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Proprietary Notice
This letter forwards proprietary information in accordance with 10CFR2.390. Upon the removal of Enclosure 1, the balance of this letter may be considered non-proprietary.

MFN 08-545

Docket No. 52-010

August 29, 2008

U.S. Nuclear Regulatory Commission

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Subject: Response to Portion of NRC Request for Additional Information Letter No. 85 – Related to ESBWR Design Certification Application – RAI Number 21.6-98

The purpose of this letter is to submit the GE Hitachi Nuclear Energy (GEH) response to the U.S. Nuclear Regulatory Commission (NRC) Request for Additional Information (RAI) sent by the Reference 1 NRC letter. GEH response to RAI Number 21.6-98 is addressed in Enclosures 1, 2 and 3.

Enclosure 1 contains GEH proprietary information as defined by 10 CFR 2.390. GEH customarily maintains this information in confidence and withholds it from public disclosure. Enclosure 2 is the non-proprietary version, which does not contain proprietary information and is suitable for public disclosure.

The affidavit contained in Enclosure 3 identifies that the information contained in Enclosure 1 has been handled and classified as proprietary to GEH. GEH hereby requests that the information in Enclosure 1 be withheld from public disclosure in accordance with the provisions of 10 CFR 2.390 and 10 CFR 9.17.

If you have any questions or require additional information, please contact me.

Sincerely,

Richard E. Kingston

Richard E. Kingston
Vice President, ESBWR Licensing

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NRO

References:

1. MFN 07-054, Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, GEH, *Request For Additional Information Letter No. 85 Related To ESBWR Design Certification Application*, dated January 19, 2007

Enclosures:

1. MFN 08-545 – Response to Portion of NRC Request for Additional Information Letter No. 85 – Related to ESBWR Design Certification Application – RAI Number 21.6-98 – GEH Proprietary Information
2. MFN 08-545 – Response to Portion of NRC Request for Additional Information Letter No. 85 – Related to ESBWR Design Certification Application – RAI Number 21.6-98 – Non-Proprietary Version
3. MFN 08-545 – Response to Portion of NRC Request for Additional Information Letter No. 85 – Related to ESBWR Design Certification Application – RAI Number 21.6-98 – Affidavit

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	eDRF	0000-0084-0333/1

Enclosure 2

MFN 08-545

Response to Portion of NRC Request for

Additional Information Letter No. 85

Related to ESBWR Design Certification Application

RAI Number 21.6-98

Non-Proprietary Version

NRC RAdI 21.6-98

The staff noted in its acceptance review of ESBWR (Reference 1) that GE did not address all of the confirmatory items that were to be performed at the Design Certification stage as stated in the Staff's SER on TRACG for ESBWR loss of coolant accident (LOCA) analyses (Reference 2). In response to the staff's acceptance review of ESBWR, GE submitted some information (Reference 3) to address the confirmatory items in Reference 2, but this information is still incomplete.

Please address the following confirmatory items:

2. *Submit the long-term core cooling analyses.*
13. *Analyze standard problems and submit to the NRC.*
14. *Provide all nodalization changes including diagrams since the approval of TRACG for ESBWR LOCA Analyses in Reference 2, include most recent changes incorporated into Rev. 2 of the DCD; Explain the statement in Reference 3 that a "Total of 5 chimneys to calculate the minimum water level." In the TRACG input decks submitted to the staff and in Figures 6.2-6 and 6.2-7, the core/chimney section is divided into only 3 rings.*
19. *GE needs to submit additional information on the passive containment cooling system (PCCS) vent system demonstrating that it will perform as expected.*
20. *Describe all design changes since the approval of TRACG for ESBWR LOCA Analyses in Reference 2 and demonstrate that the staff's conclusions would not be altered as a result of these changes.*

References:

1. *Letter to S.A. Hucik (GE) from W.D. Beckner (NRC), "Results of Acceptance Review for ESBWR Design Certification Application (TAC No. MC8168)," September 23, 2005*
2. *Letter to L.M. Quintana (GE) from W.D. Beckner (NRC), "Reissuance of Safety Evaluation Report Regarding the Application of General Electric Nuclear Energy's TRACG Code to ESBWR Loss-of-Coolant Accident (LOCA) Analyses (TAC NOS. MB6279, MB6280,MB6281, MB6282, MB6283, MB6801 and MB7255)," October 28, 2004*
3. *Letter from D.H. Hinds (GE) to NRC, MFN 05-096, "Summary of September 9, 2005 NRC/GE Conference Call on TRACG LOCA SER Confirmatory Items," September 20,2005*

GEH Response

2. Submit the long-term core cooling analyses.

The long-term core cooling analyses have already been submitted to the NRC through GEH letter MFN 07-377 (Reference 1.1).

13. Analyze standard problems and submit to the NRC.

Two standard problems, one integral containment test and one separate-effects test, have been selected and simulated with TRACG. The TRACG simulation results for the integral Marviken blowdown test #18 – International Standard Problem 17 (Reference 1.2) are included in Attachment A. The TRACG simulation results for the Wisconsin Flat Plate separate-effects condensation tests (References 1.3 and 1.4) are included in Attachment B.

14. Provide all nodalization changes including diagrams since the approval of TRACG for ESBWR LOCA Analyses in Reference 2, include most recent changes incorporated into Rev. 2 of the DCD; Explain the statement in Reference 3 that a "Total of 5 chimneys to calculate the minimum water level." In the TRACG input decks submitted to the staff and in Figures 6.2-6 and 6.2-7, the core/chimney section is divided into only 3 rings.

The changes made in TRACG nodalization for ESBWR LOCA analyses since the approval of the ESBWR LOCA analyses (Reference 1.5) and Rev. 2 of DCD are discussed in Sections 6A and 6B of DCD Tier 2, Rev. 4 (Reference 1.6).

As indicated in Item #16 of DCD Table 6.2-6a (Summary of ESBWR TRACG Nodalization Changes) in Reference 1.6, two individual chimneys are added besides the three super chimneys representing each of the three rings in the reactor vessel. This addition facilitates calculation of collapsed water levels in individual chimneys.

19. GE needs to submit additional information on the passive containment cooling system (PCCS) vent system demonstrating that it will perform as expected.

The ESBWR PCCS vent system, especially the vent submergence, has been re-evaluated and addressed in another GEH submittal documented in MFN 08-388 (Reference 1.7), which demonstrates that the system would adequately condense steam as required.

20. Describe all design changes since the approval of TRACG for ESBWR LOCA Analyses in Reference 2 and demonstrate that the staff's conclusions would not be altered as a result of these changes.

Table 1 summarizes all design changes that impact the LOCA analysis since the approval of TRACG for ESBWR LOCA analysis (Reference 1.5) through DCD Tier 2, Rev. 5 (Reference 1.10). Items #1 through #18 in the table describe all design changes since the approval of TRACG for ESBWR LOCA analyses (Reference 1.5) through DCD Tier 2, Rev. 2 (Reference 1.9). These were also submitted to the NRC via GEH letter MFN 05-105 (Reference 1.8). Items #19 through #28 in the table describe all design changes since DCD Tier 2, Rev. 2 through Rev. 5. The impacts of these changes on LOCA analyses have been re-analyzed and documented in Sections 6.2 and 6.3 in DCD Rev. 5 (Reference 1.10).

References:

1.1 *GE Hitachi Nuclear Energy, MFN 07-377, Response to Portion of NRC Request for Additional Information Letter No. 96 – Emergency Core Cooling Systems – RAI Number 6.3-79, August 24, 2007.*

1.2 *Jan-Erik Marklund, Swedish Nuclear Power Inspectorate, "Data Comparison for ISP17 An International containment standard problem based on the Marviken full scale experiment Blowdown Number 18," STUDSVIK/NR-84/466, 1984.*

1.3 *Huhtiniemi, Ilpo K., "Condensation in the presence of non-condensable gas: Effect of surface Orientation," Ph. D. Thesis, University of Wisconsin – Madison, 1991.*

1.4 *I. K. Huhtiniemi and M. L. Corradini, "Condensation in the presence of non-condensable gases," Nuclear Engineering and Design, Vol. 141, 429-446, 1993.*

1.5 *GE Nuclear Energy, "TRACG Application for ESBWR," NEDC-33083P-A, Class III, (Proprietary), March 2005, and NEDO-33083-A, Class I (non-proprietary), October 2005.*

1.6 *GE Hitachi Nuclear Energy, ESBWR Design Control Document, Tier 2, Chapter 6, Engineering Safety Features. 26A6642AT, Revision 4, September 2007.*

1.7 *GE Hitachi Nuclear Energy, MFN 08-388, Response to Portion of NRC Request for Additional Information Letter No. 102 – Related to ESBWR Design Certification Application – RAI Number 21.6-102, April 7, 2008.*

1.8 *GE Energy, MFN 05-105, TRACG LOCA SER Confirmatory Items (TAC # MC8168), Enclosure 2 – Major Design Changes from Pre-Application Review Design to DCD Design, October 6, 2005.*

1.9 *GE Nuclear Energy, ESBWR DCD Tier2, Chapter 6, "Engineering Safety Features", Rev. 2, 26A6642AT, November 2006.*

1.10 *GE Hitachi Nuclear Energy, ESBWR DCD Tier2, Chapter 6, " Engineering Safety Features ", Rev. 5, 26A6642AT, May 2008.*

