HITACHI

GE Hitachi Nuclear Energy

Richard E. Kingston
Vice President, ESBWR Licensing

PO Box 780 M/C A-65
Wilmington, NC 28402-0780
USA

T 910 819 6192
F 910 362 6192
rick.kingston@ge.com

Security Notice
This letter forwards security-related information in accordance with 10 CFR 2.390. Upon removal of Enclosure 1, the balance of this letter may be considered non-security-related.

MFN 09-791

Docket No. 52-010

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Subject: **Response to Portion of NRC RAI Letter No. 400 Related to ESBWR Design Certification Application – PRA – RAI Number 19.5-21**

Enclosure 1 contains the GE Hitachi Nuclear Energy (GEH) response to the U.S. Nuclear Regulatory Commission (NRC) Request for Additional Information (RAI) Number 19.5-21 (Reference 1).

Enclosure 1 contains security-related information as defined by 10 CFR 2.390. GEH must maintain this information in confidence and withhold it from public disclosure.

ESBWR Design Control Document (DCD) markups are provided in Enclosure 2.

If you have any questions about the information provided, please contact me.

Sincerely,

Richard E. Kingston

Richard E. Kingston
Vice President, ESBWR Licensing

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NRO

References:

1. MFN 09-777, Letter from the U.S. Nuclear Regulatory Commission to Jerald G. Head, Request for Additional Information Letter No. 400, Related to ESBWR Design Certification Application, dated December 8, 2009.

Enclosures:

1. Response to Portion of NRC Request for Additional Information Letter No. 400 Related to ESBWR Design Certification Application – PRA – RAI Number 19.5-21.
2. Response to Portion of NRC Request for Additional Information Letter No. 400 Related to ESBWR Design Certification Application – PRA – RAI Number 19.5-21 – ESBWR DCD Markups.

cc:		
	AE Cubbage	USNRC (with enclosures)
	JG Head	GEH/Wilmington (with enclosures)
	DH Hinds	GEH/Wilmington (with enclosures)
	CW Bagnal	GEH/Wilmington (with enclosures)
	eDRF Section	0000-0111-0617 (RAI 19.5-21)

Enclosure 2

MFN 09-791

Response to NRC Request for Additional Information Letter No. 400 Related to ESBWR Design Certification Application – Probabilistic Risk Assessment

RAI Number 19.5-21

ESBWR DCD Markups

The isolation condenser is started into operation by opening condensate return valves and draining the condensate to the reactor, thus causing steam from the reactor to fill the tubes which transfer heat to the cooler pool water.

5.4.6.2.2 Detailed System Description

The ICS consists of four high-pressure, independent trains, each containing a steam isolation condenser as shown on the ICS schematic (Figure 5.1-3 and 5.4-4a & b).

Each isolation condenser unit is made of two identical modules (see Table 5.4-1). The units are located in subcompartments adjacent to a large water pool (IC/PCCS expansion pool) positioned above, and outside, the ESBWR containment (drywell).

The isolation condenser is configured as follows:

- The steam supply line (properly insulated and enclosed in a guard pipe which penetrates the containment roof slab) is vertical and feeds two horizontal headers through four branch pipes. Each pipe is provided with a built-in flow limiter, sized to allow natural circulation operation of the isolation condenser at its maximum heat transfer capacity while addressing the concern of isolation condenser breaks downstream of the steam supply pipe. Steam is condensed inside Inconel 600 vertical tubes and condensate is collected in two lower headers. To achieve an adequate heat transfer coefficient, each module contains approximately 135 tubes. Two pipes, one from each lower header, take the condensate to the common drain line, which vertically penetrates the containment roof slab.
- A vent line is provided for both upper and lower headers to remove the noncondensable gases away from the unit, during isolation condenser operation. The vent lines are routed to the containment through a single penetration.
- A purge line is provided to assure that, during normal plant operation (ICS standby conditions), an excess of noncondensable gases does not accumulate in the isolation condenser steam supply line, thus assuring that the isolation condenser tubes are not blanketed with noncondensables when the system is first started. The purge line penetrates the containment roof slab.
- Containment isolation valves are provided on the steam supply piping and the condensate return piping. The valve designs are the same for all four valves, either gate valves or quarter-turn ball valves. For two of the valves (one per line), the actuators are nitrogen-powered piston operators, which are similar to piston air operators. Nitrogen is supplied from accumulators. For the other two valves, the actuators are electro-hydraulic operators, which use an electric motor-driven pump to drive the piston.
- Located on the condensate return piping just upstream of the reactor entry point is a loop seal and a parallel-connected pair of valves: (1) a condensate return valve (electro-hydraulic operated, fail as is) and (2) a condensate return bypass valve (nitrogen piston operated, fail open). Two different valve actuator types are used to assure an open flow path by eliminating common mode failure. Therefore, the condensate return valves are single failure proof for each unit. Because the steam supply line valves are normally open, condensate forms in the isolation condenser and develops a level up to the steam distributor, above the upper headers. To place an isolation condenser into operation, the

