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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 155 Related to ESBWR Design Certification Application - Technical Specifications - RAI Number 16.2-74 S03**

Enclosures 1 and 2 contain the subject supplemental RAI response resulting from NRC RAI Letter No. 155. The GE Hitachi Nuclear Energy (GEH) responses to the original, S01, and S02 RAIs were provided in References 1, 2, and 3.

Verified DCD changes associated with this RAI response are identified in the enclosed DCD markups by enclosing the text within a black box. The marked-up pages may contain unverified changes in addition to the verified changes resulting from this RAI response. Other changes shown in the markup(s) may not be fully developed and approved for inclusion in DCD Revision 5

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

Sincerely,

  
James C. Kinsey  
Vice President, ESBWR Licensing

DC68  
NRC

References:

1. MFN 07-022, Letter from Jim Kinsey to U.S. Nuclear Regulatory Commission, *Response to Portion of NRC Request for Additional Information Letter No. 63 Related to ESBWR Design Certification Application – Technical Specifications – RAI Numbers 16.2-23, 16.2-30, 16.2-45, 16.2-50, 16.2-54, 16.2-73, 16.2-74, 16.2-76, and 16.2-77*, January 19, 2007
2. MFN 06-431, Supplement 3, Letter from Jim Kinsey to U.S. Nuclear Regulatory Commission, *Response to Portion of NRC Request for Additional Information Letter No. 63 Related to ESBWR Design Certification Application – Technical Specifications – RAI Numbers 16.2-46 S01, 16.2-74 S01, and 16.2-80 S01*, May 14, 2007
3. MFN 07-022, Supplement 6, Letter from Jim Kinsey to U.S. Nuclear Regulatory Commission, *Response to Portion of NRC Request for Additional Information Letter No. 114 Related to ESBWR Design Certification Application – Technical Specifications – RAI Number 16.2-74 S02*, January 17, 2008

Enclosures:

1. MFN 07-022, Supplement 8 - Response to Portion of NRC Request for Additional Information Letter No. 155 Related to ESBWR Design Certification Application - Technical Specifications - RAI Number 16.2-74 S03
2. MFN 07-022, Supplement 8 – DCD Markups for RAI Number 16.2-74 S03

cc: AE Cubbage USNRC (with enclosures)  
DH Hinds GEH (with enclosures)  
RE Brown GEH (with enclosures)  
eDRFs 59-5595/6 (16.2-74 S03),  
59-5595/5 (16.2-74 S02),  
60-4196/3 (16.2-74 S01),  
60-4196 (16.2-74)

**Enclosure 1**

**MFN 07-022 Supplement 8**

**Response to Portion of NRC Request for**

**Additional Information Letter No. 155**

**Related to ESBWR Design Certification Application**

**- Technical Specifications -**

**RAI Number 16.2-74 S03**

**NRC RAI 16.2-74**

*Provide basis for not including an operability requirement for a decay heat removal method in the refueling mode with the head fully detensioned or removed. DCD Tier 2, Rev. 1, Chapter 16, TS 3.5.5 states that use of the ICS as an emergency backup for decay heat removal in MODE 6 requires the reactor vessel head to be in place. Once the reactor vessel head is removed, loss of the normal decay heat removal method could result in boiling in the vessel. NUREG 1434, Rev. 3.1, specifies one or more heat removal paths operable, depending on water level, and one in operation. If the operating loop fails, an alternate residual heat removal loop must be placed in operation. If no alternate heat removal path is available at high water level, the required action specifies operation of the standby gas treatment system and establishment of secondary containment.*

*Provide the basis for not including an Operability requirement for a decay heat removal method in the refueling mode with the head fully detensioned or removed. Since the basis for TS 3.5.5 describes boiling within the vessel, describe how the heat would be transferred to an ultimate heat sink, and how the potential effects of boiling would be managed.*

**GE Response**

ESBWR Technical Specifications (TSs) do establish Operability requirements for safety-related decay heat removal (DHR) capability when in the refueling mode with the head fully detensioned or removed. The safety-related DHR capability provides adequate cooling following the unlikely loss of both of the redundant trains of the reactor water cleanup/shutdown cooling (RWCU/SDC) system, which provide the nonsafety-related decay heat removal capability in all Modes, including Mode 6 with head fully detensioned or removed.

