GE Energy

David H. Hinds
Manager, ESBWR

PO Box 780 M/C L60
Wilmington, NC 28402-0780
USA

T 910 675 6363
F 910 362 6363
david.hinds@ge.com

GE Proprietary Information

MFN 06-078 Docket No. 52-010

March 16, 2006

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555-0001

Subject: **Response to NRC Request for Additional Information Letter No. 11 Related to ESBWR Design Certification Application – Control Rod Drive System – RAI Numbers 4.6-1 through 4.6-22**

Enclosure 1 contains GE's response to the subject NRC RAIs transmitted via Reference 1.

A portion of the information provided in Enclosure 1 contains proprietary information as defined by 10CFR2.790. GE customarily maintains this information in confidence and withholds it from public disclosure. A non-proprietary version of the RAI responses is provided in Enclosure 2.

The affidavit contained in Enclosure 3 identifies that the proprietary information contained in Enclosure 1 has been handled and classified as proprietary to GE. GE hereby requests that the information of Enclosure 1 be withheld from public disclosure in accordance with the provisions of 10 CFR 2.790 and 9.17.

D068

If you have any questions about the information provided here, please let me know.

Sincerely,

George Stramback for

David H. Hinds
Manager, ESBWR

Enclosures:

1. GE Response to NRC Request for Additional Information Letter No. 11 Related to ESBWR Design Certification Application – Control Rod Drive Systems – RAI Numbers 4.6-1 through 4.6-22 – Proprietary

2. GE Response to NRC Request for Additional Information Letter No. 11 Related to ESBWR Design Certification Application – Control Rod Drive Systems – RAI Numbers 4.6-1 through 4.6-22 – Non-Proprietary

3. Affidavit, George B. Stramback, March 16, 2006

Reference:

MFN 06-068, Letter from U. S. Nuclear Regulatory Commission to David Hinds, *Request for Additional Information Letter No. 11 Related to ESBWR Design Certification Application,* February 27, 2006

cc: WD Beckner USNRC (w/o enclosures)
AE Cubbage USNRC (with enclosures)
LA Dudes USNRC (w/o enclosures)
GB Stramback GE/San Jose (with enclosures)
eDRF 0000-0051-8925

Enclosure 1

MFN 06-078

GE Responses to NRC Request for Additional Information Letter No. 11 for the ESBWR Design Certification Application Section 4.6 Functional Design of Reactivity Control System

PROPRIETARY INFORMATION NOTICE

This enclosure contains proprietary information of the General Electric Company (GE) and is furnished in confidence solely for the purpose(s) stated in the transmittal letter. No other use, direct or indirect, of the document or the information it contains is authorized. Furnishing this enclosure does not convey any license, express or implied, to use any patented invention or, except as specified above, any proprietary information of GE disclosed herein or any right to publish or make copies of the enclosure without prior written permission of GE. The header of each page in this enclosure carries the notation "GE Proprietary Information."

GE proprietary information is identified by a double underline inside double square brackets. In each case, the superscript notation{3} refers to Paragraph (3) of the affidavit provided in Enclosure 3, which documents the basis for the proprietary determination. [[This sentence is an example.{3}]] Specific information that is not so marked is not GE proprietary.

Enclosure 2

MFN 06-078

GE Responses to NRC Request for Additional Information Letter No. 11 for the ESBWR Design Certification Application Section 4.6 Functional Design of Reactivity Control System

Non-Proprietary Notice

IMPORTANT NOTICE

This is a non-proprietary version of the document MFN 06-078, Enclosure 1, which has the proprietary information removed. Portions of the document that have been removed are indicated by an open and closed double brackets as shown here [[ ]].

4.6-1 Safety classification of CRD system

The control Rod Drive (CRD) system provides the high pressure make up water to the reactor when the feedwater system is not available. In DCD Section 15.2.5.3, "Loss of all Feedwater Flow", credit is taken for the CRD system in the transient analyses. Credit can be taken only for safety grade equipment in the transients and accidents analyses. Explain in detail why the CRD system is not designated as a safety grade system.

GE Response:

The high pressure makeup function of the Control Rod Drive system is designated as a non-safety-related system. Per U.S. NRC Final Safety Evaluation Report Related to Certification of the AP1000 Standard Design, NUREG-1783, Volume 2-A, Chapter 15.1.2, "non-safety-related systems or components are assumed to be operational in the following situations:

(a) when assumption of a non-safety-related system results in a more limiting transient
(b) when a detectable and nonconsequential random, independent failure must occur in order to disable the system
(c) when non-safety-related components are used as backup protection"

Per the second situation, failure of the HP_CRD system is not a consequence of Loss of All Feedwater Flow, therefore can be assumed operational.