electro-hydraulic operated condensate return valve and condensate return bypass valves are opened, whereupon the standing condensate drains into the reactor and the steam-water interface in the isolation condenser tube bundle moves downward below the lower headers to a point in the main condensate return line. The fail-open nitrogen piston-operated condensate return bypass valve opens if the DC power is lost.

- System controls allow the reactor operator to manually open both of the condensate return valves at any time.
- Located on the condensate return line, downstream from the second inboard containment isolation valve is an in-line vessel. The inline vessel is located on each ICS train to provide the additional condensate volume for the RPV. The volume of each vessel is no less than 9 m^3 (318 ft^3). This in-line vessel contributes a large portion of the total drainable water volume in the condensate return piping of each ICS train (see Table 6.3-1). The added inventory of the inline vessel supports:
  - Use of a single level logic for emergency core cooling system (ECCS) initiation, and
  - Reactor vessel level that does not fall below the Level 1 setpoint during a loss of feedwater or loss of preferred power.
- The equipment storage pool and reactor well are designed to have sufficient water volume to provide makeup water to the IC/PCCS expansion pools for the initial 72 hours of a LOCA response. This water is provided through ICS pool cross-connect valves between the equipment storage pool and IC/PCCS inner expansion pools. The pool cross-connect valves open when the level in ~~either~~the IC/PCCS inner expansion pool to which they are connected reaches a low set point. The IC/PCCS pools, equipment storage pool, and reactor well have a minimum combined water inventory of no less than 6,290 cubic meters (222,130 cu ft) to be used for 72 hours of post-accident decay heat removal.
- A loop seal at the RPV condensate return nozzle assures that condensate valves do not have superheated water on one side of the disk and subcooled water on the other side during normal plant operation, thus affecting leakage during system standby conditions. Furthermore, the loop seal assures that steam continues to enter the isolation condenser preferentially through the steam riser, irrespective of water level inside the reactor, and does not move counter-current back up the condensate return line.

During ICS normal operation, noncondensable gases collected in the isolation condenser are vented from the isolation condenser top and bottom headers to the suppression pool. Venting is controlled as follows:

- Two normally closed, fail-closed, solenoid-operated lower header vent valves are located in the vent line from the lower headers. They can be actuated both automatically (when RPV pressure is high and either of condensate return valves is open) and manually by the control room operator. There is a bypass line around the lower header vent valves, which contains one relief valve and one normally closed, fail-open solenoid valve. The valves are designed to open automatically (with or without power) at a pressure set point higher than that of the primary lower header vent valves and at a lower pressure that what is needed to lift the SRVs.

operation or isolation of each of the four separate isolation condenser trains as shown in Figure 7.4-3. The actuating logic and actuator power for the inner isolation valves for the four ICS trains are on two safety-related 120 VAC divisional UPS (Refer to Subsection 8.3.1.1.3) different from the two divisional power sources for the outer isolation valves.

ICs are initiated by two-out-of-four logic in the four divisions of SSLC/ESF inter-divisional signals are isolated at the source and transmitted using optical fiber. Each of the four IC equipment trains can be initiated by either DPS or any one of three SSLC/ESF divisions and their associated safety-related power source. Consequently, the loss of two of the four safety-related power supplies does not result in the loss of any one ICS equipment train. However, second and third sources of safety-related power are provided to operate the ICS automatic venting system during long-term ICS operation; otherwise the manually controlled backup venting system, which uses one of the divisional power sources starting the ICS, can be used for long-term operation.

If the three safety-related power supplies used to start an individual ICS equipment train fail, then the ICS would automatically start, because of the "fail open" actuation of the condensate return bypass valves upon loss of electrical power to the solenoids controlling its nitrogen-actuated valves.

The ICS is initiated automatically as part of the ECCS to provide additional liquid inventory to mitigate LOCA events. The signals that initiate ICS operation are:

- High reactor pressure;
- Low reactor water level (Level 2) with time delay;
- Low reactor water level (Level 1);
- Loss of power generation buses (loss of feedwater flow) in reactor run mode;
- MSIV position indication (indicating closure) whenever the Reactor Mode Switch is in the Run position; and
- Operator manual initiation.

