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MFN 07-285

Docket No. 52-010

May 30, 2007

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

Subject: Response to Portion of NRC Request for Additional Information Letter No. 76 – Related to ESBWR Design Certification – RAI Numbers 7.1-8, 7.1-31, 7.1-33 through 7.1-35, 7.1-37, 7.1-39, 7.1-40, 7.2-31, 7.2-32, 7.2-35, 7.2-38, 7.2-40, 7.3-2, 7.3-12, 7.4-2, 7.4-4, 7.9-2 through 7.9-4, 7.9-7 through 7.9-10, and 7.9-14

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

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

Sincerely,

Kathy Sedney for

James C. Kinsey
Project Manager, ESBWR Licensing

D068

NRO

Reference:

1. MFN 06-388 - Letter from U.S. Nuclear Regulatory Commission to David Hinds, "*Request for Additional Information Letter No. 76, Related to ESBWR Design Certification Application*", dated October 11, 2006

Enclosures:

1. MFN 07-285– Response to Portion of NRC Request for Additional Information Letter No. 76 – Related to ESBWR Design Certification – RAI Numbers 7.1-8, 7.1-31, 7.1-33 through 7.1-35, 7.1-37, 7.1-39, 7.1-40, 7.2-31, 7.2-32, 7.2-35, 7.2-38, 7.2-40, 7.3-2, 7.3-12, 7.4-2, 7.4-4, 7.9-2 through 7.9-4, 7.9-7 through 7.9-10, and 7.9-14
2. MFN 07-285 – DCD Markups – RAI Numbers 7.1-37, 7.1-39, and 7.1-40

cc: AE Cubbage USNRC (with enclosures)
GB Stramback GE/San Jose (with enclosures)
RE Brown GE/Wilmington (with enclosures)
eDRF: RAI 7.1-8 (eDRF 0000-0060-2372 R1)
RAI 7.1-31 (eDRF 0000-0061-6878 R0)
RAI 7.1-33 (eDRF 0000-0067-7747 R0)
RAI 7.1-34 (eDRF 0000-0067-9561 R0)
RAI 7.1-35 (eDRF 0000-0067-9561 R0)
RAI 7.1-37 (eDRF 0000-0068-0863 R0)
RAI 7.1-39 (eDRF 0000-0060-7565 R1)
RAI 7.1-40 (eDRF 0000-0068-0408 R1)
RAI 7.2-31 (eDRF 0000-0062-2859 R0)
RAI 7.2-32 (eDRF 0000-0062-2819 R0)
RAI 7.2-35 (eDRF 0000-0067-9054 R0)
RAI 7.2-38 (eDRF 0000-0064-6262 R1)
RAI 7.2-40 (eDRF 0000-0060-4073 R0)
RAI 7.3-2 (eDRF 0000-0060-5438 R2)
RAI 7.3-12 (eDRF 0000-0060-5795 R2)
RAI 7.4-2 (eDRF 0000-0067-9378 R0)
RAI 7.4-4 (eDRF 0000-0068-0907 R0)
RAI 7.9-2 (eDRF 0000-0060-9979 R0)
RAI 7.9-3 (eDRF 0000-0060-9979 R0)
RAI 7.9-4 (eDRF 0000-0060-9979 R0)
RAI 7.9-7 (eDRF 0000-0060-9979 R0)
RAI 7.9-8 (eDRF 0000-0060-9979 R0)
RAI 7.9-9 (eDRF 0000-0060-9979 R0)
RAI 7.9-10 (eDRF 0000-0060-9979 R0)
RAI 7.9-14 (eDRF 0000-0060-9979 R0)

MFN 07-285

Enclosure 1

Response to NRC Request for Additional Information Related to ESBWR Design Certification Application DCD Sections 7.1, 7.2, 7.3, 7.4 and 7.9

RAI Numbers
7.1-8, 7.1-31, 7.1-33 through 7.1-35, 7.1-37, 7.1-39, 7.1-40, 7.2-31, 7.2-32, 7.2-35, 7.2-38, 7.2-40, 7.3-2, 7.3-12, 7.4-2, 7.4-4, 7.9-2 through 7.9-4, 7.9-7 through 7.9-10, and 7.9-14

NRC RAI 7.1-8

Update the DCD to address how the ESBWR design is in conformance with Regulatory Guides.

*In DCD, Tier 2, Revision 1, Table 7.1-1 (pages 7.1-37 & 38), there is a footnote that states " * These criteria are addressed in conjunction with the Safety System Logic and Control System (SSLC)." However, there is no such discussion in the SSLC section of the DCD, Tier 2, Revision 1. Please provide detailed discussion how the ESBWR design is in conformance with Regulatory Guides 1.152, 1.168, 1.169, 1.170, 1.171, 1.172, 1.173, 1.180, and 1.204.*

GE Response

Conformance with RGs 1.152, 1.168, 1.169, 1.170, 1.171, 1.172, 1.173, 1.180, and 1.204 is discussed in DCD Tier 2, Revision 3, Subsection 7.1.6.4.1 and Appendix 7B. Conformance with RGs 1.180 and 1.204 has been added to Table 7.1-1, in DCD Tier 2, Revision 3, Section 7.1, in response to NRC RAI 7.1-7 via MFN 07-163.

DCD Impact

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

NRC RAI 7.1-31

DCD, Tier 2, Revision 1, Figure 7.1-1, "ESBWR Instrumentation and Control Simplified Block Diagram" shows that the ESBWR design has Flat Panels with Soft-controls for both safety-related and non-safetyrelated instrumentation. Please provide detailed design description (include interface diagrams, hardware and software requirements) of the Flat Panels with Soft-controls design

GE Response

As reflected in DCD, Tier 2, Revisions 2 and 3, Figure 7.1-1, flat panel soft control use is envisioned for the ESBWR design for both the safety-related distributed control and information system (Q-DCIS) and the nonsafety-related distributed control and information system (N-DCIS). However, the precise technology to be used has yet to be defined. Technological options include both display type (plasma, LCD, etc.) as well as controller type (trackball, mouse, touchscreen, joystick, and others) that are compatible with the applicable Human Factors Engineering (HFE), seismic and reliability criteria. The detailed design process for establishing flat panels with soft control requirements will be submitted to the NRC via NEDO-33217, "ESBWR Man-Machine Interface System and Human Factors Engineering Implementation Plan, revision 1" scheduled for submittal to the NRC on 06/27/07.

Note that whatever the implementation of the video display units (VDUs), the Q-DCIS displays will be separated divisionally from each other and from N-DCIS. For example a Division 1 VDU cannot control or monitor any Division 2 application. N-DCIS displays will (and can) never be used to command or control any safety-related application (specifically including Safety System Logic and Control/Engineered Safety Features (SSLC/ESF), Neutron Monitoring System (NMS) or Reactor Protection System (RPS)). The N-DCIS displays can only monitor safety-related information that has been suitably isolated and transmitted through the gateways.

The Licensing Topical Report NEDO –33268, "ESBWR Human-System Interface Design Implementation Plan" describes the methodology used to evaluate and select technologies for inclusion in the ESBWR design. This methodology will be used during the development of the design for the flat panels with soft controls. NEDO-33268 was submitted to the NRC via MFN 07-076.

DCD/LTR Impact

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

NRC RAI 7.1-33

DCD, Tier 2, Revision 1, Figure 7.1-1 indicated the Gateway Cabinets provides interface between safety-related I&C systems and the nonsafety-related I&C systems. Please provide detailed design description (include hardware and software requirements) of this Gateway system."

GE Response

The use of gateways in the ESBWR Q-DCIS is described in section 7.1.3.3 of the DCD Revision 3; since specific hardware has not yet been chosen it is not possible to provide detailed design information but it should be understood that the gateways are not safety-related and do not perform safety-related functions. Note that data isolation is provided by the safety-related communications interfaces in the Q-DCIS and electrical isolation by the interconnecting optical fiber used for all Q-DCIS to N-DCIS communications, allowing the gateways to be nonsafety-related. However the ESBWR Q-DCIS to N-DCIS communication scheme is designed such that there is no credible event (e.g., seismic, design basis accident, etc.) which can cause a failure of the isolation barrier. Additionally safety-related systems are designed to never depend on non-safety-related communication for their functioning, so loss of communication is never a safety issue.

