ATTACHMENT 4

TECHNICAL SPECIFICATION CHANGES

FOR

RTD BYPASS ELIMINATION

Table 2.2-1	Pages 2-4, 2-5, 2-5(a), 2-7, 2-9, 2-10
Bases	B 2-5
Table 4.3-1	Pages 3/4 3-9, 3/4 3-12a
Table 3.3-4	Pages 3/4 3-25(a), 3/4 3-25(b), 3/4 3-25(d), 3/4 3-25(e)

TABLE 2.2-1

REACTOR TRIP SYSTEM INSTRUMENTATION TRIP SETPOINTS

FUNCTIONAL UNIT	TOTAL ALLOWANCE (TA)	SENSOR ERROR Z	SENSOR ERROR (S)	TRIP SETPOINT	ALLOWABLE VALUE
1. Manual Reactor Trip	N.A.	N.A.	N.A.	N.A.	N.A.
2. Power Range, Neutron Flux					
a. High Setpoint	7.5	4.56	0	≤109% of RTP*	≤112.3% of RTP*
b. Low Setpoint	8.3	4.56	0	≤25% of RTP*	≤28.3% of RTP*
3. Power Range, Neutron Flux, High Positive Rate	2.4	0.5	0	≤4% of RTP* with a time constant ≥2 seconds	≤6.3% of RTP* with a time constant ≥2 seconds
4. Power Range, Neutron Flux, High Negative Rate	2.4	0.5	0	≤4% of RTP* with a time constant ≥2 seconds	≤6.3% of RTP* with a time constant ≥2 seconds
5. Intermediate Range, Neutron Flux	17.0	8.41	0	≤25% of RTP*	≤35.3% of RTP*
6. Source Range, Neutron Flux	17.0	10.01	0	$\leq 10^5$ cps	$\leq 1.6 \times 10^5$ cps
7. Overtemperature ΔT	9.3	6.47	1.83 +1.24***	See Note 1	See Note 2
8. Overpower ΔT	5.7	~~1.46~~ 1.90	~~1.8~~ 1.65	See Note 3	See Note 4
9. Pressurizer Pressure-Low	5.0	2.21	2.0	≥1885 psig	≥1874 psig
10. Pressurizer Pressure-High	7.5	4.96	1.0	≤2385 psig	≤2400 psig
11. Pressurizer Water Level-High	8.0	2.18	2.0	≤92% of instrument span	≤93.8% of instrument span
12. Reactor Coolant Flow-Low	2.5	1.38	0.6	≥90% of loop minimum measured flow**	≥88.8% of loop minimum measured flow**

*RTP = RATED THERMAL POWER
**Minimum Measured Flow = 95,660 gpm
***Two Allowances (temperature and pressure, respectively)

TABLE 2.2-1 (Continued)

REACTOR TRIP SYSTEM INSTRUMENTATION TRIP SETPOINTS

FUNCTIONAL UNIT	TOTAL ALLOWANCE (TA)	Z	SENSOR ERROR (S)	TRIP SETPOINT	ALLOWABLE VALUE
13. Steam Generator Water Level Low-Low					
a. Vessel ΔT Equivalent ≤ 10% RTP Vessel ΔT (Power 1)	6.0	~~2.38~~ 2.72	~~2.0~~ 1.65	≤ Vessel ΔT Equivalent to 10% RTP	≤ Vessel ΔT Equivalent to ~~14.0%~~ 13.9% RTP
Coincident with					
Steam Generator Water Level Low-Low (Adverse Containment Environment)	20.2	17.58	2.0	≥ 20.2% of Narrow Range Instrument Span	≥ 18.4% of Narrow Range Instrument Span
and					
Containment Pressure - Environmental Allowance Modifier	2.8	0.71	2.0	≤ 1.5 psig	≤ 2.0 psig
OR					
Steam Generator Water Level Low-Low (Normal Containment Environment)	14.8	12.18	2.0	≥ 14.8% of Narrow Range Instrument Span	≥ 13.0% of Narrow Range Instrument Span
With a Time Delay, (t)				≤ 232 seconds	≤ 240 seconds

TABLE 2.2-1 (Continued)

REACTOR TRIP SYSTEM INSTRUMENTATION TRIP SETPOINTS

FUNCTIONAL UNIT	TOTAL ALLOWANCE (TA)	Z	SENSOR ERROR (S)	TRIP SETPOINT	ALLOWABLE VALUE
13. Steam Generator Water Level Low-Low (Continued)					
b. 10% RTP < Vessel ΔT Equivalent < 20% RTP Vessel ΔT (Power 2)	6.0	~~2.38~~ 2.72	~~2.0~~ 1.65	< Vessel ΔT Equivalent to 20% RTP	< Vessel ΔT Equivalent to ~~24.0%~~ 23.9% RTP
Coincident with					
Steam Generator Water Level Low-Low (Adverse Containment Environment)	20.2	17.58	2.0	> 20.2% of Narrow Range Instrument Span	> 18.4% of Narrow Range Instrument Span
and					
Containment Pressure-Environmental Allowance Modifier	2.8	0.71	2.0	≤ 1.5 psig	≤ 2.0 psig
OR					
Steam Generator Water Level Low-Low (Normal Containment Environment)	14.8	12.18	2.0	> 14.8% of Narrow Range Instrument Span	> 13.0% of Narrow Range Instrument Span
With a Time Delay, (t)				≤ 122 seconds	≤ 130 seconds

TABLE 2.2-1 (Continued)

TABLE NOTATIONS

NOTE 1: OVERTEMPERATURE ΔT

$$\Delta T \frac{(1 + \tau_1 S)}{(1 + \tau_2 S)} \left(\frac{1}{1 + \tau_3 S}\right) \leq \Delta T_0 \left\{K_1 - K_2 \frac{(1 + \tau_4 S)}{(1 + \tau_5 S)} \left[T \left(\frac{1}{1 + \tau_6 S}\right) - T'\right] + K_3(P - P') - f_1(\Delta I)\right\}$$

Where: ΔT	=	Measured ΔT; ~~by RTD Manifold Instrumentation;~~
$\frac{1 + \tau_1 S}{1 + \tau_2 S}$	=	Lead-lag compensator on measured ΔT;
τ_1, τ_2	=	Time constants utilized in lead-lag compensator for ΔT, τ_1 = 8 s, τ_2 = 3 s;
$\frac{1}{1 + \tau_3 S}$	=	Lag compensator on measured ΔT;
τ_3	=	Time constant utilized in the lag compensator for ΔT, τ_3 = 0 s;
ΔT_0	=	Indicated ΔT at RATED THERMAL POWER:
K_1	=	1.15;
K_2	=	0.0251/°F;
$\frac{1 + \tau_4 S}{1 + \tau_5 S}$	=	The function generated by the lead-lag compensator for T_{avg} dynamic compensation;
τ_4, τ_5	=	Time constants utilized in the lead-lag compensator for T_{avg}, τ_4 = 28 s, τ_5 = 4 s;
T	=	Average temperature, °F;
$\frac{1}{1 + \tau_6 S}$	=	Lag compensator on measured T_{avg};
τ_6	=	Time constant utilized in the measured T_{avg} lag compensator, τ_6 = 0 s;

TABLE 2.2-1 (Continued)

TABLE NOTATIONS (Continued)

NOTE 3: OVERPOWER ΔT

$$\Delta T \frac{(1 + \tau_1 S)}{(1 + \tau_2 S)} \left(\frac{1}{1 + \tau_3 S}\right) \leq \Delta T_o \{K_4 - K_5 \left(\frac{\tau_7 S}{1 + \tau_7 S}\right) \left(\frac{1}{1 + \tau_6 S}\right) T - K_6 [T \left(\frac{1}{1 + \tau_6 S}\right) - T''] - f_2(\Delta I)\}$$

Where: ΔT = Measured ΔT; ~~by RTD Manifold Instrumentation;~~

$\frac{1 + \tau_1 S}{1 + \tau_2 S}$ = Lead-lag compensator on measured ΔT;

τ_1, τ_2 = Time constants utilized in lead-lag compensator for ΔT, τ_1, = 8 s., τ_2 = 3 s;

$\frac{1}{1 + \tau_3 S}$ = Lag compensator on measured ΔT;

τ_3 = Time constant utilized in the lag compensator for ΔT, τ_3 = 0 s;

ΔT_o = Indicated ΔT at RATED THERMAL POWER;

K_4 = 1.080;

K_5 = 0.02/°F for increasing average temperature and 0 for decreasing average temperature;

$\frac{\tau_7 S}{1 + \tau_7 S}$ = The function generated by the rate-lag compensator for T_{avg} dynamic compensation;

τ_7 = Time constant utilized in the rate-lag compensator for T_{avg}, τ_7 = 10 s;

$\frac{1}{1 + \tau_6 S}$ = Lag compensator on measured T_{avg};

τ_6 = Time constant utilized in the measured T_{avg} lag compensator, τ_6 = 0 s;

TABLE 2.2-1 (Continued)

TABLE NOTATIONS (Continued)

NOTE 3: (Continued)

K_6 = 0.0065/°F for $T > T''$ and $K_6 = 0$ for $T \leq T''$;

T = Average Temperature, °F;

T'' = Indicated T_{avg} at RATED THERMAL POWER (Calibration temperature for ΔT instrumentation, $\leq$ 588.4°F);

S = Laplace transform operator, s^{-1}; and

$f_2(\Delta I)$ = 0 for all ΔI.

NOTE 4: The channel's maximum Trip Setpoint shall not exceed its computed Trip Setpoint by more than ~~3.3%~~ 3.0% of ΔT span.

