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SUBJECT: Forwards corrected pages to rev 15 of updated SAR for Turkey Point,Units 2 & 3.

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FPL

MAY 20 1998

L-98-120
10 CFR 50.4
10 CFR 50.71

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555

Re: Turkey Point Units 3 and 4
Docket Nos. 50-250 and 50-251
Updated Final Safety Analysis Report Revision 15; Corrected Pages

Florida Power and Light Company (FPL) submitted Revision 15 of the Turkey Point Units 3 and 4 Updated Final Safety Analysis Report (UFSAR) to the USNRC by letter L-98-093, dated April 10, 1998. A duplication error has since been discovered by FPL, and the purpose of this submittal is to provide corrected pages of Revision 15 which are to be inserted in lieu of those attached to letter L-98-093. Please note that only the affected pages are enclosed with this transmittal. The affected pages are indicated by shading in the copy of the enclosed filing instructions. Please replace those pages included with the previously submitted Revision 15. All other pages of Revision 15 are correct.

Very truly yours,

R. J. Hovey
Vice President
Turkey Point Plant

CLM

Attachment

cc: Regional Administrator, Region II, USNRC
Senior Resident Inspector, USNRC, Turkey Point

9805280126 980520
PDR ADOCK 05000250
K PDR

A053 1/11

an FPL Group company

50-250
Superseded Per
Corrected Pages
To UFSAR Pkg
5/20/98
#9805280126

TABLE 7.5-2

PARAMETER LISTING SUMMARY SHEETS
UNIT 4 TURKEY POINT

10/88

ITEM	TAG NO.	VARIABLE: DESCRIPTION	TYPE	CAT	INSTRUMENT RANGE: EXISTING	INSTRUMENT RANGE: REQUIRED	ENVIRON QUAL.	SEISMIC QUAL.	REDUNDANCE	POWER SUPPLY	DISPLAY LOCATION: CR	DISPLAY LOCATION: TSC	DISPLAY LOCATION: EOF	SCHEDULE/ JUSTIFICATION
B16		MAINTAINING CTMT. INTEGRITY - CTMT. PRESSURE												
	PT-6306A	CTMT. WIDE RANGE PRESSURE	B	1	0-180 PSIG	-5 PSIG TO DESIGN PRESSURE	N/A	COMPLY	PT-6306B	NOTE 1	–	YES	YES	
	PI-6306A	CTMT. WIDE RANGE PRESS. IND.	B	1	0-180 PSIG	-5 PSIG TO DESIGN PRESSURE	N/A	COMPLY	PI-6306B	NOTE 1	YES	–	–	
	PR-6306A	CTMT. WIDE RANGE PRESS.	B	1	0-180 PSIG	-5 PSIG TO DESIGN PRESSURE	N/A	COMPLY	N/A	NOTE 1	YES	–	–	
	PT-6306B	CTMT. WIDE RANGE PRESS.	B	1	0-180 PSIG	-5 PSIG TO DESIGN PRESSURE	N/A	COMPLY	PT-6306A	NOTE 1	–	YES	YES	
	PI-6306B	CTMT. WIDE RANGE PRESS. IND.	B	1	0-180 PSIG	-5 PSIG TO DESIGN PRESSURE	N/A	COMPLY	PI 6306A	NOTE 1	YES	–	–	
	PR-6306B	CTMT. WIDE RANGE PRESS	B	1	0-180 PSIG	-5 PSIG TO DESIGN PRESSURE	N/A	COMPLY	N/A	NOTE 1	YES	–	–	
	PT-6425A	CTMT. NARROW RANGE PRESS.	B	1	-6 TO +18 PSIG	-5 PSIG TO DESIGN PRESSURE	N/A	COMPLY	PT-6425B	NOTE 1	–	YES	YES	
	PI-6425A	CTMT. NARROW RANGE PRESS. IND.	B	1	-6 TO +18 PSIG	-5 PSIG TO DESIGN PRESSURE	N/A	COMPLY	PI-6425B	NOTE 1	YES	–	–	
	PR-6306A	CTMT. NARROW RANGE PRESS.	B	1	-6 TO +18 PSIG	-5 PSIG TO DESIGN PRESSURE	N/A	COMPLY	N/A	NOTE 1	YES	–	–	
	PT-6425B	CTMT. NARROW RANGE PRESS.	B	1	-6 TO +18 PSIG	-5 PSIG TO DESIGN PRESSURE	N/A	COMPLY	PT-6425A	NOTE 1	–	YES	YES	
	PI-6425B	CTMT. NARROW RANGE PRESS. IND.	B	1	-6 TO +18 PSIG	-5 PSIG TO DESIGN PRESSURE	N/A	COMPLY	PI-6425A	NOTE 1	YES	–	–	
	PR-6306B	CTMT. NARROW RANGE PRESS.	B	1	-6 TO +18 PSIG	-5 PSIG TO DESIGN PRESSURE	N/A	COMPLY	N/A	NOTE 1	YES	–	–	
C1		FUEL CLADDING - CORE EXIT TEMPERATURE												
	TE-1E THRU TE-51E	CORE EXIT TEMPERATURE	C	1	32-2300 F	200-2300 F	N/A	COMPLY	2 CHANNEL PER QUADR	NOTE 1	SPDS	YES	YES	NOTES 1A,1B,
	QSPDS A	DISPLAY 'A'	C	1	32-2300 F	200-2300 F	N/A	COMPLY	QSPDS B	NOTE 1	YES	–	–	& 9
	QSPDS B	DISPLAY 'B'	C	1	32-2300 F	200-2300 F	N/A	COMPLY	QSPDS A	NOTE 1	YES	–	–	
C2		FUEL CLADDING - RADIOACTIVITY CONCENTRATION OR RADIATION LEVEL IN CIRCULATING PRIMARY COOLANT												
	NONE	RADIOACTIVITY CONCENTRATION OR RADIATION LEVEL	C	1	GRAB SAMPLE	1/2 TO 100 X T.S. LIMIT	–	–	–	–	–	–	–	NOTE 3
C3		FUEL CLADDING - ANALYSIS OF PRIMARY COOLANT												
	AE-6372	Rx COOL WATER RADIOACTIVITY ANALYSIS	C	3	1E-7 Ci/CC TO 10 Ci/CC	10 micro Ci/ml to 10 Ci/ml	N/A	N/A	N/A	N/A	ERDADS	YES	YES	NOTE 1B
C4		Rx COOLANT PRESSURE BOUNDARY - RCS PRESSURE												
	PT-404	RCS PRESS.	C	1	0-3000 PSIG	0-3000 PSIG	COMPLY	COMPLY	PT-406	NOTE 1	SPDS	YES	YES	NOTES 1A,1B
	PT-406	RCS PRESS.	C	1	0-3000 PSIG	0-3000 PSIG	COMPLY	COMPLY	PT-404	NOTE 1	SPDS	YES	YES	NOTES 1A,1B
	QSPDS A	DISPLAY 'A'	C	1	0-3000 PSIG	0-3000 PSIG	N/A	COMPLY	QSPDS B	NOTE 1	YES	–	–	
	QSPDS B	DISPLAY 'B'	C	1	0-3000 PSIG	0-3000 PSIG	N/A	COMPLY	QSPDS A	NOTE 1	YES	–	–	

TABLE 7.5-2

PARAMETER LISTING SUMMARY SHEETS
UNIT 4 TURKEY POINT

10/88

ITEM	TAG NO.	VARIABLE DESCRIPTION	TYPE	CAT	INSTRUMENT RANGE EXISTING	INSTRUMENT RANGE REQUIRED	ENVIRON QUAL.	SEISMIC QUAL.	REDUNDANCY	POWER SUPPLY	DISPLAY LOCATION CR	TSC	EOF	SCHEDULE/ JUSTIFICATION
E1		CONTAIMENT RADIATION - CONTAIMENT AREA RADIATION HI RANGE												
	RAD-6311A	CTMT. HIGH RANGE RAD. MONITOR CH. "A"	E	1	1 TO 1E8 R/Hr	1 TO 1E7 R/Hr	COMPLY	COMPLY	RAD-6311B	NOTE 1	–	YES	YES	
	RAI-6311A	CTMT. HIGH RANGE RAD. MONITOR CH. "A" IND.	E	1	1 TO 1E8 R/Hr	1 TO 1E7 R/Hr	N/A	COMPLY	RAI-6311B	NOTE 1	YES	–	–	
	RAR-6311A	CTMT. HIGH RANGE RAD. MONITOR CH. "A" RECORDER	E	1	1 TO 1E8 R/Hr	1 TO 1E7 R/Hr	N/A	COMPLY	RAR-6311B	NOTE 1	YES	–	–	
	RAD-6311B	CTMT. HIGH RANGE RAD. MONITOR CH. "B"	E	1	1 TO 1E8 R/Hr	1 TO 1E7 R/Hr	COMPLY	COMPLY	RAD-6311A	NOTE 1	–	YES	YES	
	RAI-6311B	CTMT. HIGH RANGE RAD. MONITOR CH. "B" IND.	E	1	1 TO 1E8 R/Hr	1 TO 1E7 R/Hr	N/A	COMPLY	RAI-6311A	NOTE 1	YES	–	–	
	RAR-6311B	CTMT. HIGH RANGE RAD. MONITOR CH. "B" RECORDER	E	1	1E-4 TO 1 R/Hr	1E-1 TO 1E4 R/Hr	N/A	COMPLY	RAR 6311A	NOTE 1	YES	–	–	
E2		AREA RADIATION - RADIATION EXPOSURE RATE												
	RD-1417	EAST END OF E/W CORRIDOR	E	3	1E-4 TO 1E4 R/Hr	1E-1 TO 1E4 R/Hr	N/A	N/A	N/A	N/A	–	YES	YES	NOTE 4
	RD-1418	WEST END OF E/W CORRIDOR	E	3	1E-4 TO 1E4 R/Hr	1E-1 TO 1E4 R/Hr	N/A	N/A	N/A	N/A	–	YES	YES	NOTE 4
	RD-1420	CONTROL ROOM	E	3	1E-4 TO 1E4 R/Hr	1E-1 TO 1E4 R/Hr	N/A	N/A	N/A	N/A	–	YES	YES	NOTE 4
	RD-1415	NORTH END OF N/S CORRIDOR	E	3	1E-4 TO 1E4 R/Hr	1E-1 TO 1E4 R/Hr	N/A	N/A	N/A	N/A	–	YES	YES	NOTE 4
	RD-1416	SOUTH END OF N/S CORRIDOR	E	3	1E-4 TO 1E4 R/Hr	1E-1 TO 1E4 R/Hr	N/A	N/A	N/A	N/A	–	YES	YES	NOTE 4
	RD-1413	OUTSIDE SAMPLE RM.-UNIT 3	E	3	1E-4 TO 1E4 R/Hr	1E-1 TO 1E4 R/Hr	N/A	N/A	N/A	N/A	–	YES	YES	NOTE 4
	RD-1414	OUTSIDE SAMPLE RM.-UNIT 4	E	3	1E-4 TO 1E4 R/Hr	1E-1 TO 1E4 R/Hr	N/A	N/A	N/A	N/A	–	YES	YES	NOTE 4
	R-1405	RECORDER	E	3	1E-4 TO 1E4 R/HR	1E-1 TO 1E4 R/HR	N/A	N/A	N/A	N/A	YES	–	–	NOTE 4
E3		AIRBORNE RADIOACTIVE MATERIALS RELEASED FROM PLANT NOBLE GAS & VENT FLOW RATE												
	NONE	CTMT. OR PURGE EFFLUENT	E	2	THIS DESIGN NOT USED	1E-6 TO 1E5 micro Ci/CC	–	–	–	–	–	–	–	NOTE 5
	NONE	CTMT. OR PURGE EFFLUENT (FLOW)	E	2	THIS DESIGN NOT USED	0-110% DESIGN FLOW	–	–	–	–	–	–	–	NOTE 5
	NONE	REACTOR SHIELD BLDG ANNULUS	E	2	THIS DESIGN NOT USED	1E-6 TO 1E4 micro Ci/CC	–	–	–	–	–	–	–	NOTE 5
	NONE	AUXILIARY BLDG	E	2	THIS DESIGN NOT USED	1E-6 TO 1E3 micro Ci/CC	–	–	–	–	–	–	–	NOTE 5
	NONE	AUXILIARY BLDG (FLOW)	E	2	THIS DESIGN NOT USED	0-110% DESIGN FLOW	–	–	–	–	–	–	–	NOTE 5
E4		CONDENSER AIR REMOVAL SYSTEM												
	RAD-6417	AIR EJECTOR CONDENSER EXH.	E	2	1E-7 TO 1E5 micro Ci/CC	1E-6 TO 1E5 micro Ci/CC	N/A	N/A	N/A	NOTE 7	ERDADS	YES	YES	NOTE 18
	NONE	AIR EJECTOR CONDENSER FLOW	E	2	...	...	–	–	–	–	–	–	–	NO INST.