Licensing Topical Report (LTR) NEDO-33288, " Application of Nuclear Measurement Analysis and Control (NUMAC) for the ESBWR Reactor Trip System," provides a more detailed description of the Reactor Protection System (RPS)/Nuclear Monitoring System (NMS) platform communication protocols and was submitted in GE letter MFN 07-160, dated March 21, 2007. As stated in MFN-07-101 GE intends to apply the Tricon architecture for the Safety System Logic and Control/ Engineered Safety Features (SSLC/ESF) platform. An updated LTR for the SSLC/ESF platform architecture containing a detailed description of the communications protocols will be submitted in accordance with the schedule described in MFN-07-004.

DCD/LTR Impact

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

NRC RAI 7.1-34

DCD, Tier 2, Revision 1, Figure 7.1-1 indicated the ""1E Communication Interface"" connected between safety-related I&C systems. DCD, Tier 2,Revision 1, Section 7.9.1 has limited information. Please provide detailed design description (include system configuration, hardware and software requirements, qualification status) of this "1E Communication Interface" system.

GE Response

The detailed design description cannot be provided until the actual hardware is chosen and communications protocols developed, however the design principles of the Neutron Monitoring System/Reactor Protection system and the Safety System Logic and Control/Engineered Safety Features (SSLC/ESF) communications interfaces can be described. The general ESBWR communication schemes are described in DCD, Tier 2, Revision 3, Subsection 7.1.3.3 but the most important design bases are that 1) whether or not the communications interface is operable or 2) whether there is anything functional on the nonsafety-related side of the communications interface, there will be no impact to safety-related system operation.

DCD/LTR Impact

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

NRC RAI 7.1-35

DCD, Tier 2, Revision 1, Figure 7.1-1 indicated the "Ethernet Network Switches" connected between nonsafety-related I&C systems. Please provide detailed design description (include hardware and software requirements) of this "Ethernet Network Switches" design. If the system will use the existing commercial computer product, provide the qualification requirements."

GE Response

DCD Revision 1 Figure 7.1-1 has been revised to add more detail in DCD, Tier 2, Revision 3. Note that it has also been re-numbered to be Figure 7.1-2. Although the specific vendor for these ESBWR network switches has not yet been chosen, the switches (sometimes called "managed switches" or "level 3 switches") are existing commercial products and are available from several sources. Qualification requirements for these switches will specifically include:

- Maximum operating temperature of 40 deg C.
- Ability to operate from either of two redundant power supplies
- Mean Time Between Failure (MTBF) of > 200,000 hours (even though these switches will be used in a redundant configuration)
- Switches will include 1 GB (or greater) uplink fiber optic ports (> 6 ports/switch)
- Switches will include 100 MB (or greater) fiber optic ports (> 100 ports/switch)

Switches will be mounted in cabinets designated Seismic Category II.

The switches will maintain a record of the nodal address of components plugged into their ports and will be able to provide simultaneous, virtual 100 MB connections between any two of their ports. Should the proper address not be located on the specific switch, the message packet will be sent on the uplink ports. The design of the network will specifically minimize uplink traffic and "segment" various functions and components of the nonsafety-related distributed control and information system (N-DCIS), e.g., "Plant Investment Protection (PIP) A" from "PIP B" and "Balance of Plant (BOP)" systems.

The multiple uplink ports allow the switches to be arranged in a ring and all of the various switches will use a "spanning tree protocol" to negotiate between themselves the best route for any uplink messages. If a single redundant switch is lost or a single uplink fiber optic port is lost, there will be no effect on the network. If multiple redundant switches are lost or enough uplink fiber optic ports are lost, the remaining switches will automatically negotiate a new message path between the connected switches; this reconfiguration usually takes less than a few seconds, does not require operator input, and maintains network operation for the remaining switches. If the isolated switch(es) are still operable, that "segment" (e.g., PIP A) will continue to operate although some non-essential functions (like alarm management) may be lost. If the isolated switches are inoperable, that segment will be lost without affecting the other segments.

Although message packet size depends on the final DCIS applications, typically switches of this type can support > 10,000 packets/second between any two ports on the network but the ESBWR applications will typically require support for 100 - 500 packets/second.

Finally the switches will include both software to manage and monitor the network and extensive self-diagnostics that will allow operator alarm notification for both hardware and software problems.

DCD/LTR Impact

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

NRC RAI 7.1-37

DCD, Tier 2, Revision 1, Section 7.1.4, "References," listed 8 documents. Item 1 is the NRC NUREG-0800, ""Standard Review Plan." Items 2, 3, and 4 were provided for information on 12/15/2005. The staff needs a copy of documents listed as items 5 through 8 for information.

GE Response

DCD, Tier 2, Revision 1, Reference 7.1-5 "NEDC-32410P-A, Nuclear Measurement Analysis and Control Power Range Neutron Monitor (NUMAC PRNM) Retrofit Plus Option III Stability Trip Function, Oct., 1995," was deleted in DCD Revision 3.

DCD, Tier 2, Revision 1, Reference 7.1-6 "NEDO-31439-A (Non Proprietary), The Nuclear Measurement Analysis and Control Wide Range Neutron Monitor System (NUMAC WRNMS) Oct., 1990," was deleted in DCD Revision 3.

Both Revision 1 References 7.1-5 and 7.1-6 have been replaced by DCD Revision 3 Reference 7.1-6, "GE Energy, 'Application of Nuclear Measurement Analysis and Control for a new BWR (NUMAC Platform Architecture),' NEDC–33288P, Class III (Proprietary), Revision 0." This reference was transmitted as a non-proprietary document by MFN-07-160 Enclosure 2. As shown in MFN-07-160, Enclosure 1, the title for NEDC-33288 in Reference 7.1-6 will be corrected to "Application Of Nuclear Measurement Analysis And Control (NUMAC) For The ESBWR Reactor Trip System."

DCD, Tier 2, Revision 1, Reference 7.1-7 has been renumbered to Reference 7.1-2 in Revision 3 as "General Electric Company, 'General Electric Environmental Qualification Program,' NEDE-24326-1-P, Revision 1, Class III (proprietary), January 1983." As addressed in NUREG-1503, "Final Safety Evaluation Report Related to the Certification of the Advanced Boiling Water Design," dated July 1994, NEDE-24326-1-P was reviewed and approved by the NRC via SER dated October 23, 1983.

DCD, Tier 2, Revision 1, Reference 7.1-8 "EPRI TR-102323, Guidelines for Electromagnetic Interference Testing in Power Plants, Final Report, June 1994," is listed in Revision 3 as Reference 7.1-3. This reference will be deleted in a later DCD revision because existing references to, RG 1.180 Revision 1, Mil Std 416E and IEC 61000-4 are sufficient.

DCD/LTR Impact

The DCD Tier 2 Revision 3 subsections 7.1.6.4, 7.1.6.6.1.5, and 7.1.8, References, will be revised as shown on the attached markup in a later DCD revision.

NRC RAI 7.1-39

Address 10 CFR 50.34(f)(2)(v), TMI item I.D.3,"Provide for automatic indication of the bypassed and inoperable status of safety systems.

DCD, Tier 2, Revision 1, Table 1A-1, "TMI Action Plan Item," referred to DCD, Tier 2, Sections 7.1.2.2, 7.2.1.3, and Table 7.1-1 to address this item. However, there is no discussion of how this item will be implemented in the ESBWR design in these DCD sections. Provide detailed description of how this TMI item will be implemented.

GE Response

The following sections of Design Control Document (DCD), Tier 2 (Rev. 3) depict automatic indication of bypass in the ESBWR design:

- Section 7.1.2.4 indicates that Safety-Related Distributed Control and Information System (Q-DCIS) conform to Regulatory Guide (RG) 1.47.
- Section 7.2.1.11 indicates that automatic indication is provided in the control room to inform the operator that the safety system is inoperable or a division is bypassed.
- Section 7.2.1.14.2 (including subsections) describes in detail the automatic and manual bypass of selected scram functions.
- Sections 7.3.5.2.3 and 7.3.5.2.4 indicate that ESBWR design is providing "indication of bypass" in the Main Control Room (MCR) for Safety System Logic and Control/Engineered Safety Features (SSLC/ESF), which covers division-of-sensors bypass and division-out-of-service bypass.
- Section 7.3.5.5 describes the Instrumentation and Control requirements for indication of bypass provided in the MCR for SSLC/ESF.

