Department of Energy
Washington, D.C. 20545

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HQ:S:83:216

FEB 15 1983

Dr. J. Nelson Grace, Director
CRBR Program Office
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Dr. Grace:

ADDITIONAL INFORMATION ON THE CLINCH RIVER BREEDER REACTOR PLANT (CRBRP) INSTRUMENTATION AND CONTROLS

Enclosed is additional information on CRBRP instrumentation (Preliminary Safety Analysis Report (PSAR) Chapter 7) that was discussed in a February 1 telecon with the Nuclear Regulatory Commission (NRC) staff reviewer. Also enclosed are revised responses to NRC Questions CS421.15, 19, and 46. The enclosed PSAR pages will be included in the next amendment to the PSAR.

Any questions regarding the enclosed information may be addressed to Mr. R. Rosecky (FTS 626-6149) or Mr. A. Meller (FTS 626-6355) of the Project Office Oak Ridge staff.

Sincerely,

John R. Longenecker

John R. Longenecker
Acting Director, Office of
Breeder Demonstration Projects
Office of Nuclear Energy

Enclosures

cc: Service List
Standard Distribution
Licensing Distribution

D001
1/40

NRC CONCERN: Containment Monitoring Instrumentation is required to be manually connected to Class 1E power for operation.

RESOLUTION: This concern arises from misinterpretation of wording in CRBRP-3 which discusses manual initiation of TMBDB equipment. Section 2.2.13 of CRBRP-3 is being modified (attached) to clearly indicate that containment monitoring instrumentation will be on a Class 1E bus and is continuously energized. Additional information about manual initiation of TMBDB equipment is provided for informational purposes.

The containment monitoring system is part of the TMBDB equipment described in CRBRP-3. The rationale for manual initiation of TMBDB equipment is provided below:

CRBRP-3 Par. 2.1.2.12 states:

> "Operator action to initiate TMBDB systems operation is required only for events beyond the design base. However, misoperation of TMBDB systems, . . . could defeat Engineered Safety Features (ESFs) required to mitigate design basis accidents."

In order to preclude defeating ESFs coupled with the fact that TMBDB features are not required for the first 24 to 36 hours of the event, only manual initiation (see Operator Action Sequence), is required and provided, and all controls are under administrative control to prevent inadvertent actuation.

NOTE: Figure 9.6-5 of the PSAR is included as background information and will not be included in CRBRP-3.

Provisions for off-site monitoring are described in the TVA Radiological Emergency Plan, as discussed in Section 13.3.11 of the PSAR.

2.2.12.2.2 High-Range Containment Area Radiation

Three High-Range Containment Area Radiation Monitors are provided to indicate the radiation levels within containment to assist in determining actions to protect the public. These monitors have a seven decade range to 10^7 R/Hr gamma. The detectors are located approximately 120 degrees apart around the Reactor Containment Building periphery in the annulus space, to take advantage of the relatively benign environment. The monitors are classified as Safety Class 1E and powered from three independent divisions of power. All three monitors have continuous display in the Control Room and one channel is recorded. 1

2.2.13 Electrical Power System

The electrical power requirements for motors, controls, and instruments will be distributed as part of the Class 1E electric power system using the appropriate standards of quality assurance, structural support, and physical separation.

~~These loads will, however, be remote manually connected to the 1E power source from the control room after removing other loads which are not essential during TMBDB conditions.~~ InserT P

2.2.14 Containment Structures

As a result of the structural analysis of the containment building, a few changes in the design have been made to provide increased thermal margins. These include:

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TMBDB instrumentation is connected to Class 1E electrical power and is energized during both normal and emergency plant operation.

Other electrical loads for TMBDB features are connected to 1E electrical power supplies, however, remain de-energized. When the equipment is required to operate during the TMBDB event, it will be remote manually energized from the Control Room.

LIST OF TMBDB EQUIPMENT CONNECTED TO 1E POWER SUPPLY

EQUIPMENT TITLE

Containment Cleanup Scrubber Exhaust Fan 175B

Containment Cleanup Scrubber Exhaust Fan 175A

Containment Cleanup Scrubber Exhaust Fan Disch Valve 109A

Containment Cleanup Scrubber Exhaust Fan Disch Valve 109B

Containment Cleanup Scrubber Exhaust Fan Bypass Valve 108A

Containment Cleanup Scrubber Exhaust Fan Bypass Valve 108B

Annulus Cooling Fan 174A

Annulus Cooling Fan 174B

Annulus Cooling Fan 174C

Annulus Cooling Fan 174D

Annulus Cooling Fan 174E

Annulus Cooling Fan 174F

Annulus Cooling Fan Damper 1A

EQUIPMENT TITLE

Annulus Cooling Fan Damper 1B

Annulus Cooling Fan Damper 1C

Annulus Cooling Fan Damper 1D

Annulus Cooling Fan Damper 1E

Annulus Cooling Fan Damper 1F

Annulus Cooling Exhaust Damper 90A

Annulus Cooling Exhaust Damper 90B

Annulus Cooling Exhaust Damper 90C

Annulus Cooling Exhaust Damper 90D

Containment Purge Valve 19A

Containment Purge Valve 19B

Containment Purge Valve 19C

Containment Purge Valve 19D

Containment Vent Valve 106A

Containment Vent Valve 106B

Containment Vent Valve 106C

LIST OF TMBDB EQUIPMENT MANUALLY ENERGIZED FROM 1E POWER SUPPLY

EQUIPMENT TITLE

Containment Vent Valve 106D

Containment Vent Flow Control Valve 107A

Containment Vent Flow Control Valve 107B

Containment Cleanup Water Supply Pump A

Containment Cleanup Water Supply Pump B

All the above equipment is Class 1E and Seismic Category I.

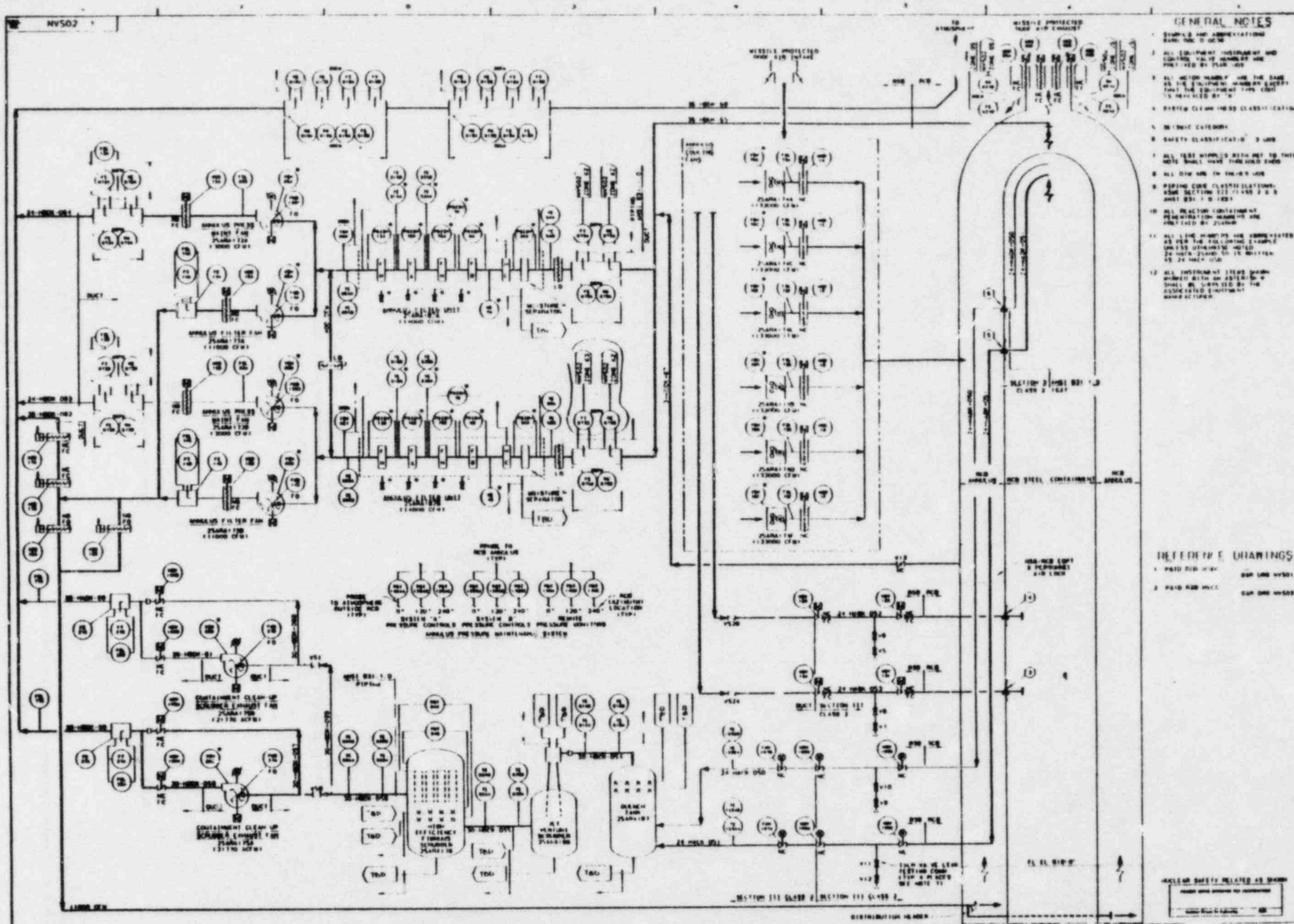

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FIGURE 9.6-5 P & I Diagram
RCB Annulus &
Cont. Clean-Up
HVAC

2.3 OPERATOR ACTION SEQUENCE

The operator action sequence following an HCDA would be as follows:

1. Shortly after the HCDA the various core and primary heat transport system instrumentation would indicate that some unidentified event has occurred, either because of readings outside the normal band or indications of failure of the instrumentation. The event might not be identifiable because the core and PHTS instrumentation is not designed to withstand an HCDA.

2. Immediately after the unidentified event, only actions such as those associated with design basis accidents would be taken in the short term. For instance, containment would isolate and the annulus filtration system would be activated when the radiation monitors sense an abnormal radiological release to containment. The operator would not perform any actions specifically related to TMBDB features.

3. In accordance with PSAR Section 13.3.3, NRC and the Tennessee Department of Public Health would be notified of the accident.

4. If materials are released to the reactor cavity following an HCDA, these releases would be expected to be monitored by radiation, temperature and pressure sensors in the reactor cavity in the short term. However, no operator actions with respect to TMBDB features are required or expected as a result of this information.

5. The operator would only act on information from the containment TMBDB instrumentation that indicates an increase in containment atmosphere pressure and temperature and the presence of hydrogen in the atmosphere that would challenge containment integrity. For design base events (not an HCDA), containment would not be challenged and the operator would not take any action to initiate operation of the TMBDB features.

6. No operator actions that would violate containment integrity (such as venting) or degrade the operation of Engineered Safety Features would be required or expected during the first 24 hours.

7. Beyond 24 hours, the operator would initiate operation of TMBDB features as required to maintain long term structural integrity of the containment. Detailed technical specifications and administrative controls will be included in the information provided for the operating license review. The following are typical of actions that would be taken by the operator:

   A. The annulus cooling system would be activated when the containment steel shell temperature reaches a prescribed value (~400 to 500°F). At this time the annulus filtration system (design base system) would be deactivated.

   B. The operator would vent containment through the TMBDB venting system when the pressure reaches a prescribed value (~15 to 20 psig), or the hydrogen concentration reaches a prescribed value (such that the concentration does not exceed 6% either before or after venting). Immediately preceding the containment venting, the cleanup system would be activated. (The TMBDB containment cleanup system is separate from the design base annulus filtration system). To accomplish these actions the TMBDB features would be manually energized from the 1E power supply system.

   C. When it is decided to vent the RCB, the Containment Vent isolation valves would be opened so that the pressure in the RCB can decrease to the atmospheric pressure.

   D. After the RCB has been depressurized, the Containment Cleanup System Exhaust blowers would be turned on and the purge isolation valves opened. The cleanup system exhaust blower would produce a suction to pull purge air through the containment.

E. When the gases released from concrete and the reactions in containment cease, the venting, purging, and cleanup systems operation could be terminated.

F. When the containment steel shell temperature falls below 200°F, the operation of the annulus cooling system could be terminated.

The results of analyses in Section 3 indicate that activation of TMBDB features by operator action would not be required for about 36 hours (although permitted after 24 hours) following an HCDA. Because of the long time available before operator action would be required, the actions are not sensitive to variations in the scenario, such as reactor vessel penetration times ranging from 100 to 10,000 seconds.