Table 1. Major Design Changes from Pre-Application Review Design to DCD Rev. 5

Item	Parameter	Pre-App. Design (Ref. 1.5)	DCD Rev. 5 Design (Ref. 1.10)	DCD Rev. Posted	Reason for change	Impact on LOCA analysis	Justification for the Applicability of TRACG
1	Core Power, MW	4000	4500	0	Power uprate – improved economics.	Higher core exit and chimney void fraction.	No new phenomena introduced, power density unchanged, selected system capacities increased. TRACG applies to new design.
2	No. of Bundles	1020	1132	0	Increased to maintain power density.	Geometry change, increased shroud diameter.	No new phenomena introduced. TRACG applies to new design.
3	Change in Core Shroud Size	Base	+0.328 m	0	Increased to accommodate additional bundles.	Loss of liquid volume in downcomer (26%). Larger initial level drop.	Additional water sources included in analysis to maintain margin to core uncovery.
4	Core Lattice	F lattice w/ wide blades	N lattice, standard blades	0	Simplification – similar to current BWR cores.	No significant LOCA effect.	No new phenomena introduced. TRACG applies to new design.
5	No. of CRDs	121	269	0	Result of going back to N lattice.	No significant LOCA effect.	No new phenomena introduced. TRACG applies to new design.
6	GDCS Pool and Airspace Location	Wetwell	Drywell	0	Simplification. Additional containment pressure margin not needed.	Tested configuration for SBWR. Loss of containment pressure margin accommodated by reduced suppression pool heatup.	TRACG applicable to both configurations; testing included both.
7	PCCS	4 x 13.5 MW	6 x 11 MW	0	Increased power level.	Percent increase larger than core power increase. Reduces pool heatup.	Heat exchanger consistent with tested prototype. TRACG applicable to the larger number of PCCS units.
8	ICS	4 x 30 MW	4 x 33.75 MW	0	Increased power level.	Maintains 3% capacity.	Tube geometry consistent with prototype, small increase in manifold length. TRACG applicable to the longer IC manifold.
9	Pressure Relief System	12 ADS valves	10 ADS valves + 8 SRV	0	Increased relief capacity.	Minor impact on minimum water level.	TRACG critical flow model is independent of the number of valves; code is applicable to current design.

Item	Parameter	Pre-App. Design (Ref. 1.5)	DCD Rev. 5 Design (Ref. 1.10)	DCD Rev. Posted	Reason for change	Impact on LOCA analysis	Justification for the Applicability of TRACG
10	Containment Vents	10	12	0	Reduced blowdown mass fluxes in vents.	Minor effect on LOCA pressure and temperature.	Reduces vent flow rate, within TRACG application range.
11	Feedwater System		30 sec delay on L2; scram on LOFW; safety grade (1E) FW pump trip on FW line differential pressure.	2	Time delay on L2 to avoid unnecessary isolations and IC initiation when FW available. Early scram on LOFW helps initial level drop. FW pump trip terminates FW pumping additional mass and energy into containment via broken FW line.	Scram on LOFW is a slight benefit for small breaks. FW pump trip has no impact on LOCA analysis because loss of AC power is assumed.	TRACG control system capable of modeling design change.
12	Turbine Bypass Capacity	33%	110% option	0	Flexibility.	No LOCA effect, slight reduction in number of scrams/ year and improved reliability of on-site AC.	TRACG control system capable of modeling design change.
13	PCC Drain Tanks	In drywell	Eliminated; PCCS drains to GDCS pools	0	Simplification.	Tested configuration for SBWR.	TRACG applicable to new configuration.
14	Suppression Pool (SP) Volume	3610 m^3 (127486 ft^3)	4424 m^3 (156232 ft^3)	0	DW/GDCS pool & WW diameter increased to provide improved equipment clearances. Additional benefit: larger suppression pool size.	Reduces pool heatup.	No new phenomena introduced. TRACG code applicable to changed volume.

Item	Parameter	Pre-App. Design (Ref. 1.5)	DCD Rev. 5 Design (Ref. 1.10)	DCD Rev. Posted	Reason for change	Impact on LOCA analysis	Justification for the Applicability of TRACG
15	DW/WW Volume Ratio	1.31	1.33	0	Ratio was not exactly maintained in containment diameter increase.	Small increase in containment pressure.	No new phenomena introduced. TRACG code applicable to changed volume.
16	Spillover Connection (DW Annulus to SP)	Holes	Pipes discharging to SP at elevation of bottom horizontal vent.	2	Enhanced SP mixing.	Reduces pool heatup and wetwell pressure. Pipes are closed until after the RPV blow down to prevent any change in hydrodynamic loads.	No new phenomena introduced. Discharge location consistent with bottom horizontal vent. TRACG code applicable.
17	Lower DW Free Volume to Top of Active Fuel Elevation	1564 m^3 (55232 ft^3)	1190 m^3 (42024 ft^3)	2	Lower drywell volume reduced.	Improved long term LOCA response in bottom drain line and GDCS breaks.	No new phenomena introduced. TRACG code applicable to changed volume.
18	SLCS Activated on ADS	No	Yes	2	Compensate for larger initial level drop	Improves LOCA minimum water level	TRACG models are applicable to liquid flow into bypass.
19	ICS In-Line Vessel	No	One 9m^3 (318 ft^3) each train	3	Improved water level margin for AOO and SBO events.	Use of a single level logic for ECCS initiation. Increased RV water level during LOCA.	No new phenomena introduced. TRACG code applicable to changed volume.
20	SRV Capacity	124 kg/s; 126 kg/s	138 kg/s; 140.2 kg/s	3	In compliance of eighteen SRVs capacity equivalent to 102% rated nuclear boiler capacity.	Minimal impact on containment pressure and RV water level responses.	No new phenomena introduced. TRACG code applicable to increased SRV capacity.
21	Feedwater Isolation Valve Configuration	5 valves per line (1 manually-operated gate valve, 3 in-series check valves, and 1 motor-operated gate valve)	4 process-operated valves per line (2 primary-containment-isolation valves, 2 shutoff valves)	3	Resolved lack of effective isolation in the event of a design basis feedwater line in-containment rupture.	Adds rapid closure of feedwater high-energy line break. Increases RV depressurization rate. Reduces containment pressurization.	No new phenomena introduced. TRACG code applicable to new feedwater-line nodalization.

Item	Parameter	Pre-App. Design (Ref. 1.5)	DCD Rev. 5 Design (Ref. 1.10)	DCD Rev. Posted	Reason for change	Impact on LOCA analysis	Justification for the Applicability of TRACG
22	Containment Drywell-SP Connection	Spillover pipes and float valves	Spillover holes 200 mm (7.87 in) at elevation 12.37 m (40.6 ft). GDCD drain line suction elevation 18.292 m (60 ft).	3	Reducing hot feedwater overflow from DW annulus into SP, with feedwater line isolation.	Reduces peak containment pressure.	No new phenomena introduced. TRACG code applicable.
23	Main Steam Line Changes	Nominal diameter = 700 mm (28 in) upstream of MSIVs; DPVs on Main Steam Line	Nominal diameter = 750 mm (30 in) upstream of MSIVs; DPVs on Isolation Condenser lines	5	Mitigation of the stall condition by reducing average velocity, and eliminating a source for acoustic loads in the Main Steam Line.	Minimal impact on LOCA.	No new phenomena introduced. TRACG code applicable.
24	Turbine Main Steam Piping Diameter	Nominal diameter = 800 mm (32 in)	Nominal diameter = 750 mm (30 in)	5	Optimize mass flow rate through the main steam piping and reduce pressure losses.	Minimal impact on LOCA.	No new phenomena introduced. TRACG code applicable.
25	Main Steam Isolation Valve	28-in (711mm) globe valve	30-in (762mm) gate valve	5	Permitting adjusting the total main steam isolation system pressure drop at rated steam flow.	Minimal impact on LOCA.	No new phenomena introduced. TRACG code applicable to new MSIV configuration.

Item	Parameter	Pre-App. Design (Ref. 1.5)	DCD Rev. 5 Design (Ref. 1.10)	DCD Rev. Posted	Reason for change	Impact on LOCA analysis	Justification for the Applicability of TRACG
26	PCCS Vent Fan	None	One 1-HP, 727 CFM ventilation fan per PCCS vent line ending submerged in GDCD pool operational after 72 hrs.	5	Remove accumulated non-condensable gases in the PCCS tubes to greatly enhance heat transfer rate in the PCCS.	Rapidly reduces containment DW pressure when putting in service at 72 hours after a LOCA.	No new phenomena introduced. TRACG code applicable.
27	Drywell Spray Flow	0.06308 m^3/s (1000 gpm)	0.03533 m^3/s (560 gpm)	5	Optimize containment spray 72 hours after a LOCA.	Controlled depressurization of the DW, when putting in service at 72 hours after a LOCA.	No new phenomena introduced. TRACG code applicable.
28	Crosstie between FAPCS and RWCU	None	Cross-tie from FAPCS suction line to RWCU train A upstream of the non-regenerative heat exchangers	5	Rapidly reduce containment pressure and temperature 7 days after a LOCA.	Controlled depressurization and cooldown of the DW airspace, when putting in service 7 days after a LOCA.	No new phenomena introduced. TRACG code applicable.

