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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 88 Related to ESBWR Design Certification Application ESBWR Probabilistic Risk Assessment RAI Numbers 19.1-81 through 19.1-95 and 19.1-97 through 19.1-101.**

The purpose of this letter is to submit the GE-Hitachi Nuclear Energy Americas LLC (GEH) response to the U.S. Nuclear Regulatory Commission (NRC) Request for Additional Information (RAI) sent by NRC letter dated December 26, 2006. GEH response to RAI Number RAI Numbers 19.1-81 through 19.1-95 and 19.1-97 through 19.1-101 is addressed in Enclosure 1.

Should you have any questions about the information provided here, please contact me at 910-675-5057 or jim.kinsey@ge.com.

Sincerely,

Kathy Sedney for

James C. Kinsey
Project Manager, ESBWR Licensing

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NRR

Reference:

1. MFN 06-551, Letter from U.S. Nuclear Regulatory Commission to David H. Hinds, *Request for Additional Information Letter No. 88 Related to ESBWR Design Certification Application,* December 26, 2006.

Enclosure:

1. Response to Portion of NRC Request for Additional Information Letter No. 88 Related to ESBWR Design Certification Application ESBWR Probabilistic Risk Assessment RAI Numbers 19.1-81 19.1-95 and 19.1-97 through 19.1-101

cc:	AE Cubbage	USNRC (with enclosure)
	GB Stramback	GEH/San Jose (with enclosure)
	RE Brown	GEH/Wilmington (with enclosure)
	eDRF 0072-3040	

Enclosure 1

MFN 07-422

Response to Portion of NRC Request for Additional Information Letter No. 88 Related to ESBWR Design Certification Application ESBWR Probabilistic Risk Assessment RAI Numbers 19.1-81 through 19.1-95 and 19.1-97 through 19.1-101

NRC RAI 19.1-81

In Section 16.2.1.2, Cold Shutdown, the PRA states that the containment is opened at some time during Mode 5, but since it is intact most of the time, the PRA assumes containment to be intact. If containment can be opened in Mode 5, the PRA should be revised to assume an open containment. Please clarify and/or revise the PRA, as needed.

GEH Response

A new mode has been defined for the shutdown analysis that accounts for Mode 5 with the containment open (see NEDO-33201, Chapter 16 Section 16.2.1.3).

This mode is the same as Mode 5 except there is no intact containment. The reactor vessel head is still on, but the containment is open.

This analysis assumes that the duration of this mode is approximately 48 hours per refueling outage. That allows for 24 hours to remove the drywell head and the reactor head, and 24 hours to re-attach both after refueling.

Tech Spec Mode 6 begins when one or more reactor vessel head closure bolts is less than fully tensioned. Mode 5 Open sequences consider pressure relief in the model. Mode 6 sequences do not consider pressure relief since the RPV head is removed for the majority of the mode. Due to the Tech Spec definition, there is a small period of time that is technically Mode 6, when the vessel head may still provide a pressure seal. Mode 6 with the vessel head still on is assumed bounded by the Mode 5 Open event trees and analysis.

DCD/NEDO-33201 Impact

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

NEDO-33201 Rev 2 Chapter 16 will be revised as described above.

NRC RAI 19.1-82

In stable shutdown, Mode 4, containment can be de-inerted, but containment integrity is required by Technical Specifications. The CDF contribution in this mode is assumed to be included in the Full Power PRA. The staff understands from DCD Chapter 6.2.1.1, that the containment is inerted during power operation to prevent the formation of a combustible mixture if oxygen were present following a severe accident. If containment integrity cannot be assured following a severe accident in Mode 4, then mode 4 should be modeled separately. Please clarify and/or revise the PRA, as needed.

GEH Response

For the shutdown PRA analysis, Mode 4 is assumed to be included in the Level 1 PRA model. A de-inerted containment has no impact on any PRA credited system in the model. Additionally, Technical Specification treatment of systems is the same for all credited systems for Modes 1 through 4. The plant is assumed to respond to a transient in Mode 4 just as it will in Mode 1.