Also, DCD, Tier 2 indicates conformance with 10 CFR 50.34(f)(2)(v) and RG 1.47 per the following sections/systems:

Sections	Systems
7.1.2.4	Q-DCIS
7.2.1.8.1; 7.2.1.11	Reactor Protection System (RPS)
7.2.2.3.2; 7.2.2.4.2; 7.2.2.4.4	Neutron Monitoring System (NMS)
7.2.3.3.2.1; 7.2.3.3.2.4; 7.2.3.3.2.6	Suppression Pool Temperature Monitoring (SPTM)
7.3.1.1.3.1; 7.3.1.1.3.4	Automatic Depressurization System (ADS)
7.3.1.2.3.1; 7.3.1.2.3.4; 7.3.1.2.3.6	Gravity-Driven Cooling System (GDCS)
7.3.3.3.1; 7.3.3.3.4; 7.3.3.3.6	Leak Detection and Isolation system (LD&IS)
7.3.5.3.1; 7.3.5.3.4	SSLC/ESF
7.5.1.3.1.1	Post Accident Monitoring (PAM) Instrumentation
7.5.2.3.1; 7.5.2.3.4; 7.5.2.3.6	Containment Monitoring system (CMS)
7.5.3.1.1; 7.5.3.1.4; 7.5.3.1.6	Process Radiation Monitoring System (PRMS)
7.6.1.3.3; 7.6.1.3.5; 7.6.1.3.7	High Pressure/Low Pressure (HP/LP) Interlocks

The information display design is also part of the Human Factors Engineering (HFE) as described in Chapter 18 of ESBWR DCD, Tier 2.

TMI requirement per 10 CFR 50.34(f)(2)(v) is addressed in Chapter 1 of DCD, Tier 2, particularly in Table 1A-1. Implementation of this requirement is covered in Chapter 7 of DCD, Tier 2 indicating its conformance for each related system (shown in table above).

ESBWR DCD, Tier 2, Chapter 1, Table 1A-1 was revised in Revision 3 of the DCD, to provide detailed description of how this TMI item is implemented.

This RAI has been addressed in DCD Tier 2, Revision 3 Sections 7.1; 7.2; 7.3; 7.5; 7.6; and Table 7.1-1. However, part of Table 1A-1 associated with this RAI was inadvertently revised with inaccurate sections numbers.

Therefore, Table 1A-1 will be revised to match the applicable sections numbers described above.

DCD/LTR Impact

ESBWR DCD, Tier 2, Chapter 1, Table 1A-1 will be revised as shown in the attached table.

NRC RAI 7.1-40

A. *Issue 50 of NUREG-0933, Reactor Vessel Level Instrumentation in BWRs, Revision 1-June21, 2004. One of the two factors that could improve water level instrumentation is precluding temperature effects, which could cause decalibration and flashing. The applicant should identify how the ESBWR design addresses this issue or provide reference to the DCD section that addresses this issue.*

B. *Issue 67.3.4 of NUREG-0933, reactor Vessel Inventory Measurement. The applicant references Appendix 1A, which addresses TMI Action Plan, item II.F.2. In the resolution of that item, the ESBWR design of the water level instrumentation is referenced. It states that the design "include a constant metered addition of purge water from the Control Rod Drive (CRD) hydraulic system to prevent the build-up of dissolved gasses in the fixed leg." This design feature, which is a resolution of a TME action item, should be included in Section 7 as part of the I&C design.*

GE RESPONSE

A. Issue 50 of NUREG-0933 references S. Levy, Inc. study SLI-8211 for the subject water level instrumentation improvement. NRC Generic Letter 84-23 provides guidance on potential water level instrumentation improvements to address SLI-8211. The specific guidance associated with temperature effects, which could cause decalibration and flashing is prevention of reference leg overheating or reduction of the vertical reference leg drops in the drywell. The ESBWR water level sensing lines will comply with this guidance. Specifically, as described in DCD, Tier 2, Revision 3, Subsection 7.7.1.3.3, the instrument sensing lines for the Nuclear Boiler System (NBS) instrumentation are in full conformance with the guidelines of RG 1.151 and ISA-S67.02. More specifically, with respect to vertical reference leg drops in the drywell, the NBS Design Specification (26A6600) requires that the instrument line connected to the bottom of the condensing chamber shall have a downward slope ≥ 1/25 inside the primary containment and to the instrument rack. The total vertical drop from the RPV to the containment penetration shall be ≤ 0.91 m (3 ft.) and be the same as other lines ± 0.30 m (1ft.).

B. The ESBWR design for water level instrumentation will include a constant metered addition of purge water from the Control Rod Drive (CRD) hydraulic system to prevent the build-up of dissolved gasses in the reference (fixed) leg of the water level instrumentation. This is discussed in the DCD Tier 2, Revision 3, Subsection 4.6.1.2.4 "Control Rod Drive Hydraulic Subsystem" and DCD Tier 2, Revision 3, Subsection 4.6.1.2.5 "Control Rod Dive System Operation". The approximate purge flow provided to the reactor water level instrumentation reference leg is shown in DCD Tier 2, Revision 3, Table 4.6-1. Subsection 7.7.1.2 will be revised as shown in the attached DCD markup to include a reference to these descriptions and the commitment to the TMI item.

DCD Impact

DCD Tier 2, Revision 3, Subsection 7.7.1.2 will be revised as shown in the attached DCD markup to include a reference to these descriptions and the commitment to the TMI item.

NRC RAI 7.2-31

ESBWR design introduces the fine motion control rod drive mechanism (FMCRD) as a non-safety, diverse backup provision for the Scram function. In addition, there is a non-safety-related Alternate Rod insertion (ARI) system for ATWS mitigation. Provide a schematic diagram and describe the interface between FMCRD, ARI, and normal hydraulic scram systems. The discussion should include but not be limited to separation between safety and non-safety circuits, reset provision, display provision, and inadvertent actuation prevention.

GE RESPONSE

The Fine Motion Control Rod Drives (FMCRD) and Alternate Rod Insertion (ARI) are described in DCD Tier 2, Revision 3, Subsection 7.1.5.4.11, "Alternate Rods Insertion (ARI)," and in Subsection 7.1.5.4.12, "Emergency Rod Insertion."

DCD Tier 2, Revision 3, Subsection 7.7.2.2.1, "System Configuration" for the Rod Control & Information System (RC&IS) discusses the input signals from safety circuits, reset provisions and discusses the Dedicated Operator Interface (DOI) Video Display Unit (VDU). DCD Tier 2, Revision 3, Figure 7.7-2 is a schematic diagram of the RC&IS system and shows the interface between the FMCRD, ARI and normal hydraulic scram systems.

Safety signals are sent to RC&IS via the nonsafety-related Distributed Control and Information System (N-DCIS.) The separation of these safety signals from the safety-related Distributed Control and Information System (Q-DCIS) to N-DCIS is discussed in DCD Tier 2, Revision 3, Section 7.1.3.3, "Q-DCIS Safety Evaluation."

Inadvertent actuation of the FMCRD is discussed in DCD Tier 2, Revision 3, Subsection 7.1.5.4.10, "Selected Control Rod Run In (SCRRI) / Select Rod Insert (SRI)." Inadvertent actuation of the ARI function is reduced by the 3 out of 3 voting logic and is discussed in DCD Tier 2, Revision 3, Subsection 7.1.5.4.11, "Alternate Rods Insertion (ARI)."

DCD/LTR Impact

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

NRC RAI 7.2-32

DCD, Tier 2, revision 1, Section 7.2.1.4 stated that "switches are installed in the main control room to permit testing of the fast scram operation of the individual pairs of control rods and to confirm that the individual control rods have scrammed." Provide description and a schematic diagram to illustrate this test provision.

Also in NEDO-33251, Section 5.3 stated that "Although the operator must usually initiate the process, it can also be automatically initiated by the "SCRAM follow" function of RC&IS or by the ATWS/SLCS logic through the DPS." Provide description and a schematic diagram to illustrate all the circuitry (all solenoids) related to scram function.