Design Control Document (DCD) Tier 2, Revision 1, Chapter 16, LCO 3.5.3, "Gravity-Driven Cooling System (GDCS - Shutdown," provides safety-related DHR capability when in Mode 6 prior to water level being increased greater than 7.01 meters (23.0 feet) over the top of the reactor pressure vessel flange with the new fuel pool gate removed (i.e., reactor pressure vessel (RPV) not flooded). LCO 3.5.3 requires operability of four branch lines of the GDCS injection subsystem capable of injecting a combined volume equal to the volume of the two smaller GDCS pools when each is filled to the normal operating level. Prior to the removal of the head, GDCS operability requires sufficient RPV venting capacity to maintain the RPV depressurized following loss of the normal DHR capability. If the Automatic Depressurization System (ADS) is selected as the available vent path, decay heat is released to the containment atmosphere. If requirements for GDCS are not met, LCO 3.5.3, Actions, require establishing an operable Reactor Building boundary, similar to the actions in NUREG-1434 for establishing secondary containment.

When in Mode 6 with the water level greater than 7.01 meters (23.0 feet) over the top of the reactor pressure vessel flange and the new fuel pool gate removed (i.e., RPV flooded), the large amount of water stored above the core provides the safety-related DHR capability. Decay heat is released to the containment atmosphere. This approach is consistent with BWR/6 Standard Technical Specifications (STS), NUREG-1434, Revision 3.1, which also use the volume of water stored above the core as a safety-related DHR capability when the RPV is flooded.

General Electric (GE) has revised DCD Tier 2, Revision 1, Chapter 16, LCO 3.5.5, Isolation Condenser System (ICS) – Shutdown," to change the Applicability to eliminate "Mode 6 when

the reactor head is in place” because adequate safety-related DHR capability when in this configuration is provided by GDCS in LCO 3.5.3. As described above, GDCS-DHR capability provides the required cooling function following the unlikely loss of both of the redundant trains of the RWCU/SDC system, which provide the normal decay heat removal capability in all Modes, including Mode 6 with the head fully detensioned or removed.

**DCD Impact**

No additional DCD changes will be made in response to this RAI.

**NRC RAI 16.2-74, Supplement 1**

*The response to RAI 16.2-74 states that, prior to the removal of the head, GDCS operability requires sufficient Reactor Pressure Vessel (RPV) venting capacity to maintain the RPV depressurized following loss of the normal Decay Heat Removal (DHR) capability. This vent path is part of the primary success path for decay heat removal using the GDCS as a source of inventory makeup, and, therefore, satisfies Criterion 3 of 10 CFR 50.36 (c)(2)(ii). If the Automatic Depressurization System (ADS) is selected as the available vent path, decay heat is released to the containment atmosphere. However, no specific availability controls on the vent path are specified.*

*Provide supporting analyses and a suitable Limiting Condition for Operation for the Reactor Coolant System (RCS) vent path necessary to allow inventory makeup from GDCS to function as a decay heat removal method in Operational Mode 6 with the reactor vessel head in place.*

**GE Response**

General Electric will revise Design Control Document (DCD), Tier 2, Revision 3, Chapters 16 and 16B, LCO 3.5.3, "Gravity-Driven Cooling System (GDCS) - Shutdown," to include a Surveillance Requirement (SR) for reactor pressure vessel (RPV) venting capability. This SR will require verification that the RPV has venting capacity capable of maintaining the RPV sufficiently depressurized to allow GDCS injection following loss of decay heat removal capability.

**DCD Impact**

DCD Tier 2, Chapters 16 and 16B, Revision 4, will include the following SR and supporting Bases:

Specification 3.5.3 INSERT:

SURVEILLANCE		FREQUENCY
SR 3.5.3.1	Verify availability of RPV venting capacity sufficient to allow GDCS injection following loss of decay heat removal capability.	24 hours

Specification 3.5.3 Bases INSERT:

**SR 3.5.3.1**

This SR requires verification every 24 hours that the RPV has venting capacity capable of maintaining the RPV sufficiently depressurized to allow GDCS injection following loss of decay heat removal capability. This SR may be met by the OPERABILITY of the ADS function. The ADS capacity needed to meet this SR is established based on the existing decay heat and include an allowance for a single failure.

RPV vent paths other than the ADS may also be used to meet this SR provided those vent path(s) are sufficient for the existing decay heat load and are maintained open.

The 24 hour Frequency for performing this SR is based on engineering judgment. This Frequency is acceptable because this SR ensures that the required RPV venting capacity is available when required to support the decay heat removal function of the GDCS.