The HP_CRD system is not the primary make-up system, but is backup to the ADS and GDCS systems. The GDCS provides makeup flow for all breaks, and ADS depressurizes the vessel to accommodate GDCS injection for small breaks. The HP_CRD system is a backup system to ADS and GDCS safety systems, thus it is a non-safety-related system.

4.6-2 CRD makeup capacity

Specify the maximum pipe break size for which the CRD system can make up for the inventory lost through the break in the reactor coolant boundary.

GE Response:

The maximum pipe break size for which the CRD system can make up for the inventory lost through the break in the reactor coolant boundary is 0.5" diameter break in the bottom drain line. At this break size the water level remains above Level 1 and does not remain below Level 1.5 for 900 seconds. At the time of high drywell pressure the water level has a 5% margin to Level 1.5.

4.6-3 Fine motion control rod drive (FMCRD) design differences between ABWR and ESBWR

The staff has previously approved an FMCRD system for the ABWR. We understand that the ESBWR FMCRD system may be similar to the system approved for ABWR. Please identify the differences, if any, between the two designs.

GE Response:

The primary differences between ESBWR and ABWR CRD Systems are related to the adoption of the induction-motor driven FMCRD for ESBWR and the addition of the high pressure makeup function. These differences are summarized in the following table.

Feature	ESBWR	ABWR
FMCRD drive motor	Induction motor	Permanent magnet stepping motor
Coupling between FMCRD motor and FMCRD drive shaft	Magnetic coupling (see DCD Figure 4.6-1). No shaft penetration of the drive pressure boundary. Provides seal-less, leak-free operation of the control rod drive mechanism.	Conventional seal housing with packing glands around the drive shaft penetrating the drive pressure boundary.
Leak detection	FMCRD leak detection equipment not required with the magnetic-coupling type design.	FMCRD leak detection system provided.
FMCRD motor-driven insertion/withdrawal speed	28 mm/sec	30 mm/sec
FMCRD step size	36.5 mm (see RAI 4.6-4 below)	18.3 mm
High Pressure Makeup (HPMU) Function	HPMU mode provided. This includes: High pressure makeup flow control lines downstream of the CRD pumps, each containing a flow control valve. A common discharge line with check valve and isolation valve to deliver the flow to the RWCU/SDC System. A full flow test line to direct HPMU test flow back to the CST.	No HPMU function.

4.6-4 Minimum drive position increment

According to the ABWR DCD, the electric motor-driven ball-nut and spindle assembly is capable of positioning the drive at a minimum of 18.3 mm increments. But for the ESBWR design, the minimum increment is 36.5 mm (1.44 in.). Why is the minimum increment increased for ESBWR?

GE Response:

The minimum increment is increased for ESBWR because of the adoption of the induction motor / magnetically-coupled (IM/MC) FMCRD design and its positioning accuracy. The IM/MC FMCRD and its control adopt a simple on/off control via contactors for motor start and start operation. Upon the loss of motor power, a built-in AC brake accomplishes the motor stop operation. The drive position information is utilized to determine the timing of the loss of motor power so that motor power is cut off when the drive position reaches a certain distance short of the target position. The IM/MC FMCRD has a positioning accuracy of 15 mm based on the variation in braking distance and the accuracy of position detection (compared to 9 mm for the ABWR permanent magnet stepping motor FMCRD).

The minimum step size is established so that a consistent distinction between adjacent step positions can be made with consideration of the positioning accuracy. On this basis the minimum step size must be greater than twice the positioning accuracy. With a positioning accuracy of 15 mm, a minimum step size greater than 30 mm is required.

Additionally, the specified step size should be consistent with the full-stroke length of 2921 mm, i.e., the full-stroke length should contain a rational, integral number of steps providing operational compatibility. The selected minimum step size of 36.5 mm provides an even 80 steps per full stroke (79 steps at 36.5 mm plus 1 step at 37.5 mm). This compares with an even 200 steps for ABWR FMCRD with its longer full stroke length of 3660 mm.

4.6-5 Address GDC 4 for control rod drive system

Standard Review Plan (SRP) Section 4.6, Draft Revision 3, April 1996, lists General Design Criteria (GDC) 4 as one of the acceptance criteria for the functional design of control rod drive system. GDC 4 is applicable to ESBWR reactivity control systems. GDC 4 is not addressed in DCD Section 4.6. Include reference to GDC 4 in the DCD Section 4.6.

GE Response:

GE will add the requested reference to GDC 4 in DCD Section 4.6 in the next revision (Revision 2) of DCD Tier 2, Chapter 4, **Reactor**.

4.6-6 Reference to DCD section 4.6 in DCD section 3.1.3.4

GDC 23 is included in DCD Section 4.6, however, there is no reference of DCD Section 4.6 in DCD Section 3.1.3.4, "Criterion 23." Add a reference to DCD Section 4.6 in DCD Section 3.1.3.4.