Intermediate and Source Range, Neutron Flux

The Intermediate and Source Range, Neutron Flux trips provide core protection during reactor startup to mitigate the consequences of an uncontrolled rod cluster control assembly bank withdrawal from a subcritical condition. These trips provide redundant protection to the Low Setpoint trip of the Power Range, Neutron Flux channels. The Source Range channels will initiate a Reactor trip at about 10^5 counts per second unless manually blocked when P-6 becomes active. The Intermediate Range channels will initiate a Reactor trip at a current level equivalent to approximately 25% of RATED THERMAL POWER unless manually blocked when P-10 becomes active.

Overtemperature ΔT

The Overtemperature ΔT trip provides core protection to prevent DNB for all combinations of pressure, power, coolant temperature, and axial power distribution, provided that the transient is slow with respect to piping transit delays from the core to the temperature detectors ~~(about 4 seconds)~~, and pressure is within the range between the Pressurizer High and Low Pressure trips. The Setpoint is automatically varied with: (1) coolant temperature to correct for temperature induced changes in density and heat capacity of water and includes dynamic compensation for piping delays from the core to the loop temperature detectors, (2) pressurizer pressure, and (3) axial power distribution. With normal axial power distribution, this Reactor trip limit is always below the core Safety Limit as shown in Figure 2.1-1. If axial peaks are greater than design, as indicated by the difference between top and bottom power range nuclear detectors, the Reactor trip is automatically reduced according to the notations in Table 2.2-1.

Delta-T_O, as used in the Overtemperature and Overpower ΔT trips, represents the 100% RTP value as measured by the plant for each loop. This normalizes each loop's ΔT trips to the actual operating conditions existing at the time of measurement, thus forcing the trip to reflect the equivalent full power conditions as assumed in the accident analyses. These differences in vessel ΔT can arise due to several factors, the most prevalent being measured RCS loop flows greater than Minimum Measured Flow, and slightly asymmetric power distributions between quadrants. While RCS loop flows are not expected to change with cycle life, radial power redistribution between quadrants may occur, resulting in small changes in loop specific vessel ΔT values. Accurate determination of the loop specific vessel ΔT value should be made when performing the Incore/Excore quarterly recalibration and under steady state conditions (i.e., power distributions not affected by Xe or other transient conditions).

Overpower ΔT

The Overpower ΔT trip provides assurance of fuel integrity (e.g., no fuel pellet melting and less than 1% cladding strain) under all possible overpower conditions, limits the required range for Overtemperature ΔT trip, and provides

TABLE 4.3-1

REACTOR TRIP SYSTEM INSTRUMENTATION SURVEILLANCE REQUIREMENTS

FUNCTIONAL UNIT	CHANNEL CHECK	CHANNEL CALIBRATION	ANALOG CHANNEL OPERATIONAL TEST	TRIP ACTUATING DEVICE OPERATIONAL TEST	ACTUATION LOGIC TEST	MODES FOR WHICH SURVEILLANCE IS REQUIRED
1. Manual Reactor Trip	N.A.	N.A.	N.A.	R(16)	N.A.	1, 2, 3*, 4*, 5*
2. Power Range, Neutron Flux						
a. High Setpoint	S	D(2, 4), M(3, 4), Q(4, 6), R(4, 5)	Q(14)	N.A.	N.A.	1, 2
b. Low Setpoint	S	R(4)	S/U(1)	N.A.	N.A.	1###, 2
3. Power Range, Neutron Flux, High Positive Rate	N.A.	R(4)	Q(14)	N.A.	N.A.	1, 2
4. Power Range, Neutron Flux, High Negative Rate	N.A.	R(4)	Q(14)	N.A.	N.A.	1, 2
5. Intermediate Range, Neutron Flux	S	R(4, 5)	S/U(1)	N.A.	N.A.	1###, 2
6. Source Range, Neutron Flux	S	R(4, 5, 12)	S/U(1),Q(9,14)	N.A.	N.A.	2##, 3, 4, 5
7. Overtemperature ΔT	S	R~~(13)~~	Q(14)	N.A.	N.A.	1, 2
8. Overpower ΔT	S	R	Q(14)	N.A.	N.A.	1, 2
9. Pressurizer Pressure-Low	S	R	Q(14)	N.A.	N.A.	1
10. Pressurizer Pressure-High	S	R	Q(14)	N.A.	N.A.	1, 2
11. Pressurizer Water Level-High	S	R	Q(14)	N.A.	N.A.	1
12. Reactor Coolant Flow-Low	S	R	Q(14)	N.A.	N.A.	1

TABLE 4.3-1 (Continued)

TABLE NOTATIONS

(10) Setpoint verification is not required.

(11) Following maintenance or adjustment of the Reactor trip breakers, the TRIP ACTUATING DEVICE OPERATIONAL TEST shall include independent verification of the Undervoltage and Shunt trips.

(12) At least once per 18 months during shutdown, verify that on a simulated Boron Dilution Doubling test signal the normal CVCS discharge valves will close and the centrifugal charging pumps suction valves from the RWST will open within 30 seconds.

(13) ~~CHANNEL CALIBRATION shall include the RTD bypass loops flow rate.~~ Deleted.

(14) Each channel shall be tested at least every 92 days on a STAGGERED TEST BASIS.

(15) The surveillance frequency and/or MODES specified for these channels in Table 4.3-2 are more restrictive and, therefore, applicable.

(16) The TRIP ACTUATING DEVICE OPERATIONAL TEST shall independently verify the OPERABILITY of the Undervoltage and Shunt Trip circuits for the Manual Reactor Trip function. The test shall also verify the OPERABILITY of the Bypass Breaker trip circuit.

(17) Local manual shunt trip prior to placing breaker in service.

(18) Automatic Undervoltage Trip.

TABLE 3.3-4 (Continued)

ENGINEERED SAFETY FEATURES ACTUATION SYSTEM INSTRUMENTATION TRIP SETPOINTS

FUNCTIONAL UNIT	TOTAL ALLOWANCE (TA)	Z	SENSOR ERROR (S)	TRIP SETPOINT	ALLOWABLE VALUE
6. Auxiliary Feedwater (Continued)					
d. Steam Generator Water Level Low-Low (Continued)					
1) Start Motor-Driven Pumps					
a. Vessel ΔT Equivalent < 10% RTP Vessel ΔT (Power-1)	6.0	~~2.38~~ 2.72	~~2.0~~ 1.65	≤ Vessel ΔT Equivalent to 10% RTP	≤ Vessel ΔT Equivalent to ~~14.0%~~ 13.9% RTP
Coincident with					
Steam Generator Water Level Low-Low (Adverse Containment Environment)	20.2	17.58	2.0	≥ 20.2% of Narrow Range Instrument Span	≥ 18.4% of Narrow Range Instrument Span
and					
Containment Pressure - Environmental Allowance Modifier	2.8	0.71	2.0	≤ 1.5 psig	≤ 2.0 psig
OR					
Steam Generator Water Level Low-Low (Normal Containment Environment)	14.8	12.18	2.0	≥ 14.8% of Narrow Range Instrument Span	≥ 13.0% of Narrow Range Instrument Span
With a Time Delay, (t)				≤ 232 seconds	≤ 240 seconds

TABLE 3.3-4 (Continued)

ENGINEERED SAFETY FEATURES ACTUATION SYSTEM INSTRUMENTATION TRIP SETPOINTS

FUNCTIONAL UNIT	TOTAL ALLOWANCE (TA)	Z	SENSOR ERROR (S)	TRIP SETPOINT	ALLOWABLE VALUE
6. Auxiliary Feedwater (Continued)					
d. Steam Generator Water Level Low-Low (Continued)					
1) Start Motor-Driven Pumps (Continued)					
b. 10% RTP < Vessel ΔT Equivalent < 20% RTP Vessel ΔT (Power-2)	6.0	~~2.38~~ 2.72	~~2.0~~ 1.65	< Vessel ΔT Equivalent to 20% RTP	< Vessel ΔT Equivalent to ~~24.0%~~ 23.9% RTP
Coincident with					
Steam Generator Water Level Low-Low (Adverse Containment Environment)	20.2	17.58	2.0	> 20.2% of Narrow Range Instrument Span	> 18.4% of Narrow Range Instrument Span
and					
Containment Pressure-Environmental Allowance Modifier	2.8	0.71	2.0	≤ 1.5 psig	≤ 2.0 psig
OR					
Steam Generator Water Level Low-Low (Normal Containment Environment)	14.8	12.18	2.0	> 14.8% of Narrow Range Instrument Span	> 13.0% of Narrow Range Instrument Span
With a Time Delay, (t)				≤ 122 seconds	≤ 130 seconds

TABLE 3.3-4 (Continued)

ENGINEERED SAFETY FEATURES ACTUATION SYSTEM INSTRUMENTATION TRIP SETPOINTS

FUNCTIONAL UNIT	TOTAL ALLOWANCE (TA)	Z	SENSOR ERROR (S)	TRIP SETPOINT	ALLOWABLE VALUE
6. Auxiliary Feedwater (Continued)					
d. Steam Generator Water Level Low-Low (Continued)					
2) Start Turbine-Driven Pump					
a. Vessel ΔT Equivalent ≤ 10% RTP Vessel ΔT (Power-1)	6.0	~~2.38~~ 2.72	~~2.0~~ 1.65	≤ Vessel ΔT Equivalent to 10% RTP	≤ Vessel ΔT Equivalent to ~~14.0%~~ RTP 13.9%
Coincident with					
Steam Generator Water Level Low-Low (Adverse Containment Environment)	20.2	17.58	2.0	≥ 20.2% of Narrow Range Instrument Span	≥ 18.4% of Narrow Range Instrument Span
and					
Containment Pressure - Environmental Allowance Modifier	2.8	0.71	2.0	≤ 1.5 psig	≤ 2.0 psig
OR					
Steam Generator Water Level Low-Low (Normal Containment Environment)	14.8	12.18	2.0	≥ 14.8% of Narrow Range Instrument Span	≥ 13.0% of Narrow Range Instrument Span
With a Time Delay, (t)				≤ 232 seconds	≤ 240 seconds

