Attachment 2

To P-88025

PROPOSED AMENDMENT REQUEST TO THE FSV
PPS TECHNICAL SPECIFICATION

Enclosure 1

OF

Attachment 2 of P-88025

SUMMARY OF PROPOSED CHANGES

SUMMARY OF PROPOSED CHANGES

SECTION		DESCRIPTION
LSSS 3.3	1.	Page 3.3-1. Definitions are added for Trip Setpoint and Allowable Value.
	2.	Pages 3.3-2a, 2b, 2c, 3a, and 3b replace old pages 3.3-2 and 3.3-3. A Trip Setpoint and Allowable Value are now specified for each parameter and two curves are used with Table 3.3-1.
Basis for LSSS 3.3	1.	Pages 3.3-4 through 3.3-8 replace old pages 3.3-4 through 3.3-8. The new basis provides the general methodology for determining Trip Setpoint and Allowable Value and then describes the basis for each limiting safety system parameter.
LCO 4.4-1	1.	Page 4.4-1. Definitions added for Trip Setpoint and Allowable Value. Two paragraphs of old page moved to next page.
	2.	Page 4.4-2. The paragraph on Table 4.4-1 expanded to add new requirements. The paragraph on Table 4.4-3 expanded and page reformatted.
	3.	Table 4.4-1 through 4.4-4. The tables were reformatted to provide for a Trip Setpoint and Allowable Value to replace the Trip Setting. Each table was split into Part 1 containing Trip Setpoint and Allowable Values for each parameter and a Part 2 containing Minimum Operable Channels, Minimum Degree

of Redundancy and Permissible Bypass Conditions. Part 2 follows Part 1 for each table.

4. Old pages 4.4-3 through 4.4-6 and 4.4-7 replaced by pages 4.4-3a, 3b, 3c, 4a, 4b, 4c, 4d, 5a, 5b, 5c, 7a, and 7b.

5. New page 4.4-4d. Permissible Bypass Conditions clarified for parameter 7c to reflect actual design.

6. Page 4.4-8. Notes for Tables 4.4-1 through 4.4-4. Note (a) deleted as Table 4.4-1 line Items 3a and 3b refer operator to Table 3.3-1. Note (d) deleted as the Trip Setpoint and Allowable Value in new tables provide specific criteria for the Plan Electrical System - Loss parameter. Note (e) updated to correctly describe the undervoltage protection system design. Note (h) in existing license split into two separate notes (h1) and (h2) to more correctly reflect applicable permissible bypass conditions for the different types of moisture monitors.

Basis for LCO 4.4-1

1. Pages 4.4-10 through 4.4-13 of existing license replaced by new pages 4.4-10, 10a, 10b, 10c, 11, 11a, 12, 12a, 12b, 12c, and 4.4-13. The new basis is more descriptive than the original.

Enclosure 2

Of

Attachment 2 Of P-88025

PROPOSED CHANGES TO LSSS 3.3 AND LCO 4.4.1
OF THE FSV TECHNICAL SPECIFICATIONS

3.3 LIMITING SAFETY SYSTEM SETTINGS

Applicability

Applies to the trip settings for instruments and devices which provide for monitoring of reactor power, hot reheat temperature, reactor internal pressure, and moisture content of the helium coolant.

Objective

To provide for automatic protective action such that the principal process variables do not exceed a safety limit as a result of transients.

Specification LSSS 3.3 - Limiting Safety System Settings

The Limiting Safety System Settings for trip shall be as specified in Table 3.3.1. The following definitions are used in the table:

Trip Setpoint - The trip setpoint is the least conservative "as left" value for a channel to be considered Operable.

Allowable Value - The allowable value is the least conservative "as found" value for a channel to be considered Operable.

Specification LSSS 3.3

Table 3.3-1

LIMITING SAFETY SYSTEM SETTINGS

PARAMETER	FUNCTION	TRIP SETPOINT	ALLOWABLE VALUE
1. Reactor Core Limiting Safety System Settings			
a) Linear Channel-High (Neutron Flux)	Scram	Varies as a Function of Indicated Thermal Power per Figure 3.3-1	Varies as a Function of Indicated Thermal Power per Figure 3.3-1
b) Reheat Steam Temperature-High	Scram	≤ 1055 degree F	≤ 1067 degree F
c) Primary Coolant Pressure-Programmed Low	Scram	≤ 68.6 psi below normal, programmed with Circulator Inlet Temperature. Upper TRIP SETPOINT of ≥ 631.1 psia.	≤ 72.7 psi below normal, programmed with Circulator Inlet Temperature per Figure 3.3-2. Upper limit to produce trip at ≥ 627 psia.

Specification LSSS 3.3

Table 3.3-1 (Continued)

LIMITING SAFETY SYSTEM SETTINGS

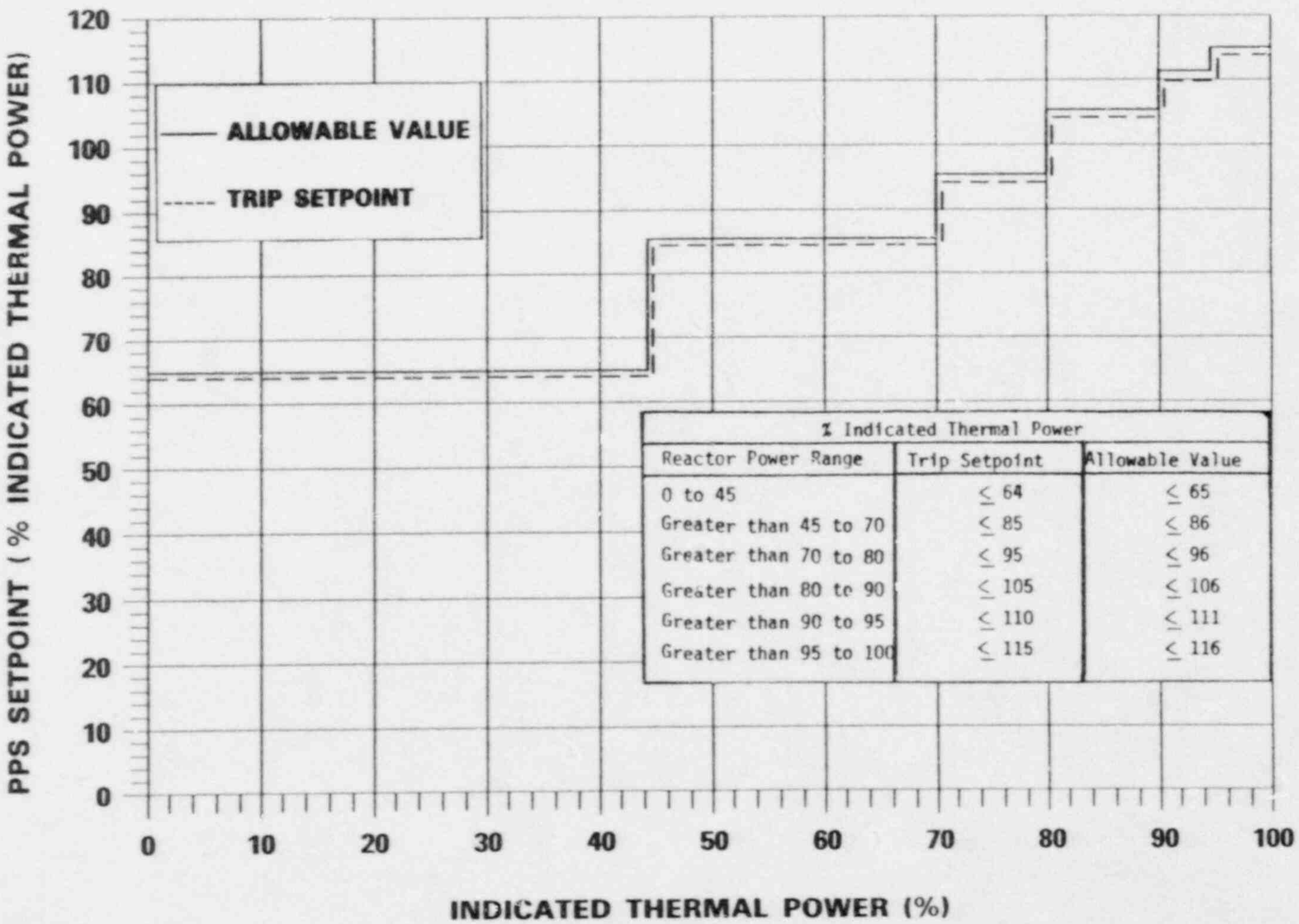
	PARAMETER	FUNCTION	TRIP SETPOINT	ALLOWABLE VALUE
2.	Reactor Vessel Pressure Limiting Safety System Settings			
	a) Primary Coolant Pressure-Programmed High	Scram and Preselected Loop Shutdown and Steam/Water Dump	≤ 46 psi above normal, programmed with Circulator Inlet Temperature. Upper TRIP SETPOINT of ≤ 746.3 psia. Lower TRIP SETPOINT of ≤ 538.3 psia.	≤ 52.7 psi above normal, programmed with Circulator Inlet Temperature per Figure 3.3-2. Upper limit to produce trip at ≤ 753 psia. Lower limit to produce trip at ≤ 545 psia
	b) Primary Coolant Moisture-High	Scram, Loop Shutdown, and Steam/Water Dump	≤ 60.5 degree F dewpoint temperature	≤ 62.2 degree F dewpoint temperature
	c) PCRV Pressure:	Pressure Relief		
	Rupture Disc (Low Set Safety Valve)		812 psig plus or minus 8 psi	820 psig

Specification LSSS 3.3

Table 3.3-1 (Continued)

LIMITING SAFETY SYSTEM SETTINGS

PARAMETER	FUNCTION	TRIP SETPOINT	ALLOWABLE VALUE
Low Set Safety Valve		796 psig plus or minus 8 psi	804 psig
Rupture Disc (High Set Safety Valve)		832 psig plus or minus 8 psi	840 psig
High Set Safety Valve		812 psig plus or minus 8 psi	820 psig
d) Helium Circulator Penetration Interspace Pressure:	Pressure Relief		
Rupture Disc (2 Per Penetration)		825 psig plus or minus 17 psi	842 psig
Safety Valve (2 Per Penetration)		805 psig plus or minus 24 psi	829 psig
e) Steam Generator Penetration Interspace Pressure:	Pressure Relief		
Rupture Disc (2 For Each Steam Generator)		825 psig plus or minus 17 psi	842 psig
Safety Valve (2 For Each Steam Generator)		475 psig plus or minus 14 psi	489 psig



% Indicated Thermal Power		
Reactor Power Range	Trip Setpoint	Allowable Value
0 to 45	≤ 64	≤ 65
Greater than 45 to 70	≤ 85	≤ 86
Greater than 70 to 80	≤ 95	≤ 96
Greater than 80 to 90	≤ 105	≤ 106
Greater than 90 to 95	≤ 110	≤ 111
Greater than 95 to 100	≤ 115	≤ 116