GE Response:

GE will add the requested reference to DCD Section 4.6 in DCD Section 3.1.3.4 in the next revision (Revision 2) of DCD Tier 2, Chapter 3 , **Design of Structures, Components, Equipment, and Systems**, Sections 3.1 – 3.8.

4.6-7 Failure Modes and Effects Analyses (FMEA) analysis for control rod drive system

SRP Section 4.6, Revision 1, July 1981, specifies that the staff reviews an FMEA to assure that a single failure occurring in the control rod drive system, or an operator error, will not result in the loss of capability for safe shutdown. We understand that an FMEA was submitted for ABWR. Submit an FMEA for the ESBWR.

GE Response:

The FMEA submitted for ABWR is provided in Appendix 15B of the ABWR DCD. The text and descriptive material in Subsections 15B.2.1 **(Introduction)**, 15B.2.2 **(Conclusion)**, 15B.2.3 **(Description)**, and 15B.2.4 **(FMCRD Failure Modes Evaluation)** are applicable to ESBWR, with the exception that the FMCRD stepping motor of the ABWR design is replaced with the induction motor / magnetically coupled (IM/MC) FMCRD design of the ESBWR. The results and conclusions of the ABWR FMEA are unchanged by this difference.

Table 15B-1 **(Failure Modes and Effects Analysis for FMCRD)** is applicable to ESBWR except for the following items that are specific to the ABWR stepping motor FMCRD design and would be modified accordingly for the ESBWR IM/MC FMCRD:

Item	Component	Difference
3.a	Lower housing	The ESBWR lower housing does not contain a shaft seal assembly. The ESBWR FMCRD magnetic coupling eliminates the drive shaft penetration of the drive pressure boundary.
4	Seal housing	The shaft seals are eliminated on ESBWR.
4.d	Drive shaft and seal housing	The shaft seals are eliminated on ESBWR.
4.e	Seal rings	The shaft seals are eliminated on ESBWR.
4.f	Seal retainer pins	The shaft seals are eliminated on ESBWR.
5	Drive shaft	For ESBWR, the motor dive shaft and the spindle are coupled by a magnetic coupling.
7	Key B	For ESBWR, the motor dive shaft and the spindle are coupled by a magnetic coupling.

Table 15B-2 **(Failure Mode and Effects Analysis for HCU Charging Water)** is applicable to ESBWR. The HCU charging function and equipment addressed in this table is the same for ESBWR.

Figure 15B-1 **(Simplified CRD System Process Flow Diagram)** would be modified to show the high pressure makeup lines for ESBWR.

Figure 15B-2 (**Simplified Hydraulic Control Unit P&ID**) would be modified to delete the FMCRD leak detection equipment for ESBWR.

Figure 15B-3 (**Fine Motion Control Rod Drive**) would be modified in accordance with the above table to reflect the adoption of the IM/MC FMCRD for ESBWR.

Figure 15B-4 (**Control Rod Drop Accident Scenario for FMCRD**) is applicable to ESBWR.

Figure 15B-5 (**Control Rod Separation Detection**) is applicable to ESBWR.

Figure 15B-6 (**Internal CRD Blowout Support Schematic**) would be replaced with Figure 4.6-7 of the ESBWR DCD.

Figure 15B-7 (**FMCRD Internal Support**) is applicable to ESBWR.

4.6-8 Sufficient differential pressure to insert FMCRD during ATWS

For the ESBWR FMCRD system, the scram discharge volume is diverted to the reactor vessel rather than to the scram discharge volume pipe as in current BWRs. There is a concern that if the reactor is at high pressure during an ATWS, there may not be sufficient differential pressure to insert the FMCRD into the reactor. Explain in detail why this is not a concern in ESBWR. Confirm that there is sufficient differential pressure to insert the FMCRD into the reactor for ESBWR.

GE Response:

The ATWS related performance requirement for the ESBWR FMCRD specifies that the drives shall be capable of insertion during pressure transients with peak pressures of 10.342 MPaG (1500 psig) or less. The HCU charging pressure and accumulator volume will be established to provide sufficient differential pressure to achieve this performance.

To clarify the ATWS performance requirement, GE proposes to modify the DCD to add the following statement at the end of the text under the **Alternate Rod Insertion** heading in Subsection 4.6.1.2.5:

"The FMCRDs are capable of inserting the control rods hydraulically during ATWS pressure transients with peak reactor pressures of 10.342 MPaG (1500 psig) or less."

4.6-9 Loss of scram function due to slow loss of control air pressure
Confirm that the design incorporates features to prevent the loss or impairment of the scram function due to a slow loss of control air pressure in the air system.

