March 23, 2007

APPLICANT: General Electric Company

PROJECT: Economic Simplified Boiling Water Reactor (ESBWR)

SUBJECT: SUMMARY OF FEBRUARY 7, 2007, PUBLIC MEETING WITH GENERAL ELECTRIC COMPANY REGARDING ESBWR CONTAINMENT CAPACITY AUDIT

On February 7, 2007, the U.S. Nuclear Regulatory Commission (NRC) held a Category 1 public meeting with representatives of General Electric Company (GE) at the GE facility in San Jose, CA. The purpose of the meeting was to discuss results of the ESBWR containment capacity audit conducted February 5 through 7, 2007. Meeting attendees are identified in Enclosure 1. The NRC's audit plan is provided as Enclosure 2.

Background

The NRC staff conducted the containment capacity audit as part of the agency's review process for ESBWR design certification. The audit included review of GE's responses to Requests for Additional Information (RAIs) associated with staff's review of the ESBWR Design Control Document (DCD) and review of GEs detailed calculations pertaining to containment capacity. The audit focused on the design and analyses of the ESBWR containment fragility assessment for beyond-design-basis severe accident induced pressure and temperature capacity and seismic margins assessment. A public meeting was held following completion of the audit.

Meeting Highlights

The staff presented a summary of audit activities and discussed the key audit issues stemming from the staff's detailed assessment of GE's responses to RAIs. GE representatives expressed an understanding of the identified issues and provided commitments for issue resolution. Key issues and their resolution are summarized as follows:

- Topic: 10CFR 50.44, Combustible Gas Control for Nuclear Power Reactors, and Regulatory Guide (RG) 1.7, Control of Combustible Gas Concentrations in Containment Following a Loss-of-Coolant Accident Revision 3.

  The ESBWR containment is inerted with a design basis pressure of 0.31 Mpa guage. However, GE had estimated the containment pressure load resulting from the 100% fuel clad-coolant reaction to be about 1.0 Mpa. From GE's review of accident sequences, the 100% fuel clad-coolant reaction sequence was ruled out among the more likely severe accident scenarios and, therefore, is not a part of the evaluation under SECY-93-087 criteria (see following topic). GE committed to meeting the analysis requirement of RG 1.7 (C)(5) for the ESBWR containment and to verify the pressure load resulting from the 100% fuel clad-coolant reaction.

- Topic: SECY-93-087, Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-water Reactor Designs (Containment Performance)

  To address the SECY-93-087 expectation with respect to deterministic containment performance assessment, GE had reviewed the accident sequences from the level 1 probabilistic risk assessment (PRA) and identified the top ten sequences contributing to core damage frequency (CDF). GE determined that the most likely (97% of the core damage sequences identified in the PRA) containment pressure and temperature time histories resulted from the sequence T_nIN_TSL (transient with no injection with release category of technical specification leakage). The containment pressure load at 24 hours after onset of core damage is 0.65 Mpa and the long term pressure is below 0.70 Mpa. The steady state temperature for this sequence is below 450^{o} K (350^{o}F). The enveloping containment pressure and temperature time histories (1% of the core damage sequences) resulted from the sequence T_nDP_nIN_TSL, where the reactor pressure vessel would remain at high pressure until lower head failure. The containment pressure load at 24 hours after onset of core damage is 0.72 Mpa and the steady-state drywell temperature is below 500^{o} K (440^{o}F). GE committed to demonstrate that the ESBWR containment capacity using the Level C or Factored Load limit exceeds the aforementioned pressure and temperature demand.

- Topic: Seismic margins analysis and High Confidence In Low Probability of Failure (HCLPF) calculations

  GE's seismic design basis spectrum is specified as the envelope of Regulatory Guide 1.60, anchored at 0.3g PGA, and North Anna site specific spectra, anchored at 0.5g PGA. To demonstrate the seismic margin of the ESBWR design, GE presented seismic HCLPF calculations using the probabilistic variable separation approach for the critical plant structures, systems, and components (SSCs) for two separate seismic demand spectra - one for soil sites and one for rock sites. For soil sites, GE used a spectrum that envelopes the latest seismic demand spectra for all the soil sites out of 28 Central and Eastern U.S. sites for which EPRI has performed seismic hazard evaluation. For rock sites, GE used the North Anna Early Site Permit (ESP) site-specific spectrum with a PGA of 0.5g.

  Consistent with SECY 93-087 seismic criteria for evolutionary and advanced light water reactor designs, the HCLPF value should be equal to or greater than 1.67xSSE. The staff questioned whether GE's demonstration of seismic margin using two separate response spectra meets the expectation of SECY 93-087 and suggested that GE pursue other HCLPF evaluation approaches, such as, conservative deterministic failure margin approach or use of push-over analysis for HCLPF capacities. GE committed to review alternative approaches to resolve this issue.

- Topic: Analysis associated with containment fragility calculations

  GE originally used an axisymmetric ANSYS containment model for determining the pressure capacity of the reinforced concrete containment vessel (RCCV) and several simplified equations for determining the pressure capacity of the drywell head. The staff had reviewed GE's analysis model presented in the PRA report and identified several

issues with GE's approach and the analysis model. To address the staff's concerns, GE proposed an alternate approach and used a detailed 3-D ABAQUS ANACAP-U model for the ESBWR RCCV. GE presented a preliminary containment fragility analysis using the ABAQUS model. Although there are some issues that need to be resolved regarding the boundary conditions for the ABAQUS analysis, the staff concluded that the ABAQUS analysis represents a significant improvement over the previous approach and will be capable of identifying potential weak links. GE committed to update the fragility and Level C analysis results in the PRA report by replacing ANSYS and empirical equations with the ABAQUS model and Code equations (for Level C only).