FIGURE 3.3-1

HIGH NEUTRON FLUX SCRAM

DETECTOR DECALIBRATION

CURVES FOR CYCLE 4

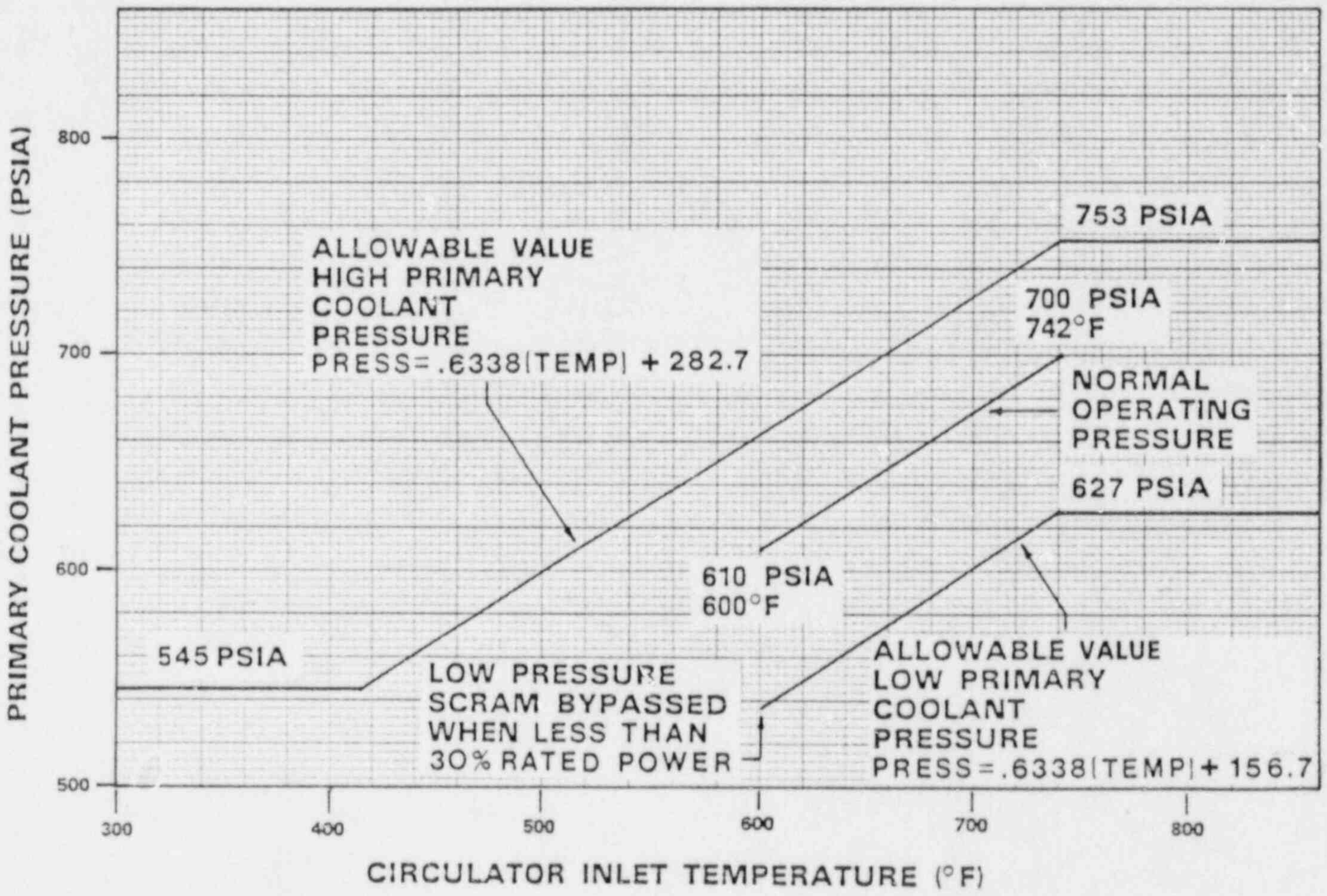


FIGURE 3.3-2

PRIMARY COOLANT PRESSURE vs. CIRCULATOR INLET TEMPERATURE
ALLOWABLE OPERATION

Basis for Specification LSSS 3.3

Safety Limits have been established in Specification SL 3.1 and SL 3.2 to safeguard the fuel particle integrity and the reactor primary coolant system barriers. Protective devices have been provided in the plant design to ensure that automatic corrective action is taken when required to prevent the Safety Limits from being exceeded during normal operation or during operational transients resulting from possible operator errors, or as a result of equipment malfunction. This specification establishes the Trip Setpoints and Allowable Values for these automatic protective devices.

Operation with setpoints less conservative than the Trip Setpoint but within the Allowable Value is acceptable since an allowance has been made in the safety analysis to accommodate this error, as described below.

General Methodology

The Analysis Value is the value of a parameter for which a Trip and initiation of automatic protective action is assumed to occur in FSV accident analyses (FSAR Chapter 14). Provided that the trip occurs at a value equal to or more conservative than the Analysis Value, analyses demonstrate that consequences of the accident or transient are acceptable.

ISA Standard, S67.04-1982 has been applied to these Analysis Values to arrive at Allowable Values and Trip Setpoints for each PPS parameter.

Basis for Specification LSSS 3.3 (Continued)

Linear Channel - High (Neutron Flux)

The neutron flux Trip Setpoints are established to protect the fuel particle integrity during rapid overpower transients. The power range nuclear channels respond to changes in neutron flux. During normal power operation, the channels are calibrated using a plant heat balance so that the neutron flux that is sensed is indicated as percent of Rated Thermal Power. For slow maneuvers, those where core thermal power, surface heat flux, and the heat transferred to the helium follow the neutron flux, the power range nuclear channels will indicate reactor Thermal Power. For fast transients, the neutron flux change will lead the change in heat transferred from the core to the helium due to the effect of the fuel, moderator and reflector thermal time constants. Therefore, when the neutron flux increases to the scram Trip Setpoint rapidly, the percent increase in heat flux and heat transferred to the helium will be less than the percent increase in neutron flux. Trip Setpoints that ensure a reactor scram at no greater than 140% Rated Thermal Power are sufficient for the plant because the negative temperature coefficient of reactivity and large heat capacity of the reactor limit the transient increases in fuel and helium temperatures to acceptable values. Control rod shim bank movement can result in decalibration of the external-core neutron flux detectors. To account for this potential decalibration and other instrumentation errors, the actual Trip Setpoint is administratively set less than 140% Rated Thermal Power based upon indicated power. These administratively set flux Trip Setpoints ensure the scram will occur at or less than 140% Rated Thermal Power for those postulated reactivity accidents evaluated in FSAR Section 14.2. Additional discussion on detector decalibration is given in updated FSAR Section 7.3.1.2.1.

Basis for Specification LSSS 3.3 (Continued)

Reheat Steam Temperature - High

High reheat steam temperature indicates either an increase in Thermal Power generation without an appropriate increase in helium cooling flow rate or a decrease in steam flow rate. (Reheat steam temperature in lieu of reactor core outlet helium temperature is used because of the difficulty in measuring gross helium temperature for protective system purposes.) The design of the steam generator is such that changes in hot helium temperature due to a power increase first affect the reheat steam temperature, thus allowing the latter to serve as an index of the helium temperature. A reheat steam temperature scram is provided to prevent excessive Power-to-Flow-Ratio due to a power increase or steam flow imbalance. (FSAR Section 14.2)

Primary Coolant Pressure - Programmed Low

The low primary coolant pressure Trip Setpoint has been established to maintain the fuel particle coating integrity due to loss of primary coolant as a result of a coolant leak.

Primary Coolant Pressure - Programmed High

The major potential source of primary coolant pressure increase above the normal operating range is due to water and/or steam inleakage by means of a defective evaporator-economizer-superheater subheader or tube. For a double-ended offset tube rupture, the rate of water and steam inleakage will not exceed 35 lbs/sec initially, resulting in a maximum rate of primary coolant pressure increase of approximately 1 psi per second. The normal PPS action upon detection of moisture is reactor scram, loop shutdown, and steam/water dump (FSAR Section 7.1.2.5), occurring after approximately 12 seconds, assuming rated power and flow conditions. In this situation, the peak PCRV pressure at 100% reactor power does not exceed 705 psia. The Trip Setpoint of less than or equal to 46 psi above the normal operating pressure between 25% and 100% rated power is selected: (1) to prevent false scrams due to normal plant transients, and (2) to allow adequate time for the normal protective action (high moisture) to terminate the accident while limiting the resulting peak PCRV pressure in the unlikely event that the normal protective action was inoperative. In this case, Reactor Pressure would continue to rise to the high pressure Trip Setpoint. The resulting peak PCRV pressure would be less than the PCRV Reference Pressure. The high pressure Trip Setpoint is programmed as a function of load, using helium circulator inlet temperature as the measured variable indicative of load, as shown in Figure 3.3-2. The PCRV safety valves provide the ultimate protection against primary coolant system pressure exceeding the PCRV Reference Pressure of 845 psig.

Basis for Specification LSSS 3.3 (Continued)

Primary Coolant Moisture - High

The high moisture Trip Setpoint corresponding to 60.5 degrees F dewpoint was established, considering the moisture monitor characteristics and the necessity to minimize water inleakage to the primary coolant system. A Trip would be reached after several hours of full power operation with a minimum water/steam inleakage rate in excess of about 20 lbs/hr. Below that inleakage rate, the Trip Setpoint would never be reached, but the indicating instruments would show an abnormal condition. For maximum design leakage rates, the system behavior is as discussed in the preceding section on Primary Coolant Pressure-Programmed High. Backup protective action is provided by the high primary coolant pressure scram, loop shutdown, and dump of a pre-selected loop and remaining loop steam depressurization. (FSAR Sections 7.1.2.3 and 7.1.2.4.)

PCRV Pressure

The PCRV safety valves provide the ultimate protection against primary coolant system pressure exceeding the PCRV Reference Pressure of 845 psig. This engineered safeguard system consists of the isolation valves, the rupture discs, the relief valves, and the containment tank. Two safety valves are provided, either of which is adequate to prevent exceeding the PCRV Reference Pressure in the event of a steam generator subheader rupture, which is the only credible means of substantially increasing the primary coolant pressure. If the pressure in the PCRV were to rise significantly above the Normal Working Pressure, the low-set rupture disc would rupture within the range of 804 psig (-1%), to 820 psig (+1%). The low set safety valve, set at 796 psig plus or minus 1%, would be wide open and relieving at full capacity at or above 820 psig (3% accumulation). If the pressure still continued to rise, the high-set rupture disc would rupture between 824 psig and 840 psig. The high-set safety valve, set at 812 psig plus or minus 1%, would be relieving at full capacity above 836 psig (3% accumulation). As the pressure decreased, the high-set safety valve would close at a pressure of approximately 690 psig and the low-set safety valve at approximately 677 psig; the corresponding primary system pressure would be approximately 737 psig when the low-set safety valve closed. The minimum permissible trip setpoint of each PCRV overpressure relief train rupture disc and relief valve is specified to provide assurance that primary coolant helium will not be vented to atmosphere during primary coolant pressure surges, resulting from transients or accidents, in which pressures do not approach the Allowable Value and thereby do not challenge the integrity of the PCRV. (FSAR Section 6.8.3)

Basis for Specification LSSS 3.3 (Continued)

Helium Circulator Penetration Interspace Pressure

The penetration interspaces are protected against pressures exceeding PCRV Reference Pressure (845 psig). The safety valves are set at 805 psig and rupture discs are set at 825 psig (nominal). A redundant safety valve and rupture disc are provided. The rupture discs would burst in the pressure range of 808 psig (-2%) to 842 psig (+2%). The safety valves would open in the range of 781 psig (-3%) to 829 psig (+3%) and would relieve at full capacity at 886 psig (10% accumulation). The safety valves would reseat at about 725 psig. The safety valve and rupture disc relieving pressures were specified so as to comply with the ASME Boiler and Pressure Vessel Code, Section III, Class B, Nuclear Vessels, for overpressure protection. The minimum permissible trip setpoint of each rupture disc and associated relief valve is specified to provide assurance that PCRV penetration interspace helium, which could potentially be radioactive, will not be vented to atmosphere during interspace pressure surges in which pressures do not approach the Allowable Value and thereby do not challenge the integrity of the PCRV penetration. (FSAR Section 5.8.2)

Steam Generator Penetration Interspace Pressure

The six steam generator penetration interspaces in each loop are provided with common upstream rupture discs and safety valves to protect against pressures exceeding PCRV Reference Pressure (845 psig). A redundant safety valve and rupture disc are provided. The rupture discs would burst in the pressure range of 808 psig (-2%) to 842 psig (+2%), with a nominal setting of 825 psig. The safety valves are each set at 475 psig which allows for a pressure drop in the inlet lines of 370 psi when relieving at valve capacity. The minimum permissible trip setpoint of each rupture disc and associated relief valve is specified to provide assurance that PCRV penetration interspace helium, which could potentially be radioactive, will not be vented to atmosphere during interspace pressure surges in which pressures do not approach the Allowable Value and thereby do not challenge the integrity of the PCRV penetration. (FSAR Section 5.8.2)

4.4 INSTRUMENTATION AND CONTROL SYSTEMS - LIMITING CONDITIONS FOR OPERATION

Applicability

Applies to the plant protective system and other critical instrumentation and controls.

Objective

To assure the operability of the plant protective system and other critical instrumentation by defining the minimum operable instrument channels and trip settings.

Specification LCO 4.4.1 - Plant Protective System Instrumentation, Limiting Conditions for Operation

The limiting conditions for the plant protective system instrumentation are shown on Tables 4.4-1 through 4.4-4. These tables utilize the following definitions:

Degree of Redundancy - Difference between the number of operable channels and the minimum number of operable channels which when tripped will cause an automatic system trip.

Operable Channel - A channel is operable if it is capable of fulfilling its design functions.

Inoperable Channel - Opposite of operable channel.

Trip Setpoint - The trip setpoint is the least conservative "as left" value for a channel to be considered Operable.

Allowable Value - The allowable value is the least conservative "as found" value for a channel to be considered Operable.