**NRC RAI 16.2-74, Supplement 2**

*In a supplement to RAI 16.2-74, the staff recommended providing a specification addressing the need to maintain a vent path for GDCS operability, when shutdown. In addition, TS availability controls should be provided for the RWCU/SDC system.*

*In its response, the applicant proposed a new SR for TS 3.5.3, GDC - Shutdown, to once per 24 hours "Verify availability of RPV venting capacity sufficient to allow GDCS injection following loss of decay heat removal capability."*

*In a teleconference between the NRC staff and the applicant on September 6, 2007, this SR was discussed. The staff suggested that the SR was actually an indirect expansion of the Applicability of the ADS from Modes 1 and 2, to add Mode 5, in order to support GDCS operability in the event of a loss of decay heat removal, because meeting the SR in Mode 5 would require making the ADS operable to provide the necessary vent path. The staff prefers revising the applicability of the ADS specification to the applicant's proposal to add a SR to the shutdown GDCS specification, recognizing that there may be other associated changes, such as to ECCS instrumentation function applicability. Pending revision of the applicability for TS 3.5.1 to include Mode 5, and other appropriate TS changes, this is designated Open Item 16.2-74.*

**GEH Response**

GEH will revise Surveillance Requirement (SR) 3.5.3.1 in Design Control Document (DCD), Tier 2, Revision 4, Chapters 16 and 16B, LCO 3.5.3, "Gravity-Driven Cooling System (GDCS) - Shutdown," to require periodic verification of the operability of sufficient Automatic Depressurization System (ADS) capacity to support the assumed GDCS injection following loss of decay heat removal capability. In conjunction with this change, GEH will add LCO 3.5.3, Condition B, to establish Actions that address GDCS inoperability due to inoperability of the required ADS function. Additionally, GEH will revise Function 1 in Table 3.3.5.2-1, Emergency Core Cooling System Actuation Instrumentation, in DCD, Tier 2, Revision 4, Chapter 16, to require operability of ADS actuation instrumentation in Mode 5 and in Mode 6 prior to the removal of the reactor pressure vessel head.

**DCD Impact**

See Enclosure 2 for changes to DCD Tier 2, Chapters 16 and 16B, LCO 3.3.5.2, "Emergency Core Cooling System (ECCS) Actuation," and LCO 3.5.3, "Gravity-Driven Cooling System (GDCS) - Shutdown," and their associated Bases.

**NRC RAI 16.2-74 Supplement 3**

1. *How does an operator know the number of required SRVs/DPVs as a function of the decay heat load? A table or figure should be added to specify the required number of SRVs and DPVs as a function of decay heat load or time since shutdown.*
2. *GTS SR 3.5.3.1 should state "For each of the SRVs and DPVs required by [table or figure], verify the ADS function is OPERABLE by verifying SR 3.5.1.1, SR 3.5.1.2, SR 3.5.1.3, SR 3.5.1.4, and SR 3.5.1.5, as applicable, are met, to ensure RCS venting capacity is sufficient to allow automatic GDCS injection following a loss of decay heat removal capability."*
3. *Required Action 3.5.3.B.1.1 should say, "Establish RCS vent flow path(s) with flow capacity equivalent to that of the SRVs and DPVs required by [table or figure]."*

**GEH Response**

As described in the response to RAI 19.1-96, Supplement 1, bounding analyses for LOCAs in Mode 5 show that two GDCS injection lines are capable of maintaining reactor pressure vessel (RPV) water level above top of active fuel when the RPV is depressurized by a vent equivalent to four depressurization valves (DPVs).

GEH will revise DCD Tier 2, Revision 4, Chapters 16 and 16B, LCO 3.5.3, "Gravity-Driven Cooling System (GDCS) - Shutdown," to require ADS valves with relief capacity equivalent to 4 DPVs are operable in Mode 5 and in Mode 6, except when the buffer pool gate is removed and water level is  $\geq 7.01$  meters (23.0 feet) over the top of the reactor pressure vessel flange. Specifically, Surveillance Requirement (SR) 3.5.3.1 will specify that GDCS operability requires performance of SRs in LCO 3.5.1, "Automatic Depressurization System (ADS) - Operating," for the ADS valves required to provide relief capacity equivalent to 4 DPVs. By ensuring the LCO 3.5.1 SRs are performed at the frequency specified in LCO 3.5.1, SR 3.5.3.1 ensures that the required ADS valves are capable of performing their required safety function.

