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Serial: NPD-NRC-2014-014
May 5, 2014

10 CFR 52.79

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555-0001

LEVY NUCLEAR PLANT, UNITS 1 AND 2
DOCKET NOS. 52-029 AND 52-030
PARTIAL RESPONSE TO NRC RAI LETTER 116 – SRP SECTIONS 6.3 AND 15.2.6

References:
1. Letter from Donald Habib (NRC) to Christopher M. Fallon (DEF), dated March 6, 2014, "Request for Additional Information Letter No. 116 Related to SRP Sections 6.3 and 15.2.6."
2. Letter from Christopher M. Fallon (DEF) to Nuclear Regulatory Commission (NRC), dated April 17, 2014, "Partial Response to NRC RAI Letter 116 – SRP Sections 6.3 and 15.2.6," Serial: NPD-NRC-2014-012

Ladies and Gentlemen:

Duke Energy Florida, Inc. (DEF) hereby submits a partial response to the Nuclear Regulatory Commission's (NRC) request for additional information (RAI) cited in Reference 1.

Enclosure 1 to this letter contains DEF's partial response consisting of responses to RAI Questions 06.03-1 and 06.03-6. Attachment A to Enclosure 1 contains the proprietary version of the response and Attachment B to Enclosure 1 contains a redacted, non-proprietary version of the response. Responses to questions provided previously are contained in Reference 2.

As Attachment 1 to Enclosure 1 contains information proprietary to Westinghouse Electric Company, LLC, this enclosure is supported by an affidavit signed by Westinghouse, the owner of the information. The affidavit sets forth the basis on which the information may be withheld from public disclosure by the Commission and addresses with specificity the considerations listed in paragraph (b)(4) of Section 2.390 of the Commission's regulations. Accordingly, DEF respectfully requests that the information (Attachment A to Enclosure 1) which is proprietary to Westinghouse be withheld from public disclosure in accordance with 10 CFR Section 2.390 of the Commission's regulations.

Westinghouse's Application for Withholding Proprietary Information from Public Disclosure CAW-14-3907 and accompanying Affidavit, and Proprietary Information Notice and Copyright Notice are provided as Enclosure 2 and Enclosure 3 respectively.

If you have any further questions, or need additional information, please contact Bob Kitchen at (704) 382-4046, or me at (704) 382-9248.

D094
NRO

I declare under penalty of perjury that the foregoing is true and correct.

Executed on May 5, 2014

Sincerely,

for

Christopher M. Fallon
Vice President
Nuclear Development

Enclosures/Attachments:

1. Levy Nuclear Plant Units 1 and 2 (LNP) Response to NRC Request for Additional Information Letter No. 116 Related to SRP Sections 06.03 and 15.02.06 for the Combined License Application, Dated 03/06/2014
   A. Responses to NRC RAIs 06.03-1 and 06.03-6 on Condensate Return Licensing Submittal (Proprietary)
   B. Responses to NRC RAIs 06.03-1 and 06.03-6 on Condensate Return Licensing Submittal (Nonproprietary)
2. Westinghouse Application Letter CAW-14-3907 and Affidavit
3. Proprietary Information Notice and Copyright Notice

cc: U.S. NRC Region II, Regional Administrator
Mr. Donald Habib, U.S. NRC Project Manager

**Levy Nuclear Power Plant Units 1 and 2
Response to NRC Request for Additional Information Letter No. 116 Related to SRP Sections 06.03 and 15.02.06 for the Combined License Application, dated March 6, 2014**

NRC RAI #	Duke Energy RAI #	Duke Energy Response
15.02.06-1	L-1081	Future Response
15.02.06-2	L-1082	Future Response
15.02.06-3	L-1085	Future Response
06.03-1	L-1086	Response enclosed – see following pages
06.03-2	L-1087	Future Response
06.03-3	L-1088	Future Response
06.03-4	L-1089	Future Response
06.03-5	L-1090	Future Response
06.03-6	L-1091	Response enclosed – see following pages
06.03-7	L-1092	NPD-NRC-2014-012, dated April 17, 2014
06.03-8	L-1093	NPD-NRC-2014-012, dated April 17, 2014
06.03-9	L-1094	Future Response

NRC Letter No.: LNP-RAI-LTR-116

NRC Letter Date: March 6, 2014

NRC Review of Section 06.03 - Emergency Core Cooling System

NRC RAI #: 06.03-1

Text of NRC RAI:

Levy submittal dated February 7, 2014, states that "Containment Response Analysis for the Long Term PRHR Operation," APP-PXS-M3C-071, Revision 1, was used to quantify condensate losses associated with the following thermodynamic phenomena during containment recirculation:

- Losses due to condensation on passive heat sinks
- Mass of steam which remains in the containment free volume
- Losses due to containment leakage

The submittal also states that APP-PXS-M3C-071 analyzed the following input and boundary conditions:

- Heat Input to the PRHR HX
- PCS flow, PCS water temperature, PCS water coverage
- Containment vessel heat transfer rates
- PCS actuation time
- IRWST water level, water temperature
- Containment initial pressure, temperature, relative humidity
- Mass of the heat sinks inside the containment

However, the submittal itself does not describe how each of the above phenomena was modeled and what values were used for the input and boundary conditions. For the staff to make a safety determination on PRHR heat exchanger with respect to General Design Criteria 34 of 10 CFR Part 50, Appendix A, please provide the following regarding APP-PXS-M3C-071 as response to this RAI:

a. Complete listing of important phenomena modeled. For example, the effect of steaming from reactor vessel bottom head by condensate accumulated in the reactor vessel cavity was credited but not noted in the submittal.
b. Description of phenomena and methodology used to analyze the phenomena.
c. Values of input and boundary conditions and justification of the values used. Important assumptions used and their justification.
d. Results of the calculations.

DEF RAI ID #: L-1086

DEF Response to NRC RAI:

See Attachment A for the proprietary version of the response to NRC RAIs 06.03-1and 06.03-6.

See Attachment B for the nonproprietary, redacted version of the response to NRC RAIs 06.03-1 and 06.03-6.

Associated LNP COL Application Revisions:

None

Attachments/Enclosures to Response to NRC:

A. Proprietary version of response to RAIs 06.03-1 and 06.03-6

B. Nonproprietary version of response to RAIs 06.03-1 and 06.03-6

NRC Letter No.: LNP-RAI-LTR-116

NRC Letter Date: March 6, 2014

NRC Review of Section 06.03 - Emergency Core Cooling System

NRC RAI #: 06.03-6

Text of NRC RAI:

The transient return rate of condensate to the IRWST used in APP-SSAR-GSC-536 ("AP1000 Safe Shutdown Temperature Evaluation"), Revision 2, seems to indicate an asymptotic long term return rate of 0.7662, while the values used in the APP-PXS-M3C-020 ("PRHR Sizing/Performance"), Revision 3, calculation indicate a long term return rate of 0.824. Justify the discrepancy between the two and explain the exact nature of the transient return rates used in the APP-PXS-M3C-020 calculation ("PRHR Sizing/Performance").

DEF RAI ID #: L-1091

DEF Response to NRC RAI:

See Attachment A for the proprietary version of the response to NRC RAIs 06.03-1 and 06.03-6.

See Attachment B for the nonproprietary, redacted version of the response to NRC RAIs 06.03-1 and 06.03-6.