GE Response:

The concern is that a slow and gradual loss of pressure in the air supply to the scram valves can cause the scram valves to partially unseat and allow the HCU accumulators to bleed down to the point where the scram function is impaired or lost. The ESBWR design incorporates the following features to prevent this from occurring:

1. As described in Subsection 4.6.1.2.6, instrumentation is provided in the scram air header piping to monitor header pressure. A low-pressure condition is alarmed in the control room to alert the operator for the need to take corrective action. The alarm setpoint is established so that the alarm occurs before pressure has degraded to the level where the scram valves can begin to unseat.
2. Safety related pressure instrumentation located in the HCU charging water header protects against loss of the accumulator scram function. As described in Subsection 4.6.1.2.6, the four Class 1E sensors provide signals to the RPS. A low-low pressure condition from two-out-of-four sensors causes the RPS to generate a scram before the scram function is impaired. The set point is established at a pressure above the minimum allowable accumulator pressure required for scram.

   If a slow and gradual loss of control air should occur and the low air header pressure alarm not function, the scram valves could begin to partially unseat. The CRD pump will make up for the leakage flow through the affected scram valves and keep the accumulators full as long as the total leakage is within the capacity of the pump to maintain the charging header pressure above the low-low pressure scram setpoint. This assures that if the pressure eventually falls to the scram set point, the accumulators will still be fully charged and capable of performing their scram function.

   Before the system reaches this degraded condition there are precursors that will also alert the operator to abnormal operating conditions as pressure in the system drops from its normal range. First, loss or degradation of system hydraulic pressure indicates the operating pump is not functioning properly to maintain normal conditions. As described in Subsection 4.6.1.2.6, two pressure sensors located in the common pump discharge line monitor system pressure. A low-pressure signal from either sensor will actuate the standby pump. This setpoint is above the scram setpoint of the charging water header instrumentation. This is to allow the standby pump to try and maintain system pressure and prevent an inadvertent scram.

   Second, the charging water header pressure instrumentation also provides signals to the RC&IS. A low pressure condition from two-out-of-four sensors causes an alarm in the control room and an all rod withdrawal block.

In summary, as system pressure degrades there are three CRD System low pressure setpoint levels where actions occur to protect the scram function. First, the standby pump will start based on low pump discharge header pressure, second an alarm and rod block will occur based on low charging water header pressure, and third a scram will occur based on low-low charging water header pressure.

4.6-10 Identification of safety related portions of CRD and separation between safety and non-safety portions

Identify the essential portions of the CRD system, which are safety related. Describe how the safety related portions of the system are isolated from the non-essential portion of the system.

GE Response:

The following constitute the safety related CRD System equipment:

1) The FMCRDs, including:
   a) Primary pressure boundary components
   b) Hollow piston
   c) Labyrinth seal
   d) Latches
   e) Guide tube
   f) Brake (passive holding function)
   g) Check valve
   h) Check valve retainers
   i) Internal anti-shootout (includes outer tube, outer tube to middle flange weld and middle flange)
   j) Parts that couple the brake with the hollow piston (keys, couplings, shafts and ball nut)
   k) Separation switches
   l) Anti-rotation device
2) Hydraulic control units (scram circuit only)
3) Scram insert piping
4) Scram charging header pressure instrumentation
5) High pressure makeup piping at the connection to RWCU/SDC (including the check valve and injection valve)

The CRD System is arranged in a manner that separates the safety related equipment from the non-safety related portions of the system. The FMCRDs are mounted to the reactor vessel bottom head inside primary containment. The HCUs are housed in four dedicated rooms located directly outside of the primary containment at the basemat elevation of the reactor building. These rooms are arranged around the periphery of the primary containment wall. Each HCU room serves the FMCRDs associated with one quadrant of the reactor core. The HCUs are connected to the FMCRDs by the scram insert piping that penetrates the primary containment wall.

The balance of the non-safety related hydraulic system equipment (pumps, valves, filters, etc.) is physically separated from the HCUs and housed at a different elevation in the reactor building. It is connected to the HCUs by three non-safety related piping headers:

the FMCRD purge water header, HCU charging water header and scram air header. As shown in Figure 4.6-8, these headers are classified as Seismic Category II so that they will maintain structural integrity during a seismic event and not degrade the functioning of the HCUs.

The high pressure makeup piping at the connection to RWCU/SDC is classified as safety related Seismic Category I piping to provide interface compatibility with the safety related Seismic Category I piping of the RWCU/SDC.

4.6-11 Power supply for CRD pumps

The control rod drive pumps are used for high pressure make-up to the reactor. Confirm that the pumps power supply is from the diesel generator bus.

GE Response:

The CRD pump motors are connected to the standby diesel generators in order to assure CRD pump availability during a loss of offsite power event. The Reactor Component Cooling Water System (RCCWS) cooling water flow to the CRD pump lube oil system is also connected to the standby diesel generators to support CRD pump operation during this event.

4.6-12 Failure of scram accumulator affect on adjacent rods

Describe the relative core location of control rods sharing a scram accumulator. Can a failure of the scram accumulator fail to insert adjacent rods? If so, discuss the consequences of that failure.