GE RESPONSE

A. Only the two control rods associated with the same Hydraulic Control Unit (HCU) can be withdrawn for the paired Control rod Drive (CRD) scram time test when the Reactor Protection system (RPS) reactor mode switch is in the REFUEL mode and the scram test mode has been activated. This function provides for performing individual HCU scram testing during planned refueling outages and is performed at the RPS scram test panel.

   The RPS scram test panel is shown in DCD Tier 2, Revision 3, Figure 7.2-1 "RPS Functional Block" and the scram test is discussed in DCD Tier 2, Revision 3 Subsection 7.2.1.7.1.1 "RPS Outputs to Interfacing Systems."

   The Scram Time Recording Panels (STRPs) and the Scram Time Recording and Analysis Panel (STRAP) are discussed in DCD Tier 2, Revision 3, Subsection 7.7.2.2.1 "System Configuration."

B. The Scram Follow function is described in DCD Tier 2, Revision 3, Subsection 4.6.1.2.5 "Control Rod Drive System Operation"

   The Scram Follow logic is depicted in DCD, Tier 2, Revision 3, Figure 7.8-2.

DCD Impact

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

NRC RAI 7.2-35

Provide detailed design information for the Oscillation Power Range Monitor (OPRM).

DCD, Tier 2, Revision 1, Section 7.2.2.2.4, Oscillation Power Range Monitor (OPRM), does not provide sufficient information to describe its compliance with IEEE Std. 603-1991 and its setpoint determination. Provide design information to address the hardware and software design of the ESBWR's OPRM system. Table 7.2-3, APRM Trip Function Summary, indicated typical analytical limit for APRM trip setpoints. Provide similar information for the OPRM system.

GE Response

The OPRM functions will be implemented using hardware described in LTR NEDO-33288, Application of Nuclear Measurement Analysis and Control (NUMAC) for the ESBWR Reactor Trip System. Section 4.2.8 of this LTR provides information on the conformance of the NUMAC hardware and the associated software functions to IEEE-603 requirements. Section 4.2.8.16 of this LTR notes that setpoint determinations will be made in accordance with the General Electric Setpoint Methodology.

LTR NEDO-33288 has been provided under separate cover in letter MFN 07-160; additional revisions will be provided in accordance with the schedule noted in letter MFN 07-004, Enclosure 1.

DCD Tier 2, Rev 3, Section 7.2.2.2.7, and Table 7.2-6 provide a summary of OPRM trip functions.

DCD Impact

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

NRC RAI 7.2-38

Provide detailed discussion of the NMS basic control logic requirements.

DCD, Tier 2, Revision 1, Section 7.2.2.5.2, Basic Control Logic Requirements does not provide sufficient detailed information to demonstrate that the control logic of the safety-related subsystems in the NMS is designed as "fail-safe." Provide detailed discussion of the NMS basic control logic with a logic diagram. Also explain the function of "Coincidence/Non-Coincidence switch."

GE Response

See DCD Tier 2, Rev 03, Section 7.2.2.6.2

Section 7.2.2.6.2 provides additional information within the "Basic Control Logic Requirements" sub-section. An inoperative channel for any reason, including cable breaks and maintenance, results in a channel trip output, the effects of which are described in this Section.

The function of "Coincidence/Non-Coincidence switch" mode is described in DCD Sections 7.2.2.2.4.6 (Bypasses and Interlocks) and 7.2.2.6.2. When the Reactor Mode switch is in RUN mode, this equates to a "Coincident" mode for the NMS. When the Reactor Mode switch is NOT in RUN mode, this equates to a "Non-Coincident" mode for the NMS.

When the NMS Coincidence/Non-Coincidence logic is in Non-Coincidence, any single SRNM channel trip can cause the reactor to scram; in the Coincidence mode, at least two out of four divisions must be tripped in order to activate the reactor scram.

When the Reactor Mode switch is in RUN, the NMS trip functions are in the Coincidence mode; the Non-Coincident NMS trip function is automatically removed when the Reactor Mode switch is in the RUN mode position.

The SRNM system also can be placed in a Non-Coincidence reactor trip mode manually from a control switch so that any single SRNM channel trip will cause a trip to the RPS. If the Coincident/Non-Coincident NMS trip selection switch is in the Non-Coincident position when the Reactor Mode Switch is in the RUN mode, this will result in an alarm in the Main Control Room.

As part of the design process, an SRNM system simplified logic diagram has been developed and forwarded to the NRC in letter MFN-07-001 along with other system simplified logic diagrams.

DCD Impact

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

NRC RAI 7.2-40

DCD, Tier 2, Revision 1, Section 7.2.1.2.4.1 stated that digital trip modules (DTMs) and trip logic units (TLUs) are microprocessor-based modules of the Safety System Logic and Control (SSLC) system. The software associated with RPS channel trip and trip system coincident logic decisions that are installed in these SSLC modules are RPS unique. Provide detail discussion with drawings to show how the DTMs and the TLUs performing their functions and address how the SSLC system design satisfy the IEEE-603 requirements (and IEEE 7-4.3.2 criteria). The response should also demonstrate that data communication between safety channels or between safety and non-safety system shall not inhibit the performance of the safety function, and shall be in conformance with IEEE-603 criterion 5.6 requirements.

GE Response

The digital trip modules (DTMs) and trip logic units (TLUs) modules are described in DCD Tier 2, Revision 3, Subsection 7.2.1.2.4. The DTMs and TLUs are microprocessor-based modules of the Reactor Protection System (RPS) within the Q-DCIS system. A description of how the Q-DCIS system conforms with IEEE Std. 603, Section 5.6, is provided in DCD Tier 2, Revision 3, Subsection 7.1.6.6.1.7.

DCD Impact

No changes to DCD Tier 2 will be made in response to NRC RAI 7.2-40.

NRC RAI 7.3-2

The staff finds that many design features described during the July 26 and 27 I&C meeting were not clearly documented in DCD, Tier 2, Revision 1, Section 7.3. A general update of DCD Section 7.3 is required. For example, ECCS/ESF Platform was never discussed in DCD. If a referenced platform will be implemented for the ESF function, it should be listed at DCD Section 7.3.6, "References." Figures 7.3.1A and 7.3.1B have not shown manual actuation which was discussed in DCD Section 7.3.1.1.2. The "joystick bypass switch" information, which was discussed in response to Staff RAI 7.2-3, should be documented in the DCD.

GE Response

DCD Section 7.3 has been updated for Revision 3, however an Engineered Safety Features Systems (ESF) platform has not been selected. A specific platform was presented in MFN 07-101 and a DCD Rev. 4 markup of DCD Section 7.3.7, "References," was provided. Note that the DCD Section 7.3.6, "References," was re-numbered to DCD Section 7.3.7 in Revision 3.

The manual actuation description in Section 7.3.1.1.2 (updated in Revision 2) is reflected in DCD, Tier 2, Revision 3. Figures 7.3-1A and 7.3-1B (also updated in Revision 2) are shown in DCD, Tier 2, Revision 3 to reflect N-2 and to reflect the DPS interaction. Figure 7.3-1C was also added in Revision 2. However, these figures are intended to be a general depiction of the actuation circuit, not a detailed depiction of the actuation logic and do not show the manual actuation logic. As part of the design process, Nuclear Boiler System (NBS) and Gravity Driven Cooling System (GDCS) system simplified logic diagrams have been developed. These logic diagrams show the manual actuation logic. These simplified logic diagrams were submitted under separate cover in MFN-07-001.

See DCD, Tier 2, Revision 3, Sections 7.2.1.2.4 and 7.2.1.14.2.2 and Figure 7.2-1 for the discussion of the RPS bypass switches. The discussion about the bypass switches in the response to RAI 7.2-3 is included in these sections.

DCD Impact

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

NRC RAI 7.3-12

Identify the differences of the Remote Mulitplexing Units (RMU) and provide the specifications In DCD, Tier 2, Revision 1, Section 7.3.1.2, Gravity-Driven Cooling System, reference is made to multiple deluge valve thermocouple signals feeding the reactor building remote multiplexing units (RMUs). Please provide the following with regards to these units:

1) *Identify which RMUs this refers to. Will the RMUs in the reactor building be all the same, including manufacturer, or will that depend on the platform (i.e. ECCS or RTS)?*
2 *Will the RMUs be built to the same hardware and software specifications, or will that depend on platform? If so provide a set of hardware and software specifications, including logic diagrams, and identify the anticipated differences between platforms.*

GE Response

The system description for the Gravity-Driven Cooling System (GDCS) deluge function is reflected in DCD, Tier 2, Revision 3, Section 7.3.1.2.2. The deluge function is performed within two separate stand-alone programmable logic controllers (PLCs) located in the Reactor Building outside containment. Associated thermocouples are connected to the two PLCs – remote multiplexing units are no longer part of the GDCS deluge function design.