TABLE 7.5-2

PARAMETER LISTING SUMMARY SHEETS
UNIT 4 TURKEY POINT

10/88

ITEM	TAG NO	VARIABLE DESCRIPTION	TYPE	CAT	INSTRUMENT RANGE EXISTING	INSTRUMENT RANGE REQUIRED	ENVIRON QUAL.	SEISMIC QUAL.	REDUNDANCE	POWER SUPPLY	DISPLAY LOCATION CR	DISPLAY LOCATION TSC	DISPLAY LOCATION EOF	SCHEDULE/ JUSTIFICATION
E1		**CONTAIMENT RADIATION - CONTAIMENT AREA RADIATION HI RANGE**												
	RAD 6311A	CTMT HIGH RANGE RAD MONITOR CH. "A"	E	1	1 TO 1E8 R/Hr	1 TO 1E7 R/Hr	COMPLY	COMPLY	RAD 6311B	NOTE 1	–	YES	YES	
	RAI 6311A	CTMT HIGH RANGE RAD MONITOR CH "A" IND.	E	1	1 TO 1E8 R/Hr	1 TO 1E7 R/Hr	N/A	COMPLY	RAI 6311B	NOTE 1	YES	–	–	
	RAR 6311A	CTMT HIGH RANGE RAD MONITOR CH. "A" RECORDER	E	1	1 TO 1E8 R/Hr	1 TO 1E7 R/Hr	N/A	COMPLY	RAR 6311B	NOTE 1	YES	–	–	
	RAD 6311B	CTMT HIGH RANGE RAD MONITOR CH. "B"	E	1	1 TO 1E8 R/Hr	1 TO 1E7 R/Hr	COMPLY	COMPLY	RAD 6311A	NOTE 1	–	YES	YES	
	RAI 6311B	CTMT HIGH RANGE RAD MONITOR CH. "B" IND.	E	1	1 TO 1E8 R/Hr	1 TO 1E7 R/Hr	N/A	COMPLY	RAI 6311A	NOTE 1	YES	–	–	
	RAR 6311B	CTMT HIGH RANGE RAD. MONITOR CH. "B" RECORDER	E	1	1E 4 TO 1 R/Hr	1E-1 TO 1E4 R/Hr	N/A	COMPLY	RAR 6311A	NOTE 1	YES	–	–	
E2		**AREA RADIATION - RADIATION EXPOSURE RATE**												
	RD 1417	EAST END OF E/W CORRIDOR	E	3	1E 4 TO 1E4 R/Hr	1E 1 TO 1E4 R/Hr	N/A	N/A	N/A	N/A	–	YES	YES	NOTE 4
	RD 1418	WEST END OF E/W CORRIDOR	E	3	1E 4 TO 1E4 R/Hr	1E-1 TO 1E4 R/Hr	N/A	N/A	N/A	N/A	–	YES	YES	NOTE 4
	RD 1419	SPENT FUEL PIT EXHAUST	E	3	1E 4 TO 1E4 R/Hr	1E-1 TO 1E4 R/Hr	N/A	N/A	N/A	N/A	–	YES	YES	NOTE 4
	RD 1420	CONTROL ROOM	E	3	1E 4 TO 1E4 R/Hr	1E 1 TO 1E4 R/Hr	N/A	N/A	N/A	N/A	–	YES	YES	NOTE 4
	RD 1415	NORTH END OF N/S CORRIDOR	E	3	1E 4 TO 1E4 R/Hr	1E 1 TO 1E4 R/Hr	N/A	N/A	N/A	N/A	–	YES	YES	NOTE 4
	RD 1416	SOUTH END OF N/S CORRIDOR	E	3	1E 4 TO 1E4 R/Hr	1E-1 TO 1E4 R/Hr	N/A	N/A	N/A	N/A	–	YES	YES	NOTE 4
	RD 1413	OUTSIDE SAMPLE RM. UNIT 3	E	3	1E 4 TO 1E4 R/Hr	1E-1 TO 1E4 R/Hr	N/A	N/A	N/A	N/A	–	YES	YES	NOTE 4
	RD 1414	OUTSIDE SAMPLE RM. UNIT 4	E	3	1E 4 TO 1E4 R/Hr	1E-1 TO 1E4 R/Hr	N/A	N/A	N/A	N/A	–	YES	YES	NOTE 4
	R 1405	RECORDER	E	3	1E 4 TO 1E4 R/HR	1E-1 TO 1E4 R/HR	N/A	N/A	N/A	N/A	YES	–	–	NOTE 4
E3		**AIRBORNE RADIOACTIVE MATERIALS RELEASED FROM PLANT NOBLE GAS & VENT FLOW RATE**												
	NONE	CTMT. OR PURGE EFFLUENT	E	2	THIS DESIGN NOT USED	1E 6 TO 1E5 micro Ci/CC	–	–	–	–	–	–	–	NOTE 5
	NONE	CTMT. OR PURGE EFFLUENT (FLOW)	E	2	THIS DESIGN NOT USED	0 110% DESIGN FLOW	–	–	–	–	–	–	–	NOTE 5
	NONE	REACTOR SHIELD BLDG ANNULUS	E	2	THIS DESIGN NOT USED	1E 6 TO 1E4 micro Ci/CC	–	–	–	–	–	–	–	NOTE 5
	NONE	AUXILIARY BLDG	E	2	THIS DESIGN NOT USED	1E-6 TO 1E3 micro Ci/CC	–	–	–	–	–	–	–	NOTE 5
	NONE	AUXILIARY BLDG (FLOW)	E	2	THIS DESIGN NOT USED	0 110% DESIGN FLOW	–	–	–	–	–	–	–	NOTE 5
E4		**CONDENSER AIR REMOVAL SYSTEM**												
	RAD 6417	AIR EJECTOR CONDENSER EXH	E	2	1E-7 TO 1E5 micro Ci/CC	1E 6 TO 1E5 micro Ci/CC	N/A	N/A	N/A	NOTE 7	ERDADS	YES	YES	NOTE 1B
	NONE	AIR EJECTOR CONDENSER FLOW	E	2	---	---	–	–	–	–	–	–	–	NO INST.

For Tag No. Column

(LS) = Limit Switch Associated with Valve

For Existing Instrument Range Column

1. Portable sampling with onsite analysis capability is capable of providing a range from less than 1E-9 micro Ci/CC to greater than 1E-3 micro Ci/CC.

2. Portable instrumentation provides a range of:

   A. 1E-3 R/HR to values greater than 1E4 R/HR photons; and

   B. 1E-3 R/HR to values greater than 1E4 R/HR beta and low-energy photons

3. Existing range monitors up to 7.4E-2 micro Ci/CC. Plant specific analysis justifies smaller range. Particulates and halogens collected on filter cartridge and monitored in lab after sample collection period (30 minutes design for accident situations).

For Required Instrument Range Column

1. RG 1.97 requires the following ranges:

   A. 1E-3 R/HR to 1E4 R/HR photons; and

   B. 1E-3 R/HR to 1E4 R/HR beta and low-energy photons

For Environmental Qualification Column

1. The Safety Injection Accumulator Discharge Valves MOV-865A, B and C are administratively controlled and are required to be in the open position during normal operation. These valves are not required to change position under accident conditions. Administrative control is accomplished by locking open the associated motor control center circuit breakers. Since administrative control via electrical de-energization of the valves ensures that the valves will be in their safe position during

an accident, environmental qualification of the limit switches providing position indication is not required.

For Power Supply Column

Power source is identified as:

1. Class 1E, 120 VAC uninterruptable power supply (inverters)

2. Class 1E, 120 VAC power backed up by the Emergency Diesel Generator

3. Class 1E, 125 VDC safety-related battery

4. Non-Class 1E, 120 VAC uninterruptable power supply

5. Indication is powered from the circuits being monitored via PTs, CTs, etc.

6. Transducers internal to the inverter providing computer display signals for inverter current and voltage are powered by the inverter internals.

7. The SPING monitors communicate with both primary and backup control terminals which are powered from plant inverters and backed up by the safety-related batteries. SPING Monitors RAD-3(4)-6417 and RAD-6426 are powered from non-vital lighting panels capable of being powered from the emergency diesel generators. SPING Monitor RAD-6403 is powered from a vital AC power panel which is automatically backed up by an emergency diesel generator.

For Display Location

1. Control Room metering is credited for primary indication of Emergency Diesel Generator Output (MW). Recording capability for this variable is also available via ERDADS.

For Schedule/Justification Column

1. The following notes referenced under the "Schedule/Just" column of the

Parameter Listing Summary Sheets correspond to the technical justifications identified below:

A. This justification demonstrates the acceptability of the existing uninterruptable power source (UPS) associated with the SPDS/ERDADS computer for the monitoring of Category 1 variables. This acceptability is based upon the existing UPS allowing the SPDS/ERDADS computer to perform its credited RG 1.97 functions:

(1) Recording of Category 1 Variables -

Control Room indication is normally used to provide trending while SPDS/ERDADS is used only as a backup to those instruments. In those cases where SPDS/ERDADS is being used to trend Category 1 variables, either the trending is not necessary to the Control Room operator's decisions or the operator can obtain the real time information via the monitoring of Control Room indication.

(2) Indication of Category 1 Variables -

SPDS/ERDADS is only used as a backup means of indication for certain containment isolation valves but is not credited for RG 1.97 indication for any other Category 1 variable.

(3) Containment Isolation Valve Indication -

In the few instances where SPDS/ERDADS is credited for backup indication associated with containment isolation valves, computer power will be available from the UPS battery for at least the first 2 hours of the accident. This period of operability is sufficient to allow the completion of containment isolation.

B. This justification demonstrates that the SPDS/ERDADS computer, although classified as non-nuclear safety-related, is capable of

providing the necessary Regulatory Guide functions for which it is credited.

(1) The SPDS/ERDADS computer is not essential to the monitoring of Category 1 variables. The computer is credited only for backup indication of a few containment isolation valves (i.e., valve position indication) but is not credited for either primary or backup indication for any other Category 1 variables.

(2) The SPDS/ERDADS computer is not essential in providing the Control Room operators with vital trending or recording information. Control Room indication is normally used to provide trending while SPDS/ERDADS is used only as a backup to those instruments. In those cases where SPDS/ERDADS is being used to trend Category 1 variables, either the trending is not necessary to the operator's decisions or the operator can obtain the real time information via the monitoring of Control Room indication.

(3) The SPDS/ERDADS computer provides primary indication of certain Category 2 and 3 variables. In general, the SPDS/ERDADS computer complies with the Category 2 and 3 design and qualification criteria identified in Table 1 of RG 1.97.

(4) The SPDS/ERDADS computer does not diminish the capability of the Control Room operators to obtain the necessary post-accident monitoring information or in achieving the safe shutdown of the plant. Based upon conclusions (1) and (2) above, it can be further concluded that the SPDS/ERDADS computer does not perform an essential function with respect to Category 1 post-accident monitoring.

C. This justification demonstrates that the lack of overlap between the ranges of Containment Sump Water Level narrow and wide range instrumentation does not jeopardize the capability of providing the Control Room operators the critical information required during

plant accident conditions. This is based on an analysis which provides the following:

(1) The deadband in Containment Sump Water Level indication between 369" and 397" causes less than 6% error in indication.