GE Response:

The specific assignments of HCUs to the FMCRDs have not been made. This is identified as a COLA Item in DCD Section 4.3.5 and Table 4.3-1. The approach for establishing these assignments will be the same as ABWR, where adequate separation is provided by assigning the rods to HCUs in a manner such that no 4X4 array of rods contain both rods connected to the same HCU. In other words, the rod pairing distance for any HCU is greater than a four rod pitch. With this as a starting point, the assignments are made such that the separation between the FMCRDs paired to the same HCU and the arrangement of the HCUs relative to each other satisfy the following requirements:

- Hot shutdown is achieved, assuming a single failure of a HCU, plus a consequential failure of an adjacent HCU.
- Cold shutdown is achieved assuming a single failure of a HCU.
- Rotational symmetry is provided between the four core quadrants, i.e., both FMCRDs connected to the same HCU must be located within the same quadrant.
- Both FMCRDs connected to the same HCU must belong to the same control rod sequence (Sequence A or Sequence B). If a HCU assigned to Sequence A control rods is adjacent to a HCU assigned to Sequence B control rods, the associated Sequence A control rods cannot be adjacent to the associated Sequence B control rods.
- The rod to HCU pairings must be compatible with the RPS scram group assignments, i.e., both control rods belong to the same scram group.
- Each FMCRD assigned to a given HCU is connected to a different electrical group.

The FMCRD to HCU assignments resulting from these requirements precludes the failure of a scram accumulator from causing adjacent rods to fail to insert.

4.6-13 Hydraulic Control Unit (HCU) design details

Submit detailed drawings of the HCU and describe in detail the design of the HCUs.

GE Response:

The HCU Outline Drawing in Figure 4.6-13-1 shows the basic configuration of an ABWR HCU and its constituent components. While the detailed drawings for the ESBWR HCU are not yet available, the ABWR design details provided in this drawing are representative of the HCU design to be applied to ESBWR.

The functions of the components that comprise the HCU assembly are described below. The Item Numbers are keyed to the component numbers and descriptions shown on the HCU drawing in Enclosure 2. The component numbers are keyed to the HCU diagram shown on the Sheet 4 of CRD System P&ID 105E3926.

Item No.	Description	Function
1, 2, 4, 5, 7, 17, 18	Isolation valves	Isolate specific portions of the HCU from either air pressure or high pressure water or high pressure nitrogen.
10	Nitrogen gas bottle	Provides a source of readily available high pressure, high discharge flow rate of nitrogen to the accumulator.
8	Accumulator	Provides the stored energy necessary to obtain the required high pressure, high flow rate discharge of water to the two associated FMCRDs. The accumulator has a floating piston with nitrogen on one side and water on the other side.
16	Scram solenoid pilot valve	The 3-way, dual acting pilot valve normally operates in the energized mode. Upon removal or loss of electric power to the solenoids, the high pressure air supply to the scram valve is shut off and the resident air in the scram valve actuator is vented to the exhaust port.
9	Scram valve	The scram valve is normally held closed by air pressure from the scram pilot solenoid valve. Upon the removal or loss of the air pressure, the valve opens and direct high pressure water from the accumulator to the FMCRD.

Item No.	Description	Function
6, 15	Check valves	The check valve prevent the reverse flow of high pressure water within the HCU in the reverse direction.
20	Restricting orifice	Provides a minimum flow of high pressure purge water to the FMCRD during normal operation.
19	Restricting orifice/solenoid valve	Consists of a restricting orifice and a 2-way solenoid valve in series. During the FMCRD insertion, this valve is energized and opens to increase the purge flow to prevent reactor coolant from entering the FMCRD.
14	Rupture unit	The rupture unit prevents overpressurization of the nitrogen bottle and associated components.
11, 12, 13	Nitrogen instrumentation	Provides information on the nitrogen system of the HCU. This consists of (1) a visual readout pressure gauge, (2) a pressure switch to detect abnormally low pressure, and (3) a water level switch to detect leakage of water past the accumulator piston seals into the nitrogen side of the HCU.

[[

]]

ABWR Hydraulic Control Unit
Figure 4.6-13-1

4.6-14 Velocity limiter

We understand that the control rod has no velocity limiter. Discuss in detail the reason for elimination of the velocity limiter in the ESBWR design.

GE Response:

The design features of the FMCRD that permitted the elimination of the velocity limiter on ABWR are the same for ESBWR. Subsection 15B.2.4.2 of the ABWR FMEA as referenced in the response to RAI 4.6-7 above addresses the rod drop accident evaluation for ABWR. The evaluation concluded that the rod drop accident is categorized as an incredible event for the ABWR design because of the numerous coincident failures that are required to reach a condition where a rod drop can occur. Because of this, the velocity limiter was eliminated from the control rod. The ABWR FMCRD was then developed and qualified based on a control rod design with no velocity limiter.