Attachment A

TRACG Simulation of International Standard Problem 17 - Marviken Blowdown Test #18

A.1 Summary

The following paragraphs describe the TRACG results in comparison with the Marviken full-scale containment test – International Standard Problem (ISP) 17 (Reference A.1). The purpose is to evaluate the capability of TRACG with respect to:

- Vent clearing transient (Short-term)
- Steam/air transport through vent system (Long-term)
- Containment pressure and temperature responses (Short- and Long -term)

ISP 17 was based on the Marviken Full Scale Experiment Blowdown Test Number 18, which was to study the behavior of a large-scale pressure suppression system under LOCA conditions. The Marviken test facility is converted from a decommissioned nuclear power plant. The large pipe break is located at the bottom of the reactor vessel. The containment is compartmentalized (Figure A-1), and the Drywell (DW) is located on the top of the Wetwell (WW). The DW connects to the WW through four large steel vent pipes connecting to a common header, which in turn connects to 58 vent pipes vertically submerged in the suppression pool. For Test # 18, 28 of these vertical vent pipes were open and the rest of vent pipes were plugged during the test.

In this evaluation, TRACG calculated results are compared with the ISP17 test data. The comparisons consist of two different time frames: short term covers the period from 0 to 4.4 seconds and long term covers the period from 0 to 220 seconds.

The results of comparisons between the TRACG calculations and the measurements are summarized in the following.

1) Vent Clearance: The TRACG results agree very well with the data for the duration of the vent clearing, and the TRACG prediction of the timing of the vent clearance is within [[ ]] second of the measurement.

2) DW, WW, and Header Pressures: For the short-term comparisons, TRACG predictions of the DW, WW, and header pressures are within the error band (±8.1 kPa) of the data. For the long-term comparisons, the TRACG predictions of the peak DW pressure is about [[ ]] higher than the measurement, and the peak header pressure is about [[ ]] higher than the measurement, and the peak WW pressure is about [[ ]] higher than the measurement but well within the error band (±8.1 kPa) of the data.

3) DW and WW Gas (air and steam mixture) and Pool Water Temperatures: For both the short-term and long-term comparisons, TRACG predictions of the DW gas temperature match very well with the data. The predicted long-term WW gas

temperature follows the same trend as the measurement, but the peak is about [[ ]] higher than the measurement. The calculated long-term average Pool temperature agrees well with the measurement, and the calculated peak temperature is about [[ ]] higher than the measurement, which is within the maximum data error bound of ±4.3°C.

4) Air Mass: The calculated total air mass through vents agrees very well with the computed test data. At 160 seconds, the TRACG calculated total air mass is about [[ ]] lower than the computed data, which is about [[ ]] of the initial DW air mass.

5) At the end of the blowdown phase at 160 seconds, the TRACG calculation and computed Marviken data show that there is still a significant amount of air remaining in the DW, about 12% of the initial DW air mass.

In conclusion, the TRACG calculations agree very well with the Markiven test data, taking into consideration of the uncertainties in the measurements. Detail comparisons are presented in Figures A-6 through A-28, and discussions in Section A.5.

A.2 Data Uncertainties

The experimental data accuracies are reported in the form of maximum errors and probable errors. The maximum error calculation applied to the whole data channel with high confidence. Whereas, the probable error is defined as one standard deviation or a confidence level of 68% (Sec. 2.4, Reference A.2). Table A-1 lists the upper bound measurement errors of data documented in Reference A.2.

Table A-1 Data Measurement Errors

Parameter	Maximum Error	Probable Error ($\pm 1\sigma$)
Discharge Mass Flow Rate	± 20%	± 7%
Specific Enthalpy	+3%/-1%	N/A*
Wetwell Air Mass Flow Rate	> ± 6%	± 6%
Wetwell Steam Mass Flow Rate	± 40%	± 15%
Wetwell Water Mass Flow Rate	N/A*	N/A*
Discharge Pipe Pressure	± 90 kPa	± 50 kPa
Containment Pressure	± 8.1 kPa	± 1.2 kPa
Containment DP	± 2.1 kPa	± 2.0 kPa
Containment Temperature	± 4.3°C	± 1°C
Pool Swell Level	N/A*	N/A*
Vent Water Plug Size	N/A*	N/A*

*Note: N/A = Not Available.

A.3 TRACG Simulation Major Assumptions

1) The heat loss from the DW and WW outer walls to the facility environment is neglected.

2) Aluminum heat soakage is assumed to be lump parameter heat slab because in Marviken facility (aluminum is only ~1mm thick). Steel and concrete are assumed to have uniform thickness and are treated as double-sided heat slab in TRACG.

A.4 TRACG Model of Marviken Experiment

Figure A-1 shows the schematic diagram of the Marviken test facility. Figure A-2 shows the TRACG nodalization of the test facility. Table A-2 shows the initial conditions inside the containment (Table A.12, Reference A.2). The nodalization utilizes [[

]]. The nodalization also models the flow paths that connect the various regions. The DW connects to the WW by a vent system (Figure A-1), which consists of four large steel pipes, a header and 58 vertical vent pipes that submerged into the suppression pool. For Test # 18, 28 of these vertical vent pipes were open and the rest of vent pipes were plugged during the test.

The subcompartment numbers labeled in the TRACG nodalization (Figure A-2) are the same as those labeled in the Marviken test facility (Figure A-1). The nodalization for the Marviken test facility closely resembles the containment nodalization for the ESBWR LOCA analyses, consisting of [[

]]. The condensation model (Kuhn-Schrock-Peterson laminar film correlation, Sec. 6.6.11 in Reference A.3) is used in this simulation and consistent with that used in the ESBWR LOCA containment analyses in the DCD (Reference A.4).

The containment geometries, heat structures, and initial conditions are modeled to match those described in Reference A.2. The mass flow rate and enthalpy of the blowdown discharge flow rate documented in Table A.11 of Reference A.2 are used as the input boundary conditions to the TRACG model. In this simulation, the air mass flow rate from the DW through the vertical vent pipes is an internally calculated TRACG output.

A.4.1. Break Flow and Enthalpy

Figures A-3 through A-5 show the break flow rate and enthalpy histories documented in Reference A.2, which are used as input boundary conditions in the TRACG simulation. As shown in the Figures, three distinct blowdown phases can be identified. During the first 1.2 seconds the blowdown was single-phase liquid, and then transitioned into two-phase between 1.2 and 165 seconds, and finally became single-phase steam after 165 seconds. The break flow was discharged into the top of Room # 122.

A.5 TRACG Simulation Results

A.5.1 Short-term Results

The calculated TRACG short-term (0 to 4.4 seconds) results compared with the Marviken test data are given in Figures A-6 through A-15, and discussed in the following sub-sections.

A.5.1.1 Short-term Pressure Results

Figures A-6, A-7, and A-8 show the comparisons of the short-term pressures in the DW (Room 122), header (Room 106), and WW air space (Room 105), respectively. The TRACG pressure calculations follow closely with those of Marviken data. [[

]] The maximum TRACG errors are within the measurement uncertainties of ±8.1 kPa reported for the containment pressure.

The TRACG header pressure calculation in Figure A-7 indicates a pressure oscillation during the initial [[ ]] seconds of the blowdown. This oscillation also shows up in the pressure differences between the DW and header in Figure A-9, and header and WW in Figure A-10. This oscillation could be attributed to the virtual-mass acceleration effect of water in the vent pipe before the vent is cleared. The experimental data in Figure A-9 also show similar oscillations.

A.5.1.2 Short-term Temperature Results

Figures A-11, A-12, and A-13 show the comparisons of the short-term gas (air and steam) mixture temperature in the DW (Room 122), header (Room 106) and WW air space (Room 105), respectively. As shown in Figure A-11, the TRACG DW gas temperature prediction follows closely with the data, well within the maximum data uncertainty of ±4.3°C. As shown in Figure A-12, the TRACG header gas temperature prediction is higher than the test measurement for the first [[ ]] seconds. The test data show a slow increase trend for the first 1.8 seconds, followed by a rapid increase trend. This could be due to water still attached to the temperature probes until the vent pipe cleared of water at 1.3 seconds (Figure A-14). As shown in Figure A-13, the measured WW gas temperature remains almost unchanged during the short-term, while the TRACG prediction indicates a gradual increase starting at [[ ]] seconds. This could be due to *"the heat transfer coefficient for the temperature transducers is quite small up to the vapor break-through the pool water surface at around 3 seconds, thus slowing down the temperature response of the probe"* (P. 45, Reference A.2).

A.5.1.3 Short-term Vent-Clearing Results

Figure A-14 shows the comparison of the average water column height in the vent pipes. The calculated TRACG results agree very well with the measurement for the duration of the vent clearing, and the timing of the vent clearance predicted by TRACG is within [[ ]] second of the measurement. As shown in Figure A-15, the calculated

TRACG pool swell level is in good agreement with the measurement for the first [[ ]] seconds. The calculated TRACG maximum height of 4.8 m (relative to the vent outlet elevation) is reached at [[ ]] seconds as compared to the measured 2.9 seconds. This result is excellent according to Sec. 5.1.17 of Reference A.2, which states:

> *"The bottom of the header, which drastically changes the available cross-sectional area (of the pool), is roughly 4.8 m above the vent pipe outlet (zero point of the level scale). Therefore, not too much attention should be paid to the behavior above that level for the measured data."*

A.5.2 Long-term Results

The calculated TRACG long-term (0 to 220 seconds) results compared with the Marviken test data are given in Figures A-16 through A-28, and discussed in the following sub-sections.

A.5.2.1 Long-term Pressure Results

Figure A-16 shows the comparison of the long-term DW-to-WW pressure difference (Rm. 110-105) results. Between the initial [[ ]] seconds, the TRACG calculated peak pressure difference is about [[ ]] higher than the maximum of measurement. After 60 seconds, the difference between TRACG and measured data gets smaller. Figure A-17 shows the comparison of Header-to-WW air space pressure difference. Between the initial [[ ]] seconds, the calculated TRACG peak pressure difference is about [[ ]] higher than the maximum of measurement. However, between [[ ]] seconds, the calculated pressure difference falls between the measurement maximum and minimum bounds.