**DCD Impact**

DCD Tier 2, Chapters 16 and 16B, LCO 3.5.3, "Gravity-Driven Cooling System (GDCS) - Shutdown," will be revised in Revision 5 as shown in Enclosure 2.

## **Enclosure 2**

### **MFN 07-022 Supplement 8**

#### **DCD Markups for RAI Number 16.2-74 S03**

Verified DCD changes associated with this RAI response are identified in the enclosed DCD markups by enclosing the text within a black box. The marked-up pages may contain unverified changes in addition to the verified changes resulting from this RAI response. Other changes shown in the markup(s) may not be fully developed and approved for inclusion in DCD Revision 5.

3.5 Emergency Core Cooling Systems (ECCS)

3.5.3 Gravity-Driven Cooling System (GDCS) - Shutdown

LCO 3.5.3 Four branch lines of the GDCS injection subsystem capable of injecting a combined volume  $\geq 986.8 \text{ m}^3$  (34,848  $\text{ft}^3$ ) from the associated GDCS pools shall be OPERABLE.

APPLICABILITY: MODE 5,  
MODE 6 except with the ~~new fuel~~ buffer pool gate removed and water level  $\geq 7.01$  meters (23.0 feet) over the top of the reactor pressure vessel flange.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One required branch line of the GDCS injection subsystem inoperable.	A.1 Restore required GDCS branch line to OPERABLE status.	14 days
B. GDCS inoperable due to required ADS valves inoperable.	B.1.1 Establish RCS vent path(s) with relief capacity equivalent to required ADS valves.	4 hours
	<u>OR</u>	
	B.1.2 Ensure capability of two methods of injecting a combined water volume of $\geq 986.8 \text{ m}^3$ (34,848 $\text{ft}^3$ ).	4 hours
	<u>AND</u>	
	B.2 Restore compliance with the LCO.	72 hours

CONDITION	REQUIRED ACTION	COMPLETION TIME
CB. GDCS inoperable LCO not met for reasons other than Condition A or B.	CB.1 Ensure capability of two methods of injecting a combined water volume of $\geq 986.8 \text{ m}^3$ (34,848 $\text{ft}^3$ ).	4 hours from discovery of each Condition CB entry
	<u>AND</u>	
	CB.2 Restore compliance with the LCO.	72 hours
DG. Required Action and associated Completion Time not met.	DG.1 Initiate action to suspend operations with a potential for draining the reactor vessel (OPDRVs).	Immediately
	<u>AND</u>	
	DG.2 Initiate action to restore Reactor Building to OPERABLE status.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE	FREQUENCY
SR 3.5.3.1	
<p><b>- NOTE -</b></p> <p>Only required to be met in MODE 5 and in MODE 6 prior to removal of the reactor pressure vessel head.</p>	
Perform applicable LCO 3.5.1, "Automatic Depressurization System (ADS) - Operating," SRs for ADS valves required for relief capacity equivalent to 4 depressurization valves (DPVs). Verify availability of RPV venting capacity sufficient to allow GDCS injection following loss of decay heat removal capability.	In accordance with applicable SRs 24 hours

## B 3.5 EMERGENCY CORE COOLING SYSTEMS (ECCS)

### B 3.5.3 GDCS - Shutdown

#### BASES

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##### BACKGROUND

A description of the ADS is provided in the Bases for LCO 3.5.1, "Automatic Depressurization System (ADS) - Operating." A description of the GDCS is provided in the Bases for LCO 3.5.2, "Gravity-Driven Cooling System (GDCS) - Operating."

In MODES 5 and 6, GDCS is used to provide additional water inventory inside the containment to respond to a loss of decay heat removal capability or a loss of reactor coolant inventory. Loss of decay heat removal capability could result from the unavailability of both Reactor Water Cleanup/Shutdown Cooling loops, loss of reactor component cooling water or plant service water systems, or loss of preferred power. Loss of reactor coolant inventory could result from pipe breaks in the RCS associated with maintenance or refueling, misalignment of systems connected to the RCS, or leakage during replacement of control rod drive assemblies.

GDCS pools with a minimum combined volume within the limit specified in this LCO provide additional water inventory to support decay heat removal for an extended period and makeup to respond to a loss of reactor coolant inventory.

ADS supports the GDCS function by providing a vent path that is adequate to maintain the RPV close to containment pressure following loss of decay heat removal capability. The number of ADS valves required to support GDCS is a function of core decay heat load.

