June 25, 2007

Mr. Robert E. Brown
Senior Vice President, Regulatory Affairs
GE-Hitachi Nuclear Energy Americas LLC
3901 Castle Hayne Rd MC A-45
Wilmington NC 28401

SUBJECT: ESBWR CHAPTER 5 OPEN ITEMS

Dear Mr. Brown:

As you are aware, the U. S. Nuclear Regulatory Commission staff is preparing the safety evaluation report (SER) for the Economic Simplified Boiling Water Reactor (ESBWR) design certification application submitted by GE-Hitachi Nuclear Energy Americas LLC (GHNEA) on August 24, 2005. The staff has identified 21 open items for SER Chapter 5, "Reactor Cooling Systems and Connected Systems," which are enclosed for your information. The staff is prepared to review your responses to the open items and have conference calls and meetings with your staff, as appropriate, to resolve these open items to support issuance of the SER.

Please provide a response date for any late or unscheduled open items discussed in the enclosure.

This open item letter is based on the staff's review of the ESBWR Design Control Document (DCD) Revision 3, Request for Additional Information (RAI) responses and other submittals received to date. The staff will continue its review as additional RAI responses and other deliverables are submitted, including future DCD Revisions. The staff will inform cognizant GHNEA staff of any resulting changes to the status of Chapter 5. If you have any questions, please contact Amy Cubbage at (301) 415-2875 or aec@nrc.gov or Shawn Williams at (301) 415-3207 or saw8@nrc.gov.

Sincerely,

/RA/

Mohammed A. Shuaibi, Chief
ESBWR/ABWR Projects Branch 1
Division of New Reactor Licensing
Office of New Reactors

Docket No. 052-010

Enclosure:
As stated

cc: See next page

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ADAMS ACCESSION NO. ML071640317

OFFICE	PM:NGE1	PM: NGE1	BC:DE:SIB2	BC:DSRA:SRSB
NAME	SWilliams	PWilson	NRay acting for KGruss	JDonohue
DATE	6/13/07	6/14/07	6/19/07	6/18/07
OFFICE	BC:DE:EMB2	PM:NGE1	BC: NGE1	
NAME	JDixon-Herrity	ACubbage by e-mail	MShuaibi	
DATE	6/19/07	6/24/07	06/25/07	

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GE-Hitachi Nuclear Energy Americas LLC (GHNEA) ESBWR
Preliminary Open Items
Chapter 5
Reactor Cooling Systems and Connected Systems

RAI 5.2.1, Supplement No. 1, 4/4/07, ML071000058

In RAI 5.2-1(b), the staff asked GE to explain how the proposed Technical Specification (TS) limit and alarm limit for the unidentified leakage of 5 gpm are consistent with the 1 gpm criterion specified in Positions C.2 and C.5 of Regulatory Guide (RG) 1.45. In GE's RAI response, MFN-06-085, and in a conference call on January 16, 2007, GE maintained its position for the TS limit and alarm limit being specified as 5 gpm based on its historical leakage detection/alarm limits being specified for BWRs. GE stated that Positions C.2 and C.5 only specified the "sensitivity" of the instrument rather than the TS limit or alarm limit, and stated that the ESBWR instrument has the sensitivity of 1 gpm. RG 1.45 (page 1.45-2) provides guidance on the "detector sensitivity," and states that "sumps and tanks used to collect unidentified leakage and air cooler condensate should be instrumented to alarm for increases of from 0.5 to 1.0 gpm." The sensitivity of 1 gpm, claimed by ESBWR design, is not demonstrated in the alarm set point, or in the TS limit, and is not explicitly shown being used by operators under any procedures. The staff believes that the alarm limit needs to be set as low as practicable to provide an early warning signal to alert operator taking actions. The current ESBWR alarm limit of 5 gpm is not acceptable because it is not consistent with RG 1.45 stated above, nor does it serve the intended function to alert operator taking actions before the TS limit is reached.

Provide and justify a revised alarm limit for the unidentified leakage. Revise the DCD, Tier 2, Section 5.2.5.4, accordingly.

Status: GHNEA committed to provide a response by 6/14/07.
No response has been submitted as of the date of this letter.