Mode 4 is treated separately in both the Fire PRA and the Level 2 PRA. A special fire scenario will be added to the fire analysis for mode 4 in Revision 2 of NEDO-33201 Section 12. The treatment of de-inerted operation in the Level 2 PRA is shown in NEDO-33201 Section 8.1.4.

DCD/NEDO-033201 Impact

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

NEDO-33201, Rev 2, Sections 8.1.4 and Section 12 will be revised as noted above.

NRC RAI 19.1-83

Assess de-inerted containment in Modes 5 and 6 when reactor vessel head is on. The PRA should address the risk of a failed containment during Modes 5 and 6 when the reactor vessel head is on. Please clarify and/or revise the PRA, as needed.

GEH Response

A de-inerted containment has no impact on the internal events shutdown PRA as currently modeled. The upper drywell head is removed for refueling activities during Mode 5, and it is removed all of Mode 6. Whether the containment is inert or not is irrelevant for these periods since the containment itself is not intact. To simplify the model, it has also been assumed that the containment is not intact for the rest of Mode 5 (potentially open upper & lower drywell hatches). Containment systems have been removed from the shutdown model. All previously credited systems have been taken out of the event trees in all modes (PCCS, Suppression Pool Cooling, Vacuum Breakers, Containment Venting). See NEDO 33201 Revision 2, Chapter 16 for full details.

DCD/NEDO-033201 Impact

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

NEDO-33201 Rev 2, Chapter 16 will be revised as noted above.

NRC RAI 19.1-84

In section 16.2.1.2, the PRA states, "Initial RPV conditions in this mode are a pressure of .75 MPA (109 psia) and a temperature of 334oF." This statement is inconsistent with the definition of cold shutdown as defined in Technical Specifications Table 1.1-1, dated 2/28/06. Please clarify and/or revise the PRA, as needed.

GEH Response

Definitions have been edited to match Technical Specification definitions. Table 1.1-1 has been added to the Chapter 16 section describing the shutdown modes in NEDO-33201, Chapter 16, Section 16.2.1, Rev 2.

DCD Impact

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

NEDO-33201 Rev 2 will be revised as noted above.

NRC RAI 19.1-85

Section 16.3.1.2.1.1 of the PRA indicates that no specific shutdown LOCAs are required for shutdown modes where the reactor vessel is closed. LOCAs during Mode 5 should not be included in the full power PRA and should be assessed separately considering the containment can be open and/or de-inerted. Please clarify and/or revise the PRA, as needed.

GEH Response

LOCAs for Mode 5 have been evaluated for this revision of the shutdown PRA. Separate evaluations have been done for LOCAs during Mode 5 both with and without an open containment. See NEDO-33201 Chapter 16, Rev 2 (sections 16.3 and 16.4) for details.

DCD/NEDO-33201 Impact

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

NEDO-33201 Rev 2 Chapter 16, Rev 2 will be revised as noted in the attached markup as described above.

NRC RAI 19.1-86

The staff reviewed P&IDs for the Reactor Water Cleanup/Shutdown Cooling System (RWCU/SDC), evaluated piping penetrations in the reactor vessel bottom head upstream of containment isolation valves in the RWCU/SDC, and found numerous piping connections to low conductivity waste and the process sampling system. To justify that draindown events do not need to be quantified in the shutdown PRA, please document: (1) the sizes of the lines in the reactor vessel bottom head and (2) the administrative controls necessary to prevent these lines from becoming RCS draindown paths from operator error.

GEH Response

RWCU pipe drawings have been evaluated. Two potential draindown paths exist upstream of the containment isolation valves per train (a total of four). The first one on each train is a 20mm line to the Primary Sample System. This line has a 20 mm drain connection upstream of the containment isolation valves and a line that goes to the Primary Sample System. The drain connection has two normally closed manual isolation valves and is a capped connection. The line to the Primary Sample System has two normally closed/fail closed isolation valves with valve position indication available. The second path on each train is a 20mm vent line with two normally closed manual isolation valves and a pipe cap installed. Because of the small sizes associated with these lines (20mm), they are not assumed to be credible RCS drain paths needing detailed analysis.

