UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001

November 03, 2010

MEMORANDUM TO: ACRS Members

FROM: Christopher L. Brown, Senior Staff Engineer` /RA/
Reactor Safety Branch A, ACRS

SUBJECT: CERTIFICATION OF THE MINUTES OF THE ACRS **OPEN** ESBWR SUBCOMMITTEE MEETING, AUGUST 16-17, 2010, 2010, ROCKVILLE, MARYLAND

The minutes of the subject meeting were certified on November 03, 2010, as the official record of the proceedings of that meeting. A copy of the certified minutes is attached.

Attachment: As stated

cc w/o Attachment: E. Hackett
C. Santos

UNITED STATES
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WASHINGTON, DC 20555 - 0001

MEMORANDUM TO: Christopher Brown, Senior Staff Engineer
ACRS

FROM: Michael Corradini, Chairman
ESBWR Subcommittee

SUBJECT: CERTIFICATION OF MINUTES OF THE ACRS OPEN ESBWR SUBCOMMITTEE MEETING, AUGUST 16-17, 2010, ROCKVILLE, MARYLAND

I hereby certify, to the best of my knowledge and belief, that the minutes of the subject meeting on August 16 -17, 2010, are an accurate record of the proceedings for that meeting.

/RA/ 11/ 02 /10
Michael Corradini, Chairman Date
ESBWR Subcommittee

Certified by: M. Corradini
Certified: November 03, 2010

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
MINUTES OF ACRS ESBWR SUBCOMMITTEE MEETING
AUGUST 16-17, 2010, 2010
ROCKVILLE, MARYLAND

INTRODUCTION

The Advisory Committee on Reactor Safeguards (ACRS) Subcommittee on the ESBWR met in room T-2B1 at the Headquarters of the U.S. Nuclear Regulatory Commission (NRC), located at 11545 Rockville Pike, Rockville, Maryland, on August 16th and 17th, 2010. The Subcommittee was briefed by representatives of NRC's Office of New Reactor Licensing (NRO) on select portions of SERs Chapters (2, 9, 10, 12, 14, 16, 18, and 21) and associated RAI responses for the ESBWR DCD.

The Subcommittee planned to gather information, analyze relevant issues and facts, and formulate proposed positions and actions, as appropriate, for deliberation by the full Committee of the ACRS at a later date.

The Chairman for this ACRS Subcommittee was Dr. Michael Corradini. Mr. Christopher Brown was the ACRS staff cognizant engineer for this topic and served as the Designated Federal Official for this meeting. This meeting was open to public attendance and no proprietary information was discussed. The Subcommittee received no written comments or requests for time to make oral statements from any members of the public concerning the subject of this meeting. The meeting convened at approximately 8:30am.

The detailed agenda identifying the specific presentation topics comprising this meeting can be found in Attachment 1. Both during and following the scheduled presentations, the speakers responded to specific questions and comments from the ACRS Subcommittee members. The scope of the questions, comments, and answers thereto, and the speaker's responses thereto, have been captured in the verbatim meeting transcript.

ACRS Subcommittee meeting transcripts can be found at the following NRC Internet website location*: http://www.nrc.gov/ reading-rm/doc-collections/acrs/tr/subcommittee/*.

ATTENDEES:

The following list of Individuals (and their affiliations) attending this meeting was compiled using both the sign-in sheets and the Subcommittee meeting transcript.

ACRS Members

M. Corradini, Subcommittee Chairman
J. S. Armijo
S. Abdel-Khalik
J. Stetkar

T. Kress, Consultant
G. Wallis, Consultant

ACRS Staff

C. L. Brown, Designated Federal Official

K. D. Weaver, ACRS staff

C. Santos

NRC Staff

A. Cubbage, NRO

B. Bavol

K. Hawkins

G. Thomas

B. Harvey

S. Tammara

L. Perkins

R. Hernandez

C. Hinson

D. Misenhimer

M Norato

A. Hsia

D. Galvin

J. Gilmer

M. Patterson

B. Davis

G. Thomas

J. Gilmer

General Electric-Hitachi (GEH) Staff

P. Campbell

W. Marquino

E. Kirstein

A. Beard

R. Kingston

J. Deaver

W. Marquino

G. Anthony

OPENING REMARKS AND OBJECTIVES:

Dr. Michael L. Corradini, Chairman of the ACRS ESBWR Subcommittee, convened the meeting at 8:30 a.m.

Ms. Amy Cubbage, the NRO Acting Branch Chief and lead PM responsible for the ESBWR DCD review, also made an opening statement.

