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

June 23, 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 ESBWR SUBCOMMITTEE MEETING **OPEN** PORTION, MAY 19, 2010, ROCKVILLE, MARYLAND

The minutes of the subject meeting were certified on June 20, 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
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001

June 23, 2010

MEMORANDUM TO: Christopher Brown, Senior Staff Engineer
ACRS

FROM: Michael Corradini, Chairman
ESBWR Subcommittee

SUBJECT: CERTIFICATION OF MINUTES OF THE ACRS ESBWR SUBCOMMITTEE MEETING OPEN PORTION, MAY 19, 2010, ROCKVILLE, MARYLAND

I hereby certify, to the best of my knowledge and belief, that the minutes of the subject meeting on May 19, 2010, are an accurate record of the proceedings for that meeting.

R/A 6/20/10
Michael Corradini, Date
ESBWR Subcommittee Chairman

Certified by: M. Corradini Issued: June 23, 2010
Certified: June 20, 2010

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
MINUTES OF ACRS ESBWR SUBCOMMITTEE MEETING
May 19, 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 May 19, 2010. The Subcommittee was briefed by representatives of NRC's Office of New Reactor Licensing (NRO) on a RAI responses relating to control room habitability analysis

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. Part of meeting was open to public attendance and part of the meeting, involving with the proprietary information discussion, was closed. 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. As a result of Member questions and comments, and speaker responses (answers) thereto – so-called 'Qs and As', a number of follow-up actions were identified for further discussion at subsequent Subcommittee meetings. These follow-up actions will be tracked by the ACRS staff.

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 (Attachment 2) and the Subcommittee meeting transcript.

ACRS Members

M. Corradini, Subcommittee Chairman

J. S. Armijo

S. Abdel-Khalik

G. Wallis, Consultant

T. Kress, Consultant

ACRS Staff

C. L. Brown, Designated Federal Official

C. Santos

K. D. Weaver, ACRS staff

NRC Staff

A. Cubbage, NRO

James Gilmer, NRO

Dennis Galvin, NRO

L. Dudes, NRO

Bruce Bavol, NRO

General Electric-Hitachi (GEH) Staff

Patricia Campbell

Rick Kingston

Russ Fawcett

Stephan Moen

Brian Moore

Nayem Jahingir

Peter Diller

Scott Nelson

Gabriel Cuevas-Vivas

Rick Wachowiak (via teleconference)

SCHEDULED PRESENTATIONS:

The published meeting agenda for this Subcommittee meeting include the following topic:

The ESBWR subcommittee has begun reviewing the final set of topical reports as well as the staff's final SER's for the General Electric-Hitachi (GEH) ESBWR Design Certification Document (DCD).

The committee meeting focused open items resolved by staff review of GEH RAI responses; specifically, control room habitability analysis. No significant issues were identified. There were a couple of topics that the subcommittee discussed with GEH and the staff to clarify key points.

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.

SUMMARY OF PRESENTATION:

No significant issues were identified. There were certain topics that the subcommittee discussed with GEH and the staff to clarify key points:

1. The control room habitability analysis was discussed by the staff. In order to assess the GEH analyses the staff performed audit calculations with a first-principles model. The staff agreed to transmit a short memo of their results to the subcommittee (This is an action item that will be tracked by ACRS staff). The members also noted and the staff agreed that the concrete walls were the dominant heat sink for control room cooling during accident simulation to assure habitability. Given this fact, the concrete temperature (where and how it is measured) and its verification for Tech Specs Limiting Condition of Operation should be better characterized as a prerequisite.

SUBCOMMITTEE FOLLOW-UP ACTIONS/SIGNIFICANT ISSUES/COMMENTS

1. Member Kress indicated that the staff's review and confirmatory analyses for the temperature and humidity levels in the control room under passive cooling following a loss of the HVAC system were appropriate and sufficient (assumptions on initial and boundary conditions) to assure that acceptance criteria established for temperature and humidity will be met.