DCD/NEDO-033201 Impact

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

No changes will be made to. NEDO-33201 Rev 2 in response to this RAI .

NRC RAI 19.1-87

The initiating event frequency used in the Shutdown PRA is based only on pipe breaks. However, EPRI derived an initiating event frequency for RPV leaks or diversion of 2.8E-5 per hour (Table 7-3 of "An Analysis of Loss of DHR Trends and IEF (1989--2000), EPRI 1003113, November 2001) and the data for this initiating event frequency does not include pipe breaks. Please assess and document in the shutdown PRA the additional initiating event frequency contribution from non-pipe breaks to reflect actual industry experience.

GEH Response

Reactor leaks/diversions during shutdown have been investigated for the ESBWR.

EPRI 1003113 was reviewed in response to this RAI. The events in '**Table A-2 BWR Shutdown Initiating Events (1989-2000)**' used to develop the leak/diversion initiating event frequency were evaluated to determine which are applicable to the ESBWR design. Very few of either the large drain events (greater than 10,000 gallons) or small drain events (less than 10,000 gallons) in the referenced table are relevant based on the design differences between existing BWRs and the ESBWR. Additionally, all the referenced leak events that are relevant would be isolated by the RWCU/SDC automatic isolation function on low level or flow mismatch.

The only operating system that has the potential to drain the RPV during shutdown is RWCU/SDCS. This system is connected to the RPV during shutdown and it is used to discharge excess reactor coolant to the main condenser or to the radwaste system during startup, shutdown and hot standby conditions. This system has redundant automatic isolation valves. The valves isolate the system on either a system flow mismatch, or low RPV level. The only lines between the vessel and the isolation valves that could leak or divert flow are 20mm diameter pipes. These small pipes are not considered large enough to cause a credible initiating event.

The ESBWR design has significantly reduced the number of potential RPV diversion paths (non-pipe break leaks) during shutdown conditions.

Compared to Residual Heat Removal System in current BWRs, the RWCU/SDCS in the ESBWR does not have the potential for diverting RPV inventory to the suppression pool through the SP suction, return, or spray lines. RWCU/SDCS does not provide any drywell spray function, so the potential RPV draindown through drywell spray does not exist. In addition, the absence of recirculation lines in the ESBWR design further reduces the potential RPV draining paths.

With the current ESBWR design, a RPV leak or diversion during shutdown would have to be in the RWCU/SDC system. For example, diversion through a feedwater line would require three or four passive valve failures (see response to NRC RAI 19.1-119). All credible paths are past two sets of redundant isolation valves which will isolate the leak on RPV low level, or flow mismatch (a tell tale sign of a diversion). The likelihood of a diversion or leak occurring, both sets of isolation valves failing to isolate the leak, and operators failing to act is assumed to be negligible.

DCD/NEDO-033201 Impact

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

No changes will be made to. NEDO-33201 Rev 2 in response to this RAI .

NRC RAI 19.1-88

The PRA states that breaks outside containment can originate only in RWCU/SDC piping, as this is the only system that moves reactor coolant from the containment in Mode 6; the rest of the RPV piping is isolated. The RWCU/SDC containment penetrations have redundant and automatic power-operating containment isolation valves that close on signals from the leak detection and isolation system and the reactor protection system. However, the Technical Specifications (dated 2/28/06) identify that isolation instrumentation discussed in Section 3.3.6.1 is only required in Modes 1-4 and, as stated in Section 3.6.1.3, the containment isolation valves are only required to be operable in Modes 1-4. Since containment isolation valves are not required to be operable in Modes 5 and 6, the Shutdown PRA does not include the risk of reactor vessel drain downs through the RWCU/SDC outside containment. Please clarify and/or revise the PRA, as needed.

GEH Response

Per DCD Tier 2, Rev. 3, Chapter 16, Technical Specification 3.3.6.3, Table 3.3.6.3-1, Item 9 and 3.3.6.4, Table 3.3.6.4-1, Item 2, the RWCU/SDCS isolation function will be operable in Modes 5 and 6.