Associated LNP COL Application Revisions:

None

Attachments/Enclosures to Response to NRC:

A. Proprietary version of response to RAIs 06.03-1 and 06.03-6

B. Nonproprietary version of response to RAIs 06.03-1 and 06.03-6

Serial: NPD-NRC-2014-014
Attachment B to Enclosure 1 (Nonproprietary)
(30 pages including cover page)

Responses to NRC RAIs 06.03-1 and 06.03-6 on Condensate Return

(Nonproprietary)

NRC RAI #: 06.03-1
Text of NRC RAI:

Levy submittal dated February 7, 2014, states that "Containment Response Analysis for the Long Term PRHR Operation," APP-PXS-M3C-071, Revision 1, was used to quantify condensate losses associated with the following thermodynamic phenomena during containment recirculation:

- *Losses due to condensation on passive heat sinks*
- *Mass of steam which remains in the containment free volume*
- *Losses due to containment leakage*

The submittal also states that APP-PXS-M3C-071 analyzed the following input and boundary conditions:

- *Heat Input to the PRHR HX*
- *PCS flow, PCS water temperature, PCS water coverage*
- *Containment vessel heat transfer rates*
- *PCS actuation time*
- *IRWST water level, water temperature*
- *Containment initial pressure, temperature, relative humidity*
- *Mass of the heat sinks inside the containment*

However, the submittal itself does not describe how each of the above phenomena was modeled and what values were used for the input and boundary conditions. For the staff to make a safety determination on PRHR heat exchanger with respect to General Design Criteria 34 of 10 CFR Part 50, Appendix A, please provide the following regarding APP-PXS-M3C-071 as response to this RAI:

a. *Complete listing of important phenomena modeled. For example, the effect of steaming from reactor vessel bottom head by condensate accumulated in the reactor vessel cavity was credited but not noted in the submittal.*
b. *Description of phenomena and methodology used to analyze the phenomena.*
c. *Values of input and boundary conditions and justification of the values used. Important assumptions used and their justification.*
d. *Results of the calculations.*

Response

1.0 Introduction

The **AP1000**®[1] passive residual heat removal (PRHR) heat exchanger is designed to transfer energy from the reactor coolant system (RCS) to the sub-cooled water in the in-containment refueling water storage tank (IRWST). The PRHR will be actuated following a complete loss of alternating current (station blackout event) at the site. The IRWST water temperature will slowly increase due to sensible heat addition. After several hours, unless ac power is restored, the water in the IRWST will eventually reach the saturation temperature and pool boiling will begin around the PRHR heat exchanger. The steam release from the IRWST will cause the containment pressure and temperature to slowly increase. Unless ac power is restored, the Hi-2 containment pressure signal will eventually be actuated, the passive containment cooling system (PCS) valves will open, and gravity driven, sub-cooled water will begin to flow from the passive containment cooling water storage tank (PCCWST) onto the surface of the containment shell. Evaporation of this water will provide cooling for the containment and mitigate the event. A large fraction of the steam that is released from the IRWST will condense on the containment shell and be directed back to the IRWST by the condensate return flow paths. This will extend the time that the IRWST is able to remain an effective heat sink for the RCS.

The **AP1000** containment response for long-term PRHR operation was required to support the condensate return rate study. The containment model provided some of the input and boundary conditions for downstream calculations. The purpose of the containment model was to quantify the amount of IRWST water lost due to: condensation on the passive heat sinks, steam remaining in the containment free volume, and steam lost due to containment leakage.

The **AP1000** containment response for long-term PRHR operation following a station blackout with a loss of main feedwater event is documented in calculation APP-PXS-M3C-071. The request for additional information asks for the following information from the containment response calculation:

a) A complete listing of important phenomena modeled,
b) A description of phenomena and methodology used to analyze the phenomena,
c) Values of input and boundary conditions and justification of the values used,
d) Important assumptions used and their justification, and
e) Results of the calculations.

A description of the transient scenario, along with the phenomena that needed to be modeled for the containment response, is provided in Section 2.0. The important modeling assumptions for these analyses are also described in Section 2.0. The WGOTHIC® **AP1000** containment evaluation model is acceptable for modeling many of the phenomena; however, the model

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[1] **AP1000** and WGOTHIC are trademarks or registered trademarks of Westinghouse Electric Company LLC, its affiliates and/or its subsidiaries in the United States of America and may be registered in other countries throughout the world. All rights reserved. Unauthorized use is strictly prohibited. Other names may be trademarks of their respective owners.

needed to be modified to address several new phenomena for these analyses. A description of the new phenomena and the methodology that is used to analyze them is provided in Section 3.0. Sections 4.0, 5.0 and 6.0 describe other model input changes that were made to conservatively model the PCS and internal containment heat sinks for these analyses. Section 7.0 describes the sensitivity cases that were made to identify conservative containment initial conditions for these analyses. Finally, Section 8.0 describes the results of the containment response calculations.

2.0 Scenario Description and Phenomena Identification

The following scenario and phenomena were considered in the containment response analysis for the station blackout with long-term PRHR operation event:

1) Heat will be transferred from the PRHR heat exchanger to the water in the IRWST. The IRWST water level will increase as the temperature slowly increases. Depending on the initial IRWST water level, some water may flow through the overflow vents into the refueling cavity during this sensible heating period. Safety grade drains from the refueling cavity will allow this water to flow down to a sump in the lower west steam generator compartment. The steam generator (SG) compartment sump drains to the reactor coolant drain tank (RCDT) sump.
2) Eventually, the IRWST will begin to boil and steam will be released to the containment atmosphere through the vents that are located above the operating deck. Prior to IRWST steaming, most internal containment heat sink surfaces are at a subcooled temperature. After the IRWST begins to boil, some of the steam will condense on the surfaces of these subcooled heat sinks. A condensate film will build up on these surfaces and some will eventually fall to the operating deck floor.
3) The containment pressure will slowly increase as the PRHR heat exchanger (HX) continues to boil water from the IRWST.
4) Some of the steam that is released above the operating deck will condense on the cold containment shell. Some of this condensate will return to the IRWST, but a fraction of it will fall down from the shell on to the operating deck floor or other **AP1000** components. Large openings on the operating deck allow some of the subcooled condensate to drain from the operating deck to the compartments below.
5) Prior to PCS actuation, condensation on the containment shell and internal heat sinks only occurs in the region above the operating deck. After PCS actuation, the negatively buoyant plume of air and steam, which is formed by cooling of the containment shell, may be able to penetrate the region below the operating deck. This would allow some of the steam to condense on the heat sinks that are located below the operating deck. The steam would mainly condense on the heat sinks that are located in the core makeup tank (CMT) compartment.
6) Eventually, the condensation rate (primarily on the containment shell) will exceed the steaming rate and containment pressure will slowly decrease.
7) Due to the limited number of openings on the CMT floor, the compartments below the operating deck will develop a stratified atmosphere, limiting the condensation rates in the compartments below the CMT floor.

a. There are a limited number of openings through the CMT floor to the compartments below. The largest opening is the vertical access area (VAA) that is above the RCDT room. The condensate from above the operating deck that accumulates on the CMT floor and the condensation on the heat sinks in the CMT compartment will naturally drain into the sump pits first, then through the VAA and into the RCDT room. Note, the openings to the passive core cooling system (PXS) and chemical and volume control system (CVS) compartments are surrounded by curbs to prevent water from flowing down into them.