TABLE 3.3-4 (Continued)

ENGINEERED SAFETY FEATURES ACTUATION SYSTEM INSTRUMENTATION TRIP SETPOINTS

FUNCTIONAL UNIT	TOTAL ALLOWANCE (TA)	Z	SENSOR ERROR (S)	TRIP SETPOINT	ALLOWABLE VALUE
6. Auxiliary Feedwater (Continued)					
d. Steam Generator Water Level Low-Low (Continued)					
2) Start Turbine-Driven Pump (Continued)					
b. 10% RTP < Vessel ΔT Equivalent < 20% RTP Vessel ΔT (Power-2)	6.0	2.72 ~~2.38~~	1.65 ~~2.0~~	< Vessel ΔT Equivalent to 20% RTP	< Vessel ΔT Equivalent to ~~24.0%~~ RTP 23.9%
Coincident with					
Steam Generator Water Level Low-Low (Adverse Containment Environment)	20.2	17.58	2.0	> 20.2% of Narrow Range Instrument Span	> 18.4% of Narrow Range Instrument Span
And					
Containment Pressure - Environmental Allowance Modifier	2.8	0.71	2.0	≤ 1.5 psig	≤ 2.0 psig
OR					
Steam Generator Water Level Low-Low (Normal Containment Environment)	14.8	12.18	2.0	> 14.8% of Narrow Range Instrument Span	> 13.0% of Narrow Range Instrument Span
With a Time Delay, (t)				≤ 122 seconds	≤ 130 seconds

ATTACHMENT 5

DRAFT FSAR REVISIONS

FOR

RTD BYPASS ELIMINATION

Table 3.11(B)-3	Sheets 41, 42, 43
Table 3.11(B)-7	Sheet 3
Figure 5.1-1	Sheet 1
Figure 5.1-2 and Notes (Sheets 1, 2)	
Pages 5.4-24 through 5.4-27	
Insert A	
Insert B	
Pages 7.2-13, 7.2-14, 7.2-34, 7.2-35	

TABLE 3.11(B)-3 (Sheet 41)

COMPONENT NUMBER	DESCRIPTION	LOCATION ROOM NUMBER	SPEC. NUMBER	(4) SHUTDN HOT	COLD	CATEGORY LOCA	MSLB	HELB	NORM ENV	ACCIDENT ENVIRONMENT T	P	R	H	SP		R
BB-SBB05A	RTD CL Loop 1	2000	M 725			B	B	D	T1	F3	F6	T2	T2	T2	*	1
BB-SBB05B	RTD CL Loop 2	2000	M 725			B	B	D	T1	F3	F6	T2	T2	T2	*	1
BB-SBB05C	RTD CL Loop 2	2000	M 725			B	B	D	T1	F3	F6	T2	T2	T2	*	1
BB-SBB05D	RTD CL Loop 2	2000	M 725			B	B	D	T1	F3	F6	T2	T2	T2	*	1
BB-TBB03	Pressurizer	2000	M 713	X	X	B	B	D	T1	F3	F6	T2	T2	T2	*	16
BB-T/C-XXXX	RV Core Subcooling Monitor Thermocouples (50)	2000	W (ESE-43A)			A	A	D	T1	F3	F6	T2	T2	T2		11
BB-T/C-XXXX	RV Core Subcool. Mon. Thermocoup. Connectors (50)	2000	W (ESE-43B)			A	A	D	T1	F3	F6	T2	T2	T2		11
BB-T/C-XXXX	RV Core Subcool. Mon. TC Splices (50)	2000	W (J-1034)			A	A	D	T1	F3	F6	T2	T2	T2		15
BB-TE-0410A1 ✓, A2, A3	RCS Hot Leg RTD ~~Manif~~ Temp Ele (Installed Spare)	2201	~~W (HE-8)~~ S 1027			C	A	D	T1	F3	F6	T2	T2	T2		8
BB-TE-0410A1 ✓, A2, A3	RCS Hot Leg RTD ~~Manif~~ Temp Ele Connector ✓ (Installed Spare)	2201	~~W (ESE-5)~~ S 1027			C	A	D	T1	F3	F6	T2	T2	T2		
BB-TE-0410B	RCS Cold Leg RTD ~~Manif~~ Temp Ele (Installed Spare)	2201	~~W (ESE-5)~~ S 1027			C	A	D	T1	F3	F6	T2	T2	T2		
BB-TE-0410B	RCS Cold Leg RTD ~~Manif~~ Temp Ele Connector ✓ (Installed Spare)	2201	~~W (HE-8)~~ S 1027			C	A	D	T1	F3	F6	T2	T2	T2		8
BB-TE-0411A1 ✓, A2, A3	RCS Hot-Leg RTD ~~Manifold~~ Temp Element Loop 1	2201	~~W (ESE-5)~~ S 1027	X	X	C	A	D	T1	F3	F6	T2	T2	T2		16
BB-TE-0411A1 ✓, A2, A3	RCS Hot-Leg RTD ~~Manifold~~ Temp Element Loop 1 Connector ✓	2201	~~W (HE-8)~~ S 1027	X	X	C	A	D	T1	F3	F6	T2	T2	T2		16
BB-TE-0411B	RCS Cold-Leg RTD ~~Manifold~~ Temp Element Loop 1	2201	~~W (ESE-5)~~ S 1027	X	X	C	A	D	T1	F3	F6	T2	T2	T2		16
BB-TE-0411B	RCS Cold-Leg RTD ~~Manifold~~ Temp Element Loop 1 Connector ✓	2201	~~W (HE-8)~~ S 1027	X	X	C	A	D	T1	F3	F6	T2	T2	T2		16
BB-TE-0413A	RCS Hot-Leg Temperature Element (WR) Loop 1	2201	W (HE-8)	X	X	A	A	D	T1	F3	F6	T2	T2	T2		16
BB-TE-0413A	RCS Hot-Leg Temperature Element (WR) Loop 1	2201	W (ESE-6)	X	X	A	A	D	T1	F3	F6	T2	T2	T2		16
BB-TE-0413B	RCS Cold Leg Temp Element (WR) Loop 1	2201	W (ESE-6)	X	X	A	A	D	T1	F3	F6	T2	T2	T2		16
BB-TE-0413B	RCS Cold Leg Temp Element (WR) Loop 1	2201	W (HE-8)	X	X	A	A	D	T1	F3	F6	T2	T2	T2		16

TABLE 3.11(B)-3 (Sheet 42)

COMPONENT NUMBER	DESCRIPTION	LOCATION ROOM NUMBER	SPEC. NUMBER	(4) SHUTDN HOT	COLD	CATEGORY LOCA	MSLB	HELB	NORM ENV	ACCIDENT ENVIRONMENT T	P	R	H	SP	R
BB-TE-0420A1, A2, A3	RCS Hot Leg RTD ~~Manif~~ Temp Ele (Installed Spare)	2201	~~W (ESE-5)~~ S 1027			C	A	D	T1	F3	F6	T2	T2	T2	
BB-TE-0420A1, A2, A3	RCS Hot Leg RTD ~~Manif~~ Temp Ele Connector (Installed Spare)	2201	~~W (HE-8)~~ S 1027			C	A	D	T1	F3	F6	T2	T2	T2	8
BB-TE-0420B	RCS Cold Leg RTD ~~Manif~~ Temp Ele (Installed Spare)	2201	~~W (ESE-5)~~ S 1027			C	A	D	T1	F3	F6	T2	T2	T2	
BB-TE-0420B	RCS Cold Leg RTD ~~Manif~~ Temp Ele Connector (Installed Spare)	2201	~~W (HE-8)~~ S 1027			C	A	D	T1	F3	F6	T2	T2	T2	8
BB-TE-0421A1, A2, A3	RCS Hot Leg RTD ~~Manifold~~ Temp Element Loop 2	2201	~~W (HE-8)~~ S 1027	X	X	C	A	D	T1	F3	F6	T2	T2	T2	16
BB-TE-0421A1, A2, A3	RCS Hot Leg RTD ~~Manifold~~ Temp Element Loop 2 Connector	2201	~~W (ESE-5)~~ S 1027	X	X	C	A	D	T1	F3	F6	T2	T2	T2	16
BB-TE-0421B	RCS Cold Leg RTD ~~Manifold~~ Temp Element Loop 2	2201	~~W (ESE-5)~~ S 1027	X	X	C	A	D	T1	F3	F6	T2	T2	T2	16
BB-TE-0421B	RCS Cold Leg RTD ~~Manifold~~ Temp Element Loop 2 Connector	2201	~~W (HE-8)~~ S 1027	X	X	C	A	D	T1	F3	F6	T2	T2	T2	16
BB-TE-0423A	RCS Hot Leg Temp Element (WR) Loop 2	2201	W (ESE-6)	X	X	A	A	D	T1	F3	F6	T2	T2	T2	16
BB-TE-0423A	RCS Hot Leg Temp Element (WR) Loop 2	2201	W (HE-8)	X	X	A	A	D	T1	F3	F6	T2	T2	T2	16
BB-TE-0423B	RCS Cold Leg Temp Element (WR) Loop 2	2201	W (ESE-6)	X	X	A	A	D	T1	F3	F6	T2	T2	T2	16
BB-TE-0423B	RCS Cold Leg Temp Element (WR) Loop 2	2201	W (HE-8)	X	X	A	A	D	T1	F3	F6	T2	T2	T2	16
BB-TE-0430A1, A2, A3	RCS Hot Leg RTD ~~Manif~~ Temp Ele (Installed Spare)	2201	~~W (HE-8)~~ S 1027			C	A	D	T1	F3	F6	T2	T2	T2	8
BB-TE-0430A1, A2, A3	RCS Hot Leg RTD ~~Manif~~ Temp Ele Connector (Installed Spare)	2201	~~W (ESE-5)~~ S 1027			C	A	D	T1	F3	F6	T2	T2	T2	
BB-TE-0430B	RCS Cold Leg RTD ~~Manif~~ Temp Ele (Installed Spare)	2201	~~W (ESE-5)~~ S 1027			C	A	D	T1	F3	F6	T2	T2	T2	
BB-TE-0430B	RCS Cold Leg RTD ~~Manif~~ Temp Ele Connector (Installed Spare)	2201	~~W (HE-8)~~ S 1027			C	A	D	T1	F3	F6	T2	T2	T2	8
BB-TE-0431A1, A2, A3	RCS Hot Leg RTD ~~Manifold~~ Temp Element Loop 3	2201	~~W (ESE-5)~~ S 1027	X	X	C	A	D	T1	F3	F6	T2	T2	T2	16
BB-TE-0431A1, A2, A3	RCS Hot Leg RTD ~~Manifold~~ Temp Element Loop 3 Connector	2201	~~W (HE-8)~~ S 1027	X	X	C	A	D	T1	F3	F6	T2	T2	T2	16
BB-TE-0431B	RCS Cold Leg RTD ~~Manifold~~ Temp Element Loop 3	2201	~~W (ESE-5)~~ S 1027	X	X	C	A	D	T1	F3	F6	T2	T2	T2	16
BB-TE-0431B	RCS Cold Leg RTD ~~Manifold~~ Temp Element Loop 3 Connector	2201	~~W (HE-8)~~ S 1027	X	X	C	A	D	T1	F3	F6	T2	T2	T2	16