NRC CONCERN: The non-1E classification of certain Recirculating Gas Subsystems needs clarification.

RESPONSE: Revised Section 9.16. Paragraph 9.16.3 is attached clarifying non-safety classification and use of non-1E power. Recirculating Gas Subsystems PA, PB, PC, CR, CT, RC, EC, ET and FH are non-1E and their operation is not required for safe shutdown of the plant.

9.16.2.9 EVS Loop 3 - Subsystem EC

The subsystem EC consists of one 100% cooler and one 100% fan, is shown in Figure 9.16-6 and cools the third EVS Na Loop cell which uses natural convection to circulate the EVS sodium.

Separate cooling subsystems are provided to ensure that any accident in any one of the three EVS sodium cooling loops will be confined to that loop only.

9.16.2.10 Ex-Vessel Storage Tank (EVST) Cavity - Subsystem ET

The subsystem ET consists of one 100% cooler and one 100% fan, is shown in Figure 9.16-7 and cools the EVST cavity and the EVST support ledge.

The supply and return gas piping is embedded in shielding concrete blocks along the West wall and below the floor of the EVST cell. The main supply gas is discharged in the center of the cell below the guard vessel.

This stream in passing through several holes along the side of the guard vessel support skirt cools it to keep the temperature at the guard vessel support embedments within the allowable limits. Additionally, two supply gas branches supply gas below the entire circumference of the EVST vessel support ledge. The return gas is collected over the EVST vessel support ledge area as well as at high points within the cavity. The return gas is drawn by a fan through the cooler and supplied back to EVST.

The cooling function at the subsystem ET is non-safety related and hence piping is designed to the requirements of ANSI B31.1. However, a portion of the piping which may be below the sodium pool level in case of a sodium leak, is designed to the requirement of ASME Section III, Class 3 to prevent Na/concrete reaction.

9.16.2.11 Fuel Handling Cell (FHC) - Subsystem FH

The subsystem FH consists of two 100% coolers and two 100% fans, is shown in Figure 9.16-7 and cools the FHC cell, spent fuel and the cell equipment. The RGCS subsystem terminates at the FHC manifolds. Recirculation and distribution of cooled argon gas is addressed in Section 9.1.3.2.

A separate subsystem is used because the recirculated gas is argon and the coolant is Dowtherm J. This subsystem has redundant coolers. The two Dowtherm J loops serving the two coolers are, in turn, cooled by the two emergency chilled water supplies. The redundancy in the cooling system is provided for plant personnel safety and plant availability reasons.

9.16.3 Safety Evaluation

The non-safety related subsystems are classified as Safety Class "None" and are designated in Table 9.16-1 as having no safety classification. Loss of cooling to the area served by these subsystems due to loss of normal electrical power will not result in loss of capability to bring the plant to safe shutdown condition. Hence, these subsystems are supplied with normal electric power.

Enclosure 3

NRC CONCERN: Provide additional information about SSPLS including a listing of equipment controlled by SSPLS

RESOLUTION: A revised response to question 421.15 is attached. A list of equipment controlled by SSPLS is provided for informational purposes.

Question CS421.15

Identify and document where microprocessors, multiplexers, or computer systems may be used in or interface with safety-related systems.

Response

Many microprocessors, multiplexers, and computers are used in CRBRP systems; however, in general, they are used in non-Class 1E applications. Whenever a microprocessor, multiplexer or computer acquires a Class 1E signal, that signal is isolated by a qualified Class 1E isolator before being utilized by a non-Class 1E system.

The two systems which use microprocessors, multiplexers or computers for Class 1E applications are the Solid State Programmable Logic System (SSPLS) and the Radiation Monitoring System. Information about these systems is provided below. The Plant Data Handling and Display System (PDH&DS) is the largest computer system used in the plant. Information about this system is also provided below.

The Radiation Monitoring System has Remote Processor Stations which are microporcessor based, radiation monitoring electronic and communication assemblies. PSAR Paragraph 11.4.2.1 describes the Remote Process Stations. The microprocessor receives raw count rate and process system data, and manipulates the data into the desired form. Data exchange and monitor control is via channel dedicated multiplexed signal paths. Non-Class 1E equipment cannot exercise control over a Class 1E radiation monitor. Any data extracted from the Class 1E monitors for use in non-Class 1E equipment is via Class 1E grade buffers.

The Solid State Programmable Logic System controls and actuates Safety-Related, Class 1E equipment. It contains the control logic, signal conditioners, isolation devices, and auxiliary circuits. The SSPLS can potentially use microprocessor based circuitry. PSAR Paragraph 8.3.1.1.2 describes the SSPLS.

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The CRBRP Plant Data Handling and Display System (PDH&DS) is a non-safety-related microprocessor based system that interfaces with safety-related systems and non-safety-related systems as well for the purpose of retrieving data for operator information. The system provides for information display and data handling, inoperable status monitoring of safety systems and emergency response facility data display. In all cases, Class 1E grade buffers are used for isolation between the PDH&DS and safety-related systems. The PDH&DS is described in PSAR paragraph 7.8.

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The solid state programmable logic system (SSPLS) can potentially use microprocessor based circuitry for control of safety-related equipment. Multiplexers and computers are not used in SSPLS.

The SSPLS will be utilized to control categories of equipment from the control room and remote shutdown panels such as: Circuit breakers and contactors for motors, chillers, solenoid valves, etc.

The SSPLS will receive manual inputs from the control pushbuttons and inputs from the field and other equipment for control of each device. The SSPLS will perform the necessary logic operations and interlocking functions and provide final outputs to each piece of equipment to be controlled. It contains control logic, signal conditioners, Class 1E to non-Class 1E isolation devices, power supplies and auxiliary circuits. The SSPLS equipment will be qualified to IEEE Standards 279-1971, 323-1974, 344-1975 and 383-1974 as required for all Class 1E equipment. The SSPLS is comprised of three (3) separate and functionally redundant safety-related divisions such that the failure of one division will not affect any component or equipment of the other two divisions. Equipment of different safety divisions are located in separate cells of the plant. Each of the three safety divisions has the capability to safely shutdown the plant. In addition, each functional circuit has been provided with dedicated components such that a circuit or component failure will only affect the operation of a single equipment. This will be achieved whether discrete logic components or microprocessors are used in the design of the SSPLS system.

Microprocessors, if used, will be tested and qualified to meet all requirements applicable to Class 1E equipment as described above. In addition, the microprocessor based circuitry will be dedicated to control only one device so that failure of the microprocessor will not affect the failure of any other controlled component.

When microprocessor based systems are used, they will meet the following requirements:

Modules using microprocessors shall be capable of being tested on a discrete basis.

SSPLS cards shall not use multiplexing.

Each microprocessor shall be furnished with continuous self-diagnostic capability to interrogate its function.

SSPLS will be designed for maximum reliability and availability. SSPLS availability for each device channel shall be 99.9955%. In determining device channel availability, a device channel failure is defined as the inability of the SSPLS to initiate equipment actuation signals and associated status indication signals in response to any input command.

A description of the transfer of SSPLS controls is given below.

Each SSPLS cabinet shall be provided with one Master Transfer Switch (MTS) and Individual Transfer Switches (ITS) for each individual equipment to be controlled.

The Master Transfer Switch will permit the transfer of control of all the associated equipment from Control Room to the local control panels and vice versa.

The Individual Transfer Switch will permit the transfer of control of individual equipment from the Control Room to the local control panel and vice versa.

In order to control individual equipment from a remote location, both MTS and ITS must be in the remote position.

Similarly, in order to control individual equipment from a local station, ITS must be in local position.

Irrespective of the type of hardware used (discrete components or microprocessor), the channel information is processed to the end actuator and each piece of the process is testable on a periodic basis to demonstrate integrity. This includes any manual actuation functions supplied by the system to insure compliance with IEEE 279. If microprocessor based circuitry is used, the software used to implement the microprocessor logic will also be testable. The software used will be subjected to verification and validation and will meet the requirements of IEEE 730-1981 (Standards for Software Quality Assurance Plans). The features provided for periodic testing can also be used to operate the equipment manually.

Also, in the unlikely event of a random failure of the SSPLS control circuitry for any device controlled by one SSPLS safety division, the ability to initiate the redundant device in the other SSPLS safety divisions will not be affected.

LIST OF SOLID STATE

PROGRAMMABLE LOGIC SYSTEM CIRCUITS

SYSTEM	DESCRIPTION		VOLTAGE	SAFETY DIVISION
Power Dist. System	Bus 3A	Undervoltage Monitoring	4.16 KV	1
↓	↓	Off-Site Voltage Mon.	↓	↓
		Aux. Transf. Inc. Bkr.		
		Res. Transf. Inc. Bkr.		
		Diesel Gen. DG-A Control		
		Diesel Gen. DG-A Bkr.		
		Diesel Gen. DG-A Sequencer		
		USS 27A FDR		
		USS 28A FDR		
		USS 32A FDR		
		USS 33A FDR		
	Bus 3B	Undervoltage Monitoring		2
	↓	Off-site Voltage Mon.		↓
		Aux. Transf. Inc. Bkr.		
		Res. Transf. Inc. Bkr.		
		Diesel Gen. DG-B Control		
		Diesel Gen. DG-B Bkr		
		Diesel Gen. DG-B Sequencer		
		USS 27B FDR		
		USS 28B FDR		
		USS 32B FDR		
		USS 33B FDR		
	USS 27A	Undervoltage Monitoring	480 V	1
	↓	Main Bkr.	↓	↓
		MCC 42A FDR		
		MCC 60A FDR		

SYSTEM	DESCRIPTION		VOLTAGE	SAFETY DIVISION
Power Dist. System	USS 28A	Undervoltage Monitoring	480 V	1
		Main Bkr.		
		MCC 40A FDR		
		MCC 50A FDR		
		MCC 52A FDR		
	USS 32A	Undervoltage Monitoring		
		Main Bkr.		
		MCC 41A FDR		
		MCC 58A FDR		
	USS 33A	Undervoltage Monitoring		
		Main Bkr.		
		MCC 51A FDR		
	USS 27B	Undervoltage Monitoring		2
		Main Bkr.		
		MCC 42B FDR		
		MCC 60B FDR		
	USS 28B	Undervoltage Monitoring		
		Main Bkr.		
		MCC 40B FDR		
		MCC 50B FDR		
		MCC 52B FDR		
	USS 32B	Undervoltage Monitoring		
		Main Bkr.		
		MCC 41B FDR		
		MCC 58B FDR		
	USS 33B	Undervoltage Monitoring		
		Main Bkr.		
		MCC 51B FDR		

SYSTEM	DESCRIPTION	VOLTAGE	SAFETY DIVISION
Emergency Chilled Water System	Emerg. Chiller 1A	4.16 KV	1
	Emerg. Chiller 1B		2
	Emerg. Chiller Wtr. Pump 2B	480 V	2
	Emerg. Chiller Wtr. Pump 2A		1
	Chilled Water Dowtherm J Pump 6A		3
	Chilled Water Dowtherm J Pump 6B		3
	ISMS CAB 91AAB019		2
	ISMS CAB 91AAB019		1
	AOV 141AB	120 V	2
	AOV 141AD		2
	AOV 141BB		2
	AOV 141BD		2
	AOV 13 & 23A		1
	AOV 19A & 22A		1
	AOV 13B & 23B		2
	AOV 18B, 19B & 22B		2
	AOV 304A		1
	AOV 304B		2

SYSTEM	DESCRIPTION	VOLTAGE	SAFETY DIVISION
HVAC System	RSB UCA137 Fan K137	480 V	2
	RSB Filter Unit A184A Fan K185A		1
	RSB Filter Unit A184B Fan K185A		2
	RSB Filter Unit A104A Fan K104A		1
	RSB UCA104B Fan K104B		2
	RSB UCA133 Fan K133		1
	RSB UCA134 Fan K134		2
	RSB UCA145 Fan K145		2
	RSB UCA132 Fan K132		2
	RSB Unit Clr. A139A Fan K139A		1
	RSB Unit Clr. A139B Fan K139B		2
	RSB Unit Clr. A142A Fan K142A		1
	RSB Unit Clr. A142B Fan K142B		2
	RSB Unit Clr. A143 Fan K143		1
	RSB Unit Clr. A146 Fan K146		1
	RSB Unit Clr. A138 Fan K138		1
	RSB Filt. Unit A184A Isln. Dampers	120 V	1
	RSB Filt. Unit A184B Isln. Dampers		2
	RSB AHU A184A A0D032A, 33A, 262A		1
	RSB AHU A184A A0D263, 264, 265A		1
	RSB AHU A184B A0D32B, 33B, 262B		2
	RSB AHU A184B A0D263B, 264B, 265B		2
	RSB AHU A184A MOD 186A & 203A		1
	RSB Filter Unit A184A MOD 197A & MOD200A		1
	RSB Filter Unit A184A & B FMD196A & MOD 269A		1
	RSB Filter Unit A184B FMD196B & MOD 269B		2
	RSB Filter Unit A184B MOD 186B & MOD 203B		2