Figure A-18 shows the comparison of the long-term DW pressure (Room 110) results. The calculated TRACG peak DW pressure is about [[ ]] higher than the measurement, and closely follows the trend of the measurement. Figure A-19 shows the comparison of the header pressure (Room 106) results (data not available for time < 45 seconds). The calculated TRACG peak header pressure is about [[ ]] higher than that of the measurement. However, the calculated header pressure falls within the maximum bound of the measurement between [[ ]] seconds. Figure A-20 shows the comparison of the WW pressure (Room 105) results. The calculated peak TRACG WW pressure is about [[ ]] higher than that of the measurement and well within the error band (±8.1 kPa) of the data, and follows the same trend as the measurement.

A.5.2.2 Long-term Temperature Results

Figures A-21 through A-24 show the temperature comparisons of the DW (Room 111), header (Room 106), WW air space (Room 105), and Pool, respectively.

As shown in Figure A-21, the calculated DW temperature agrees well with the measurement well within the maximum error of ±4.3°C. The slightly higher DW temperatures predicted by TRACG could be due to the slightly higher predicted air mass trapped in the DW (Figure A-26), thus resulting in less wall condensation heat transfer.

As shown in Figure A-22, the calculated header temperature follows closely with the measurement (peak error of +4°C), barely touching the upper error bound of measured data for the most of the duration.

The calculated TRACG WW gas temperature follows the same trend as the measurement, but is higher than the measurement by as much as [[ ]] as shown in Figure A-23. One possible explanation for the lower measured value is that *"there could also be some delay in the measured data due to slow reaction of probes, and in particular due to water drops attaching to the probes"* (Sec. 5.2.8, Reference A.2).

As shown in Figure A-24, the calculated TRACG average Pool temperature agrees well with the measurement. The calculated peak temperature is about [[ ]] higher than the measured value, which is within the maximum error bound of ±4.3°C.

A.5.2.3 Long-term Wetwell Air and Steam Mass Flow Results

Figures A-25 and A-26 show the comparisons of the air mass flow rate and the total air mass through the vent pipes, respectively. The Marviken data shown on these figures are not actually measured, but computed with the ideal gas law based on the measured pressures and temperatures in the WW gas space and measured pool temperature between 0 and 55 seconds (Sec. 5.2.10, Reference A.2).

As shown in Figure A-26, the predicted total air mass by TRACG agrees very well with the revised Marviken data. At 160 seconds (end of the two-phase blowdown phase), TRACG predicts a significant amount of air still remaining in the DW, about [[ ]] of the initial DW air mass. Data also shows comparable amount of air (12% of initial amount) remaining in the DW.

Figure A-27 shows the comparison of the steam mass flow rate through the vent pipes. As shown, TRACG calculation under-estimates the initial peak steam mass flow rate by about [[ ]]. However, this is within the probable error of 15% (or 1σ) of the measurement. While near the end of blowdown, the calculated steam mass flow rate drops sharply to zero at about [[ ]] seconds later.

Figure A-28 shows the comparison of the total steam mass through the vent pipes. As shown, the calculated TRACG steam mass passing through the vents lags behind the measurement by about [[ ]] seconds. However, at the end of blowdown at 170 seconds, the total steam mass calculated by TRACG matches the measured value very well.

A.6 Conclusions

Extensive comparisons of TRACG simulation results with measured data from the Marviken blowdown test #18 have demonstrated that TRACG is able to predict both the short-term and long-term DW and WW pressure and temperature responses within the data uncertainties for most of the blowdown duration. Furthermore, TRACG is able to predict the vent clearance timing within [[ ]] seconds of measurement.

A.7 References

A.1 *Committee on the Safety of Nuclear Installations, "International Standard Problems (ISP) Brief descriptions (1975-1999)," Nuclear Energy Agency, NEA/CSNI/R(2000)5, March 2000.*

A.2 *Jan-Erik Marklund, Swedish Nuclear Power Inspectorate, "Data Comparison for ISP17 An International containment standard problem based on the Marviken full scale experiment Blowdown Number 18," STUDSVIK/NR-84/466, 1984.*

A.3 *GE Hitachi Nuclear Energy, "TRACG Model Description," NEDE-32176P, Rev. 4, January 2008.*

A.4 *GE Hitachi Nuclear Energy, ESBWR DCD Tier2, Chapter 6, " Engineering Safety Features ", Rev. 5, 26A6642AT, May 2008.*

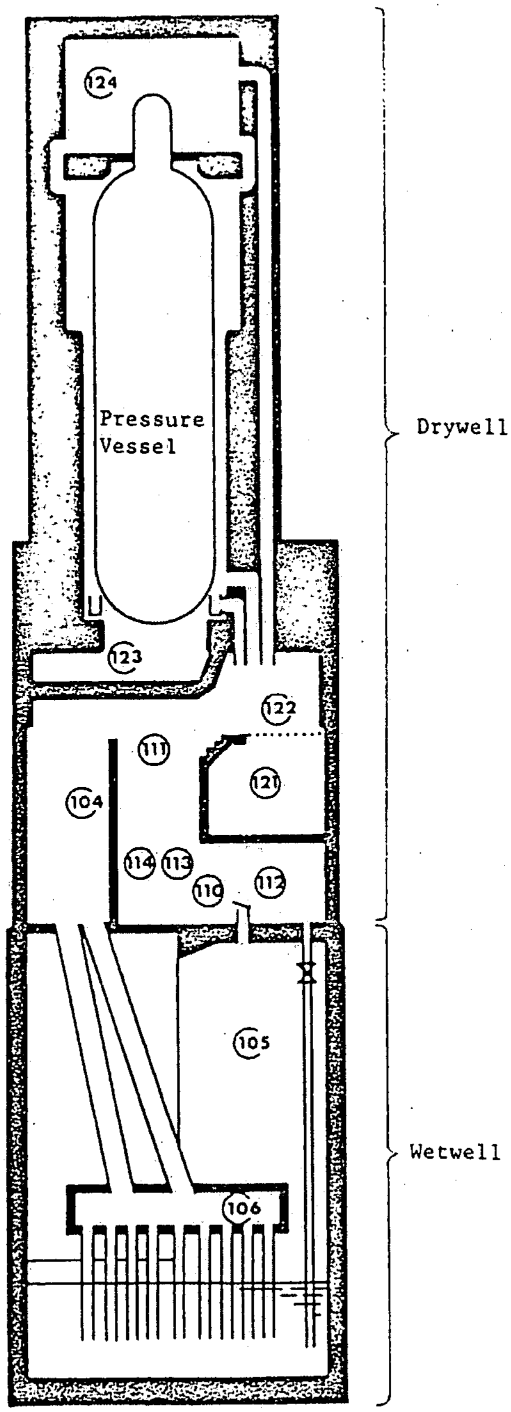

Figure A-1. Schematic of the Marviken Test Facility

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Figure A-2. TRACG Nodalization

Table A-2. TRACG Initial Conditions

Initial Containment Temperature and Pressure						
Compartment	**Color Code**	**Temp (°C)**	**Humidity (g/kg)**	**Initial PA (bar)**	**Initial PV (bar)**	**Initial PN (bar)**
DW AirSpace		61.0	12	0.994	0.051	1.045
DW AirSpace		49.5	9	0.977	0.068	1.045
DW AirSpace		21.9	4	0.904	0.141	1.045
DW AirSpace		19.0	4	0.904	0.141	1.045
POOL		16.0				
WW AirSpace		16.0		1.027	0.018	1.045

PA = partial pressure of air
PV = partial pressure of steam
PN = total pressure of mixture

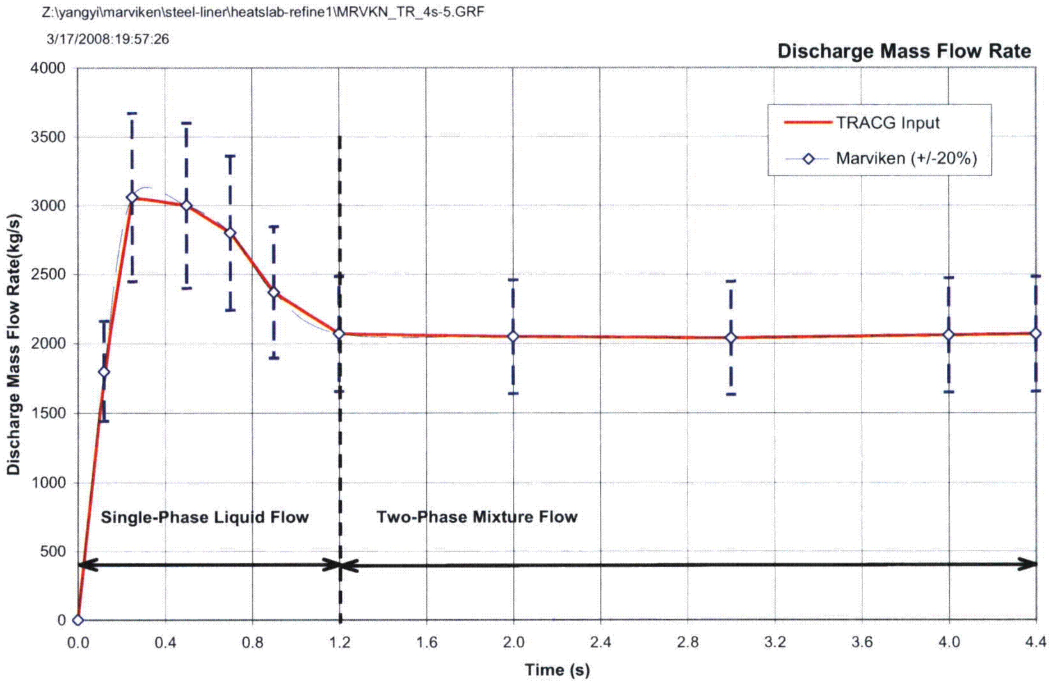

Figure A-3. Break Flow Rate Inputs in TRACG Simulation (4.4s)