DCD Impact

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

NRC RAI 7.4-2

DCD, Tier 2, Revision 1, Table 1A-1, "TMI Action Plan Items," item II.K.2.10 stated that a reactor trip and initiation of the Isolation Condenser Systems (ICS) will occur in response to a loss of all feed-water event. Please provide logic diagram of the ICS and discuss the testability provisions of this system to perform channel functional tests at power.

GE Response

The Isolation Condenser System simplified logic diagrams were submitted by GE in MFN 07-001.

The testing provisions are described in Design Control Document (DCD), Tier 2, Revision 3, Subsection 7.3.5.4, "Testing and Inspection Requirements." The bypass feature allowing online testing is described in DCD, Tier 2, Revision 3, Subsection 7.3.5.2.3, "Division-of-Sensors Bypass."

DCD Impact

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

NRC RAI 7.4-4

Discuss the capability to achieve and maintain safe shutdown condition under the station blackout scenario. The maximum capacity of the Class IE battery is 72-hours. Discuss the provisions to recharge the battery after 72-hours, and to maintain the safe shutdown condition.

GE Response

As discussed in DCD Revision 3, Tier 2 Chapter 15, subsection 15.5.5, ESBWR can successfully achieve and maintain the hot shutdown condition during the Station Blackout (SBO) event to meet the requirements of 10 CFR 50.63. After 72 hours the safe shutdown condition can be maintained without reliance on the safety-related batteries being recharged. Credit for maintaining safe shutdown conditions is based on the Fire Suppression System diesel-driven pump providing makeup to the IC/PCC pools.

As a backup, the safety related batteries are charged by either the normal or alternate power supply or by one of the two non-safety diesel-generators, as discussed in response to RAI 8.5-15 and documented in MFN 07-161 dated April 4, 2007.

DCD/LTR Impact

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

NRC RAI 7.9-2

Provide clarification on diverse means of indication and manual controls on loss of safety related video display units (VDUs) due to common cause. DCD, Tier 2, Revision 1, Section 7.9.1.1 and Figure 7.9-1 describe the functionality of safety related VDUs. These descriptions do not indicate that the operating system and the application software used for manual control and display are diverse between various channels or divisions. A common cause failure can disable all safety related VDUs of all channels/divisions. Please provide a response to address what diverse means are available to overcome this common cause issue.

GE Response

Section 7.9, "Data Communication System," was deleted in DCD Revision 3. Data Communications Systems that were discussed in Section 7.9 of DCD Tier 2, Revision 2 are addressed in Section 7.1 of DCD Tier 2, Revision 3. The term Essential Distributed Control and Information System (E-DCIS) has been replaced with the term Safety-related Distributed Control and Information System (Q-DCIS) throughout DCD Chapter 7, Revision 3. The term Non-Essential Distributed Control and Information System (NE-DCIS) has been replaced with the term Nonsafety-related Distributed Control and Information System (N-DCIS) throughout DCD Chapter 7, Revision 3.

Manual control and display are not diverse between the divisions of a safety-related system. The four divisions use the same hardware/software platform (The Safety System Logic and Control (SSLC)/Engineered Safety Features (ESF) and the Reactor Protection System (RPS) use different hardware/software platforms). While highly unlikely, if it is assumed that all four divisions of safety-related displays fail simultaneously, then it is expected that almost all safety-related SSLC/ESF manual control and display capability will be lost. Note specifically that a common cause failure of the safety-related displays and resulting loss of manual control and indication does not necessarily cause the loss of the automatic SSLC/ESF or RPS/Neutron Monitoring System (NMS) functions.

Whatever the status of the manual and automatic capabilities of the Q-DCIS, the operator will always have the ability to manually scram and isolate the reactor without any software involvement by directly interrupting the current to the applicable solenoids.

Since a common cause failure cannot be precluded, the ESBWR uses an entirely separate hardware/software platform (i.e., the diverse protection system (DPS)) that provides for both manual and automatic operation of a subset of RPS and SSLC/ESF functions. Additionally the loss of the safety-related displays does not disable the gateways to the N-DCIS such that safety-related information may still be monitored on the nonsafety-related side to confirm reactor shutdown and isolation and SSLC/ESF functions.

As described in the NEDO-33251 "ESBWR I&C Defense-in-Depth and Diversity Report," the ESBWR DCIS includes the Diverse Protection System (DPS) which responds directly and specifically to NRC Branch Technical Position HICB-19, "Defense-in-Depth and Diversity," concerns about common cause failure of the Q-DCIS. The DPS utilizes a hardware/software platform that is different from the Q-DCIS hardware/software platforms and is therefore not subject to the same common cause failures. The same N-DCIS VDUs are capable of adding inventory to the core via condensate/feedwater, the low pressure coolant injection mode of the Fuel and Auxiliary Pools Cooling System and cooling the core via Reactor Water Cleanup/Shutdown Cooling since there is no reason to assume that the simultaneous common

cause failure of the safety-related VDUs will disable any nonsafety-related functions of the N-DCIS.

DCD/LTR Impact

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

NRC RAI 7.9-3

Gateways have been used as isolation mediums between E-DCIS and NE-DCIS (Reference: DCD, Tier 2, Revision 1, Sections 7.9.1.1 and 7.9.1.2). What type of gateways are envisioned and how do they achieve the isolation. Please confirm that all gateways have one way communication from essential (E) to non-essential (NE) only and no feedback, check back, time sync or similar signals are sent from NE to E side. Is there any credible event e.g seismic, design basis accident etc. which can cause a failure of the isolation barrier between E and NE parts of the isolator. Describe how the design meets IEEE 603 -1991, paragraph 5.6.3.1.

GE Response

Section 7.9, "Data Communication System," was deleted in DCD Revision 3. Data Communications Systems that were discussed in Section 7.9 of DCD Tier 2, Revision 2 are addressed in Section 7.1 of DCD Tier 2, Revision 3. The term Essential Distributed Control and Information System (E-DCIS) has been replaced with the term Safety-related Distributed Control and Information System (Q-DCIS) throughout DCD Chapter 7, Revision 3. The term Non-Essential Distributed Control and Information System (NE-DCIS) has been replaced with the term Nonsafety-related Distributed Control and Information System (N-DCIS) throughout DCD Chapter 7, Revision 3.

A general discussion of gateways appears in Section 7.1.3.3 of the DCD Revision 3, however it should be emphasized that the gateways are not safety-related and therefore are not used as isolation media as premised in the RAI; gateways are data translators and packagers of data between safety-related and nonsafety-related systems. The data and electrical isolation functions are performed in safety-related communication interface modules or directly in certain Q-DCIS components and in the safety-related electrical to optical converters in Q-DCIS.

DCD/LTR Impact

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

NRC RAI 7.9-4

Non-safety redundant ethernet is envisioned in the system architecture for plant data highway (Reference: DCD, Tier 2, Revision 1,Section 7.9.1.2). Since ethernet serves as the communication network between safety related and non-safety related parts of the system, its loss can lead to unavailability of safety related data on the control room displays. The reliability of the ethernet is a concern by the staff. Is this ethernet network tied to any other systems such as intranet, firewalls, etc. Please confirm that no such connection exists. If such a connection exists then inform staff of the connections and address the safeguards to prevent any degradation of this network from outside influences.

GE Response

Section 7.9, "Data Communication System," was deleted in DCD Revision 3. Data Communications Systems that were discussed in Section 7.9 of DCD Tier 2, Revision 2 are addressed in Section 7.1 of DCD Tier 2, Revision 3.