SYSTEM	DESCRIPTION	VOLTAGE	SAFETY DIVISION
	RSB Filter Unit A184B MOD197B & 200B	120	2
	RSB Filter Unit A184A FMD196A & MOD 269A		1
	RSB Filter Unit A184B FMD 196 B & MOD 269B		2
	ECT H&V Unit Supply Fan K100A	480 V	1
	ECT H&V Unit Supply Fan K100B		2
	ECT H&V Unit A100A TMD002AA & 002AB	120 V	1
	ECT H&V Unit A100B TMD002BA&002BB		2
	CB ACU A412 Supply Fan K412	480 V	2
	CB ACU A410A Supply Fan K410A		1
	CB ACU A410B Supply Fan K410B		2
	CB ACU A411 Supply Fan K411		1
	CB ACU A411 Supply Fan K452		1
	CB Filter Unit A471A Supply Fan K441A		1
	CB Filter Unit A471B Supply Fan K441B		2
	CB Control Rm Return Air Fan K451A		1
	CB ACU A412 Return Fan K453		2
	CB Battery Rm. Exh. Fan K461		2
	CB Battery Rm. Exh. Fan K462		1
	CB Control Rm. Return Air Fan K451B		2
	CB Battery Rm. Exh. Fan K464		2
	CB Battery Rm. Exh. Fan K463		1
	CB ACU A410B MOD057B &077B	120 V	2
	CB ACU A410A MOD 057A &077A		1
	CB Filter Unit A471B Damper MOD 167B		2
	CB Filter Unit A471A Damper MOD 167A		1
	CB Intake Isln. V AOV 122A		1

SYSTEM	DESCRIPTION	VOLTAGE	SAFETY DIVISION
	CB Exh. Isln V A0V064A	120 V	1
	CB Intake Isln V A0V123A		1
	CB Intake Isln V A0V122B		2
	CB Exh Isln V A0V064B		2
	CB Intake Isln V A0V123B		2
	CB Intake Isln V MOV047A		1
	CBIntake Isln V MOV104A		1
	CB Intake Isln V MOV047B		2
	CB Intake Isln V MOV104B		2
	CB Filter Unit A471A MOD076A		1
	CB Filter Unit A471B MOD076B		2
	CB Filter Unit A410B MOD075BA & BB		2
	CB ACU A410A MOD075AA & AB		1
	CB ACU A410B PMD056BA & BB		2
	CB ACU A410A PMD056AA & AB		1
	CB Fans K465 & K467 AOD169		2
	CB Fans K465 & K467 A0D168		1
	CB Filter Unit A471A FMD072A		1
	CB Filter Unit A471B FMD072B		2
	RCB Annulus CLG Fan K174A	480 V	1
	RCB Annulus CLG Fan K174C		1
	RCB Annulus CLG Fan K174E		1
	RCB Annulus CLG Fan K174B		2
	RCB Annulus CLG Fan K174D		2
	RCB Annulus CLG Fan K174F		2
	RCB Scrubber EXH Fan K175A		1
	RCB Scrubber EXH Fan K175B		2
	RCB Annulus Filter Fan 173A		1
	RCB Annulus Filter Fan K173B		2
	RCB Annulus Fan K172A		1
	RCB Annulus Fan K172B		2
	RCB Unit Cooler A021 Supply Fan K021		1

SYSTEM	DESCRIPTION	VOLTAGE	SAFETY DIVISION
↓	RCB Unit Cooler A022 Supply Fan K022	480	2
	RCB Unit Cooler A023 Supply Fan K023	↓	1
	RCB Scrubber Exh Fan K175A		1
	RCB Annulus CLG Fan K174A		1
	RCB Annulus CLG Fan K174C		1
	RCB Annulus CLG Fan K174E		1
	RCB Annulus CLG Fan K174F		2
	RCB Scrubber Exh Fan K175B		2
	RCB Annulus CLG Fan K174B		2
	RCB Annulus CLG Fan K174D		2
	RCB Exh Fan A175A FMD027A		1

SYSTEM	DESCRIPTION	VOLTAGE	SAFETY DIVISION
5A	RCB Annulus Filter A182A AOD017A	120	1
	RCB Annulus Filter A182A AOD018A	120	1
	RCB Annulus Filter A182B AOD017B	120	2
	RCB Annulus Filter A182B AOD018B	120	2
	RCB Containment Purge Valves MOV019A, 19C	480	1
	RCB Containment Purge Valves MOV019B & 19D		2
	RCB Containment Vent Valve MOV106A		1
	RCB Containment Vent Valve MOV106B		2
	RCB Containment Vent Valve MOV106C		1
	RCB Containment Vent Valve MOV106D		2
	RCB Containment Vent Valve FMV107A	120	1
	RCB Containment Vent Valve FMV107B	120	2
	RCB Annulus Fan A172B MOD015B & PMD 138B	480	2
	RCB Annulus Fan A172A MOD015A & PMD 138A		1
	RCB Annulus Fan A172A FMD014A & MOD016A		1
	RCB Annulus Fan A173B FMD014B & MOD016B		2
	RCB CLG Fan A174A, C, E, MOD001A, 001C, 001E		1
	RCB CLG Annulus CLG Sys MOD090A, 090C		1
	RCB Annulus CLG Sys MOD090B & 090D		2
	RCB CLG Fan A174B, D, F MOD001B, 001D & 001F		2
	RCB EXH FAN A175A MOV108A, 109A		1
	RCB EXH FAN A175B MOV108B & 109B		2
	RCB EXH FAN A175B, FMD027B	120	2
	DGB Room A Emer Sply Fan K341	480	1
	DGB Room A Emer Sply Fan K341B		1
	DGB Room B Emer Sply Fan K342A		2
	DGB Room B Emer Sply Fan K342B		2

SYSTEM	DESCRIPTION	VOLTAGE	SAFETY DIVISION
	DGB Sply Fan K341A&B MOD002A & 002B	480	1
	DGB Sply Fan K341A&B TMD001A & TMD001C		1
	DGB Sply Fan K341A&B TMD001B & TMD001D		2
	DGB Sply Fan K342A&B TMD008A & 008C		2
	DGB Sply Fan K342A&B TMD008B & 008D		2
	DGB Sply Fan K342A&B MOD010A & MOD010B		2
	SGB UC A221A Fan K221A		1
	SGB UC A221B Fan K221B		2
	SGB UC A222A Fan K222A		1
	SGB UC A222B Fan K222B		2
	SGB UC A223A Fan K223A		1
	SGB UC A223B Fan K223B		2
	SGB AHU A204 Supply Fan K244A		2
	SGB AHU A204 Supply Fan K244B		2
	SGB AHU A201 Exhaust Fan K261A		1
	SGB AHU A201 Exhaust Fan K261B		1
	SGB AHU A202 Exhaust Fan K262A		2
	SGB AHU A202 Exhaust Fan K262B		2
	SGB AHU A203 Exhaust Fan K263A		1
	SGB AHU A203 Exhaust Fan K263B		1
	SGB AHU A204 Supply Fan K264A		2
	SGB AHU A204 Supply Fan K264B		2
	SGB AHU A206 Supply Fan K249A		1
	SGB AHU A206 Supply Fan K249B		1
	SGB AHU A206 Exhaust Fan K267A		1
	SGB AHU A206 Exhaust Fan K267B		1
	SGB UC A237A Fan K237A		1
	SGB UC A237B Fan K237B		2
	SGB UC A237C Fan K237C		1

SYSTEM	DESCRIPTION	VOLTAGE	SAFETY DIVISION
	SGB AHU A203 MOD47A, 56A & 56B	120	1
	SGB Loop 1 Supply Fan K241A	480	1
	SGB Loop 1 Supply Fan K241B		1
	SGB Loop 2 Supply Fan K242A		2
	SGB Loop 3 Supply Fan K243A		1
	SGB Loop 3 Supply Fan K243B		1
	SGB AHU A206 Damper Control	120	1
	SGB AHU A204 Damper Control		2
	SGB AHU A206 TMD196B,C,D & E		1
	SGB AHU A204 MOD095A & 095B		2
	SGB AHU A206 TMD196B,C,D & E		1
	SGB AHU A206 MOD200A&B		1
	SGB Loop 2 Supply Fan K242B	480	2
	SGB AHU A204 MOD072A, 082A & 082B	120	2
	SGB AHU A206 MOD196A, SOV092A&B		1
	SGB AHU A204 MOD072A, 082A, 082B		2
	SGB AHU A204 TMD110, SOV071A&B		2
	SGB AHU A203 MOD047A, 056A & 056B		1
	SGB AHU A202 Damper Control		2
	SGB AHU A203 Damper Control		1
	SGB AHU A203 SOV164A&B, TMD175		1
	SGB AHU A202 Damper TMD174		2
	SGB AHU A206 MOD198A&B		1
	SGB Exhaust Fan A263A&B, MOD058A&B		1
	SGB AHU A203 TMD047B,C,D & E		1
	SGB AHU A201 Damper Control		1
	SGB Loop 1 Supply Fan K241A	480	1
	SGB Loop 1 Supply Fan K241B		1
	SGB Loop 2 Supply Fan K242A		2
	SGB Loop 2 Supply Fan K242B		2

SYSTEM	DESCRIPTION	VOLTAGE	SAFETY DIVISION
↓	SGB Loop 3 Supply Fan K243A	480	1
	SGB Loop 3 Supply Fan K243B	480	1
	SGB AHU A206 TMD238	120	1
	SGB AHU A201 TMD173, SOV159A&B	↓	1
	SGB AHU A203 TMD047B,C,D & E		1
	SGB Exhaust Fan A262A&B, MOD036A&B		2
	SGB AHU A202 TMD025B,C,D & E		2
	SGB Exhaust Fan A261A&B, MOD012A&B		1
	SGB AHU A201 TMD001B,C,D & E		1
	SGB Supply Fan K241A&B, MOD010A, 010B & 1A		1
	SGB Supply Fan A242A&B, MOD033A&B, 025A		2
	SGB AHU A203 TMD047B,C,D & E		1
	SGB AHU A204 TMD072B,C,D & E		2

SYSTEM	DESCRIPTION	VOLTAGE	SAFETY DIVISION
	Fire Pump 4A	480	1
Fire Protection System	Fire Pump 4B	↓	2
↓	MOV121A	↓	1
↓	MOV121B	↓	2
↓	MOV141	↓	2
↓	MOV269	↓	1
↓	MOV207	↓	1
↓	MOV362	↓	1
↓	MOV303	↓	2

SYSTEM	DESCRIPTION	VOLTAGE	SAFETY DIVISION
Recirculating Gas Cooling System	EVST Loop 1 ISLN V 23ECNV040 & 410	120	1
	Na Mkup Pp & Pipeways Isln V NV001A&B		1
	Na Mkup Pp & Vessels Isln V 23ECNV353 & 354		2
	Na Mkup Pp & Pipeways Isln V 23ECNV400 & 401		1
	EVST Loop 2 Isln V 23ECNV403		2
	EVST Loop 1 Fan K001	480	1
	EVST Loop 2 Fan K001	480	2
	Na Mkup Pp & Pipeways Fan K001		1
	Na Mkup Pp & Vessels Fan K001		2
	EVST Loop 2 Isln V NV001A & B	120	2
	Na Mkup Pp & Vessels Isln V NV001A&B		2
	EVST Loop 1 Isln V NV001A&B		1
	Na Mkup Pp/Pipeways Na Leak Detector		1

SYSTEM	DESCRIPTION	VOLTAGE	SAFETY DIVISION
Reactor Heat Transport System	PHTS Pony Motor 201A	480	1
↓	IHTS Pony Motor 201A	↓	1
↓	IHTS Pony Motor 201B	↓	2
↓	PHTS Pony Motor 201B	↓	2
↓	IHTS BRG Fan 112A	↓	1
↓	PHTS BRG Fan 112A	↓	1
↓	IHTS BRG Fan 112B	↓	2
↓	PHTS BRG Fan 112B	↓	2
↓	IHTS BRG Fan 112C	↓	3
↓	PHTS BRG Fan 112C	↓	3
↓	IHTS Pony Motor 201C	↓	3
↓	PHTS Pony Motor 201C	↓	3