RAI 5.2-2, Supplement No. 1, 4/4/07, ML071000058

In GE's response to RAI 5.2-2, MFN 06-085, GE stated that an evaluation of the effects of relative humidity including that which is attributable to the proposed leakage limits up to 5 gpm would be included as part of equipment qualification requirements in the procurement of equipment. The staff reviewed the current equipment qualification and found that it was not adequate to address the concern of long term leakage. Under current TS, the plant operators could continuously operate the plant for years with unidentified reactor coolant system (RCS) leakage of less than 5 gpm. In response to the RAI, GE stated that the design of ESBWR has been improved to reduce the likelihood of leaks resulting from stress corrosion cracking (SCC), and historically, good operator practice plays a role in the event of an anomaly in unidentified leakage. Typical operator practice will investigate, record, track, evaluate trends of the leakage, and take necessary measures to locate, assess, and repair the source of the leakage. The staff agreed that the material design improvement can reduce the likelihood of leaks resulting from SCC, but the improvement cannot eliminate all the possible leaks. The staff also agreed that good operator actions at low level leakage below the TS limit are acceptable measures to address the concern of long term leakage. To account for the good operator practice, every COL applicant should have operating procedures to manage the low level RCS leakage, and the alarm limit should be set as low as practicable to provide an early warning signal to the operators to implement the procedures. Therefore, it needs a new COL action item, and an appropriate alarm limit in the design.

In the conference calls, dated August 14, 2006, and January 16, 2007, the applicant agreed to add a COL holder item in Revision 3 of DCD Section 5.2.6. The COL holder item now states that "operators will be provided with procedures to assist in monitoring, recording, trending, determining the source of leakage, and evaluating potential corrective action." The staff finds this statement unacceptable for the following reasons.

A. Revise the COL Holder item to state that "The COL Holder is responsible for the development of a procedure ..." rather than the current statement that the "Operators will be provided with procedures ..."

B. B. Revise the COL Holder item to indicate that the procedures are for low level unidentified leakage, (lower than the TS limit). {This RAI response is associated with the above RAI 5.2-1 supplement resolution as it needs an appropriate alarm limit in the design to provide an early warning signal to the operators to implement the procedures.}

Status: GHNEA committed to provide a response by 6/14/07.
No response has been submitted as of the date of this letter.

RAI 5.2-20 and 5.2-22, Supplemental No. 2, ML071580941

GE's RAI response to supplemental RAIs 5.2-20 and 5.2-22, MFN 06-178, states that purchase specification for the safety relief valves (SRVs) "has yet to be written." GE further explains that the DCD, Tier 1, Revision 3, Table 2.1.2-2, Item 1, contains an ITAAC to confirm the basic configuration for the Nuclear Boiler System (NBS) and that inspections shall be conducted with the acceptance criteria that "the as-built NBS conforms to the basic configuration as defined in Subsection 2.1.2." GE's position is that this ITAAC includes programmatic reviews of the SRV design and environmental qualifications, which meets the intent of the supplemental RAI for which staff requested that "GE specify its acceptance criteria for the design and qualification of the SRV's to be used in the ESBWR, including appropriate ITAAC." DCD, Tier 1, Revision 3, Section 1.2.2.1 (4), "Verifications for Basic Configuration for Systems," states that the basic configuration ITAAC includes "Tests or type tests of active safety-related valves identified in the Design Description to demonstrate that the valves are qualified to perform their safety-related functions under design basis differential pressure, system pressure, fluid temperature, ambient temperature, minimum voltage, and minimum and/or maximum stroke times."

A. The referenced ITAAC is not sufficient. Revise the ITAAC table to include verification for the SRV discharge capacity and setpoints to demonstrate that the as-built is consistent with the assumptions of the safety analyses

B. Include a COL Applicant or COL Holder Item to the DCD to ensure that operating experience, for example, issues identified in Regulatory Issue Summary 00-012, "Resolution of Generic Safety Issue B-55, 'Improved Reliability of Target Rock Safety Relief Valves,' "IE Circular 79-18,"Proper Installation of Target Rock Safety Relief Valves," Bulletin 74-04,"Malfunction of Target Rock Safety Relief Valves," and NUREG-0763, "Guidelines for Confirmatory in-plant Tests of Safety Relieve Valve Discharges for BWR Plants" are addressed when the SRV's are procured.

C. Revise the DCD, Tier 1, Section 1.2.2.1 to expand the environmental qualification verifications to include mechanical equipment such as seals and gaskets.

Status: GHNEA has not committed a response date.