Although "the" ethernet is completely redundant, self- healing by automatic reconfiguration using managed switch technology, and continuously monitored, the safety to non-safety gateways are connected to both of the redundant ethernets to ensure a highly reliable system. The non-safety redundant ethernet network that handles non-safety control, monitoring and the various gateways (unit data highway) is separate from the non-safety redundant ethernet network that handles printers, internal (to the control building area) engineering workstations, text procedure workstations and the firewall (plant data highway). The two ethernet networks are bridged by workstations that control data flow. No workstations outside the main control room (MCR) area and remote shutdown (RSS) panel area are allowed to perform control functions. The separate firewall workstations control all data sent from the control building area to the outside world (including any "intranets", administration building workstations, technical support center, emergency offsite facility, nuclear data link or simulator); the firewall will specifically not allow "outside" machines to "see" any internal workstation node addresses and only plant predefined workstations in the MCR and RSS panel areas are allowed control capability which specifically excludes "outside" machines.

Note also that the loss of the ethernet networks, however unlikely, does not "lead to unavailability of safety-related data on the control room displays" since the safety-related displays in the MCR or the RSS panels do not use the ethernet networks.

DCD/LTR Impact

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

NRC RAI 7.9-7

This communication exists from the 3D Monicore function of the NE-DCIS to the Power Range Neutron Monitoring (PRNM) function of the Neutron Monitoring System (NMS). Section 7.9.1.2 of the DCD, Tier 2, Revision 1, states that this data communication is a dedicated input to NMS and does not pass through the E-DCIS network. Please clarify and explain how separation between essential (E) and non-essential (NE) sections is met in light of the clarifications regarding classification of interconnected equipment noted in Regulatory Guide 1.152, Rev. 2, Part B. Regulatory Guide 1.152 in Part B references IEEE Std. 603-1991, paragraph 5.6.3.1, "Interconnect Equipment", which requires that equipment that is used for both safety and nonsafety functions shall be classified as part of the safety systems. The term equipment includes both software and hardware of digital systems.

GE Response

Section 7.9, "Data Communication System," was deleted in DCD Revision 3. Data Communications Systems that were discussed in Section 7.9 of DCD Tier 2, Revision 2 are addressed in Section 7.1 of DCD Tier 2, Revision 3. The term Essential Distributed Control and Information System (E-DCIS) has been replaced with the term Safety-related Distributed Control and Information System (Q-DCIS) throughout DCD Chapter 7, Revision 3. The term Non-Essential Distributed Control and Information System (NE-DCIS) has been replaced with the term Nonsafety-related Distributed Control and Information System (N-DCIS) throughout DCD Chapter 7, Revision 3.

Communication from the 3D Monicore function to NMS is described in Section 7.1.3.3 of the DCD Revision 3.

DCD/LTR Impact

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

NRC RAI 7.9-8

Where is the time tagging done for the safety related parameters and how is it passed through to the NE part of the network (Reference: DCD, Tier 2, Revision 1, Section 7.9.1.2)? What kind of time tagging delay is possible if the data is not time tagged at the source? How is time tagging synchronized between the essential distributed control and information system (E-DCIS) and the non-essential distributed control and information system (NE-DCIS)? Are separate Global Positioning System (GPS) clocks used for E-DCIS and NE-DCIS?"

GE Response

Section 7.9, "Data Communication System," was deleted in DCD Revision 3. Data Communications Systems that were discussed in Section 7.9 of DCD Tier 2, Revision 2 are addressed in Section 7.1 of DCD Tier 2, Revision 3. The term Essential Distributed Control and Information System (E-DCIS) has been replaced with the term Safety-related Distributed Control and Information System (Q-DCIS) throughout DCD Chapter 7, Revision 3. The term Non-Essential Distributed Control and Information System (NE-DCIS) has been replaced with the term Nonsafety-related Distributed Control and Information System (N-DCIS) throughout DCD Chapter 7, Revision 3.

Time tagging of safety-related data sent to the N-DCIS for monitoring and recording is described in Sections 7.1.3.3 and 7.1.5.5.10 of the DCD, Revision 3. Time tagging is generally done in the chassis/components where the data are originally acquired or calculated. A redundant nonsafety-related pair of GPS synchronized clocks is used for ESBWR timing and those time signals are sent to the Q-DCIS and N-DCIS as necessary. Time information (or its correctness or its existence) is never necessary to perform a safety-related function.

DCD/LTR Impact

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

NRC RAI 7.9-9

Please provide the information to confirm that the reliability of the Engineering Work Station (EWS) and VDUs is commensurate with the reliability of the other parts of the safety related systems (General question, no specific paragraph to be referenced in Section 7.9). Is a separate EWS provided for the safety related parts of the system? If so how does it interface with various division signals? Are these computers provided with redundant power supplies, redundant processors/redundant motherboards to enhance reliability?

GE Response

Section 7.9, "Data Communication System," was deleted in DCD Revision 3. Data Communications Systems that were discussed in Section 7.9 of DCD Tier 2, Revision 2 are addressed in Section 7.1 of DCD Tier 2, Revision 3. The term Essential Distributed Control and Information System (E-DCIS) has been replaced with the term Safety-related Distributed Control and Information System (Q-DCIS) throughout DCD Chapter 7, Revision 3. The term Non-Essential Distributed Control and Information System (NE-DCIS) has been replaced with the term Nonsafety-related Distributed Control and Information System (N-DCIS) throughout DCD Chapter 7, Revision 3.

There are no safety-related engineering workstations in the Q-DCIS. Safety System Logic and Control and safety-related displays are controlled by their display generators. Within a safety division, communication and power is redundant, but video display units (VDUs) and their display generators are not. Since each VDU (per safety division) is not dedicated and all corresponding divisional monitoring and control can be done on any one of the two or three VDUs per division, each VDU is redundant to the others.

On the N- DCIS, engineering workstations or processors performing non-safety functions, such as plant investment protection and power generation are redundant with each component connected to both non-safety networks; the power and communications to each of these workstations are redundant even though the individual processors are not. Redundant motherboards are not used.

DCD/LTR Impact

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

NRC RAI 7.9-10

A large number of data may be exchanged quickly during transients and plant upset conditions. To prevent locking up of the processors and gateways, sufficient spare memory and speed are required. Please provide staff the design guidelines and design approach to these issues.

GE Response

Section 7.9, "Data Communication System," was deleted in DCD Revision 3. Data Communications Systems that were discussed in Section 7.9 of DCD Tier 2, Revision 2 are addressed in Section 7.1 of DCD Tier 2, Revision 3. The term Essential Distributed Control and Information System (E-DCIS) has been replaced with the term Safety-related Distributed Control and Information System (Q-DCIS) throughout DCD Chapter 7, Revision 3. The term Non-Essential Distributed Control and Information System (NE-DCIS) has been replaced with the term Nonsafety-related Distributed Control and Information System (N-DCIS) throughout DCD Chapter 7, Revision 3.

The safety-related networks are completely deterministic and all processors and communications run at constant speed regardless of plant events. The processors and communications cannot be overloaded; the only concern is that the various processor and communications rates be fast enough to accomplish the design goals at the chosen speeds. The ESBWR Reactor Protection Systems (RPS) need to function in the 10's of millisecond intervals (process exceeding setpoint to solenoid release) to satisfy the various transient and accident analyses. The Safety System Logic and Control (SSLC)/ Engineered Safety Feature (ESF) functions are very slow (compared to processor speeds) and generally have intentional time delays such that processor speeds are largely irrelevant; generally these functions demand speeds in the 100's of milliseconds. The final processor and communication speeds have not yet been chosen, but they will be faster than the already licensed Nuclear Measurement Analysis and Control (NUMAC) instrumentation and faster than relay based logic. In all cases the SSLC/ESF and RPS/Neutron Monitoring System (NMS) processors, Remote Multiplexer Units (RMUs) and communications are thoroughly factory tested and then functionally confirmed by periodic surveillance testing.

Although the N- DCIS is not deterministic, the 100 mb ethernet ports and dedicated RMU to control processor communications make the design almost so. The ESBWR and Lungmen designs are expected to be similar, in that the Lungmen design has network switch ports (at 100 mb) capable of 10 - 15 thousand message packets/second but operated at 10 - 15 packets/second. Additionally, the control processors have prioritized functions such that closed loop control (which does not involve operator input) is more important than (for example) screen updates; the control processors also control the data that are acquired at rates much lower than network capability. Since no ESBWR closed loop control need operate at faster than 10/second (input/process/output) and screen updates are required at no more that once or twice per second and the processors are deliberately operated at much less than their capacity, it is considered to be statistically impossible to overload the N- DCIS networks and controllers. Given that processor capabilities are fixed and communication speeds constant, it is the application of the N- DCIS design (number of controllers, RMUs, network switches, etc.) that will determine the final suitability of the design not the processor memory or network communications speed.
These functions will also be factory tested by deliberately increasing network message traffic, operator requests, and transient recording to values far greater than real transients will require (for example reactor transient and accident level rates and pressure rates are well understood). It should be noted that the Lungmen tests were performed at 5 to 10 times the expected real transient rates and no "overloads" were encountered.