SYSTEM	DESCRIPTION	VOLTAGE	SAFETY DIVISION
Plant Service Water System	Emerg Plant SVCE Clg Twr Fan K002A	480	1
	Emerg Plant SVCE Clg Twr Fan K002B		2
	Emerg Plant SVCE Clg Twr Fan K002C		1
	Emerg Plant SVCE Clg Twr Fan K002D		2
	Emerg Plant SVCE Clg Twr Fan K002E		1
	Emerg Plant SVCE Clg Twr Fan K002F		2
	Emerg Plant SVCE Wtr Pump K001A		1
	Emerg Plant SVCE Wtr Pump K001B		2
	Emerg Plant SVCE Mk Up Pump K002A		1
	Emerg Plant SVCE Mk Up Pump K002B		2

SYSTEM	DESCRIPTION	VOLTAGE	SAFETY DIVISION
Aux Liquid Metal System	Aux Liquid Metal Panel 2A Fdr	480	1
	Aux Liquid Metal Panel 2B Fdr	↓	2

LIST OF ACRONYMS

AUX - Auxiliary

AOV - Air Operated Valve

AOD - Air Operated Damper

ACU - Air Conditioning Unit

AHU - Air Handling Unit

BRG - Bearing

CB - Control Building

CLG - Cooling

DGB - Diesel Generator Building

EVST - Ex-Vessel Storage Tank

ECT - Emergency Cooling Tower

FDR - Feeder

FMD - Flow Control Motor Operated Damper

EXH - Exhaust

INC - Incoming

ISMS - Inoperable Status Monitoring System

ISLN - Isolation

IHTS - Intermediate Heat Transport System

MCC - Motor Control Center

MOD - Motor Operated Damper

MG - Motor Generator

MOV - Motor Operated Valve

MK UP - Make Up

Na - Sodium

PHTS - Primary Heat Transport System

List of Acronyms, Continued

PP - Pump

RES - Reserve

RSB - Reactor Service Building

RCB - Reactor Containment Building

RM - Room

SGB - Steam Generator Building

SOV - Solenoid Operated Valve

SVCE - Service

TMD - Temperature Control Motor Operated Damper

TWR - Tower

UC - Unit Cooler

USS - Unit Sub-Station

WTR - Water

Enclosure 4

NRC CONCERN: The staff requires the applicant to provide a definitive statement that the single event that causes multiple control system failures (failure or malfunction of shared power sources, or common sensors), concurrent with a protection channel in test, and any additional single random failure within the protection system will not result in consequences more severe than those acceptable on CRBR for anticipated operational occurrences.

RESOLUTION: The response to question 421.19, which addresses multiple control system failures, has been reviewed and it has been determined that the statement requested in the concern can be made. The revised response to 421.19 is attached.

Question CS421.19

A number of concerns have been expressed regarding the adequacy of safety systems in mitigation of the kinds of control system failures that could actually occur at nuclear plants, as opposed to those analyzed in PSAR Chapter 15 safety analyses. Although the Chapter 15 analyses are based on conservative assumptions regarding failures of single control systems, systematic reviews have not been reported to demonstrate that multiple control system failures beyond the Chapter 15 analyses could not occur because of single events. Among the types of events that could initiate such multiple failures, the most significant are in our judgement those resulting from failure or malfunction of power supplies or sensors common to two or more control systems.

To provide assurance that the design basis event analyses adequately bound multiple control system failures you are requested to provide the following information:

1) Identify those control systems whose failure or malfunction could seriously impact plant safety.

2) Indicate which, if any, of the control systems identified in (1) receive power from common power sources. The power sources considered should include all power sources whose failure or malfunction could lead to failure or malfunction of more than one control system and should extend to the effects of cascading power losses due to the failure of higher level distribution panels and load centers.

3) Indicate which, if any, of the control systems identified in (1) receive input signals from common sensors, common hydraulic headers, or common impulse lines.

The PSAR should verify that the design criteria for the control systems will be such that simultaneous malfunctions of control systems which could result from failure of a power source, sensor, or sensor impulse line supplying power or signals to more than one control system will be bounded by the analysis of anticipated operational occurrences in Chapter 15 of the Final Safety Analysis Report.

Response

The design criteria for the Plant Protection System requires that control system malfunctions do not as a consequence compromise the capability of plant systems to maintain the plant in a safe condition. Accordingly, the Plant Protection System has been designed to provide continuing protection in the event of control system failures and malfunctions. The Plant Protection System is designed as a safety related system and includes redundant instrument channels, qualified to safety grade requirements. Where control actions are accomplished by plant control systems, functions important to safety are monitored through the Plant Protection System. Thus, the Plant Protection System through its redundant sensory channels will sense and respond appropriately to the consequential effects of control system failures or malfunctions. This includes failures or malfunctions within one control system that directly affect the functioning of other control systems, e.g., loss of a power supply common to several control systems, or shared sensor inputs.

Evaluation of the application of these design criteria applied to CRBRP Plant Protection System and Plant Control System involves analysis of postulated events which could propagate the effects of failures or malfunctions through more than one control system. Events which are considered to cause or result in such propagation are:

1) Loss of a single instrument

2) Break of a single instrument line

3) Loss of power supply for all systems provided from a common power source (e.g., a single inverter supplying several systems).

CRBRP control systems which may affect functions important to safety are:

A) Supervisory Control
B) Reactor Control
C) PHTS and IHTS Sodium Flow Control
D) PHTS and IHTS Pump Speed Control
E) Steam Drum Level Control
F) Turbine Control
G) Bypass Valve Control

Analysis of such events have been conducted for the control systems above. These analyses show that for postulated events considered in 1) thru 3) above the plant is maintained in a safe condition and no conditions result which are worse than those addressed in the PSAR Chapter 15, Accident Analyses.

Insert

The analyses assume initial conditions to be anywhere within the full operating power range of the plant (i.e., 0-100%), where applicable.

The results of the analyses indicate that, for any of the postulated events considered in 1) thru 3) above, the accident analyses in Chapter 15 of the PSAR are bounding.

Insert

"Control system failures (including malfunctions of shared power sources or common sensors), which cause plant transients requiring reactor shutdown system action, will be terminated by the shutdown system within the CRBR limits for anticipated operational occurrences. This includes the condition of a protection channel in test and any additional single random failure within the reactor shutdown system."

Loss of Any Single Instrument

Median select circuits are used by most of the control systems itemized above to provide the median (or middle) of three sensors as the control feedback signal. For systems using median select circuits the failure of one sensor will not result in loss of control. The analysis in this section, however, goes beyond a sensor failure for these systems and considers a failure in the controller circuitry such that the feedback signal fails high or low. Table 1, Loss of Any Controller Feedback Signal, is an evaluation of the effect on the control systems and the plant caused by loss of the feedback signal either high or low. For control action in the unsafe direction, the bounding PSAR accident is listed. Where no control action occurs or where control action is in a safe direction, no bounding accident is given. This table clearly shows that for the feedback signal failing high or low, events in Chapter 15 of the PSAR are bounding. Control systems that don't use median select circuits are discussed below.

The turbine EHC speed control as well as primary and intermediate pump speed control systems use auctioneering circuits rather than a median select circuit. The circuits are designed such that one sensor failure will not affect control. Two failures are required for loss of the control function. Even though one sensor failure has no effect, this analysis considers failure of the feedback signal high or low. Plant effects and bounding events are given in Table QCS421.19-1.

The turbine EHC flow control and bypass valve position control systems do not use median select circuits but rather single sensors for the feedback signal. For these systems the failure of one sensor will result in a plant disturbance. Plant effects and the bounding event for failure of the feedback signal high or low is provided in Table QCS421.19-1.

The analysis in Table 1 also covers the case of a sensor failure while testing a redundant PPS channel. Control systems that use buffered PPS signals all have median select circuits. For the worst case, the median select circuit would choose one of the failed input signals as the controller feedback. The resulting transient is the same as that in Table 1 where the feedback signal downstream of the median select is assumed to be failed high or low.

Common Sensors Used By Control Systems

There are two cases where common sensors are used by control systems. The Supervisory Control and Bypass Valve Pressure Control systems both use pressure sensors in the main steam header. Each system has its own median select circuit, and the two systems are not in operation at the same time, therefore, failure of a common sensor will not result in loss of control.

The second case involves the Supervisory and Steam Drum Level Control systems. Both systems use superheater steam flow sensors and a common median select circuit in each loop. Since median select circuits are used in each loop, the failure of a single sensor will not result in loss of control in either control system. In the event the median select circuit fails low, the NSSS power is reduced by the supervisory controller and feedwater in the affected loop is reduced by the drum level controller. A reactor scram and SGAHRS initiation results due to low drum level. The bounding event is Loss of Normal Feedwater (PSAR Section 15.3.1.6). In the event the median select fails high, NSSS power is increased but limited to 100% power by a reactor control limiter and feedwater increases until a high drum level condition results in isolation of the main feedwater and a reactor trip. The Chapter 15 bounding event is not applicable for this case.

Break of Any Single Instrument Line

The break of an instrument line common to more than one control system is not applicable to CRBRP. There are only two cases in which sensors are common to more than one control system and the common point is at the transmitter or median select output. These two cases were addressed in the previous section.

Loss of Power to a Protection Separation Group

This section analyzes the effects on the control systems caused by the loss of an inverter powering a protection channel. If the bus to protection channel A, B or C fails low, then the affected PPS channel will trip and the following PPS buffered signals used by the control systems will drop to zero: Channel A, B or C corresponding to the failed bus for reactor flux, primary sodium flow, intermediate sodium flow, steam drum level, superheater steam flow and feedwater flow. Since median select circuits are used to provide the median of the three buffered PPS signals as the controller feedback signal, there will be no loss of control and no effect on the plant. Chapter 15 accident analysis is not applicable.

The following describes the effects in the event power is lost to a redundant protection channel while a PPS channel is under test:

1) If an inverter fails with power lost to the PPS logic, the channel under test is tripped during test satisfying the 2/3 trip logic, and a reactor scram will occur.

2) If a bus fails such that power is lost to a sensor or transmitter but not to the PPS logic, the controller feedback signal in the worst case will be low as a result of two input signals low. (One due to power failure and one due to channel test condition.

Loss of Power to Control Systems

This section examines the effects on the control systems caused by loss of a bus powering these systems. Most of the control systems are supplied by primary and alternate sources of power and have redundant power supplies in the cabinets. The alternate power source will supply power in the event of a failure of the primary source. Thus, total loss of power requires failure of both power sources and is unlikely. For these control systems, loss of one supply will not result in loss of the control function and the Chapter 15 accident analysis, therefore, is not applicable. Control systems that are powered from one source are discussed below.

For the primary rod controller, there is some circuitry that is not powered from redundant supplies. In the event Non-1E UPS system A bus fails low, all rod position displays will be lost and rod movement in group or single modes will be inhibited. No plant disturbance results since primary rods are powered from redundant MG sets and remain stationary. Plant operation will proceed in accordance with technical specification limits.

For the primary and intermediate speed control systems, loss of either Non-Class 1E 13.8 KV, 480 VAC or 120 VAC buses feeding the pump drive equipment will lead to a pump trip followed by a reactor scram. The bounding event is Spurious Primary Pump Trip (PSAR 15.3.1.2).

Besides the loss of power to control systems from the loss of a power distribution bus, there is a chance of having an electrical fault on one of the control system circuit cards. The control systems are designed so that each card is used in only one control system. A circuit card failure cannot directly impact more than one control system. A failure on a control card would cause the controller to generate either an "off" or a "full on", or "as is" or "between off and full on" output, depending on the type of failure. This result would be similar to having the feedback signal fail high or low. Therefore, the failure of or loss of power in any control system circuit card would be bounded by the Loss of Any Controller Feedback signal analysis described in Table QCS421.19-1.

Conclusions

The preceding sections have shown that failures of individual sensors, loss of controller feedback signals, breaks in instrument lines and loss of power to protection channels and control systems all result in events which are bounded by Chapter 15 of the PSAR or result in events with no control or plant impact. Therefore, the PSAR Chapter 15 Accident Analysis adequately bounds the consequences of these fundamental failures.