2. Dr. Wallis indicated that at our previous meeting the staff appeared to be well aware of the issues and on track to resolve a few remaining questions. They have now resolved those issues. They also performed confirmatory calculations and performed sensitivity studies. The walls are relied upon as heat sinks. Attention should be given to how their temperatures are measured and monitored and how suitable criteria are met. A possible question concerns "margin". The predictions come close to the criteria. Can the margin due to conservatism be estimated?

BACKGROUND MATERIALS PROVIDED TO THE SUBCOMMITTEE PRIOR TO THIS MEETING:

1. Response to Portion of NRC Request for Additional Information Letter No. 388 Related to ESBWR Design Certification Application – Engineered Safety Systems – RAI Numbers 6.4-22 and 6.4-23.

2. Response to NRC Request for Additional Information Letter No. 404 Related to ESBWR Design Certification Application – Engineered Safety Systems – RAI Number 6.4-22 S01.

3. Response to Portion of NRC Request for Additional Information Letter No. 388 Related to ESBWR Design Certification Application – Control Room Habitability – RAI Numbers 9.4-29 S04 and 9.4-57.

Attachments (3):
1. Meeting Agenda
2. Sign-In Sheets
3. Presentation Materials
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Advisory Committee on Reactor Safeguards
Meeting of the Subcommittee on ESBWR
Rockville, MD

Tuesday, May 18, 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	**NEDC-33239P, "GEI4 for ESBWR Nuclear Design Report" & NEDC-33197P, "Gamma Thermometer System for LPRM Calibration and Power Shape Monitoring" ***	a. GEH – b. NRO – Bruce Bavol (PM), Peter Yarsky, James Gilmer	8:40 – 10:45 a. m.
	Break		10:45 - 11:00 a. m.
4	**NEDE-33237P, "ESBWR Critical Power Correlation Correction" & (NEDC-33413P, "Full Scale Critical Power Testing of GE14E and Validation of GEXL14E") ***	a. GEH – b. NRO – Bruce Bavol (PM), James Gilmer, Anthony Attard	11:00 – 12:00 p.m.
	Lunch		12:00 – 1:00 p.m.
5	**NEDC-33240P, "GE14E Fuel Assembly Mechanical Design Report" & NEDC-33242P, "GE14 for ESBWR Fuel Rod Thermal-Mechanical Design Report" ***	a. GEH – b. NRO – Bruce Bavol (PM), Chris Van Wert, Paul Clifford	1:00 – 3:00 p.m.
	Break		3:00 – 3:15 p.m.
	NEDE-33243P, Revision 1 "ESBWR Control Rod Nuclear Design" & NEDE-33244P, Revision 2 "ESBWR Control Rod Mechanical Design Report" *	a. GEH – b. NRO – Bruce Bavol (PM), Chris Van Wert, Paul Clifford	3:15 – 4:30 p.m.
6	Committee Discussion	**Dr. Corradini, ACRS**	4:30 p.m.
	Adjourn		4:45 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.

*** Portion of meeting discussion may be CLOSED due to proprietary material**

Wednesday, May 19, 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	**NEDE-33516P, "ESBWR Qualification Plan Requirements for a 72-hour Duty Cycle Battery" ***	a. GEH - b. NRO – Dennis Galvin (PM), Tania Martinez-Navedo	8:40 – 9:45 a. m.
	Break		9:45 – 10:00 a.m.
4	**Control Room Habitability**	a. NRO – Ilka Berrios (PM), James O'Driscoll	10:00 – 11:15 a.m.
	Committee Discussion	**Dr. Corradini, ACRS**	11:15 - 11:30 a. m.
	Adjourn		11:30 a. m.