(2) The resulting error in indication is introduced in a non-critical range of the required indication. Thus the deadband does not prevent the operator from obtaining the required information:

(a) Low level (narrow range) indication of the initial ingress of water into the sump to allow the assessment of water source and rate.

(b) High level (wide range) indication for operator response to containment flooding.

(c) Determination of the ability to transfer to cold leg recirculation in the event of loss of reactor or secondary coolant based upon having achieved minimum pump NPSH.

D. This justification clarifies the inconsistency between the Accumulator Tank Level ranges identified in the previous FPL RG 1.97 submittals of January 26, 1984 and May 10, 1985, and the existing Control Room instrumentation range of 6,500 to 6,750 gals. The existing Control Room range of 6,500 to 6,750 gals. uses the same basis for justification as identified and approved by NRC in its Safety Evaluation dated March 20, 1986. Accumulator tank pressure is also credited for determining accumulator tank level. As pressure drops in the accumulators, application of the Ideal-Gas state equation provides indication of how much water remains in the accumulator following actuation. As an operator aid, a curve has been made available to the operator which correlates accumulator pressure to accumulator level.

E. This justification clarifies the use of flow meters integral to hand indicating controllers as a means of providing valve position indication. The integral flow meters provide "closed" position indication by indicating zero flow and "not closed" position indication by indicating higher than zero flow.

F. This justification identifies alternative instrumentation being credited for the monitoring of Containment Spray Flow. An alternative method of monitoring this variable was identified in Attachment 1 to FPL RG 1.97 submittal dated May 10, 1985. The alternative instrumentation provides monitoring of the operation of the Containment Spray System, as intended by RG 1.97. This is accomplished by monitoring the proper alignment of Containment Spray valves and operation of the Containment Spray pumps. In addition, the monitoring of containment temperature and pressure assures that containment cooling systems are performing their required function. Monitoring of RWST level provides indirect indication of the Containment Spray flow function.

G. This justification identifies alternative instrumentation being credited for the monitoring of Containment Fan Heat Removal. An alternative method of monitoring this variable was identified in Attachment 1 to FPL RG 1.97 submittal dated May 10, 1985. The method used to address this variable monitors the operation of the Emergency Containment Cooling (ECC) fans and verifies that Component Cooling Water (CCW) flow has been established to the ECC coolers. In addition, the monitoring of containment pressure and temperature provides indirect indication of the Containment Fan Heat Removal function.

H. This justification provides the rationale for not recording containment isolation valve position (Category 1 variable). Recording of containment isolation valve position is not essential for operator action. Containment valve position is available to the operators via Control Room indicating lights. The operators depend on the real time information provided by indicating lights to verify containment isolation. Thus the operators do not need trending of valve position to verify isolation.

I. This justification provides the basis for the acceptability of the existing range for Containment Sump Water Level narrow range indication. The existing range of LI-6308A&B includes a 0-5 inch deadband (i.e., no specific reading can be obtained). However, since the 0-5 inch deadband is outside of the loop measurement range and insignificant compared to the span of 364 inches, the lower limit of the indicator scale of 0-5 inches is acceptable.

J. This justification provides the basis for the acceptability of the existing range for Containment Sump Water Level narrow range recording. The existing range of LR-6308A&B includes a 0-5 inch deadband (i.e., no specific reading can be obtained). However, since the 0-5 inch deadband is insignificant compared to the span of 364 inches, the lower limit of the recorder scale of 0-5 inches is acceptable.

K. Wide range monitoring for Steam Generator Level is provided via a single non-Class 1E wide range level loop. This justification demonstrates that, although wide range monitoring may not be available during an accident scenario, the Control Room operator will have sufficient information to identify and mitigate an accident and to determine the availability of the steam generators as heat sinks. This is based upon the following:

(1) Steam generator level will either remain within narrow range level indication or, if steam generator level has fallen below narrow range indication, that Auxiliary Feedwater has been initiated and will result in the recovery of steam generator level to within narrow range limits. This is accomplished via the associated emergency operating procedures.

(2) RCS temperature (i.e., hot and cold leg water temperature) and pressure are available to determine the effectiveness of the steam generators as heat sinks.

2. Since the original containment isolation design for Turkey Point was not required to provide redundant valve position indication, the redundancy

criteria of RG 1.97 are not applicable to the existing plant design. As a result, in order to address the RG 1.97 concern for ensuring Control Room capability to verify isolation status, an RG 1.97 Containment Isolation Valve Evaluation was performed. The evaluation considers the effects of single failure of valve indication and demonstrates the capability for the Control Room operator to verify isolation of Containment penetrations.

3. An exception to this variable has been accepted by NRC in its Safety Evaluation Report dated March 20, 1986.

4. All 24 channels of the Area Radiation Monitoring System (ARMS) have been replaced by PC/M 89-462 to comply with commitments made to the NRC in FPL letter L-88-290 (Reference 6). L-88-290 commitments require the use of instrumentation with a range of 10^{-3} R/hr to 10^{2} R/hr. Instrumentation installed under PC/M 89-462 has a range of 10^{-4} R/hr to 10^{4} R/hr, which exceeeds both Regulatory Guide 1.97 recommendations and L-88-290 commitments.

5. No instrumentation has been provided since effluent discharge is through a common plant vent.

6. No recording capability exists for 4KV Bus Voltage (Category 1 variable). The emergency operating procedures presently credit the monitoring of 4KV Bus Voltage to allow the Control Room operator to determine the loss of power to a 4KV bus. Based upon the loss of 4KV bus voltage, the operator is required to take manual action to restore power to the battery chargers. Control Room meter indication of 4KV bus voltage is available and is adequate to allow the operator to identify the loss of bus voltage on a realtime basis. Trending of bus voltage is not necessary to ensure accomplishment of this manual action. Therefore, recording of the variable is not essential.

7. This device does not electrically transmit a signal to ERDADS. The data is obtained by plant personnel and then manually inputted into ERDADS where it is stored and available for display.

8. The range of the existing plant instrumentation for this variable (i.e., Item E6) does not envelop the RG 1.97 required range. However, the difference in low end range (i.e., 1 versus 0.1 micro Ci/CC) is not critical to the monitoring of main steam line radiation.

NOTES FOR TABLE 7.5-2 (Continued)

9. The original plant design included 51 core exit thermocouples. Due to the potential for individual sensor failures, the actual number of operable thermocouples may be reduced below this value.

7.6 IN-CORE INSTRUMENTATION

7.6.1 DESIGN BASIS

The in-core instrumentation is designed to yield information on the neutron flux distribution and fuel assembly outlet temperatures at selected core locations. Using the information obtained from the in-core instrumentation system, it is possible to confirm the reactor core design parameters and calculated hot channel factors. The system provides means for acquiring data and performs no operational control.

7.6.2 SYSTEM DESIGN

The in-core instrumentation system consists of the Inadequate Core Cooling System and flux thimbles, which run the length of selected fuel assemblies to measure the neutron flux distribution within the reactor core.

The Inadequate Core Cooling System (ICCS) consists of:

1. Core Exit Thermocouples System (CET)
2. Heated Junction Thermocouples System (HJTC)
3. Subcooled Margin Monitoring System (SMM)

These three systems are briefly discussed below:

1. Core-Exit Thermocouples System

This system originally included 51 thermocouples positioned to measure fuel assembly coolant outlet temperature at preselected locations; some thermocouples have been abandoned in accordance with plant procedures. During the Unit 4 Cycle 17 refueling, the northeast core exit thermocouple column, containing 13 core exit thermocouples, was damaged while removing the reactor vessel closure head. During the outage the

upper portion of the column was removed. The loss of this column's 13 thermocouples will not impede the ability to provide core exit temperature monitoring during mid-loop operations, and monitoring of post-accident conditions.

The temperatures measurement signals from these thermocouples are carried through mineral insulated cables routed in redundant channels. The thermocouples for the two channels have been selected in such a way that each channel indicates the temperature of the whole core. The thermocouple outputs are recorded in the computer room and indicated in the control room.

2. <u>Heated Junction Thermocouple System</u>

This system includes eight pairs of heated/unheated thermocouples located axially in a probe assembly; some probes have had pairs of heated/unheated thermocouples abandoned in accordance with plant procedures. There are two identical probe assemblies in each reactor vessel. The measurements from these thermocouples are carried through mineral insulated cables routed in two redundant channels. Two pairs of thermocouples are located in the upper head region above the upper support plate and six pairs are located in the upper plenum region between core alignment and support plates. These thermocouples provide information regarding reactor coolant inventory. The outputs from these thermocouples are processed in the computer room and indicated in the control room.

3. <u>Subcooled Margin Monitoring System</u>

This system includes two pressure transmitters to measure RCS pressure and one dual RTD in each hot and cold leg to measure RCS temperature. Reactor coolant system hot leg temperature (3/channel), cold leg temperature (3/channel) and pressurizer pressure (1/channel) are routed

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in two redundant channels to the computer room for saturation margin calculations.

In the computer room, the signals for these systems are processed by a microcomputer installed in a seismically qualified cabinet for each channel. A gas plasma display unit and page control module for each channel are installed in the control room for indication of processed parameters and these are connected to the microcomputer with a fiberoptic data link. Each ICCS (QSPDS) Channel is powered from a station vital power supply.

The measured data obtained from the in-core temperature and flux distribution instrumentation system, in conjunction with previously determined analytical information, can be used to determine the fission power distribution in the core at any time throughout core life. This method is more accurate than using calculations alone.

Once the fission power distribution has been established, the maximum power output is primarily determined by thermal power distribution and the thermal and hydraulic limitations determine the maximum core capability.

The incore instrumentation provides information which may be used to calculate the coolant enthalpy distribution, the fuel burnup distribution, and an estimate of the coolant flow distribution.

Both radial and azimuthal symmetry of power may be evaluated by combining the detector and thermocouple information from the one quadrant with similar data obtained from the other three quadrants.

The station blackout intertie is a cross connection between Turkey Point Units 3 and 4, 4.16 kV Switchgear 3D and 4D. Refer to Section 8.2.2.2 for additional details.

480V Bus Tie Breakers

The breakers associated with the bus ties on the 480V load centers are administratively controlled in the open position [with the exception of the swing load center (3H/4H) bus ties]. Overload protection is provided via direct acting/series or solid-state trip devices with long-term and short-time elements.

Load centers 3A/4A and 3B/4B, and load centers 3C/4C and 3D/4D are cross-tied and powered from either 4160 VAC switchgear 3A/4A or 3B/4B when one of the switchgears is taken out of service during a unit refueling outage. Appropriate electrical bus load reductions are implemented and other precautions are taken during this condition to ensure that onsite power sources can perform required safe shutdown functions. Appropriate evaluations have been performed to impose required restrictions during these periods (Reference 4).

Each 480V swing load center (3H/4H) is provided with tie feeders to 480V load centers (3C/4C, 3D/4D) via two circuit breakers in series for each train. The C and D load centers are associated with the A and B power trains. Thus, a swing load center has a capability of receiving power from either power train. The tie breakers are interlocked so that the 480V swing load center is connected to only one source of power at any given time. Each breaker is closed/tripped as a result of any of the following actions: (1) operation of a local control switch; (2) operation of the transfer switch in the Control Room; (3) automatic transfer action; or (4) overcurrent conditions. Position indication is provided in the main Control Room.

Operation of the tie breakers is controlled through the use of a three-position, spring return to "AUTO", control switch in the Control Room installed in Vertical Panels 3C04 and 4C04 to allow manual or auto transfer of supply power between the A and B trains. Indicating lights, which indicate the breaker status are installed for each of the feeder and supply breakers that tie Load Center 3H/4H to Load Centers 3C-3D/4C-4D, respectively. Alarms in the Control Room include 480V swing load center undervoltage/trouble.