Besides the RWCU/SDC lines (which have redundant automatic isolation valves), no other credible drain down paths outside containment exist during shutdown.

DCD/NEDO-033201 Impact

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

No changes are required to NEDO-33201 Rev 2.

NRC RAI 19.1-89

As stated in the PRA, the potential exists for an operator to remove the control rod blade inadvertently, establishing a direct path for draining the RPV during fine motion control rod drive (FMCRD) maintenance. The PRA should document the controls (e.g. Technical Specifications) that prevent the operator from: (1) failing to install the blind flange and (2) failing to recognize that the blade to be pulled out is withdrawn and already decoupled.

GEH Response

Draining the RPV during FMCRD maintenance has been evaluated, but is not considered a shutdown PRA initiating event. With the tools used for the actions, and the controls in place to monitor the evolution, the chance of a significant RPV leak due to the activity is assumed to be negligible.

The below section is from DCD Tier 2, Chapter 4. This information is also included in NEDO 33201 Chapter 16, Rev 2.

> "The procedure for removal of the FMCRD for maintenance or replacement is similar to previous BWR product lines. The control rod is first withdrawn to the full-out position. During removal of the lower housing (spool piece) following removal of the position indicator probes and motor unit, the control rod backseats onto the control rod guide tube. This metal-to-metal contact provides the seal that prevents draining of reactor water when the FMCRD is subsequently lowered out of the CRD housing. The control rod normally remains in this backseated condition at all times with the FMCRD out; however, in the unlikely situation that it also has to be removed, a temporary blind flange is first installed on the end of the CRD housing to prevent draining of reactor water.
>
> If the operator inadvertently removes the control rod after FMCRD is out without first installing the temporary blind flange, or conversely, inadvertently removes the FMCRD after first removing the control rod, an un-isolable opening in the bottom of the reactor is created, resulting in drainage of reactor water. The possibility of inadvertent reactor drain-down by this means is considered remote for the following reasons: "
>
> - Procedural controls similar to those of current BWRs provide the primary means for prevention. Current BWR operating experience demonstrates these procedural controls to be an acceptable approach. There has been no instance of an inadvertent drain-down of reactor water due to simultaneous CRD and control rod removal.

- During drive removal operations, personnel are required to monitor under the RPV for water leakage out of the CRD housing. Abnormal or excessive leakage occurring after only a partial lowering of the FMCRD within its housing indicates the absence of the full metal-to-metal seal between the control rod and control rod guide tube required for full drive removal. In this event, the FMCRD can then be raised back into its installed position to stop the leakage and allow corrective action. "

The COL applicant shall develop maintenance procedures with provisions to prohibit coincident removal of the control rod and CRD of the same assembly. In addition, the COL applicant shall develop contingency procedures to provide core and spent fuel cooling capability and mitigative actions during CRD replacement with fuel in the vessel.

The FMCRD design also allows for separate removal of the motor unit, position indicator probe (PIP), separation indicator probe (SIP) and spool piece for maintenance during plant outages without disturbing the upper assembly of the drive. While these FMCRD components are removed for servicing, the associated control rod is maintained in the fully inserted position by one of two mechanical locking devices that prevent rotation of the ball screw and drive shaft.

The first anti-rotation device is engaged when the motor unit consisting of the induction motor, reduction gear, brake and position signal detector is removed. It is a spring-actuated locking cam located on the bottom of the spool piece. When the motor unit is lowered away from the spool piece, the locking cam is released from its normally retracted position and engaged by spring force with gear teeth on the bottom of the magnetic coupling outer rotor, thereby locking the shaft in place.

With the motor unit removed, the locking cam can be visually checked from below the drive to verify that it is properly engaged. When the vessel head is removed, another means of verification of proper locking is for the operator to view the top of the control rod from over the reactor vessel. If the top of the control rod is visible at its normal full in position, it provides both direct indication that the control rod remains fully inserted and additional assurance that the ball screw is restrained from reverse rotation. The drive shaft remains locked in this manner until the motor unit is reattached to the spool piece. During motor installation, a release pin on the motor unit pushes up a plunger linked to the locking cam as the motor unit is raised into contact with the spool piece. The release pin forces the locking cam away from the teeth on the bottom of the magnetic coupling outer rotor and into the normally retracted, unlocked position.