Tables 4.4-1 through 4.4-4 are to be read in the following manner: If the minimum operable channels or the minimum degree of redundancy for each functional unit of a table cannot be met or cannot be bypassed under the stated permissible bypass conditions, the following action shall be taken:

For Table 4.4-1, the reactor shall be shut down within 12 hours, except that to facilitate maintenance on the Plant Protective System (PPS) moisture monitors, the moisture monitor input trip functions to the Plant Protective System which cause scram, loop shutdown, circulator trip, and steam water dump may be disabled for up to 72 hours. During the time that the Plant Protective System moisture monitor trips are disabled, an observer in direct communication with the reactor operator shall be positioned in the control room in the location of pertinent instrumentation. The observer shall continuously monitor the primary coolant moisture levels indicated by at least two moisture monitors and the primary coolant pressure indications, and shall alert the reactor operator to any indicated moisture or pressure change. During the time in which the trip functions are disabled the requirements of LCO's 4.2.10 and 4.2.11 shall be met and primary coolant shall not exceed a moisture concentration of 100 ppmv.

For Table 4.4-2, the affected loop shall be shut down within 12 hours.

For Table 4.4-3, perform one of the following within 12 hours:

a. The reactor shall be shutdown, or

b. the affected helium circulator shall be shutdown.

For Table 4.4-4, the reactor shall be shut down within 24 hours.

If, within the indicated time limit, the minimum number of operable channels and the minimum degree of redundancy can be reestablished, the system is considered normal and no further action needs to be taken.

Specification LCO 4.4.1

Table 4.4-1 (Part 1)

INSTRUMENT OPERATING REQUIREMENTS FOR PLANT PROTECTIVE SYSTEM, SCRAM

NO.	FUNCTIONAL UNIT	TRIP SETPOINT	ALLOWABLE VALUE
1a.	Manual Scram (Control Room)	Not Applicable	Not Applicable
1b.	Manual Scram (Outside Control Room)	Not Applicable	Not Applicable
2.	Startup Channel-High Count Rate	$\leq$ 8.3E+04 cps	$\leq$ 9.3E+04 cps
3a.	Linear Channel-High Channels 3,4,5 (Neutron Flux)	-----------See Table 3.3-1-------	
3b.	Linear Channel-High Channels 6,7,8 (Neutron Flux)	-----------See Table 3.3-1-------	
4.	Primary Coolant Moisture High Level Monitor	$\leq$ 60.5 degree F dewpoint	$\leq$ 62.2 degree F dewpoint
	Loop Monitor	$\leq$ 20.4 degree F dewpoint	$\leq$ 22.1 degree F dewpoint
5.	Reheat Steam Temperature -High	$\leq$ 1055 degree F	$\leq$ 1067 degree F

Notes for Tables 4.4-1 through 4.4-4 are on Pages 4.4-8 and 4.4-9

Specification LCO 4.4.1

Table 4.4-1 (Part 1)

INSTRUMENT OPERATING REQUIREMENTS FOR PLANT PROTECTIVE SYSTEM, SCRAM

NO.	FUNCTIONAL UNIT	TRIP SETPOINT	ALLOWABLE VALUE
6.	Primary Coolant Pressure -Programmed Low	---------See Table 3.3-2---------	
7.	Primary Coolant Pressure -Programmed High	---------See Table 3.3-2---------	
8.	Hot Reheat Header Pressure -Low	≥ 44 psig	≥ 43 psig
9.	Main Steam Pressure-Low	≥ 1529 psig	≥1517 psig
10.	Plant Electrical System-Loss	≥ 278V ≤ 31.5 Seconds	≥ 266V ≤ 35 Seconds
11.	Two Loop Trouble	Not Applicable	Not Applicable
12.	High Reactor Building Temperature (Pipe Cavity)	≤ 161 degree F	≤ 166 degree F

Notes for Tables 4.4-1 through 4.4-4 are on Pages 4.4-8 and 4.4-9

SPECIFICATION LCO 4.4.1

TABLE 4.4-1 (Part 2)

INSTRUMENT OPERATING REQUIREMENTS FOR PLANT PROTECTIVE SYSTEM, SCRAM

NO.	FUNCTIONAL UNIT	MINIMUM OPERABLE CHANNELS	MINIMUM DEGREE OF REDUNDANCY	PERMISSIBLE BYPASS CONDITIONS
1a.	Manual (Control Room)	1	0	None
1b.	Manual (Outside Control Room)	2 (f)	1	None
2.	Startup Channel-High Count Rate	2	1	Reactor Mode Switch in "RUN"
3a.	Linear Channel-High, Channels 3, 4, 5	2 (f)	1	None
3b.	Linear Channel-High, Channels 6, 7, 8	2 (f)	1	None
4.	Primary Coolant Moisture			
	High Level Monitor	1 (f,t)	1(c)	(h2)
	Loop Monitor	2/Loop (f,t)	1/Loop	(h1)
5.	Reheat Steam Temperature - High	2 (b,f)	1	None
6.	Primary Coolant Pressure - Programmed Low	2 (f,k)	1	Less Than 30% Rated Power
7.	Primary Coolant Pressure - Programmed High	2 (f,k)	1	None
8.	Hot Reheat Header Pressure - Low	2 (f)	1	Less Than 30% Rated Power
9.	Main Steam Pressure - Low	2 (f)	1	Less Than 30% Rated Power
10.	Plant Electrical System - Loss	2 (e,f)	1	None
11.	Two Loop Trouble	2	1	Reactor Mode Switch in "Fuel Loading"
12.	High Reactor Building Temperature (Pipe Cavity)	2 (f)	1	None

Notes for Tables 4.4-1 through 4.4-4 are on Pages 4.4-8 and 4.4-9

Specification LCO 4.4.1

Table 4.4-2 (Part 1)

INSTRUMENT OPERATING REQUIREMENTS
FOR THE PLANT PROTECTIVE SYSTEM, LOOP SHUTDOWN

NO.	FUNCTIONAL UNIT	TRIP SETPOINT	ALLOWABLE VALUE
1a.	Deleted		
1b.	Deleted		
1c.	Deleted		
1d.	Deleted		
1e.	Deleted		
1f.	Deleted		
2a.	Deleted		
2b.	Deleted		
2c.	Deleted		
2d.	Deleted		
3a.	Loop 1 Shutdown Logic	Not Applicable	Not Applicable
3b.	Loop 2 Shutdown Logic	Not Applicable	Not Applicable
4a.	Circulator 1A and 1B Shutdown - Loop Shutdown Logic	Not Applicable	Not Applicable

Notes for Tables 4.4-1 through 4.4-4 are on Pages 4.4-8 and 4.4-9

Specification LCO 4.4.1

Table 4.4-2 (Part 1)

INSTRUMENT OPERATING REQUIREMENTS
FOR THE PLANT PROTECTIVE SYSTEM, LOOP SHUTDOWN

NO.	FUNCTIONAL UNIT	TRIP SETPOINT	ALLOWABLE VALUE
4b.	Circulator 1C and 1D Shutdown - Loop Shutdown Logic	Not Applicable	Not Applicable
5a.	Steam Generator Penetration Overpressure, Loop 1	≤ 796 psig	≤ 801 psig
5b.	Steam Generator Penetration Overpressure, Loop 2	≤ 796 psig	≤ 801 psig
6a.	High Reheat Header Activity, Loop 1	≤ 3.2 mrem/hr Above Background	≤ 3.5 mrem/hr Above Background
6b.	High Reheat Header Activity, Loop 2	≤ 3.2 mrem/hr Above Background	≤ 3.5 mrem/hr Above Background
7a.	Low Superheat Header Temperature, Loop 1 (p)	≥ 798 degree F	≥ 794 degree F
7b.	Low Superheat Header Temperature, Loop 2 (p)	≥ 798 degree F	≥ 794 degree F
7c.	High Differential Temperature Between Loop 1 and Loop 2 (p)	≤ 44.8 degree F	≤ 46.7 degree F

Notes for Tables 4.4-1 through 4.4-4 are on Pages 4.4-8 and 4.4-9

SPECIFICATION LCO 4.4.1

TABLE 4.4-2 (Part 2)

INSTRUMENT OPERATING REQUIREMENTS FOR PLANT PROTECTIVE SYSTEM, LOOP SHUTDOWN

NO.	FUNCTIONAL UNIT	MINIMUM OPERABLE CHANNELS	MINIMUM DEGREE OF REDUNDANCY	PERMISSIBLE BYPASS CONDITIONS
1a.	Deleted			
1b.	Deleted			
1c.	Deleted			
1d.	Deleted			
1e.	Deleted			
1f.	Deleted			
2a.	Deleted			
2b.	Deleted			
2c.	Deleted			
2d.	Deleted			
3a.	Loop 1 Shutdown Logic	2	1	None
3b.	Loop 2 Shutdown Logic	2	1	None

Notes for Tables 4.4-1 through 4.4-4 are on Pages 4.4-8 and 4.4-9

SPECIFICATION LCO 4.4.1

TABLE 4.4-2 (Part 2)

INSTRUMENT OPERATING REQUIREMENTS FOR PLANT PROTECTIVE SYSTEM, LOOP SHUTDOWN

NO.	FUNCTIONAL UNIT	MINIMUM OPERABLE CHANNELS	MINIMUM DEGREE OF REDUNDANCY	PERMISSIBLE BYPASS CONDITIONS
4a.	Circulator 1A and 1B Shutdown - Loop Shutdown Logic	2	1	None
4b.	Circulator 1C and 1D Shutdown - Loop Shutdown Logic	2	1	None
5a.	Steam Generator Penetration Overpressure, Loop 1	2 (f)	1	None
5b.	Steam Generator Penetration Overpressure, Loop 2	2 (f)	1	None
6a.	High Reheat Header Activity, Loop 1	2 (f)	1	None
6b.	High Reheat Header Activity, Loop 2	2 (f)	1	None
7a.	Low Superheat Header Temperature, Loop 1 (p)	2 (f)	1	Less Than 30% Rated Power
7b.	Low Superheat Header Temperature, Loop 2 (p)	2 (f)	1	Less Than 30% Rated Power
7c.	High Differential Temperature Between Loop 1 and Loop 2 (p)	2 (f)	1	Less Than 30% Rated Power

Notes for Tables 4.4-1 through 4.4-4 are on Pages 4.4-8 and 4.4-9

Specification LCO 4.4.1

Table 4.4-3 (Part 1)

INSTRUMENT OPERATING REQUIREMENTS FOR THE PLANT PROTECTIVE SYSTEM, CIRCULATOR TRIP

NO.	FUNCTIONAL UNIT	TRIP SETPOINT	ALLOWABLE VALUE
1.	Circulator Speed - Low	≤ 1850 rpm Below Normal As Programmed by Feedwater Flow	≤ 2035 rpm Below Normal As Programmed by Feedwater Flow
2a.	Loop 1, Fixed Feedwater Flow - Low (Both Circulators)	≥ 230,500 lb/hr (20% of normal Full Load)	≥ 230,500 lb/hr (20% of normal Full Load)
2b.	Loop 2, Fixed Feedwater Flow - Low (Both Circulators)	≥ 230,500 lb/hr (20% of normal Full Load)	≥ 230,500 lb/hr (20% of normal Full Load)
3.	Loss of Circulator Bearing Water	≥ 459 psid	≥ 454 psid
4.	Circulator Penetration Trouble	≤ 796 psig	≤ 801 psig
5.	Circulator Drain Malfunction	≥ 8.5 psid	≥ 8.0 psid
6.	Circulator Speed - High Steam	≤ 11,495 rpm	≤ 11,684 rpm
7.	Manual	Not Applicable	Not Applicable

Notes for Tables 4.4-1 through 4.4-4 are on Pages 4.4-8 and 4.4-9

Specification LCO 4.4.1

Table 4.4-3 (Part 1)

INSTRUMENT OPERATING REQUIREMENTS FOR THE PLANT PROTECTIVE SYSTEM, CIRCULATOR TRIP

NO.	FUNCTIONAL UNIT	TRIP SETPOINT	ALLOWABLE VALUE
8.	Circulator Seal Malfunction	≥ -5.2" H20, ≤ +74.8" H20	≥ -6.1" H20, ≤ +76.1" H20
9.	Circulator Speed - High Water	≤ 8,589 rpm	≤ 8,786 rpm

Notes for Tables 4.4-1 through 4.4-4 are on Pages 4.4-8 and 4.4-9

SPECIFICATION LCO 4.4.1

TABLE 4.4-3 (Part 2)

INSTRUMENT OPERATING REQUIREMENTS FOR PLANT PROTECTIVE SYSTEM, CIRCULATOR TRIP

NO.	FUNCTIONAL UNIT	MINIMUM OPERABLE CHANNELS	MINIMUM DEGREE OF REDUNDANCY	PERMISSIBLE BYPASS CONDITIONS
1.	Circulator Speed - Low (r)	2 (f)	1	Less Than 30% Rated Power
2a.	Loop 1, Fixed Feed-water Flow - Low (Both Circulators)	2 (f)	1	Less Than 30% Rated Power
2b.	Loop 2, Fixed Feed-water Flow - Low (Both Circulators)	2 (f)	1	Less Than 30% Rated Power
3.	Loss of Circulator Bearing Water (r)	2 (f)	1	None
4.	Circulator Penetration Trouble (r)	2 (f)	1	None
5.	Circulator Drain Malfunction (r)	2 (f)	1	None
6.	Circulator Speed - High Steam (r)	2 (f)	1	None
7.	Manual	1	0	None
8.	Circulator Seal Malfunction (r)	2 (f)	1	Opposite loop shutdown *or* circulator seal malfunction trip of other circulator in same loop
9.	Circulator Speed - High Water	2 (f)	1	None