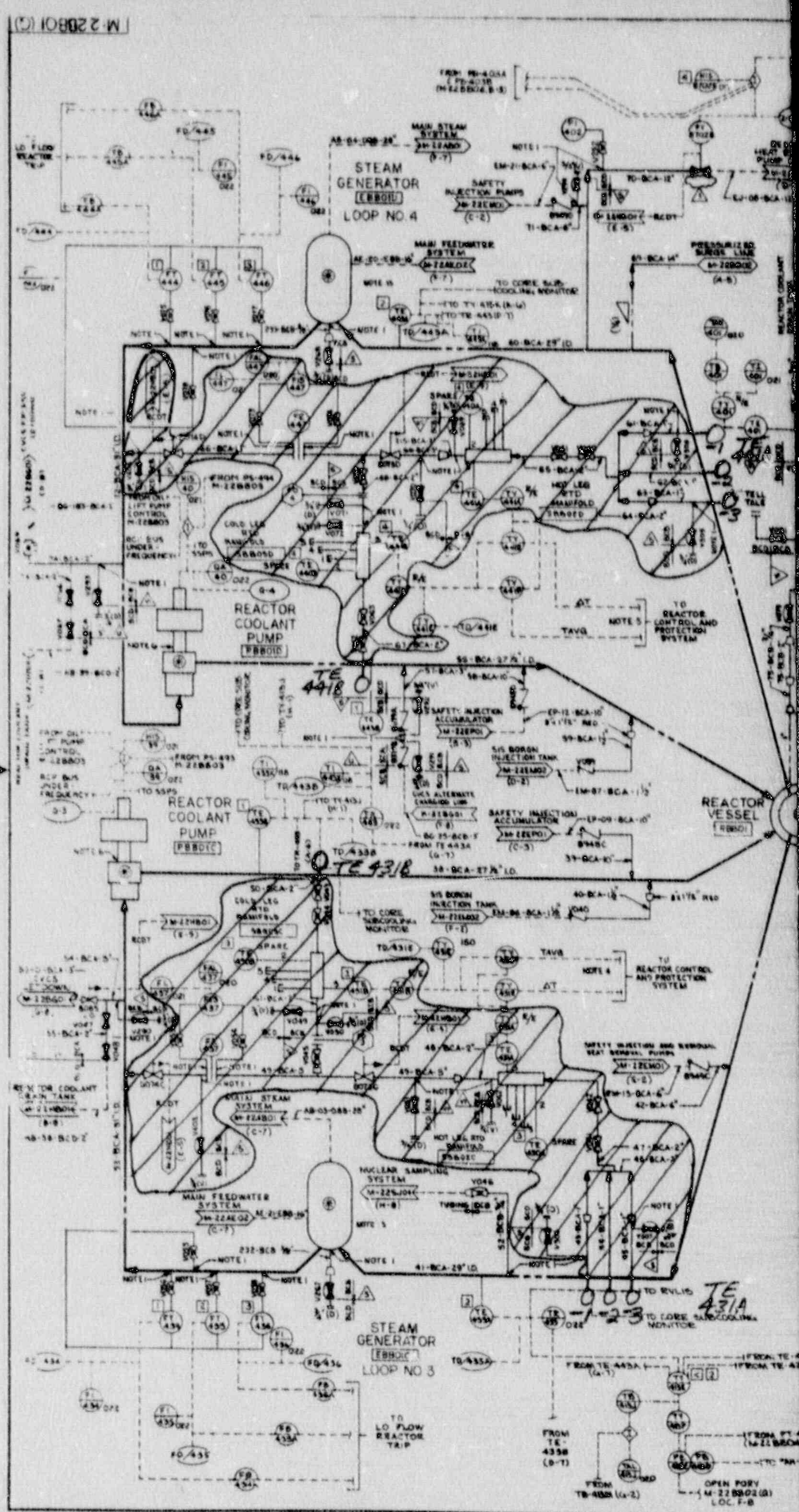
TABLE 3.11(B)-3 (Sheet 43)

COMPONENT NUMBER	DESCRIPTION	LOCATION ROOM NUMBER	SPEC. NUMBER	(4) SHUTDN HOT	COLD	CATEGORY LOCA	MSLB	HELB	NORM ENV	ACCIDENT ENVIRONMENT T	P	R	H	SP	R
BB-TE-0433A	RCS Hot Leg Temperature Element (WR) Loop 3	2201	W (HE-8)	X	X	A	A	D	T1	F3	F6	T2	T2	T2	16
BB-TE-0433A	RCS Hot Leg Temperature Element (WR) Loop 3	2201	W (ESE-6)	X	X	A	A	D	T1	F3	F6	T2	T2	T2	16
BB-TE-0433B	RCS Cold Leg Temperature Element (WR) Loop 3	2201	W (ESE-6)	X	X	A	A	D	T1	F3	F6	T2	T2	T2	16
BB-TE-0433B	RCS Cold Leg Temperature Element (WR) Loop 3	2201	W (HE-8)	X	X	A	A	D	T1	F3	F6	T2	T2	T2	16
BB-TE-0440A1, A2, A3	RCS Hot Leg RTD ~~Manif~~ Temp Ele (Installed Spare)	2201	~~W (ESE-5)~~ S 1027			C	A	D	T1	F3	F6	T2	T2	T2	
BB-TE-0440A1, A2, A3	RCS Hot Leg RTD ~~Manif~~ Temp Ele Connector (Installed Spare)	2201	~~W (HE-8)~~ S 1027			C	A	D	T1	F3	F6	T2	T2	T2	8
BB-TE-0440B	RCS Cold Leg RTD ~~Manif~~ Temp Ele (Installed Spare)	2201	~~W (ESE-5)~~ S 1027			C	A	D	T1	F3	F6	T2	T2	T2	
BB-TE-0440B	RCS Cold Leg RTD ~~Manif~~ Temp Ele Connector (Installed Spare)	2201	~~W (HE-8)~~ S 1027			C	A	D	T1	F3	F6	T2	T2	T2	8
BB-TE-0441A1, A2, A3	RCS Hot Leg RTD ~~Manifold~~ Temp Element Loop 4	2201	~~W (HE-8)~~ S 1027	X	X	C	A	D	T1	F3	F6	T2	T2	T2	16
BB-TE-0441A1, A2, A3	RCS Hot Leg RTD ~~Manifold~~ Temp Element Loop 4 Connector	2201	~~W (ESE-5)~~ S 1027	X	X	C	A	D	T1	F3	F6	T2	T2	T2	16
BB-TE-0441B	RCS Cold Leg RTD ~~Manifold~~ Temp Element Loop 4	2201	~~W (ESE-5)~~ S 1027	X	X	C	A	D	T1	F3	F6	T2	T2	T2	16
BB-TE-0441B	RCS Cold Leg RTD ~~Manifold~~ Temp Element Loop 4 Connector	2201	~~W (HE-8)~~ S 1027	X	X	C	A	D	T1	F3	F6	T2	T2	T2	16
BB-TE-0443A	RCS Hot Leg Temperature Element (WR) Loop 4	2201	W (ESE-6)	X	X	A	A	D	T1	F3	F6	T2	T2	T2	16
BB-TE-0443A	RCS Hot Leg Temperature Element (WR) Loop 4	2201	W (HE-8)	X	X	A	A	D	T1	F3	F6	T2	T2	T2	16
BB-TE-0443B	RCS Cold Leg Temperature Element (WR) Loop 4	2201	W (ESE-6)	X	X	A	A	D	T1	F3	F6	T2	T2	T2	16
BB-TE-0443B	RCS Cold Leg Temperature Element (WR) Loop 4	2201	W (HE-8)	X	X	A	A	D	T1	F3	F6	T2	T2	T2	16
BB-TE-1313	RVLIS Head Impulse Line Temp Element	2000	W (ESE-42A)			A	A	D	T1	F3	F6	T2	T2	T2	15
BB-TE-1314	RVLIS Head Impulse Line Temp Element	2000	W (ESE-42A)			A	A	D	T1	F3	F6	T2	T2	T2	15
BB-TE-1317	RVLIS Seal Impulse Line Temp Element	2000	W (ESE-42A)			A	A	D	T1	F3	F6	T2	T2	T2	15
BB-TE-1318	RVLIS Seal Impulse Line Temp Element	2000	W (ESE-42A)			A	A	D	T1	F3	F6	T2	T2	T2	15