The second anti-rotation device is engaged when the spool piece is removed from the FMCRD. As described in DCD Subsection 4.6.2.1.3, this device is a spline arrangement between the ball screw lower coupling and the middle flange backseat. When removing and lowering the spool piece, the weight of the ball screw, hollow piston and control rod provides a vertical force in the downward direction that brings the two splines together. This locks the ball screw into the backseat and prevents reverse rotation. As with the first anti-rotation device, proper engagement of this device can be visually checked from below the drive. If the splines do not completely lock together, there is indication of this because the ball screw does not seat against the backseat and there is a small gap for leakage of water. If this should occur, removal of the spool piece can be discontinued and corrective action taken. If there is no leakage, it confirms that the splines are properly locked together. Also as in the case of the first anti-rotation device, visual observation of the top of the control rod from over the reactor vessel provides another means for verifying proper locking of the ball screw. The ball screw remains locked in this position until the spool piece is reattached to the FMCRD. During spool piece installation, the end of the drive shaft fits into a seat on the end of the ball screw. As the ball screw piece is raised off the middle flange backseat, the anti-rotation splines disengage and the weight of the ball screw, hollow piston and control rod is transferred to the spool piece assembly. "

DCD/NEDO-033201 Impact

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

NEDO-33201 Rev 2 Chapter 16 has been updated as noted above.

NRC RAI 19.1-90

Address operator closure of both equipment hatches following a LOCA at shutdown. The PRA credits the operator in closing both containment hatches before RCS overflows through the hatches (water level is below the bottom edge of the hatch). Please document in the PRA whether equipment hatch closure takes place inside primary containment or outside primary containment. This detail is important in understanding how the human error probabilities can be quantified. Current models for operator actions may not be applicable if the operator has to close the equipment hatch from inside primary containment while the lower drywell is flooding.

GEH Response

Closure of both the lower drywell hatches (equipment and personnel) can be accomplished outside the lower drywell. NEDO-33201, Chapter 16 Rev 2, Table 16.3-6 gives the time available for the two cases analyzed (assuming worst case pipe breaks). Screening values are used for the human actions to close the hatches, and sensitivity cases in the results section show the results with higher and lower values for the actions (NEDO-33201 Chapter 16, Section 16.6.2.2).

DCD/NEDO-033201 Impact

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

NEDO-33201 Chapter 16, Rev 2 will be revised as described above.

NRC RAI 19.1-91

In the PRA, the Isolation Condenser System (ICS) function is credited in the events for losses of decay heat removal in Mode 5. According to Technical Specifications (dated 2/28/06), the ICS is required to be operable, but the staff could not find the operability of the ICS instrumentation and/or the operability of the ICS in Sections 3.3 and 3.4. Please clarify and/or modify the PRA to reflect that operator action is needed to initiate the ICS.

GEH Response

According to Technical Specifications (DCD Rev 3, Tier 2):

3.3.5.3 Isolation Condenser System (ICS) Instrumentation

> LCO 3.3.5.3 Three ICS instrumentation channels associated with the DC and Uninterruptible AC Electrical Power Distribution Divisions required by LCO 3.8.6, "Distribution Systems - Operating," and LCO 3.8.7, "Distribution Systems - Shutdown," for the Functions in Table 3.3.5.3-1 shall be OPERABLE.

Per Technical Specification Table 3.3.5.3-1, ICS actuation instrumentation will be operable in Mode 5 to actuate the ICS on both 'Reactor Vessel Water Level - Low, Level 2' and 'Reactor Vessel Water Level - Low, Level 1.'

Operator initiation of ICS is also available should available automatic actuation fail.

DCD/NEDO-033201 Impact

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

No Changes to NEDO 33201 will be made in response to this RAI.