Notes for Tables 4.4-1 through 4.4-4 are on Pages 4.4-8 and 4.4-9

Specification LCO 4.4.1

Table 4.4-4 (Part 1)

INSTRUMENT OPERATING REQUIREMENTS FOR THE PLANT PROTECTIVE SYSTEM, ROD WITHDRAWAL PROHIBIT (RWP)

NO.	FUNCTIONAL UNIT	TRIP SETPOINT	ALLOWABLE VALUE
1.	Startup Channel-Low Count Rate	$\geq$ 4.2 cps	$\geq$ 3.2 cps
2a.	Linear Channel-Low Power RWP (Channels 3, 4 and 5)	> 5% Indicated Thermal Power (m)	>5% Indicated Thermal Power
2b.	Linear Channel-Low Power RWP (Channels 6, 7 and 8)	> 5% Indicated Thermal Power (m)	>5% Indicated Thermal Power
3a.	Linear Channel-High Power RWP (Channels 3, 4 and 5)	< 30% Indicated Thermal Power (n)	< 30% Indicated Thermal Power
3b.	Linear Channel-High Power RWP (Channels 6, 7 and 8)	< 30% Indicated Thermal Power (n)	< 30% Indicated Thermal Power

Notes for Tables 4.4-1 through 4.4-4 are on Pages 4.4-8 and 4.4-9

SPECIFICATION LCO 4.4.1

TABLE 4.4-4 (Part 2)

INSTRUMENT OPERATING REQUIREMENTS
FOR REACTOR PROTECTIVE SYSTEM, ROD WITHDRAWAL PROHIBIT (RWP)

NO.	FUNCTIONAL UNIT	MINIMUM OPERABLE CHANNELS	MINIMUM DEGREE OF REDUNDANCY	PERMISSIBLE BYPASS CONDITIONS
1.	Startup Channel - Low Count Rate	2	1	Above 1.0E-03% Rated Power
2a.	Linear Channel - Low Power RWP (Channels 3, 4, and 5)	2	1	(g)
2b.	Linear Channel - Low Power RWP (Channels 6, 7, and 8)	2	1	(g)
3a.	Linear Channel - High Power RWP (Channels 3, 4, and 5)	2 (f)	1	None
3b.	Linear Channel - High Power RWP (Channels 6, 7, and 8)	2 (f)	1	None

Notes for Tables 4.4-1 through 4.4-4 are on Pages 4.4-8 and 4.4-9

SPECIFICATION LCO 4.4.1
NOTES FOR TABLES 4.4-1 THROUGH 4.4-4

a) Deleted.

b) Two thermocouples from each loop, total of four, constitute one channel. For each channel, two thermocouples must be operable in at least one operating loop for that channel to be considered operable.

c) With one primary coolant high level moisture monitor tripped, trips of either loop primary coolant moisture monitors will cause full scram. Hence, number of operable channels (1) minus minimum number required to cause scram (0) equals one, the minimum degree of redundancy.

d) Deleted.

e) One channel consists of three undervoltage relays each monitoring a single phase of a 480 VAC essential bus. A channel trip will occur when two of the three undervoltage relays comprising that channel operate after a preset time delay indicating loss of bus voltage. Initiation of a scram requires two of the three undervoltage relays on two of the three 480 VAC essential buses to operate.

f) The inoperable channel must be in the tripped condition, unless the trip of the channel will cause the protective action to occur. Failure to trip the inoperable channel requires taking the appropriate corrective action as listed on Pages 4.4-1 and 4.4-2 within the specified time limit.

g) RWP bypass permitted if the bypass also causes associated single channel scram.

h1) For loop monitors only, permissible bypass conditions include:
  I. Any circulator buffer seal malfunction.
  II. Loop hot reheat header high activity.
  III. As stated in LCO 4.9.2.

h2) For high level monitors only, permissible bypass conditions include:
  I. As stated in LCO 4.9.2.

j) Deleted.

k) One operable helium circulator inlet thermocouple in an operable loop is required for the channel to be considered operable.

m) Low Power RWP bistable resets at 4% after reactor power initially exceeds 5%.

n) Power range RWP bistables automatically reset at 10% after reactor power is decreased from greater than 30%. The RWP may be manually reset between 10% and 30% power.

p) Item 7a. must be accompanied by item 7c. for Loop 1 shutdown. Item 7b. must be accompanied by item 7c. for Loop 2 shutdown.

Basis for Specification LCO 4.4.1

The plant protection system automatically initiates protective functions to prevent established limits from being exceeded. In addition, other protective instrumentation is provided to initiate action which mitigates the consequences of accidents. Some protective actions are necessary only during startup and/or Low Power and require bypass at power; others are required during power operation and need to be bypassed at startup and/or Low Power. A simple method, based on a minimum of administrative control, has been devised to sequence and bypass protective actions. The equipment consists of two selector switches (Reactor Mode and Interlock Sequence) on the reactor control board. This specification provides the limiting conditions for operation necessary to preserve the effectiveness of these instrument systems.

If the minimum operable channels or the minimum degrees of redundancy for each functional unit of a table cannot be met or cannot be bypassed under the stated permissible bypass conditions, the following action shall be taken:

For Table 4.4-1, the reactor shall be shut down within 12 hours.

For Table 4.4-2, the affected loop shall be shut down within 12 hours.

For Table 4.4-3, perform one of the following within 12 hours:

1) The reactor shall be shutdown, or

2) the affected helium circulator shall be shutdown.

For Table 4.4-4, the reactor shall be shut down within 12 hours.

If, within the indicated time limit, the minimum number of operable channels and the minimum degree of redundancy can be reestablished, the system is considered normal and no further action needs to be taken.

The trip level settings are included in this section of the specification. The bases for these settings are briefly discussed below. Additional discussions pertaining to the scram, loop shutdown and circulator trip inputs may be found in Sections 7.1.2.3, 7.1.2.4 and 7.1.2.6, respectively, of the FSAR. High moisture instrumentation is discussed in Section 7.3.2 of the FSAR.

Basis for Specification LCO 4.4.1 (Continued)

To accommodate the instrument drift assumed to occur between operational tests and the accuracy to which Trip Setpoints can be measured and calibrated, Allowable Values and Trip Setpoints have been specified in Part 1 of Tables 4.4-1 through 4.4-4. The methodology used for calculating the Allowable Values and Trip Setpoints is discussed in Technical Specification LSSS 3.3.

a. Scram Inputs

The simultaneous insertion of the control rods will be initiated by the following conditions:

Manual Scram

A manual scram is provided to give the operator means for emergency shutdown of the reactor independent of the automatic reactor protective system. The Reactor Mode Switch (RMS) in the "off" position also causes a manual scram.

Start-up Channel - High Count Rate

High start-up count rate is provided as a scram for use during fuel loading, preoperational testing, or other low-power operations.

Linear Channel - High (Neutron Flux)

See Technical Specification LSSS 3.3.

Basis for Specification LCO 4.4.1 (Continued)

Primary Coolant Moisture - High

See Technical Specification LSSS 3.3

Reheat Steam Temperature - High

See Technical Specification LSSS 3.3.

Primary Coolant Pressure - Programmed Low

See Technical Specification LSSS 3.3.

Primary Coolant Pressure - Programmed High

See Technical Specification LSSS 3.3.

Hot Reheat Header Pressure - Low

Low reheat steam pressure is an indication of either a cold reheat steam line or a hot reheat steam line rupture in a section of line common to both loops. Loss of the cold reheat steam line results in loss of the steam supply to the circulators which necessitates plant shutdown. The direct scram in this case precedes a scram resulting from the two-loop trouble. The loss of either steam line results in loss of plant generation output, and a reactor scram is appropriate in this situation. The Trip Setpoint is selected to be below normal operating and transient levels, which vary over a wide range.

Main Steam Pressure - Low

Low main steam pressure is an indication of main steam line rupture or loss of feedwater flow. Immediate shutdown of the reactor is appropriate in this case. In addition, the superheater outlet stop check valves are automatically closed to reroute main steam to the flash tank (through the individual loop bypass valves and desuperheaters). This is required for the continued operation of the helium circulators on steam. The Trip Setpoint is selected to be below normal operating levels and system transients.

Plant Electrical System - Loss

Loss of plant electrical system power requires a scram to prevent any Power-to-Flow mismatches from occurring. A preset time delay is provided following a power loss before the scram is initiated to allow an emergency diesel generator to start. If it does start, the scram is avoided.

Basis for Specification LCO 4.4.1 (Continued)

Two-Loop Trouble Scram Logic

Operation on one loop at a maximum of about 50% power may continue following the shutdown of the other loop (unless preceded by scram as in the case of high moisture). Onset of trouble in the remaining loop (two-loop trouble) results in a scram. Trouble is defined as a signal which normally initiates a loop shutdown. Similarly, simultaneous shutdown signals to both loops result in shutdown of one of the two loops only, and a reactor scram. However, actuation of both Steam Line Rupture Detection/Isolation System (SLRDIS) loops, effectively shuts down both loops because it sends an actuation logic signal to all four circulator trip logic channels. The consequences of a two-loop shutdown and subsequent loss of forced circulation have been analyzed and found to be acceptable. The consequences are bounded by an interruption of forced circulation cooling accident described in FSAR Section 14.4.2.2, Safe Shutdown Cooling.

High Reactor Building Temperature (Pipe Cavity)

High temperature in the pipe cavity would indicate the presence of a steam leak. A steam leak or pipe rupture under the PCRV within the support ring would also be detectable in the pipe cavity, therefore only one set of sensors and logic is required to monitor both areas. The setpoint has been set above the SLRDIS pre-trip temperature alarm.

Basis for Specification LCO 4.4.1 (Continued)

b. Loop Shutdown Inputs

The following loop shutdown inputs are provided primarily for equipment protection and are not relied upon to protect Safety Limits. Malfunction of these items could prevent a scram due to loss of the two loop trouble scram input.

Shutdown of Both Circulators (Loop Shutdown Logic)

Shutdown of both circulators in one loop is a loop shutdown input so that secondary coolant flow is automatically isolated to the affected loop's steam generator upon loss of primary coolant flow in that loop. This loop shutdown ensures proper reactor protection system action (scram) through the two-loop trouble scram in the event of the loss of all four circulators. Low feedwater flow to both loops can result in automatic trip of all four circulators, which would activiate the two loop trouble scram.

Steam Generator Penetration Overpressure (Loop 1/Loop 2)

Steam generator penetration overpressure is indicative of a pipe rupture within the penetration. A loop shutdown is appropriate for such an accident, and the helium pressurizing line to the penetration is closed to prevent moisture backflow to the purified helium system. The penetration overpressure is handled by relief valves; however, to minimize the amount of steam/water released, the steam generator contents are also dumped.

The steam generator interspace rupture discs are set at 825 psig (nominal). The burst pressure range (plus or minus 2%) is 808 psig to 842 psig (Technical Specification LSSS 3.3, Table 3.3-1). The relief valve is sized to allow a 370 psi pressure drop in a safety valve inlet line when the valve is relieving at nameplate capacity of 126,000 lb/hr superheated steam at 1000 degree F. This prevents the penetration pressure from exceeding the reference pressure of 845 psig.

Basis for Specification LCO 4.4.1 (Continued)

High Reheat Header Activity - (Loop 1/Loop 2)

High reheat header activity is an indication of a reheater tube rupture resulting in leakage of reactor helium into the steam system. The Trip Setpoint ensures detection of major reheat tube ruptures and an on-scale reading, with up to design value circulating activity for post accident monitoring. Detection of smaller size leaks or leaks with low circulating coolant activity can be detected and alarmed by the backup reheat condensate monitors and/or the air ejector monitor.

Low Superheat Header Temperature (Loop 1/Loop 2) and High Differential Temperature Between Loop 1 and Loop 2

Low superheat header temperature in a loop is indicative either of a feedwater valve or controller failure yielding an excessive loop feedwater flow rate or a deficiency of helium flow rate, and a loop shutdown is appropriate. The required coincident high differential temperature between loops functions to prevent the loop Trip from occurring during normal operation at low main steam temperatures such as in a normal plant shutdown.