*** Portion of meeting discussion may be CLOSED due to proprietary material**

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

SUBCOMMITTEE MEETING ON ESBWR

May 19, 2010
Date

[redacted] SIGN IN FOR ACRS MEETING

PLEASE PRINT

	NAME	[redacted] ORGANIZATION
1	Rick Kingston	GE Hitachi
2	KEVIN NUNES	GE Hitachi
3	PETER YANOW	GE HITACHI
4	Jon McLamb	GE Hitachi
5	Antonio Barrett	GE Hitachi
6	DAVID PIEPMEYER	GE HITACHI NUCLEAR ENERGY
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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

SUBCOMMITTEE MEETING ON ESBWR

May 19, 2010
Date

NRC STAFF SIGN IN FOR ACRS MEETING

PLEASE PRINT

	NAME	NRC ORGANIZATION
1	Perry KANG	NRC/NRO/EEB
2	Tania Martinez Navedo	NRO/DE/EEB
3	Dennis Galvin	NRO/DNRL/NGE1
4	Jonathan DeJesus	NMSS/FCSS
5	John McKirgan	NRO/DSRA/SBCV
6	Amar PAL	NRO/DE/EEB
7	Mark Lombard	NRO/DSRA
8	ED FORREST	NRO/DSRA
9	PAUL PIERINGER	NRO/DCIP/CQCP
10	Ilka Berrios	ACRS/RSB-A
11	Amy Cubbage	NRO
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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

SUBCOMMITTEE MEETING ON ESBWR

May 18, 2010
Date

NRC STAFF SIGN IN FOR ACRS MEETING

PLEASE PRINT

	NAME	NRC ORGANIZATION
1	Bruce Bavol	NRO/DNRL/NGE1
2	Joe Donoghue	NRO
3	Amrit Patel	NRO
4	GEORGE THOMAS	NRO
5	James Gilmer	NRO
6	PAUL CLIFFORD	NRR/DSS
7	Chris Van West	NRO
8	Mark Lombard	NRO
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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

SUBCOMMITTEE MEETING ON ESBWR

May 18, 2010
Date

Non - **NRC STAFF SIGN IN FOR ACRS MEETING**

PLEASE PRINT

	NAME	Non - [redacted] ORGANIZATION
1	Peter Yarsky	RES/DSA/RSAB
2	Nayem Tahirali	GEH/GNF
3	DAVID PIEPMEYER	GE HITACHI NUCLEAR ENERGY
4	Jon McLamb	GEH
5	Rick Kingston	GEH
6	Patricia Campbell	GEH
7	Steve Moen	GEH
8	Russ Fawcett	GEH
9	Lambros Lois	ORNL/Contractor
10	AHSAN SALLMAN	NRR/DSS/SCVB.
11	SCOTT NELSON	GEH
12	D.	
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U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Presentation to the ACRS Subcommittee

ESBWR Design Certification Review Chapter 9.4,“HVAC,” and Section 6.4, “Control Room Habitability System”

May 19, 2010

Purpose

- Brief the Subcommittee on the staff's review of the ESBWR design certification application, Chapter 9.4, "HVAC," and Section 6.4, "Control Room Habitability System"; ventilation issues
  - Previous briefing on this issue was given to the subcommittee on November 17, 2009.

- Answer the Subcommittee's questions

Project and Technical Review Team

- Project Managers
  - Dennis Galvin, Project Manager (9.4)
  - Ilka Berrios, Project Manager (6.4)

- Technical Reviewers
  - Jim O'Driscoll (6.4, 9.4.1 - 9.4.8) – Lead
  - Ed Forrest
  - Syed Haider
  - Shie-Jeng Peng

Staff Focus

- Expected performance of the passive cooling of Control Room Habitability Area (CRHA) and Reactor Building (RB)
  - Ability to maintain habitability and operability of equipment for 72 hours following an accident.