SCHEDULED PRESENTATIONS:

The committee meeting focused on select portions of Chapters 2, 9, 10, 12, 14, 16, 18, and 21 with open items resolved by staff review of GEH RAI responses. No significant issues were identified. There were a couple of topics that the subcommittee discussed with GEH and the staff to clarify key points.

Chapter 15 – Transient and Accident Analyses: The staff evaluated DCD Revision 6, Chapter 15, "Safety Analyses," and discussed the bases for GEH's safety analysis. GEH proposed a new subcategory of events—infrequent events (IEs)—under the broad category of accidents. GEH proposed this re-categorization of events because of the unique passive cooling design of the ESBWR, the anticipated lower frequency of event occurrence, and the unique design features. The events that were grouped as IE's are subjected to a different technical basis. For AOO's the applicant must demonstrate that such events result in less than 0.1% of the fuel rods would undergo failure (specifically, that is based on the specific criteria that the RPV level remains above the top of the active fuel, that MCPR > SLMCPR and that the RPV pressure remains below 1375psig). For IE's, the applicant compares the consequences of such events to a dose criteria; i.e., 10% of 10CFR50.34(a)(ii)(D1) which is 2.5rem TEDE plus RPV level remains above the top of the active fuel and that the RPV pressure remains below 1500psig.

Consider an example; to reduce the frequency of unanticipated scrams, the ESBWR is to utilize a combination of an SCRRI electrical insertion of rods to a pre-set pattern and an SRI hydraulic scram of pre-determined rods. This is a unique system and ACRS asked questions that included: What events would trigger this system? To what power levels of reduction are anticipated? Is there a xenon issue associated with returning to full power? As core burnup proceeds, is there a need to periodically change the patterns and set points? Is there any potential to affect power oscillations? Staff should review such issues to assure proper operation under various conditions.

The staff issued an RAI requesting the applicant identify all possible transients and accidents that may result from the unique design features of the ESBWR. GEH performed the requested study, which covered all the ESBWR systems and addressed possible new events resulting from the unique design features of the ESBWR. The staff evaluated the response and agreed with GEH's assessment.

Chapter 9 – NEDO-33373 – Dynamic, Load-Drop and Thermal Analyses for Fuel Racks: GEH analyzed the dynamic behavior and presented the structural analysis of Spent Fuel High Density Fuel Storage Racks (FSR) for the Spent Fuel Pool located in the Fuel Building (FB). The NRC staff reviewed (1) the dynamic analyses of the spent fuel storage racks in the spent fuel pool located in the fuel building and in the buffer pool in the reactor building, and (2) the dynamic analysis of the new fuel storage racks in the buffer pool. The staff also reviewed the drop analyses performed for both spent fuel racks and new fuel racks. They concluded that the dynamic, load-drop analyses, and the structural design of the fuel storage racks are acceptable. The staff also reviewed the thermal-hydraulic analyses of the spent FSRs. The staff verified that the design of the spent fuel pool racks complies with the requirements of GDC 61 regarding the decay heat removal of spent fuel in the storage racks. The analyses provided by the applicant in NEDO-33373 reference design specifications and drawings that are the bases for the CFD model geometry and boundary conditions input. Staff evaluated the calculation for the maximum temperatures in the spent fuel (fluid and clad) with 80-percent blockage of rack outlets. The staff found that the thermal-hydraulic analyses demonstrate that the spent fuel storage racks meet the requirements of GDC 61 and the guidelines of RG 1.13 for the decay heat removal of spent fuel in the storage racks. The staff found that the thermal-hydraulic design for the FSR's acceptable. The ACRS members were confused about the decay heat used in these analyses and asked the staff to verify that combination of the recent core assemblies unloaded into the pool along with the aged spent fuel represented a maximum that the spent

fuel cooling had to adequately meet. Additionally, we felt that although the GEH topical report shows that the analysis is reasonable, and spent fuel cooling is maintained, the details of the analysis in the report were too vague and more information was needed to provide better explain the basis that the decay heat used is a maximum and the particular local conditions that demonstrate that the analysis are reasonable.

Chapter 21: This chapter describes the use of TRACG for the full range of AOO, ATWS, Stability and LOCA calculations. The staff reviewed the usage and found that TRACG was acceptable for these uses. The staff also performed TRACE analyses for realistic conditions to assure that TRACG are bounding.