8) As the RCDT room fills with water, an opening between the RCDT room and the Reactor Cavity will allow the subcooled condensate to flow into the Reactor Cavity.
9) As the water level in the Reactor Cavity increases, the subcooled condensate will eventually come in contact with the Reactor Vessel. Since the temperature of the RCS is always higher than the temperature of the subcooled condensate, the water in the Reactor Cavity will start to boil.
10) Steam generated by boiling on the outside of the Reactor Vessel can exit the Reactor Cavity to either the SG compartment or the CMT compartment. The opening from the reactor cavity to the CMT compartment is a much smaller and more torturous path for the steam; therefore, most of the steam will go to the SG compartment. The flow of steam through the CMT compartment and SG Rooms will improve the mixing of the atmosphere below the operating deck.
11) As long as the heat sinks located in the CMT compartment and steam generator rooms are not saturated, some of the steam from the Reactor Cavity will condense on them. The remaining steam will return to the containment volume above the operating deck.
12) After all of the internal heat sinks are saturated, including the containment shell in the middle annulus below the operating deck, steam from the Reactor Cavity will be able to return to the containment volume above the operating deck and condense on the containment shell.
13) Throughout the transient, some of the steam and air from the containment volume will be lost to the environment due to leakage. This will slowly reduce the amount of water inside containment.

3.0 Containment Modeling Considerations

The approach for the long-term PRHR operation containment response analyses was to calculate a conservative minimum condensate return rate to the IRWST while maintaining a relatively high containment backpressure for the RCS model. The condensate return rate was reduced by removing a portion of the condensate from the PCS shell (due to splashing and spilling) and by increasing the condensation rate to the internal heat sinks. The condensation rate to the internal heat sinks was increased by increasing the heat transfer areas and reducing the initial temperature inside containment.

This containment analysis was performed with both design basis accident (DBA) and better estimate (BE) conditions to determine the effect on the transient response. The modeling assumptions and initial conditions that were selected for this analysis are shown in Table 1. The bases for these values are described later. The modeling assumptions for the BE cases attempt to use nominal operating conditions with nominal heat and mass transfer coefficients. The modeling assumptions for the DBA cases attempt to conservatively address uncertainties. The DBA modeling assumptions attempt to:

1. Minimize the condensation rate on the containment shell (delay PCS flow initiation, use evaporation limited PCS flow rate, use minimum initial coverage area, reduce heat transfer coefficients, increase PCS water temperature),
2. Maximize the condensation rate on internal heat sinks (increase heat sink volume, reduce initial containment temperatures),
3. Maximize the steaming rate from the IRWST (increase decay heat rate, increase initial power, reduce initial IRWST inventory) and,
4. Maximize containment pressure (increase initial pressure, decrease initial humidity, increase external temperature).

Table 1 – Initial Conditions and Modeling Assumptions for Condensate Return Analyses		
Parameters	**DBA Containment Response**	**BE Containment Response**
PCS - water flow	Min water flow, evaporation limited	BE water flow, evaporation limited
- initial water coverage	[ ]a,c [ ]a,c	[ ]a,c [ ]a,c
- initial water temperature	120°F	85°F
- CV heat transfer rates	[ ]a,c	[ ]a,c
PCS actuation	Safety Analysis Limit [ ]a,c with 400 sec or more water coverage delay	Nominal setpoint [ ]a,c with 400 sec or more water coverage delay
Decay heat – uncertainty	+ 2 sigma	0 sigma
- reactor power before trip	101%	100%
IRWST – initial level	Min tech spec level, 73,100 ft^3 (2)	Nominal level, 74,389 ft^3
- initial temperature	85°F (1)	85°F
- water below HX	Not included (1)	Included
Containment – initial pressure	15.7 psia	14.7 psia
- initial air / heat sink temp	85°F (1)	85°F
- initial humidity	0%	20%
Containment Heat Sinks Included		
- above operating deck	[ ]a,c	[ ]a,c
- below operating deck – from elevation 107.17 to 135.25 ft	[ ]a,c	[ ]a,c
Metallic heat sinks volume multiplier	[ ]a,c	[ ]a,c
Concrete heat sinks volume multiplier	[ ]a,c	[ ]a,c
Uchida heat transfer coefficient multiplier	[ ]a,c	[ ]a,c
Middle annulus initial air temperature (1)	85°F	85°F
Outside temperature	115°F	80°F
PXS Condensate Spill fraction (1)	[ ]a,c	[ ]a,c
Reactor Vessel Temperature (1)	LOFTRAN Conservative results	LOFTRAN BE results
Surface Area	[ ]a,c	[ ]a,c
Heat Transfer Coeff	WGOTHIC film boiling	WGOTHIC film boiling

(1) This represents a change from the **AP1000** peak containment pressure design basis evaluation model.

(2) The water volume below the PRHR heat exchanger is excluded to further reduce the time to boil.

Table 1 summarizes the modifications that were made to the WGOTHIC **AP1000** containment evaluation model assumptions to analyze the long-term PRHR operation. This model is normally used to calculate the peak containment pressure for loss of coolant accident (LOCA) and main steam line break (MSLB) events. Many of the phenomena that are required to be considered for the peak containment pressure analysis are the same as those required for the analysis of the station blackout with long-term PRHR operation event. The model implements conservative biases for the containment volumes, heat sink areas, heat transfer coefficients, passive containment cooling system (PCS) flow rates, water coverage areas, and environmental conditions with respect to the calculation for peak containment pressure. This provides a high level of confidence that the results of the peak pressure calculations will bound the actual plant performance during these events.

As shown in Table 1, two constant condensate spill rates – a lower bounding [ ]^{a,c} and an upper bounding [ ]^{a,c} – from the containment shell will be assumed to determine the effect on the transient response. Based on preliminary calculations, the actual condensate spill rate was predicted to be within this range.

The noding structure in the WGOTHIC **AP1000** containment model could affect the modeling of circulation and stratification within containment. The relevant test data for circulation and stratification was reviewed and the applicability of this data for modeling this event was evaluated. The noding structure for modeling circulation and stratification within containment was determined to be acceptable for the analysis of this event.

There could be a significant amount of heat transfer from the inactive metal in the reactor vessel upper head, pressurizer and tops of the steam generators to the containment atmosphere over the long-term transient simulation. Steam generation by water dripping on these sources could increase the condensate return rate; but has been neglected for this analysis. However, steaming from the outside of the lower reactor vessel head has been considered for this application because it has a significant impact on the long-term condensate return rate and steam/air mixing within containment.

A large number of weld plates are attached to the inside surface of the containment shell. [ ]^{a,c} The effects of these weld plates on the condensation heat and mass transfer through the containment shell has not been considered in this analysis. An evaluation has shown that a reduction in the shell area equivalent to the plate area results in a negligible effect on the calculated containment pressure and temperature.

The polar crane girder is constructed from a series of open faced boxes that are welded to the containment shell. The condensate return features (the proposed downspout network) are designed to collect the condensate from the inside of these boxes and return it to the IRWST. The condensate on the surface of the shell within the boxes is considered, but all of the condensate on the polar crane girder itself is assumed to fall to the operating deck in this analysis. The rate of heat conduction through the polar crane girder to the containment shell was found to be negligible when compared with the total condensation rate on the shell.

Therefore, conduction between the polar crane girder and the shell, and between the internal stiffener ring and the shell have been ignored in this analysis.

4.0 Containment Model Modifications Required for this Application

The WGOTHIC **AP1000** containment evaluation model was modified for use in the long-term PRHR operation analyses. Based on the transient scenario described in Section 2.0, the following new phenomena were considered for the long-term PRHR operation analyses:

- IRWST water level and heat addition,
- IRWST overflow and steam release to containment,
- Condensate losses from the containment shell,
- Condensate flood up and water holdup,
- Containment leakage,
- Steam generation from the outside of the reactor vessel,
- Heat transfer to the middle annulus.

The WGOTHIC **AP1000** containment evaluation model that was used for the analyses in DCD Rev. 19 was modified as described below to calculate the containment response for the long-term PRHR operation analyses.

