PMSTPCOL PEmails

From:	Price John E [jeprice@STPEGS.COM]
Sent:	Monday, April 20, 2009 6:36 PM
To:	Adrian Muniz; Belkys Sosa; George Wunder; Loren Plisco; Raj Anand; Rocky Foster; Stacy Joseph; Tekia Govan; Tom Tai
Cc:	Tomkins, James
Subject:	RAI Response on Section 3.9 and Section 6.2
Attachments:	U7-C-STP-NRC-090036 RAI Response(SIGNED).pdf; U7-C-STP-NRC-090033 RAI Response(SIGNED).pdf

Attached is a courtesy copy of the letters answering the NRC's Requests for Additional Information related to COLA Part 2, Tier 2, Section 3.9.3 and Section 6.2.1.1.C. The official paper copies were sent via UPS according to the letter addressee lists.

If you have any questions, please contact John Price at (361) 972-4748 (Section 3.9.3), Jim Tomkins at (805) 215-6129 (Section 6.2.1.1.C), or Bill Mookhoek at (361) 972-7274.

John E. Price
Licensing Engineer - STP Units 3 & 4
361.972.4748 (site office)
972.754.8221 (cell)

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Created By: jeprice@STPEGS.COM

Recipients:
"Tomkins, James" <jetomkins@STPEGS.COM>
Tracking Status: None
"Adrian Muniz" <Adrian.Muniz@nrc.gov>
Tracking Status: None
"Belkys Sosa" <Belkys.Sosa@nrc.gov>
Tracking Status: None
"George Wunder" <George.Wunder@nrc.gov>
Tracking Status: None
"Loren Plisco" <Loren.Plisco@nrc.gov>
Tracking Status: None
"Raj Anand" <Raj.Anand@nrc.gov>
Tracking Status: None
"Rocky Foster" <Rocky.Foster@nrc.gov>
Tracking Status: None
"Stacy Joseph" <Stacy.Joseph@nrc.gov>
Tracking Status: None
"Tekia Govan" <Tekia.Govan@nrc.gov>
Tracking Status: None
"Tom Tai" <Tom.Tai@nrc.gov>
Tracking Status: None

Post Office: exgmb2.CORP.STPEGS.NET

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Nuclear Operating Company

South Texas Project Electric Generating Station 4000 Avenue F – Suite A Bay City, Texas 77414

April 20, 2009
U7-C-STP-NRC-090036

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
One White Flint North
11555 Rockville Pike
Rockville MD 20852-2738

South Texas Project
Units 3 and 4
Docket Nos. 52-012 and 52-013
<u>Response to Request for Additional Information</u>

Attached is the response to an NRC staff question included in Request for Additional Information (RAI) letter number 87 related to Combined License Application (COLA) Part 2, Tier 2, Section 3.9. This submittal completes the response to this RAI letter.

The Attachment addresses the response to the RAI question listed below:

RAI 03.09.03-2

When a change to the COLA is indicated, the change will be incorporated into the next routine revision of the COLA following NRC acceptance of the RAI response.

There are no commitments in this letter.

If you have any questions, please contact me at (361) 972-7136, or Bill Mookhoek at (361) 972-7274.

STI 32459264

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

Executed on 4/20/09

Scott Head
Manager, Regulatory Affairs
South Texas Project Units 3 & 4

jep

Attachment:
Question 03.09.03-2

cc: w/o attachment except*
(paper copy)

Director, Office of New Reactors
U. S. Nuclear Regulatory Commission
One White Flint North
11555 Rockville Pike
Rockville, MD 20852-2738

Regional Administrator, Region IV
U. S. Nuclear Regulatory Commission
611 Ryan Plaza Drive, Suite 400
Arlington, Texas 76011-8064

Kathy C. Perkins, RN, MBA
Assistant Commissioner
Texas Department of Health Services
Division for Regulatory Services
P. O. Box 149347
Austin, Texas 78714-9347

Alice Hamilton Rogers, P.E.
Inspections Unit Manager
Texas Department of Health Services
P. O. Box 149347
Austin, Texas 78714-9347

C. M. Canady
City of Austin
Electric Utility Department
721 Barton Springs Road
Austin, TX 78704

*Steven P. Frantz, Esquire
A. H. Gutterman, Esquire
Morgan, Lewis & Bockius LLP
1111 Pennsylvania Ave. NW
Washington D.C. 20004

*George F. Wunder
*Tom Tai
Two White Flint North
11545 Rockville Pike
Rockville, MD 20852

(electronic copy)

*George Wunder
*Tom Tai
Loren R. Plisco
U. S. Nuclear Regulatory Commission

Steve Winn
Eddy Daniels
Joseph Kiwak
Nuclear Innovation North America

Jon C. Wood, Esquire
Cox Smith Matthews

J. J. Nesrsta
R. K. Temple
Kevin Pollo
L. D. Blaylock
CPS Energy

RAI 03.09.03-2

QUESTION:

Section 3.9.3.4.2 of the STP 3 and 4 FSAR, Revision 2 added a STP DEP Admin item. It requires replacement of equation 3.9-1.