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Manual alignment of the load center to either train can be accomplished by manual manipulation of the switch to either the "C" or "D" position. Manipulation of the selector switch to the "C" position, will result in the tie breakers aligned with Load Center D receiving a trip signal and the tie breakers aligned with Load Center C receiving a close signal. Manipulation of the selector switch to the "D" position, will result in the tie breakers

aligned with Load Center C receiving a trip signal and the tie breakers aligned with Load Center D receiving a close signal. Once a power source is selected, the tie breakers are subject to an automatic transfer scheme as follows:

> If the voltage on the primary supply bus is not present, the auto-transfer circuit checks the voltage on the alternate supply bus. If the voltage on the alternate supply bus is available, the auto-transfer action to the alternate supply bus is initiated. The auto-transfer action issues a signal to trip the tie breakers to the primary supply bus and, once the primary supply breaker is in an open position, issues a signal to close the tie breakers to the alternate supply bus. However during a LOOP scenario, the failure of Charging Pump C to strip from Load Center H may result in an EDG overload after load center transfer; therefore, transfer will be blocked if stripping did not occur. After normal EDG loading by the load sequencer, Load Center H can be manually loaded by the operator, if desired.

<u>480V Load Center Supply Breakers</u>

Each breaker can be closed/opened at the 480V Load Center. The breaker is maintained in the closed position. With the exception of the swing load centers (3H/4H - refer to discussion above), these non-automatic breakers are opened only for maintenance purposes.

<u>480V Load Center Feeder Breakers to 480V MCCs</u>

Each breaker can be closed/opened with controls located at the load center and can be opened manually. Overload protection is provided via direct acting/series or solid-state trip devices with long- and short-time elements.

<u>480V Load Center Feeder Breakers to Motors</u>

Each breaker is automatically tripped under LOOP conditions, and the required breakers are automatically closed by the load sequencer. Overload protection is provided via direct acting/series or solid-state trip devices with long-time and instantaneous elements.

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vital swing MCC of the opposite unit. The stability of the battery charger output is not load dependent, but is self-regulating over the working range from no load to full load.

The Technical Specifications require the performance of a battery service test at least once every 18 months and a battery performance test at least once every 60 months. In order to provide additional assurance for reliable and continuous operation of the reactors, it is desirable to keep the affected DC bus energized and connected to an equivalent battery during the testing of the station batteries. The spare station battery is an equivalent source for any of the four station batteries during maintenance or testing, and allows continuous operation of the units without entering into a Limiting Condition for Operation while performing these functions. The spare battery charger is non-safety related and is used to keep the spare battery charged when not in use. The spare battery charger is also used to recharge a battery following testing or maintenance prior to its return to service. The charger is fed from a non-vital MCC and is not used to feed plant loads.

All circuits related to engineered safeguards, such as automatic sequence equipment, loss of voltage logic, and containment isolation logic, have redundant circuits fed from separate DC buses. Also, as shown in Figures 8.2-4a through 8.2-4f, there are dual feeds to each 4.16 kV safety related switchgear. No credible single failure in any portion of the DC system can adversely affect the starting and loading of more than one EDG.

To protect the DC system against gross overvoltages from the battery chargers, an overvoltage relay is connected internally, across the output terminals of each charger. Actuation of this relay will trip the charger off the line and provide an alarm.

Two non-safety related switchyard batteries, each with two associated battery chargers, are provided for DC control power in the switchyard. Switchyard circuit breaker control, primary relaying with associated trip coils, and emergency lighting are supplied from switchyard Battery No. 1. This load can be transferred to fossil Units 1 and 2 station battery, if necessary, through a normally open tie breaker and interconnecting cable. Switchyard Battery No. 2 supplies the backup relaying and secondary trip coil on each

circuit breaker and additional emergency lighting. The switchyard batteries have no effect on plant equipment, load shedding or EDG operation.

Each unit also has a non-safety related DC bus, battery and battery charger. This non-vital bus supplies power to the non-safety related 4.16 kV C Bus, non-safety related 480V switchgear, non-safety related 120V AC inverter, C Bus transformer relay panels, and the turbine emergency oil pumps. A spare non-safety related charger is capable of being tied to the non-safety related DC bus of either unit.

No credible single failure in any portion of the DC System can adversely affect the shedding and loading of more than one EDG. The switchyard batteries have no effect on plant equipment, load shedding or EDG operation.

8.2.3 REFERENCES

1. NRC Supplemental Safety Evaluation of the Emergency Power System Enhancement Project dated October 1, 1991.

2. Engineering Evaluation JPN-PTN-SEIP-91-012, Revision 0, "Engineering Evaluation of Electromagnetic Interference (EMI) Testing for the Sequencers," dated February 20, 1992.

3. NRC Letter from Richard Croteau to J. H. Goldberg Dated May 20, 1994, TURKEY POINT UNITS 3 & 4 -ISSUANCE OF AMENDMENTS RE: ELIMINATION OF CRANKING DIESEL GENERATORS (TAC NOS. M87662 AND M87663).

4. Safety Evaluations JPN-PTN-SEEJ-89-085 (Unit 3) and JPN-PTN-SEEJ-88-042 (Unit 4), "De-Energization of Unit 3 (4) 4160 Volt Safety Related Busses".

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FINAL SAFETY ANALYSIS REPORT

FIGURE 8.2-4a

REFER TO ENGINEERING DRAWING

5613-E-11 , SHEET 1

REV. 15 (4/98)

FLORIDA POWER & LIGHT COMPANY
TURKEY POINT PLANT UNIT 3

ELECTRICAL 125V DC AND
120V INSTRUMENT AC
ONE LINE DIAGRAM - SHEET 1
FIGURE 8.2-4a

b) Non safety electric equipment whose failure under postulated environmental conditions could prevent satisfactory accomplishment of safety functions specified previously.

c) Certain post-accident monitoring equipment (Refer to Regulatory Guide 1.97, Revision 3, "Instrumentation for Light Water Cooled Nuclear Power Plants to Assess Plant and Environs During and Following an Accident."

These components are identified on the Environmental Qualification (EQ) List for 10CFR50.49.

8A.4 QUALIFICATION OF COMPONENTS

If the equipment in question meets the requirement found in Subsection 8A.3 and is located in a harsh environment, it must be qualified to 10CFR50.49. The Equipment Qualification Documentation Package 1001 (Doc Pack 1001), "Environmental Qualification Generic Approach and Treatment of Issues," provides the information required to properly identify the environment to which the specific equipment must be qualified. Operability requirements associated with the component are discussed along with the required temperature, pressure, humidity, radiation, aging and submergence.

Harsh environments are characterized by abnormally high temperatures, pressures, radiation doses, exposure to chemical spray, high relative humidity or submergence which are postulated to result from a Design Basis Event.

A mild environment is an environment that would at no time be significantly more severe than the environment which would occur during normal operation, including operational occurrences. Mild environment operability is assured by: (a) engineering requirements during specification development for purchasing equipment; (b) periodic maintenance, inspection and/or a replacement program based on sound engineering judgement or manufacturer's recommendations.

Environments in which radiation is the only parameter of concern are considered to be mild if the total radiation dose (includes 40-year normal dose plus the post accident dose) is 1.0E5 rads or less. This value is the threshold for evaluation and consideration based on EPRI NP-2129. However, certain solid state electronic components and components that utilize teflon are considered to be in a mild environment only if total radiation dose is 1.0E3 rads or less.

For additional detail on the identification of environmental conditions refer to Equipment Qualification Documentation Package 1001, "Generic Approach and Treatment of Issues."

8A.5 MAINTENANCE

The purpose of the Turkey Point Equipment Qualification Maintenance Program is the preservation of the qualification of systems, structures and components. In order to accomplish this task, the plants have developed approved Design Control, Procurement and Maintenance Procedures. In addition, the component specific documentation package contains the equipment's qualified life. The qualified life is developed based upon the qualification test report reviewed in conjunction with the environmental parameters associated with the area. After this review is completed a qualified life is established. Maintenance activities to be performed in addition to the vendor recommended maintenance are determined to insure that qualification of each piece of equipment is maintained throughout its qualified life.

8A.6 RECORDS/QUALITY ASSURANCE

A documentation package is prepared for the qualification of each manufacturer's piece of equipment under the auspices of 10CFR50.49. This package contains the information, analysis and justifications necessary to demonstrate that the equipment is properly and validly qualified as defined in 10CFR50.49 for the environmental effects of 40 years of service plus a design basis accident.

This documentation package is developed from the criteria stipulated in Doc Pack 1001.

A complete listing of equipment under the auspices of 10CFR50.49 is maintained.

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9.2 CHEMICAL AND VOLUME CONTROL SYSTEM

The Chemical and Volume Control System a) adjusts the concentrations of chemical neutron absorber for chemical reactivity control, b) maintains the proper water inventory in the Reactor Coolant System, including makeup for system leakages, c) provides the required seal water flow for the reactor coolant pump shaft seals, d) processes reactor coolant letdown, e) maintains the proper concentration of corrosion inhibiting chemicals in the reactor coolant and f) maintains the reactor coolant and corrosion activities to within design levels. The system is also used to fill and hydrostatically test the Reactor Coolant System.

9.2.1 DESIGN BASES

Redundancy of Reactivity Control

Criterion: Two independent reactivity control systems, preferably of different principles, shall be provided. (GDC 27)

In addition to the reactivity control achieved by the rod cluster control assemblies (RCCA) as detailed in Section 7, reactivity control is provided by the Chemical and Volume Control System which regulates the concentration of boric acid solution neutron absorber in the Reactor Coolant System. The system is designed to limit the rate of uncontrolled or inadvertent reactivity changes to a value which provides the operators sufficient time to correct the situation prior to system parameters exceeding design limits.

Reactivity Hot Shutdown Capability

Criterion: The reactivity control system provided shall be capable of making and holding the core subcritical from any hot standby or hot operating condition. (GDC 28)

The reactivity control systems provided are capable of making and holding the core subcritical from any hot standby or hot operating condition, including those resulting from power changes. The maximum excess reactivity expected

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for the core occurs for the cold, clean condition at the beginning of life of the initial RCC assemblies and boric acid. The full length RCC assemblies are divided into two categories comprising control and shutdown groups.

The control group, used in combination with boric acid, provides control of the reactivity changes of the core throughout the life of the core at power conditions. This group of RCC assemblies is used to compensate for short term reactivity changes at power such as those produced due to variations in reactor power requirements or in coolant temperature. The boric acid control is used to compensate for the more slowly occurring changes in reactivity throughout core life such as those due to fuel depletion and fission product buildup and decay.

Reactivity Shutdown Capability

Criterion: One of the reactivity control systems provided shall be capable of making the core subcritical under any anticipated operating condition (including anticipated operational transients) sufficiently fast to prevent exceeding acceptable fuel damage limits. Shutdown margin should assure subcriticality with the most reactive control rod fully withdrawn. (GDC 29)

The reactor core, together with the reactor control and protection system is designed so that the minimum allowable DNBR is no less than 1.30 and there is no fuel melting during normal operation including anticipated transients.

The shutdown groups are provided to supplement the control group of RCC assemblies to make the reactor at least one per cent subcritical ($k_{eff} = 0.99$) following trip from any credible operating condition to the hot, zero power condition assuming the most reactive RCC assembly remains in the fully withdrawn position.

Sufficient shutdown capability is also provided to maintain the core subcritical for the most severe anticipated cooldown transient associated with a single active failure, e.g., accidental opening of a steam bypass or relief valve. This is achieved with combination of control rods and automatic boron addition via the Safety Injection System with the most reactive rod assumed to be fully withdrawn.

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Reactivity Hold-Down Capability

Criterion: The reactivity control systems provided shall be capable of making the core subcritical under credible accident conditions with appropriate margins for contingencies and limiting any subsequent return to power such that there will be no undue risk to the health and safety of the public. (GDC 30)

Normal reactivity shutdown capability is provided by RCC assemblies, with boric acid injection used to compensate for the long term xenon decay transient and for cooldown. Any time that the unit is at power, the quantity of boric acid retained in the boric acid tanks and ready for injection will always exceed that quantity required to support a cooldown to cold shutdown conditions without letdown. Under these conditions, adequate boration can be achieved simply by providing makeup for coolant contraction from a boric acid tank and the refueling water storage tank. The minimum volume maintained in the boric acid tanks, therefore, is that volume necessary to increase the RCS boron concentration during the early phase of the cooldown of each unit, such that, subsequent use of the refueling water storage tank for contraction makeup will maintain the required shutdown margin throughout the remaining cooldown. In addition, the boric acid tanks have sufficient boric acid solution to achieve cold shutdown for each unit if the most reactive RCCA is not inserted. This quantity will always exceed the quantity of boric acid required to bring the reactor to hot standby and to compensate for subsequent xenon decay.