The operator is able to stop any individual ICS equipment train whenever the RPV pressure is below a reset value overriding the ICS automatic actuation signal following MSIV closure.

The IC/PCCS pool has four safety-related level sensors in each IC/PCCS inner expansion pool. These level sensors are part of the Fuel and Auxiliary Pool Cooling System (FAPCS). Each IC/PCCS inner expansion pool is connected to the equipment storage pool by two cross-connect valves in parallel where one valve is a pneumatic operated valve with an accumulator and two load drivers per initiator (actuation similar to Figure 7.4-3) and the other is a squib valve with three load drivers per initiator (actuation similar to Figure 7.3-2). Each valve has four initiators (three divisional initiators and one DPS initiator [see Section 7.8]). These valves open when a low water level condition is detected in ~~either of~~ the IC/PCCS inner expansion pool~~s~~ to which they are connected to provide makeup water for the first 72 hours of design basis events. The residual heat removal function of the safety-related ICS is further backed up by the safety-related ESF combination of ADS, PCCS, and GDCS; by the nonsafety-related RWCU/SDC loops; or by the makeup function of the CRD system operating in conjunction with safety relief valves and the suppression pool cooling systems.

water-level setpoint is established to prevent inadvertent draining of the IC/PCCS expansion pool water below the minimum safe level.

The instruments provide necessary information to the operator for refilling the IC/PCCS pools following an accident. Safety-related water level sensors are included to allow ICS to automatically open the pool cross-connect valves between the equipment storage pool and the IC/PCCS expansion pools when a low water level is detected in ~~either of~~ the IC/PCCS inner expansion pools to which the valves are connected to provide makeup water to support design basis events, as discussed and evaluated in Subsection 7.4.4. The FAPCS also includes nonsafety-related IC/PCCS expansion pool level sensors for use by DPS as described in Subsection 7.8.1.2.5.

Spent Fuel Pool

The FAPCS provides the Spent Fuel pool with safety-related instruments that monitor water level. Each instrument generates a high and low water level signal when the water level reading increases above or decreases below its setpoint. Anti-siphoning holes are provided in all submerged portions of FAPCS discharge lines at the elevation of normal water level to prevent significant draining of the pool in the event of a pipe break. These level instruments are safety-related to ensure proper level is maintained.

The skimmer surge tanks are used for receiving overflow water from the spent fuel pool, and as a pump suction source during the spent fuel pool-cooling mode of operation. These tanks are provided with instruments that monitor their water level. The instruments generate high-high, high, low, or low-low water level signals when the water level reading increases above or decreases below its setpoint. The high and low level signals are used for the opening and closing of the Condensate Storage and Transfer System valve for makeup water to skimmer surge tanks. The high-high and low-low signals initiate high and low water level alarms in the MCR. Additionally, the low level signal is used for tripping the FAPCS pump operating in the spent fuel pool-cooling mode. The high level setpoint is established to avoid overflow of skimmer surge tank water. The low water level setpoint is established to prevent inadvertent draining of the tank water below the minimum safe level.

The level instruments for the spent fuel pool are classified as safety-related components because they provide necessary information to the operator for performing the safety-related function of refilling the spent fuel pool following an accident.

Buffer Pool

The FAPCS provides the buffer pool with safety-related instruments that monitor water level. Each instrument generates low water level signals when the water level reading decreases below its setpoint. Each low-level signal initiates an alarm in the MCR.

The level instruments for the buffer pool are classified as safety-related components because they provide necessary information to the operator for refilling the buffer pool following an accident.

7.5.5.1 System Design Bases

See Subsection 9.1.3.1.

- With logic similar to the SSLC/ESF, the DPS initiates the ICS on high RPV dome pressure, low RPV water level (Level 2), or MSIV closure to provide core cooling.
- The DPS trips the feedwater pumps on high RPV water level (Level 9).
- The DPS opens pool cross-connect valves between the equipment storage pool and the IC/PCCS expansion pools when a low level condition is detected in either of the IC/PCCS inner– expansion–poolspool to which the valves are connected. DPS uses the four nonsafety-related level sensors in each IC/PCCS inner expansion pool which are part of FAPCS (Subsection 9.1.3.5).

The diverse protection logics for ESF function initiation, in combination with the ATWS mitigation feature, other diverse backup scram protection, and selected diverse RPS logics provide the diverse protection necessary to satisfy the design position specified in BTP HICB-19.