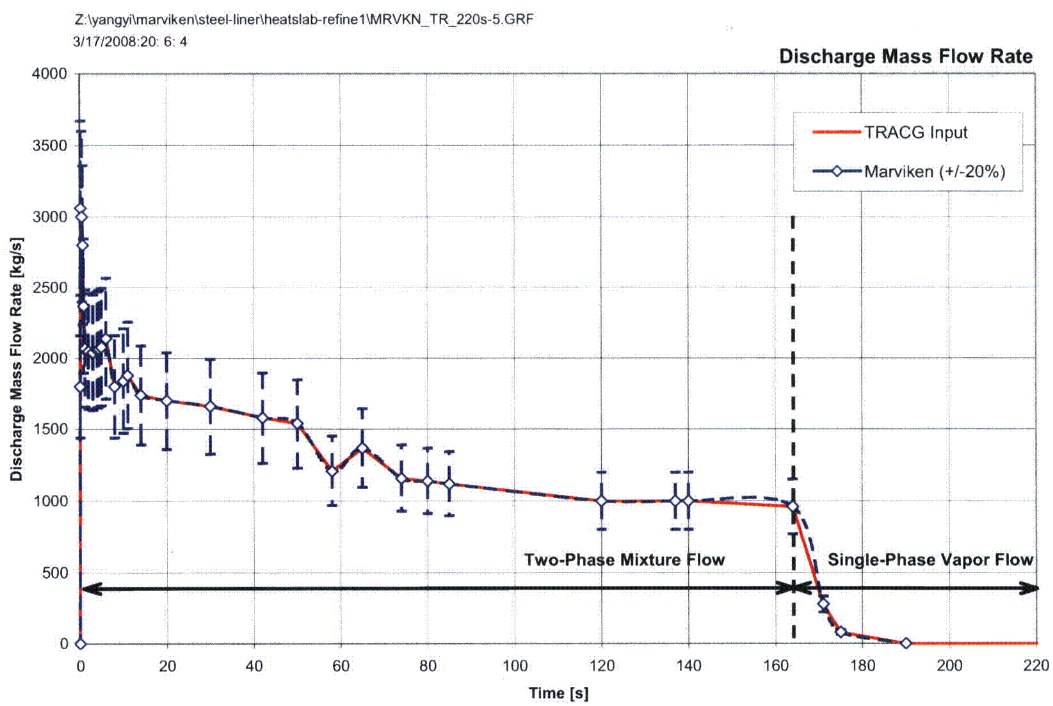

Figure A-4. Break Flow Rate Inputs in TRACG Simulation (220s)

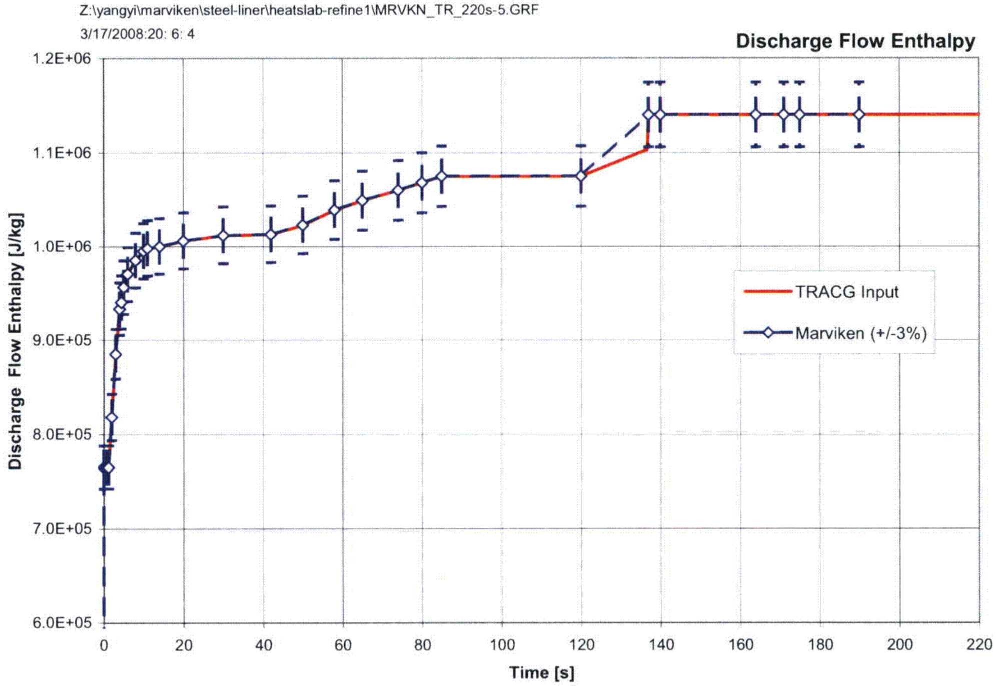

Figure A-5. Break Enthalpy Inputs in TRACG Simulation

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Figure A-6. DW Pressure (Rm. 122) – Short-term

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Figure A-7. Header Pressures (Rm. 106) – Short-term

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Figure A-8. WW Pressures (Rm. 105) – Short-term

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Figure A-9. DW to Header Pressures Difference (Rm. 122-106) – Short-term

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Figure A-10. Header to WW Pressures Difference (Rm. 106-105) – Short-term

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Figure A-11. DW Gas Temperature (Rm. 122) – Short-term

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Figure A-12. Header Gas Temperature (Rm. 106) – Short-term

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Figure A-13. WW Gas Average Temperature (Rm. 105) – Short-term

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Figure A-14. Water Column Height (Vent Clearing) – Short-term

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Figure A-15. Pool Swell Level – Short-term (Reference to Vent Exit Elevation)

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Figure A-16. DW-to-WW Pressure Difference (Rm.110-105) - Long Term

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Figure A-17. Header-to-WW Pressure Difference (Rm.106-105) - Long Term

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Figure A-18. DW Pressures (Rm. 110) - Long Term

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Figure A-19. Header Pressures (Rm. 106) - Long Term

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Figure A-20. WW Pressures (Rm. 105) - Long Term

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Figure A-21. DW Gas Temperatures (Rm. 111) - Long Term

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Figure A-22. Header Gas Temperatures (Rm. 106) - Long Term

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Figure A-23. WW Average Gas Temperatures (Rm. 105) - Long Term

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Figure A-24. Average Pool Temperatures - Long Term

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Figure A-25. Air Mass Flow Rate Through Vents - Long Term

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Figure A-26. Total Air Mass Through Vents - Long Term

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Figure A-27. Steam Mass Flow Rate Through Vents - Long Term

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Figure A-28. Total Steam Mass Through Vents - Long Term

Attachment B

TRACG Evaluation of Steam Condensation in the Presence of Non-condensable Gases

B.1 Summary

TRACG simulation of the University of Wisconsin Flat Plate (WFP) Steam Condensation Experiment in the Presence of Non-Condensable Gases (References B.1 and B.2) has been performed. The scope of comparison is based on the following considerations relevant to the TRACG application to ESBWR post-LOCA containment analysis:

1) The focus is on the experimental data obtained in the vertical position of the test section since the TRACG ESBWR LOCA model treats all condensing surfaces in the containment in the vertical direction. This is justified by the fact that the measured average heat transfer coefficients (HTCs) are not sensitive to the cooling plate inclination angles as shown in Figure B-1 (prepared based on data available in Appendix C, Reference B.1).

2) Two TRACG condensation heat transfer options are used for this evaluation. These are:

   a. Kuhn-Schrock-Peterson (K-S-P) correlation (Reference B.5) modified for Steam Condensation in Containment (Subsection 6.6.11.1 in Reference B.4), i.e., K-S-P correlation with the $f_{1\ shear}$ set equal to 1. We refer to this option as KSP_w.

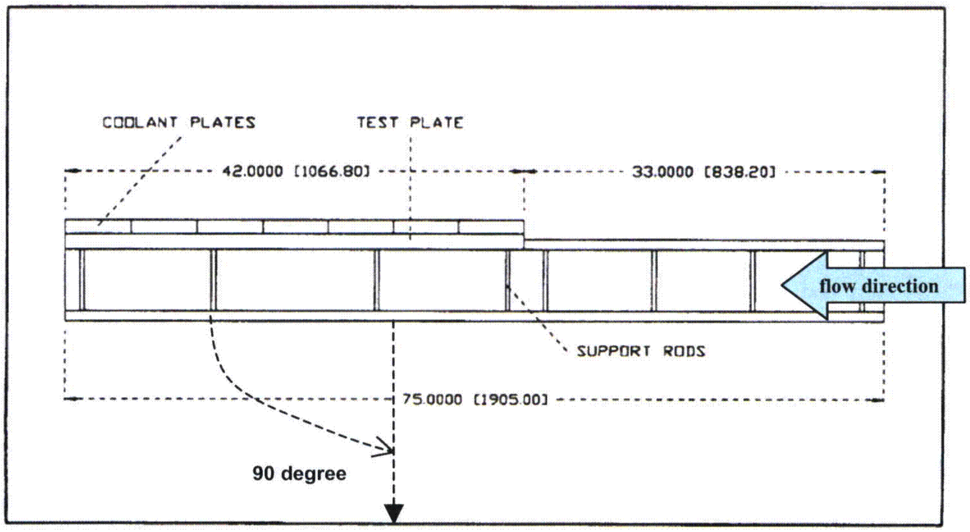
   b. Minimum of "Uchida" correlation (Eq. 6.6-106 in Subsection 6.6.11.1 of Reference B.4) and KSP_w correlation. We refer to this option as Min (Uchida, KSP_w).