The boric acid solution is transferred from the boric acid tanks by boric acid pumps to the suction of the charging pumps which inject boric acid into the reactor coolant. Any charging pump and any boric acid transfer pump can be operated from diesel generator power on loss of power. Boric acid can be injected by one charging pump and one boric acid transfer pump at a rate which shuts the reactor down with no rods inserted in less than forty minutes when a feed and bleed process is utilized (less than 30 minutes when the available pressurizer volume is utilized). In forty additional minutes, enough boric acid can be injected to compensate for xenon decay although xenon decay below the equilibrium operating level will not begin until approximately 12-15 hours after shutdown. If two boric acid pumps and two

charging pumps are available, these time periods are reduced. Additional boric acid is employed if it is desired to bring the reactor to cold shutdown conditions.

On the basis of the above, the injection of boric acid is shown to afford backup reactivity shutdown capability, independent of control rod clusters which normally serve this function in the short term situation. Shutdown for long term and reduced temperature conditions can be accomplished with boric acid injection using redundant components.

Codes and Classifications

All pressure retaining components (or compartments of components) which are exposed to reactor coolant, comply with the following codes:

a) System pressure vessels - ASME Boiler and Pressure Vessel Code, Section III, Class C, including para. N-2113, original equipment; Section III, Class 3 or Class 2, post-steam generator repair equipment.

b) System valves, fittings and piping - USAS B31.1, including nuclear code cases.

System component code requirements are tabulated in Table 9.2-1.

The tube and shell sides on the regenerative heat exchanger and the tube side of the excess letdown exchanger are designed to ASME Section III, Class C. This designation is based on the following considerations: (a) each exchanger is connected to the reactor coolant system by lines equal to or less than 3", and (b) each is located inside the containment. Analyses show that the accident associated with a 3" line break does not result in clad damage or failure. Reactor coolant escaping during such an accident is confined to the containment building.

9.2.2 SYSTEM DESIGN AND OPERATION

Various components of the Chemical and Volume Control System are shared by the two units. These components are shown in Table 9.2-3 and discussion concerning the sharing is given in Appendix A. The following discussion is for the Chemical and Volume Control System for one unit and applies equally to either unit.

The Chemical and Volume Control System, shown in Figures 9.2-1 through 9.2-10, provides a means for injection of boric acid, chemical additions for corrosion control, and reactor coolant cleanup and degasification. This system also adds makeup water to the Reactor Coolant System, processes water let down from the Reactor Coolant System, and provides seal water injection to the reactor coolant pump seals. Materials in contact with the reactor coolant are austenitic stainless steel or equivalent corrosion resistant materials.

System components whose design pressure and temperature are less than the Reactor Coolant System design limits are provided with overpressure protective devices.

System discharges from overpressure protective devices (safety valves) and system leakages are directed to closed systems. Effluents removed from such closed systems are monitored and discharged under controlled conditions.

During operation, reactor coolant flows through the letdown line from a loop cold leg on the discharge side of the pump and, after processing is returned to the cold leg of another loop on the discharge side of the pump via a charging line. An alternate charging connection is provided on a loop hot leg. An excess letdown line is also provided for removing coolant from the reactor coolant system. The largest required charging pump flow to maintain normal operation with 45 gpm letdown orifice, 9 gpm RCP seals runoff and 1 gpm RCS leakage is supplied by one charging pump in operation.

Each of the connections to the Reactor Coolant System has an isolation valve located close to the loop piping. In addition, a check valve is located downstream of each charging line isolation valve. Reactor coolant entering the Chemical and Volume Control System flows through the shell side of the regenerative heat exchanger where its temperature is reduced. The coolant then flows through a letdown orifice which reduces the coolant pressure. The cooled, low pressure water leaves the containment and enters the auxiliary building where it undergoes a second temperature reduction in the tube side of the non-regenerative heat exchanger followed by a second pressure reduction by the low pressure letdown valve. After normally passing through one of the CVCS letdown demineralizer(s), where impurities are removed, coolant flows through the reactor coolant filters and enters the volume control tank through a spray nozzle.

Hydrogen is automatically supplied, as determined by pressure control, to the vapor space in the volume control tank, which is predominantly hydrogen and water vapor. The hydrogen supply line has an excess flow valve (Figure 9.2-11) upstream and outside of the Charging Pump Room which will automatically close if the hydrogen flow increases beyond its specific flow setting due to a downstream pipe rupture thus eliminating possible release of hydrogen into the charging pump room. The hydrogen within this tank is supplied to the reactor coolant for maintaining a low oxygen concentration. Fission gases are periodically removed from the system by venting the volume control tank to the Waste Disposal System.

The charging pumps take suction from the volume control tank and return the coolant to the Reactor Coolant System through the tube side of the regenerative heat exchanger.

A newly borated bed of mixed resin ($H\text{-}BO_3$ form) is used intermittently to remove excess lithium which is formed from $B^{10}(n,\alpha)Li^7$ reaction. After saturation with lithium the mixed bed ($Li\text{-}BO_3$) is ready for service as a mixed bed demineralizer for purification.

Boric acid is dissolved in water in the batching tank to a concentration of approximately 3.0 to 3.5 percent by weight. A transfer pump is used to transfer the batch to the boric acid tanks. Small quantities of boric acid solution are metered from the discharge of an operating transfer pump for blending with primary water as makeup for normal leakage or for increasing the reactor coolant boron concentration during normal operation. The solubility limit for 3.5 weight percent boric acid is reached at a temperature of 50°F. This temperature is sufficiently low that the normally expected ambient temperatures within the auxiliary building will maintain boric acid solubility.

Excess liquid effluents containing boric acid flow from the Reactor Coolant System through the letdown line and are collected in the holdup tanks. As liquid enters the holdup tanks, the nitrogen cover gas is displaced to the gas decay tanks in the Waste Disposal System through the waste vent header. The concentration of boric acid in the holdup tanks varies throughout core life from the refueling concentration to essentially zero at the end of the core cycle. A recirculation pump is provided to transfer liquid from one holdup tank to another and to recirculate the contents of individual holdup tanks.

Liquid effluent in the holdup tanks is processed as a batch operation. This liquid is pumped to the waste holdup tank for processing as liquid waste.

A fresh bed of mixed resin (H-OH form) can be used intermittently to remove boron from the reactor coolant near the end of core life. When the mixed bed has been saturated with Boron ($H-BO_3$), it is ready for use in removing cesium and lithium.

During cooldown when the residual heat removal loop is operating and the letdown orifices are not in service, a flow path is provided to remove corrosion impurities and fission products. A portion of the flow leaving the residual heat exchangers passes through the non-regenerative heat exchanger, mixed bed demineralizers, reactor coolant filters and volume control tank. The fluid is then pumped, via the charging pump, through the tube side of the regenerative heat exchanger into the Reactor Coolant System.

Expected Operating Conditions

Tables 9.2-2, 9.2-3, and 9.2-5 list the system performance requirements, data for individual system components and reactor coolant equilibrium activity concentration. Table 9.2-4 supplements Table 9.2-5.

Reactor Coolant Activity Concentration

The parameters used in the calculation of the reactor coolant fission product inventory, including pertinent information concerning the expected coolant cleanup flow rate and demineralizer effectiveness, are presented in Table 9.2-4. The results of the calculations are presented in Table 9.2-5. In these calculations defects in one percent of the fuel rods are assumed to be present at initial core loading and are uniformly distributed throughout the core and the fission product escape rate coefficients are therefore based upon an average fuel temperature.

The fission product activity in the reactor coolant during operation with small cladding pinholes or cracks in 1% of the fuel rods is computed using the following differential equations:

For parent nuclides in the coolant,

$$\frac{dN_{wI}}{dt} = Dv_I N_{C_I} - (\lambda_I + Rn_I + \frac{B'}{B_o - tB'}) N_{wI}$$

for daughter nuclides in the coolant,

$$\frac{dN_{wJ}}{dt} = Dv_J N_{C_J} - (\lambda_J + Rn_J + \frac{B'}{B_o - tB'}) N_{wJ} + \lambda_I N_{w_I}$$

where:

N = population of nuclide

D = fraction of fuel rods having defective cladding

R = purification flow, coolant system volumes per sec.

B_o = initial boron concentration, ppm

B' = boron concentration reduction rate by feed and bleed, ppm per sec

η = removal efficiency of purification cycle for nuclide

λ = radioactive decay constant

ν = escape rate coefficient for diffusion into coolant

Subscript C refers to core

Subscript w refers to coolant

Subscript i refers to parent nuclide

Subscript j refers to daughter nuclide

Tritium is produced in the reactor from ternary fission in the fuel, irradiation of boron in the burnable poison rods (during initial fuel cycle only) and irradiation of boron, lithium and deuterium in the coolant. The deuterium contribution is less than 0.1 curie per year and may be neglected. The parameters used in the calculation of tritium production rate are presented in Table 9.2-6.

Reactor Makeup Control

The reactor makeup control consists of a group of instruments arranged to provide a manually pre-selected makeup composition to the charging pump suction header or the volume control tank. The makeup control functions are to maintain desired operating fluid inventory in the volume control tank and to adjust reactor coolant boron concentration for reactivity and shim control.

Makeup for normal leakage is regulated by the reactor makeup control which is set by the operator to blend water from the primary water storage tank with concentrated boric acid to match the reactor coolant boron concentration.

The makeup system also provides concentrated boric acid or primary water to either increase or decrease the boric acid concentration in the Reactor Coolant System. To maintain the reactor coolant volume constant, an equal amount of reactor coolant is let down to the holdup tanks. Should the letdown line be out of service during operation, sufficient volume exists in the pressurizer to accept the amount of boric acid necessary for hot standby.

Boration to the cold shutdown concentration is also achievable without letdown when boration is performed in conjunction with the plant cooldown through the required makeup for coolant contraction. Specifically, if boric acid is injected first from the boric acid tanks and then from the refueling water storage tank to maintain constant pressurizer level during the cooldown, sufficient boric acid will be added to the RCS to maintain the required shutdown margins.

Makeup water to the Reactor Coolant System is provided by the Chemical and Volume Control System from the following sources:

a) The primary water storage tank, which provides water for dilution when the reactor coolant boron concentration is to be reduced.

b) The boric acid tanks, which supply concentrated boric acid solution when reactor coolant boron concentration is to be increased.

c) The refueling water storage tank, which supplies borated water for normal or emergency makeup.

d) The chemical mixing tank, which is used to inject small quantities of solution when additions of hydrazine or pH control chemical are necessary.

Makeup is provided to maintain the desired operating fluid inventory in the Reactor Coolant System. The operator can stop the makeup operation at any time in any operating mode by remotely closing the makeup stop valves. One primary water makeup pump and one boric acid transfer pump are normally operated.

A portion of the high pressure charging flow is injected into the reactor coolant pumps between the pump impeller and the shaft seal so that the seals are not exposed to high temperature reactor coolant. Part of the flow is the shaft seal leakage flow and the remainder enters the Reactor Coolant System through a labyrinth seal on the pump shaft. The shaft seal leakage flow cools the lower radial bearing, passes through the seals, is cooled in the seal water heat exchanger, filtered, and returned to the volume control tank.

Seal water inleakage to the Reactor Coolant System requires a continuous letdown of reactor coolant to maintain the desired inventory. In addition, bleed and feed of reactor coolant are required for removal of impurities and adjustment of boric acid in the reactor coolant.

Automatic Makeup

The "automatic makeup" mode of operation of the reactor makeup control provides boric acid solution preset by the operator to match the boron concentration in the Reactor Coolant System. The automatic makeup compensates for minor leakage of reactor coolant without causing significant changes in the coolant boron concentration.