TABLE 3.11(B)-7 (Sheet 3)

SPECIFICATION	DESCRIPTION
M236	Motor-Operated Butterfly Valves (1)
M237-1	Butterfly Valves (Limitorque) (OC)
M237-2	Butterfly Valves (Limitorque) (IC)
M237-3	Butterfly Valves (Bettis)
M612	Room Coolers
M619.3	Hydrogen Mixing Fans
M620	Containment Cooling Fans
M627A	Dampers
M628	Steam Isolation Valves
M630	Feedwater Isolation Valves
S1027	Narrow Range RCS RTDs
W(AE2)	Large Pump Motors
W(AE3)	Canned Safety-Related Pump Motors (1)
W(ESE-01A)-1	Pressure Transmitters (A) (Barton-IC)
W(ESE-01A)-2	Pressure Transmitters (A) (Barton-OC)
W(ESE-01B)	Pressure Transmitters (A) (Veritrak)
W(ESE-01C)-1	Pressure Transmitters (A) (Tobar-IC)
W(ESE-01C)-2	Pressure Transmitters (A) (Tobar-OC)
W(ESE-03A)	D.P. Transmitters (A) (Barton)
W(ESE-03C)	D.P. Transmitters (A) (Tobar)
W(ESE-04A)	D.P. Transmitters (B) (Barton)
W(ESE-04D)	D.P. Transmitters (B) (Rosemount)
~~W(ESE-05)~~	~~RTDs (bypass)~~
W(ESE-06)	RTDs
W(ESE-08)	Excore Neutron Detectors (power range) (1)

See CN# 89-06



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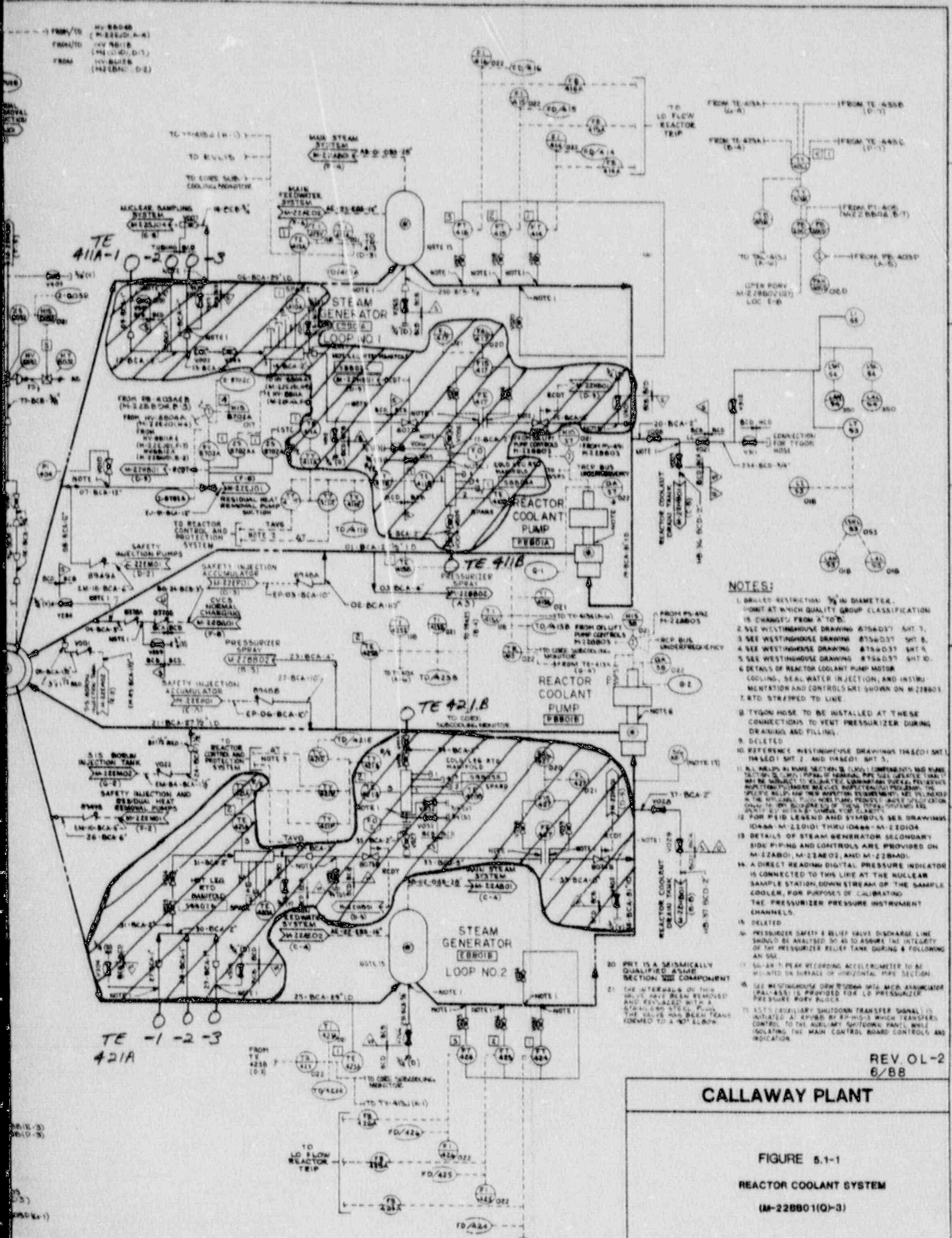
Also Available On Aperture Card



NOTES:

1. DRILLED RESTRICTION 3/8" IN DIAMETER. POINT AT WHICH QUALITY GROUP CLASSIFICATION IS CHANGED FROM 'A' TO 'B'.
2. SEE WESTINGHOUSE DRAWING 8756D37 SHT 7.
3. SEE WESTINGHOUSE DRAWING 8756D37 SHT 8.
4. SEE WESTINGHOUSE DRAWING 8756D37 SHT 9.
5. SEE WESTINGHOUSE DRAWING 8756D37 SHT 10.
6. DETAILS OF REACTOR COOLANT PUMP MOTOR COOLING, SEAL WATER INJECTION, AND INSTRUMENTATION AND CONTROLS ARE SHOWN ON M-22BB03.
7. RTD STRAPPED TO LINE.
8. TYGON HOSE TO BE INSTALLED AT THESE CONNECTIONS TO VENT PRESSURIZER DURING DRAINING AND FILLING.
9. DELETED
10. REFERENCE WESTINGHOUSE DRAWINGS 1145E01 SHT 1, 1145E01 SHT 2, AND 1145E01 SHT 3.
11. [illegible]
12. FOR P&ID LEGEND AND SYMBOLS SEE DRAWINGS 10466-M-220101 THRU 10466-M-220104.
13. DETAILS OF STEAM GENERATOR SECONDARY SIDE PIPING AND CONTROLS ARE PROVIDED ON M-22AB01, M-22AE02, AND M-22BM01.
14. A DIRECT READING DIGITAL PRESSURE INDICATOR IS CONNECTED TO THIS LINE AT THE NUCLEAR SAMPLE STATION, DOWNSTREAM OF THE SAMPLE COOLER, FOR PURPOSES OF CALIBRATING THE PRESSURIZER PRESSURE INSTRUMENT CHANNELS.
15. DELETED.
16. PRESSURIZER SAFETY & RELIEF VALVE DISCHARGE LINE SHOULD BE ANALYSED SO AS TO ASSURE THE INTEGRITY OF THE PRESSURIZER RELIEF TANK DURING & FOLLOWING AN SSE.
17. SG-AR-1 PEAK RECORDING ACCELEROMETER TO BE MOUNTED ON SURFACE OF HORIZONTAL PIPE SECTION.
18. SEE WESTINGHOUSE DRW 7520D66 SHT 6. MCB ANNUNCIATOR (PAL-455) IS PROVIDED FOR LO PRESSURIZER PRESSURE PORV BLOCK.
19. ASTS (AUXILIARY SHUTDOWN TRANSFER SIGNAL) IS INITIATED AT RP118B BY RP-HIS-3 WHICH TRANSFERS CONTROL TO THE AUXILIARY SHUTDOWN PANEL WHILE ISOLATING THE MAIN CONTROL BOARD CONTROLS AND INDICATION.
20. PRT IS A SEISMICALLY QUALIFIED ASME SECTION VIII COMPONENT
21. THE INTERNALS OF THIS VALVE HAVE BEEN REMOVED AND REPLACED WITH A STAINLESS STEEL PLUG. THE VALVE HAS BEEN TRANSFORMED TO A 90° ELBOW.