RAI 5.2-36, Supplement No. 1, 11/7/06, ML063110346

In GE's response to RAI 5.2-36 (MFN 06-260), GE did not provide material specifications for isolation and check valves used in the Class 1 portion of the feedwater system. The staff requests the applicant to perform a complete review of the reactor coolant pressure boundary (RCPB) system and compare it to DCD, Tier 2, Revision 1, Table 5.2-4 and verify that all materials used as a pressure boundary for reactor coolant are included in Table 5.2-4

Status: GHNEA committed to provide a response by 5/24/07.
No response has been submitted as of the date of this letter.

RAI 5.2-37, Supplement No. 1, 11/7/06, ML063110346

In GE's response to RAI 5.2-37 (MFN 06-260), GE stated that SA-106 Gr. B may be used in the RCPB but did not include the materials in the Table 5.2-4. Provide correct materials specifications and Grades in Table 5.2-4.

Status: GHNEA committed to provide a response by 5/24/07.
No response has been submitted as of the date of this letter.

RAI 5.2-38, Supplement No. 1, 11/7/06, ML063110346

In GE's response to RAI 5.2-38 (MFN 06-260), GE indicated that it will use ASTM A800 in lieu of Hull's equivalent factors. The staff's position is that percent ferrite is calculated using Hull's equivalent factors as indicated in NUREG/CR-4513, Rev.1 (May 1994). NUREG/CR-4513, Rev.1, states that ASTM A800 may produce lower ferrite numbers than Hull's equivalent factors for materials with greater than 12 percent ferrite. In response to RAI 6.1-15 (MFN 06-365) GE stated that, "It is agreed that the A800 method tends to predict somewhat lower values at higher ferrite levels than the Hull's equivalent method. However, when the two methods are compared to the corresponding measured values reported in the NUREG using rigorous statistical analysis, it can be demonstrated the two methods are equally accurate." Provide the "rigorous statistical analysis" that shows that the method to calculate ferrite in ASTM A800 and Hulls equivalent factors are equally accurate.

Status: GHNEA responded on 6/6/07, MFN 06-260 Supplement 2.
GHNEA's response is under staff review.

RAI 5.2-50, Supplement No. 1, 1/19/07, ML070190264

In GE's response to RAI 5.2-50 (GE Letter MFN 06-290), GE referenced Code Case N–634. Code Case N-634 has not been endorsed by the NRC staff. The staff requests that the applicant provide a list of all materials that it intends to attach to the containment liner that do not meet the provisions of CC-2511 regarding liner attachments. Provide a basis for using each material not meeting the requirements of CC-2511.

Status: GHNEA responded on 5/21/07, MFN 06-290 Supplement 2. GHNEA's response is under staff review.

RAI 5.2-61, 4/12/07, ML070920099

The following statement in the DCD, Tier 2, Revision 1, Section 5.2.6, COL Information, was deleted in Revision 2 (without describing the reason for the deletion): "The COL applicant is required to submit an overpressure protection analysis for core loadings different than the reference ESBWR core loading". Staff believes that the COL action item should have been revised (rather than deleted) to state that: "The COL applicant is required to submit an overpressure protection analysis for the actual core for the initial start-up." Please respond as to whether or not GE agrees to staff's position that the above statement should be a COL action item, and if so, revise the DCD accordingly.

Status: GHNEA has committed to respond by 7/20/07.

RAI 5.2-62, 5/22/07, ML071410310

This RAI supercedes RAIs 6.6-1, 6.6-2, 6.6-3, 6.6-4, 5.2-51, 5.2-53, 5.2-54 5.2-57, and 5.2-58. The staff requests that the applicant modify the DCD (1) to specify the inspection methods that are practical to use for inservice inspection (ISI) of welds in ASME Boiler and Pressure Vessel (B&PV) Code Class 1 and 2 austenitic and dissimilar metal welds, and (2)to add COL action items to Sections 5.2.4 and 6.6 for COL applicants to ensure that a COL applicant referencing the ESBWR will provide a detailed description of its plans to incorporate, during design and construction, access to piping systems to enable nondestructive examinations (NDE) of such welds during ISI.