Chapter 2 – Site Characteristics: Site characteristics include potential hazards in proximity of the plant, meteorology, hydrology, geology, seismology, and geotechnical parameters. An applicant for a COL that references the ESBWR DCD will establish the site characteristics when it applies for a COL, or it will reference an early site permit (ESP) that reflects these characteristics. In either case, the COL applicant must show that the site parameters considered in the ESBWR DCD bound the actual site characteristics. Should the ESBWR design parameters not encompass the actual site characteristics, the COL applicant will need to demonstrate by other means, that the proposed reactor plant design is acceptable at that site.

The ESBWR standard plant design was modified from one main stack and replaced it with three ventilation stacks that are in the radwaste building, the turbine building, and the reactor building. It was not clear to how design basis accidents are dealt with when there are multiple release locations. What is to be used for the various location source terms and stack flow determination and how is the timing of there related to each other? The staff should review this further to assure such a modification is not more limiting than a single stack.
There were many clarification questions about the ambient design temperature parameters (dry bulb, wet bulb and global wet bulb) provided by GEH in response to a staff RAI. The approach seems likely to bound many potential sites for an ESBWR, but the specific example was more confusing than helpful to clarify the proposed approach. As these are subject to verification at the COL stage, we see no particular issue with the values provided.

Chapter 12 – Radiation Protection: This chapter describes the types and quantities of radioactive materials expected to be produced during the operation of the ESBWR, as well as the means for controlling or limiting radiation exposures within the requirements of 10 CFR Part 20. The measures are intended to ensure that radiation exposures to plant personnel, contractors, and the general public, resulting from plant operation and anticipated operational occurrences are within regulatory limits and are as low as reasonably achievable. The ESBWR approach to limiting the potential for site contamination was particularly good. The staff has appropriately close the open items associated with Chapter 12.

Chapter 10 – Steam and Power Conversion Systems: The components of the steam and power conversion system are designed to produce electrical power using steam generated by the reactor to flow through steam turbines, condense steam into water, and return the water to the reactor as heated feedwater. In addition, a major portion of the gaseous, dissolved, and particulate impurities are removed in order to satisfy water quality requirements. The steam and power conversion system also includes protective features that accommodate key potential challenges. No significant issues were identified.

Chapter 14 & 16 – ITAAC and Testing Program and Technical Specifications: The purpose of the ITAAC is to verify that an as-built facility conforms to the approved plant design and

applicable regulations. When coupled in a COL with the ITAAC for site-specific portions of the design, they constitute verification activities for a facility that should be met prior to fuel load. The ACRS members were most interested in the Passive Safety Systems testing procedure and frequency. The members suggested that the passive control habitability could be tested empirically under controlled conditions to benchmark the heating/cooling analysis. The members also felt the passive systems be tested consistently in staggered time periods over a 10yr period; i.e., PCCS, ICS, GDCS have redundant trains that can be tested staggered over that 10yr time span.

SUBCOMMITTEE FOLLOW-UP ACTIONS/SIGNIFICANT ISSUES/COMMENTS

See attached (none).

BACKGROUND MATERIALS PROVIDED TO THE SUBCOMMITTEE PRIOR TO THIS MEETING:

1. Memoranda from David Matthews, transmitting ~~"F~~inal Safety Evaluation Reports Chapters 1 – 22," (ML102850502 package)

2. Letter to U.S. Nuclear Regulatory Commission, transmitting ~~"T~~ransmittal of ESBWR DCD Markups to Tier 1 and Chapter 2, 3, and 19 Related to GEH Internal Corrective Actions and Discussions with the NRC," (ML102730795) 09/24/2010.

3. Letter to U.S. Nuclear Regulatory Commission, transmitting ~~"E~~SBWR Design Control Document, Tier 2 Chapter 7 and Tier 1 Changes to Respond to ACRS Remarks," (ML102700297) 09/23/2010.

4. Letter to U.S. Nuclear Regulatory Commission, transmitting ~~"E~~SBWR Design Control Document, Revision 7, Tier 1 and Tier 2," (ML1013401430 and ML101340380) 03/29/2010.

5. Letter to R.W. Borchardt, transmitting ~~"I~~nterim Letter 6: Chapters 7 and 14 of the NRC Staff's Safety Evaluation Report with Open Items Related to the Certification of the ESBWR Design," (ML083460306) 12/22/2008.

6. Letter to R.W. Borchardt, transmitting ~~"I~~nterim Letter 4: Chapter 3 of the NRC Staff's Safety Evaluation Report with Open Items Related to the Certification of the ESBWR Design," (ML081930777) 07/21/2008.