Under normal operating conditions, the mode selector switch and makeup stop valves are set in the "AUTO" position. A preset low level signal from the volume control tank level controller causes the automatic makeup control action to open the makeup stop valve to the charging pump suction, open the concentrated boric acid control valve and the primary water makeup control valve. The flow controllers adjust flow so that the concentration of the blend matches that of the preset concentration. The primary water and the boric acid streams meet and are mixed in the boric acid blender. Makeup addition to the charging pump suction header causes the water level in the volume control tank to rise. At a preset high level point, the makeup is stopped; the primary water makeup control valve closes, the concentrated boric acid control valve closes and the makeup stop valve to charging pump suction closes.

Dilution

The "dilute" mode of operation permits the addition of a pre-selected quantity of primary water makeup at a pre-selected flow rate to the Reactor Coolant System. The operator sets the makeup stop valves to the volume control tank and to the charging pump suction in the "auto" position, the mode selector switch to "dilute", the primary water makeup flow controller set point to the desired flow rate, and the primary water makeup batch integrator to the desired quantity. If the dilution flow deviates ±5 gpm from the preset flow

rate, an alarm indicates the deviation. One primary water pump runs continuously to provide makeup water as required. Makeup water is added to the volume control tank and then goes to the charging pump suction header. Excessive rise of the volume control tank water level is prevented by automatic actuation (by the tank level controller) of a three-way diversion valve, which routes the reactor coolant letdown flow to the holdup tanks. When the preset quantity of primary water makeup has been added, the batch integrator causes the primary water makeup control valve to close.

Alternate Dilute

The "Alternate Dilute" mode of operation permits the addition of a pre-selected quantity of reactor makeup water at a pre-selected flow rate to the Reactor Coolant System. A primary water pump is normally operating. Before actuation of the "Start" Control Station, the operator sets the mode selector switch to "Alternate Dilute", the reactor makeup water flow controller set point to the desired flow rate, and the reactor makeup water "batch integrator" to the desired quantity.

The operator actuates the "Start" Control Station. This mode of operation is similar to the "dilute" mode except both the makeup stop valves to the Volume Control tank and charging pump suction are opened. Primary water is simultaneously added in the volume control tank and in the charging pump suction header. By adding primary water at both locations the delay time for injecting primary water is reduced and hydrogen is added to a portion of the primary water flow. Excessive water level in the volume control tank is prevented by automatic actuation of a three-way diversion valve (by the tank level controller), which routes the reactor coolant letdown flow to the hold-up tanks. When the preset quantity of reactor makeup water has been added, the batch integrator causes the reactor makeup water control valves to close. This mode of control is used when there are daily load changes. After the "Alternate Dilute" mode requirements are satisfied, the operator may return the mode selector switch back to "Dilute" to permit the addition of reactor makeup water as required.

Boration

The "borate" mode of operation permits the addition of a pre-selected quantity of concentrated boric acid solution at a pre-selected flow rate to the Reactor Coolant System. The operator sets the makeup stop valves to the volume control tank and to the charging pump suction in the "Auto" position, the mode selector switch to "borate", the concentrated boric acid flow controller set point to the desired flow rate, and the concentrated boric acid batch integrator to the desired quantity. If the boration flow deviates 1.5 gpm from the preset flow rate, an alarm indicates the deviation. Placing the reactor makeup control switch in the "start" position starts the selected boric acid transfer pump, and permits the concentrated boric acid to be added to the charging pump suction header. The total quantity added in most cases is so small that it has only a minor effect on the volume control tank level. When the preset quantity of concentrated boric acid solution has been added, the batch integrator causes the concentrated boric acid transfer pump to stop and the concentrated boric acid control valve to close.

The capability to add boron to the reactor coolant is sufficient so that no limitation is imposed on the rate of cooldown of the reactor upon shutdown. The maximum rates of boration and the equivalent coolant cooldown rates are given in Table 9.2-2. One set of values is given for the addition of boric acid from a boric acid tank with one transfer and one charging pump operating. The other set assumed the use of refueling water but with two of the three charging pumps operating. The rates are based on full operating temperature and on the end of the core life when the moderator temperature coefficient is most negative.

By manual action of the operator, the boric acid transfer pump can discharge directly to the charging pump suction and bypass the blender and volume control tank.

Alarm Functions

The reactor makeup control is provided with alarm functions to call the

operator's attention to the following conditions:

a) Deviation of primary water makeup flow rate from the control set point

b) Deviation of concentrated boric acid flow rate from the control set point

c) If the reactor makeup control selector is not set for the automatic makeup control mode, a volume control tank low level alarm occurs at 12% of tank level.

Charging Pump Control

Three positive displacement variable speed drive charging pumps are used to supply charging flow to the Reactor Coolant System.

The speed of each pump can be controlled manually or automatically. During normal operation, only one of the three pumps is automatically controlled. During normal operation, only one charging pump is operating and the speed is modulated in accordance with pressurizer level. During load changes the pressurizer level set point is varied automatically to compensate partially for the expansion or contraction of the reactor coolant associated with the Tavg changes. Tavg compensates for power changes by varying the pressurizer level set points in conjunction with pressurizer level for charging pump control. The level set points are varied between 20 and 60 percent of the adjustable range depending on the power level. Charging pump speed does not change rapidly with pressurizer level variations due to the reset action of the pressurizer level controller.

If the pressurizer level increases, the speed of the pump decreases, likewise if the level decreases, the speed increases. If the charging pump on automatic control reaches the high speed limit, an alarm is actuated and a second charging pump is manually started. The speed of the second pump is manually regulated. If the speed of the charging pump on automatic control does not decrease and the second charging pump is operating at maximum speed, the third charging pump can be started and its speed manually regulated. If

the speed of the charging pump on automatic control decreases to its minimum value, an alarm is actuated and the speed of the pumps on manual control is reduced.

Components

A summary of principal component data is given in Table 9.2-3.

Regenerative Heat Exchanger

The regenerative heat exchanger is a multiple shell and U-tube unit which is designed to recover the heat from the letdown stream by reheating the charging stream during normal operation. This exchanger also limits the temperature rise which occurs at the letdown orifices during periods when letdown flow exceeds charging flow by a greater margin than at normal letdown conditions.

The letdown stream flows through the shell of the regenerative heat exchanger and the charging stream flows through the tubes. The unit is made of austenitic stainless steel, and is of all-welded construction.

Letdown Orifices

One of the three letdown orifices controls flow of the letdown stream during normal operation and reduces the pressure to a value compatible with the non-regenerative heat exchanger design. Two of the letdown orifices are each designed to pass normal letdown flow. These orifices are used in parallel to pass maximum purification flow at normal Reactor Coolant System operating pressure. The remaining orifice is designed to pass three-fourths of the normal letdown flow. The orifices are placed in and taken out of service by remote manual operation of their respective isolation valves. One or both of the standby orifices may be used in parallel with the normally operating orifice in order to increase letdown flow when the Reactor Coolant System pressure is below normal. This arrangement provides a full standby capacity for control of letdown flow. Each orifice consists of bored pipe made of austenitic stainless steel.

Non-Regenerative (letdown) Heat Exchanger

The non-regenerative heat exchanger cools the letdown stream to the operating temperature of the mixed bed demineralizers. Reactor coolant flows through the tube side of the exchanger while component cooling water flows through the shell. The letdown stream outlet temperature is manually controlled by throttling manual valve *-834. The unit is a multiple-pass-tube heat exchanger. All surfaces in contact with the reactor coolant are austenitic stainless steel, and the shell is carbon steel.

CVCS Letdown Demineralizers

Five flushable demineralizers maintain reactor water chemistry. The main demineralizers are the A, B, D, and E demineralizers. The C demineralizer has smaller capacity and may be connected in series with either the A or B demineralizers.

A hydrogen ion form cation resin and a hydroxyl form anion resin are initially charged into the demineralizers. This resin bed is used to reduce RCS boron concentration (usually near the end of core life).

When saturated with boron, the resin is converted to an $H\text{-}BO_3$ form and is used intermittently to control the concentration of lithium-7 which builds up in the coolant from the $B^{10}(n,\alpha)Li^7$ reaction. In addition, each of the main demineralizers have sufficient capacity to maintain the cesium-137 concentration in the coolant below 1.0 μc/cc with one percent defective fuel. The demineralizer would be used intermittently to control cesium.

When saturated with lithium, the resin is converted to an $Li^7\text{-}BO_3$ form and is used to maintain reactor coolant purity. This form of resin removes both fission and corrosion products. In this form, the resin bed is designed to reduce the concentration of isotopes in the purification stream (except for cesium, yttrium, and molybdenum) by a minimum factor of 10. Each of the main demineralizers has sufficient capacity after operation for one core cycle with one percent defective fuel rods to reduce the activity of the primary coolant to refueling concentration.

With the exception of the C demineralizer, each demineralizer is sized to accommodate the maximum letdown flow. The number of demineralizers available provides flexibility and ensures standby capacity should a demineralizer become exhausted during operation. Additionally, the demineralizers may be charged with specialized resins (OH^- Anion, H^+ Cation, or Li^7-OH mixed bed) if desired. The C demineralizer is limited in use to 60 gpm letdown flow, and if used, is placed in series with either A or B demineralizers.

The demineralizers are made of austenitic stainless steel and are provided with suitable connections to facilitate resin replacement when required. The vessels are equipped with resin retention screens.

Resin Fill Tank

The resin fill tank is used to charge fresh resin to the demineralizers. The line from the conical bottom of the tank is fitted with a dump valve and may be connected to any one of the demineralizer fill lines. The demineralizer water and resin slurry can be sluiced into the demineralizer by opening the dump valve. The tank, designed to hold approximately one third of the resin volume of demineralizers A, B, D, or E, is made of austenitic stainless steel.

Reactor Coolant Filter

The three filters collect resin fines and particulates larger than 25 microns from the letdown stream. The vessel is made of austenitic stainless steel, and is provided with connections for draining and venting. Design flow capacity of the filters shall at least be equal to the maximum purification flow rate. Bases considered to determine when the reactor coolant filter will be replaced are: (1) a high pressure differential across the filter, (2) a set time limit after which the filter will be replaced, and (3) when a portable radiation monitor shows radiation in excess of established limits.

Volume Control Tank

The volume control tank collects the excess water released from zero power to full power, that is not accommodated by the pressurizer. It also receives the excess coolant release caused by the deadband in the reactor control

temperature instrumentation. Overpressure of hydrogen gas is maintained in the volume control tank to control the hydrogen concentration in the reactor coolant at 25 to 50 cc per kg of water.

The reactor coolant hydrogen concentration can be reduced to 15 cc per kg prior to shutdown, provided that the operating period does not exceed two days and the reactor coolant hydrogen is monitored once per shift.

A spray nozzle is located inside the tank on the inlet line from the reactor coolant filter. This spray nozzle provides intimate contact of the gas and liquid phases. A remotely operated vent valve discharging to the Waste Disposal System permits removal of gaseous fission products which are stripped from the reactor coolant and collected in this tank. The volume control tank also acts as a head tank for the charging pumps and a reservoir for the leakage from the reactor coolant pump controlled leakage seal. The tank is constructed of austenitic stainless steel.

Charging Pumps

Three charging pumps inject coolant into the Reactor Coolant System. The pumps are the variable speed positive displacement type, and all parts in contact with the reactor coolant are fabricated of austenitic stainless steel and other material of adequate corrosion resistance. Pump seal leakage is collected and routed to the holdup tanks for disposal. In order to minimize this leakage, which has proven to be a burden on the waste disposal systems of previous nuclear units, the pumps were modified after installation. This modification which has been successful in other projects, consists of new design plungers and seals, with a seal head tank. The pump design precludes the possibility of lubricating oil contaminating the charging flow, and the integral discharge valves act as check valves. Hydraulic accumulators are installed on the suction and discharge piping of the charging pumps to attenuate vibration and acoustically decouple this piping from the pumps.

Each pump is designed to provide the full charging flow and the reactor coolant pump seal water supply with normal seal leakage. Each pump is designed to provide rated flow against a pressure equal to the sum of the

Reactor Coolant System maximum pressure (existing when the pressurizer power operated relief valve is operating) and the piping, valve and equipment pressure losses of the charging system at the design charging flows.