Input Changes to Model IRWST Water Level and Heat Addition

[

]a,c

As specified in Table 1, the PRHR heat rate to be used for the DBA analysis cases is to be based on a reactor trip from full power, including a 1% power level uncertainty. The core decay heat is to be based on the 1979 ANS decay heat standard with 2 sigma uncertainty. These modeling assumptions maximize the PRHR heat rate to the IRWST. This will minimize the time to start boiling, maximize the steaming rate from the IRWST, and result in a higher calculated containment pressure, which is conservative for this analysis.

The PRHR heat rate input for the BE and DBA analysis cases is based on transient PRHR heat rate data calculated by the LOFTRAN RCS transient response model and the long-term decay heat model. The LOFTRAN PRHR heat rate curves include the decay heat and sensible energy released during the RCS cooldown that occurs early in the event. [

]a,c

Input Changes to Model IRWST Overflow and Steam Venting

There are 3 types of vents from the IRWST: SG wall vents, Hood vents, and Overflow vents. The IRWST Hood vents and SG wall vents open based on differential pressure. The Hood vents open with a higher [ ]a,c differential pressure than the SG wall vents [ ]a,c. The Overflow vents are modeled to open when the IRWST water level is greater than [ ]a,c and close when the level is less than [ ]a,c.

[

]a,c

Input Changes to Model Condensate Losses from the Shell and Return to IRWST

A condensate film will develop as steam condenses on the inside surface of the containment shell. The condensate collection system employs gutters and downspouts to collect the film at the two major obstructions (crane girder and stiffener ring) and pipe it back to the IRWST. As the film flows down along the shell, it will encounter various obstacles (e.g. weld plates). Some of the film will splash off when it strikes an obstacle. [ ]a,c

The calculations that determine the PXS condensate spill fraction are performed in a downstream calculation. Based on those calculations, and as stated in earlier, the containment analysis cases assume a maximum PXS condensate spill fraction [ ]a,c.

[

]a,c

Input Changes to Model Condensate Flood up and Water Holdup

Condensate that runs off the various internal heat sinks will collect on the compartment floors within containment and run down to the drains or through openings to compartments below. The compartment floor drains eventually lead to the RCDT room, which is at the lowest elevation in containment; so, condensate that deposits on the internal heat sinks or spills from the containment shell will collect there.

[

]a,c

For the condensate return analysis, it was desired to model the filling of the lower RCDT room volume, overflow into the reactor cavity, and boiling from the outside of the reactor vessel to promote mixing of the lower containment atmosphere. Therefore, the water holdup volumes and non-safety grade drain lines to the RCDT room were considered in this analysis.

The places where water could potentially collect inside containment are shown in Figures 1 and 2.

a,c

Figure 1 – Water Traps in Lower Northeast Containment

a,c

Figure 2 – Water Traps in Lower Southeast Containment

[

]a,c

Input Changes to Model Containment Leakage

The maximum containment leak rate is specified as 0.1% air mass/day at the calculated peak containment pressure for the LOCA event. Leakage will remove some steam and air from the containment atmosphere. This will slightly reduce containment pressure, but also slowly reduce the amount of water within containment.

[

]a,c

<u>Input Changes to Model Steam Generation from the Outside of the Reactor Vessel</u>

As mentioned earlier, the RCDT room will eventually flood with condensate to the elevation of the flow path that connects it with the reactor cavity. After this happens, the water will be able to enter, and begin filling, the reactor cavity. The water level in the reactor cavity will eventually reach the bottom of the reactor vessel and steam will be generated and released to the SG compartments.

[

]a,c

[ ]a,c

Figure 3 – Reactor Cavity/RCDT Room Connection

The bottom of the RCDT room is located at an elevation of 69-ft, 6-inches. As shown in Figure 3, the volumes of the lower RCDT room and lower reactor cavity must be filled before water can come into contact with the reactor vessel.

The adjustments to the <u>W</u>GOTHIC **AP1000** containment model to address water that could be held up in the various pits within containment were described previously. The volume in the lower RCDT room that must be filled with water, prior to spilling over into the reactor cavity, also accounts for the water that could be held up in the other pits within containment. |

]a,c

Input Changes to Model Heat Transfer to the Middle Annulus

The middle annulus is a sealed compartment outside the containment shell that is located between the 100-ft and approximately 133.5-ft elevations (see Figure 4). The air within this compartment is normally maintained at a constant temperature by the heating, ventilating, and air conditioning (HVAC) system. However, the HVAC system is without power following a station blackout event. The dampers close on the loss of power and prevent natural circulation, so the middle annulus compartment temperature will increase as heat is transferred through the containment shell.

[ ]a,c

Figure 4 – Middle Annulus Region of Containment

[

]a,c

5.0 PCS Input Changes for the Analyses

The containment Hi-2 pressure setpoint for PCS actuation is reached several hours after event initiation in these analyses. PCS actuation causes the PCCWST isolation valves to open and water from the PCS storage tank begins flowing into the bucket above the top of the steel containment dome. [

]a,c The time required to cover the surface of the containment shell following PCS flow initiation is conservatively estimated to be approximately 400 seconds.

Most of the steam that condenses on the containment shell above the operating deck will return to the IRWST. Therefore, it is conservative to adjust the modeling assumptions and initial conditions to minimize the condensation rate on the containment shell for the DBA cases. This was accomplished by reducing the evaporative cooling from the shell by minimizing the water coverage area, minimizing the PCS flow rate, maximizing the initial PCS water temperature, and reducing the heat and mass transfer coefficients to/from the containment shell.

[

]a,c The initial PCS water temperature is set to the maximum allowed by the tech specs (120°F) for the DBA cases and a more nominal value (85°F) for the BE cases.

The transient PCS flow rate that is used as the starting point for the safety analyses is given in Table 6.2.2-1 of the DCD. The PCS flow rate that is input to the containment model is adjusted to conservatively account for the change in the water coverage area over time and elevation on the shell. This is an iterative process that uses the evaporation limited PCS flow methodology, which is described in Section 7 of WCAP-15846.

[

]a,c

6.0 Containment Heat Sink Input Changes for the Analyses

Steam condensing on anything other than the containment shell above the operating deck essentially reduces the amount of water that can be returned to the IRWST. Therefore, it is conservative for the DBA cases to maximize the condensate rate on the internal heat sinks.

[

]a,c

7.0 Initial Condition Input Changes for the Analyses

As mentioned earlier, the modeling assumptions and initial conditions for these analyses attempt to calculate a conservative minimum PXS condensate return rate to the IRWST while maintaining a relatively high containment backpressure for the RCS model. To that end, the initial conditions for the DBA analyses were defined by running sensitivity cases to changing the initial containment pressure, temperature, and humidity. The IRWST level response was used to determine which conditions were more limiting with regard to maximizing the condensate losses. The containment pressure response was used to determine which conditions maximized the backpressure for the RCS model.

[

][a,c]

a,c

Figure 5 – Containment Pressure Comparison

a,c

Figure 6 – IRWST Level Comparison

8.0 Containment Response Analysis Results

The containment response analysis was performed using the updated WGOTHIC **AP1000** containment evaluation model. Four cases were analyzed: a DBA and a BE case with the minimum predicted condensate spill [ ]^{a,c} and a DBA and a BE case with the maximum predicted condensate spill [ ]^{a,c}. The DBA cases use conservative modeling assumptions and initial conditions in an attempt to reduce the IRWST return rate by minimizing the condensation on the PCS shell, maximizing the condensation on the internal heat sinks, and maximizing the containment pressure.