- Post Accident Emergency Filter Unit (EFU) Operation
  - Quantity of Air Supply
  - Air distribution, mixing, flow paths, and temperature
  - Carbon Dioxide Levels
  - Power Supply

RAI Status Summary

Chapter 9.4

- Issued RAIs = 58
- Resolved = 58
- Open Items = 0

Section 6.4

- Issued RAIs = 25
- Resolved = 25
- Open Items = 0

RB and CRHA Temperature Control

- Can passive cooling of ESBWR CRHA and RB maintain habitability and operability of equipment for 72 hours following an accident?

- Key Questions for a review of this feature:
  - Determine reasonable habitability acceptance criteria (AC) for CRHA temperature/humidity
  - Review applicant's AC and method of demonstration
  - Determine required level of detail/verification for a supporting heat up analysis
  - Determine important assumptions and appropriate level of configuration control to maintain them

Staff Review Approach – CHRA Temperature and Humidity

- Review supporting heat up analyses of RB and CB
  - Review proposed performance acceptance criteria
  - Review input assumptions in design basis calc
  - Review verification methodology / analyses
    - Identify sensitivities
  - Review results of analyses
  - Identify documentation of insights in analyses vs. design basis information
  - Review proposed ITAAC

Staff Review Approach – CHRA Temperature and Humidity

Applicant Actions completed

- CONTAIN 2.0 analysis submitted
  - as the design basis calculation for the CRHA analysis
- CRHA GOTHIC analysis submitted
  - to demonstrate mixing in MCR
- First principle calculation submitted
  - As alternate method of demonstration of passive heat removal
- ITAAC added
  - to update and validate design basis calc with as-built building dimensions, thermal properties, and exposed surface areas, heat loads, and environmental assumptions.

Staff Actions Completed

- Staff review of CONTAIN 2.0 analysis of CRHA and RB
- Staff review of CRHA GOTHIC analysis results
- Staff review of applicant's first principles calculation
- Staff review of DCD changes and ITAAC
- Staff performed confirmatory calculations

Staff Review Approach – Temperature

Applicant's CRHA Maximum Temperature Criteria

- Based on EPRI Utility Requirements Document guidance: CRHA max temperature rise limited to 15°F for a MCR with a normal temp range of 73-78°F
  - Proposed ESBWR CRHA temp acceptance criteria: <93°F
    - ESBWR CRHA max temp limited to 74°F per TS; allowing a maximum rise of 19°F
  - Staff concludes this criteria is consistent with URD guidance

Applicant's Outside Temperature Input Assumptions

- 117°F coincident with 80°F wet bulb
  - Site envelope 0% exceedance value per EPRI URD guidance
- Temperature daily swing of 27°F chosen for DCD calculation
  - Applicant used ASHRAE Fundamentals handbook to develop representative swing
  - Swing amount to be updated with site specific information in COL analyses ITAAC
  - Staff concludes that the input assumptions are acceptable

Staff Review Approach – Humidity

Applicant's Operator Functionality Criteria

- Applicant uses Wet Bulb Globe Temperature (WBGT) Index, a widely used Industry standard to assess heat stress
- 90°F WBGT index maximum was proposed by applicant
  - NIOSH standard is WBGT <86°F allows unlimited stay time for light work
  - NUREG 0700 recommends stay times implemented for WBGT >90°F

Applicant's Outside Humidity Input Assumptions

- 88°F non-coincident wet bulb temp per DCD chapter 2
  - Highest coincident Dry bulb temp of 92°F chosen (86% RH)
- 8°F daily temperature swing allowed
  - Based on weather station data from 3 gulf coast states
  - results in outside air relative humidity to cycle daily from 86% to 100%;
- Initial CHRA humidity is assumed 60% (maximum of normal range in DCD)
- Staff concludes that the input assumptions are acceptable

Summary of Submitted Analyses

<u>CRHA Temp/ Heat Stress at the end of 72 hour passive cooling</u>

- Design Basis: CONTAIN single node model
  - To demonstrate bulk room temperature and heat stress conditions meet proposed acceptance criteria.
- Supplementary models
  - GOTHIC
    - To demonstrate that some convective mixing is expected in CRHA
  - First Principles calculation
    - To support the use of CONTAIN as design basis method