Comparison of TRACG-predicted average condensation heat transfer coefficients (HTC) with the experimental values, as presented in Tables B-1 and B-2 shows that TRACG with KSP_w option overpredicts the WFP data by around [[ ]], whereas TRACG with Min (Uchida, KSP_w) option overpredicts the same set of WFP data by around [[ ]]. Sensitivity study performed with these two condensation heat transfer options (KSP_w and Min (Uchida, KSP_w)) shows that the ESBWR post-LOCA peak Drywell (DW) pressure is insensitive to these options. Relevant results of this sensitivity analysis are discussed in Section B.5 of this Attachment. Therefore, use of the KSP_w option is justified for ESBWR post-LOCA containment analyses.

B.2. Introduction

The purpose of this TRACG simulation is to model the Wisconsin Flat Plate Condensation experiment in References B.1 and B.2, and to evaluate the capability of TRACG with respect to predicting the condensation heat transfer coefficient in the presence of non-condensable gases.

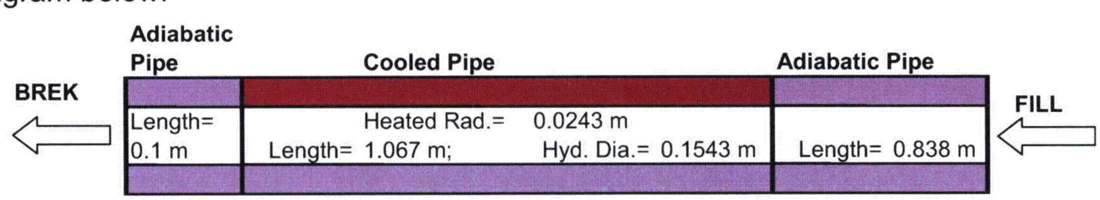
The WFP experiment examined the effects of surface orientation on the condensation of steam in the presence of a non-condensable gas (air). Steam and air mixture flowed downward through a rectangular channel, which is approximately 1.9m long with a cross section 0.154m x 0.154m. The condensation occurred on the inner surface of the top wall of test section. The top plate was made of aluminum and had a painted finish. A schematic diagram of the test section is shown below with British units (inch) and SI units (mm) in brackets. There are seven test stations in the WFP condensation section. TRACG nodalization uses seven cells corresponding to these seven test stations to model the condensation section.



WFP Test Section Schematic

B.3. TRACG Simulation Approach

A one-dimensional TRACG nodalization using the Pipe component was developed to simulate the WFP condensation tests. The TRACG model uses the same geometrical data as in the WFP tests, including the pipe hydraulic diameter, flow area, cooling surface area, and flow channel inclination angle. The flow parameters of incoming air-steam mixture (temperature, air mass ratio, total pressure and velocity) and the boundary conditions used for each TRACG case are the same as those for the test. All test cases simulated with TRACG were conducted at 0.1 MPa pressure. In the TRACG simulation model, the square test section is represented by a series of connected pipes, matching both the flow area and cooled surface area as shown in the nodalization diagram below.



TRACG WFP Nodalization Diagram

The TRACG default KSP condensation model (with f_1_s=1.0) for application to walls without shear enhancement (KSP_w) and the Min (Uchida, KSP_w) options are used for all TRACG cases in this simulation. The KSP_w and Uchida models are described in Section 6.6.11 of Reference B.4.

B.4. Comparisons between TRACG Results and WFP Test Data

The TRACG calculated results and WFP tests are compared and discussed in this section. The comparisons include average heat transfer coefficient, effect of air mass ratio, effect of mixture velocity and local heat transfer coefficient.

B.4.1. Average Heat Transfer Coefficient (HTC) Comparisons

The Heat Transfer Coefficient (HTC) data for WFP tests were measured by both Heat Flux Meters (HFM) and Coolant Energy Balance (CEB) methods. The averaged HTCs can be found in Appendix C of Reference B.1. In Section 6.3 of Reference B.1, it is stated that the discrepancy between the average HTC measured by the HFM method was consistently lower than the CEB by 5-10 percent. Furthermore, Reference B.1 reports the standard error of the HFM to be less than 3 percent, while the accuracy of the CEB measurement was less than 10 percent (Chapter 4, Reference B.1). Therefore, the HFM measurements are used to compare with the calculated TRACG average HTCs.

Two key parameters, which were found to have significant effect on HTC, as reported in Reference B.1, are air-steam mixture velocity and air mass ratio in the mixture. The summary of the measured and predicted average HTC comparisons with effects of air mass ratio and mixture velocity is presented in Tables B-1 and B-2 for two different TRACG options mentioned earlier. It should be noticed that for the Min (Uchida, KSP_w) option, the HTC for pure steam, i.e., air mass ratio of zero (Test Case THERM99), is the same as the KSP_w option; for higher air mass ratio, Min (Uchida, KSP_w) option selects the Uchida correlation. This is due to the nature of Uchida correlation (Equation 6.6-106 of Reference B.4), which goes to "infinity" as the air mass ratio approaches zero or pure steam. The overall comparisons with the test data show that TRACG over-predicts the average HTC for 90-degree angle (or vertical surface) by an average of [[ ]] for KSP_w option and by [[ ]] for the Min (Uchida, KSP_w) option. Comparisons of specific effects are discussed as follows:

B.4.1.1. Mixture Velocity Effect

Figure B-2 shows the effect of mixture velocity (for condensation on vertical surface) for the measured and predicted average HTC. As shown, TRACG, particularly the KSP_w option, predicts the same trend as the measured HTC versus the air-steam mixture velocity. That is, higher mixture velocity results in higher average HTC in both TRACG predictions and test data. This is due to the forced convection effect.

B.4.1.2. Air Mass Ratio Effect

Figures B-3 and B-4 show the effect of air mass ratio for the measured and predicted average HTC. As shown, TRACG predicts (with both options) the same trend as the measured HTC versus the air mass ratio for both 1 m/s and 3 m/s mixture velocities. Both the measured and predicted HTCs decrease rapidly as the air mass ratio increases. This is because the higher air mass concentration near the cooling surface impedes steam condensation on the wall. Also note that Figures B-3 and B-4 show similar trend with respect to the KSP and Uchida correlations as shown in Figure 6-38 of Reference B-4. For ready reference, Figure 6-38 of Reference B-4 is reproduced here as Figure B-5. Please note that at very small air mass ratio, less than ~0.02, the KSP correlation yields lower HTC compared to the Uchida correlation. The opposite is true for higher air mass ratio, greater than ~0.04.

B.4.1.3. Downstream Distance from Entrance Effect

Figure B-6 compares the predicted and the measured local HTCs (for Test Case THERM83) along the flow channel downstream from entrance for vertically oriented channel. Figure B-6 shows:

- TRACG overpredicts the local HTC along the flow channel downstream from entrance. This is consistent with overprediction of average HTC shown in Tables B-1 and B-2 for Test case THERM83.
- TRACG predicts the correct trend of local HTC decreasing along the downstream from entrance.

B.5. TRACG Sensitivity Study for ESBWR Containment Analysis

The effect of Min (Uchida, KSP_w) condensation heat transfer correlation has been studied for long term (72 hours) ESBWR post-LOCA containment analysis. The bounding Main Steam Line Break with one Safety Relief Valve (SRV) failure case, discussed in the DCD (Reference B.3), has been rerun with the Min (Uchida, KSP_w) option and the results have been compared with the DCD results obtained using the KSP_w option with minor difference for film Reynolds number greater than 1000. Figure B-7 shows the comparison between the Drywell (DW) and Wetwell (WW) pressures with these two condensation heat transfer options. The results of both these options are almost identical.

The reason for this very good agreement between the containment pressures for two different options is clear from Figure B-8 where the air mass fractions near the DW wall are plotted. It is seen that after ~2 hours, the air mass fraction stays below 0.01 where the KSP_w correlation yields lower heat transfer coefficients than the Uchida correlation. Therefore, both options, KSP_w and Min (Uchida, KSP_w)), select and use the KSP_w correlation, and so the long-term containment pressures are almost the same for both options. Also, it is clear that even though TRACG simulation of WFP tests (air mass fraction much greater than 0.04) suggests that KSP_w correlation significantly over-predicts the WFP test data, these data are not very relevant to the long-term ESBWR post-LOCA containment analysis because the air mass fraction in the ESBWR DW decreases to a very small value. Most of the non-condensable move to the WW gas space. Therefore, use of the KSP_w correlation or slight modification thereof is justified for ESBWR post-LOCA containment analysis.