Basis for Specification LCO 4.4.1 (Continued)

c. Circulator Shutdown Inputs

All circulator shutdown inputs are equipment protection items. With the exception of Circulator Speed High on water turbine drive, all circulator shutdown inputs are connected to the two-loop trouble scram logic through the loop shutdown system. These items are included in Table 4.4-3 because a malfunction could prevent a scram due to loss of the two-loop trouble scram input. Circulator Speed High on water turbine drive is included to afford protection to the water turbine assembly against the effects of overspeed during continued core cooling upon loss of steam drive capability.

Circulator Speed - Low

Too low a circulator speed causes a mismatch between thermal power input and heat removal (feedwater flow) in a steam generator, which may result in flooding the superheater section. The circulator Trip causes an automatic adjustment, as required, in the turbine governor setting, feedwater flow rate, and remaining circulator speed to maintain stable steam pressure and temperature conditions.

Loop 1/Loop 2 Fixed Feedwater Flow - Low

The Fixed Feedwater Flow - Low is an equipment protection feature designed to protect the steam generator from overheating for complete loss of feedwater flow.

Loss of Circulator Bearing Water

In order to prevent circulator damage upon loss of normal and backup bearing water supplies, a gas pressurized water accumulator is fired when water pressure falls below the Trip Setpoint value. The Trip Setpoint value is selected so that adequate water pressure is available during circulator coastdown, which lasts for about 30 seconds, to maintain clearances within the circulator bearings of at least 0.001 in. Tests and analyses have shown that a Trip at 450 psid provides substantial clearance margin above 0.001 in. when the circulators are operating at normal speeds.

Basis for Specification LCO 4.4.1 (Continued)

Circulator Penetration Trouble

Circulator penetration overpressure is indicative of a pipe rupture within the penetration. A circulator Trip is appropriate for such an accident and the helium pressurizing line to the penetration is closed to prevent moisture backflow to the purified helium system. The overpressure is handled by the penetration relief valves. The penetration interspace rupture discs are set at 825 psig (nominal). The burst pressure range (plus or minus 2%) is 808 psig to 842 psig (Technical Specification LSSS 3.3, Table 3.3-1). The relief valve is sized to allow a 40 psi pressure drop in the safety valve inlet line when the valve is relieving at nameplate capacity (170 gpm).

Circulator Drain Malfunction

This Trip is provided to prevent steam from entering the bearing of an operating circulator. A differential pressure controller is utilized to maintain the bearing water main drain pressure above the steam turbine exhaust pressure. When the pressure differential drops, the steam water drain control valves are opened to prevent steam from entering the bearings. If the above controls do not work, three PPS differential pressure switches for each circulator, set at greater than or equal to 8.5 psid, will initiate an automatic shutdown of the circulator.

Circulator Speed - High Steam

The speed sensing system response and Trip setting are chosen so that under the maximum overspeed situation possible (loss of restraining torque) the circulator will remain within design criteria.

Circulator Trip - Manual (Steam/Water)

A manual Trip of each circulator for both steam and water turbine drives is available so that in an emergency an operator can trip a circulator when required.

Basis for Specification LCO 4.4.1 (Continued)

Circulator Seal Malfunction (Low/High)

A high reverse differential of -6.1" H2O would be reasonable evidence that bearing water is leaking into the primary coolant system. An increasing differential pressure of +76.1" H2O would be reasonable evidence that primary coolant is leaking into the bearing water and thus into the closed circulator service system. In both cases a circulator trip with brake and seals set is appropriate.

Circulator Speed - High Water

The Trip Setpoint has been established above normal operating speed. Equipment testing ensures that this Trip Setpoint will prevent failure due to fatigue cracking.

Steam Leak Detection in the Reactor Building

Steam Leak Detection in the Reactor Building is required for equipment qualification of Safe Shutdown Cooling Systems. The ALLOWABLE VALUE is set at ≤ 52.8 degrees F per minute rate of rise in order to prevent exceeding the harsh environment temperature profile to which the safe shutdown electrical equipment is qualified, per the requirements of 10CFR50.49. A setpoint calculation analysis performed per ISA Standard S67.04 and RG1.105 results in the stated ALLOWABLE VALUE and TRIP SETPOINT as specified in the LCO and this basis. The TRIP SETPOINT has been established with sufficient margin between the technical specification limit for the process variable and the nominal TRIP SETPOINT to allow for 1) inaccuracy of the instruments; 2) uncertainties in the calibration; 3) instrument drift that could occur during the interval between calibrations; and 4) inaccuracies due to ambient temperature changes, vibration and other environmental conditions. The TRIP SETPOINT is set at ≤ 52.3 degrees F per minute rate of rise until such time as the drift characteristics of the detection system are better understood from actual plant operating experience and the assumptions used in the setpoint analysis are verified.

SLRDIS design incorporates two panels, each with its own set of sensors for the Reactor and Turbine Buildings and dual logic trains in each panel. The SLRDIS design preserves the single failure concept. A single failure will neither cause nor prevent SLRDIS actuation in the event of a high energy line break. The probability of an inadvertent actuation is extremely small due to the matrix logic employed for circulator trip and valve actuation. The SLRDIS panels are referred to as "loops"; however, due to the way the outputs of the panels are combined to provide protective action and satisfy the single failure concept, the SLRDIS loops do not correspond to primary or secondary loops.

Basis for Specification LCO 4.4.1 (Continued)

For each SLRDIS loop, the OPERABILITY requirements and their respective ACTIONs represent good operating practices and judgment for a four channel detection system with a 2 of 4 coincidence trip logic. The fourth channel may be placed in bypass for test and/or maintenance purposes, subject to the ACTION statement restrictions, while preserving a 2 of 3 coincidence logic OPERABLE. The Steam Line Rupture Detection/Isolation System as designed and installed has spare channels available for input. Any of the available channels may be selected for input signal processing provided the surveillances are current on the channels used. The SLRDIS is required to be OPERABLE only at power (above 2% rated thermal power). Analyses with rated reactor power at 2% demonstrate that automatic actuation of SLRDIS is not likely to occur during a high energy line break lasting until it is manually terminated at one hour following initiation. The temperatures as analyzed in both the reactor and turbine buildings stay well below the temperature for which the equipment is qualified.

The ACTION statements for inoperable SLRDIS detection and information processing equipment allow one channel in each building to be inoperable for up to 7 days; a second inoperable channel in either building requires that power be reduced to below 2% within 12 hours. The 7 day ACTION time for a single detector channel is acceptable based on preservation of a 2 out of 3 coincidence detection system still in operation. ACTION 3 is applicable to other functions within the SLRDIS instrumentation panel such as loss of power from instrument buses, or other failures in the logic trains and associated electronics. A 12 hour time period in ACTION 3 for inoperability of those associated SLRDIS functions minimized the time that SLRDIS may operate with limited functional capability. An inoperable valve or associated equipment is allowed for 72 hours. High energy line break analysis for environmental qualification assumes the worst-case single active failure. Thus, a single valve inoperable for up to 72 hours is within the bounds of analysis. When two or more valves and/or associated equipment is inoperable, 24 hours is allowed to restore the inoperable equipment. Repairs may be performed while the plant is at power, thus, minimizing thermal cycling of plant and installed equipment.

Steam Leak Detection in the Turbine Building is required for equipment qualification of Safe Shutdown Cooling Systems. Thus, the limits and basis are the same as discussed in the basis for steam leak detection in the reactor building.

Basis for Specification LCO 4.4.1 (Continued)

d. Rod Withdrawal Prohibit Inputs

The termination of control rod withdrawal to prevent further reactivity addition will occur with the following conditions:

Startup Channel - Low Count Rate

Start-up Channel - Low Count Rate is provided to prevent control rod pair withdrawal and reactor startup without adequate neutron flux indication. The trip level is selected to be above the background noise level.

Linear Channel - Low Power RWP

Linear Channel (5% Power) directs the reactor operator's attention to either a downscale failure of a power range channel or improper positioning of the Interlock Sequence Switch. (FSAR Sections 7.1.2.2 and 7.1.2.8)

Linear Channel - High Power RWP

Linear Channel (30% Power) is provided to prevent control rod pair withdrawal if reactor power exceeds the Interlock Sequence Switch limit for the "Low Power" position. (FSAR Sections 7.1.2.2 and 7.1.2.8)

Attachment 3

To P-88025

Significant Hazards Consideration Analysis

SIGNIFICANT HAZARDS CONSIDERATIONS ANALYSIS

I. INTRODUCTION

This Significant Hazards Considerations Analysis describes the reevaluation of Fort St. Vrain (FSV) Nuclear Generating Station Plant Protective System (PPS) setpoints, and describes the method used to determine those setpoints. The results of this setpoint reevaluation require a revision to the Facility Operating License, Technical Specification LSSS 3.3, Table 3.3-1, LCO 4.4.1, and Tables 4.4-1 through 4.4-4.

In response to a Commission letter from Speis to Fuller, dated August 28, 1978, PSC reevaluated FSV PPS setpoints. As a result, PSC informed the Commission, in a letter from Lee to Miller dated October 1, 1980 (P-80340), that the first phase of identifying Instrument Trip Settings and Absolute Values for Category I and II setpoints contained in LSSS 3.3, Table 3.3-1 and LCO 4.4.1, Tables 4.4-1 through 4.4-4 had been completed. In this submittal, the existing Technical Specification Trip Setpoint was redefined as the Absolute Value, and a new Trip Setpoint was calculated. The minimum difference between the Absolute Value and the new Trip Setpoint was the instrument channel cumulative inaccuracy, determined by the least squares method utilizing manufacturers' published accuracy data. Included in PSC's October 1980 submittal, was supportive information for the proposed new Absolute Values for Low Circulator Speed, Fixed Feedwater Flow - Low, Loss of Circulator Bearing Water and the applicability of 5% and 30% Rod Withdrawal Prohibits.

In a Commission letter from Madsen to Lee, dated July 11, 1983 (G-83255) PSC was informed that their October 1980 submittal did not adhere to the current practice used for the Standard Technical Specifications (STS). PSC utilized Absolute Values rather than Allowable Values in their proposed Technical Specifications. Setpoints in the STS are defined as limits with either greater than or less than, in contrast to the tolerances with plus or minus used by PSC. In addition, PSC defined a reportable occurrence as exceeding an Absolute Value, as opposed to an Allowable Value. As a result, in their letter The Commission recommended that FSV PPS setpoints be specified in terms of an Allowable Value and a Trip Setpoint, "expressed as either greater than or less than as well as equal to the value specified." The Commission also informed PSC that the method described by the Commission was consistent with industry consensus as stated in ISA Standard S67.04-1982, "Setpoints for Nuclear Safety-Related Instrumentation Used in Nuclear Power Plants" and that the standard would be endorsed by a Commission Regulatory Guide in the near future. (A draft of ISA Standard

S67.04 was endorsed by a draft of proposed Revision 2 to Regulatory Guide 1.105, issued for comment in December 1981. Subsequently, this issue of ISA-S67.04 was finalized in 1982.) The Commission requested in their letter of July 11, 1983 (G-83255), a discussion on the various types of data used and sample calculations, addressing "test equipment accuracy, process measurement accuracy, environmental effects, component accuracy and drift rates." It was also recommended that the Technical Specifications for FSV be revised to "bring them more in line with the format and degree of specifically used in STS for water reactors."

In order to clarify the method used in the calculation of setpoints, a meeting between PSC and the Commission was held on October 27, 1983. In this meeting, the application of ISA Standard S67.04-1982 to FSV PPS Setpoints was discussed. As described in a Commission letter dated November 3, 1983 (G-83409), PSC agreed to revise the 1980 application to include the STS type format, the analysis of Category III instruments, as defined in P-80340, and bases for the numerical values selected. In a letter dated March 9, 1984 (P-84078), PSC enclosed the work specification for the setpoint reevaluation program for the Commission's review, which incorporated the method recommended by the Commission. In addition, PSC agreed to resubmit the proposed amendment to the Facility Operating License.

In a letter dated June 21, 1985 (P-85214), PSC submitted an amendment request to the PPS Instrumentation Technical Specification utilizing ISA Standard S67.04-1982 as guidance and in the STS upgraded format. The NRC in a letter dated January 24, 1986 (G-86053) submitted a Draft Safety Evaluation Report (SER) and requested that a new amendment, using the existing Technical Specifications with the new Trip Setpoints and Allowable Values, be resubmitted.

PSC resubmitted an amendment request dated May 15, 1986 (P-86279), addressing only those parameters currently specified in the existing Technical Specifications with the new analyzed Trip Setpoints and Allowable Values. Several discussions with the NRC staff were held subsequent to the May 15, 1986 letter to address an issue that arose on the methodology (based on the monthly surveillance frequency) and the basis for determining a reportable event.