Tables 2 and 3 present the sequence of events for the station blackout event with DBA conditions and BE conditions respectively.

Table 2 Station Blackout Event Sequence of Events – DBA Cases

Time (sec)	Description
0.0	Event initiation, loss of all AC
225	PRHR cooling initiated
13000	IRWST temperature reaches saturation, boiling starts
16600	Containment pressure reaches PCS actuation setpoint
17000	PCS water flow is applied in the model
33000	Steam generation from Rx cavity starts (with max. PXS condensate spill)
38000	Steam generation from Rx cavity starts (with min. PXS condensate spill)
276200	PCS flow rate is maintained at 100 gpm for the remainder of the event

Table 3 Station Blackout Event Sequence of Events – BE Cases

Time (sec)	Description
0.0	Event initiation, loss of all AC
237	PRHR cooling initiated
17000	IRWST temperature reaches saturation, boiling starts
21600	Containment pressure reaches PCS actuation setpoint
22000	PCS water flow is applied in the model
34000	Steam generation from Rx cavity starts (with max. PXS condensate spill)
38000	Steam generation from Rx cavity starts (with min. PXS condensate spill)
281200	PCS flow rate is maintained at 100 gpm for the remainder of the event

The PRHR is actuated shortly after a station blackout event and begins transferring energy from the RCS to the IRWST. The IRWST level initially swells as heat from the PRHR heat exchanger begins to increase the water temperature. During this period of time, some water may flow through the overflow vents and into the refueling cavity if the initial IRWST level is high. The water that spills into the refueling cavity will end up in the RCDT room sump.

After the water in the IRWST begins to boil, steam is released into the containment atmosphere above the operating deck from the SG wall vents. The water level in the IRWST begins to decrease. The steam begins condensing on the structures and containment shell above the operating deck. Most of the condensate from the containment shell is returned to the IRWST. The condensate that spills or splashes off of the inside of the containment shell, as well as the condensate on other structures above the operating deck, eventually finds its way down to the containment sump. As a result, the IRWST level continues to slowly decrease while the containment pressure, temperature above the operating deck, and the sump water level all increase.

Figure 7 presents a comparison of the IRWST level response for the 4 transient cases. The IRWST levels for the upper bounding spill rate cases decrease at a much faster rate than the lower bounding spill rate cases and do not equilibrate. The level that is shown in this plot is based on the water volume in the IRWST, as modeled, and is not representative of the actual IRWST water level.

The containment pressure eventually reaches the Hi-2 setpoint and the PCS water flow is actuated. After a short period of time, a steady state water coverage develops.

Evaporative cooling by the PCS causes the condensation rate on the containment shell to increase. This slows the rate of pressure increase. Eventually the containment pressure stops increasing and begins to decrease (see Figure 8).

The water level in the RCDT compartment continues to increase as it fills with the condensate that spills or splashes off of the inside of the containment shell, as well as the condensate from the various heat sinks inside containment. The RCDT compartment fills at a much faster rate and to a higher level with the higher PXS condensate spill rate (see Figure 9). In both cases, the water level eventually reaches the water door located above the lower RCDT compartment and begins to fill the lower reactor cavity.

After the water level in the reactor cavity reaches the bottom of the reactor vessel, it begins to heat up and boil. The circulation of steam rising up through the reactor cavity, out into the loop compartments, and then up into the CMT compartment improves mixing of the containment atmosphere.

In the lower bounding spill cases, the RCDT room water level stops increasing about 18 ft above the floor. For these cases, the evaporation rate from the water pool must be about equal to the sum of the condensation rate on the internal heat sinks and the PXS condensate spill. The condensation rate on the internal heat sinks reduces as the temperature of the internal heat sinks increases to the ambient temperature. This causes the water level in the IRWST to stabilize.

In the upper bounding spill cases, the RCDT room water level continues to increase. For these cases, the evaporation rate must be less than the sum of the condensation rate on the internal heat sinks and the PXS condensate spill. The increasing water level causes pools to form in the lower SG compartments. The evaporation rate from these pools increases as the water temperature increases and the containment pressure decreases. The water levels in the IRWST and lower compartments stabilize after the evaporation rate becomes greater than or equal to the PCS condensate spill rate.

A short-term (48 hour) BE-max case was run to calculate the containment pressure response for the LOFTRAN safe shutdown analysis input. The PRHR heat rate for this case was calculated using a lower, better estimate decay heat model.

Plots comparing the short-term BE-max case with the long-term BE-max case results are shown in Figures 10 through 12. The better estimate decay heat model primarily affected the calculated steaming rate and containment pressure response. The lower calculated pressure is a benefit for the LOFTRAN safe shutdown analysis because the saturation temperature of the water in the IRWST is lower.