B.6. Conclusions

TRACG default (KSP_w) correlation generally over-predicts the WFP test HTC in the presence of non-condensable gas (air mass ratio of 0.24 or greater) for vertical plates by an average of [[ ]]. The agreement is much better, about [[ ]], for a different condensation heat transfer option, namely, Min (Uchida, KSP_w). However, TRACG sensitivity study presented in Section B.5 shows that both options produce almost the same result for the long-term post-LOCA ESBWR containment pressure. This is because during a LOCA in the ESBWR system, most of the non-condensable is displaced to the WW gas space and the non-condensable mass fraction near the DW wall is very small (less than 0.01). Therefore, use of the KSP_w correlation or some small variation thereof is justified for the ESBWR post-LOCA containment analysis. This is also evident from the TRACG simulation results of the Marviken blowdown test #18 presented in Attachment A of this RAI response, which shows that TRACG with the default condensation heat transfer option is able to predict well both the short-term and long-term Drywell and Wetwell pressure and temperature responses.

B.6. References

B.1 I. K. Huhtiniemi, "Condensation In The Presence Of Non-Condensable Gas: Effect of Surface Orientation," Ph. D. Thesis, University of Wisconsin – Madison, August 1991.

B.2 I. K. Huhtiniemi and M. L. Corradini, "Condensation in the presence of non-condensable gases," Nuclear Engineering and Design, Vol. 141, 429-446, 1993.

B.3 GE Hitachi Nuclear Energy, ESBWR DCD Tier2, Chapter 6, " Engineering Safety Features ", Rev. 5, 26A6642AT, May 2008.

B.4 GE Hitachi Nuclear Energy, "TRACG MODEL DESCRIPTION," NEDE-32176P, Rev. 4, January 2008.

B.5 S. Z. Kuhn, V. E. Schrock and P. F. Peterson, "Final Report on U. C. Berkeley Single Tube Condensation Studies," UCB-NE-4201 Rev. 2, August 1994.

Table B-1. Summary of Measured and Predicted **(KSP$_w$)** Average HTCs

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Table B-2. Summary of Measured and Predicted **(Min (Uchida, KSP$_w$))** Average HTCs

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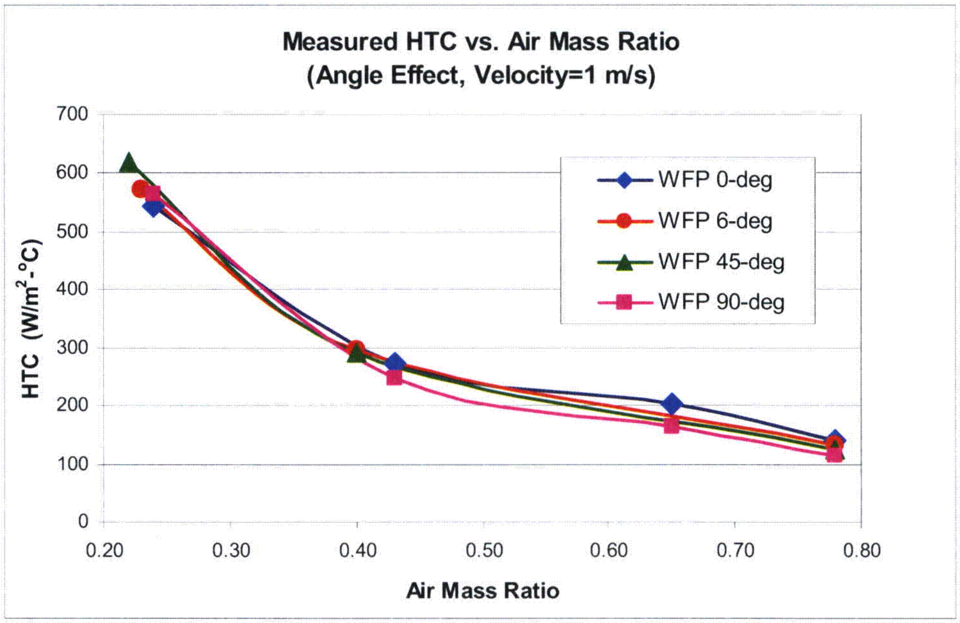

Figure B-1. Measured Average HTC – Effect of Air Mass Ratio and Inclination Angle

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Figure B-2. Average HTC – Effect of Mixture Velocity at Air Mass Ratio of 0.65

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Figure B-3. Average HTC – Effect of Air Mass Ratio at 1 m/s Mixture Velocity

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Figure B-4. Average HTC – Effect of Air Mass Ratio at 3m/s Mixture Velocity

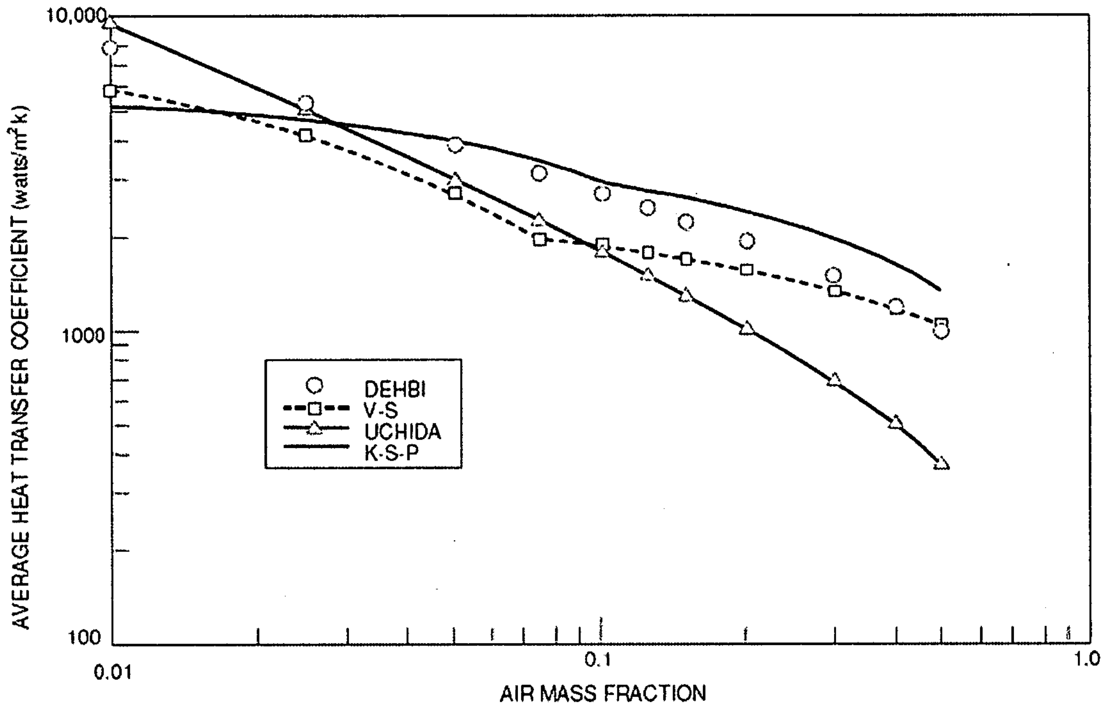

Figure B-5. Comparison of Average Heat Transfer Coefficients Predicted by Four Correlations under Containment Conditions

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Figure B-6. Local HTC (For Test Case THERM83) – Distance from Entrance

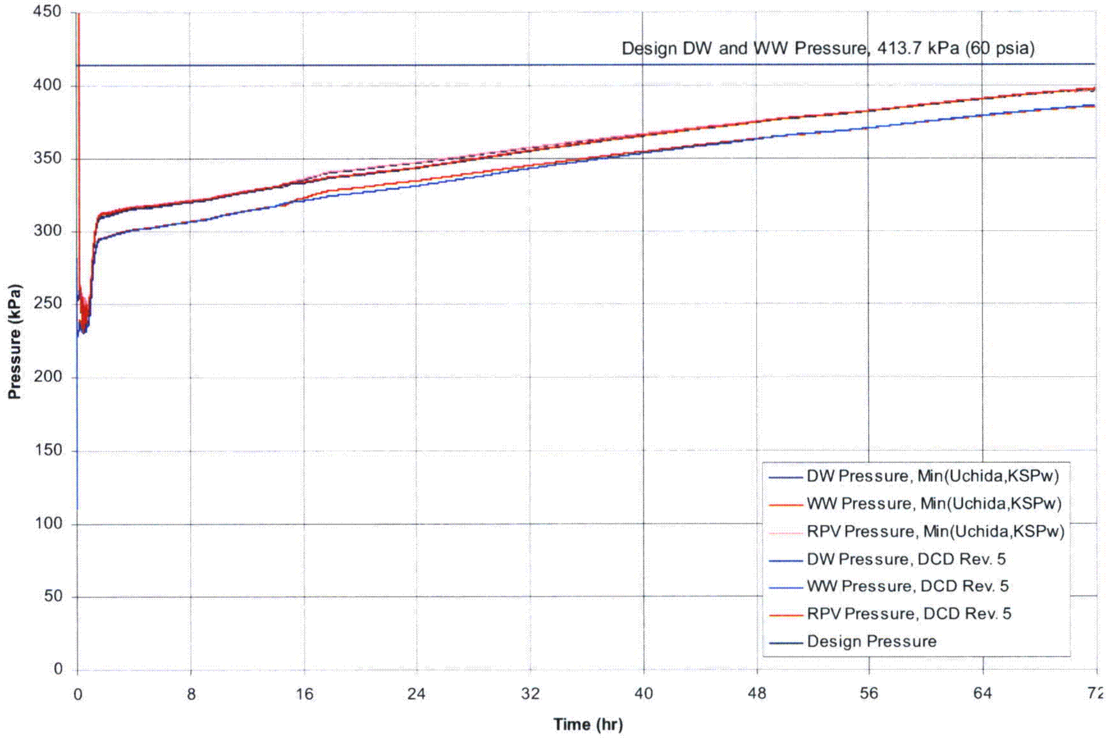

Figure B-7. Comparison of ESBWR Bounding MSLB Containment Pressures for Two Options of Condensation Heat Transfer Correlations.