DCD/LTR Impact

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

NRC RAI 7.9-14

Integrated overview displays are described in Section 7.9.2.1 of the DCD, Tier 2, Revision 1 document. Certain portions of the dedicated dynamic display are driven by dedicated microprocessor based controllers which are independent of the non-essential distributed control and information system (NE-DCIS). Certain safety related information is not from NE-DCIS. Are both safety related and non-safety related display processors utilized for the fixed dynamic displays? If so, how are they separated and updated from the process information networks?

GE Response

Section 7.9, "Data Communication System," was deleted in DCD Revision 3. Data Communications Systems that were discussed in Section 7.9 of DCD Tier 2, Revision 2 are addressed in Section 7.1 of DCD Tier 2, Revision 3. The term Essential Distributed Control and Information System (E-DCIS) has been replaced with the term Safety-related Distributed Control and Information System (Q-DCIS) throughout DCD Chapter 7, Revision 3. The term Non-Essential Distributed Control and Information System (NE-DCIS) has been replaced with the term Nonsafety-related Distributed Control and Information System (N-DCIS) throughout DCD Chapter 7, Revision 3.

Safety-related microprocessors are only indirectly used as input to the integrated overview displays in that they are the source of the safety information. All safety-related information is sent through the gateways previously described in the response to RAI 7.1-33 and becomes available to the N-DCIS for use in alarming, monitoring, recording and driving the integrated overview displays.

DCD/LTR Impact

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

MFN 07-285

Enclosure 2

DCD Markups

RAI Numbers
7.1-37, 7.1-39, and 7.1-40

RAI 7.1-37 Markups

- Electrical Surge

In the ESBWR design, EMI qualifications follow the requirements defined in Mil Std. 461E and IEC 61000-4. Q-DCIS equipment is qualified to perform continuously within specified ranges even when exposed to EMI environmental limits at the hardware mounting location. ~~Reference 7.1-3 is used to define the envelope limits.~~ To that end, EMI qualification for safety-related systems in the ESBWR design meets the proposed requirements of RG 1.180, Rev 1 "Guidelines for Evaluating Electromagnetic and Radio-Frequency Interference in safety-related Instrumentation and Control Systems."

RG 1.204 – Guidelines for Lightning Protection of Nuclear Power Plants

The surge withstanding capability of the safety-related I&C design conforms with IEEE Std. 1050. See Subsection 8A.1.2 for detailed information about conformance with RG 1.204 and the lightning protection system.

7.1.6.5 Conformance with Branch Technical Positions

Applicable BTPs are identified relative to the I&C systems in Table 7.1-1. BTPs are guidance documents and the systems are generally designed to conform with the BTPs. The degree of conformance, along with any clarifications or exceptions, is discussed in the Safety Evaluation Subsections of Sections 7.1 through 7.8.

BTP HICB-8 - Guidance on Application of RG 1.22. Q-DCIS is fully-operational during reactor operation and is tested in conjunction with the SSLC/ESF. Therefore, Q-DCIS fully meets this BTP.

BTP HICB-11: Guidance on Application and Qualification of Isolation Devices. Refer to Subsection 7.2.1.12 discussion. Q-DCIS conforms with this BTP.

BTP HICB-12: Guidance on Establishing and Maintaining Instrument Setpoints. Refer to Subsection 7.2.1.12 discussion. Q-DCIS conforms with this BTP.

BTP HICB-14: Guidance on Software Reviews for Digital Computer-based Instrumentation and Control Safety Systems. Refer to Subsections 7.1.2.4 and 7.2.1.12 and Appendix 7B discussion. Q-DCIS conforms with the guidance of this BTP.

Q-DCIS and N-DCIS will follow a development process that is in accordance with BTP HICB-14. Compliance with BTP HICB-14 is explained and summarized in Appendix 7B of this chapter. As part of the ESBWR Certification activity, the software development process plans require NRC review and approval.

ESBWR safety-related I&C systems (RPS and SSLC/ESF) use computers for their logic functions. A description of Q-DCIS design, together with the description of the DPS is included in Section 7.8, and specifically addresses the issues of defense-in-depth and diversity and defense against common mode failures.

will be required to confirm that the maximum control room temperature plus mounting panel temperature rise, allowing for the heat load of the Q-DCIS equipment, does not exceed the temperature limit, and that control room humidity is maintained within limits.

Pressure: Q-DCIS components are designed to be qualified (by analysis) to perform to specification for any absolute pressure in the range specified. The design of the HVAC systems surrounding the Q-DCIS components ensures that the maximum control room pressure does not exceed the specified limit.

Radiation: Q-DCIS components are designed to be qualified (by analysis) to perform within specification limits over their service life under the specified radiation conditions. The design ensures that the maximum radiation levels at the equipment locations do not exceed the allowed limits.

Seismic Qualification: Q-DCIS components are designed to be qualified (by type testing and analysis) to demonstrate that the components will perform all specified functions correctly when operated within the specified seismic limits, and when mounted in accordance with the specified mounting methods. Q-DCIS components are to be qualified in accordance with the requirements of RG 1.100 (IEEE Std. 344 - 1975). Qualification is based on type testing. The design ensures that the maximum seismic accelerations at the mounting locations of the equipment do not exceed the allowed limits.

EMI Qualification: Q-DCIS components in conformance with RG 1.180, when mounted in accordance with the specified mounting methods, are designed to be qualified by type testing and analysis to demonstrate that the components will perform all specified functions correctly when operated within the specified EMI limits. Q-DCIS equipment is designed to be not susceptible to electromagnetic disturbances from neighboring modules and does not cause electromagnetic disturbances to neighboring modules. The EMI qualification design follows the requirements specified in Mil Std. 461E and IEC 61000-4, depending on the specific requirement conditions. Q-DCIS equipment is qualified to perform within its specifications continuously while exposed to EMI environmental limits at the hardware mounting location. ~~Reference 7.1-3 is used for the envelope limits.~~ The EMI susceptibility and emissions testing is performed by type testing. In addition to the equipment design considerations, plant-specific actions are required to establish practices to control emission sources, maintain good grounding practices, and maintain equipment and cable separation.

7.1.6.6.1.6 System Integrity (IEEE Std. 603, Section 5.5)

Q-DCIS systems are required to accomplish their safety-related functions under the full range of applicable conditions enumerated in the design basis. Other areas addressed as requirements include adequate system real-time performance for digital computer-based systems to ensure completion of protective action, evaluation of hardware integrity and software integrity (software safety-related analysis, as part of BTP HICB-14 requirements), failure to a safe state upon loss of energy or adverse environmental conditions, and the requirements for manual reset.

Q-DCIS meets the integrity requirements described in IEEE Std. 603, Section 5.5. The RPS functions fail in the tripped state. The SSLC/ESF fails to a state such that the actuated component remains "as-is;" this prevents a control system induced LOCA. Hardware and

generators or off-site power. This allows for operation of the Q-DCIS when one power supply is in maintenance bypass. Further discussion of the safety-related power supplies is provided in Chapter 8.

7.1.6.6.1.28 Cyber Security (IEEE Std. 7-4.3.2)

The security requirements included in RG 1.152 are evaluated and incorporated in the Q-DCIS design and include both plant hardware and software security measures. The software development process plans will be developed with the security requirements incorporated for actual detailed design implementation.

The comprehensive cyber security program plan identifies security risks and outlines appropriate procedures to ensure that hardware, controls, and data networks comprising the control network cannot be disrupted, interrupted or negatively impacted by unauthorized users or external systems. It also documents the design commitments meeting the applicable requirements of RG 1.152, Section C.2, and Positions 2.1 through 2.9.

Inspections, tests, analyses, and acceptance criteria (ITAAC) associated with the cyber-security program plan are provided in ESBWR DCD, Tier 1 together with the software development plan.

