250	2250	2250
Flow GPM	72/10	10	10	10	10	10	62/0	62/0	62/0

INPUT FILE = inp18

REFERENCE - HISTOGRAM VII

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CALCULATION SHEET

CALC. TITLE AUXILIARY SPRAY LINE THERMAL STRATIFICATION CALC. NO 13-MC-ZZ-643

SUBJECT STRATIFIED THERMAL ANALYSIS OF THE 2-INCH DIA. PIPE SHEET NO. 24

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE
1	DRG	8/6/93	KLS	8/9/93					

Rev. Indicator ↓

inp19

PIPE TEMPERATURES FOR TRANSIENT HISTOGRAMS – AUXILIARY SPRAY PIPE SYSTEM

NORMAL PLANT COOLDOWN (B): During Normal Plant Cooldown Operations there is intermittent flow in the auxiliary spray line. At this time the auxiliary spray pipe has a flow condition of 62 GPM for two, (2), minutes and shuts down for twenty, (20), minutes to zero flow. Stratification in pipe section is conservatively assumed to exist for this operation in the pipe section I, CH-E-009-BCAA-2". There is a possibility that the regenerative heat exchanger is not operating so various temperatures are assumed and accounted for by PLANT COOLDOWN (A), (B), and (C) Conditions

Number of Cycles: COOLDOWN CONDITION (B) – 92 cycles

Pipe Section	A	B	C	D	E	F	I	J	K
Reference Temp. F	110	70	70	70	70	70	110	110	110
System Temp. F	435	435	435	435	435	435	435	110	110
Delta Temp. F	325	365	365	365	365	365	375	0	0
THERMAL STRATIFICATION IS TO BE INCLUDED IN PIPE SECTION I									
Pressure psig	400	400	400	400	400	400	2250	2250	2250
Flow GPM	72/10	10	10	10	10	10	62/0	62/0	62/0

INPUT FILE = inp19

REFERENCE - HISTOGRAM VII

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CALCULATION SHEET

CALC. TITLE AUXILIARY SPRAY LINE THERMAL STRATIFICATION CALC. NO 13-MC-ZZ-643

SUBJECT STRATIFIED THERMAL ANALYSIS OF THE 2-INCH DIA. PIPE SHEET NO. 25

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	Rev. Indicator
1	DRB	8/6/93	KES	8/9/93						↓

inp20

PIPE TEMPERATURES FOR TRANSIENT HISTOGRAMS – AUXILIARY SPRAY PIPE SYSTEM

NORMAL PLANT COOLDOWN (C): During Normal Plant Cooldown Operations there is intermittent flow in the auxiliary spray line. At this time the auxiliary spray pipe has a flow condition of 62 GPM for two, (2), minutes and shuts down for twenty, (20), minutes to zero flow. Stratification in pipe section is conservatively assumed to exist for this operation in the pipe section I, CH-E-009-BCAA-2". There is a possibility that the regenerative heat exchanger is not operating so various temperatures are assumed and accounted for by PLANT COOLDOWN (A), (B), and (C) Conditions

Number of Cycles: COOLDOWN CONDITION (C) – 368 cycles

Pipe Section	A	B	C	D	E	F	I	J	K
Reference Temp. F	160	70	70	70	70	70	160	160	160
System Temp. F	435	435	435	435	435	435	435	160	160
Delta Temp. F	275	365	365	365	365	365	275	0	0
				THERMAL STRATIFICATION IS TO BE INCLUDED IN PIPE SECTION I					
Pressure psig	400	400	400	400	400	400	2250	2250	2250
Flow GPM	72/10	10	10	10	10	10	62/0	62/0	62/0

INPUT FILE = inp20

REFERENCE - HISTOGRAM VII

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CALCULATION SHEET

CALC. TITLE AUXILIARY SPRAY LINE THERMAL STRATIFICATION CALC. NO 13-MC-ZZ-643

SUBJECT STRATIFIED THERMAL ANALYSIS OF THE 2-INCH DIA. PIPE SHEET NO. 32

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	Rev. Indicator
1	[signature]	9/5/93	KRS	9/7/93						↓

TABLE 1

STRESS SUMMARY FOR EFFECT ON 4X4X2 TEE (DATA POINT 7)
(Load Cases are per Class 1 Design Basis Calc. for 4x4x2 Tee documented in Ref. 6)

LOAD CASE	MAX. STRESS INTENSITY, S.I. psi		
	RUN	BRANCH	COMBINED
inp12	6371	6687	13058
inp13	6370	6685	13055
inp14	6364	5211	11575
inp15	6370	6713	13083
inp16	6361	9457	15818
inp17	6372	7819	14191
inp18	6361	6692	13053
inp19	6356	6647	13003
inp20	6351	6602	12953

Maximum Stress is per inp16 and equals 6361+9457=15818 psi per ANSYS analysis.

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	Rev. Indicator
1	[signature]	9/8/93	KRS	9/9/93						↓

TABLE 2

STRESS SUMMARY FOR EFFECT ON CHECK VALVE TAPER TRANSITION JOINTS (DATA PTS 51 & 52)

(Load Cases are per Class 1 Design Basis Calc. for Check Valve V431 documented in Ref. 5)

LOAD CASE	MAX. STRESS INTENSITY, S.I. psi	NODE POINT
inp14	5842	51
inp16	6632	51
inp18	9149	52
inp19	9154	52
inp20	9159	52

Maximum Stress is per inp20 and equals 9159 psi with SIF=1.9 per ANSYS analysis. The base stress used in the code evaluation done in Section 5.0 is, therefore, 9159/1.9=4821 psi.