NRC RAI 19.1-92

In section 16.4.1.1. of the PRA, automatic high pressure injection using Control Rod Drive (CRD) pumps is credited on RPV water level 2. However, automatic actuation of CRD on level 2 is not covered in Technical Specifications (dated 2/28/06) for Modes 5 and 6. Please clarify and/or revise the PRA to reflect that operator action is needed to initiate the CRD pumps.

GEH Response

No credit is given in the shutdown PRA for automatic actuation of CRD injection. CRD pump injection in Modes 5 and 6 is assumed to require an operator action. The fault tree for CRD injection used in the Level 1 PRA is used in the shutdown PRA (NEDO-33201, Chapter 16, Rev 2) with one variation. The automatic start logic is flagged TRUE (failed) for shutdown quantification, and system success is completely dependent on successful operator action.

DCD/NEDO-033201 Impact

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

NEDO-33201 Rev 2 Chapter 16 will be revised as noted above.

NRC RAI 19.1-93

In section 16.4 of the PRA, alternate decay heat removal using the Safety Relief Valves (SRVs) is credited in many shutdown success paths. However, operability of the SRVs is not covered in Technical Specifications (dated 2/28/06) in Modes 5 and 6 when the reactor vessel head is on. Please clarify and/or revise the PRA to reflect that the SRVs may not be available for decay heat removal.

GEH Response

SRVs are credited in the Mode 5 event trees for depressurization to allow low pressure feed (FPS & FAPCS). This function requires manual action. ADS actuation on RPV Level 1 is also modeled. This actuation is assumed to be automatic (with manual initiation as a backup).

The explicit availability of the automatic actuation function is not currently covered in ESBWR Technical Specifications. RAI 16.2-74 S01 committed to revising 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.

Since these valves can't be tested until Mode 6, NEDO-33201 assumes the automatic ADS function of these valves on RPV L1 is available as long as the vessel head is in place. There appears no credible reason to remove the function from service.

DCD/NEDO-033201 Impact

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

No NEDO-33201 Rev 2 changes will be made in response to this RAI.

NRC RAI 19.1-94

In section 16.4 of the PRA, the opening of the SRVs is credited for enabling low pressure makeup using the Fuel and Auxiliary Pool Cooling System (FAPCS) or the Fire Protection System (FPS). Additionally, the opening of the Depressurization Valves (DPVs) is credited for enabling GDCS. Please revise the PRA to address whether operator action is needed to open the SRVs and/or DPVs.

GEH Response

The current (Revision 2) shutdown PRA model has three separate event tree nodes for depressurization. Two of the three are assumed to be automatic. The 'at least 2 SRVs open' node is fully dependant on operators. The opening of one SRV for overpressure protection is assumed to be automatic. ADS on RPV Level L1 is also assumed to be automatic (with operator action available if auto fails). The manual opening of 2 SRVs to allow low pressure feed (FAPCS/FPS) before reaching automatic depressurization requires operator action.

The three event tree nodes are:

MS-TOP18-At Least 1 SRV Open

If the Isolation Condenser (IC) function fails, the RPV pressure will increase up to the SRVs setpoint. The success criterion for this function is the automatic operation of at least 1 SRV. Failure of this function is conservatively assumed to lead to core damage.

The possibility of a stuck open relief valve is not modeled. As no credit is given for the IC function after the opening of an SRV, it is not necessary to assume that all SRVs are closed.

MS-TOP2-At Least 2 SRVs Open

If no high pressure injection system is available, it is necessary to depressurize the RPV to allow FAPCS or FPS injection to the RPV.

Success of this function requires the operator to manually open at least 2 SRVs.

The time available to the operator to manually initiate RPV depressurization is defined by the time when RPV level falls below L2 to the time when the ADS system will automatically initiate (i.e., at RPV Level 1).

XD-TOPDPV-ADS-At Least 4 DPVs Open Automatically

If the RPV water level falls below Level 1, the ADS system automatically initiates.

The success criterion for this function is that at least 4 DPVs automatically open.