CONTAIN Review

- Reviewed CRHA heat up calc report and data files
  - Heat sinks and heat source information does not conflict with DCD Tier 2 information.
- Staff Sensitivity Studies
  - Concrete density and specific heat
  - Heat transfer Area
  - EFU fan flow rate
  - Moisture generation rate (i.e. perspiration and respiration)
  - Outside Air temp; not likely to be higher than assumed
  - Humidity of outside air; not likely to be worse than assumed

<u>CRHA bulk temperature value varies most with concrete thermal properties; other parameters are less sensitive</u>

<u>CRHA heat stress index value varies most with respect to outside air relative humidity assumption</u>

GOTHIC Review

- Applicants provided multi node GOTHIC analysis in order to demonstrate convective mixing in the MCR due to temperature differences in room
    1. Used 20% lower sensible heat loads than CONTAIN
    2. Used lower EFU fan flow
    3. Used higher initial heat sink temperature
- Staff compared GOTHIC against the design basis analysis
  - Case 1: Staff run of Applicant's input file- no changes
    - Staff obtained similar results (93°F average of nodes)
  - Case 2: Staff revised GOTHIC input parameters #1 and #2.
    - CRHA bulk temperature obtained was close to CONTAIN
    - Revising parameter #3 further would likely result in lower calculated CRHA temps.

<u>Staff considers GOTHIC results support use of CONTAIN for this application.</u>

First Principles Calculation Review

- Applicant submitted analysis as an alternate demonstration of the CRHA passive cooling mechanism
  - Bulk room temp shown to be 91ºF
  - CRHA heat up rate profile graph similar to CONTAIN
- Staff compared against the design basis analysis
  - Overall heat sink mass and heat load is same
  - Distribution of heat sink mass simplified
  - Mass of CRHA air assumed to remain constant
- Staff modeled CRHA using first principles
  - In order to check the design basis winter case
  - In order to obtain insights in sensitivities on other cases
  - Used Visual C++ to model room
  - Same heat sink mass and properties as CONTAIN
  - Using same input assumptions as applicant, the bulk room temp shown to be close to CONTAIN and GOTHIC results

<u>Staff considers first principles results support use of CONTAIN for this application.</u>

Insights From Staff Review of Analyses

- CONTAIN model has some conservative assumptions
- GOTHIC demonstrates convective mixing is expected
- Highest averaged temperature in the occupied zone observed in GOTHIC model
  - Staff's sensitivity study approached CONTAIN result when most inputs were matched.
  - The small differences between the 3 different model's temperature results is small and considered inconsequential.
  - Agreement in model results support use of CONTAIN.
  - CONTAIN Methodology made Tier 2*
  - ITAAC added for verification of heat stress conditions using site specific environmental data and as built heat sink information.

<u>Staff concludes that supplemental analyses support the use of CONTAIN for demonstration of performance of CRHA passive cooling features for the ESBWR.</u>

Insights From Staff Analyses

- Applicant's CONTAIN results are close to the acceptance criteria of 93°F at end of 72 hours
  - Maintenance of margin may be important for sites located in hot dry, or very humid locations.
  - Configuration control of heat loads and sinks may be important for some sites.
    - Some passive cooling CRHA design detail description added to Tier 2.
  - Details on how EQ service temperature will be determined was added to DCD
    - CRHA Computer-based I&C systems will be type tested at much higher temperatures than observed in these analyses (140°F), and preferentially as a complete system (inside cabinets)

<u>The Tier 2 CRHA Description, EQ service temperature description and proposed ITAAC provide confidence that CRHA will meet AC when built.</u>

United States Nuclear Regulatory Commission

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Discussion/Subcommittee Questions