The ESBWR FMCRD design features that prevent control rod drop are described in Subsection 4.6.2.1.3 of the ESBWR DCD. These features are the same as the ABWR FMCRD. On this basis, the ESBWR control rod design also has no velocity limiter.

4.6-15 Separation between standby liquid control system (SLCS) and FMCRD

Confirm that the SLCS and the safety related portions of the FMCRD system are located in different parts of the reactor building and are not vulnerable to common mode failure.

GE Response:

The SLCS and the safety related portions of the CRD System are located in different parts of the reactor building and are not susceptible to common mode failure. As described in the response to RAI 4.6-10, the FMCRDs are mounted to the reactor vessel bottom head inside primary containment (Room 1170 shown on DCD Figures 1.2-1 and 1.2-10). The HCUs are housed in four dedicated rooms located directly outside of the primary containment at the basemat elevation of the reactor building (Floor Elevation – 11500). These rooms are arranged around the periphery of the primary containment wall (Rooms 1110, 1120, 1130 and 1140 shown on DCD Figures 1.2-1 and 1.2-10). Each HCU room serves the FMCRDs associated with one quadrant of the reactor core. The HCUs are connected to the FMCRDs by the scram insert piping that penetrates the primary containment wall.

Each train of the SLCS (tank and associated valves and equipment) is housed in its own room located at an upper elevation in the reactor building (Floor Elevation 17500). These rooms are located on opposite sides of the reactor (Rooms 1713 and 1723 shown on DCD Figure 1.2-7). This arrangement provides the required physical separation between the SLCS and the safety related CRD System equipment.

4.6-16 Power supply to the cooling water to the CRD pump oil cooler and operation of auxiliary oil pump

Confirm that the power supply to the reactor component cooling water system which supplies cooling water to the lube oil cooler is from the diesel generator. Confirm whether the auxiliary oil pump shown on page 2 of the P & I.D. 105E3926,Rev.0 is run continuously or only intermittently to make up the oil supply.

GE Response:

As indicated in the response to RAI 4.6-11, the Reactor Component Cooling Water System (RCCWS) cooling water flow to the CRD pump lube oil system is connected to the standby diesel generators to support CRD pump operation during a loss of offsite power event.

The motor-driven auxiliary lube oil pump shown on page 2 of the P&ID is run only during startup and shutdown of the main CRD pump, and only intermittently, if needed, during continuous operation. When the main pump is signaled to start, the motor-driven auxiliary lube oil pump is started first to pressurize the lube oil system and establish oil flow. A pressure interlock prevents startup of the main pump until the oil pressure exceeds a predetermined setpoint. Once the main pump has started, a second auxiliary lube oil pump driven by the main pump shaft provides the required continuous lube oil system flow and pressure during normal operation. A second oil pressure interlock shuts down the motor-driven auxiliary oil pump at this time. When the main pump is shutdown the shaft-driven oil pump cannot maintain pressure in the oil system. The motor-driven auxiliary lube oil pump will then restart on a low oil pressure signal and run continuously after the main pump stops in order to cool down the main pump bearings. After a fixed time delay, the motor-driven pump is then signaled to stop.

The motor-driven auxiliary lube oil pump may also run intermittently during main pump operation if the shaft-driven oil pump cannot maintain required oil pressure. In this situation, it will cycle on and off between low oil pressure and high oil pressure conditions. Because this mode of operation indicates a failure of the shaft driven oil pump, the operator can transfer system operation to the other main CRD pump and perform corrective maintenance on the malfunctioning pump.

4.6-17 CRD supply pump discharge check valve

In DCD Section 4.6.1.2.4, CRD supply pump (Page 4.6-12) it is stated that: "— A discharge check valve prevents backflow through the non-operating pump." But the P & I.D 105E3926, Sheet No. 2 does not show any check valve at the pump discharge. Clarify this discrepancy.

GE Response:

The P&ID is incorrect. Each header on the CRD pump discharge requires a check valve to prevent backflow through the non-operating pumps. The P&ID includes these check valves in the lines to the pump minimum flow header and the lines to the HCU charging water and purge water headers. Similarly, a check valve should be located upstream of the flow element (FE-N019A and B) in each line to the high pressure makeup header. This will be corrected at the next revision of the P&ID. Also, Tier 2 DCD Figure 4.6-8 and Tier 1 Figure 2.2.2-1 require correction to move the check valves to the upstream side of the high pressure makeup line flow elements.

4.6-18 Function and operation of fill pump

What is the purpose of the Fill Pump shown on sheet 2 of the P& I.D. 105E3926,Rev.0? Confirm whether this pump will be running continuously.

