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Subject: **Partial GEH Response to NRC Request for Additional Information Letter No. 96 Related to ESBWR Design Certification Application, RAI Numbers 14.3-146**

The purpose of this submittal is to provide a response to a U.S. Nuclear Regulatory Commission (NRC) Requests for Additional Information (RAIs) contained in NRC Letter No. 96, dated April 12, 2007 (Reference 1). Enclosure 1 contains GEH response to RAI Number 14.3-146.

If you have any questions or require additional information regarding the information provided here, please contact me.

Sincerely,

James C. Kinsey

James C. Kinsey
Vice President, ESBWR Licensing

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NRO

Reference:

1. MFN 07-231, Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, *Request for Additional Information Letter No. 96 Related to ESBWR Design Certification Application,* April 12, 2007.

Enclosure:

1. Response to Portion of NRC Request for Additional Information Letter No. 96 Related to ESBWR Design Certification Application, DCD Tier 1, RAI Number 14.3-146

cc:	AE Cubbage	USNRC (with enclosure)
	GB Stramback	GEH/San Jose (with enclosure)
	RE Brown	GEH/Wilmington (with enclosure)
	DH Hinds	GEH/Wilmington (with enclosure)
	eDRF	0000-0073-0421\1 NRC RAI 14.3-146

Enclosure 1

MFN 08-196

Response to Portion of NRC Request for

Additional Information Letter No. 96

Related to ESBWR Design Certification Application

DCD Tier 1

RAI Number 14.3-146

NRC RAI 14.3-146

NRC Summary:

Request for additional ITAAC on IC/PCC pool capacity and for verification of ICS drain line flow resistance.

NRC Full Text:

The staff believes the following ITAAC are needed in DCD Tier 1,Table 2.4.1-1:

A. Add ITAAC to verify that the as-built design provides the total volume of the isolation condenser (IC)/passive containment cooling system (PCCS) expansion pool as assumed in the safety analysis. Specify the value for the required volume in the acceptance criteria.

B. Add ITAAC to verify the flow resistance for each ICS condensate line as follows:

Design Commitment: ICS provides safety injection during design basis events.

Inspections, Tests, Analyses: A low-pressure injection test and analysis for each ICS condensate line to the RPV will be conducted. Each IC/PCCS expansion pool will be initially filled with water. All valves in these lines will be open during the test.

Acceptance Criteria: The calculated flow resistance for each ICS condensate line to the RPV between the IC/PCCS expansion pool and the reactor vessel is ________.

GEH Response

Note that some tables have been renumbered for Tier 1 Revision 4. Table 2.4.1-1 has been renumbered 2.4.1-3.

A. The 72-hour safety related decay heat removal assumes water is available from the reactor well, dryer/separator pool, and the IC/PCC pools. The combined volume of these pools is 6,290 m^3 (222,000 ft^3). In Tier 1 Table 2.4.1-3, the acceptance criteria for ITAAC Item 24 has been modified to define this total volume required for 72 hours of safety related decay heat removal.

B. The heat removal capacity is a key safety significant parameter for the ICS. However, the ICS performance is not determined by controlling the drain line flow resistance. Rather, the heat removal capacity of these heat exchangers will be tested as defined in DCD Tier 1 Rev. 4, Table 2.4.1-3. Therefore, as long as the heat removal capacity is tested and verified, a maximum flow resistance ITAAC for the ICS condensate return line is not needed, nor required.

DCD Impact

A. DCD Tier 1, Table 2.4.1-3 will be revised as noted in the attached markup.

   DCD Tier 2, Section 5.4.6 will be revised as noted in the attached markup.

B. No DCD Change

Table 2.4.1-3

ITAAC For The Isolation Condenser System

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
23. Each ICS train provides at least [13.88 m^3 (490 ft^3)] drainable liquid volume available for return to the RPV.	An analysis will be performed for the as-built isolation condenser system.	An analysis exists and demonstrates that the as-built ICS trains provides the required volume of liquid available for return to the RPV.
24. The Dryer/Separator Pool and Reactor Well provide sufficient makeup water volume to the IC/PCC expansion pool to support operation of the ICS and PCCS for the first 72 hours..	a) A valve-opening test will be performed using simulated low-level water signal from the IC/PCC expansion pool. b) ~~An analysis will be performed to demonstrate the as-built Dryer/Separator Pool and Reactor Well provide sufficient makeup water volume to the IC/PCC expansion pool on a low water signal in the initial 72 hours of a LOCA.~~A physical measurement will be performed on the dimensions and water level in the IC/PCC pools, Dryer / Separator Pool, and Reactor Well to demonstrate that the required water volume is achieved.	a) Test report(s) document that the two-series, valves open on a simulated low-level water signal from the IC/PCC expansion pool. b). ~~An analysis exists and demonstrates that the as-built Dryer/Separator Pool and Reactor Well provide sufficient makeup water volume to the IC/PCC expansion pool on a low water signal in the initial 72 hours of a LOCA.~~Measurements show that the combined water volume of the IC/PCC pools, Dryer / Separator Pool, and Reactor Well is no less than 6,290 m^3 (222,000 ft^3).

5.4.6.2 System Description

5.4.6.2.1 Summary Description

The ICS consists of four independent trains, each containing an isolation condenser (IC) that condenses steam on the tube side and transfers heat to the IC/PCC pool, which is vented to the atmosphere as shown on the ICS schematic.

The IC, connected by piping to the reactor pressure vessel, is placed at an elevation above the source of steam (vessel) and, when the steam is condensed, the condensate is returned to the vessel via a condensate return pipe.

The steam side connection between the vessel and the IC is normally open and the condensate line is normally closed. This allows the IC and drain piping to fill with condensate, which is maintained at a subcooled temperature by the pool water during normal reactor operation.

The IC 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 IC as shown on the ICS schematic (Figure 5.1-3 and 5.4-4a & b).

Each IC 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/PCC expansion pool) positioned above, and outside, the ESBWR containment (drywell).

The IC 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 IC at its maximum heat transfer capacity while addressing the concern of IC breaks downstream of the steam supply pipe. Steam is condensed inside 135 Inconel 600 vertical tubes and condensate is collected in two lower headers. 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 IC 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 (IC system standby conditions), an excess of noncondensable gases does not accumulate in the IC steam supply line, thus assuring that the IC 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.

- 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 (nitrogen-operated, fail as is) and (2) a condensate return bypass valve (nitrogen piston operated, fail open). Two different valve actuator types are used to ensure 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 IC and develops a level up to the steam distributor, above the upper headers. To start an IC into operation, the nitrogen motor-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 IC 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 $9 m^3$ ($318 ft^3$). The added inventory the inline vessel supports:
  - Use of a single level logic for 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 dryer/separator pool and reactor well are designed to have sufficient water volume to provide makeup water to the IC/PCC expansion pools for the initial 72 hours of a LOCA response. This water is be provided through ICS connections between the dryer/separator pool and IC/PCC pools. These connections open passively when the level in the IC/PCC pool reaches a low set point relative to the level in the Dryer/Separator pool. The IC/PCC pools, dryer / separator pool, and reactor well have a minimum combined water inventory of no less than $6{,}290 m^3$ 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 IC 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 IC are vented from the IC 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. Two normally closed, solenoid-operated lower header bypass