7.8.1.3 Diverse Manual Controls and Displays

All safety-related systems have displays and controls located in the MCR that provide manual system-level actuation of their safety-related functions and monitoring of parameters that support those safety-related functions.

In addition to the manual controls and displays for the safety-related reactor protection and SSLC/ESF functions, the DPS also has displays and manual control functions that are independent and diverse from those of the safety-related protection and SSLC/ESF functions. They are not subject to the same common mode failure as the safety-related protection system components. The manual controls permit manual initiation of the SRV, DPV, GDCS, and SLC System valves, and the ICS.

The operator is provided with a set of diverse displays separate from those supplied through the safety-related software platform. The displays that provide independent confirmation of the status of major process parameters include:

- Reactor pressure;
- Reactor pressure high alarm;
- RPV water level;
- RPV water level high alarm;
- RPV water level low alarm;
- Drywell pressure;
- Drywell pressure high alarm;
- Drywell water level;
- Drywell water level high alarm;
- Suppression pool temperature;
- Suppression pool temperature high alarm;
- SRV solenoid-controlled valves opening;

their supporting systems are electrically and physically separated. Pneumatic power assisted containment isolation valves on the suppression pool supply and return lines are designed to fail as-is upon loss of its electric power or pneumatic (air or nitrogen) supply. All other containment isolation valves are designed to fail closed.

Provisions are provided to protect FAPCS components from fire, missile generating event, plant internal flooding, or seismic event of intensity up to and including a Safe Shutdown Earthquake (SSE) so that sufficient capability is retained for the fuel pool cooling function.

The FAPCS is designed to permit surveillance testing and in-service inspection of the safety-related components in accordance with ASME Section XI. Additionally, the FAPCS is designed to permit leak rate testing of its components required to perform containment isolation, in accordance with 10 CFR 50 Appendix J.

Piping and components completely separate from FAPCS pool cooling piping provide flow paths for post-accident makeup water transfer from the Fire Protection System (or offsite water supply sources) to the IC/PCCS pool andor spent fuel pool. Active FAPCS valves located inside the RB are not required to operate to accomplish this makeup. This piping and components are designed to meet Quality Group C and Seismic Category I requirements.

The equipment storage pool and reactor well contains valves that, when opened, create a connection between the two IC/PCCS expansion pools through the equipment storage pool. These valves are designed to open upon receiving a low level signal from either of the IC/PCCS expansion pools to which they are connected., and allow makeup water supplied to one of the IC/PCCS expansion pools to communicate with the other expansion pool.

Branch connections are provided on the suppression pool suction line and return line, which serve as attachments for portable external cooling equipment that bypasses the FAPCS cooling and cleanup trains.

FAPCS piping and components, relied upon for containment integrity, are designed to Quality Group B and Seismic Category I requirements.

System Operation

FAPCS cooling and cleanup trains operate continuously to cool and clean the water in the Spent Fuel Pool during normal plant operation and refueling outages. Operation of only one FAPCS cooling and cleanup train is sufficient to handle the cooling requirements under the normal heat load condition in the Spent Fuel Pool. Operation with up to two FAPCS cooling and cleanup trains is sufficient to handle the cooling requirement under the maximum heat load condition. At least one FAPCS cooling and cleanup train is available for cooling the Spent Fuel Pool, except for a short period as long as the water temperature in the pool remains below the maximum temperature limit for normal operation.

During a refueling outage, FAPCS can be operated in the Fuel and Auxiliary Pool Cooling and Cleanup mode with both cooling and cleanup trains under the maximum heat load condition in the Spent Fuel Pool.

If necessary the FAPCS can operate in a dual mode using two separated FAPCS cooling and cleanup trains with separate suction and discharge piping loops. However, dual mode operation using a single train is prohibited by logic in the Nonsafety-related Distributed Control and

B 3.3 INSTRUMENTATION

B 3.3.8.1 Diverse Protection System (DPS)

BASES

BACKGROUND

The DPS comprises a portion of the diverse instrumentation and control systems that are part of the diversity and defense-in-depth strategy.

The DPS functions are implemented in the Nonsafety-Related Distributed Control and Information System (N-DCIS) as a highly reliable, triple redundant control system whose sensors, hardware and software are diverse from their counterparts on any of the safety-related instrumentation and control systems. The DPS is a nonsafety-related, triple redundant system powered by redundant nonsafety-related load group power supplies.