By way of background, the staff understands that materials selected for use in ESBWR ASME B&PV Code Class 1 and 2 austenitic and dissimilar metal welds are not expected to encounter stress corrosion cracking or appreciable amounts of other forms of degradation based on currently available information. However, the staff notes that stress corrosion cracking was not expected in previously built PWRs and BWRs based on information that was available at the time of their licensing and construction. Accordingly, the staff considers that the design of components should include provisions to enable NDE to detect future component degradation, such as stress corrosion cracking. This is a critical attribute of any new reactor design.

The ASME B&PV Code, Section XI, as incorporated into 10 CFR 50.55a(g), currently allows for either ultrasonic or radiographic examination of welds in Code Class 1 and 2 piping systems. Please modify the DCD in Tier 1 to state that one or both of these types of examination is practical for ISI of austenitic and dissimilar metal welds. The staff notes that ultrasonic examination has advantages with respect to ALARA considerations, and with this change to the DCD, any design certification rule that might be issued for the ESBWR will preclude the granting of relief under 10 CFR 50.55a(g)(6) for ISI of such welds. Please confirm that austenitic or dissimilar metal welds in Class 1 and 2 piping systems will be accessible for examination by either ultrasonic or radiographic examination to satisfy § 50.55a(g)(3).

In support of these DCD changes, a COL applicant referencing the ESBWR design certification application should inform the staff of how it plans to meet all access requirements during construction and operation as required by 10 CFR 50.55a(g)(3)(i) and (ii). The staff notes that the preservice inspection (PSI) requirements are known at the time a component is ordered,

and 10 CFR 50.55a(g) does not contain provisions for consideration of relief requests for impractical examination during the construction phases of the component. The COL action items requested above should reflect these considerations.

Status: Staff requested a response date of 7/23/07 in RAI Letter No. 102.
GHNEA has not committed to a response date.

RAI 5.2-63, 5/30/07, ML071490166

DCD, Tier 2, Revision 3, Chapter 5.2.4 indicates that the development of the preservice and inservice inspection (PSI/ISI) program plans is the responsibility of the Combined Operating License (COL) Holder and shall be based on the ASME Code, Section XI, Edition and Addenda specified in the Table 1.9-22. DCD, Tier 2, Revision 3, Table 1.9-22, "Industrial Codes and Standards Applicable to ESBWR," references the 2001 Edition through the 2003 Addenda. Chapter 6.6 indicates that the development of the PSI/ISI program plans will be the responsibility of the COL Holder, and is based on the ASME Code, Section XI, Edition and Addenda specified in accordance with 10 CFR 50.55a. Chapter 6.6 further states that the COL Holder specifies the Edition of ASME Code to be used, based on the date of issuance of the construction permit or license, per 10 CFR 50.55a. There appears to be an inconsistency in the DCD between the Editions and Addenda of ASME Section XI that the COL Applicants will use to develop their PSI/ISI programs.

Please revise the DCD in Sections 6.6 and 5.2.4 to clearly and accurately state the requirements governing the applicable ASME Code Edition and Addenda used by the COL Applicant to develop PSI/ISI programs.

Status: Staff requested a response date of 7/12/07 in RAI Letter No. 100.
GHNEA has not committed to a response date.

RAI 5.2-64, 5/30/07, ML071490166

DCD, Tier 2, Revision 3, Chapters 5.2.4 and 6.6, states that the COL Holder is responsible for the development of PSI/ISI programs.

Revise the DCD Chapters 5.2.4 and 6.6 to include a COL Applicant Action Item to provide a detailed description of the PSI/ISI programs and augmented inspection programs and to provide milestones for their implementation.

Status: Staff requested a response date of 7/12/07 in RAI Letter No. 100.
GHNEA has not committed to a response date.

RAI 5.2-65, 5/30/07, ML071490166

DCD, Tier 2, Revision 3, Chapters 5.2.4.6 and 6.6.6 reference certain portions of IWA-5000, IWB-5000, IWC-5000 and IWD-5000 in the description of System Leakage and Hydrostatic Pressure Tests.

Revise DCD, Chapters 5.2.4.6 and 6.6.6 to clarify that System Leakage and Hydrostatic Pressure Tests will meet all requirements of ASME Code Section XI, IWA-5000, IWB-5000, IWC-5000 and IWD-5000.

Status: Staff requested a response date of 7/12/07 in RAI Letter No. 100.
GHNEA has not committed to a response date.