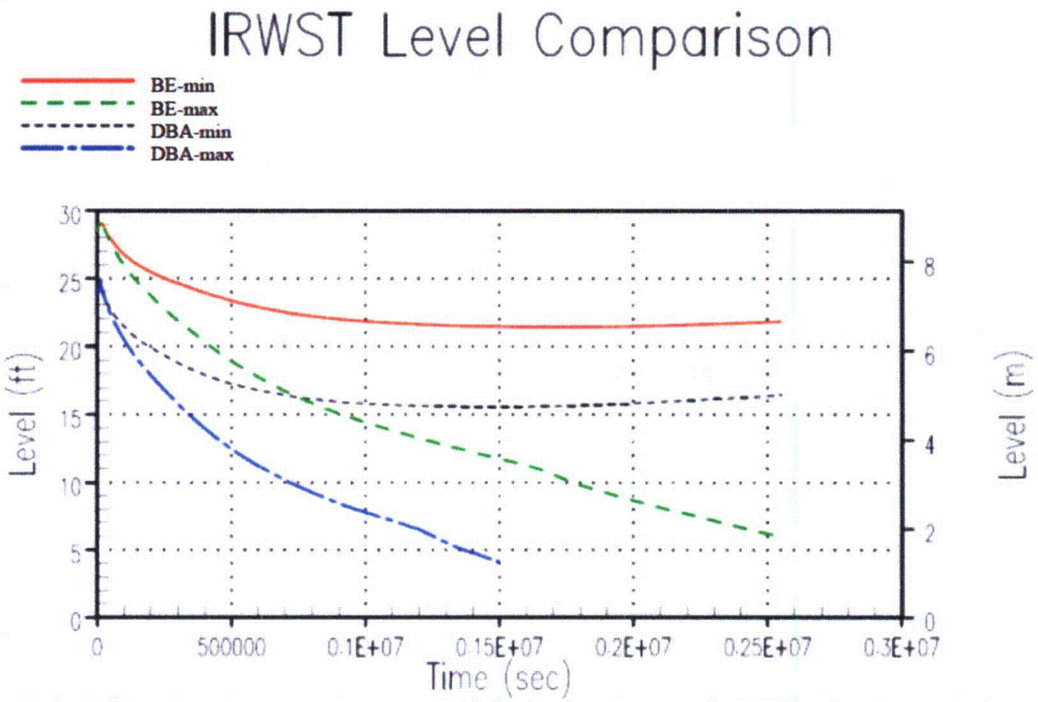

Figure 7 – IRWST Level Comparison

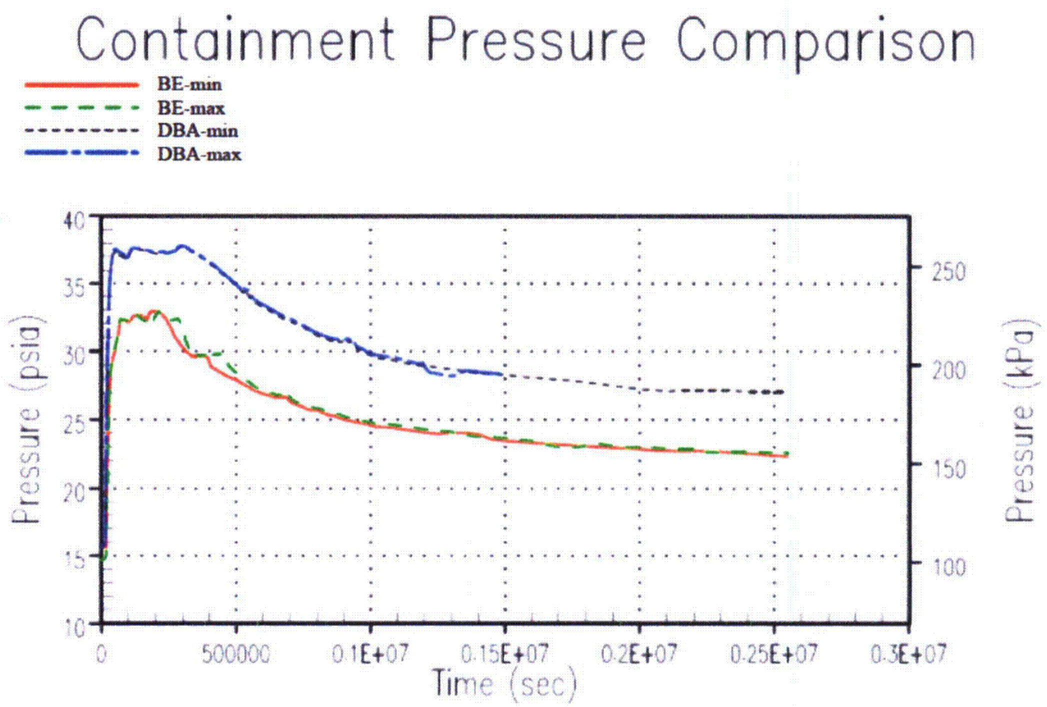

Figure 8 – Containment Pressure Comparison

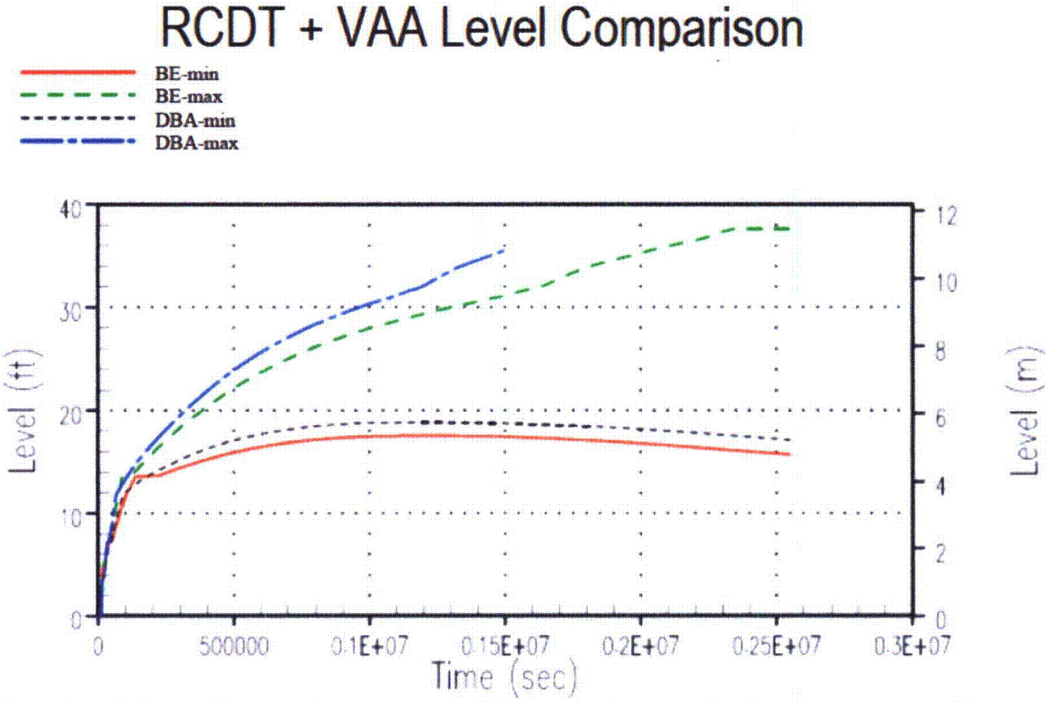

Figure 9 – RCDT+VAA Level Comparison

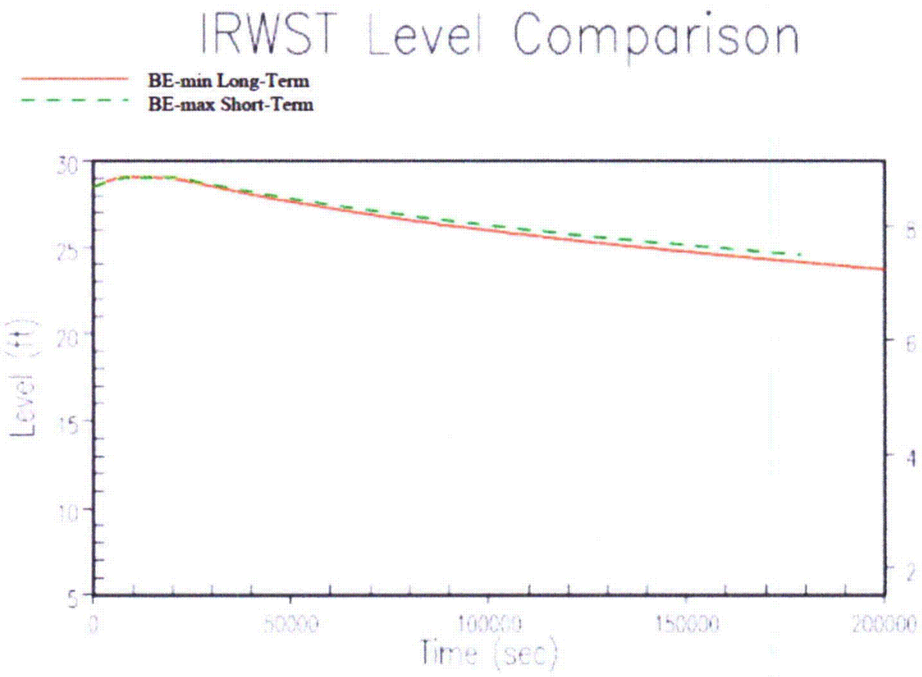

Figure 10 – IRWST Level Comparison

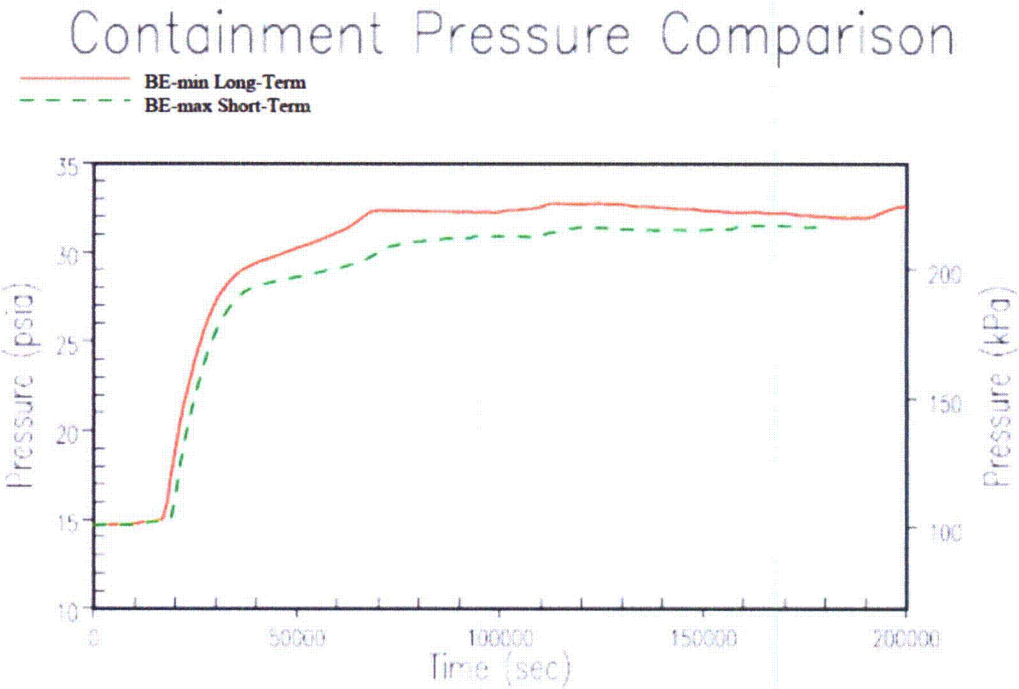

Figure 11 – Containment Pressure Comparison

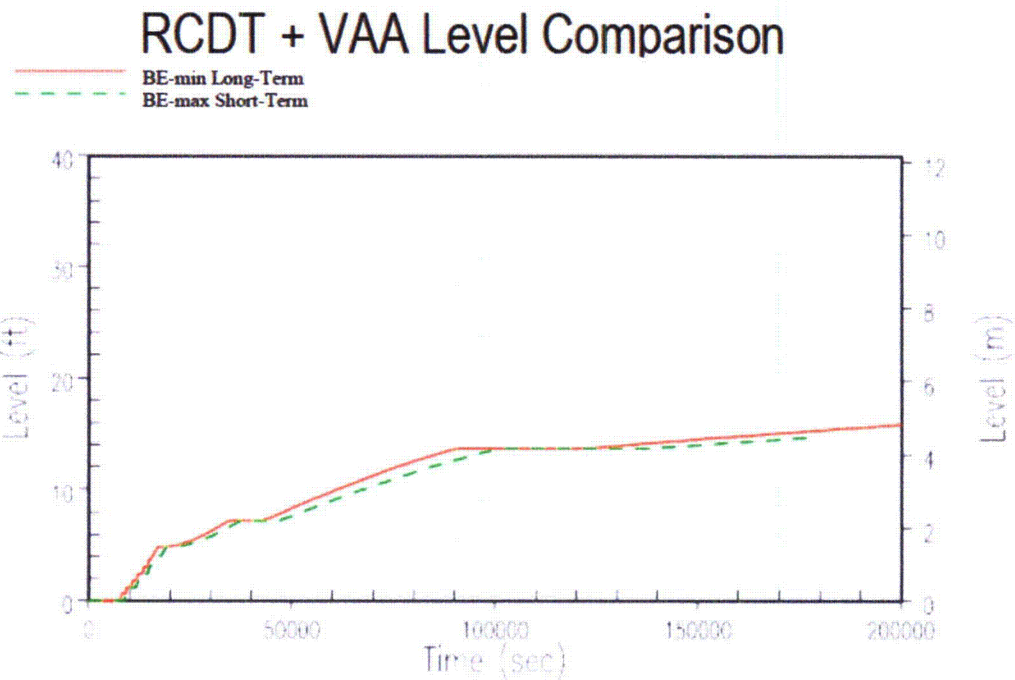

Figure 12 – RCDT+VAA Level Comparison

9.0 Summary

The containment response for long-term PRHR operation following a station blackout with a loss of main feedwater event was documented in calculation APP-PXS-M3C-071. The output from the containment response calculation was used as input to subsequent calculations for the variable condensate return rate and the RCS safe shutdown transient response.

The request for additional information asked for the following information from the containment response calculation:

a) A complete listing of important phenomena modeled
b) A description of phenomena and methodology used to analyze the phenomena,
c) Values of input and boundary conditions and justification of the values used,
d) Important assumptions used and their justification, and
e) Results of the calculations.

A description of the transient scenario, along with the phenomena that need to be modeled for the containment response, was provided in Section 2.0 of this response. The important modeling assumptions for these analyses were described in Sections 2.0. The WGOTHIC **AP1000** containment evaluation model was determined to be acceptable for modeling many of the phenomena; however, the model needed to be modified to address several new phenomena for these analyses. A description of the new phenomena and methodology that was used to analyze them was provided in Section 3.0. Sections 4.0, 5.0 and 6.0 described other input changes that were made to conservatively model the PCS and internal containment heat sinks for these analyses. Section 7.0 described the sensitivity cases that were made to identify conservative containment initial conditions for these analyses. Finally, Section 8.0 described the results of the containment response calculations.

NRC RAI #: 06.03-6
Text of NRC RAI:

The calculated values used for the long-term return rate of condensate to the IRWST in the APP-SSAR-GSC-536, "AP1000 Safe Shutdown Temperature Evaluation," Revision 2 and APP-PXS-M3C-020, "PRHR Sizing/Performance," Revision 3 calculations differ. Justify the discrepancy and explain the exact nature of the transient return rates used in the APP-PXS-M3C-020 calculation.