7.1.7 COL Information

None.

7.1.8 References

Not Used.

7.1-1 USNRC, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," NUREG-0800.

7.1-2 General Electric Company, "General Electric Environmental Qualification Program," NEDE-24326-1-P, Revision 1, Class III (proprietary), January 1983.

7.1-3 ~~Electric Power Research Institute (EPRI) TR-102323 (TR-1003697), "Guidelines for Electromagnetic Interference Testing of Power Plant Equipment", Revision 3.~~

7.1-4 GE Energy Licensing Topical Report (LTR) entitled, "ESBWR I&C Defense-In-Depth and Diversity Report." NEDO-33251, Class I (Non-proprietary), Revision 0, July 2006.

7.1-5 GE Energy, "ESBWR Safety Criteria for Instrumentation & Control Systems." NEDO-33294, Class I (Non-proprietary), Revision 0.

7.1-6 GE Energy, "Application of Nuclear Measurement Analysis and Control for a new BWR (NUMAC Platform Architecture.)" NEDC-33288P, Class III (Proprietary), Revision 0

7.1-7 GE Energy, "SSLC/ESF Licensing Topical Report (Platform Architecture.)" Class III (Proprietary), Revision 0

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Table 1A-1

TMI Action Plan Items

Regulation	TMI Item	Description	ESBWR Resolution	Associated Tier 2 Location(s)
			part of the plant status summary information which is continuously displayed on the fixed-position displays on a large display panel, and also incorporates the use of on-screen control video display units (VDUs), independent of the plant computer, for control and monitoring of both safety-related and nonsafety-related systems. Other VDUs, driven by the plant computer, are available for monitoring of safety-related systems and monitoring and control of nonsafety-related systems.	
10 CFR 50. 34(f)(2)(v)	I.D.3	Provide for automatic indication of the bypassed and [in]operable status of safety systems.	ESBWR design of I&C provides automatic indication of the bypasses and inoperable status of safety systems.	7.2.1.8.1 (RPS); 7.2.2.3.2 (NMS); 7.2.3.3.2.1 (SPTM); 7.3.1.1.3.1 (ADS); 7.3.1.2.3.1 (GDCS); 7.3.3.3.1, 7.3.3.3.6 (LD&IS);

Table 1A-1

TMI Action Plan Items

Regulation	TMI Item	Description	ESBWR Resolution	Associated Tier 2 Location(s)
				7.3.5.3.1 (SSLC/ESF); 7.5.1.3.1.1 (PAM); 7.5.2.3.1, 7.5.2.3.6 (CMS); 7.5.3.1.1, 7.5.3.1.6 (PRMS); 7.6.1.3.3, 7.6.1.3.7 (HP/LP Interlocks); 7.1.2.4 (Q-DCIS); Table 7.1-1
10 CFR 50. 34(f)(2)(vi)	II.B.1	Provide the capability of high point venting of noncondensable gases from the reactor coolant system, and other systems that may be required to maintain adequate core cooling. Systems to achieve this capability shall be capable of being operated from the control room and their	During reactor operation the ESBWR design provides continuous venting from the RPV head and the IC driven by the differential pressure between the primary system pressure and a downstream steamline location where the non-condensables are extracted and swept to the main condenser, where the gasses are extracted.	5.4.6 and 5.4.12

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temperature compensated through the thermocouples installed on the sensing line. The reactor water level instrumentation is referenced to a common reference zero - the TAF.

Reactor water level instrumentation that initiates safety-related systems and engineered safeguards systems is discussed in Subsections 7.2.1 and 7.3.1. Reactor water level instrumentation that is used as part of the FWCS is discussed in Subsection 7.7.3. Reactor water level instrumentation used for Diverse Protection System (DPS) functions is discussed in Subsection 7.8.1.

As described in Subsection 4.6.1.2.4, the CRDHS provides a purge flow which maintains the RPV water level reference leg instrument lines filled to address the effects of non-condensable gases in the instrument lines to prevent erroneous reference information after a rapid RPV depressurization event.

Shutdown Range Water
shutdown conditions wh
refueling or maintenanc
chamber reference leg ty
calibration are given in
water level measurement are located at the top of the RPV head and are just below the bottom of the dryer skirt.

Narrow Range Water Level - This range uses the RPV taps near the top of the steam outlet nozzle and the taps near the bottom of the dryer skirt. The instruments are calibrated to be accurate during the normal reactor operating conditions. The method of water level measurement is the condensing chamber reference leg type and uses differential pressure devices as its primary elements. The FWCS uses this range for its water level control and indication inputs. Refer to Subsection 7.7.3 for more information on the FWCS.

Wide Range Water Level - This range uses the RPV taps above the top of the active fuel. The upper taps are the same as the Narrow Range Water Level. The instruments are calibrated to be accurate at normal power operating conditions. The water level measurement method is the condensing chamber reference leg type and uses differential pressure devices as its primary elements. The RPV wide range water level instrumentation is both safety-related and nonsafety-related (for DPS) and is provided for the range of normal, transient, and accident conditions. Separate sensors and indicators are provided for wide range level indication.

Fuel Zone Range Water Level - This range uses the RPV taps near the top of the steam outlet nozzle and the taps below the bottom of the active fuel. The instruments are calibrated to be accurate at zero Pa gauge (0 psig) and saturated conditions. The water level measurement method is the condensing chamber reference type and uses differential pressure devices as its primary elements. The RPV fuel zone water level instrumentation is safety-related and is provided for post-accident monitoring situations in which the water level may be substantially below the normal range. Separate sensors and indicators are provided for wide range level indication.

Reactor Vessel Pressure

Pressure transmitters detect reactor vessel pressure from the same instrument lines used for measuring reactor vessel water level, and provide indication in the control room. The following lists the Subsections in which other reactor vessel pressure measuring functions are discussed.

Pressure transmitters and trip actuators for initiating scram, and pressure transmitters and trip actuators for bypassing the main steam line isolation valve closure scram are discussed in

Subsection 7.2.1. High pressure and low pressure (HP/LP) interlocks are discussed in Subsection 7.6.1.1

Pressure transmitters that are used for pressure recording are discussed in Subsection 7.2.1.4.

Safety/Relief Valve (SRV) Leak Detection

Thermocouples are located in the discharge pipes of eight Safety Relief Valves (SRVs). The temperature signals are recorded and temperatures indicative of a leaking SRV are alarmed in the Main Control Room (MCR).

Main Steam Flow

Differential pressure transmitters are used to detect steam flow. Pressure taps from the throat of the RPV steam outlet nozzles, in conjunction with the RPV dome pressure taps measure differential pressure, which is proportional to main steam flow. Safety-related transmitters input to the Leak Detection and Isolation System (LD&IS) logic. Nonsafety-related transmitters are used for feedwater control.

7.7.1.3 Safety Evaluation

The safety-related reactor water level and dome pressure instruments are designed to withstand the loads and environmental conditions under which they must function. Sufficient separate sensors and indicators are provided so that a single failure cannot result in the loss of level indication. The combined range of the wide range and fuel zone instrumentation ensures that adequate level information is available over the full extent of postulated design basis accident conditions (IEEE Std. 603, Sections 4.8 and 5.1).

The nonsafety-related instruments discussed in this Subsection are designed to operate under normal and peak operating conditions of system pressures, and ambient pressures and temperatures. Any mechanical interface of nonsafety-related instruments with safety-related instrument piping or the Reactor Coolant Pressure Boundary (RCPB) is classified as safety-related to avoid compromise of the safety-related sensing capability and/or the RCPB. Should a line break occur in a nonsafety-related portion of a sensing line, the excess flow check valve would close to stop the flow of reactor coolant. In the event of a single failure of the excess flow check valve, the restriction orifice limits the flow of coolant to within acceptable bounds.

7.7.1.3.1 Specific Regulatory Requirements Conformance

Table 7.1-
codes and
monitoring
Section 7.

10 CFR 50.34(f)(2)(xviii) TMI Item II.F.2

Conformance: Reactor water level instrumentation errors due to non-condensable gases in instrument reference legs have been addressed as discussed in 7.7.1.2.2

7.7.1.3.1.1 10 CFR Part 50 and 52

The NBS complies with these criteria.

10 CFR 50.55a(1) Quality Standards Important to Safety