Please provide justification for changing the transverse shear stress term in equation 3.9-1.

RESPONSE:

This change was made in COLA Rev. 0 as an administrative departure. However, STPNOC no longer has access to the information that provided the basis for this departure. Therefore this STD DEP Admin will be removed in the next COLA revision.

The following changes to the COLA Rev. 2 text in Tier 2, Section 3.9.3.4.2 will be provided as an update in COLA Rev. 3. The changes to COLA Rev. 2 text are shown below with gray highlighting.

~~3.9.3.4.2 Reactor Pressure Vessel Support Skirt~~

~~STD DEP Admin~~

~~Replace the following equation (3.9-1)~~

$$\cancel{\left(\frac{P}{P_{crit}}\right)+\left(\frac{q}{q_{crit}}\right)+\left(\frac{\tau}{\tau_{crit}}\right)<\left(\frac{1}{S.F.}\right)}$$

~~with~~

$$\cancel{\left(\frac{P}{P_{crit}}\right)+\left(\frac{q}{q_{crit}}\right)+\left(\frac{\tau}{\tau_{crit}}\right)^2<\left(\frac{1}{S.F.}\right)}$$

Nuclear Operating Company
South Texas Project Electric Generating Station P.O. Box 289 Wadsworth, Texas 77483

April 20, 2009
U7-C-STP-NRC-090033

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
One White Flint North
11555 Rockville Pike
Rockville, MD 20852-2738

South Texas Project
Units 3 and 4
Docket Nos. 52-012 and 52-013
Response to Request for Additional Information

References:

1. Letter, Mark McBurnett to Document Control Desk, "Response to Requests for Additional Information", dated February 19, 2009 (U7-C-STP-NRC-090010) (ML090540471)

2. Letter, Mark McBurnett to Document Control Desk, "Response to Requests for Additional Information", dated February 19, 2009 (U7-C-STP-NRC-090014) (Proprietary)

Attached are responses to NRC staff questions included in Request for Additional Information (RAI) letter number 76 related to Combined License Application (COLA) Part 2, Tier 2, Section 6.2 and Appendix 3B.

Attachments 1 and 2 are responses to the RAI questions listed below. The response to RAI 06.02.01.01.C-1 is a supplement to a previous response to this RAI question. The proprietary and non-proprietary versions of this response were transmitted to the NRC in the above references.

RAI 06.02.01.01.C-1
RAI 06.02.01.01.C-6

There are no commitments in this letter.

If you have any questions regarding these responses, please contact me at (361) 972-7136, or Bill Mookhoek at (361) 972-7274.

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

Executed on 4/20/09

Scott Head
Manager, Regulatory Affairs
South Texas Project Units 3 & 4

jet

Attachments:

1. Question 06.02.01.01.C-1
2. Question 06.02.01.01.C-6

cc: w/o attachment except*

(paper copy)

Director, Office of New Reactors
U. S. Nuclear Regulatory Commission
One White Flint North
11555 Rockville Pike
Rockville, MD 20852-2738

Regional Administrator, Region IV
U. S. Nuclear Regulatory Commission
611 Ryan Plaza Drive, Suite 400
Arlington, Texas 76011-8064

Kathy C. Perkins, RN, MBA
Assistant Commissioner
Texas Department of Health Services
Division for Regulatory Services
P. O. Box 149347
Austin, Texas 78714-9347

Alice Hamilton Rogers, P.E.
Inspections Unit Manager
Texas Department of Health Services
P. O. Box 149347
Austin, Texas 78714-9347

C. M. Canady
City of Austin
Electric Utility Department
721 Barton Springs Road
Austin, TX 78704

*Steven P. Frantz, Esquire
A. H. Gutterman, Esquire
Morgan, Lewis & Bockius LLP
1111 Pennsylvania Ave. NW
Washington D.C. 20004

*George F. Wunder
*Stacy Joseph
Two White Flint North
11545 Rockville Pike
Rockville, MD 20852

(electronic copy)

*George Wunder
*Stacy Joseph
Loren R. Plisco
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Eddy Daniels
Joseph Kiwak
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Cox Smith Matthews

J. J. Nesrsta
R. K. Temple
Kevin Pollo
L. D. Blaylock
CPS Energy

RAI 06.02.01.01.C-1:

QUESTION:

Section 6.2.1.1.3: The staff found the containment analyses in support of the certified ABWR design to be acceptable based on the use of the GESSAR methodology and confirmatory calculations by the staff. It is the staff's understanding that the applicant plans to replace GESSAR with the GOTHIC computer program. It is also the staff's understanding that the GOTHIC code was adapted to employ models and assumptions outlined in the NEDO-20533 reports. Please, provide:

- GOTHIC input deck/description for the STP ABWR DBA containment analyses,

- detailed description of how the models and assumptions presented in the NEDO-20533 reports were incorporated into the GOTHIC model, and

- reference for qualification and/or benchmarking of GOTHIC to be used as an acceptable tool for performing the STP ABWR DBA containment analysis.