Response

The condensate return rate is a transient return rate and is modeled as such in the PRHR HX Sizing / Performance calculation (APP-PXS-M3C-020) and the Safe Shutdown Temperature Evaluation (APP-SSAR-GSC-536). There is no discrepancy between the return rate used in these two calculations. The effective condensate return rate is developed as a function of time in APP-PXS-M3C-020, conducting a mass balance on the steam generation from the In-containment Refueling Water Storage Tank (IRWST), and the steam losses due to condensation on heat sinks, pressurization of containment, containment leakage, and losses from the Containment Vessel (CV) shell.

The PRHR HX Sizing / Performance calculation (APP-PXS-M3C-020) calculates and uses the effective return rate to determine the long-term transient performance of the PRHR HX. This effective return rate considers losses from each of the aforementioned phenomena, and is documented in Appendix E of APP-PXS-M3C-020. There may appear to be a discrepancy between the constant return rate which is reported in Section 2.0 of APP-PXS-M3C-020, and the array of return rates shown in Appendix E. The constant return rate documented in Section 2.0 was reported to show an approximation of the long-term return rate for information in the summary of the results and conclusion section of the calculation. However, the constant rate in Section 2.0 is not indicative of the actual transient return rate modeled throughout each specific Best Estimate or Design Basis cooldown case.

The Safe Shutdown Temperature Evaluation (APP-SSAR-GSC-536) also uses the return rate documented in Appendix E of the PRHR HX Sizing / Performance calculation (APP-PXS-M3C-020). There is a minor difference between the return rate in these two calculations - that being in APP-SSAR-GSC-536 the return rate is shifted to match the time at which the IRWST begins to boil in the LOFTRAN code. In the Safe Shutdown Temperature Evaluation, the time to IRWST saturation is delayed because of the cooling effects of the core makeup tanks. The method for how the return rates were implemented as a function of time into the LOFTRAN code is documented in Section 5.1.3 of the Safe Shutdown Temperature Evaluation. In all other respects, the return rate used in both calculations is the same.