DCD/NEDO-033201 Impact

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

NEDO-33201 Rev 2 Chapter 16 will be revised as noted above.

NRC RAI 19.1-95

In Section 16.4, the PRA credits automatic short term and long term cooling using 2 out of 8 lines of the Gravity Driven Cooling System (GDCS), 2 out of 3 GDCS pools and the opening of at least one equalizing line. However, depressurization is accomplished by the Automatic Depressurization System (ADS) and operability of ADS is not covered in Technical Specifications (dated 2/28/06). Please clarify and/or revise the PRA to reflect that operator action is needed to initiate ADS, and the ADS function may not be operable.

GEH Response

Automatic actuation of ADS is assumed to be available during Mode 5 (see response to RAI 19.1-93 for more details) if RPV level fall to L1. Manual actuation of ADS is modeled should the auto actuation fail.

DCD/NEDO-033201 Impact

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

No NEDO-33201 Rev 2 changes will be made in response to this RAI.

NRC RAI 19.1-97

Please clarify in the PRA whether the RWCU/SDC restarts automatically after a loss of preferred power (LOPP) event following start up of the non-safety related diesel generators.

GEH Response

No credit is given in the shutdown PRA for automatic re-start of RWCU pumps following a LOPP event. Operator action to start the pumps is modeled for RWCU/SDCS in LOPP sequences. System success is fully dependant on successful operator action.

DCD/NEDO-033201 Impact

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

NEDO-33201 Rev 2 Chapter 16 will be revised as noted above.

NRC RAI 19.1-98

Numerous operator actions are discussed in the PRA, but the PRA does not address how failure of these operator actions were quantified. Please clarify and/or revise the PRA to address how the human error probabilities were estimated.

GEH Response

The values assigned to the actions credited in the model come from two sources. Most actions credited are actions that are also credited in the Level 1 PRA (aligning FAPCS, FPS, starting CRD pumps). For those events, the same values applied in the Level 1 model are used. Actions unique to the shutdown model (lower drywell hatch closure) have been given screening values.

For example, two lower drywell LOCA events are analyzed in each mode. In one case (instrument line LOCA), operators have 6 hours to close the lower drywell hatches before water reaches the bottom of the hatch. In another case (RWCU drain line LOCA), operators have only 90 minutes to close the hatches in the event of a worst-case pipe break. A failure rate of 0.01 is applied to the first case, and a failure rate of 0.1 (one failure in ten) is applied to the second.

Five human action sensitivity cases are presented in the results section to demonstrate how the model results change as the numbers assigned to actions change (NEDO 33201, Rev 2, Chapter 16, Section 16.6). Only a couple systems credited in the model are not entirely dependant on operators for actuation. The values applied to the actions determine the quantification results to a large degree.

DCD/NEDO-033201 Impact

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

NEDO-33201 Rev 2 Chapter 16 will be revised as noted above.

NRC RAI 19.1-99

The staff needs additional information to understand the role of the operator in preventing and mitigating shutdown events to prevent core damage. Please provide a human error sensitivity analysis for the Shutdown PRA. For example, assume all operator actions failed (i.e., human error probability is 1.0) and assume operator actions have a failure rate of .01.

GEHResponse

Most systems credited in the shutdown model are entirely dependant on operators for actuation. ICS, GDCS, and ADS are the only systems credited with auto actuation in the shutdown model. The values applied to the actions determine the quantification results to a large degree. Five human action sensitivity cases are presented in the results section to demonstrate how the model results change as the numbers assigned to actions change (NEDO 33201, Rev 2, Chapter 16, Section 16.6).

The sensitivity cases include:

- Three cases related to closure of the drywell hatch with variations on the failure probabilities assigned (in the base case, lower drywell LOCA events account for 98% of the total CDF).
- One case with all human actions set to TRUE.
- One case with all human actions set to 0.001 (an order of magnitude lower than most modeled actions).

DCD/NEDO-033201 Impact

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

NEDO-33201 Rev 2 Chapter 16 will be revised as noted above.