RAI 5.4-20, Supplement No. 1, 1/4/07, ML070100427

A. In GE's response to RAI 5.4-20, it was indicated that the isolation condenser (IC) tubes will be solution annealed while straight and then bent by induction bending. Discuss how you confirmed that the material properties of the most limiting bent tube remained acceptable following induction bending. Include a discussion of the material properties tested (e.g., hardness), the results, and the acceptance criteria.

B. In GE's response to RAI 5.4-20, it was indicated that the design of the support structures for the IC tubes on the poolside are not available. Given that material selection and specific design attributes, such as the presence of crevices, can contribute to degradation, provide a COL Action Item to submit this information.

C. Given that crevices exist in both the passive containment cooling system (PCCS) heat exchanger and the IC, discuss the inspection requirements for these locations. If there are no inspection requirements, provide a technical justification for why no inspections are needed.

D. Clarify the material of construction for the IC tubes. In several places the material of construction for the IC tubes was specified as SB-163 (e.g., refer to Table 6.1-1 in your August 17, 2006 letter (MFN 06-265); refer to your response to NRC RAI 5.4-48). However, in other documents, Code Case N-580-1 is referenced for the specification for the IC tubes (refer to response to NRC RAI 6.1-10). Code Case N-580-1 refers to SB-167 (for pipes).

Status: GHNEA has committed to respond by 7/13/07.

RAI 5.4-22, Supplement No. 2, 5/7/07, ML071280108

Please discuss the means that will be in place to ensure that the isolation condenser system drain line is full during normal operation to ensure that the water volume assumed in the safety analysis is available for injection on a Loss-of-Coolant Accident signal.

Status: GHNEA responded on 6/21/07, MFN 06-265 Supplement 1.
GHNEA's response is under staff review.

RAI 5.4-32, Supplement No. 2, 5/7/07, ML071270549

GE's response to 5.4-32 (MFN 06-249) states the purpose and actuation logic, but it does not describe how the nitrogen rotary motor operated valve (NMOV) and the pneumatic piston operated valve (NO) valve operate. Since these valves are not the standard valves, please provide a detailed description of the valve operation, specifically the actuator, in the DCD.

Status: GHNEA has committed to respond by 8/31/07.

RAI 5.4-53, Supplemental No. 1, 1/4/07, ML070100427

In response to RAI 5.4-53, GE indicated that the alarm setpoint for the IC radiation monitor is selected close enough to background so that an early warning of a leak is detected, but with adequate margin to prevent spurious actuation. However, the response did not fully address several aspects of the staff's original question. For example, it did not address the operator actions to be taken in response to leakage and it did not address why the leak rate for a critical size flaw was not determined and used in determining when the isolation condenser should be isolated. Address these questions. If these are more appropriately treated as COL Actions Items, please discuss your plans to add this as a COL Action Item.

Status: GHNEA responded on 5/31/07, MFN 06-508 Supplement 1. GHNEA's response is under staff's review.

RAI 5.4-55, Supplement No. 1, 1/4/07, ML070100427

In GE's response to RAI 5.4-55, GE indicated that the Alloy 600 tubing (presumably SB-163 and not SB-167) was used as replacement tubing for several early BWR isolation condenser and that the material performed satisfactorily without incident due to general corrosion in this application. Discuss whether there were any other "incidents" associated with the use of these materials in these applications.

Status: GHNEA has committed to respond by 7/13/07.

RAI 5.4-56, Clarification to Supplemental No. 1, 6/12/07, ML071630061

This supplemental RAI clarifies the last sentence in the supplemental RAI 5.4-58, ML070100427 sent to GE on January 4, 2007. This clarification specifically addresses the supplemental request for RAI 5.4-56.

Original RAI 5.4-56, RAI Letter No. 77:
"Please confirm that the method/technique for inspecting the IC tubes is capable of detecting general wall thinning, pit-like defects, and stress corrosion cracking along the entire length of the tube (and through the entire tube wall thickness). Please discuss the method/techniques that can be used for inspecting the tubes and the qualification requirements for these methods. Please provide the qualification data supporting the inspection technique (to demonstrate that the tubes are inspectible)."