7. Letter to R.W. Borchardt, transmitting ~~"I~~nterim Letter 3: Chapters 4, 6, 15, 18, and 21 of the NRC Staff's Safety Evaluation Report with Open Items Related to the Certification of the ESBWR Design," (ML081330447) 05/23/2008.

1. Meeting Agenda
2. Sign-In Sheets
3. Follow-up items
4. Presentation Materials
5. Consultant Report

Attachment 1 **ACRS Meeting of the Subcommittee on ESBWR**

Rockville, MD

Monday, August 16, 2010

Cognizant Staff Engineer: Christopher L. Brown (301)-415-7111, Christopher.Brown@nrc.gov

Item	Topic	Presenter(s)	Time
1	Opening Remarks and Objectives	**Dr. Michael L. Corradini, ACRS**	8:30 – 8:35 a.m.
2	Staff Opening Remarks	**Amy Cubbage, NRO**	8:35 – 8:40 a.m.
3	**Chapter 15** FSER - Transient and Accident Analysis	a. GEH – Wayne Marquino, (phone support - David Hindera, Antonio Barrett, and M.D. Alamgir) b. NRO – Bruce Bavol (PM), Lambros Lois, George Thomas	8:40 – 9:40 a.m.
4	**Chapter 9** NEDO-33373, "Dynamic, Load-Drop and Thermal-Hydraulic Analysis for ESBWR Fuel Racks"	a. GEH – Jerry Deaver, (phone support - Tom Walker, Dave Davenport, Mike Arcaro) b. NRO – Dennis Galvin (PM)	9:40 – 10:45 a.m.
	Break		10:45 - 11:00 a. m.
5	**Chapter 9** *NEDC-33374P, "Safety Analysis Report for Fuel Storage Racks Criticality Analysis for ESBWR Plants"	a. GEH – Erik Kirstein, (phone support - John Hannah, Mike Arcaro) b. NRO – Dennis Galvin (PM)	11:00 – 12:00 p.m.
	Lunch		12:00 – 1:00 p.m.
6	***Chapter 3** Issue: 3.6.2 jet impingement	a. GEH – Jerry Deaver b. NRO – David Misenhimer (PM), Renee Li, Dr. Stephen Hambric, Dr. Jules Lindau	1:00 – 2:00 p.m.
7	***Chapter 21** FSER - Codes and Test Programs *NEDE-33083P, —RACG Application for ESBWR" (ATWS) *NEDE-33083P, —RACG Application for ESBWR" (AOO) *NEDE-33083P, —RACG Application for ESBWR" (Stability) *NEDC-33083P, —RACG Application for ESBWR" (LOCA)	GEH – Wayne Marquino, (phone support - Antonio Barrett and M.D. Alamgir)	2:00 – 3:30 p.m.
	Break		3:30 – 3:45 p.m.
8	***Chapter 21** FSER - Codes and Test Programs *NEDE-33083P, —RACG Application for ESBWR" (ATWS) *NEDE-33083P, —RACG Application for ESBWR" (AOO) *NEDE-33083P, —RACG Application for ESBWR" (Stability) *NEDC-33083P, —RACG Application for ESBWR" (LOCA)	NRO – Bruce Bavol (PM), James Gilmer	3:45 – 5:15 p.m.
9	Committee Discussion	**Dr. Corradini, ACRS**	5:15 p.m.
	Adjourn		5:30 p.m.