Enclosure 2
Westinghouse Application Letter CAW-14-3907
and Affidavit
(7 pages including cover page)

Westinghouse

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Project letter: APC_APG_000140

Our ref: CAW-14-3907

May 1, 2014

APPLICATION FOR WITHHOLDING PROPRIETARY
INFORMATION FROM PUBLIC DISCLOSURE

Subject: Transmittal **Responses to NRC RAIs 06.03-1 and 06.03-6 on Condensate Return** (Proprietary) and (Non-Proprietary)

The proprietary information for which withholding is being requested in the above-referenced letter is further identified in the affidavit signed by Westinghouse Electric Company LLC. The affidavit accompanying this letter, sets forth the basis on which the information may be withheld from public disclosure by the Commission and address with specificity the considerations listed in paragraph (b) (4) of 10 CFR Section 2.390 of the Commission's regulations.

Accordingly, this letter authorizes the utilization of the accompanying affidavit by APOG.

Correspondence with respect to the proprietary aspects of this application for withholding or the accompanying affidavit should reference CAW-14-3907 and should be addressed to J. A. Gresham, Manager, Regulatory Compliance, Westinghouse Electric Company, Suite 310, 1000 Westinghouse Drive, Cranberry Township, Pennsylvania 16066.

Very truly yours,

JA Gresham

James A. Gresham
Manager Regulatory Compliance

CAW-14-3907
May 1, 2014

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

ss

COUNTY OF BUTLER:

Before me, the undersigned authority, personally appeared **James A. Gresham**, who, being by me duly sworn according to law, deposes and says that he is authorized to execute this Affidavit on behalf of Westinghouse Electric Company LLC (Westinghouse), and that the averments of fact set forth in this Affidavit are true and correct to the best of his knowledge, information, and belief:

J A Gresham

James A. Gresham
Manager Regulatory Compliance

Sworn to and subscribed
before me this 1st day
of May 2014.

COMMONWEALTH OF PENNSYLVANIA
Notarial Seal
Linda J. Bugle, Notary Public
City of Pittsburgh, Allegheny County
My Commission Expires June 18, 2017
MEMBER, PENNSYLVANIA ASSOCIATION OF NOTARIES

Linda J. Bugle

Notary Public

(1) I am Manager Regulatory Compliance, International Licensing Programs, Westinghouse Electric Company, LLC (Westinghouse), and as such, I have been specifically delegated the function of reviewing the proprietary information sought to be withheld from public disclosure in connection with nuclear power plant licensing and rule making proceedings, and am authorized to apply for its withholding on behalf of Westinghouse.

(2) I am making this Affidavit in conformance with the provisions of 10 CFR Section 2.390 of the Commission's regulations and in conjunction with the Westinghouse "Application for Withholding" accompanying this Affidavit.

(3) I have personal knowledge of the criteria and procedures utilized by Westinghouse in designating information as a trade secret, privileged or as confidential commercial or financial information.

(4) Pursuant to the provisions of paragraph (b)(4) of Section 2.390 of the Commission's regulations, the following is furnished for consideration by the Commission in determining whether the information sought to be withheld from public disclosure should be withheld.

(i) The information sought to be withheld from public disclosure is owned and has been held in confidence by Westinghouse.

(ii) The information is of a type customarily held in confidence by Westinghouse and not customarily disclosed to the public. Westinghouse has a rational basis for determining the types of information customarily held in confidence by it and, in that connection, utilizes a system to determine when and whether to hold certain types of information in confidence. The application of that system and the substance of that system constitute Westinghouse policy and provide the rational basis required.

Under that system, information is held in confidence if it falls in one or more of several types, the release of which might result in the loss of an existing or potential competitive advantage, as follows:

(a) The information reveals the distinguishing aspects of a process (or component, structure, tool, method, etc.) where prevention of its use by any of Westinghouse's competitors without license from Westinghouse constitutes a competitive economic advantage over other companies.

(b) It consists of supporting data, including test data, relative to a process (or component, structure, tool, method, etc.), the application of which data secures a competitive economic advantage, e.g., by optimization or improved marketability.

(c) Its use 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 a similar product.

(d) It reveals cost or price information, production capacities, budget levels, or commercial strategies of Westinghouse, its customers or suppliers.

(e) It reveals aspects of past, present, or future Westinghouse or customer funded development plans and programs of potential commercial value to Westinghouse.

(f) It contains patentable ideas, for which patent protection may be desirable.

There are sound policy reasons behind the Westinghouse system which include the following:

(a) The use of such information by Westinghouse gives Westinghouse a competitive advantage over its competitors. It is, therefore, withheld from disclosure to protect the Westinghouse competitive position.

(b) It is information that is marketable in many ways. The extent to which such information is available to competitors diminishes the Westinghouse ability to sell products and services involving the use of the information.

(c) Use by our competitor would put Westinghouse at a competitive disadvantage by reducing his expenditure of resources at our expense.

(d) Each component of proprietary information pertinent to a particular competitive advantage is potentially as valuable as the total competitive advantage. If competitors acquire components of proprietary information, any one component may be the key to the entire puzzle, thereby depriving Westinghouse of a competitive advantage.

(e) Unrestricted disclosure would jeopardize the position of prominence of Westinghouse in the world market, and thereby give a market advantage to the competition of those countries.

(f) The Westinghouse capacity to invest corporate assets in research and development depends upon the success in obtaining and maintaining a competitive advantage.

(iii) The information is being transmitted to the Commission in confidence and, under the provisions of 10 CFR Section 2.390; it is to be received in confidence by the Commission.

(iv) The information sought to be protected is not available in public sources or available information has not been previously employed in the same original manner or method to the best of our knowledge and belief.

(v) The proprietary information sought to be withheld from within the **Responses to NRC RAIs 06.03-1 and 06.03-6 on Condensate Return,** and may be used only for that purpose.

The information requested to be withheld reveals details of the AP1000 design; sequence and method of construction; and timing and content of inspection and testing. This information was developed and continues to be developed by Westinghouse. The information is part of that which enables Westinghouse to manufacture and deliver products to utilities based on proprietary designs.

Public disclosure of this proprietary information is likely to cause substantial harm to the competitive position of Westinghouse because it would enhance the ability of competitors to provide similar commercial power reactors without commensurate expenses.

The information requested to be withheld is the result of applying the results of many years of experience in an intensive Westinghouse effort and the expenditure of a considerable sum of money.

In order for competitors of Westinghouse to duplicate this information, similar technical programs would have to be performed and a significant manpower effort, having the requisite talent and experience, would have to be expended.

Further the deponent sayeth not.

Enclosure 3
Proprietary Information Notice and Copyright Notice
(2 pages including cover page)

May 1, 2014

PROPRIETARY INFORMATION NOTICE

Transmitted herewith are proprietary and/or non-proprietary versions of documents furnished to the NRC in connection with requests for generic and/or plant-specific review and approval.

In order to conform to the requirements of 10 CFR 2.390 of the Commission's regulations concerning the protection of proprietary information so submitted to the NRC, the information which is proprietary in the proprietary versions is contained within brackets, and where the proprietary information has been deleted in the non-proprietary versions, only the brackets remain (the information that was contained within the brackets in the proprietary versions having been deleted). The justification for claiming the information so designated as proprietary is indicated in both versions by means of lower case letters (a) through (f) located as a superscript immediately following the brackets enclosing each item of information being identified as proprietary or in the margin opposite such information. These lower case letters refer to the types of information Westinghouse customarily holds in confidence identified in Sections (4)(ii)(a) through (4)(ii)(f) of the affidavit accompanying this transmittal pursuant to 10 CFR 2.390(b)(1).