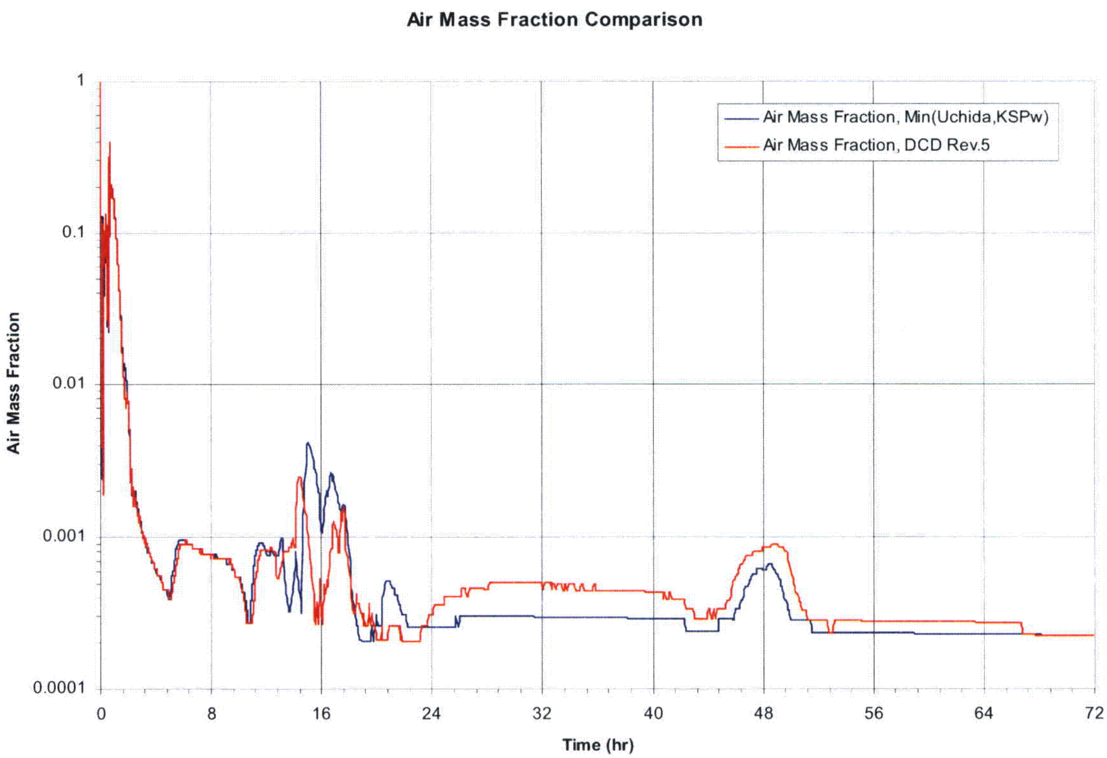

Figure B-8. Comparison of Non-condensable (Air) Mass Fractions in ESBWR Containment (DW) after MSLB for Two different Condensation Heat Transfer Options.

DCD Impact

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

Enclosure 3

MFN 08-545

Response to Portion of NRC Request for

Additional Information Letter No. 85

Related to ESBWR Design Certification Application

RAI Number 21.6-98

Affidavit

Enclosure 3

MFN 08-545

Response to Portion of NRC Request for

Additional Information Letter No. 85

Related to ESBWR Design Certification Application

RAI Number 21.6-98

Affidavit

GE-Hitachi Nuclear Energy LLC

AFFIDAVIT

I, David H. Hinds, state as follows:

(1) I am General Manager, New Units Engineering, GE Hitachi Nuclear Energy ("GEH"), and have been delegated the function of reviewing the information described in paragraph (2) which is sought to be withheld, and have been authorized to apply for its withholding.

(2) The information sought to be withheld is contained in enclosure 1 of GEH's letter, MFN 08-545, Mr. Richard E. Kingston to U.S. Nuclear Energy Commission, entitled "*Response to Portion of NRC Request for Additional Information Letter No. 85 – Related to ESBWR Design Certification Application – RAI Number 21.6-98,*" dated August 29, 2008. The proprietary information in enclosure 1, which is entitled "*MFN 08-545 – Response to Portion of NRC Request for Additional Information Letter No. 85 – Related to ESBWR Design Certification Application – RAI Number 21.6-98 – GEH Proprietary Information,*" is delineated by a [[dotted underline inside double square brackets{3}]]. Figures and large equation objects are identified with double square brackets before and after the object. In each case, the superscript notation {3} refers to Paragraph (3) of this affidavit, which provides the basis for the proprietary determination.

(3) In making this application for withholding of proprietary information of which it is the owner or licensee, GEH relies upon the exemption from disclosure set forth in the Freedom of Information Act ("FOIA"), 5 USC Sec. 552(b)(4), and the Trade Secrets Act, 18 USC Sec. 1905, and NRC regulations 10 CFR 9.17(a)(4), and 2.390(a)(4) for "trade secrets" (Exemption 4). The material for which exemption from disclosure is here sought also qualify under the narrower definition of "trade secret", within the meanings assigned to those terms for purposes of FOIA Exemption 4 in, respectively, Critical Mass Energy Project v. Nuclear Regulatory Commission, 975F2d871 (DC Cir. 1992), and Public Citizen Health Research Group v. FDA, 704F2d1280 (DC Cir. 1983).

(4) Some examples of categories of information which fit into the definition of proprietary information are:

a. Information that discloses a process, method, or apparatus, including supporting data and analyses, where prevention of its use by GEH's competitors without license from GEH constitutes a competitive economic advantage over other companies;

b. Information which, if used by a competitor, would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing of a similar product;

c. Information which reveals aspects of past, present, or future GEH customer-funded development plans and programs, resulting in potential products to GEH;

d. Information which discloses patentable subject matter for which it may be desirable to obtain patent protection.

The information sought to be withheld is considered to be proprietary for the reasons set forth in paragraphs (4)a. and (4)b. above.

(5) To address 10 CFR 2.390(b)(4), the information sought to be withheld is being submitted to NRC in confidence. The information is of a sort customarily held in confidence by GEH, and is in fact so held. The information sought to be withheld has, to the best of my knowledge and belief, consistently been held in confidence by GEH, no public disclosure has been made, and it is not available in public sources. All disclosures to third parties, including any required transmittals to NRC, have been made, or must be made, pursuant to regulatory provisions or proprietary agreements which provide for maintenance of the information in confidence. Its initial designation as proprietary information, and the subsequent steps taken to prevent its unauthorized disclosure, are as set forth in paragraphs (6) and (7) following.

(6) Initial approval of proprietary treatment of a document is made by the manager of the originating component, the person most likely to be acquainted with the value and sensitivity of the information in relation to industry knowledge, or subject to the terms under which it was licensed to GEH. Access to such documents within GEH is limited on a "need to know" basis.

(7) The procedure for approval of external release of such a document typically requires review by the staff manager, project manager, principal scientist, or other equivalent authority for technical content, competitive effect, and determination of the accuracy of the proprietary designation. Disclosures outside GEH are limited to regulatory bodies, customers, and potential customers, and their agents, suppliers, and licensees, and others with a legitimate need for the information, and then only in accordance with appropriate regulatory provisions or proprietary agreements.

(8) The information identified in paragraph (2) above is classified as proprietary because it contains the results of TRACG analytical models, methods and processes, including computer codes, that GEH has developed and applied to ESBWR containment response evaluations. GEH has developed this TRACG code for over fifteen years, at a significant cost. The reporting, evaluation and interpretation of the results, as they relate to the containment response evaluations for the ESBWR was achieved at a significant cost to GEH

(9) Public disclosure of the information sought to be withheld is likely to cause substantial harm to GEH's competitive position and foreclose or reduce the availability of profit-making opportunities. The information is part of GEH's comprehensive BWR safety and technology base, and its commercial value

extends beyond the original development cost. The value of the technology base goes beyond the extensive physical database and analytical methodology and includes development of the expertise to determine and apply the appropriate evaluation process. In addition, the technology base includes the value derived from providing analyses done with NRC-approved methods.

The research, development, engineering, analytical and NRC review costs comprise a substantial investment of time and money by GEH.

The precise value of the expertise to devise an evaluation process and apply the correct analytical methodology is difficult to quantify, but it clearly is substantial.

GEH's competitive advantage will be lost if its competitors are able to use the results of the GEH experience to normalize or verify their own process or if they are able to claim an equivalent understanding by demonstrating that they can arrive at the same or similar conclusions.

The value of this information to GEH would be lost if the information were disclosed to the public. Making such information available to competitors without their having been required to undertake a similar expenditure of resources would unfairly provide competitors with a windfall, and deprive GEH of the opportunity to exercise its competitive advantage to seek an adequate return on its large investment in developing and obtaining these very valuable analytical tools.

I declare under penalty of perjury that the foregoing affidavit and the matters stated therein are true and correct to the best of my knowledge, information, and belief.

Executed on this 29th day of August 2008.

David H. Hinds
GE-Hitachi Nuclear Energy LLC