One of the three charging pumps can be used to hydrotest the Reactor Coolant System. The pumps are normally energized manually from the control room, and flow is automatically controlled by pressurizer level.

Chemical Mixing Tank

The chemical mixing tank is used to prepare caustic solutions for pH control and hydrazine for oxygen scavenging.

The capacity of the chemical mixing tank is determined by the quantity of 35 per cent hydrazine solution necessary to increase the concentration in the reactor coolant by 10 ppm. This capacity is more than sufficient to prepare the solution of pH control chemical for the Reactor Coolant System.

The chemical mixing tank is made of austenitic stainless steel.

Excess Letdown Heat Exchanger

The excess letdown heat exchanger cools reactor coolant letdown flow until the flow rate is equal to the nominal injection rate through the reactor coolant pump labyrinth seal, if letdown through the normal letdown path is blocked. The unit is designed to reduce the letdown stream temperature from the cold leg temperature to 195 F. The letdown stream flows through the tube side and component cooling water is circulated through the shell side. All surfaces in contact with reactor coolant are austenitic stainless steel and the shell is carbon steel. All tube joints are welded.

Seal Water Heat Exchanger

The seal water heat exchanger removes heat from the reactor coolant pump seal water returning to the volume control tank and reactor coolant discharge from the excess letdown heat exchanger. Reactor coolant flows through

the tubes and component cooling water is circulated through the shell side. The tubes are welded to the tube sheet because leakage could occur in either direction, resulting in undesirable contamination of the reactor coolant or component cooling water. All surfaces in contact with reactor coolant are austenitic stainless steel and the shell is carbon steel.

The unit is designed to cool the excess letdown flow and the seal water flow to the temperature normally maintained in the volume control tank if all the reactor coolant pump seals are leaking at the maximum design leakage rate.

Seal Water Filter

The two filters collect particulates from the reactor coolant pump seal water return and from the excess letdown heat exchanger flow. The filter is designed to pass the sum of the excess letdown flow and the maximum design leakage from the reactor coolant pump seals. The vessel is constructed of austenitic stainless steel.

Seal Water Injection Filters

Two filters are provided in parallel, each sized for the injection flow. They collect particulates from the water supplied to the reactor coolant pump seal.

Boric Acid Filter

The boric acid filter collects particulates from the boric acid solution being pumped to the charging pump suction line. The filter is designed to pass the design flow of two boric acid pumps operating simultaneously. The vessel is constructed of austenitic stainless steel and the filter elements are disposable synthetic cartridges.

Boric Acid Tanks

The boric acid tank capacities are sized to store sufficient boric acid solution to support a cooldown to cold shutdown conditions without letdown. Under these conditions, adequate boration can be achieved simply by providing makeup for coolant contraction from a boric acid tank and the refueling water storage tank. The minimum volume maintained in the boric acid tanks, therefore, is that volume necessary to increase the RCS boron concentration during the early phase of the cooldown of each unit, such that, subsequent use of the refueling water storage tank for contraction makeup will maintain the required shutdown margin throughout the remaining cooldown. In addition, the boric acid tanks have sufficient boric acid solution to achieve cold shutdown for each unit if the most reactive RCCA is not inserted.

The concentration of boric acid solution in storage is maintained between 3.0 and 3.5 percent by weight. Periodic manual sampling is performed and corrective action is taken, if necessary, to ensure that these limits are maintained. Therefore, measured amounts of boric acid solution can be delivered to the reactor coolant to control the concentration. The combination overflow and breather vent connection has a water loop seal to minimize vapor discharge during storage of the solution. The tanks are constructed of austenitic stainless steel.

Batching Tank

The batching tank is sized to hold several days makeup supply of boric acid solution for the boric acid tank. The basis for makeup is reactor coolant leakage of 1/2 gpm at beginning of core life. The tank may also be used for solution storage. A local sampling point is provided for verifying the solution concentration prior to transferring it to the boric acid tank or for draining the tank.

The tank manway is provided with a removable screen to prevent entry of foreign particles. In addition, the tank is provided with an agitator to improve mixing during batching operations. The tank is constructed of austenitic stainless steel, and is not used to handle radioactive substances.

The batching tank is also used to mix post-LOCA chemicals to neutralize the containment recirculation sump for corrosion protection of fluid systems and equipment involved in the long term cooing of the core and the containment. No temperature control is required to assure solubility of the post-LOCA neutralization chemicals.

Boric Acid Transfer Pumps

Two 100% capacity centrifugal pumps per unit are used to circulate or transfer chemical solutions. The pumps circulate boric acid solution through the boric acid tanks and inject boric acid into the charging pump suction header.

Although one pump is normally used for boric acid batching and transfer and the other for boric acid injection, either pump may function as standby for the other. The design capacity of each pump is equal to the normal letdown flow rate. The design head is sufficient, considering line and valve losses, to deliver rated flow to the charging pump suction header when volume control tank pressure is at the maximum operating value (relief valve setting). All parts in contact with the solutions are austenitic stainless steel and other adequately corrosion-resistant material.

The transfer pumps are operated either automatically or manually from the control room or from a local control panel. The reactor makeup control operates one of the pumps automatically when boric acid solution is required for makeup or boration.

Boric Acid Blender

The boric acid blender promotes thorough mixing of boric acid solution and reactor makeup water from the reactor coolant makeup circuit. The blender consists of a conventional pipe fitted with a perforated tube insert. All material is austenitic stainless steel. The blender decreases the pipe length required to homogenize the mixture for taking a representative local sample.

Recycle Process

The recycle process is common to Units 3 and 4 and the description below is of the components furnished to serve both units.

Holdup Tanks

Three holdup tanks contain radioactive liquid which enters the tank from the letdown line. The liquid is released from the Reactor Coolant System during

startup, shutdowns, load changes and from boron dilution to compensate for burnup. The contents are processed through the waste holdup tank.

The three liquid storage tanks' capacity is approximately four Reactor Coolant System volumes. The tanks are constructed of austenitic stainless steel.

Holdup Tank Recirculation Pump

The holdup tank recirculation pump is used to mix the contents of a holdup tank or transfer the contents of one holdup tank to another holdup tank. The wetted surface of this pump is constructed of austenitic stainless steel.

Gas Stripper Feed Pumps

The three gas stripper feed pumps are used to transfer the contents of the holdup tanks to the waste holdup tank #1. One pump is normally used during the transfer operation. The non-operating pumps are maintained in standby and are available for operation in the event that the operating pump malfunctions. These centrifugal pumps are constructed of austenitic stainless steel.

Base and Cation Ion Exchangers

Three flushable base and cation ion exchangers remove anions and cations (primarily cesium and lithium) from the holdup tank effluent. The resin is initially in the hydrogen form. Experiments performed by Westinghouse indicate that the decontamination factor for cesium (see Table 9.2-4) is conservative. The design flow rate is equal to the gas stripper-evaporator design capacity for one unit. The demineralizer vessel is constructed of austenitic stainless steel and contains a resin retention screen.

Ion Exchanger Filters

These two filters collect resin fines and particulates from the cation ion exchanger. The vessel is made of austenitic stainless steel and is provided with connections for draining and venting. Disposable synthetic filter

cartridges are used. The design flow capacity is equal to the boric acid evaporator concentrates transfer pump flow rate.

Evaporator Condensate Demineralizers

Two anion demineralizers remove any boric acid contained in the evaporator condensate. Hydroxyl based ion-exchange resin is used to produce evaporator condensate of high purity. Connections are provided for regeneration of the resin. Spent resin is flushed to the spent resin storage tank.

Condensate Filters

Two filters collect resin fines and particulates from the boric acid evaporator condensate streams. Each vessel is made of austenitic stainless steel, and is provided with a connection for draining and venting. Disposable synthetic filter elements are used. The design flow capacity of each filter is equal to the boric acid evaporator flow rate.

Monitor Tanks

Two monitor tanks permit continuous operation of the evaporator trains. When one tank is filled, the contents are analyzed and either reprocessed, discharged to the Waste Disposal System, or pumped to the primary water storage tank. These tanks are stainless steel.

Monitor Tank Pumps

Two monitor tank pumps discharge water from the monitor tanks. Each pump is sized to empty a monitor tank in approximately 2.0 hours. The pumps are constructed of austenitic stainless steel.

Concentrates Filters

Two disposable synthetic cartridge type filters remove particulates from the evaporator concentrates. Design flow capacity of each filter is equal to the boric acid evaporator concentrates transfer pump capacity. The vessels are made of austenitic stainless steel.

Concentrates Holding Tank

The concentrates holding tank is sized to hold the production of concentrates from one batch of evaporator operation. The tank is supplied with an electrical heater which prevents boric acid precipitation and is constructed of austenitic stainless steel.

Concentrates Holding Tank Transfer Pumps

Two holding tank transfer pumps discharge boric acid solution from the concentrates holding tank to the hold up tanks. Each canned centrifugal pump is sized to empty the concentrates holding tank in approximately 10 minutes. The wetted surfaces are constructed of authentic stainless steel and other adequately corrosion-resistant material.

Valves

Some valves that perform a modulating function are equipped with two sets of packing and an intermediate leakoff connection that discharges to the Waste Disposal System. Other valves may have stem leakage control. Globe valves are installed with flow over the seats when such an arrangement reduces the possibility of leakage. Basic material of construction is stainless steel for all valves except the batching tank steam jacket valves which are carbon steel. Although originally designed for steam service, the source of steam to the batching tank steam jacket has since been abandoned.

Isolation valves are provided at all connections to the Reactor Coolant System. Lines entering the reactor containment also have check valves inside the containment to prevent reverse flow from the containment.

Safety related power operated gate valves were evaluated for their susceptibility to pressure locking and thermal binding as required by NRC Generic Letters 89-10 and 95-07. The emergency boration valves (MOV-*-350) have a design feature (a hole drilled in the upstream disc to provide relief from the inter-disc space) which preclude the potential for pressure locking as described in the two generic letters.

Relief valves are provided for lines and components that might be pressurized above design pressure by improper operation or component malfunction. Pressure relief for the tube side of the regenerative heat exchanger is provided by a thermal relief valve which is designed to open when pressure under the seat exceeds 2735 psig. Relief valves settings and capacities are given in Table 9.2-3.

Turkey Point has installed manual operating features to selected air-operated valves (Table 9.6A-11) in the Chemical and Volume Control System. The installation of these features provides an alternate means of operating these valves if the valve misoperates due to receipt of a spurious electrical signal resulting from a postulated fire. These changes implement recommendations made as part of the Appendix R Safe Shutdown Analysis in order to meet the licensing commitments of 10CFR50 Appendix R (see Subsection 9.6A-5.6).

Piping

All Chemical and Volume Control System piping handling radioactive liquid is austenitic stainless steel. All piping joints and connections are welded, except where flanged connections are required to facilitate equipment removal for maintenance and hydrostatic testing.

9.2.3 SYSTEM DESIGN EVALUATION

Availability and Reliability

A high degree of functional reliability is assured in this system by providing standby components where performance is vital to safety and by assuring fail-

safe response to the most probable mode of failure.

The system has three charging pumps, each capable of supplying the normal reactor coolant pump seal and makeup flow.

The electrical equipment of the Chemical and Volume Control System is arranged so that multiple items receive their power from various 480 volt buses (refer to Section 8.2). Each of the three charging pumps is powered from separate 480 volt buses. The two boric acid transfer pumps are also powered from separate 480 volt buses. One charging pump and one boric acid transfer pump are capable of meeting cold shutdown requirements shortly after full-power operation. In cases of loss of AC power, a charging pump and a boric acid transfer pump can be placed on the emergency diesels if necessary.

Control of Tritium

The Chemical and Volume Control System is used to control the concentration of tritium in the Reactor Coolant System. Essentially all of the tritium is in chemical combination with oxygen as a form of water. Therefore, any leakage of coolant to the containment atmosphere carries tritium in the same proportion, as it exists in the coolant. Thus, the level of tritium in the containment atmosphere, when it is sealed from outside air ventilation, is a function of tritium level in the reactor coolant, the cooling water temperature at the cooling coils, which determines the dew point temperature of the air, and the presence of leakage other than reactor coolant as a source of moisture in the containment air.