The NRC staff, in a letter dated November 26, 1986, (G-86624), requested that PSC resubmit the amendment request based on the refueling interval calculated Allowable Values. In a letter dated August 28, 1987 (P-87278), PSC resubmitted the amendment request on the existing PPS Technical Specification parameters using the Refueling interval revised methodology.

In a letter dated November 25, 1987 (G-87422), the NRC submitted a Draft Technical Evaluation Report (TER), including portions of the January 24, 1986 SER, and addressing additional issues as a result of the August 28, 1987 amendment request. On December 3, 1987, a PSC/NRC meeting was held to discuss and reach resolution on the conclusions documented in the above Draft TER.

This Significant Hazards Consideration Analysis supports the proposed amendment in Attachment 2 of this letter.

II. METHODOLOGY

The method used by PSC for the reevaluation of PPS setpoints was requested by the Commission in the October 27, 1983 meeting between PSC and the Commission and submitted to the Commission in a letter dated March 9, 1984 (P-84078). ISA Standard S67.04-1982 was used by PSC as a guideline, and the standard, was endorsed in Revision 2 to Regulatory Guide 1.105, February, 1986. Therefore, the method used as guidance for reevaluation has been recommended for use by both the nuclear industry and the Commission.

ISA Standard S67.04-1982 defines Safety Limits as "limits upon important process variables which are found to be necessary to reasonably protect the integrity of certain physical barriers which guard against the uncontrolled release of radioactivity." Specifically, in the FSV Technical Specifications, "Safety Limits are defined to protect the fuel particle integrity and the integrity of the primary reactor coolant system boundaries. The integrity of these barriers will ensure that an uncontrolled release of radioactivity could not occur." Thus, the specific physical barriers protected at FSV are the fuel particle coating and the primary coolant system boundaries.

The FSV Technical Specifications also define the Limiting Safety System Settings (LSSS), which "are established for instrumentation and protective devices related to the process variables upon which Safety Limits are based." The LSSS parameters monitored by instrumentation at FSV are listed in Technical Specification LSSS 3.3, Table 3.3-1, as follows: High Neutron Flux, High Reheat Steam Temperature, Low Primary Coolant Pressure, High Primary Coolant Pressure, and High Moisture in the Primary Coolant.

ISA S67.04-1982 applies only to LSSS parameters associated with Safety Limits. In the October 27, 1983 meeting between PSC and the Commission, the Commission requested that PSC apply the ISA Standard to all FSV PPS parameters. The majority of FSV PPS parameters protect safety related equipment and are not associated with the Safety Limits. Therefore, the Commission requested PSC to identify an "Analysis Value" for each parameter, whether it be an LSSS parameter or not.

The Analysis Value is the value of a parameter for which a trip and initiation of automatic protective action is assumed to occur in FSV accident analyses. Provided that the trip occurs at a value equal to or more conservative than the Analysis Value, analyses demonstrate that consequences of the accident or transient are acceptable and do not exceed Safety Limits or equipment design limits. Since safety analyses documented in the

FSV FSAR assume that trip and initiation of automatic protective action occur at the least conservative trip setting permitted by the current Technical Specifications Tables 4.4-1, 4.4-2, and 4.4-3, for any parameter, these Trip Settings are the Analysis Values. The Commission requested that PSC apply the ISA Standard methodology to these Analysis Values to arrive at Monthly Allowable Values and Trip Setpoints for each PPS parameter.

The factors which are identified by the ISA Standard and considered in the determination of Analysis Values are:

(1) The effects of potential transient overshoot. (Section 4.3.1 (4))

(2) The effects of transient time response characteristics. (Section 4.3.1 (5))

(3) Process measurement inaccuracy. (Section 4.3.1 (3))

The effects of these factors are discussed for each Analysis Value.

The ISA Standard states that "For each LSSS a Trip Setpoint and its associated Allowable Value shall be established." An Allowable Value is defined in the ISA Standard by the allowances for instrument error between the Allowable Value and the Safety Limit. These allowances are divided into six factors in Section 4.3.1 of ISA S67.04-1982. Three of these factors are accounted for in the determination of the Analysis Value (as described above), using PSC's revised ISA methodology. The remaining three factors contributing to instrument error and used to determine the Monthly Allowable Values have been addressed in the following manner:

(1) Accuracy (including drift) of components not tested when the setpoint is measured. (Section 4.3.1 (1))

This factor was determined by PSC as the accuracy, including drift, of components not tested when the monthly surveillance is performed. The greater of two values, either the manufacturer's inaccuracy or the yearly drift, was used in the Monthly Allowable Value calculation.

(2) Accuracy of test equipment. (Section 4.3.1 (2))

Test equipment accuracy was determined by PSC using the manufacturer's quoted accuracy of the least accurate equipment permitted to be used for a given surveillance.

(3) Environmental effects on equipment accuracy (Section 4.3.1 (6))

These were determined using the environmental qualification report and manufacturer's data. The use of the environmental qualification report and method of application in many cases resulted in the use of a more conservative value than required by the ISA Standard. The environmental qualification report gives the most extreme conditions for which the equipment is qualified. The ISA Standard requires only that the conditions which are a result of the accident which that particular component is required to mitigate be considered. Also, the effects of seismic and environmental events were combined as if these events occurred simultaneously, which is more restrictive than the design basis accident analysis for FSV.

The items considered above were combined using the square root of the sum of the squares where no common source error existed and algebraically when the effects could occur concurrently. A "total inaccuracy" value was calculated which was used to determine the margin between the Analysis Value and the Monthly Allowable Value.

The Trip Setpoint, according to the ISA Standard, is to be established by determining the margin for drift between the Monthly Allowable Value and Trip Setpoint. This margin is defined by the ISA Standard as "Drift of that portion of the instrument channel which is tested when the setpoint is determined." In the October 27, 1983 meeting, the Commission further specified that the test of the instrument channel to be utilized for this drift consideration is the monthly functional test, as opposed to the annual calibration test. The drift of the latter is taken into consideration in the allowances between the Analysis Value and the Monthly Allowable Value. For certain parameters, the portion of the instrument channel which is tested monthly is checked only for logic operability by pulse testing. Therefore, the Monthly Allowable Value and the Trip Setpoint are the same for those parameters. Two years of monthly surveillance data was reviewed to determine instrument channel drift.

In the process of applying ISA Standard S67.04-1982 to FSV PPS setpoints, certain Trip Setpoints resulted which could infringe on the normal operating range of their parameters. Operation with these setpoints would result in unnecessary reactor scrams, loop shutdowns and circulator trips occurring during minor transients under normal operating conditions. In these cases, an evaluation was performed to determine if a less conservative Analysis Value could be used, which continued to protect the Safety Limit or equipment design limit. The reanalyzed Analysis Values and their resulting Trip Setpoints continue to provide overall plant safety. Their reanalysis will reduce the number of challenges to plant systems without a significant reduction in margins from the Safety Limit or equipment design limit.

The reanalyzed Analysis Values are discussed in detail in the following section.

PSC notified the NRC in late 1986 of concerns regarding identification of the "Monthly Allowable Value" in the FSV Technical Specification. The concerns centered on reportability of instrument Trip Setpoints determined in surveillances which exceed the Monthly Allowable Value. As explained above, the Monthly Allowable Value is offset from the Analysis Value by a margin which accommodates, among other items, the accuracy or drift (whichever is greater) of components in the instrument train not tested in the monthly Technical Specification Surveillance.

The Trip Setpoint is offset from the Monthly Allowable Value by a margin which accommodates drift of components in the instrument train which are tested in the monthly Technical Specification Surveillance.

For those monthly surveillances in which the Trip Setpoint is determined (as stated above, it is not determined for certain parameters pulse tested monthly for logic operability), it is anticipated that the AS FOUND Trip Setpoint will be more conservative than the Monthly Allowable Value. Provided the portion of the instrument train which is tested in the monthly surveillance has not drifted excessively and the AS FOUND Trip Setpoint remains below the Monthly Allowable Value, the margin between the Monthly Allowable Value and the Analysis Value provides assurance that the entire instrument train will actuate the trip function before the measured parameter reaches the Analysis Value. In addition to the monthly surveillances, the Technical Specifications also require that the PPS instrument trains be tested in an annual/refueling surveillance. Typically, the annual/refueling surveillance tests all components in an instrument train, from the detector to the final trip device. Provided the entire instrument train is capable of actuating its trip function before the measured parameter reaches the Analysis Value, it will accomplish its safety function. It is likely that the Trip Setpoint of the entire instrument train, as determined in the annual/refueling surveillance, will exceed the Monthly

Allowable Value, since the margin between the Trip Setpoint and the Monthly Allowable Value only accommodates drift of those components in the instrument train which are tested during the monthly surveillance. The margin between the Trip Setpoint and the Monthly Allowable Value does not accommodate accuracy and drift of the remaining components in the instrument train, which are tested in the annual/refueling surveillance. Therefore, the Monthly Allowable Value can not be compared to the Trip Setpoint of the entire instrument train which is typically determined in the annual/refueling surveillance to assess capability of the instrument train to perform its safety function. Since the Monthly Allowable Value only applies to monthly surveillances, the NRC decided that the Monthly Allowable Value should not be incorporated into the FSV Technical Specification since its incorporation would result in reportable occurrences whenever the Trip Setpoint determined in the annual/refueling surveillance exceeded the Monthly Allowable Value, even though the instrument may be capable of performing its safety function (trip actuation before the measured parameter reaches the Analysis Value). In NRC Letter dated 11/26/86, Heitner to Williams (G-86624), the NRC recommended that PSC "propose Technical Specifications based on the annual (or refueling interval) allowable values. Monthly allowable values should be the basis for your administrative controls."

"Annual/refueling Allowable Values" (referred to simply as Allowable Values) are calculated by applying paragraph 4.3.1 of the ISA Standard S67.04-1982 to the annual/refueling surveillances. The margin between the Analysis Value and the Allowable Value (not the Monthly Allowable Value) accommodates, among other items, accuracy or drift (whichever is greater) of components in the instrument train not tested in the annual/refueling surveillance. Since the entire instrument train from detector to the final trip device is tested in all but several annual/refueling surveillances, the margin between the Allowable Value and the Analysis Value is much less than that between the Analysis Value and the Monthly Allowable Value. Provided the AS FOUND Trip Setpoint determined in the annual/refueling surveillance is more conservative than the Allowable Value, there is assurance that the instrument train would actuate its trip function before the Analysis Value is reached, thus accomplishing its safety function. For this reason the Allowable Values, which are based on the annual/refueling surveillance, will be incorporated into the FSV Technical Specifications. The factors contributing to Instrument error and used to determine the Allowable Value are as follows:

(1) Accuracy (including Drift) of components not calibrated when the setpoint is measured during the annual/refueling surveillance.

This factor was determined by PSC as the greater of (1) the component's accuracy or (2) The drift data from the annual/refueling calibrations.

(2) Accuracy of Test Equipment.

This factor was determined by PSC as the accuracy of the test equipment used to calibrate instruments during the annual/refueling surveillance.

(3) Design Drift Allowances.

These factors were determined by PSC as the accuracies for environmental and seismic effects, power supply variations, vibration, etc.

The above items were combined using the square root of the sum of the squares. A total inaccuracy value was calculated and was used to determine the margin between the Analysis Value and the Allowable Value.

The 5% and 30% reactor power Rod Withdrawal Prohibits, Table 4.4-4 of the Technical Specifications, were not analyzed in this program. They are administrative in nature and no credit is taken for them in accident analyses; therefore, the ISA Standard does not apply. Trip Setpoints and Allowable Values for those parameters have been established to assure operator compliance with Administrative Procedures to maintain the Interlock Sequence Switch in the proper position consistent with the reactor power level. The issue of not applying instrumentation uncertainties to the RWP Instrumentation for future submittals is considered an NRC open Item as addressed in the Draft TER of November 25, 1987.

III. EVALUATION

A. PRIMARY COOLANT PRESSURE LOW

Primary Coolant Pressure - Low is listed in FSV Technical Specification LSSS 3.3, Table 3.3-1. Although low primary coolant pressure itself is not a Safety Limit, it is an indication of inadequate core cooling and protects PCRV internal thermal temperature limits. The present Technical Specification Trip Setting of ≤ 50 psi below normal gage pressure, programmed with circulator inlet temperature, was established for depressurization accidents analyzed in FSAR sections 14.11, 4.3.3, 14.7 and 14.8.

Design Basis Accident No. 2 (DBA-2) "Rapid Depressurization/Blowdown," FSAR Section 14.11, assumes primary coolant pressure decay is instantaneous in the analysis of subsequent cooling. Therefore, the consequences of DBA-2 are not affected by changing the Primary Coolant Pressure - Low Analysis Value.