ACRS Meeting of the Subcommittee on ESBWR
Rockville, MD

Tuesday, August 17, 2010

Item	Topic	Presenter(s)	Time
1	Opening Remarks and Objectives	**Dr. Michael L. Corradini, ACRS**	8:30 – 8:35 a.m.
2	Staff Opening Remarks	**Amy Cubbage, NRO**	8:35 – 8:40 a.m.
3	**Chapter 2 FSER -** Site Characteristics	a. GEH – Rick Wachowiak, Erik Kirstein (Appendices 2A and 2B), (phone support - Dave Hamon, Sujit Niogi (Snow Load), Antonio Barrett (CR Habitability), David Hindera (Appendix 2A) b. NRO – David Misenhimer (PM), Brad Harvey, Seshagiri Tammara , Malcolm Patterson	8:40 – 9:40 a. m.
4	**Chapter 12** FSER - Radiation Protection	a. GEH – Erik Kirstein, (phone support - David Hindera) b. NRO – David Misenhimer (PM), Charles Hinson, George Cicotte	9:40 – 10:45 a.m.
	Break		10:45 - 11:00 a. m.
5	***Chapter 18** FSER - Human Factors Engineering	a. GEH – Wayne Marquino, (phone support - Don Taylor, Jeff Grogan) b. NRO – Dennis Galvin (PM)	11:00 – 12:00 p.m.
	Lunch		12:00 – 1:00 p.m.
6	**Chapter 10** FSER - Steam and Power Conversion System	a. GEH – Gary Anthony b. NRO –Leslie Perkins (PM), Devender Reddy, Bob Davis	1:00 – 2:00 p.m.
7	**Chapter 14** FSER - Initial test Program and ITAAC	a. GEH – Rick Wachowiak b. NRO – Leslie Perkins (PM), Frank Talbot, Amar Pal, Charlie Hinson	2:00 – 3:00 p.m.
	Break		3:00 – 3:15 p.m.
8	**Chapter 16** FSER - Technical Specifications	a. GEH – Rick Wachowiak, (phone support - Sara Andersen, Joel Friday) b. NRO – Leslie Perkins (PM), Craig Harbuck	3:15 – 4:15 p.m.
9	**Chapter 20** FSER - Generic Issues	a. GEH – Rick Wachowiak b. NRO – Leslie Perkins (PM)	4:15 – 5:15 p.m.
10	Committee Discussion	**Dr. Corradini, ACRS**	5:15 p.m.
	Adjourn		5:30 p.m.

ACRS Notes:

- During the meeting, 301-415-7360 should be used to contact anyone in the ACRS Office.
- Presentation time should not exceed 50 percent of the total time allocated for a given item. The remaining 50 percent of the time is reserved for discussion.
- Thirty five (35) hard copies (2 B&W slides per page) of each presentation or handout should be provided to the Designated Federal Official 30 minutes before the meeting.
- 10 full page colored copies for the ACRS members and the court reporter.

One (1) electronic copy of each presentation should be emailed to the Designated Federal Official 1 day before the meeting. If an electronic copy cannot be provided within this timeframe, presenters should provide the Designated Federal Official with a CD containing each presentation at least 30 minutes before the meeting.

Attachment 2

CONSULTANT'S REPORT ESBWR SUBCOMMITTEE MEETING
August 16/17 2010

Graham Wallis 8/21/10

Most of the meeting was devoted to wrapping up remaining questions on several chapters of the SER. This was achieved in most cases, but a few items appear to justify further explanation or investigation.

Spent fuel pool cooling

The heat load appears low. The immediate decay heat of a full core load is about 30MW. A detailed explanation of how the pool heat load varies with time following shutdown is needed in order to justify the choice of less than 10MW for the contribution of a full core offload to the total heat load.

CFX is capable of handling this problem straightforwardly. The overall heat transfer predictions appear reasonable.

The velocity vectors in the LTR (NEDO-33373, rev 4) are impossible to discern, though there is a vague indication of a plume above the hottest region of the racks.

The streamlines that are presented in Figure 5-9 of the LTR for "Normal Conditions" are peculiar. There appear to be only 3-5 coming in and 2-3 leaving, though 6 or more pass through the hot region of the racks. Several streamlines appear to meander around the pool dozens (hundreds?) of times without going through the racks at all. This is the kind of figure one would present to make the case that CFX was not working properly, or that cooling was very inefficient. A similar impression is given by the streamlines for "Abnormal Conditions" in Figure 5-12. These figures could be much improved in order to establish credibility.

Spent Fuel Criticality

The analysis was 2-D. It was claimed that treating the part-length rods as either full-length or absent entirely would bound actual behavior.

I would prefer to see a full 3-D analysis, which I understand is done for PWRs, that would be more realistic and conclusive.

Blowdown Jet Impingement

GEH is undertaking an ambitious program of modeling transient 3-D jet behavior. This has potential to be a significant improvement over the previous ANS Standard approach.

Several members thought this would be difficult to accomplish, but it should be within the state of the art and feasible with modern computing techniques. Thought should be given to the number of cases, such as break locations, sizes, and shapes, that need evaluation.

It is appropriate that NRO is asking RES to sponsor a test research program. Confirmatory data have not been found for dynamic supersonic jets.

TRACE Calculations

TRACE predicted about 3meters greater collapsed water level than TRACG. Though this errs on the conservative side, I would like to see the staff discover the main reasons for such a large discrepancy. Explanations at the meeting were vague.