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CALLAWAY PLANT

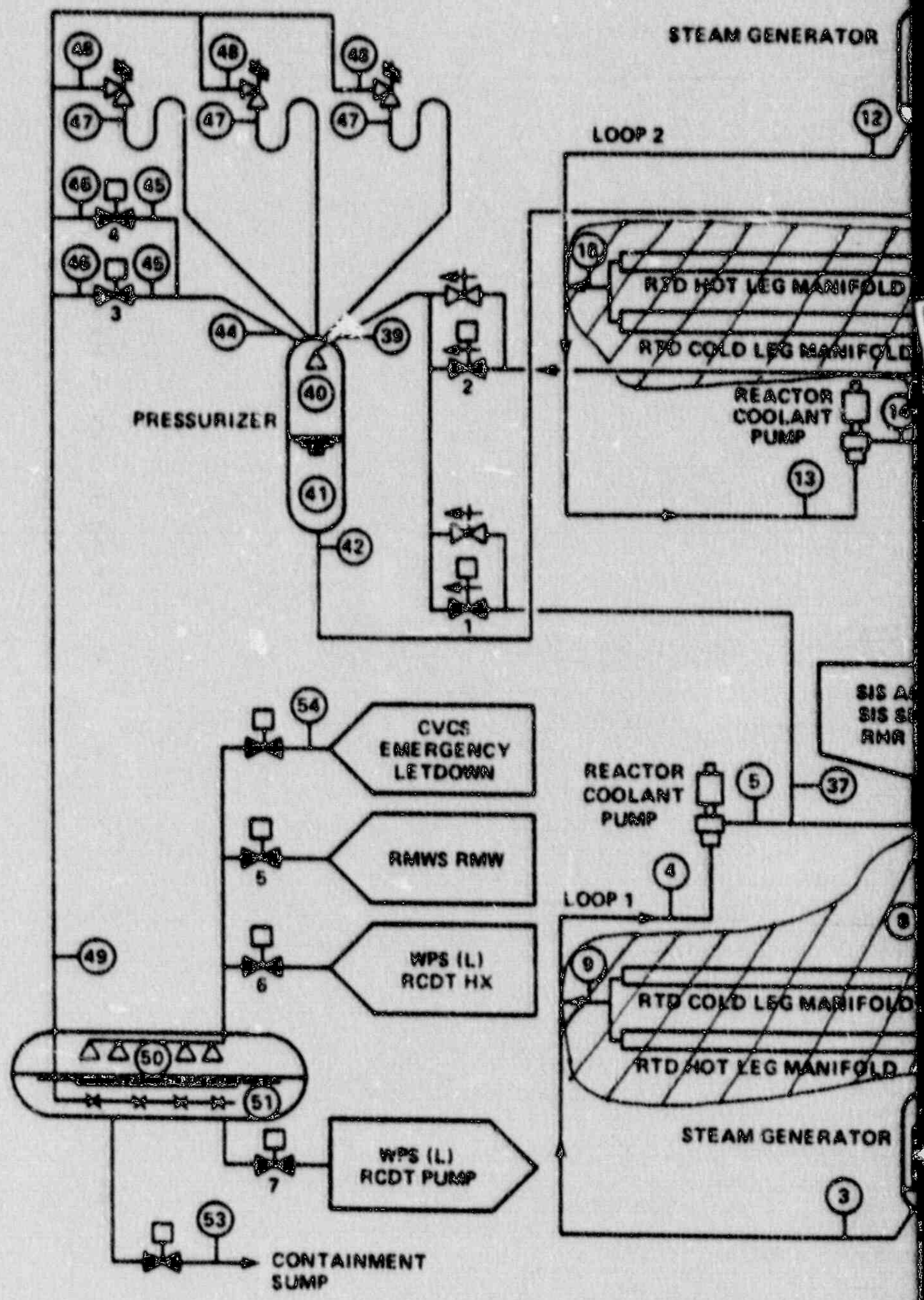
FIGURE 5.1-1

REACTOR COOLANT SYSTEM

(M-22BB01(Q)-3)

SHEET 1

9004200105-01



NOTES:

THIS DIAGRAM IS A SIMPLIFICATION OF THE SYSTEM INTENDED TO FACILIATE THE UNDERSTANDING PROCESS. FOR DETAILS OF THE PIPING, VALVES, INSTRUMENTATION, ETC. REFER TO THE ENGINEER FLOW DIAGRAM. REFER TO PROCESS FLOW DIAGRAM TABLES FOR THE CONDITIONS AT EACH NUMBE

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CARD

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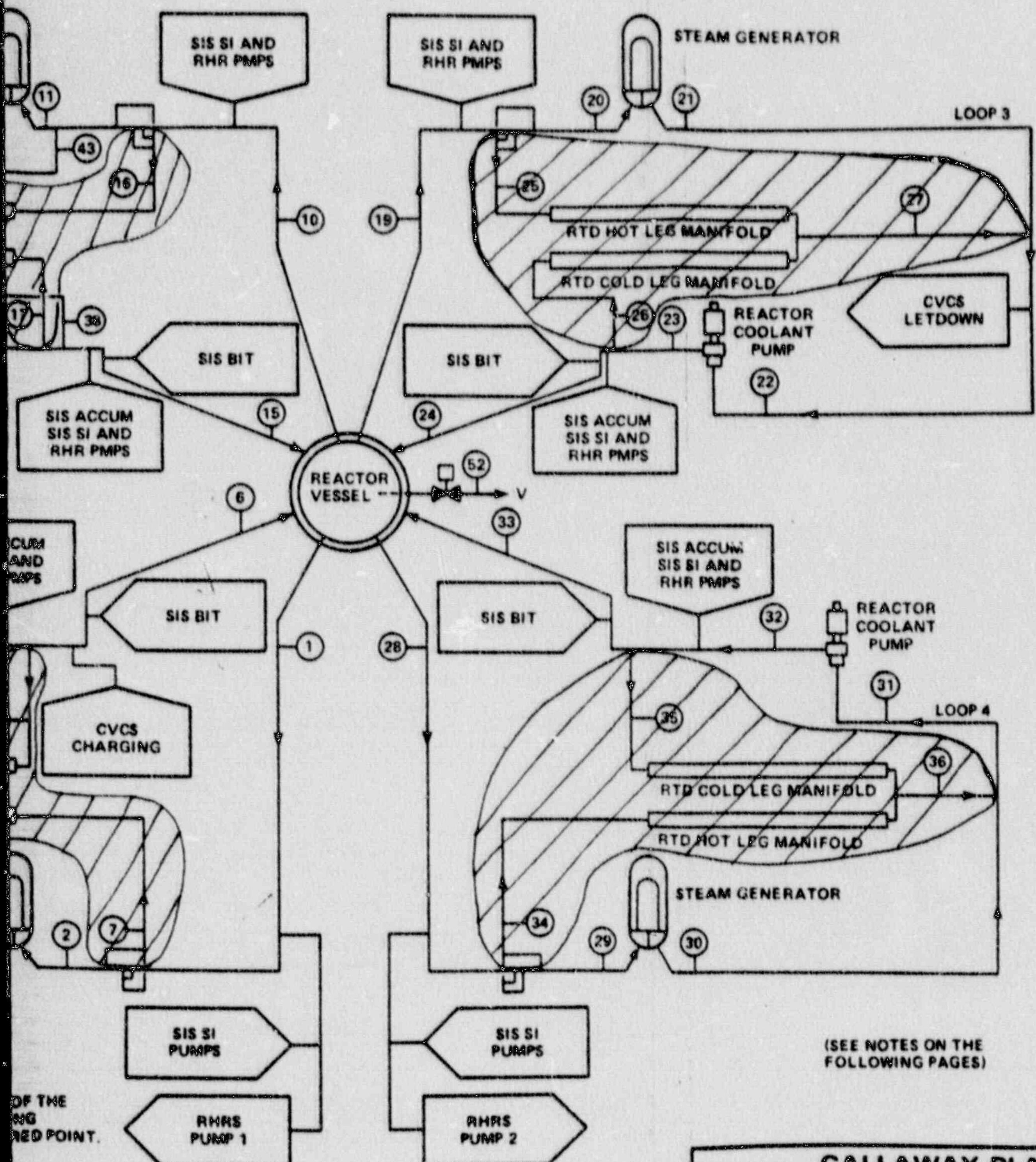
Also Available On
Aperture Card



(SEE NOTES ON THE FOLLOWING PAGES)

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CALLAWAY PLANT

FIGURE 5.1-2

REACTOR COOLANT SYSTEM
PROCESS FLOW DIAGRAM

9004200105-02

NOTES TO FIGURE 5.1-2

Mode A Steady State Full Power Operation

Location	Fluid	Pressure (psig)	Temperature (F)	Flow gpm(1)	Flow lb/hr(2)	Volume
1	Reactor coolant	2,235.0	616.9	110,250	36.7125	-
2	Reactor coolant	2,233.1	616.9	110,150	36.6792	-
3	Reactor coolant	2,195.9	559.1	98,930	36.6792	-
4	Reactor coolant	2,192.4	559.1	99,100	36.7403	-
5	Reactor coolant	2,285.1	559.4	99,000	36.7428	-
6	Reactor coolant	2,283.2	559.4	98,900	36.7125	-
~~7(3)~~	~~Reactor coolant~~	~~2,234.1~~	~~616.9~~	~~100~~	~~0.0333~~	~~-~~
~~8(4)~~	~~Reactor coolant~~	~~2,285.1~~	~~559.4~~	~~100~~	~~0.0371~~	
~~9~~	~~Reactor coolant~~	~~2,194.2~~	~~587.8~~	~~199~~	~~0.0704~~	~~-~~
10-~~18~~ 15	Reactor coolant	See Loop #1 Specifications				
19-~~27~~ 24	Reactor coolant	See Loop #1 Specifications				
28-~~36~~ 33	Reactor coolant	See Loop #1 Specifications				
37	Reactor coolant	2,285.1	559.4	1.0	0.0004	-
38	Reactor coolant	2,285.1	559.4	1.0	0.0004	-
39	Reactor coolant	2,235.0	559.4	2.0	0.0008	-