For the Maximum Credible Accident analyzed in FSAR Section 4.3.3 and 14.8, multiple failures are assumed in conjunction with the offset rupture of 2 inch diameter helium purification system regeneration piping. The accident is assumed to occur from 100% rated power. The PCRV pressure decays due to a loss of primary coolant inventory at a rate corresponding to a time constant of about 1600 seconds. Primary coolant pressure drops 50 psi below normal at about 120 seconds, at which time primary coolant flow is 97% of rated, and the average core outlet temperature has peaked at 13 degrees F above normal for 100% power operation.

For an analysis value of 90 psi below normal, reactor scram occurs at about 220 seconds after the loss of helium is initiated. This results in primary coolant flow of 92.5% of rated flow at the time of the trip, and a peak average core outlet temperature of 44 degrees F above normal for 100% power operation. After the reactor scram, the core outlet temperature declines steadily with continued core cooling by the continually decreasing primary coolant inventory.

The effects of an ingress of air due to the decreasing primary coolant temperature after completion of the depressurization are analyzed in Section 14.11.2.3.1 of the FSAR. This analysis hypothesizes an instantaneous primary coolant system depressurization. As a result, reactor scram is also instantaneous and therefore the low primary coolant pressure setpoint does not affect the consequences of the accident.

Analyses were performed to determine the effects of an Analysis Value of 90 psig below normal by evaluating the end points at 100% and 25% load using the SCAP heat balance code. The results demonstrate the operation 90 psi below normal is acceptable. The reduction in helium pressure from 700 psia to 610 psia at 100% power, and about 615 psia to about 525 psia at 25% power, results in a reduced helium density. The circulator speeds increase from about 8263 rpm to about 3004 rpm at 25% power, to compensate for the reduced helium density. Because the circulator speeds increase, helium flow does not drop significantly. Helium flow decreases to about 3,484,285 lb/hr from 3,532,213 lb/hr at 100% power, and decreases to about 1,053,262 lb/hr from about 1,059,439 lb/hr at 25% power. Core power to flow ratio changes only .01 at both 25% and 100% power. Helium temperatures at the steam generator inlet only change from about 1383 degrees F to about 1392 degrees F at 100% power, and from about 1192 degrees F to about 1194 degrees F at 25% power.

As demonstrated by the analyses described above, the effects of changing the Analysis Value for Primary Coolant Pressure - Low from 50 psi to 90 psi below normal programmed pressure are not significant. The new Analysis Value continues to protect against inadequate core cooling and exceeding PCRV internal temperature limits.

B. PRIMARY COOLANT PRESSURE - HIGH

High primary coolant pressure indicates continued steam/water leakage into the PCRV and serves as a backup trip to the PPS moisture monitors. For significant steam leakage into the PCRV, compounded by coincident failure of the redundant moisture monitors, the high primary coolant pressure trip initiates reactor scram, shutdown and dump of a preselected loop, and main steam depressurization of the remaining operating loop. These actions are designed to prevent opening the PCRV relief valves. The high primary coolant pressure trip is programmed with reactor power (using circulator inlet temperature), with the most severe consequences, in terms of graphite oxidation, occurring at 100% power.

The existing value of 7.5% above normal, programmed with reactor power, has been reanalyzed to justify an Analysis Value of 70 psi above normal gage pressure.

FSAR Section 14.5.3 analyzes six accident cases resulting from steam ingress into the PCRV. Cases 1 and 3 are not included here because they analyze events which are detected by the moisture monitors, so the high primary coolant system pressure setpoint is not reached. Cases 2, 4, 5 and 6 postulate multiple failures in the moisture monitor system, resulting in a high primary coolant pressure trip. Therefore, these cases have been reanalyzed for a high primary coolant pressure Analysis Value of 70 psi above normal, programmed with reactor power by utilizing circulator inlet temperature. Since a leak from 100% power causes the most severe consequences in terms of graphite oxidation, only a trip at 100% power has been reanalyzed. Multiple failures must take place in the moisture monitor system before action by the high primary coolant pressure trip occurs, therefore no additional failures in the high primary coolant pressure system are assumed in the accident scenarios.

For each case reanalyzed, the same conditions are applied. Cooling is continued with the remaining operating main loop for about 30 minutes, at which time the temperature of the core and the steam generators is about 500 degrees F. If, at this time, PCRV pressure indicates significant leakage in the operating loop, the economizer-evaporator-superheater sections are isolated and dumped, and the reheater sections in that loop are flooded. No credit is taken in these reanalyses for moisture removal by condensation in the primary circuit excluding the graphite, or by the helium purification system.

<u>FSAR 14.5.3.2 Case 2 - Subheader Rupture and Wrong Loop Dump</u>

PCRV Pressure, steam content and maximum graphite temperature during this accident scenario are shown in Figure 2.

As a result of the failure of the redundant moisture monitors in the leaking loop, the high moisture level is detected by the monitors in the intact loop in about 13.6 seconds. The intact loop is then tripped, shutdown and dumped, concurrent with a reactor scram. The leaking loop, continuing to operate, leaks at the equilibrium rate of 21.5 lb/sec. Cooling after the scram tends to reduce the system pressure, but the continued steam/water leakage and steam formation will cause the pressure to rise. In about 2 minutes the Analysis Value of 70 psi above normal pressure, programmed with circulator inlet temperature, is reached due to the reduction in circulator inlet temperature. At this time, a feedwater pressure reduction is initiated for the leaking loop which further reduces the leakage rate. A maximum primary coolant pressure of 739 psia is reached approximately 10 minutes after the start of the leak.

For the next 20 minutes the PCRV pressure rises and falls, reaching a value of 648 psia at the end of the 30 minute main loop cooldown. From this point on, cooling is accomplished with the flooded reheaters, and the main section of the leaking steam generator is isolated and dumped. During the cooldown utilizing the flooded reheaters, the pressure rises to 658 psia but the steam-graphite reaction is negligible due to the low temperature of the graphite. The steam/water leakage for this case is 15,000 lbs. of which only 180 lbs. react with the core graphite as shown in Table 1.

FSAR 14.5.3.4 Case 4 - Subheader Rupture with Moisture Monitor Failure and Correct Loop Dump

For this accident, the redundant moisture monitors in both loops are assumed to fail to detect and dump the leaking steam generator. Water/steam continues to leak into the primary coolant system until the analysis Value, equivalent to 775 psia for this case, is reached at 157 seconds. A reactor scram is initiated and the correct loop is isolated and dumped. Of the 3200 lbs. total H20 inleakage, 1112 lbs. react with the core graphite, as shown by Figure 3. In this case, reactor cooling utilizing feedwater is maintained by the remaining operating loop for the total duration of the accident since the leaking loop was correctly isolated and dumped.

FSAR 14.5.3.4 Case 5 - Subheader Rupture with Moisture Monitor Failure and Wrong Loop Dump

In this case, the moisture monitors are assumed to fail so that a reactor scram with an immediate turbine trip and a steam generator dump of one loop is initiated on high PCRV pressure (775 psia) at 157 seconds. Further, the wrong loop is dumped but the faulty loop, which is used for the cooldown, is operated at reduced pressure to minimize steam inleakage during the cooldown. The maximum pressure reached during the 30 minutes of main loop cooling is 783 psia at 200 seconds after the start of the leak. During cooling the total H20 inleakage for this case is 15,600 lbs. of which 1162 lbs. reacts with the core graphite, as is shown on Figure 4.

It is noted that the 15,600 lbs. total H2O inleakage is a slight reduction from the 15,740 lbs. value shown in FSAR Table 14.5-1. The initial evaluation, contrary to Note (3) of the table, assumed for Case No. 5 only, that the leakage was terminated after 30 minutes from scram and not 30 minutes from the start of the leakage. This inconsistency has been corrected in this evaluation.

FSAR 14.5.3.4 Case 6 - Subheader Rupture with Moisture Monitor Failure, Correct Loop Isolation and Failure to Dump

In this case, moisture monitors in both loops are postulated to fail to detect the leaking steam generator. Water/steam continues to leak into the primary coolant until the Analysis Value, equivalent to 775 psia is reached at 157 seconds. A reactor scram is initiated at this point and the leaking loop is isolated but not dumped. During the 157 seconds prior to isolation of the leaking loop, about 3200 lbs. of H2O will leak into the primary coolant system. Following this initial inleakage, the entire 6000 lbs. inventory of the steam generator is assumed to enter the primary coolant system. Conservatively assuming that the isolated leaking steam generator is pressurized to 1000 psia because of steam line isolation valve leakage, the draining rate is specified as the inleakage rate from an operating leaking loop with reduced feedwater pressure (about 8 lb/sec.). The primary coolant pressure reaches a peak of 785 psia 200 seconds after the start of the leak. Figure 5 shows that the total H2O inleakage for this case is about 9200 lbs., of which approximately 1200 lbs. reacts with the core graphite.

C. LOW SUPERHEAT HEADER TEMPERATURE AND HIGH DIFFERENTIAL TEMPERATURE BETWEEN LOOP 1 and LOOP 2

Low superheat header temperature, in conjunction with high differential temperature between loop 1 and loop 2, initiates a loop shutdown. The function of the Low Superheat Header Temperature trip is to provide safe shutdown of a loop on early indication of potential superheater header floodout. This action will also preclude unnecessary turbine trips when only a loop trip is required to prevent wet steam or water from flowing into the main turbine. The turbine control system, which includes a low main steam temperature turbine trip, is available as a backup to the loop trip.

The existing Low Superheat Header Temperature Analysis Value of 800 degree F has been reanalyzed to justify an Analysis Value of 780 degree F. At normal main steam operating pressure of 2400 psig, the saturation (floodout) temperature of the steam is about 660 degree F. The Low Superheat Header Temperature Analysis Value of 780 degree F was selected to provide early indication of a floodout event but to be sufficiently below the expected main steam temperature range to avoid spurious trips during normal plant operation.

A 65 degree F High Differential Temperature Between Loops Analysis Value was reviewed to determine if this 15 degree higher value would result in a significant time delay in the initiation of the loop trip after a flow imbalance event begins. Since the operating intact loop main steam temperature will be controlled at the nominal setpoints of about 880 degree F at 30% load and 1000 degree F at 100% load, the loop temperature differences will be between approximately 80 and 200 degree F when the malfunctioning loop reaches the Low Superheat Header Temperature setpoint. Therefore, High Differential Temperature Between Loops 1 and 2 will be tripped first, before the Los Superheat Header Temperature trip occurs, even if the differential temperature trip does not occur until the Analysis Value of 65 degree F is reached.

The low main steam temperature setpoint for the turbine trip is 800 degree F, therefore, the loop trip interaction with this system was reviewed to determine if trip of a malfunctioning loop occurs first over the normal power operating range of the plant. Main steam from the two loops is mixed upstream of the turbine inlet temperature sensors. The temperature of this mixture is compared with malfunctioning loop temperature at the point at which Analysis Values for Low Superheat Header Temperature and High Differential Temperature Between Loops are reached. This analysis is presented here and demonstrates that the conditions for trip of a malfunctioning loop are attained prior to reaching the turbine trip setpoint.

30% Power

Malfunctioning Loop Temp: 780 degree F
Other Loop Temp: 880 degree F
Turbine Mixed Inlet Steam Temp: 830 degree F
Loop-to-Loop delta T: 100 degree F

100% Power

Malfunctioning Loop Temp: 780 degree F
Other Loop Temp: 1000 degree F
Turbine Mixed Inlet Steam Temp: 890 degree F
Loop-to-Loop delta T: 220 degree F

From the above it can be seen that conditions for trip of a malfunctioning loop are attained prior to reaching the turbine trip setpoint. Therefore, turbine trip is precluded dur to a single malfunctioning loop over the plant power operating range.

The new Analysis Values for Low Superheat Header Temperature and High Differential Temperature continue to ensure that steam generator floodout does not occur. In addition, they ensure that unnecessary trips of the turbine do not occur due to low main steam temperature.

D. CIRCULATOR SPEED LOW

Low circulator speed initiates a circulator trip to avert a loop shutdown as a result of only one malfunctioning circulator. Low circulator speed indicates speed control or equipment malfunction, resulting in decreased helium flow. This may cause a mismatch between heat input and heat removal (by feedwater flow) in a steam generator, resulting in a loop shutdown due to Low Superheat Header Temperature - High Differential Between Loops (discussed in the previous paragraphs). The remaining circulator in the affected loop is released to exceed its normal programmed speed, allowing operation at up to 50% power on a single loop.

The existing Technical Specification trip setting of 1910 rpm below normal as programmed by feedwater flow, has been reanalyzed to justify an Analysis Value of 2390 rpm.