RESPONSE:

1st Bullet Item:
In response to the request of the first bullet in this RAI, the input parameters for the GOTHIC pressure/temperature containment model are provided in RAI 06.02.01.01.C-1 Table 1, which was previously transmitted to NRC in STPNOC Letter U7-C-STP-NRC-090014 dated February 19, 2009. The non-proprietary version of this response was transmitted to the NRC in STPNOC Letter U7-C-STP-NRC-090010 also dated February 19, 2009.

2nd Bullet Item:
Westinghouse (WEC) is preparing a containment Pressure/Temperature (P/T) report that will be submitted to NRC by June 30, 2009. This report, WCAP-17058, will describe the WEC approach for adapting the GOTHIC code to employ models and assumptions outlined in the ABWR DCD and NEDO-20533. The WCAP will provide a detailed comparison of the DCD approach using NEDO-20533 and the WEC method, and evaluate the impact on the analysis results of the few unavoidable modeling differences due to certain features in the GOTHIC code. The WEC method of analysis will be benchmarked against the DCD analysis results for both the short term and long term P/T analysis. The report will also address the modeling updates as described in Part 7 STD DEP 6.2-2 of Rev 2 of the STP 3 & 4 COLA.

The analysis for calculation of pool swell, including pool swell height, velocity, bubble pressure and wetwell airspace pressure which is also affected by the modeling updates described above, will be addressed in a separate departure and will be removed from the STD DEP 6.2-2 scope. Details of this departure and analysis are described in the response to RAI 06.02.01.01.C-6 in Attachment 2.

Consistent with this approach, COLA Rev 2 will be revised as follows : (1) Part 7 STD DEP 6.2-2 will be revised to describe the updated containment analysis, reference WCAP-17058, and refer pool swell changes to a new departure for Appendix 3B. Part 7 tables will also be updated to reflect this change; (2) Technical Specification 3.6.1.1, 3.6.1.2 and 3.6.1.4 Bases will be revised in both Part 2 Chapter 16 and in Part 4 to reflect the revised peak containment pressure, and (3) Part 2 Tier 2 Section 6.2 text, Table 6.2-1 and Figures 6.2-3, 6.2-4, 6.2-6, 6.2-7, 6.2-12, and 6.2-13, will be revised to reflect updated containment temperatures and pressures. The updates to the figures will be provided in a supplemental RAI response upon completion of the containment analysis by June 30, 2009 and will be provided in COLA Rev. 3. The supplemental RAI response will be provided by July 15, 2009.

COLA changes described above are provided in the markups in this attachment. Please note that portions of the markups where data is not currently available are shown as blank [ ]. This data will be available upon completion of the containment analysis and will be provided in COLA Rev 3. It will also be provided as part of the supplemental RAI response by July 15, 2009. Changed portions of the COLA Rev 2 are shown with gray highlighting.

3rd Bullet Item:
The qualification and benchmarking of GOTHIC for the ABWR containment P/T analysis will be provided in WCAP-17058, as described above. The benchmarking performed to date shows close agreement between the WEC results and the DCD results for the short term analysis. In addition, the GOTHIC program was used to calculate short-term pressure and temperature in the containment for the Feedwater Line Break (FWLB) and Main Steam Line Break (MSLB) using the DCD modeling assumptions with the updates identified in STD DEP 6.2-2. These results for the short term analysis are in close agreement with the results from NEDO-33372 which incorporated the analysis methodology and assumptions from the DCD with the updates incorporated.

6.2.1.1.2.1 Drywell

STD DEP 6.2-2

The maximum drywell temperature occurs in the *case of a steamline break (~~169.7°C~~*161 [ ]°C) *and is below the design value (171.1°C).*

The maximum drywell pressure occurs in the *case of a feedwater line break (~~268.7~~*240 [ ] *kPaG). The design pressure for the drywell (309.9 kPaG) includes ~~16%~~* approximately ~~22~~ [ ]% *margin.*

No vacuum breaker system is required for the primary containment-to-Reactor Building negative pressure, which is predicted to be maximum ~~11.8~~ [ ] *kPaG, between the wetwell and the Reactor Building, compared to the design negative pressure of 13.7 kPaG.*

6.2.1.1.2.2 Wetwell

STD DEP 6.2-2

*The wetwell chamber design pressure is 309.9 kPaG and design temperature is ~~103.9°C~~*104°C.