GE Response:

The purpose of this small pressurizing pump is to maintain normal operating pressure in the HCU charging water header when overall system pressure decreases during surveillance testing of the high pressure makeup function of the main CRD pumps. The pump total developed head will decrease as a result of operating at the higher flow rate required by this test. Running the pressurizing pump will prevent a drop in the HCU charging water header pressure during this condition. This in turn prevents an inadvertent initiation of scram due to low HCU charging water header pressure that would otherwise occur.

For this purpose, the pressurizing pump does not run continuously during normal plant operation but only when the high pressure makeup function surveillance testing is being conducted.

4.6-19 Scram time for electric scram

DCD Table 4.6-2 indicates the scram time for the hydraulic scram. Specify the scram time for the electric scram.

GE Response:

The specified FMCRD motor-driven insertion/withdrawal speed is 28 ± 5 mm/sec. The time to insert the control rod over its full stroke of 2921 mm from full-out to full-in is:

- 127 seconds at the minimum speed of 23 mm/sec
- 104.3 seconds at the rated speed of 28 mm/sec
- 88.5 seconds at the maximum speed of 33 mm/sec

4.6-20 Ball check valve function

In the operating BWRs, the ball check valves ensure rod insertion in the event the accumulator is not charged or the inlet scram valve fails to open if the reactor pressure is above 600 psig. This feature was not provided in the ABWR and SBWR designs. Confirm whether this feature exists for ESBWR. If so, confirm that the ball check valve ensures rod insertion in the event the accumulator is not charged or the inlet scram valve fails to open if the reactor pressure is above 600 psig, and include a discussion of the function of the ball check valve in the DCD.

GE Response:

The ABWR, SBWR and ESBWR designs do not have the reactor pressure assisted scram provided in the operating BWRs. The check valve is provided in the FMCRD drive housing flange to prevent a rod ejection in the event of a break of the connected scram insert line. Should the scram line break, the ball check valve will actuate to close the scram inlet port. This prevents the loss of pressure to the underside of the hollow piston and the generation of loads on the drive that could cause a rod ejection. The FMCRD brake and ball check valve provide redundant protection against a rod ejection caused by a scram line break. A discussion of the FMCRD brake and ball check valve are provided in DCD Subsections 4.6.1.2.1 (**FMCRD Brake and Ball Check Valve**, page 4.6-8) and 4.6.2.1.3 (**Rupture of Hydraulic Line to Drive Housing Flange**, page 4.6-20).

4.6-21 ITAAC for CRD pump motor speed

In DCD Tier 1 Table 2.2.2-1, ITAAC for CRD system, Item No. 3, motor speed is not specified. Include the motor speed as in the ABWR ITAAC.

GE Response:

GE will add the FMCRD motor-driven insertion speed of 28 ± 5 mm/sec to Design Commitment 3 in DCD Tier 1 Table 2.2.2-1 **(ITAAC for Control Rod Drive System)** in Revision 2. Also, the second sentence of DCD Subsection 4.6.1.2.1 will be changed to the following in Revision 2 (new text underlined):

"An electric motor-driven ball-nut and ball screw assembly is capable of positioning the drive at <u>both</u> a minimum of 36.5 mm (1.44 in.) increments <u>and continuously over its entire range at a speed of 28 ± 5 mm/sec</u>."

4.6-22 Function of purge water flow

On page 4.6-12 of the DCD, it is stated that "the purge flow maintains the RPV water level reference leg instrument lines filled to address the effects of noncondensible gases in the instrument lines to prevent erroneous reference information after a rapid RPV depressurization event." According to P & I.D. 105E3926, Rev.0, the purge line branches into two, one going to the RPV level instrument reference legs, and the other branch goes to the individual drives.

In the CRD system for operating BWRs, the major function of the cooling water was to cool the drive mechanism and its seals to preclude damage resulting from long term exposure to reactor temperature. It is our understanding that the seals are eliminated for ESBWR. What is the function of purge water flow to the drives?

GE Response:

Unlike the drive mechanisms in operating BWRs, the FMCRDs do not have any internal seals requiring cooling. The function of the FMCRD purge water flow is to keep reactor water from entering the FMCRDs during plant operation. This prevents long-term contamination of the FMCRDs and consequently reduces potential radiation exposure to plant personnel during drive maintenance operations.

Enclosure 3

MFN 06-078

Affidavit

General Electric Company

AFFIDAVIT

I, George B. Stramback, state as follows:

(1) I am Manager, Regulatory Services, General Electric Company ("GE") and have been delegated the function of reviewing the information described in paragraph (2) which is sought to be withheld, and have been authorized to apply for its withholding.