Table QCS421.19-1. Loss of Any Controller Feedback Signal

Feedback Signal	System	Assumed Failure Direction	Effect	Bounding Event
Reactor Flux	Reactor Control	Lo	Control rods are withdrawn if flux control in auto until high flux or flux-to-flow deviation rod blocks stop rod motion.	Bounding event is Maloperation of Reactor Plant Controllers (PSAR Section 15.2.2.3).
		Hi	Control rods are inserted if flux control in auto.	Not applicable.
Core Exit Temperature	Reactor Control	Lo	Control rods are withdrawn if core exit temperature control in auto until high flux or flux-to-flow deviation rod blocks stop rod motion.	Bounding event is Maloperation of Reactor Plant Controllers (PSAR Section 15.2.2.3).
		Hi	Control rods are inserted if core exit temperature control in auto.	Not applicable.
Turbine Inlet Temperature	Turbine Inlet Temperature Control	Lo	Control rods are withdrawn if turbine inlet temperature control in auto until high flux or flux-to-flow deviation rod blocks stop rod motion.	Bounding event is Maloperation of Reactor Plant Controllers (PSAR Section 15.2.2.3).
		Hi	Control rods are inserted if turbine inlet temperature control in auto.	Not applicable.

Table QCS421.19-1 (Continued)

Feedback Signal	System	Assumed Failure Direction	Effect	Bounding Event
Turbine Inlet Pressure	Turbine Inlet Pressure Control	Lo	Intermediate pump speed in all loops increases if turbine inlet pressure control in auto.	Not applicable
		Hi	Intermediate pump speed in all loops decreases if turbine inlet pressure control in auto.	Bounding event is Loss of Off-Site Electrical Power (PSAR Section 15.3.1.1).
Superheater Steam Flow	Unit Load Control (Load Programmer)	Lo	Setpoints to all NSSS control systems will decrease to 40% of design.	Not applicable.
		Hi	Setpoints to all NSSS control systems will increase to 100% of design.	Bounding event is Maloperation of Reactor Plant Controllers (PSAR Section 15.2.2.3).
Primary Sodium Flow	Primary Sodium Flow Control	Lo	Primary pump speed increases if primary flow control in auto mode.	Not applicable.
		Hi	Primary pump speed decreases if primary flow control in auto mode.	If flow controller output change is greater than 10%, pump speed does not change due to speed control mode transfer to manual (open loop). If flow controller output change is less than 10% pump speed decreases over time. Hence, bounding event is Spurious Primary Pump Trip (PSAR 15.3.1.2).

Table QCS421.19-1 (Continued)

Feedback Signal	System	Assumed Failure Direction	Effect	Bounding Event
Intermediate Sodium Flow	Intermediate Flow Control	Lo	Intermediate pump speed increases if intermediate flow control in auto mode.	Not applicable.
		Hi	Intermediate pump speed decreases in affected loop if intermediate flow control in auto mode. Pressure control increases pump speed in other loops.	If flow controller output change is greater than 10%, pump speed does not change due to speed control mode transfer to manual (open loop). If flow controller output change is less than 10% pump speed decreases over time. Hence, bounding event is Loss of Off-Site Electrical Power (PSAR Section 15.3.1.1).
Primary Speed	Primary Speed Control	Lo	Speed control automatically transfers to open loop control. No plant disturbance.	Not applicable.
		Hi	Same as above.	Not applicable.
Intermediate Speed	Intermediate Speed Control	Lo	Speed control automatically transfers to open loop control. No plant disturbance.	Not applicable.
		Hi	Same as above.	Not applicable.

Table QCS421.19-1 (Continued)

Feedback Signal	System	Assumed Failure Direction	Effect	Bounding Effect
Steam Drum Level	Steam Drum Level Control	Lo[1]	Main feedwater flow increases if steam drum level control is in auto. Increase in feedwater flow results in a high drum level and isolation of feedwater. Reactor trips upon isolation of main feedwater.	Not applicable.
		Hi[2]	Main feedwater flow decreases if steam drum level control in auto. Reactor scram and SGAHRS initiation result due to low drum level.	Bounding event is Loss of Normal Feedwater (PSAR Section 15.3.1.6).
Flow Reference Trim	Turbine EHC Speed Control	Lo	Turbine steam flow decreases as control valves close. NSSS follows steam flow if in supervisory control mode.	Not applicable.
		Hi	Turbine steam flow increases as all control valves open. NSSS follows steam flow up to 100% power (high flux limiter in reactor control) if in supervisory control mode. At 100% power, mismatch condition results in cooldown of the NSSS followed by a turbine trip on low pressure.	Bounding event is Turbine Trip (PSAR Section 15.3.1.5).

(1) Same effect for feedwater flow feedback failing low or superheater steam flow feedback failing high.

(2) Same effect for feedwater flow feedback failing high or superheater steam flow feedback failing low.

Table QCS421.19-1 (Continued)

Feedback Signal	System	Assumed Failure Direction	Effect	Bounding Event
Valve Position	Turbine EHC Flow Control	Lo	Turbine steam flow initially increases as affected control valve opens. Increase in flow is minimized by other 3 control valves closing to compensate. Disturbance on NSSS is small and bounded by normal plant transients.	Not applicable.
		Hi	Turbine steam flow initially decreases as affected control valve closes. Decrease in flow is minimized by the other 3 control valves opening to compensate. At 100% power, flow decrease continues due to limited compensation (valves fully open). NSSS follows steam flow if in supervisory control mode.	Not applicable.
Valve Position	Bypass Valve Control	Lo	Steam flow increases and pressure decreases as affected valve opens. If in load error mode, turbine trips on low pressure. If in pressure mode, other valves close to compensate; Possible turbine trip.	Bounding event is Turbine Trip (PSAR Section 15.3.1.5).
		Hi	Steam flow decreases and pressure increases as affected valve closes. If in load error mode, NSSS follows steam flow reduction. If in presure mode, other valves open to compensate.	Not applicable.

Table QCS421.19-1 (Continued)

Feedback Signal	System	Assumed Failure Direction	Effect	Bounding Event
Pressure	Bypass Valve Control	Lo	Valves close increasing turbine inlet pressure and decreasing steam flow.	Bounding event is Failure of Steam Bypass System (PSAR Section 15.3.2.4).
		Hi	Valves open decreasing turbine inlet pressure and increasing steam flow with possible turbine trip on low pressure.	Bounding event is Turbine Trip (PSAR Section 15.3.1.5).

NRC CONCERN: The applicant is required to provide justification(s) for the design criteria used when the physical separation does not meet R.G. 1.75 for the same divisions of the Primary and Secondary RSS and for the same division of DHRS and SGAHRS.

RESOLUTION: Resolution of this issue is presented in two parts. The first part sets forth our reasoning for why it is acceptable to locate in the same hazard area Primary and Secondary equipment of the same division; why it is acceptable to route Primary and Secondary cable in the same hazard area; and why it is acceptable to route SGAHR's and DHRS cable of the same division in the same hazard area. (There is no SGAHR's and DHRS equipment located in the same hazard area, except for the control room).

The second part of our response describes our criteria for equipment and cable separation, provides rationale why this criteria is acceptable and then describes where PPS, SGAHR's and DHRS equipment is located. In examining Table 1, Part 2, which shows equipment location, every item referenced by note 1 meets R.G. 1.75 separation requirements completely. Equipment referenced by notes 2 and 3 meet R.G. 1.75 requirements within its own system; however, for the RSS, Primary and Secondary equipment/cable of the same division may be located/routed in the same hazard area. To the extent practicable, five or more feet of physical separation is maintained between primary and secondary conduit when routed through the same hazard area. Note 3 provides the basis for why this is acceptable. Note 4 indicates that SGAHR's and DHRS equipment is located in separate areas, however, there is a limited amount of DHRS cable that is routed with SGAHR's cable of the same division. When this occurs, it is only for a distance of approximately 75 feet.

PART 1: Adequacy of CRBRP Equipment Location and Cable Separation

Part 1 addresses how CRBRP equipment location and cable separation criteria for the Reactor Shutdown System comply with the requirements of GDC 24 for independency and redundancy.

Part 1 also shows how DHRS equipment location and cable separation comply with GDC 35.

Criterion 24 - Reactivity Control System Redundancy and Capability

"Two independent reactivity control systems of different design principles shall be provided. One system shall be capable of independently and reliably sensing and responding to off normal conditions to assure that under conditions of normal operation, including anticipated operational occurrences, and with appropriate margin for malfunctions such as a stuck rod, specified acceptable fuel design limits are not exceeded. The other system shall be capable of independently and reliably sensing and responding to off-normal conditions to assure that under conditions of normal operation, including anticipated operational occurrences, and with appropriate margin for malfunctions such as a stuck rod, the capability to cool the core is maintained. Each system shall have sufficient worth, assuming failure of any single active component, to shut down the reactor from any operating condition to zero power and maintain subcriticality at the hot shutdown temperature of the coolant, with allowance for the maximum reactivity associated with any anticipated operational occurrence or postulated accident. One of the systems shall be capable of holding the reactor core subcritical for any coolant temperature lower than the Hot Shutdown temperature."

For the concern of RSS cable routing and equipment location, sufficient cable and equipment separation has to be provided to assure that the two shutdown systems are independent. Application of Regulatory Guide 1.75 is one way to provide assurance that the shutdown systems have a sufficient degree of independency. For CRBRP, Regulatory Guide 1.75 has been used for separation between redundant divisions within an individual shutdown system. For separation between Primary and Secondary, Reactor Shutdown Systems, CRBRP considers that sufficient independency is provided if it can be demonstrated that concurrent failure of equipment located in areas subjected to a common accident environment does not prevent the safety functions from being performed. The following discussion shows that with concurrent failure of equipment located in a single hazard area the system function can be performed.

The design of the CRBRP RSS, as described in Chapter 7, has three divisions for each RSS - Primary and Secondary. Each individual RSS is designed to the single failure criteria. Analyses have been performed which demonstrate that each individual shutdown system can shut down the plant within acceptable design limits - without assistance from the other shutdown system. Because of the above, CRBRP equipment location and cable routing criteria allow equipment and cable of the same primary and secondary division to be located in the same hazard area since failure or destruction of cable and equipment in one hazard area which contains one division of primary and secondary equipment/cable will not affect the operation of primary and secondary equipment/cable of the other two divisions. Since each RSS shutdown system is designed to the single failure criteria, each shutdown system will be capable of individually safely shutting down the plant with two divisions of equipment and cable available and thus their safety function will be performed.

In cases where primary and secondary equipment of the same division exist in a single area:

- o All protection system equipment located in the area is qualified for the limiting environmental conditions in which it would be expected to operate, or

- o Backup trip functions for both the RSS systems are provided in separate areas. Each backup function would not be subjected to the accident environment before the backup trip performed its reactor shutdown function in the event of failure of the first-out trip.

Table 1 provides examples of the design features related to those cases where primary and secondary system equipment may be subject to a common accident environment.

It is concluded that this interpretation of independence fully meets the intent of Regulatory Guide 1.75 for a plant with two protection systems and that the separation of equipment supports GDC 24 which requires two independent reactivity control systems.

Criterion 35 - Reactor Residual Heat Extraction System

"A reactor residual heat extraction system shall be provided to reliably transfer residual heat from the reactor coolant system to ultimate heat sinks under all plant shutdown conditions following normal operation, including anticipated operational occurrences and postulated accident conditions. A passive boundary shall normally separate reactor coolant from the working fluids of the reactor residual heat extraction system. Any fluid in the residual heat extraction system that is separated from the reactor coolant by a single passive barrier shall not be chemically reactive with the reactor coolant.

Suitable redundancy, independence and diversity in systems, components and features, and suitable interconnections, leak detection, and isolation capabilities shall be provided to assure that for onsite electrical power systems operation (assuming offsite power is not available) and for offsite electrical power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single feature, with at least two flow paths remaining available for residual heat removal."

For the SGAHRS/DHRS cable routing concern, the analysis of the following three limiting scenarios which bound design basis failures shows the adequacy of DHR separation.

1) A PHTS Na leak as an initiating event, followed by loss of one division of 1E power, with off-site power unavailable, and

2) Failure of one division of 1E power, followed by loss of second division of 1E power, with off-site power unavailable,[1]

3) Failure of one division of 1E power, with loss of off-site power followed by a steam leak disabling one steam generator loop.

For the first scenario, the initiating event removes one

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1 This is not a credible event since it presupposes losing two divisions of 1E power, however it is being used as a limiting event for this analysis.

Heat Transport System Path and the DHRS from consideration. The loss of 1E power removes forced circulation from a second Heat Transport System path and from one-half the active components in the DHRS; however, the DHRS has already been disabled by the initiating event.[2]

Decay heat removal continues with one Heat Transport System path on pony motor operation and one Heat Transport System path on natural circulation. Transfer of the heat to the ultimate heat sink is provided by vent valves, with feedwater makeup by one motor-driven AFW pump and the turbine-driven AFW pump, in the two Heat Transport System Loops. The requirements of Criterion 35 are satisfied since one Heat Transport System path with pony motor flow is capable of removing all heat from the time of shutdown and the two available Heat Transport paths, one on flow and one on natural circulation flow, meet the two flow path requirement.