NRC RAI 19.1-100

As described in PRA Section 20.4.4.6, Loss of Shutdown Cooling was excluded from the initiating events assessment since both trains of RWCU/SDCS need to fail to cause a loss of the decay heat removal function. Common cause failure of the non-safety related RWCU/SDC pumps or the common cause failure of the non-safety related Reactor Component Cooling Water System (RCCWS) pumps was not considered. Please revise the RTNSS evaluation to consider common cause failure of non-safety related components associated with RWCU/SDCS and its support systems for the shutdown initiating events evaluation.

GEH Response

The initiating event frequency for 'Loss of both RWCU/SDC trains' has been revised to now include several common cause failures that could lead to loss of both trains. The value does not, however, include loss of RCCWS pumps. The initiating event 'Loss of all Service Water PSWS/RCCWS' accounts for loss of the RCCWS pumps. The value for that initiator is from Chapter 2 of NEDO-33201 (Table 2.3-3).

The Loss of both RWCU/SDC initiating event in revision 1 of NEDO-33201 was obtained from the common cause failure of the RWCU pumps to run. The new initiating event is the sum of several RWCU common cause failures.

The new number includes CCF failures for:

- Pumps to run,
- AOV/NOV valves to spuriously transfer to de-energized position,
- MOVs to close, and
- Suction Transmitters failing low.

The frequency does not include RWCU pumps CCF failure to start, and breakers failing to close. Since at least one train is running during shutdown, these events were not credited in determining the shutdown initiating event for loss of both trains (NEDO-33201 Chapter 16, Table 16.3-3b).

The evaluation section in Section *DCD chapter 19 states:*

i. PRA Initiating Events Assessment

The At-Power and Shutdown PRA models are reviewed to determine whether non-safety SSCs could have a significant effect on the estimated frequency of initiating events. The following screening criteria are imposed on the at-power and shutdown initiating events:

- *Are nonsafety related SSCs considered in the calculation of the initiating event frequency?*
- *Does the unavailability of the nonsafety-related SSCs significantly affect the calculation of the initiating event frequency?*
- *Does the initiating event significantly affect CDF or LRF for the baseline PRA?*

If the answer to all three of these questions is "Yes", then the non-safety SSC is a RTNSS candidate. The results are discussed below.

With the above criteria, RWCU/SDC is not a candidate for regulatory oversight. The answer to the third questions above is 'No' for RWCU. There is no RWCU initiating event in the Level 1 PRA model. Loss of RWCU/SDC is only an initiating event during shutdown. Additionally, with a higher initiating event frequency than the previous revision, Loss of both RWCU/SDC trains accounts for less than 1% of the total shutdown CDF (NEDO 33201, Chapter 16, Table 16.9-2).

DCD/NEDO-033201 Impact

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

NEDO-33201 Rev 2 will be revised as noted above.

NRC RAI 19.1-101

Address isolation of containment penetrations for Modes 4 - 6.

As described in PRA Section 20.4.4.7, Shutdown LOCA was excluded from regulatory oversight based on automatic isolation of RWCU/SDCS and FAPCS containment penetrations which are not required by Technical Specifications. Please revise the RTNSS evaluation to reflect that the Technical Specifications do not require these isolations to be operable during Modes 4, 5, and 6.

GEH Response

Per DCD Tier 2, Rev. 3, Chapter 16, Technical Specification 3.3.6.3, Table 3.3.6.3-1, Item 9 and 3.3.6.4, Table 3.3.6.4-1, Item 2, the RWCU/SDCS isolation function will be operable in Modes 5 and 6. (it has been changed from past the previous revision which did not have isolation explicitly stated as operable in shutdown modes).

The FAPCS is an alternative to RWCU/SDC during refueling operation when the reactor well is flooded. When in this setup, suction is taken from the skimmer surge tank that is lined up with the reactor well. A break in this mode would not be a LOCA.

With the updated Technical Specifications, the statements in 20.4.4.7 are correct.

DCD/NEDO-033201 Impact

The DCD has been changed as stated above.

No NEDO 33201 changes will be made in response to this RAI.