GE's RAI 5.4-56 response, MFN 06-501:
"Due to their size (NPS 2), the IC tubes are exempt from volumetric and surface inservice examinations by ASME Section XI, IWC-1220 (exempts size NPS 4 and smaller). Requirements for Class 2 inservice inspection (ISI) are addressed in Subsection IWC of ASME Section XI, which is referenced by DCD Section 6.6 for ISI. The eddy current inspection of IC tubing mentioned in Section 5.4.6.4 refers to Construction Code, ASME Section III, NC-2550, which addresses examination of the tubing material. The isolation condensers are subject to leakage (VT-2) examination under ASME Section XI, IWC-2500, Category C-H, and the system is monitored for radiation leakage as described in Section 5.4.6.2.2."

RAI 5.4-56 and 5.4-58, Supplemental No. 1:

"Given the lack of operational data and the limitations of accelerated corrosion testing to fully simulate all of the combinations of water chemistry, material properties, and stresses that may exist in the field, provide your proposed inspection and acceptance requirements for these tubes and discuss where these regulatory requirements should be incorporated (e.g., technical specifications, tier 1, ASME Code). In addition, provide a response to NRC RAI 5.4-56."

Staff's Clarification on Supplemental Request RAI 5.4-56:
Alloy 600, the material used for the IC tubes, is susceptible to degradation under certain conditions. Visual examination, as proposed by the applicant, will only indicate whether the degradation has penetrated through-wall, which is normally detected through radiation monitoring techniques. The applicant has neither provided long term corrosion tests that address the wide variation that could exist in material properties and water chemistry (given the existing regulatory requirements pertaining to fabrication and water chemistry) nor have they provided any supporting information such as from inspections of current materials that support that the material will not degrade.

The applicant has not adequately demonstrated that the IC tubes are not susceptible to degradation taking into account:

(1) the range of material and environmental conditions that could exist in the water chemistry and fabrication requirements,

(2) the lack of long-term service experience (with inspection results), and

(3) the limitations of accelerated corrosion testing to fully simulate the range of variables that may exist in the field (and pertinent to corrosion). Thus,

A. Demonstrate that the IC tubes are not susceptible to degradation given the requirements pertaining to water chemistry and fabrication for the IC tubes or demonstrate the IC tubes have sufficient margin to failure (given the potential for degradation to occur).

B. Develop an inspection program that will periodically verify the integrity of the IC tubes or provide adequate justification for why no inspection requirements are needed.

Status: GHNEA has not committed to a response date.

RAI 5.4-57, Supplement No. 1, 1/4/07, ML070100427

For the PCCS, provide the same information as requested in the enclosed supplemental questions for 5.4-53 and 5.4-58. In addition, discuss whether the cracking that occurred in the earlier ICs (refer to your response to RAI 5.4-54)could occur in the PCCS heat exchanger. If so, discuss what inspections should be performed to ensure timely detection of the cracking?

Status: GHNEA has committed to respond by 7/13/07.

RAI 5.4-59, 5/10/07, ML071230389

Provide additional information regarding operation of the reactor water clean up/shutdown cooling (RWCU/SDC) system during Modes 5 and 6 (cold shutdown and refueling).

A. Provide a drawing of the ESBWR vessel showing the elevations of the feedwater (FW) nozzles and the RWCU/SDC piping penetrations inside and outside the shroud.

B. Include a discussion in the DCD regarding vessel level for normal RWCU/SDC operation in all modes, including Modes 4, 5, and 6.

C. Perform a calculation demonstrating under what temperatures and levels the RWCU/SDC system can adequately remove decay heat in Modes 4, 5, and 6 (with the RPV head installed) including any minimum and maximum temperatures and levels.

D. Include a discussion in the DCD regarding RWCU/SDC flow and mixing within the vessel and within the shroud.

E. Address thermal-hydraulic uncertainty.

F. Address the impact on the ESBWR shutdown PRA.

Status: GHNEA has committed to respond by 12/6/07.

cc:

Ms. Michele Boyd
Legislative Director
Energy Program
Public Citizens Critical Mass Energy
and Environmental Program
215 Pennsylvania Avenue, SE
Washington, DC 20003

Mr. Marvin Fertel
Senior Vice President
and Chief Nuclear Officer
Nuclear Energy Institute
1776 I Street, NW
Suite 400
Washington, DC 20006-3708

Mr. Ray Ganthner
AREVA, Framatome ANP, Inc.
3315 Old Forest Road
P.O. Box 10935
Lynchburg, VA 24506-0935

Dr. Gail H. Marcus
U.S. Department of Energy
Room 5A-143
1000 Independence Avenue, SW
Washington, DC 20585