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2 This is not a credible event since only large PHTS leaks will disable DHRS and large leaks are not in the design base. It is being used as a limiting event to conservatively illustrate the adequacy of the design.

For the second scenario, the initiating event removes power from one Heat Transport System path and one-half the DHRS. The single active failure likewise removes power from the second Heat Transport System path and one-half the DHRS. Decay heat removal continues with one Heat Transport System path on pony motor flow and two Heat Transport System paths on Natural Circulation. As explained above for scenario one, the requirement of Criterion 35 are satisfied.

For the third scenario, a steam line rupture is the postulated initiating event followed by loss of one electrical division, with off-site power unavailable. For this scenario, the initiating event removes one Heat Transport System Path, due to loss of the ability to transfer heat through one path of the Steam Generator System to the Ultimate Heat Sink. The loss of one electrical division removes forced circulation from a second Heat Transport System Path and removes one train of active components in the DHRS. Decay heat removal continues with one Heat Transport System path on pony motor operation and one Heat Transport System path on natural circulation. Additionally, the DHRS is available as a backup with the capability to remove all reactor residual heat.

Transfer of the heat to the ultimate heat sink is provided by vent valves, with feedwater makeup by one motor-driven AFW pump and the turbine-driven AFW pump, in the two Heat Transport System Loops. The requirements of Criterion 35 are satisfied since one Heat Transport System path with pony motor flow is capable of removing all reactor residual heat. Two available Heat Transport paths, one on pony motor flow and one on natural circulation flow meet the two flow path requirement. DHRS is also available as a third flow path.

In summary, the three scenarios explained above conservatively illustrate how the top level requirements provides in CRBRP Principal Design Criterion 35 for the Residual Heat Removal Systems are satisfied even though a failure in one division of 1E power (e.g., cable fire affecting DHRS and SGHRS cables routed in the same cable tray) can affect both SGAHRS and DHRS.

SGAHRS and DHRS Separation

As shown in Table 1, (Part 2), equipment associated with DHRS and SGAHRS are not located within the same hazard area. DHRS backup panels 81EPB003A (Division 1, 1E) and 81EPB003B (Division 2, 1E) are both located in Cell 311 to enhance operability of local control for EVST Processing. DHRS backup panels 81PPB002B (Division 1, 1E) and 81PPB002B (Division 2, 1E) are both located in Cell 105V to enhance operability for local control of Primary Sodium Processing. The safety related cooling functions of both panels may be performed from the control room. Therefore, since the local panels can be electrically isolated and the safety function performed from the control room, location of the panels is judged to be adequate.

ABLE 1

DESIGN FEATURES WHICH ALLOW LOCATION OF PRIMAL.. AND SECONDARY PPS EQUIPMENT IN AREAS WITH A COMMON ACCIDENT ENVIRONMENT

AREA	PRIMARY EQUIPMENT	SECONDARY EQUIPMENT	LIMITING ACCIDENT	RESOLUTION
Reactor Cavity (Inerted cell no combustibles)	3 Ion Chambers	3 Fission Chambers 3 Sets of Permanent Magnet flowmeter electrodes	Sodium Leak or Loss of Cooling	All flux sensors located in separate thimbles. All flux sensors qualified to withstand environment following specified hazards. Failure mode of flowmeter electrodes would result in safe failure.
Steam Generator Cells* (3 separate cells)	3 Steam Venturi flowmeter dp tubes 3 feed flowmeter dp tubes PPS Signal conditioning for 1 channel	3 Steam Drum Level transmitters PPS Signal Conditioning for 1 channel	Steam Pipe rupture or sodium leak	Primary system has IHX outlet temperature backup trip in a separate cell. Secondary System has evaporator outlet temperature backup trip in a cell separated by a blow out panel from the S.G. cell.

* Note that a failure of all equipment associated with Steam/feed and steam drum level trips in one steam generator cell would still allow operation of both protection systems through the action of the channels located in the other two cells (based on 2 ex 3 operation).

TABLE 1 (Continued)

AREA	PRIMARY EQUIPMENT	SECONDARY EQUIPMENT	LIMITING ACCIDENT	RESOLUTION
Instrument Mezzanines (3 separate structures within containment, each structure contains one division of equipment)	1 vessel inlet pressure signal conditioning 1 Reactor Na level signal conditioning 1 IHX Outlet temperature signal conditioning	1 primary flow meter signal conditioning panel	Storage tank Na fire incontainment during shutdown maintenance. Conventional fire in area.	Reactor is shut down and PPS not needed for Na fire. Also, fire within one structure would not be related to any accident requiring protection system action. Physical separation of instrument areas will allow PPS operation by channels in other 2 structures.

PART 2: Equipment Location and Cable Separation Criteria

Part 2 defines the CRBRP equipment location and cable separation criteria used for the RSS, SGAHRS and DHRS. It provides details about the actual equipment location and the basis for equipment location. The information is provided in DRAFT form since the design is not finalized.

RSS, SGAHRS AND DHRS SEPARATION CRITERIA

Reactor Shutdown System

The following criteria shall be followed for the separation of RSS equipment and cables.

- o All RSS cables shall be run in conduits or enclosed raceways with cables of redundant channels run in separate conduits or enclosed raceways.

- o Primary and Secondary RSS cables shall be run in separate conduits or enclosed raceways.

- o Wiring (cables) for redundant channels shall be brought through separate containment electrical penetrations. Separate penetrations shall be used for Primary and Secondary RSS cables.

- o A minimum separation of 5 feet shall be maintained between conduits or enclosed raceways of Primary and Secondary RSS of the same channel

(Division), except in some areas of the HAA where geometry prohibits 5 feet of separation or in other areas where panel locations prohibit 5 feet of separation.

DHRS and SGAHRS

The following criteria shall be followed for the separation of DHRS and SGAHRS equipment and cable.

- SGAHR's and DHRS equipment shall be located in different hazard areas except for the equipment in the control room.

- Redundant cable within SGAHRS and within DHRS shall be routed in accordance with Reg. Guide 1.75.

- SGAHRS and DHRS cable of the same division may be routed together, but this will be limited.

RSS, SGAHRS, and DHRS Equipment Location and Cable Separation Design

The attached TABLE 1 provides a listing of major equipment associated with the RSS, SGAHRS and DHRS systems. The TABLE also contains their location, safety class and physical separation.

It should be noted that the equipment located in the Main Control Room meet the separation requirements of IEEE 384-1974 and Regulatory Guide 1.75. SGAHRS and DHRS equipment located in the Reactor Containment Building (RCB) are contained in different cells as such, they are in separate hazard zones and, therefore, meet the separation requirements of IEEE 384-1974 and Regulatory Guide 1.75. Additionally, no SGAHRS equipment are located in the Reactor Service Building (RSB) and similarly, no DHRS equipment are located in the Steam Generator Building (SGB). Therefore, as far as the equipment of SGAHRS and DHRS system are concerned, they meet the separation requirements of IEEE 384-1974 and Regulatory Guide 1.75.

The majority of the cables and raceway associated with the DHRS system are run in the RSB, similarly, the majority of the cables and raceways of the SGAHRS system are run in the SGB. The cables of the DHRS and SGAHRS system, which run from the Main Control Room, may share common raceway for a short run in the vicinity of the Main Control Room. After a short distance into the SGB, (approximately 75 feet), the cables of SGAHRS and DHRS systems are separated and run in different raceways.

The cables of the primary and secondary RSS systems are run in separate conduits. These conduits will be installed such that they are as far apart as practical.

It should be noted that cables, raceways and equipment of safety channels A, B and C (Division 1, 2 and 3) of RSS, SGAHRS and DHRS systems are separated from each other as per IEEE 384-1974 and Regulatory Guide 1.75.

SUMMARY:

1. RSS, SGAHRS and DHRS equipment, cables and raceways of channels A, B and C (Divisions 1, 2 and 3) are separated from each other as per IEEE 384-1974 and Regulatory Guide 1.75.

2. SGAHRS and DHRS equipment of the same safety channel/division are separated from each other as per IEEE 384-1974 and Regulatory Guide 1.75.

3. Cables and raceway of primary and secondary RSS will be physically separated to the maximum extent practical.

4. The cables of the same safety channel/division of the SGAHRS and DHRS systems are generally in separate plant areas and share common raceway for a very short distance (approximately 75 feet).

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TABLE 1

SYSTEM	EQUIPMENT	CHANNEL/ DIVISION	LOCATION BLDG.	LOCATION EL.	LOCATION CELL	REMARKS
PRIMARY RSS	56PRB111BP Panel, I&C Loop 2 PRI PPS	B/2	RCB	824	163	Note 2 & 3
	56PRB111AP Panel, I&C Loop 1 PRI PPS	A/1	RCB	824	162	↓
	56PRB111CP Panel, I&C Loop 3 PRI PPS	C/3	RCB	824	164	↓
	99PSB001A Cabinet, PRI BUFF, CH. A	A/1	CR	816	431	Note 1
	99PSB001B Cabinet, PRI TERM, CH. A	A/1	CR	816	431	↓
	99PSB001C Cabinet, PRI COMP, CH. A	A/1	CR	816	431	↓
	99PSB003A Cabinet, PRI ISOL 1	A,B,C	CR	816	431	Note 5
	99PSB003B Cabinet, PRI LOGIC 1	Logic 1	CR	816	431	Note 6
	99PSB001D Cabinet, PRI BUFF CH. B	B/2	CR	816	431	Note 1
	99PSB001E Cabinet, PRI TERM, CH. B	B/2	CR	816	431	↓
	99PSB001F Cabinet, PRI COMP CH. B	B/2	CR	816	431	↓

CR - Main Control Room
EEB - Electrical Equipment Building
RCB - Reactor Containment Building
SGB - Steam Generator Building
RSB - Reactor Service Building

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SYSTEM	EQUIPMENT	CHANNEL/ DIVISION	LOCATION BLDG.	LOCATION EL.	LOCATION CELL	REMARKS
PRIMARY RSS	56SGB098B Rack, Primary PPS, CH. B	B/2	SGB	806	242	Notes 2 & 3
	56SGB099B Rack, Primary PPS, CH. B	B/2	SGB	806	242	
	56SGB097C Rack, Primary PPS, CH. C	C/3	SGB	806	243	
	56SGB098C Rack, Primary PPS, CH. C	C/3	SGB	806	243	
	56SGB099C Rack, Primary PPS, CH. C	C/3	SGB	806	243	
	56INB111AP Panel I&C Loop 1 PRI PPS	A/1	SGB	733	207	
	56INB111BP Panel, I&C Loop 2 PRI PPS	B/2	SGB	733	208	
	56INB111CP Panel, I&C Loop 3 PRI PPS	C/3	SGB	733	209	
	12NIB003A 13.8KV PT & Relay CAB Primary	A/1	EEB	794	521	
	12NIB003B 13.8KV PT & Relay CAB Primary	B/2	EEB	794	524	
	12NIB003C 13.8KV PT & Relay CAB Primary	C/3	EEB	765	532	

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SYSTEM	EQUIPMENT	CHANNEL/ DIVISION	LOCATION BLDG.	EL.	CELL	REMARKS
PRIMARY RSS	99PSB003C Cabinet, PRI ISOL 2	A,B,C,	CR	816	431	Note 5
	99PSB003D Cabinet, PRI LOGIC 2	Logic 2	CR	816	431	Note 6
	99PSB001G Cabinet, PRI BUFF CH. C	C/3	CR	816	431	Note 1
	99PSB001H Cabinet, PRI TERM, CH. C	C/3	CR	816	431	↓
	99PSB001J Cabinet, PRI COMP, CH. C	C/3	CR	816	431	↓
	99PSB003E Cabinet, PRI ISOL 3	A,B,C	CR	816	431	Note 5
	99PSB003F Cabinet, PRI LOGIC 3	Logic 3	CR	816	431	Note 6
	56SGB097A Rack, Primary PPS, CH. A	A/1	SGB	806	241	Notes 2 & 3
	56SGB098A Rack, Primary PPS, CH. A	A/1	SGB	806	241	↓
	56SGB099A Rack, Primary PPS, CH. A	A/1	SGB	806	241	↓
	56SGB097B Rack, Primary PPS, CH. B	B/2	SGB	806	242	↓