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##### APPLICABLE SAFETY ANALYSES

Two GDCS trains are required to be OPERABLE in MODES 5 and 6 to provide additional water inventory inside the containment to respond to a loss of non-safety-related decay heat removal capability or a loss of reactor coolant inventory (Ref. 1). Additionally, ADS capacity equivalent to four depressurization valves (DPVs), which is sufficient to maintain the RPV close to containment pressure following a LOCA or loss of decay heat removal capability, is required to support GDCS injection.

The GDCS satisfies Criterion 4 of 10 CFR 50.36(d).

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BASES

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LCO

This LCO requires that four branch lines of the GDCS injection subsystem are OPERABLE and capable of injecting the specified combined volume from the associated GDCS pools. Additionally, this LCO requires OPERABILITY of ADS capacity (i.e., DPVs or SRVs or a combination of each) with relief capacity equivalent to four DPVs. ~~The RPV must have or have the ability to establish sufficient RPV venting capacity to maintain the RPV depressurized following loss of decay heat removal capability for a GDCS injection branch line to be capable of injecting into the RPV.~~

APPLICABILITY

Two GDCS divisions are required to be OPERABLE in MODES 5 and 6 to assure adequate coolant inventory and sufficient heat removal capability for the irradiated fuel in the core in response to a loss of decay heat removal capability, a LOCA, or an inadvertent draindown of the RPV. These requirements are not applicable when the ~~new fuel~~ buffer pool gate is removed and water level is above the specified level over the top of the reactor pressure vessel flange because of the additional inventory available when in this configuration.

ACTIONS

A.1

If one GDCS injection branch line is inoperable, the remaining OPERABLE branch lines provide sufficient RPV flooding capability to recover from a loss of decay heat removal capability, LOCA, or inadvertent vessel draindown. However, overall reliability is reduced. Therefore, the inoperable branch line must be restored to OPERABLE within 14 days. The 14 day Completion Time for restoring the required secondary line to OPERABLE status has been shown to be acceptable by Reference 2.

B.1.1, B.1.2, B.2

If GDCS is inoperable due to the required ADS valves being inoperable, RPV venting capacity may not be sufficient to allow GDCS injection. Required Action B.1.1 requires that GDCS injection capability be restored within 4 hours by establishing RCS vent path(s) with area equivalent to the required ADS valves. Manually actuated ADS valves may be used to satisfy this requirement. RCS vent paths other than ADS valves may be used provided the vent path(s) establish an RCS vent equivalent to 4 DPVs and are maintained open. A combination of OPERABLE ADS valves and other open vent paths can satisfy this Required Action.

BASES

for LCO 3.6.3.1, "Reactor Building." This action is needed to establish appropriate compensatory measures for a potential loss of decay heat removal as a result of an inadvertent draindown event. The Completion Times are based on engineering judgment considering the need for

ACTIONS (continued)

prompt action to mitigate the consequences of a potential loss of decay heat removal capability, LOCA, or inadvertent vessel draindown have been shown to be acceptable by Reference 2.

SURVEILLANCE  
REQUIREMENTS

SR 3.5.3.1

~~This SR requires verification every 24 hours verifies that the RPV has ADS capacity sufficient venting capacity capable of maintaining the RPV sufficiently depressurized to allow GDCS injection following a LOCA or loss of decay heat removal capability is OPERABLE. This SR is met by requiring that LCO 3.5.1 SRs are met for ADS valves (i.e., DPVs or SRVs or a combination of each) that provide ADS relief capacity equivalent to four DPVs. The Frequency requires that the applicable SRs be performed at the Frequencies specified in the applicable SRs. This SR may be met by the OPERABILITY of the ADS function. The ADS capacity needed to meet this SR is established based on the existing decay heat and include an allowance for a single failure. RPV vent paths other than the ADS may also be used to meet this SR provided those vent path(s) are sufficient for the existing decay heat load and are maintained open.~~

~~The 24 hour Frequency for performing this SR is based on engineering judgment. This Frequency is acceptable because this SR ensures that the required RPV venting capacity is available when required to support the decay heat removal function of the GDCS.~~

SR 3.5.3.1 is modified by a Note that states this SR is required only in MODE 5 and in MODE 6 prior to removal of the reactor pressure vessel head. ADS is not required for GDCS injection following removal of the reactor pressure vessel head.

SR 3.5.3.2

This SR requires verification every 24 hours that the combined water volume associated with Operable GDCS injection branch lines is greater than or equal to the specified limit. This SR ensures adequate inventory