DPS provides a set of initiation logics that provide a diverse means to initiate certain engineered safety feature (ESF) functions using sensors, hardware and software that are separate from, and independent of, the primary ESF systems. The ESF Functions include core cooling provided by the Gravity-Driven Cooling System (GDCS) and the Automatic Depressurization System (ADS) function using safety relief valves (SRVs) and depressurization valves (DPVs). The initiating logic is based on Reactor Pressure Vessel Level – Low, Level 1.

The initiation logic is "energize to actuate," similar to that described in the Bases for LCO 3.3.5.1, " Emergency Core Cooling System (ECCS) Instrumentation," and LCO 3.3.5.2, " Emergency Core Cooling System (ECCS) Actuation." The diverse ECCS automatic initiation signal is based on two-out-of-four coincident logic processed by triple redundant processors. If the DPS ECCS initiation signal persists for 10 seconds, the logic seals in and a DPS ECCS start signal is initiated. Manual initiation requires operation of two switches, with each switch requiring two distinct operator actions. The manual initiation signal is based on two-out-of-two coincident logic processed by triple redundant processors. A coincident logic trip decision is required from two-out-of-three processors to generate the start signal. Series discrete output switches independently process the two-out-of-three voted start signal. A valid initiation signal from all series output switches is required to generate diverse actuation.

BACKGROUND (continued)

For the ADS SRV opening function, three of the four solenoids on each SRV are powered by three of the four divisional safety-related power sources in the Safety System Logic and Control Engineered Safety Features (SSLC/ESF) ADS described in the Bases for LCO 3.3.5.1 and LCO 3.3.5.2. A fourth solenoid on each SRV is powered by the nonsafety-related load group, with the trip logic controlled by DPS. All ten SRVs in the ADS are controlled by the DPS through the fourth solenoid on each valve.

For the ADS DPV opening function, one of the four squib initiators on each DPV is controlled by and connected to the nonsafety-related DPS logic. The other three solenoids are controlled by the SSLC/ESF ADS logic described in the Bases for LCO 3.3.5.1 and LCO 3.3.5.2. It takes three simultaneous DPS trip signals in a triple redundant logic path to initiate the squib valve opening.

The logic application for the GDCS squib valves from the DPS is similar to that of the DPV logic application described above. For the GDCS squib valve-opening function, one of the four squib initiators on each GDCS valve is controlled by and connected to the nonsafety-related DPS logic. The DPS logic requires three simultaneous GDCS trip initiation signals to initiate a GDCS squib valve opening.

The DPS also performs selected containment isolation functions as part of the diverse ESF function using two-out-of-four sensor logic and two-out-of-three processing logic. The containment isolation functions performed by DPS include closure of the Reactor Water Cleanup and Shutdown Cooling (RWCU/SDC) isolation valves on Reactor Water Cleanup/Shutdown Cooling System Differential Mass Flow - High.

The DPS also opens ~~equalizing~~pool cross-connect valves between the equipment storage pool and the Isolation Condenser/Passive Containment Cooling System (IC/PCCS) expansion pools when a low level condition is detected in ~~either of~~ the IC/PCCS inner expansion pool to which the valves are connected. Each IC/PCCS pool is connected to the equipment storage pool by two cross-connect valves in parallel where one valve is a pneumatic operated valve with an accumulator and the other is a squib valve. Each expansion pool-to-equipment pool cross-connect~~isolation~~ squib valve is equipped with four~~three~~ squib initiators. The expansion pool-to-equipment pool cross-connect~~isolation~~ pneumatic valves are equipped with four~~three~~ solenoid valves (i.e., initiators). A signal to any of the four~~three~~ initiators will actuate the valve. One of the four~~three~~ initiators on each valve is actuated by DPS.

BASES

APPLICABLE SAFETY ANALYSES, LCO, and APPLICABILITY

The DPS Functions are required to provide a diverse capability to actuate the specified safety-related equipment based on risk importance (Ref. 1). The DPS Functions are not credited for mitigating accidents in the safety analyses (Ref. 2). The DPS satisfies Criterion 4 of 10 CFR 50.36(c)(2)(ii).

Each Function must have its setpoint in accordance with the Setpoint Control Program (SCP), where appropriate. The actual setpoint is calibrated consistent with the SCP.

Nominal Trip Setpoints ($NTSP_F$s) are specified in the Setpoint Control Program (SCP), as required by Specification 5.5.11. The $NTSP_F$s are selected to ensure the actual setpoints are conservative with respect to the Allowable Value between successive CHANNEL CALIBRATIONS. Operation with a trip setpoint less conservative than the $NTSP_F$, but conservative with respect to its Allowable Value, is acceptable. A Function is inoperable if its actual trip setpoint is non-conservative with respect to its required Allowable Value.