There are two major considerations with regard to the presence of tritium:

a) Possible plant personnel hazard during access to the containment. Leakage of reactor coolant during operation with a closed containment causes an accumulation of tritium in the containment atmosphere. It is desirable to limit the accumulation to allow containment access.

b) Possible public hazard due to release of tritium to the plant environment.

Neither of these considerations is limiting in this plant.

The concentration of tritium in the reactor coolant is maintained at a level which precludes personnel hazard during access to the containment. This is achieved by discharging processed letdown water to the circulating water discharge.

Leakage Prevention

Quality control of the material and the installation of the Chemical and Volume Control valves and piping, which are designated for radioactive service, is provided in order to essentially eliminate leakage to the atmosphere. The components designated for radioactive service are provided with welded connections to prevent leakage to the atmosphere. However, flanged connections are provided in each charging pump suction and discharge, on each boric acid pump suction and discharge, on the relief valves inlet and outlet, on three-way valves and on the flow meters to permit removal for maintenance. Holdup tanks are provided with threaded vacuum breakers.

All valves which are larger than 2 inches and which are designated for radioactive service at an operating fluid temperature above 212 F are provided with a stuffing box and lantern leakoff connections. Leakage to the atmosphere is essentially zero for these valves. All control valves are either provided with stuffing box and leakoff connections or are totally enclosed. Leakage to the atmosphere is essentially zero for these valves.

Diaphragm valves are provided where the operating pressure and the operating temperature permit the use of these valves. Leakage to the atmosphere is essentially zero for these valves.

Incident Control

The letdown line and the reactor coolant pumps seal water return line penetrate the containment. The letdown line contains three air-operated valves inside the containment and one air-operated valve outside the

containment which are automatically closed by the containment isolation signal.

The reactor coolant pumps seal water return line contains one motor-operated isolation valve outside the containment which is automatically closed by the containment isolation signal.

The three seal water injection lines to the reactor coolant pumps and the charging line are inflow lines penetrating the containment. Each line contains two check valves inside the containment to provide isolation of the containment if a break occurs in these lines outside the containment.

Malfunction Analysis

To evaluate system safety, failures or malfunctions were assumed concurrent with a loss-of-coolant accident and the consequences analyzed and presented in Table 9.2-7. As a result of this evaluation, it is concluded that proper consideration has been given to unit safety in the design of the system.

If a rupture were to take place between the reactor coolant loop and the first isolation valve or check valve, this incident would lead to an uncontrolled loss of reactor coolant. The analysis of loss of coolant accidents is discussed in Section 14.

Should a rupture occur in the Chemical and Volume Control System outside the containment, or at any point beyond the first check valve or remotely operated isolation valve, actuation of the valve would limit the release of coolant and assure continued functioning of the normal means of heat dissipation from the core. For the general case of rupture outside the containment, the largest source of radioactive fluid subject to release is the contents of the volume control tank. The consequences of such a release are considered in Section 14.

When the reactor is subcritical; i.e., during cold or hot shutdown, refueling and approach to criticality, the relative reactivity status (neutron source multiplication) is continuously monitored and indicated by BF_3 counters and

count rate indicators. Any appreciable increase in the neutron source multiplication, including that caused by the maximum physical boron dilution rate (See Table 9.2-2), is slow enough to give ample time to start a corrective action (boron dilution stop and/or emergency boron injection) to prevent the core from becoming critical. The maximum dilution rate is based on the abnormal condition of two charging pumps operating at full speed delivering unborated primary water to the Reactor Coolant System at a particular time during refueling when the boron concentration is at the maximum value and the water volume in the system is at a minimum.

At least two separate and independent flow paths are available for reactor coolant boration; i.e., the charging line, or the reactor coolant pumps labyrinths. The malfunction or failure of one component will not result in the inability to borate the Reactor Coolant System. An alternate flow path is always available for emergency boration of the reactor coolant. As backup to the boration system the operator can align the refueling water storage tank outlet to the suction of the charging pumps.

Boration during normal operation to compensate for power changes will be indicated to the operator from two sources; (a) the control rod movement and (b) the flow indicators in the boric acid transfer pump discharge line. When the emergency boration path is used, three indications to the operator are available. The primary indication is a flow indicator in the emergency boration line. The charging line flow indicator will indicate boric acid flow since the charging pump suction is aligned to the boric acid transfer pump discharge for this mode of operation. The change in boric acid tank level is another indication of boric acid injection.

On loss of seal injection water to the reactor coolant pump seals, seal water flow may be reestablished by manually starting a standby charging pump. Even if the seal water injection flow is not reestablished, the unit can be operated indefinitely since the thermal barrier cooler has sufficient capacity to cool the reactor coolant flow which would pass through the thermal barrier cooler and seal leakoff from the pump volute.

Galvanic Corrosion

The only types of materials which are in contact with each other in borated water are stainless steels, Inconel, Stellite valve materials and Zircaloy fuel element cladding. These materials have been shown[1] to exhibit only an insignificant degree of galvanic corrosion when coupled to each other.

For example, the galvanic corrosion of inconel versus 304 stainless steel resulting from high temperature tests (575 °F) in lithiated, boric acid solution was found to be less than -20.9 mg/dm^2 for the test period of 9 days. Further galvanic corrosion would be trivial since the cell currents at the conclusion of the tests were approaching polarization. Zircaloy versus 304 stainless steel was shown to polarize at 180 °F lithiated, boric acid solution in less than 8 days with a total galvanic attack of -3.0 gm/dm^2. Stellite versus 304 stainless steel was polarized in 7 days at 575 °F in lithiated boric acid solution. The total galvanic corrosion for this couple was -0.98 mg/dm^2.

As can be seen from the tests, the effects of galvanic corrosion are insignificant to systems containing borated water.

(1) WCAP 1844 "The Galvanic Behavior of Materials in Reactor Coolants" D. G. Sammarone, August, 1961 Non-Proprietary.

TABLE 9.2-1
CHEMICAL AND VOLUME CONTROL SYSTEM CODE REQUIREMENTS

Regenerative heat exchanger	ASME III [1], Class C
Non-regenerative heat exchanger	ASME III, Class C, tube side, ASME VIII, shell side
CVCS letdown demineralizers	ASME III, Class C
Reactor coolant filters	ASME III, Class C
Volume control tank	ASME III, Class C
Seal water heat exchanger	ASME III, Class C, tube side, ASME VIII, shell side
Excess letdown heat exchanger	ASME III, Class C, tube side, ASME VIII, shell side
Chemical mixing tank	ASME VIII
Seal water injection filters	ASME III, Class C
Holdup tanks	ASME III, Class C
Boric acid filter	ASME III, Class C
Evaporator condensate demineralizers	ASME III, Class C
Concentrates filter	ASME III, Class C
Cation ion exchanger	ASME III, Class C
Ion exchanger filter	ASME III, Class C
Condensate filter	ASME III, Class C
Hydraulic Accumulators	ASME III, Class 2, 1977 plus Summer 77 Addenda [4]
Piping and Valves [3]	USAS B31.1 [2]

NOTES :

1. ASME III - American Society of Mechanical Engineers, Boiler and Pressure Vessel Code Section III, Nuclear Vessels.
2. USAS B31.1 - Code for Pressure Piping, and special nuclear cases where applicable.
3. Aloyco valve weld ends in accordance with Westinghouse Spec. No. G-676241, Dwg. No. 498B932, hydrostatically retested at system test pressures after installation.
4. Replacement parts are procured in accordance with NRC Generic Letter 89-09, since the original manufacturer has dropped their N-stamp.

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TABLE 9.2-2

NOMINAL CHEMICAL AND VOLUME CONTROL SYSTEM PERFORMANCE [1]

Unit design life, years	40
Seal water supply flow rate, gpm [2]	24
Seal water return flow rate, gpm	9
Normal letdown flow rate, gpm	60
Maximum letdown flow rate, gpm	120
Normal charging pump flow (one pump), gpm	69
Normal charging line flow, gpm	45
Maximum rate of boration with one transfer and one charging pump from an initital RCS concentration of 1800 ppm, ppm/min	5.4
Equivalent cooldown rate to above rate of boration, °F/min	1.5
Maximum rate of boron dilution with two charging pumps from an initial RCS concentration of 2500 ppm, ppm/hour	350
Two-pump rate of boration, using refueling water, from initial RCS concentration of 10 ppm, ppm/min	6.2
Equivalent cooldown rate to above rate of boration, °F/min	1.7
Temperature of reactor coolant entering system at full power (design), °F	555.0
Temperature of coolant return to reactor coolant system at full power (design), °F	493.0
Normal coolant discharge temperature to holdup tanks, °F	127.0
Amount of 3.0 weight percent boron solution required to meet cold shutdown requirements, at end of life with peak xenon (including consideration for one stuck rod) gallons	7500

NOTES :

1. Reactor coolant water quality is given in Table 4.2-2.

2. Volumetric flow rates in gpm are based on 130°F and 2350 psig.

TABLE 9.2-3

PRINCIPLE COMPONENT DATA SUMMARY

	Quantity[1]	Heat Transfer Btu/hr	Letdown Flow lb/hr	Letdown ΔT F	Design Pressure psig,shell/tube	Design Temperature F,shell/tube
Heat Exchangers						
Regenerative	1	8.65×10^6	29,826	265	2485/2735	650/650
Non-regenerative	1	14.8×10^6	29,826	163	150/600	250/400
Seal water	1	2.17×10^6	126,756	17	150/150	250/250
Excess letdown (Unit 3)	1	4.75×10^6	12,400	360	150/2485	250/650
Excess Letdown (Unit 4)	1	4.75×10^6	12,400	360	200/2485	250/650

	Quantity[1]	Type	Capacity Each gpm	Head	Design Pressure psig	Design Temperature F
Pumps						
Charging	3	Pos.displ.	77	2385 psi	3000	250
Boric acid transfer	4*	Centrifugal	60	235 ft.	150	250
Holdup tank recirculation	1*	Centrifugal	500	100 ft.	150	200
Monitor tank	2*	Centrifugal	100	150 ft.	150	200
Concentrates holdings						
Tank transfer	2*	Canned	20	150 ft.	75	250
Gas stripper feed	3*	Canned	25	185 ft.	150	200

	Quantity[1]	Type	Volume,Each	Design Pressure psig	Design Temperature F
Tanks					
Volume	1	Vert.	300 ft^3	75 Int/15 Ext	250
Boric Acid	3*	Vert.	9100 gal	Atmos.	250
Chemical mixing	1	Vert.	6.0 gal	150	250
Batching	1*	Jacket Btm.	800 gal	Atmos.	250
Holdup	3*	Vert.	13,000 ft^3	15	200
RWST	1	Vert.	338,000 gal	Atmos.	200

	Quantity[1]	Type	Volume	Design Pressure psig	Design Temperature F
Tanks (continued)					
Concentrates holding	1*	Vertical	925 gal	Atmos.	250
Monitor	2*	Vertical	10,000 gal	Atmos.	150

	Quantity[1]	Type	Resin Volume ft^3	Flow gpm	Design Pressure psig	Design Temperature F
Demineralizer Vessels						
Mixed beds	2	Flushable	30	120	200	250
Cation beds	1	Flushable	20	60	200	250
Base and cation ion Exchangers	3*	Flushable	30	25	150	250
Evaporator condensate	2*	Fixed	30	25	200	250
Deborating	2	Fixed	43	120	200	250

	Quantity[1]	Relief Pressure psig	Capacity
Relief Valves			
Charging pumps	3	2735	100 gpm
Regenerative heat exchanger	1	2735	N/A
Holdup tank	3	12	120 gpm
Letdown line (intermediate pressure section)	1	600	240 gpm
Seal water return line	1	150	165 gpm
Batching tank heating jacket	1	20	320 lb/hr
Volume control tank	1	75	170 gpm
Holdup tank vacuum brks	2	3 in/WC	100 scfm

[1] Quantity per unit unless otherwise specified.

* Shared or capable of being shared by Unit 3 and Unit 4.