Email

APH@NEI.org (Adrian Heymer)
awc@nei.org (Anne W. Cottingham)
bob.brown@ge.com (Robert E. Brown)
BrinkmCB@westinghouse.com (Charles Brinkman)
chris.maslak@ge.com (Chris Maslak)
CumminWE@Westinghouse.com (Edward W. Cummins)
cwaltman@roe.com (C. Waltman)
dan1.williamson@ge.com (Dan Williamson)
david.hinds@ge.com (David Hinds)
david.lewis@pillsburylaw.com (David Lewis)
David.piepmeyer@ge.com (David Piepmeyer)
dlochbaum@UCSUSA.org (David Lochbaum)
don.lewis@ge.com (Don Lewis)
erg-xl@cox.net (Eddie R. Grant)
frankq@hursttech.com (Frank Quinn)
Frostie.white@ge.com (Frostie White)
gcesare@enercon.com (Guy Cesare)
george.honma@ge.com (George Honma)
george.stramback@gene.ge.com (George Stramback)
george.wadkins@ge.com (George Wadkins)
GovePA@BV.com (Patrick Gove)
greshaja@westinghouse.com (James Gresham)
gzinke@entergy.com (George Alan Zinke)
hickste@earthlink.net (Thomas Hicks)
james.beard@gene.ge.com (James Beard)
jcurtiss@winston.com (Jim Curtiss)
jgutierrez@morganlewis.com (Jay M. Gutierrez)
jim.kinsey@ge.com (James Kinsey)
jim.riccio@wdc.greenpeace.org (James Riccio)
JJNesrsta@cpsenergy.com (James J. Nesrsta)
joel.Friday@ge.com (Joel Friday)
john.leatherman@ge.com (John Leatherman)
john.o'neil@pillsburylaw.com (John O'Neil)
john.sorensen@ge.com (John Sorensen)
Joseph.savage@ge.com (Joseph Savage)
Joseph_Hegner@dom.com (Joseph Hegner)
junichi_uchiyama@mhi.co.jp (Junichi Uchiyama)
kathy.sedney@ge.com (Kathy Sedney)
KSutton@morganlewis.com (Kathryn M. Sutton)
kurt.schaefer@ge.com (Kurt Schaefer)
kwaugh@impact-net.org (Kenneth O. Waugh)
lou.lanese@ge.com (Lou Lanese)
lynchs@gao.gov (Sarah Lynch - Meeting Notices Only)
MaddenG@BV.com (George Madden)
maria.webb@pillsburylaw.com (Maria Webb)
mark.beaumont@wsms.com (Mark Beaumont)
Marvin_Smith@dom.com (Marvin L. Smith)
matias.travieso-diaz@pillsburylaw.com (Matias Travieso-Diaz)

media@nei.org (Scott Peterson)
mgiles@entergy.com (M. Giles)
mike_moran@fpl.com (Mike Moran)
mwetterhahn@winston.com (M. Wetterhahn)
mwl@nei.org (Melanie Lyons)
pareez.golub@ge.com (Pareez Golub)
patriciaL.campbell@ge.com (Patricia L. Campbell)
paul.gaukler@pillsburylaw.com (Paul Gaukler)
peter.jordan@ge.com (Peter Jordan)
Petrovb@westinghouse.com (Bojan Petrovic)
PGunter@NIRS.org (Paul Gunter)
phinnen@entergy.com (Paul Hinnenkamp)
pshastings@duke-energy.com (Peter Hastings)
RJB@NEI.org (Russell Bell)
RKTemple@cpsenergy.com (R.K. Temple)
roberta.swain@ge.com (Roberta Swain)
ronald.hagen@eia.doe.gov (Ronald Hagen)
sandra.sloan@areva.com (Sandra Sloan)
SauerB@BV.com (Robert C. Sauer)
sfrantz@morganlewis.com (Stephen P. Frantz)
steven.hucik@ge.com (Steven Hucik)
steven.stark@ge.com (Steven Stark)
tom.miller@hq.doe.gov (Tom Miller)
tom.miller@nuclear.energy.gov (Thomas P. Miller)
trsmith@winston.com (Tyson Smith)
waraksre@westinghouse.com (Rosemarie E. Waraks)
wayne.marquino@ge.com (Wayne Marquino)
whorin@winston.com (W. Horin)