$NTSP_F$s are those predetermined values of output at which an action should take place. The setpoints are compared to the actual process parameter (e.g., reactor vessel water level), and when the measured output value of the process parameter exceeds the setpoint, an actuation signal is generated. For those limiting safety system settings (LSSS) related to variable protecting Safety Limits (SLs), the Analytical Limits are derived from the limiting values of the process parameters obtained from the safety analysis. For those LSSS related to variables having significant safety functions but which do not protect SLs, the Design Limits are those settings that must initiate automatic protective actions consistent with the design basis. The Allowable Values are derived from the Analytical / Design Limits, corrected for calibration, process and some of the instrument errors. The $NTSP_F$s are then determined accounting for the remaining instrument errors (e.g., drift). The trip setpoints derived in this manner provide adequate protection because instrumentation uncertainties, process effects, calibration tolerances, instrument drift and severe environment errors (for instrumentation that must function in harsh environments as defined by 10 CFR 50.49) are accounted for.

The specific Applicable Safety Analyses, LCO, and Applicability discussions are listed below on a Function-by-Function basis.

BASES

APPLICABLE SAFETY ANALYSES, LCO, AND APPLICABILITY (continued)

1.a, 2.a Reactor Vessel Level – Low, Level 1

Automatic actuation of ADS (consisting of the SRVs and DPVs) and GDCS injection occurs upon detection of Reactor Vessel Level – Low, Level 1. Reactor Vessel water level is detected by four wide range water level sensors that are different from those used for the SSLC/ESF wide range level sensors. Low RPV water level indicates the capability to cool the fuel may be threatened. Should RPV water level decrease too far, fuel damage could result.

The Reactor Vessel Level - Low, Level 1 Function is required to be OPERABLE in MODES 1, 2, 3, and 4, consistent with the assumptions in Reference 1.

1.b, 2.b Drywell Pressure – High (Manual Actuation)

Manual controls are provided for ADS (consisting of the SRVs and DPVs) and GDCS injection initiation upon detection of high drywell pressure sustained for 60 minutes. This control is provided to mitigate small and medium break LOCA scenarios that do not result in GDCS and ADS initiation from low RPV water level. This Function also requires OPERABILITY of DPS indication of the high drywell pressure condition.

The Drywell Pressure – High (Manual Actuation) Function is required to be OPERABLE in MODES 1, 2, 3, and 4 consistent with the assumptions in Reference 1.

3.a Reactor Water Cleanup/Shutdown Cooling System Differential Mass Flow - High

Automatic isolation of RWCU/SDC occurs upon detection of Reactor Water Cleanup/Shutdown Cooling System Differential Mass Flow - High. Isolation of the RWCU System is initiated when RWCU/SDC System Differential Mass Flow - High is sensed to prevent exceeding off-site doses.

The function of the RWCU/SDC isolation valves, in combination with other accident mitigation systems, is to limit fission product release during a postulated Design Bases Accident (DBA).

The Reactor Water Cleanup/Shutdown Cooling System Differential Mass Flow - High Function is required to be OPERABLE in MODES 1, 2, 3, and 4, consistent with the assumptions in Reference 1.

BASES

APPLICABLE SAFETY ANALYSES, LCO, AND APPLICABILITY (continued)

4.a Isolation Condenser/Passive Containment Cooling System Pool Level - Low

Automatic actuation of the IC/PCCS expansion pools-to-equipment pool cross-connect occurs upon detection of Isolation Condenser/Passive Containment Cooling System Pool Level – Low in either of the associated IC/PCCS inner expansion pools. Actuation of the IC/PCCS expansion pools-to-equipment pool cross-connect ensures a sufficient quantity of water is available for decay heat removal in the event of a design basis accident.

The Isolation Condenser/Passive Containment Cooling System Pool Level – Low Function is required to be OPERABLE in MODES 1, 2, 3, and 4, consistent with the assumptions in Reference 1.

ACTIONS

A Note has been provided to modify the ACTIONS related to the DPS Functions. Section 1.3, Completion Times, specifies once a Condition has been entered, subsequent divisions, subsystems, components or variables expressed in the Condition discovered to be inoperable or not within limits, will not result in separate entry into the Condition. Section 1.3 also specifies Required Actions of the Condition continue to apply for each additional failure, with Completion Times based on initial entry into the condition. However, the Required Actions for inoperable DPS Functions provide appropriate compensatory measures for separate inoperable Functions. As such, a Note has been provided which allows separate Condition entry for each inoperable DPS Function.