NOTES TO FIGURE 5.1-2 (Sheet 2)

Location	Fluid	Pressure (psig)	Temperature (F)	Flow gpm[(1)]	lb/hr[(2)]	Volume
40	Steam	2,235.0	652.7	-	-	720
41	Reactor coolant	2,235.0	652.7	-	-	1,080
42	Reactor coolant	2,235.0	652.7	2.5	0.0008	-
43	Reactor coolant	2,235.0	652.7	2.5	0.0008	-
44	Steam	2,235.0	652.7	0	0	-
45	Reactor coolant	2,235.0	<652.7	0	0	Minimize
46	N_2	3.0	120	0	0	-
47	Reactor coolant	2,235.0	<652.7	0	0	Minimize
48	N_2	3.0	120	0	0	-
49	N_2	3.0	120	0	0	-
50	N_2	3.0	120	-	-	450
51	Pres-surizer relief tank water	3.0	120	-	-	1,350
52	Steam/H_2	2,235.0	559	0	0	-
53	Reactor coolant	3.0	120	0	0	-
54	Reactor coolant	50	170	0	0	-

(1) At the conditions specified.

(2) X 10^6.

~~(3) Location point refers to the three 1" connections on the hot leg.~~

~~(4) Location point refers to the 2" connection on the cold leg.~~

Class 1 formula of Paragraph NB-3641.1(3) with an allowable stress value of 17,550 psi. The pipe wall thickness for the pressurizer surge line is Schedule 160. The minimum pipe bend radius is 5 nominal pipe diameters, and ovality does not exceed 6 percent.

All butt welds, branch connection nozzle welds, and boss welds are of a full penetration design.

Processing and minimization of sensitization are discussed in Section 5.2.3.

Flanges conform to ANSI B16.5.

Socket weld fittings and socket joints conform to ANSI B16.11.

Inservice inspection is discussed in Section 5.2.4.

5.4.3.2 Design Description

The RCS piping includes those sections of piping interconnecting the reactor vessel, steam generator, and reactor coolant pump. It also includes the following:

a. Charging line and alternate charging line from the system isolation valve up to the branch connections on the reactor coolant loop

b. Letdown line and excess letdown line from the branch connections on the reactor coolant loop to the system isolation valve

c. Pressurizer spray lines from the reactor coolant cold legs to the spray nozzle on the pressurizer vessel

d. Residual heat removal lines to or from the reactor coolant loops up to the designated check valve or isolation valve

e. Safety injection lines from the designated check valve to the reactor coolant loops

f. Accumulator lines from the designated check valve to the reactor coolant loops

~~g. Resistance temperature detector manifold bypass loop piping~~

g. ~~h.~~ Loop fill, loop drain, sample*, and instrument* lines to or from the designated isolation valve to or from the reactor coolant loops

h. ~~i.~~ Pressurizer surge line from one reactor coolant loop hot leg to the pressurizer vessel inlet nozzle

i. ~~j.~~ Resistance temperature detector scoop element, pressurizer spray scoop, sample connection* with scoop, reactor coolant temperature element installation boss, and the temperature element thermowell itself

j. ~~k.~~ All branch connection nozzles attached to reactor coolant loops

k. ~~l.~~ Pressure relief lines from nozzles on top of the pressurizer vessel up to and through the power operated pressurizer relief valves and pressurizer safety valves

l. ~~m.~~ Seal injection water lines to the reactor coolant pump to the designated check valve (injection line)

m. ~~n.~~ Auxiliary spray line from the isolation valve to the pressurizer spray line header

n. ~~o.~~ Sample lines* from pressurizer to the isolation valve

o. ~~p.~~ Reactor vessel head vent lines* to the isolation valves

Principal design data for the reactor coolant piping are given in Table 5.4-5.

Details of the materials of construction and codes used in the fabrication of reactor coolant piping and fittings are discussed in Section 5.2.

The reactor coolant piping and fittings which make up the loops are austenitic stainless steel. Pipe and fittings are cast, seamless without longitudinal or electroslag welds, and comply with the requirements of the ASME Code, Section II (Parts A and C), Section III, and Section IX. All smaller piping which is part of the RCS, such as the pressurizer surge line, spray and relief line, loop drains and connecting lines to other systems,

* Lines with a 3/8-inch (liquid service), 3/4-inch (steam service), or less flow restricting orifice qualify as Safety Class 2. In the event of a break in one of these Safety Class 2 lines, the normal makeup system is capable of providing makeup flow while maintaining pressurizer water level.

are also austenitic stainless steel. The nitrogen supply line for the pressurizer relief tank is carbon steel. All joints and connections are welded, except for the pressurizer code safety valves, where flanged joints are used. A thermal sleeve is installed on the pressurizer spray line nozzle.

All piping connections from auxiliary systems are above the horizontal centerline of the reactor coolant piping, with the exception of:

a. Residual heat removal pump suction lines, which are 45 degrees down from the horizontal centerline. This enables the water level in the RCS to be lowered in the reactor coolant pipe while continuing to operate the residual heat removal system, should this be required for maintenance.

b. Loop drain lines and the connection for temporary level measurement of water in the RCS during refueling and maintenance operation.

c. The differential pressure taps for flow measurement, which are downstream of the steam generators of the first 90-degree elbow.

d. The pressurizer surge line, which is attached at the horizontal centerline.

e. Two of the three ~~taps~~ scoops in each resistance temperature detector hot leg connection.

f. The hot leg sample connections, the loop 3 thermowell, and the loop 4 boron injection tank injection connection, all located on the horizontal centerline.

Penetrations into the coolant flow path are limited to the following:

a. The spray line inlet connections extend into the cold leg piping in the form of a scoop so that the velocity head of the reactor coolant loop flow adds to the spray driving force.

b. The reactor coolant sample system taps protrude into the main stream to obtain a representative sample of the reactor coolant.

c. The hot leg ~~bypass~~ connections to the resistance temperature detectors have scoops which extend into the reactor coolant to collect a representative temperature sample for the individual hot leg resistance temperature detectors ~~manifold~~.

d. The wide range temperature detectors are located in resistance temperature detector wells that extend into both the hot and cold legs of the reactor coolant pipes.

→ INSERT A

~~Separate bypass lines for each reactor coolant loop hot and cold leg are provided so that individual temperature signals may be developed for use in the reactor control and protection system. The bypass line around each steam generator obtains a representative hot leg temperature by mixing the flow from three scoop connections, which extend into the flow stream at locations 120 degrees apart in the cross-sectional plant, on the reactor coolant leg. The hot leg bypass flow exits the manifold to a common return line.~~

~~Flow for the cold leg bypass line is obtained downstream of the pump discharge. Because of the mixing action of the pump, only one connection is required to obtain a representative sample. This connection is located close to the weld connection at the pump discharge, and is in the same relative position in each loop.~~

~~The bypass lines join downstream of each set of temperature detectors and discharge into a common line. The combined bypass flow passes through a flow indicator before being discharged to the suction side of the reactor coolant pump.~~

~~Resistance temperature detectors extend directly into the flow path in the bypass lines to minimize the instrument time delay. Two isolation valves in series are provided on each side of the temperature detector manifold to allow for resistance temperature detector maintenance. The valve nearest the connection to the main coolant piping is located above the elevation of the reactor vessel nozzles to permit valve repair during cold shutdown, without draining the RCS. In addition, vents and drains are provided in each manifold to be used, in conjunction with the isolation valve, for maintenance.~~

Signals from the temperature detectors are used to compute the reactor coolant ΔT (temperature of the hot leg, T_{hot}, minus the temperature of the cold leg, T_{cold}) and an average reactor coolant temperature (T_{avg}). The T_{avg} for each loop is indicated on the main control board.

5.4.3.3 Design Evaluation

Piping load and stress evaluation for normal operating loads, seismic loads, blowdown loads, and combined normal, blowdown, and seismic loads is discussed in Section 3.9(N).

INSERT A

One hot leg and one cold leg temperature reading are provided from each coolant loop to use for protection. Narrow range, thermowell-mounted Resistance Temperature Detectors (RTDs) are provided for each coolant loop. In the hot legs, sampling scoops are used because the flow is stratified. That is, the fluid temperature is not uniform over a cross section of the hot leg. One dual element RTD is mounted in a thermowell in each of the three sampling scoops associated with each hot leg. The scoops extend into the flow stream at locations 120° apart in the cross sectional plane. Each scoop has five orifices which sample the hot leg flow along the leading edge of the scoop. Outlet ports are provided in the scoops to direct the sampled fluid past the sensing element of the RTDs. One of each of the RTD's dual elements is used while the other is an installed spare. Three readings from each hot leg are averaged to provide a hot leg reading for that loop.

One dual element RTD is mounted in a thermowell associated with each cold leg. No flow sampling is needed because coolant flow is well mixed by the reactor coolant pumps. One RTD element is used while the other is an installed spare.