(2) The information sought to be withheld is contained in Enclosure 1 of GE letter MFN 06-078, David H. Hinds to USNRC, *Response to NRC Request for Additional Information Letter No. 11 Related to ESBWR Design Certification Application – Control Rod Drive System – RAI Numbers 4.6-1 through 4.6-22,* dated March 16, 2006. The proprietary information in Enclosure 1, *GE Responses to NRC Request for Additional Information Letter No. 11 for the ESBWR Design Certification Application Section 4.6 Functional Design of Reactivity Control System,* is delineated by a double underline inside double square brackets. Figures and large equation objects are identified with double square brackets before and after the object. In each case, the superscript notation{3} refers to Paragraph (3) of this affidavit, which provides the basis for the proprietary determination.

(3) In making this application for withholding of proprietary information of which it is the owner, GE relies upon the exemption from disclosure set forth in the Freedom of Information Act ("FOIA"), 5 USC Sec. 552(b)(4), and the Trade Secrets Act, 18 USC Sec. 1905, and NRC regulations 10 CFR 9.17(a)(4), and 2.790(a)(4) for "trade secrets" (Exemption 4). The material for which exemption from disclosure is here sought also qualify under the narrower definition of "trade secret", within the meanings assigned to those terms for purposes of FOIA Exemption 4 in, respectively, Critical Mass Energy Project v. Nuclear Regulatory Commission, 975F2d871 (DC Cir. 1992), and Public Citizen Health Research Group v. FDA, 704F2d1280 (DC Cir. 1983).

(4) Some examples of categories of information which fit into the definition of proprietary information are:

a. Information that discloses a process, method, or apparatus, including supporting data and analyses, where prevention of its use by General Electric's competitors without license from General Electric constitutes a competitive economic advantage over other companies;

b. Information which, if used by a competitor, would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing of a similar product;

c. Information which reveals aspects of past, present, or future General Electric customer-funded development plans and programs, resulting in potential products to General Electric;

d. Information which discloses patentable subject matter for which it may be desirable to obtain patent protection.

The information sought to be withheld is considered to be proprietary for the reasons set forth in paragraphs (4)a., and (4)b, above.

(5) To address 10 CFR 2.390 (b) (4), the information sought to be withheld is being submitted to NRC in confidence. The information is of a sort customarily held in confidence by GE, and is in fact so held. The information sought to be withheld has, to the best of my knowledge and belief, consistently been held in confidence by GE, no public disclosure has been made, and it is not available in public sources. All disclosures to third parties including any required transmittals to NRC, have been made, or must be made, pursuant to regulatory provisions or proprietary agreements which provide for maintenance of the information in confidence. Its initial designation as proprietary information, and the subsequent steps taken to prevent its unauthorized disclosure, are as set forth in paragraphs (6) and (7) following.

(6) Initial approval of proprietary treatment of a document is made by the manager of the originating component, the person most likely to be acquainted with the value and sensitivity of the information in relation to industry knowledge. Access to such documents within GE is limited on a "need to know" basis.

(7) The procedure for approval of external release of such a document typically requires review by the staff manager, project manager, principal scientist or other equivalent authority, by the manager of the cognizant marketing function (or his delegate), and by the Legal Operation, for technical content, competitive effect, and determination of the accuracy of the proprietary designation. Disclosures outside GE are limited to regulatory bodies, customers, and potential customers, and their agents, suppliers, and licensees, and others with a legitimate need for the information, and then only in accordance with appropriate regulatory provisions or proprietary agreements.

(8) The information identified in paragraph (2), above, is classified as proprietary because it contains detailed ESBWR design information developed by GE over a period of more than ten years at a cost of several million dollars. This information, if used by a competitor, would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing of a similar product.

(9) Public disclosure of the information sought to be withheld is likely to cause substantial harm to GE's competitive position and foreclose or reduce the availability of profit-making opportunities. The information is part of GE's comprehensive BWR safety and technology base, and its commercial value extends

beyond the original development cost. The value of the technology base goes beyond the extensive physical database and analytical methodology and includes development of the expertise to determine and apply the appropriate evaluation process. In addition, the technology base includes the value derived from providing analyses done with NRC-approved methods.

The research, development, engineering, analytical and NRC review costs comprise a substantial investment of time and money by GE.

The precise value of the expertise to devise an evaluation process and apply the correct analytical methodology is difficult to quantify, but it clearly is substantial.

GE's competitive advantage will be lost if its competitors are able to use the results of the GE experience to normalize or verify their own process or if they are able to claim an equivalent understanding by demonstrating that they can arrive at the same or similar conclusions.

The value of this information to GE would be lost if the information were disclosed to the public. Making such information available to competitors without their having been required to undertake a similar expenditure of resources would unfairly provide competitors with a windfall, and deprive GE of the opportunity to exercise its competitive advantage to seek an adequate return on its large investment in developing these very valuable analytical tools.

I declare under penalty of perjury that the foregoing affidavit and the matters stated therein are true and correct to the best of my knowledge, information, and belief.

Executed on this 16th day of March 2006

George B. Stramback
General Electric Company