A.1

In this Condition, required safety-related initiators will actuate the components assumed in the design basis LOCA analysis in Reference 2 concurrent with any additional single failure. However, design features intended to mitigate digital protection system common mode failures may not be available.

In this Condition, the inoperable Function must be restored to OPERABLE status within 30 days. This Completion Time is acceptable because the required safety-related initiators will actuate the minimum number of components required to respond to the design basis LOCA concurrent with any additional single failure.

B 3.7 PLANT SYSTEMS

B 3.7.1 Isolation Condenser/Passive Containment Cooling System (IC/PCCS) Pools

BASES

BACKGROUND

The Ultimate Heat Sink (UHS) is the IC/PCCS Pools that transfer heat from the Isolation Condenser System (ICS) and the PCCS to the atmosphere (Ref. 1). The ICS removes heat from the Reactor Coolant System (RCS) following RCS isolation, a loss of feedwater or a Loss of Coolant Accident (LOCA). The PCCS removes heat from the containment following a LOCA or any transient that releases heat to the containment.

The IC/PCCS pools are located above and outside the containment boundary, directly above the drywell top slab. The condenser module associated with each ICS train and PCCS condenser is submerged in a separate subcompartment of the IC/PCCS pools. Subcompartments (i.e., pools) P3A, P3B, P3C, and P3D contain the condenser modules for the ICS trains. Subcompartments P4A, P4B, P4C, P3D, P4E, and P4F contain the condenser modules for the PCCS condensers.

Heat from the ICS and PCCS condensers is transferred to water in the associated subcompartment causing the water in the subcompartment to boil. Following reactor pressure vessel (RPV) isolation or a LOCA, subcompartment water temperature could rise to about 102°C (216°F). The steam formed will be non-radioactive and have a slight positive pressure. The steam from each subcompartment collects in the common air/steam space above the subcompartments and IC/PCCS pools. The steam is then released to the atmosphere through two large-diameter discharge vents located on opposite sides of the expansion pools. A moisture separator is installed at the entrance to the discharge vent lines to preclude excessive moisture carryover and loss of IC/PCCS pool water. No forced circulation equipment is required for operation (Refs. 2 and 3).

To support decay heat removal for 72 hours without operator action, water must be supplied to the ICS and PCCS subcompartments to replace the water lost by boiling. This water is supplied from the two IC/PCCS expansion pools, the equipment pool, and the reactor well pool.

Each ICS and PCCS subcompartment is connected to its associated expansion pool by a manually operated valve located below the water level, which allows makeup water from the expansion pool to flow into the bottom of the subcompartment. The subcompartment isolation valves are

BASES

BACKGROUND (continued)

normally locked open so that the full inventory of the associated expansion pool is available to any subcompartment. The subcompartment isolation valves can be closed to isolate a subcompartment allowing it to be emptied for maintenance of the condenser.

In addition to the ICS and PCCS subcompartments, each expansion pool is partitioned into three parts. Manually operated valves, which are normally locked open, separate each partition.

The equipment pool is connected to the reactor well pool through the reactor well gate, which is not installed during normal plant operation. By connecting the equipment pool and reactor well pool to the expansion pools, the volume of water available to the ICS and PCCS subcompartments is sufficient to support decay heat removal for 72 hours without operator action or the need to replenish the water in the expansion pools.

The equipment pool and reactor well pool are normally isolated from the expansion pools because the equipment pool and reactor well are maintained at a higher water level than the expansion pools. Each of the two expansion pools is connected to the equipment pool by two piping connections. One connection to each expansion pool is isolated by a squib-actuated cross-connect valve and the other connection is isolated by a fail-as-is double acting pneumatic piston cross-connect valve. Each connection also includes a manually operated valve, which is normally locked open. Opening one piping connection from the equipment pool to each expansion pool provides the required makeup from the equipment pool to the expansion pools.

The Safety System Logic and Control/Engineered Safety Features (SSLC/ESF) System controls the initiation signals and logic for the opening of the IC/PCCS expansion pool-to-equipment pool cross-connect valves. SSLC/ESF is a four division, separated protection logic system designed to provide a very high degree of assurance to both ensure initiation when required and prevent inadvertent initiation. The input and output trip determination is based upon a two-out-of-four logic arrangement. Each division of SSLC/ESF is configured such that all functions (e.g., the digital trip module (DTM) function and voter logic unit (VLU) function) are implemented in triply redundant processors to support the requirement that single divisional failures cannot result in inadvertent actuation.