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SYSTEM	EQUIPMENT	CHANNEL/ DIVISION	LOCATION BLDG.	EL.	CELL	REMARKS
SECONDARY RSS	99PSB002G Cabinet, SEC BUFF, CH. C	C/3	CR	816	431	Note 1
	99PSB002H Cabinet, SEC TERM, CH. C	C/3	CR	816	431	
	99PSB002J Cabinet, SEC COMP, CH. C	C/3	CR	816	431	
	99PSB004C Cabinet, SEC SOL., DR. C	C/3	CR	816	431	
	56SGB094A Rack, Secondary PPS CH. A	A/1	SGB	806	241	Notes 2 & 3
	56SGB095A Rack, Secondary PPS CH. A	A/1	SGB	806	241	
	56SGB096A Rack, Secondary PPS CH. A	A/1	SGB	806	241	
	56SGB094B Rack, Secondary PPS CH. B	B/2	SGB	806	242	
	56SGB095B Rack, Secondary PPS CH. B	B/2	SGB	806	242	
	56SGB096B Rack, Secondary PPS CH. B	B/2	SGB	806	242	
	56SGB094C Rack, Secondary PPS CH. C	C/3	SGB	806	243	

SYSTEM	EQUIPMENT	CHANNEL/ DIVISION	LOCATION BLDG.	LOCATION EL.	LOCATION CELL	REMARKS
Primary RSS	95AAB003A Enclosure, P.R. Junc. Box, Ch. A	A/1	RCB	802	151	Note 1
	95AAB003B Enclosure, P.R. Junc. Box, Ch. B	B/2	RCB	802	151	
	95AAB003C Enclosure, P.R. Junc. Box, Ch. C	C/3	RCB	802	151	
	92AAB002A Termination Reactor Level Sensor Ch. A	A/1	RCB	802	151	
	92AAB002B Termination Reactor Level Sensor Ch. B	B/2	RCB	802	151	
	92AAB002C Termination Reactor Level Sensor Ch. C	C/3	RCB	802	151	
Secondary RSS	95AAB006A Enclosure, W.R. Preamp. Ch. A	A/1	RCB	802	151	
	95AAB006B Enclosure, W.R. Preamp. Ch. B	B/2	RCB	802	151	
	95AAB005C Enclosure, W.R. Preamp. Ch. C	C/3	RCB	802	151	

In the Remarks column, an arrow runs down from "Note 1" to the last row.

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SYSTEM	EQUIPMENT	CHANNEL/ DIVISION	LOCATION BLDG.	EL.	CELL	REMARKS
SECONDARY RSS	56SGB095C Rack, Secondary PPS CH. C	C/3	SGB	806	243	Notes 2 & 3
	56SGB096C Rack, Secondary PPS CH. C	C/3	SGB	806	243	
	56INB111AS Panel I&C Loop 1 SEC PPS	A/1	SGB	733	207	
	56INB111BS Panel I&C Loop 2 SEC PPS	B/2	SGB	733	208	
	56INB111CS Panel I&C Loop 3 SEC PPS	C/3	SGB	733	209	
	12NIB004A 13.8KV PT & Relay CAB Secondary	A/1	EEB	794	521	
	12NIB004B 13.8KV PT & Relay CAB Secondary	B/2	EEB	794	524	
	12NIB004C 13.8KV PT & Relay CAB Secondary	C/3	EEB	765	532	

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SYSTEM	EQUIPMENT	CHANNEL/ DIVISION	LOCATION BLDG.	EL.	CELL	REMARKS
SECONDARY RSS	56PRB111BS Panel, I&C Loop 2 SEC PPS	B/2	RCB	824	163	Notes 2 & 3
	56PRB111AS Panel, I&C Loop 1 SEC PPS	A/1	RCB	824	162	
	56PRB111CS Panel, I&C Loop 3 SEC PPS	C/3	RCB	824	164	
	99PSB002A Cabinet, SEC BUFF, CH. A	A/1	CR	816	431	Note 1
	99PSB002B Cabinet, SEC TERM, CH. A	A/1	CR	816	431	
	99PSB002C Cabinet, SEC COMP, CH. A	A/1	CR	816	431	
	99PSB004A Cabinet, SEC SOL DR. A	A/1	CR	816	431	
	99PSB002D Cabinet, SEC BUFF, CH. B	B/2	CR	816	431	
	99PSB002E Cabinet, SEC TERM, CH. B	B/2	CR	816	431	
	99PSB002F Cabinet, SEC COMP, CH. B	B/2	CR	816	43.	
	99PSB004B Cabinet, SEC SOL, DR. B	B/2	CR	816	431	

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SYSTEM	EQUIPMENT	CHANNEL/ DIVISION	LOCATION BLDG.	EL.	CELL	REMARKS
SGAHRS	52ACH001A Condenser, PRO Air Cooled	A/1	SGB	862	281	Notes 3 & 4
	52ACH001B Condenser, PRO Air Cooled	B/2	SGB	862	282	
	52ACH001C Condenser, PRO Air Cooled	C/3	SGB	862	283	
	52AFK001A Drive, Motor, AFW Pump	A/1	SGB	733	204A	
	52AFK001B Drive, Motor, AFW Pump	B/2	SGB	733	204B	
	56HRB110A Panel, SGAHRS I&C Loop 1	A/1	SGB	836	272A	
	56HRB110B Panel, SGAHRS I&C Loop 2	B/2	SGB	836	272B	
	56HRB110C Panel, SGAHRS I&C Loop 3	C/3	SGB	836	272C	
	56HRB010A SGAHRS ST TURBINE GOVERNOR CONT	C/3	SGB	733	202A	

SYSTEM	EQUIPMENT	CHANNEL/ DIVISION	LOCATION BLDG.	EL.	CELL	REMARKS
SGAHRS	56INK201A Motor, IHTS Pony Mtr DR	A/1	SGB	806	244	Notes 3 & 4
	56INK201B Motor, IHTS Pony Mtr DR	B/2	SGB	806	245	
	56INK201C Motor, IHTS Pony Mtr DR	C/3	SGB	806	246	
	56PRK201A PHTS Pony Motor DR	A/1	RCB	795	161C	
	56PRK201B PHTS Pony Motor DR	B/2	RCB	795	161D	
	56PRK201C PHTS Pony Motor DR	C/3	RCB	795	161E	
	56SGB001A Panel, OSIS I&C Loop 1	A/1	SGB	836	272A	
	56SGB001B Panel, OSIS I&C Loop 2	B/2	SGB	836	272B	
	56SGB001C Panel, OSIS I&C Loop 3	C/3	SGB	836	272C	

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SYSTEM	EQUIPMENT	CHANNEL/ DIVISION	LOCATION BLDG.	EL.	CELL	REMARKS
SGAHRS	56SGB002A Panel SWRPRS I&C Loop 1	A/1	SGB	836	272A	Notes 3 & 4
	56SGB002B Panel SWRPRS I&C Loop 2	B/2	SGB	836	272B	↓
	56SGB002C Panel SWRPRS I&C Loop 3	C/3	SGB	836	272C	↓
	56SGB100A SGS/SGAHRS Logic PNL DIV 1	A/1	CB	816	431	↓
	56SGB100B SGS/SGAHRS Logic PNL DIV 2	B/2	CB	816	431	↓
	56SGB100C SGS/SGAHRS Logic PNL DIV 3	C/3	CB	816	431	↓

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SYSTEM	EQUIPMENT	CHANNEL/ DIVISION	LOCATION BLDG.	EL.	CELL	REMARKS
DHRS	81AAB018A Panel, Control Room	A/1	CB	816	431	Notes 3 & 4
	81AAB018B Panel, Control Room	B/2	CB	816	431	
	81EPB003A Panel, EVS Processing	A/1	RSB	842	311	
	81EPB003B Panel, EVS Processing	B/2	RSB	842	311	
	81EPE004A Cabinet, EVST Pump Control	A/1	RSB	765	352A	
	81EPE004B Cabinet, EVST Pump Control	B/2	RSB	765	353A	
	81EPE005A Cabinet VAR XFRM EVST Pump	A/1	RSB	765	352A	
	81EPE005B Cabinet VAR XFRM EVST Pump	B/2	RSB	765	353A	
	81EPE006A Cabinet, Capacitor EVST Pump	A/1	RSB	765	352A	
	81EPE006B Cabinet, Capacitor EVST Pump	B/2	RSB	765	353A	
	81EPH002A Heat Exchr EVST Air Blast	A/1	RSB	765	352A	
	81EPH002B Heat Exchr EVST Air Blast	B/2	RSB	765	353A	

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SYSTEM	EQUIPMENT	CHANNEL/ DIVISION	LOCATION BLDG.	EL.	CELL	REMARKS
DHRS	81EPP002A Pump, NA EM EVST	A/1	RSB	779	360	Notes 3 & 4
	81EPP002B Pump, NA EM EVST	B/2	RSB	779	357	↓
	81PPB002A Panel, PRI NA Process	A/1	RCB	794	105V	↓
	81PPB002B Panel, PRI NA Process	B/2	RCB	794	105V	↓
	81PPE001A Cabinet, Makeup Pump Power	A/1	RCB	733	105F	↓
	81PPE001B Cabinet, Makeup Pump Power	B/2	RCB	733	105A	↓
	81PPE002A Cabinet, Makeup Pump CAP	A/1	RCB	733	105F	↓
	81PPE002B Cabinet, Makeup Pump CAP	B/2	RCB	733	105A	↓
	81PPE003A Cabinet, VAR XFRM Drive	A/1	RCB	733	105F	↓
	81PPE003B Cabinet, VAR XFRM Drive	B/2	RCB	733	105A	↓
	81PPP001A Pump PRI NA Makeup	A/1	RCB	733	103	↓
	81PPP001B Pump PRI NA Makeup	B/2	RCB	733	104	↓

NOTES:

1. Meets guidelines of Regulatory Guide 1.75 with regards to equipment and cable separation between Channels A, B and C (Division 1, 2 and 3) and also between Primary and Secondary RSS of the same channel/division.

2. RSS equipment and cables of Channels A, B and C (Division 1, 2 and 3) are separated from each other as per IEEE 384-1974 and Regulatory Guide 1.75.

3. Based on the following justification, it is considered that separation between Primary and Secondary RSS equipment and cables and between SGAHRS & DHRS equipment cables of the same safety channel (Division) is not required.

   The fire hazard analysis (ES-26NS-10-004) has determined the following:

   a. The sources of fire in cells other than Non-Hazardous cells, where Primary and Secondary RSS equipment and cables are located, mainly consist of the following:

      - cable insulation
      - electrical panelboards and equipment
      - cable termination and installation material including cable ties
      - lubricating oils

   b. The bulk of the heat sources are determined to be those associated with the cable insulation. The cables used are fire retardant and are qualified in accordance with IEEE 383. The lubricating oils are contained within the bearings or lubrication system of equipment and constitute a very small portion of the total combustibles. An extensive fire detection system is provided in these areas.

      Additionally, line type heat detectors are provided in cable trays containing safety related cables. As such, the fire hazard from cable insulation and other materials located in these cells is considered minimal.

4. The equipment associated with SGAHRS & DHRS systems are located in separate hazard areas.

NOTES: (Continued)

5. Physical barriers are provided within cabinets to separate redundant channels into three areas. Material and cabling are flame retardant within the cabinet and there is no power source contained within the cabinet.

6. Logic trains 1, 2 and 3 are redundant to each other.

NRC CONCERN: The staff requested the applicant to provide additional information about safety classification of SWRPS electrical equipment.

Resolution: This concern was addressed by revising sections of PSAR chapters 3 and 7 as shown attached.

TABLE 3.2-3 (Continued)

Cold Trap Temperature Switches

Pump Temp. Switch

Fan Motor

Cables

Nuclear Island General Purpose Maintenance Equipment System

Containment Isolation Valve Operators

Cables

Steam Generator Auxiliary Heat Removal System

Auxiliary Feedwater Pump Motors

Auxiliary Feedwater Flow Meter

Protected Air Cooled Condenser Condensate Flow Meter

Auxiliary Feedwater Valve Operators

Vent Control Valve Operators

Water Storage Tank Fill Valve Operator

AFW Turbine Steam Supply Valve Operator

AFW Turbine Pressure Control Valve Operator

Cables

Steam Generator System

Feedwater Valve Operators

Superheater Outlet Valve Operators

Steam Drum Drain Valve Operators

61 Cables

Sodium-Water Reaction Pressure Relief System Instrumentation and Controls

TABLE 7.1-1

SAFETY-RELATED INSTRUMENTATION AND CONTROL SYSTEMS*

Reactor Shutdown Systems

Includes all RSS sensors, signal conditioning calculation units, comparators, buffers, 2/3 logic, scram actuators, scram breakers, control rods, back contacts on scram breakers, HTS shutdown logic, coolant pump breakers, and mechanical mounting hardware (equipment racks).