Control Room Habitability

The subcommittee had many questions about the treatment of wet and dry bulb data. Discussion of one particular example of weather data was confusing and issues were not resolved. It was unclear that the approach was unequivocal; it seemed likely to lead to a variety of interpretations by licensees, particularly when the data deviated significantly from an idealized sinusoidal variation with time. This needs to be cleared up.

Screening of External Hazards

I doubt if the approach of screening out low frequency external events with a frequency comparable with the overall CDF is reasonable. Taking them into account might have potential to change the CDF by an amount comparable with its original value.

Generic Issues

These appear to be resolved, though the staff could have done a better job of explaining why they accepted the GEH submissions.

Consultant's Report on the August 16 -17, 2010 ESBWR Subcommittee Meeting

T. S. Kress

Background

The purpose of this meeting was to continue the reviews of selected chapters of the ESBWR SER and DCD in anticipation of eventually granting a certification. Selected portions of Chapter 15 FSER were reviewed (reactivity insertion accidents), Chapter 3 (issue 3.6.2 jet impingement), Chapter 2 (snow levels and control room habitability), Chapter 12 (radiation protection), Chapter 18 (human factors engineering), Chapter 14 (initial test program), and Chapter 16 (technical specifications). In addition, a number of topical reports were discussed.

Comments

General
In general, I did not see any real ~~-s~~how-stoppers" in the issues discussed at this meeting.

Rapid Power Reduction

To react to needs for power reductions but to avoid undesirable scrams, the ESBWR is to utilize a combination of an SCRRI electrical insertion of rods to a pre-set pattern and an SRI hydraulic scram of pre-determined rods.

We did not hear enough details for this system and the staff had no comments on its use. I think the ACRS needs to have additional review of this new system not used elsewhere. Some questions might include: What events would trigger this system? To what power levels of reduction are anticipated? Is there a xenon issue associated with returning to full power? As core burnup proceeds, is there a need to periodically change the patterns and set points? Is there any potential to affect power oscillations?

Reactivity Insertion Events

Rod withdrawal has been reclassified as an AOO of frequency ≥ 10^{-2}/yr but there is no resulting fuel damage or dose and all acceptance criteria for this frequency are met. Consequently, there doesn't seem to be any issue here.

Jet Impingement

The plans for a 3-D analysis of shock and jet impingement loads for high energy breaks using the CFD code FLUENT are ambitious but I believe doable. This will help resolve the levels of conservatism (if any) associated with the 2-D analyses and may lead to identification of resonance effects. ACRS should support this effort and eventually review the results. It is unfortunate that this will not be completed in time to be useful for developing a less conservative ~~"~~zone-of-influence" for GSI-191.

χ/Q Values

The standard plant design has removed the main stack and replaced it with 3 ventilation stacks that appear to be in the rad-waste building, the turbine building, and the reactor building.

It is not clear to me how design basis accidents are dealt with when there are multiple release locations. What is to be used for the various location source terms and stack flow determination and how are the timing of there related to each other? ACRS should give additional review to this change.

Control Room Temperatures

There were many questions about the ambient design temperature parameters provided by GEH in response to a staff RAI. Although these appeared to come directly from some unspecified site, they are likely to bound many potential sites for an ESBWR. As these are subject to verification at the COL stage, I see no particular issue with the values provided.

Radiation Protection

The ESBWR approach to limiting the potential for site contamination was particularly good. The staff has appropriately close the open items associated with Chapter 12.

Human Factors Engineering

For use in establishing risk importance (safety significance), importance measures (RAW and F-V) are determined for operator actions called upon during defined events in the PRA. The values for these are based on human factors models that are not well validated. Some uncertainty determination should accompany these and be used in developing the safety significance.

Decay Heat

The level of decay heat in the spent fuel pool was said to be maximized for determination of the associated temperatures and potential for boiling. I have no reason to doubt that the levels discussed are the maximum, however we were not provided with sufficient information about decay times during off-loading of full cores to make a judgment.

The use of the CFD code CFX is an appropriate way to determine the flow patterns and associated temperatures. The example calculated streamlines, however, need additional discussion and explanation – particularly as to the quantities of coolant passing through the hot bundles and the production of natural convection patterns.

Screening of External Hazards

While it is generally not a good idea to screen out events of frequency ≤ 10^{-7}/yr in a PRA, this can be appropriate for specific event categories. It is my opinion that the number and magnitudes of seismic event with the screened out frequencies are very limited and are not likely to add significantly to the CDF and LRF seismic contributions. I would accept this screening criterion.