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BACKGROUND (continued)

Four separate instrument channels are used to monitor each IC/PCCS inner expansion pool level. Signals from sensors are multiplexed at the divisional level and the triply redundant sensor data is then transmitted to the SSLC/ESF triply redundant digital trip module (DTM) function for setpoint comparison. The output of each divisional DTM function (a trip/no-trip condition) is routed to all four divisional triply redundant VLU functions such that each divisional VLU function receives input from each of the four divisional DTM functions.

For maintenance purposes and added reliability, each DTM function has a division of sensors bypass such that all instruments in that division will be bypassed in the trip logic at the VLU functions. Thus, each VLU function will be making its trip decision on a two-out-of-three logic basis for each variable. It is possible for only one division of sensors bypass condition to be in effect at any time.

The processed trip signal from its own division and trip signals from the other three divisions are processed in the triply redundant VLU function for two-out-of-four voting. ~~All four of the~~Each pair of IC/PCCS expansion pool-to-equipment pool cross-connect valves receive an open signal on low level in ~~either~~ the associated inner expansion pool.

~~Four level instrument channels monitor each IC/PCCS expansion pool and initiate an opening signal to all four of the expansion pool-to-equipment pool isolation valves on low level in either expansion pool.~~

Each expansion pool-to-equipment pool cross-connect~~isolation~~ squib valve is equipped with ~~three~~four squib initiators. Each expansion pool-to-equipment pool cross-connect~~isolation~~ pneumatic valve is equipped with ~~three~~four solenoid valves (i.e., initiators). A signal to any of the ~~three~~four initiators will actuate the associated cross-connect valve. ~~As such, at least two of the three initiators in each valve will be associated with divisions required by LCO 3.8.6, "Distribution Systems - Operating."~~ ~~Two~~Three of the ~~three~~four initiators on each valve are actuated by ~~Safety-Related Distributed Control and Information System (Q-DCIS)~~SSLC/ESF. As such, at least two of the three safety-related initiators on each valve will be associated with divisions required by LCO 3.8.6, "Distribution Systems - Operating." The ~~third~~fourth initiator is actuated by the Diverse Protection System (DPS), which is designed to mitigate digital protection system common mode failures.

Cooling and clean up of IC/PCCS pool water is performed by Fuel and Auxiliary Pools Cooling System (FAPCS). The FAPCS includes a

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separate subsystem with its own pump, heat exchanger, and water treatment unit that is dedicated for cooling and cleaning of the IC/PCCS pools to prevent radioactive contamination of the IC/PCCS pools. The FAPCS includes flow paths for post-accident make-up water transfer, from the fire protection system and off-site water supply sources to the IC/PCCS pools (Ref. 1).

APPLICABLE SAFETY ANALYSES

In the event of a LOCA, the passive PCCS is required to maintain the containment peak pressure and temperature below design limits for at least 72 hours after the LOCA without operator action (Ref. 3).

In the event of reactor isolation or a station blackout, the ICS must maintain the reactor coolant system pressure and temperature below design limits and remove core decay heat for at least 72 hours after reactor isolation without operator action (Ref. 2).

The IC/PCCS pools are also needed as a heat sink for the ICS condensers when ICS is used as a backup to the Reactor Water Cleanup/Shutdown Cooling (RWCU/SDC) System for decay heat removal when shutdown.

The IC/PCCS pools satisfy Criterion 3 of 10 CFR 50.36(c)(2)(ii).

LCO

This LCO requires that the IC/PCCS pools are OPERABLE. Operability requires the IC/PCCS pools be maintained within specified limits for minimum level and maximum average temperature.

To ensure that the total volume of water in the IC/PCCS pools is available to the ICS and PCCS condensers, manual isolation valves between the partitions within each expansion pool and between the equipment pool and each expansion pool must be locked open. Cross-connect~~Isolation~~ valves between the equipment pool and the expansion pools must open automatically on a low water level signal from ~~either~~the associated expansion pool. Additionally, the reactor well gate, which connects the reactor well to the equipment pool, must be removed.

OPERABILITY of the expansion pool-to-equipment pool cross-connect function ~~isolation valves~~ requires OPERABILITY of three channels of ~~the~~safety-related IC/PCCS expansion pool level instrumentation in each pool and three safety-related actuation logic divisions. OPERABILITY of an instrumentation channel requires OPERABILITY of the instrumentation from the input variable sensor through the DTM function. Each