The thermowells are pressure boundary parts which completely enclose the RTD. They have been shop hydrotested to 1.25 times the RCS design pressure. The external design pressure and temperature are the RCS design temperature and pressure. The RTD is not part of the pressure boundary. The scoop, thermowell, and thermowell/scoop assembly have been analyzed to the ASME Boiler and Pressure Vessel Code, Section III, Class 1. The effects of seismic and flow-induced loads were considered in the design.

b. Blocks of reactor trips at low power

Interlock P-7 blocks a reactor trip at low power (below approximately 10 percent of full power) on a low reactor coolant flow in more than one loop, reactor coolant pump undervoltage, reactor coolant pump underfrequency, pressurizer low pressure or pressurizer high water level. See Figure 7.2-1 (Sheets 5 and 6) for permissive applications. The low power signal is derived from three out of four power range neutron flux signals below the setpoint in coincidence with two out of two turbine impulse chamber pressure signals below the setpoint (low plant load). See Figure 7.2-1 (Sheets 4 and 16) for the derivation of P-7.

The P-8 interlock blocks a reactor trip when the plant is below approximately 50 percent of full power, on a low reactor coolant flow in any one loop.

The block action (absence of the P-8 interlock signal) occurs when three out of four neutron flux power range signals are below the setpoint. Thus, below the P-8 setpoint, the reactor has the capability to operate with one inactive loop and trip will not occur until two loops are indicating low flow. See Figure 7.2-1 (Sheet 4) for derivation of P-8 and Sheet 5 for applicable logic.

Interlock P-9 blocks a reactor trip following a turbine trip below 50 percent power. See Figure 7.2-1 (Sheet 16) for the implementation of the P-9 interlock and Sheet 4 for the derivation of P-9.

7.2.1.1.4 Coolant Temperature Sensor Arrangement

INSERT B →

~~The hot and cold leg resistance temperature detectors are inserted into reactor coolant bypass loops. A bypass loop from upstream of the steam generator to downstream of the steam generator is used for the hot leg resistance temperature detectors, and a bypass loop from downstream of the reactor coolant pump to upstream of the pump is used for the cold leg resistance temperature detectors. Both bypass loops are inside the containment. The resistance temperature detectors are located in manifolds and are directly inserted into the reactor coolant bypass loop flow without thermowells. Thermowells are not used in order to minimize the detector thermal lag. The bypass arrangement permits replacement of defective temperature elements while the plant is at hot shutdown without draining or depressurizing the reactor coolant loops.~~

~~Three sampling probes are installed in a cross-sectional plane of each hot leg at approximately 120-degree intervals. Each of the sampling probes, which extend several inches into the~~

INSERT B

One hot leg and one cold leg temperature reading are provided from each coolant loop to use for protection. Narrow range, thermowell-mounted Resistance Temperature Detectors (RTDs) are provided for each coolant loop. In the hot legs, sampling scoops are used because the flow is stratified. That is, the fluid temperature is not uniform over a cross section of the hot leg. One dual element RTD is mounted in a thermowell in each of the three sampling scoops associated with each hot leg. The scoops extend into the flow stream at locations 120° apart in the cross sectional plane. Each scoop has five orifices which sample the hot leg flow along the leading edge of the scoop. Outlet ports are provided in the scoops to direct the sampled fluid past the sensing element of the RTDs. One of each of the RTD's dual elements is used while the other is an installed spare. Three readings from each hot leg are averaged to provide a hot leg reading for that loop.

One dual element RTD is mounted in a thermowell associated with each cold leg. No flow sampling is needed because coolant flow is well mixed by the reactor coolant pumps. As is the case with the hot leg, one element is used while the other is an installed spare.

Certain control signals are derived from individual protection channels through isolation cards. The isolation cards are classified as a part of the protection system. The rod control system uses the auctioneered (high) value of four isolated T-AVG signals.

The RTDs are a fast response design which conform to the applicable IEEE standards and 10 CFR 50.49 requirements.

hot leg coolant stream, contains five inlet orifices distributed along its length. In this way, a total of 15 locations in the hot leg stream are sampled, providing a representative coolant temperature measurement. The 2-inch-diameter pipe leading to the resistance temperature detectors manifold provides mixing of the samples to give representative temperature measurement.

Care has been taken to distribute the flow evenly among the five orifices of each probe by effectively restricting the flow through the orifices. This has been done by designing a smaller overall orifice flow area than that of the common flow channel within the probe. This arrangement has also been applied to the flow transition from the three probe flow channels to the pipe leading to the temperature element manifold. The total flow area of these channels has, therefore, been designed to be less than that of the 2-inch pipe connecting the probes to the manifold.

The cold leg reactor coolant flow is well mixed by the reactor coolant pump, thereby eliminating any cold leg temperature spatial dependence. Therefore, the cold leg sample is taken directly from a 2-inch pipe tap off the cold leg downstream of the pump.

7.2.1.1.5 Pressurizer Water Level Reference Leg Arrangement

The design of the pressurizer water level instrumentation employs the usual tank level arrangement, using differential pressure between an upper and a lower tap on a column of water. A reference leg connected to the upper tap is kept full of water by condensation of steam at the top of the leg.

7.2.1.1.6 Analog System

The analog system consists of two instrumentation systems - the process instrumentation system and the nuclear instrumentation system.

Process instrumentation includes those devices (and their interconnection into systems) which measure temperature, pressure, fluid flow, fluid level as in tanks or vessels, and occasionally physiochemical parameters, such as fluid conductivity or chemical concentration. Process instrumentation specifically excludes nuclear and radiation measurements. The process instrumentation includes the process measuring devices, power supplies, indicators, recorders, alarm actuating devices, controllers, signal conditioning devices, etc., which are necessary for day-to-day operation of the NSSS, as well as for monitoring the plant and providing initiation of plant protective functions.

The primary function of nuclear instrumentation is to protect the reactor by monitoring the neutron flux and generating appropriate trips and alarms for various phases of reactor

Any reactor trip will actuate an alarm and an annunciator. Such protective actions are indicated and identified down to the channel level.

Alarms and annunciators are also used to alert the operator of deviations from normal operating conditions so that he may take appropriate corrective action to avoid a reactor trip. Actuation of any rod stop or trip of any reactor trip channel will actuate an alarm.

u. System repair

The system is designed to facilitate the recognition, location, replacement, and repair of malfunctioning components or modules. Refer to the discussion in item j above.

7.2.2.3 Specific Control and Protection Interactions

7.2.2.3.1 Neutron Flux

Four power range neutron flux channels are provided for overpower protection. An isolated auctioneered high signal is derived by auctioneering the four channels for automatic rod control. If any channel fails in such a way as to produce a low output, that channel is incapable of proper overpower protection but will not cause control rod movement because of the auctioneer. Two-out-of-four overpower trip logic will ensure an overpower trip if needed, even with an independent failure in another channel.

In addition, channel deviation signals in the control system will give an alarm if any neutron flux channel deviates significantly from the average of the flux signals. Also, the control system will respond only to rapid changes in indicated neutron flux; slow changes or drifts are compensated by the temperature control signals. Finally, an overpower signal from any nuclear power range channel will block manual and automatic rod withdrawal. The setpoint for this rod stop is below the reactor trip setpoint.

7.2.2.3.2 Coolant Temperature

The accuracy of the narrow range resistance temperature detector (RTD) ~~bypass loop~~ temperature measurements is demonstrated during plant startup tests by comparing temperature measurements from ~~all bypass loop~~ these RTDs with one another as well as with the temperature measurements obtained from the wide range RTD located in the hot leg and cold leg piping of each loop. The comparisons are done with the reactor coolant system in an isothermal condition. The linearity of the ΔT measurements obtained from the hot leg and cold leg ~~bypass loop~~ RTDs as a function of plant power is also checked during plant startup tests. The absolute value

of ΔT versus plant power is not important, per se, as far as reactor protection is concerned. Reactor trip system setpoints are based upon percentages of the indicated ΔT at nominal full power rather than on absolute values of ΔT. This is done to account for loop differences which are inherent. The percent ΔT scheme is relative, not absolute, and therefore provides better protective action without the requirement of absolute accuracy. For this reason, the linearity of the ΔT signals as a function of power is of importance rather than the absolute values of the ΔT. As part of the plant startup tests, the ~~bypass loop~~ RTD signals will be compared with the core exit thermocouple signals.

Reactor control is based upon signals derived from protection system channels after isolation by isolation amplifiers such that no feedback effect can perturb the protection channels. Since control is based on the average temperature of the loop with the highest temperature, the control rods are always moved based upon the most pessimistic temperature measurement with respect to margins to DNB. A spurious low average temperature measurement from any loop temperature control channel will cause no control action. A spurious high average temperature measurement will cause rod insertion (safe direction).

~~Individual low flow alarms with individual status lights for each reactor coolant loop bypass flow are provided on the main control board. The alarm and status lights provide the operator with immediate indication of a low flow condition in the bypass loops associated with any reactor coolant loop.~~

~~Local indicators are provided to monitor total flow through the RTD bypass manifolds for each loop. The indicators are located inside the containment but are accessible during power operations.~~

~~Flow will be locally monitored:~~

~~a. Prior to restoring temperature channels to normal service following reopening of bypass loop stop valves whenever a bypass loop has been out of service~~

~~b. On a periodic basis~~

~~c. Following any bypass loop low flow alarm (see above)~~

~~In addition,~~ Channel deviation signals in the control system will give an alarm if any temperature channel deviates significantly from the auctioneered (highest) value. Automatic rod withdrawal blocks and turbine runback (power demand reduction) will also occur if any two out of the four overtemperature or overpower ΔT channels indicate an adverse condition.