GE committed to document the containment performance, in both deterministic and fragility terms, and the Level C results in the ESBWR DCD. GE will identify, as Tier 2* information, that the as-built and as-procured plant will possess the same containment performance attributes as reviewed by the staff.

- Topic: PRA Level 2 RAIs

  During the audit, a breakout session was held to discuss the Level 2 portion of the PRA and severe accident evaluations. The staff provided comments on certain GE responses to existing RAIs and identified additional RAIs. GE discussed their approach to responding to these issues. GE committed to provide responses to the comments in the near future and to provide responses to the new RAIs on a schedule consistent with their preparation of revision 2 of the PRA. The Staff concurred with GE's approach.

Members of the public attended the meeting by teleconference. No public meeting feedback forms were received. Please direct any inquires concerning this meeting to me at 301-415-0224 or tak@nrc.gov.

/RA/

Thomas A. Kevern, Senior Project Manager
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Office of New Reactors

Docket No. 52-00010

Enclosures:
As stated

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Public Meeting with General Electric Company
Regarding ESBWR Containment Capacity Audit

February 7, 2007, 4:00 p.m.

General Electric Company, San Jose, CA

Name	Organization
Tom Kevern	NRC/NRO/DNRL
Goutam Bagchi	NRC/NRO/DRES
Ed Fuller	NRC/NRO
Jim Xu	Brookhaven Nat'l Lab
Rich Morante	Brookhaven Nat'l Lab
Kathy Sedney	GE- Regulatory Affairs
Ai-Shen Liu	GE
Henry Solorzano	GE
Hideyasu Furukawa	Hitachi
Tetsuya Naguta	Hitachi
Teresa Dominguez	Empresarios Agrupados (EA)
Alfredo Orden	Empresarios Agrupados
Miguel Diaz-Llanos	Empresarios Agrupados
Randy James	Anatech
Wen H. Tong	Ares Corporation
Rick Wachowiak	GE
Theo Theofana	UCSB
Sid Bhatt	GE
Maryann Herzog	GE
* Amy Cubbage	NRC

Enclosure 1

Name	Organization
* Greg Ralston	Entergy
* Mohammed Shuaibi	NRC
* Jim Kinsey	GE
* George Stramback	GE
* David Hinds	GE
* Hugh Upton	GE

* By Teleconference

NRC Audit Plan
ESBWR Containment Capacity Audit
General Electric Company, San Jose, CA
February 5 through 7, 2007

Audit Team

NRC: G Bagchi, E Fuller, T Kevern
Brookhaven National Laboratory: J Xu, R Morante

Audit Scope

- General Electric (GE) responses to previously-provided NRC Requests for Additional Information (RAIs) and the staff assessment of GE responses.

- ESBWR design analyses of the pressure capacity in accordance with ASME Code Level C or Factored Load Category for the following containment structural components: Wetwell, Upper Drywell, Lower Drywell (reactor Pedestal), Suppression Pool Slab, Basemat, Drywell Head and PCCS heat exchangers. Information may include: analysis methods, drawings for structural details, critical sections governing component pressure capacity, material properties at ambient and accident temperature (500^{o} F), etc.

- Staff review of details of the capacity factors in the calculations related to the containment capacity. The staff intends to utilize GE's results of analysis of containment capacity to conduct a confirmatory containment fragility analysis of containment internal pressure capability. The staff's confirmatory analysis will utilize an approximate method which identifies various factors of conservatism and associated uncertainties in the design calculations and estimates the pressure capacity with a high confidence by scaling the design pressure upward using a number of appropriately derived and defensible multiplicative random constants.

- Additional information as needed by the staff related to audit activities.

Agenda

02/05/07 (Monday):

1. Informal entrance meeting

2. GE presentation on ESBWR structural and system safety features for preventing and mitigating beyond-design-basis severe accidents (phenomenological events such as EVE, DCH, CCI, system failure initiated overpressurization, and external initiated seismic events), and GE's approach to fragility analysis for the containment. Specifically, GE's presentation should address: a) deterministic containment performance evaluation under SECY 93-087 (categories of accident scenarios, pressure/temperature transients (loads) for each scenario,

temperature effect on material properties), b) development of containment fragilities (capacities) for the applicable temperature scenarios and corresponding failure modes, and c) assessment for concrete ablation due to CCI.

3. Staff assessment of RAI responses.

020/6/07 (Tuesday):

1. Continue staff assessment of RAI responses from Monday.

2. Review design/analysis documentation of the pressure capacity in accordance with ASME Code Level C or Factored Load Category for the following containment structural components: Wetwell, Upper Drywell, Lower Drywell (reactor Pedestal), Suppression Pool Slab, Basemat, Drywell Head and PCCS heat exchangers.

02/07/07 (Wednesday):

1. Continue staff assessment of RAI responses from Tuesday.

2. Continue review of design/analysis documentation of the pressure capacity in accordance with ASME Code Level C or Factored Load Category for the following containment structural components: Wetwell, Upper Drywell, Lower Drywell (reactor Pedestal), Suppression Pool Slab, Basemat, Drywell Head and PCCS heat exchangers.

3. Define data needed for the staff's confirmatory fragility analyses of above-mentioned structural components. Confirm availability of information in desired format. Arrange for the data transfer with GE.

4. Exit Meeting at 4:00 pm.

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