Circulator coastdown characteristics are such that circulator malfunctions are detected quickly on the basis of a speed measurement. Upon complete loss of driving power, the time taken to coast down 25% (2390 rpm) from rated speed is 2 seconds; at part load the time would be up to 4 seconds. PPS action has an intentional delay of 5 seconds to discriminate against transient speed deviations. The time constant of the steam generator superheater header temperature responding to a change in helium flow is approximately 30 seconds. Therefore, a reduction in circulator speed of 2390 rpm (Analysis Value) in less than 30 seconds will result in the trip of a single circulator followed by a power runback (if required) and a speedup of the remaining circulator, thus avoiding a loop trip on Low Superheat Header Temperature.

E. LOSS OF CIRCULATOR BEARING WATER

Loss of circulator bearing water initiates a circulator trip to ensure sufficient lubrication for circulator bearings. Recirculating water is supplied to each circulator bearing, set at about 170 gpm and at a pressure about 640 psi above primary coolant pressure. Each circulator bearing set includes two journal bearings, a main thrust bearing and a reverse thrust bearing. The recirculating water is normally supplied by 2 of 3 (1 standby) pumps and is referred to as the normal bearing water (NBW). A backup source is available from the feedwater system and is referred to as backup bearing water (BUBW). Given the sudden loss of bearing water from both of the above two sources, a third supply is available for safe shutdown of the circulator. This safe shutdown supply consists of a gas pressurizer and water accumulator capable of supplying bearing water for at least 30 seconds at design flow rate. This is adequate for safe shutdown of the affected circulator.

The setpoint at which the accumulator is fired given a sudden loss of bearing water is the subject of this evaluation. The setpoint needs to be sufficiently high to ensure the bearings are not damaged and yet low enough not to cause unnecessary circulator trips during plant transients, including transfers from NBW to BUBW.

1. Bearing Clearances

Normal operating clearances for the circulator bearings are:

Turbine Journal Bearing (centered)	0.0025 in.
Compressor Journal Bearing (centered)	0.0035 in.
Main Thrust Bearing (centered)	0.0045 in.
Reverse Thrust Bearing (centered)	0.0045 in.

A clearance of 0.001 in. is conservatively selected as the minimum clearance to assure adequate lubrication during shutdown of a circulator from 100% speed.

2. Circulator Shutdown Tests

Bearing pressure dynamics during circulator shutdown were measured as a part of the RT-368B tests. During these tests, the NBW and BUBW supplies were terminated and an accumulator was fired at the 475 psid setpoint. Following accumulator firing, momentary dips in bearing cartridge differential pressure were recorded on Brush recorders during the transfer to the accumulator water supply. Minimum pressures observed during these dips are:

Circulator	Minimum Pressure (psid)
A	405
B	405
C	375
D	378

For 'C' and 'D' circulators, these dips in delta P occurred within 0.5 seconds after firing of the accumulator and recovered within 1 second to above 400 psid and within 4 seconds to 450 psid.

From this data, it follows that if the accumulators were fired at 450 psid instead of 475 psid, the momentary pressure dips would also be 25 psi less, or a minimum of 350 psid for the 'C' circulator.

3. Journal Bearings

Each circulator is equipped with two journal bearings. The purpose of the bearings is to center the shaft in the housing. Load on the journal bearings is solely a function of the imbalance on the rotor. Prior to assembly of the FSV circulators, the rotor is balanced so that the residual static imbalance and the dynamically imposed imbalance due to the coupling moments during rotation is less than 0.2 inch ounces in 10,800 rpm with a bearing water flow generated delta P of 700 psid across the bearing housing. Displacement increases with increasing circulator speed.

Since the stiffness of the bearings is generated by the pressure differential across them, as the pressure drops the stiffness decreases, and therefore for the same imbalance load the shaft displacement will increase. Thus, at 350 psid, the shaft displacement will only be 0.00008 in. at 10,800 rpm with an imbalance of 0.2 inch ounces. Thus, it can be seen that the minimum delta P that may occur during a sudden loss of bearing water incident has practically no effect on the journal bearing operating clearances.

Further evidence as to the large margin of safety on the journal bearings was demonstrated in tests performed as part of RT-368B. For these tests, the circulators were shut down with pressure drops across the bearings of only 50 psid, generated by accumulator water flow. This pressure drop is considered adequate to shut down the circulator from 8000 RPM.

4. Thrust Bearings

Each circulator is also equipped with two thrust bearings: a main thrust bearing, and a reverse thrust bearing. Extensive design margin in these thrust bearings occurs at the design operating speed where the generated thrust is - 2000 lbs. (i.e., the thrust load is carried by the reverse thrust bearing). The thrust goes through zero at 90% speed and up to a running maximum of +8000 lbs. on the main thrust bearing at 30% speed.

The maximum load on the reverse thrust bearing would occur during a rapid PCRV depressurization event while the circulator is at 100% speed. During this event, the operating reverse thrust load would increase from 2000 lbs. to 2900 lbs. in conjunction with the helium pressure decay while the reheat steam pressure in the circulator turbine would remain at operating pressure. For this reverse thrust load, a bearing water pressure of 263 psid is required to maintain a clearance of 0.001 in. on the reverse thrust bearing.

The thrust load on the main thrust bearing, as described above, varies with circulator speed, and is about 8000 lbs. at 30% of rated speed. This bearing, however, was designed to accept a maximum thrust load of 11,400 lbs. Assuming a minimum 350 psid bearing water pressure as discussed under "Circulator Shutdown Tests", the minimum clearance of 0.001 is maintained with the maximum thrust load (11,400 lbs.) at normal circulator operating speeds. The clearance improves with increasing circulator speed as shown in the attached table.

Circulator Speed (RPM)	Running Clearance for 350 psid Bearing delta P and 11,400 Thrust Load
2,000	0.0010
4,000	0.0011
6,000	0.0012
8,000	0.0014
10,000	0.0018

There is one case resulting from multiple failures, in which the running clearance on the main thrust bearing is reduced slightly below 0.001 in. This case is an offset steam generator tube rupture with wrong loop dump, producing high PCRV pressure but below the PCRV relief valves' setpoint. A circulator in the shutdown loop is self-turbining at 300 rpm with atmospheric circulator steam turbine. Under the above conditions, the maximum thrust load of 11,400 lbs. is experienced. With sudden loss of bearing water, the rotor is stopped by application of the brake within 6 to 10 seconds. Assuming the minimum bearing pressure of 350 psid, the running clearance is reduced during the 6 to 10 seconds shutdown time to 0.0009 in. This would not cause any damage to the main thrust bearing. In fact, the original (first prototype) circulator tested at Valmont had no brakes and was normally stopped by reducing the bearing water flow and allowing the thrust runner to rub on the bearing surface. No damage occurred to the thrust runner as a result of this shutdown method.

Thus, at any speed above self-turbining, the shaft clearance will be maintained over the conservative 0.001 in. value during a circulator shutdown, protecting the 450 psid Analysis Value.

F. CIRCULATOR SPEED HIGH - STEAM

High circulator speed initiates a circulator trip to provide equipment protection for the helium circulators. The limiting accidents leading to circulator overspeed are loss of restraining torque due to blade shedding and reheat steam line ruptures downstream of the circulator turbines.

High circulator speed trip settings of 11,000 rpm and 11,500 rpm were analyzed, and resulted in peak speeds of 13,050 rpm and 13,267 rpm, respectively. Extrapolating this data for the 11,700 rpm analysis value results in a peak speed of 13,360 to 13,370 rpm. The design overspeed of the circulators is 13,500 rpm, thus the new analysis value results in acceptable consequences.

Steam line ruptures downstream of the circulators were postulated, and an overspeed trip setting of 11,000 was analyzed. The analysis determined that an overspeed of 13,264 rpm would be reached with no control action or trip. This is less than the design overspeed at 13,500 rpm. Therefore, a trip at 11,700 rpm will not result in circulator speeds beyond design conditions.

The trip at 11,700 rpm has been reviewed and approved in License Amendment No. 52 to the Facility operating License, dated April 6, 1987 (G-87117).

IV. Significant Hazards Consideration

Evaluation:

The proposed Amendment would modify Technical Specification Sections LSSS 3.3 and LCO 4.4.1, which provides a listing of the Plant protective System (PPS) Instrumentation parameters and the associated Bases.

The Plant Protective System consists of the instrumentation and controls required to initiate automatic corrective actions upon the onset of unsafe conditions. Individual instrumentation protective channels consists of various instruments from sensor to final output devices to supply the required input(s) into the PPS tripping logic. Each protective channel or instrument loop is provided with a Trip Setpoint where specific actions are either initiated, terminated or prohibited.

The Trip Setpoints selected should contain sufficient margin between the Trip Setpoint and the analyzed safety limits (Analysis Values) to account for uncertainties, such as accuracy, drift and dynamic responses, of the instrumentation.

The above Technical Specification sections have been modified to apply instrumentation uncertainties to the PPS parameters. The uncertainties have been determined using the NRC regulatory endorsed (Reg. Guide 1.105, Rev. 2) Standard ISA S67.1982, "Setpoints for Safety-Related Instruments in Nuclear power Plants", as guidance.

Basis for No Significant Hazards Determination:

The proposed amendment does not involve a significant hazards consideration because operation of the Fort St. Vrain Nuclear Generating Station in accordance with this change would not:

(1) Involve a significant increase in the probability or consequences of an accident previously evaluated. This change specifies Trip Setpoints with an adequate margin based on calculations of the installed instrumentation accuracies, surveillance requirements and surveillance data. The specified margin ensures that upon the onset of plant conditions, which require the need for automatic protective actions, appropriate actions are initiated prior to reaching an equipment design limit or a safety limit specified in the equipment design and accident bases.

For those parameters where the instrumentation uncertainties applied challenged normal plant operation, new Analysis Values for which the trip and initiation of a protective action is assumed to occur in the Accident analyses was justified. While the new values as analyzed in the evalution (Section III) show increases in the consequences of the accident or transient (such as the amount of graphite oxidation, fuel temperatures, etc...), these changes are not significant and do not present an increase in the radiological consequences. The analyses demonstrated that the consequences of the accident or transient are acceptable and do not exceed the equipment design limits or safety limits. Therefore, this change cannot significantly increase the probability or consequences of an accident.

(2) Create the possibility of a new or different kind of accident from any previously analyzed. The design basis of the PPS is to initiate protective actions upon the occurrence of equipment failures, abnormal conditions and misoperation resulting in a potentially unsafe condition. This is accomplished by monitoring numerous equipment and system operating parameters. Applying an adequate margin to the settings of those variables for automatic protective functions ensures that equipment design basis limits and Safety Limits will not be exceeded. Therefore, this change does not create the possibility of a new or different kind of accident.

(3) Involve a significant reduction in a margin of safety. Accounting for instrumentation uncertainties in the determination of the Trip Setpoints of protective devices whose variables have a safety function, ensures conservatively that equipment design limits and safety limits are not exceeded. Analyses demonstrate that the protective trip function occurs at a value equal to or more conservative than the values assumed in the accident or transient analyses. While the new Analysis Values are less conservative than those currently assumed in the FSAR and the margin between the Analysis Value and Safety Limit has been reduced, the analyses in Section III show this reduction to not be significant. Equipment Design and Safety Limits are not compromised. Therefore, this change does not significantly reduce the margin of safety.

For those parameters where the instrumentation uncertainties applied challenged normal plant operation, new Analysis Values for which the trip and initiation of a protective action is assumed to occur in the Accident analyses was justified. While the new values as analyzed in the evalution (Section III) show increases in the consequences of the accident or transient (such as the amount of graphite oxidation, fuel temperatures, etc...), these changes are not significant and do not present an increase in the radiological consequences. The analyses demonstrated that the consequences of the accident or transient are acceptable and do not exceed the equipment design limits or safety limits. Therefore, this change cannot significantly increase the probability or consequences of an accident.

(2) Create the possibility of a new or different kind of accident from any previously analyzed. The design basis of the PPS is to initiate protective actions upon the occurrence of equipment failures, abnormal conditions and misoperation resulting in a potentially unsafe condition. This is accomplished by monitoring numerous equipment and system operating parameters. Applying an adequate margin to the settings of those variables for automatic protective functions ensures that equipment design basis limits and Safety Limits will not be exceeded. Therefore, this change does not create the possibility of a new or different kind of accident.

(3) Involve a significant reduction in a margin of safety. Accounting for instrumentation uncertainties in the determination of the Trip Setpoints of protective devices whose variables have a safety function, ensures conservatively that equipment design limits and safety limits are not exceeded. Analyses demonstrate that the protective trip function occurs at a value equal to or more conservative than the values assumed in the accident or transient analyses. While the new Analysis Values are less conservative than those currently assumed in the FSAR and the margin between the Analysis Value and Safety Limit has been reduced, the analyses in Section III show this reduction to not be significant. Equipment Design and Safety Limits are not compromised. Therefore, this change does not significantly reduce the margin of safety.