Containment Isolation System

Includes radiation monitoring sensors, signal conditioning, comparators, 2/3 logic, containment isolation valve actuators and valves.

Decay Heat Removal System Instrumentation and Control System

Includes initiating sensors, signal conditioning, calculation units, comparators, logic, auxiliary feedwater pump actuators and controls including feedwater turbine pump, PACC DHX actuators and controls, steam relief valve actuators and valves; sensors, signal conditioning, logic and actuators related to decay heat removal functions of DHRS including control of sodium and NaK pumps and air blast heat exchangers; and sensors, signal conditioning, logic and actuators related to removal of heat from the EVST.

INSERT →

Other Safety-Related Instrumentation and Control

Includes instrumentation and Controls for portions of the following functions to assure the plant is maintained in a safe shutdown condition:

- o Emergency Chilled Water System
- o Emergency Plant Service Water System
- o Instrumentation necessary to assure plant is maintained in safe shutdown status (See Table 7.5-4)
- o Heating, Ventilating, and Air Conditioning System
- o Recirculating Gas Cooling System

*The Clinch River Breeder Reactor Plant (CRBRP) safety-related structures, systems, and components are designed to remain functional in the event of a Safe Shutdown Earthquake (SSE). These include, but are not limited to, those structures, systems and components which are necessary:

a. To assure the integrity of the Reactor Coolant Boundary;
b. To shutdown the reactor and maintain it in a safe shutdown condition;
c. To prevent or mitigate the consequences of accidents which could result in potential off-site exposures comparable to the guideline exposures of 10CFR100.

NOTE: Class IE equipment loads are identified in Chapter 8.

INSERT PAGE 7.1-7

Sodium-Water Reaction Pressure Relief System (SWRPRS)

The instrumentation, initiation and control logic which achieves adequate isolation and blow-down of the waterside of a superheater or evaporator in the event of a sodium/water reaction is Class 1E. The instrumentation used to initiate the isolation and blow-down valves are the rupture disc pressure detectors located downstream of the rupture discs. The other pressure and temperature instrumentation distributed throughout the sodium/water reaction pressure relief subsystem is used for status indication and is not Class 1E.

7.5.6.1.1 Function

The Sodium-Water reaction Pressure Relief System (SWRPRS) Instrumentation and Control System detects the inception of a large or intermediate water to sodium leak in any of the steam generator modules (see Section 5.5.2.6).

For a large leak, three 1E pressure sensors (nine per loop) are provided immediately downstream from each pair of rupture disks in the superheater and evaporator's (two) reaction products vent line. The signals are transmitted to the PPS Secondary Shutdown System which initiates a reactor trip and PHTS and IHTS sodium pump trip. Buffered signals are transmitted to the SWRPRS trip logic which isolates the affected loop. A group alarm is transmitted to the Plant Annunciation System (PAS).

For intermediate leaks, three pressure sensors are provided in the IHTS sodium expansion tank equalization line to the sodium dump tank, downstream of the rupture disks. These signals are transmitted directly to the SWRPRS trip logic via a two-out-of-three coincidence logic which isolates the affected loop. Reactor trip and trip of the PHTS and IHTS sodium pumps is initiated via the PPS Primary Shutdown System as a result of a high steam-to-feedwater flow in the affected loop.

7.5.6.1.2 SWRPRS Trip Logic

There are three separate SWRPRS trip logics, one each loop. Thus, only the affected loop will be isolated leaving the other two loops for shutdown heat

SWRPRS instrumentation and control which is used to initiate and control the SWRPRS function is 1E. Instrumentation which is used to monitor the status of SWRPRS serves no safety function and accordingly is non-1E.

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7.5.6.1.3 Bypasses and Interlocks 40

The control logic for the actuation of the Sodium-Water Reaction Pressure Relief System will be designed to insure reliability and freedom from spurious operation. A discussion of the bypasses and interlock functions will be provided as detail system design and analysis progresses. Bypasses and interlock functions which are required for operation of the initiation and control logic will be Class 1E.

7.5.6.1.4 Sodium Dump 40

No automatic action is associated with the removal of sodium from the affected loop. However, sodium dump valves are provided for draining sodium to the sodium dump tank, and can be initiated by operator action. 40

Drain valves are located in five piping runs between the IHTS sodium loop and the sodium dump tank. Each piping run contains a pair of drain valves arranged in series. Controls and indications for all these valves are located on the Main Control Board. 40

7.5.6.1.5 Monitoring Instrumentation 40

In addition to the instrumentation required for the initiating circuitry, the following parameters are measured to aid the plant operator in assessing the performance of the Sodium-Water Pressure Relief System:

- Pressure in the gas space between each pair of rupture disks is monitored to detect leakage, or failure of the sodium side rupture disk. Spark plug leak detectors are also provided in the gas space to detect rupture disk failure.

- Thermocouple elements are provided for monitoring surface temperatures of the reaction products separator tank, centrifugal separator, centrifugal separator drain tank, and the hydrogen igniter.

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7.5.6.2 Design Analysis

Because of the large increase in pressure from the formation of reaction products during a large sodium-water reaction, rupture disc operation is necessary to prevent excessive pressure surges in the Intermediate Heat Transport System and possible primary boundary rupture at the Intermediate Heat Exchanger. Reaction products vent line sensors are part of the Reactor Shutdown System and as such meet the requirements of the Plant Protection System (see Section 7.1.2 and 7.2.2). The initiation of isolation and dump of the water side of the steam generators, trip of the recirculation pumps and inerting of the steam generators normally follows after rupture disc operation in a large sodium-water reaction and is desirable from the operational standpoint of minimizing the time to recover from the incident. However, the initiation of these actions after rupture disc operation is not necessary from a safety standpoint to assure protection of the core or the safety of the public.

All SWRPRS equipment associated with isolation or dump of evaporator or superheater modules is designed to assure that no credible single event can disable more than one of the three redundant decay heat removal paths. All electronic equipment is designed to withstand the Safe Shutdown Earthquake. The mechanical equipment associated with the 3 steam generators is physically separated in 3 different steam generators bays. Electrical and pneumatic supplies are arranged such that a single failure disables at most one decay heat removal path. Where practicable, the preferred failure position for equipment is in a direction to assure the safe operation of the SGAHRS.

SWRPRS equipment whose failure could cause loss of decay heat removal capability of the SGAHRS is safety related. This includes SWRPS initiation and control equipment which is used to initiate and blowdown the water side of the affected loop. Any credible single failure in the SWRPRS can lead to the failure of at most one of the three decay heat removal loops. Since the three decay heat removal loops are redundant and independent, the SGAHRS will meet the single failure criterion and the adequacy of the decay heat removal system following a credible single failure in the SWRPRS is assured.

NRC CONCERN: The staff requires additional information on position indication of safety relief valves.

RESOLUTION: The response to question 421.46, which addresses direct indication of valve position is revised as shown attached.

QUESTION CS421.46

As called for in Section 7.1 of the Standard Review Plan, provide information as to how your design conforms with the following TMI Action Plan Items as described in NUREG-0737:

a) II.D.3 - Relief and safety valve position indication

b) II.E.4.2 - Containment isolation dependability (positions 4, 5 and 7)

c) II.K.3 - Final recommendations

.9 - PID controller

.12 - Anticipatory reactor trip

It has been the case for light water reactors to provide an anticipatory reactor trip following a turbine trip directly from the turbine bypass and/or control valves. In the PSAR, Table 7.2-2 indicates that a turbine trip will cause a reactor trip upon a steam feedwater flow mismatch and/or steam drum level indication. Justify the lack of an anticipatory reactor trip initiated from turbine bypass or control valve closure.

Response

a) II.D.3 Direct Indication of Relief and Safety Valve Position

Position

"Reactor coolant system relief and safety valves shall be provided with a positive indication in the control room derived from a reliable valve position detection device or a reliable indication of flow in the discharge pipe."

CRBRP Design

As stated in Appendix H of the PSAR, which addresses TMI position II.D.3, the CRBRP, unlike pressurized water reactors, has an unpressurized reactor coolant system and has no relief and safety valves in the reactor coolant loop. Thus, the potential for loss of coolant to the reactor through safety relief valves such as occurred at TMI does not exist on the CRBRP plant. TMI II.D.3 deals with the inability to cool the reactor as a result of loss of coolant to the reactor through the safety relief valves. Therefore, neither the requirement nor the principle of the requirement have any application on CRBPR.

Safety relief valves and vent control valves are utilized in the steam side of the heat transport system for overpressure protection and venting for SWRPRS and SGAHRS operation. A failure to close when expected or leakage from one of these valves could result in loss of water inventory from that particular steam generation loop, which could lead to the loss of the heat removal capability of that loop. Should the leak be sufficient to prevent the affected loop from removing decay heat, there are two remaining loops which are capable of performing the required safety function of decay heat removal.

The SGS safety valves are pilot operated valves which will open when system pressure reaches their set points. In addition, the evaporator outlet and superheater outlet safety valves will open when actuated by an air-operated actuator. Main control room indication of pilot stem position, not main valve stem position, is provided for these valves. To provide a backup to the pilot stem position indicators, an acoustic sensor has been added to the vent piping downstream of each SGS safety valve. These sensors will detect either a stuck open valve or any steam leakage past the seat of a closed valve. These conditions will be alarmed and annunciated in the main control room.

The SGAHRS steam drum and superheater vent control valves have electric/hydraulic operators and are provided with Class 1E direct stem position indicators in the main control room. Acoustic sensors located on the vent piping downstream of the valves will detect any steam leakage past the seat of a closed valve, and the leakage will be alarmed and annunciated in the main control room.

In addition to the above mentioned valve position indication, the loss of water inventory at a rate sufficient to be of a safety concern can be detected and the loop isolated by Class 1E instrumentation. These are, steam drum pressure, steam drum level and main feedwater flow or SGAHRS AFW flow.

b) Item II.E.4.2 Containment Isolation System Dependability

Position (4)

"The design of control systems for automatic containment isolation valves shall be such that resetting the isolation signal will not result in the automatic reopening of containment isolation valves. Reopening of containment isolation valves shall require deliberate operator action."

Clarification

"(4) Administrative provisions to close all isolation valves manually before resetting the isolation signals is not an acceptable method of meeting position 4.

(5) Ganged reopening of containment isolation valves is not acceptable. Reopening of isolation valves must be performed on a valve-by-valve basis, or on a line-by-line basis, provided that electrical independence and other single-failure criteria continue to be satisfied."

CRBRP Design:

CIS valve closure is controlled by initiating an isolation signal to the CIS breaker undervoltage coil. Reset of the isolation signal to the CIS breaker undervoltage coil will not automatically reset the CIS valves. Reset of the CIS valves requires the operator to manually close the CIS breaker. Individual valve control switches are provided, which will allow the operator to manually select all valves closed prior to closing the CIS breaker. This will allow each CIS valve to be individually opened under administrative control. This meets the intent of Position 4 and Clarifications 4 and 5.

Position (5)

"The containment setpoint pressure that initiates containment isolation for nonessential penetrations must be reduced to the minimum compatible with normal operating conditions."

CRBRP Design:

Containment pressure is not used to initiate automatic containment isolation. The CIS back pressure valve setpoints are chosen to assure that, upon system failure, the containment isolation valves remain closed for the highest containment pressure.

Position (7)

"Containment purge and vent isolation valves must close on a high radiation signal."

CRBRP Design:

CRBRP purge and vent lines will isolate on a high radiation signal. There are no sealed-closed purge isolation valves.

c) II.K.3 Final Recommendations

.9 Proportional Integral Derivative Controller Modification

Position

"The Westinghouse-recommended modification to the proportional integral derivative (PID) controller should be implemented by affected licensees."

CRBRP Design:

This TMI action plan requirement was provided to preclude the spurious opening of pressurizer power operated relief valves (PORVs) in Westinghouse-designed PWRs. There are no PORVs on the CRBRP reactor coolant boundary; therefore, this action plan requirement is not applicable to CRBRP.

.12 Anticipatory Trip

"Position

Licensees with Westinghouse-designed operating plants should confirm that their plants have an anticipatory reactor trip upon turbine trip. The licensee of any plant where this trip is not present should provide a conceptual design and evaluation for the installation of this trip."

CRBRP Design:

An anticipatory trip upon turbine trip is not required because the Intermediate Heat Transport System acts as a buffer between the reactor and the Steam Generator System (SGS). This arrangement loosely couples the reactor and SGS such that events in the SGS (such as turbine trip) are not immediately reflected as changes in reactor parameters. Response time of the Steam to Feedwater Mismatch is more than adequate to scram the reactor upon a turbine trip making the anticipatory trip from the bypass/control valves unnecessary.