Under normal plant operating conditions, the maximum suppression pool water and wetwell airspace temperature is 35°C or less. Under blowdown conditions following an isolation event or LOCA, the initial pool water temperature may rise to a maximum of ~~76.7~~ [ ]*°C. The continued release of decay heat after the initial blowdown may result in suppression pool temperatures as high as ~~97.2~~*[ ]*°C. The Residual Heat Removal (RHR) System is available in the Suppression Pool Cooling mode to control the pool temperature. Heat is removed via the RHR heat exchanger(s) to the Reactor Building Cooling Water (RCW) System and finally to the Reactor Service Water (RSW) System. The RHR System is described in Subsection 5.4.7.*

6.2.1.1.3.3 Accident Response Analysis

STD DEP 6.2-2

The containment design pressure and temperature were established based on enveloping the results of this range of analyses ~~plus providing NRC prescribed margins~~.

For the ABWR pressure suppression containment system, the peak containment pressure following a LOCA is ~~very~~ relatively *insensitive to variations in the size of the assumed primary system rupture. This is because the peak occurs late in the blowdown and is determined in very large part by the transfer of the noncondensible gases from the drywell to the wetwell airspace. ~~This process is not significantly~~*

~~*influenced by the size of the break.*~~ *In addition, there is* ~~*a 15%*~~ an approximately ~~22~~ [ ] % *margin between the peak calculated value and the containment design pressure that will easily accomodate small variations in the calculated maximum value.*

Tolerances associated with fabrication ~~*and installation may result in the as-built size of the postulated break areas being 5% greater than the values presented in this chapter Based on the above, these as-built variations would not invalidate the plant safety analysis presented in this chapter and Chapter 15*~~ of the RPV nozzles have been taken into account in this analysis.

6.2.1.1.3.3.1.1 Assumptions for Short-Term Response Analysis

STD DEP 6.2-2

The response of the Reactor Coolant System and the Containment System during the short-term blowdown period of the accident has been analyzed using the following assumptions:

(1) The initial conditions for the FWLB accident ~~*are such that system energy is maximized and the system mass is minimized*~~ maximize the containment pressure response. That is:

(a) The reactor is operating at 102% of the rated thermal power, which maximizes the post-accident decay heat.

(b) The initial suppression pool mass is at the ~~*low*~~~~nominal~~ *low water level.*

(c) The initial wetwell air space volume is at the high water level.

(d) The suppression pool temperature is the operating maximum ~~*temperature*~~ value.

(4) ~~*The main steam isolation valves (MSIVs) start closing at 0.5 s after the accident*~~. *The main steam isolation valves (MSIVs) start closing at 0.5 s after the accident.* ~~*They are fully closed in the shortest possible time (at 3.5 s) following closure initiation..*~~ The turbine stop valves are closed in 0.2 seconds after reactor trip/turbine trip (RT/TT). *By assuming rapid closure of these valves, the RPV is maintained at a high pressure, which maximizes the calculated discharge of high energy water into the drywell.*

(5) ~~*The vessel depressurization flow rates are calculated using Moody's homogeneous equilibrium model (HEM) for the critical break flow (Reference 6.2-2).*~~ *The vessel depressurization flow rates are calculated using Moody's homogeneous equilibrium model (HEM) for the critical break flow (Reference 6.2-2).* ~~*The break area on the RPV side for this study is shown in Figure 6.2-2. During the inventory depletion period, subcooled blowdown occurs and the effective break area at saturated conditions is much less than the actual area. The detailed calculational method is provided in Reference 6.2-1*~~.

~~*Reactor vessel internal heat transfer is modeled by dividing the vessel and internals into six metal nodes. A seventh node depends on the fluid (saturated or subcooled liquid, saturated steam) covering the node at the time. The assumptions include:*~~

~~*(a) The center of gravity of each node is specified as the elevation of that node.*~~

~~*(b) Mass of water in system piping (except for HPCF and feedwater) is included in initial vessel inventory.*~~

~~*(c) Initial thermal power is 102% of rated power at steady-state conditions with corresponding heat balance parameters which correspond to turbine control valve constant pressure of 6.75 MPaA.*~~

~~*(d) Pump heat, fuel relaxation, and metal-water reaction heat are added to the ANSI/ANS-5.1 decay heat curve plus 20% margin.*~~

~~*(e) Initial vessel pressure is 7.31 MPaA.*~~~~Not Used~~

(6) There are two HPCF Systems, one RCIC System, and three RHR Systems in the ABWR. ~~*One HPCF System, one RCIC System and two RHR Systems are assumed to be available.*~~ *One HPCF System, one RCIC System and two RHR Systems are assumed to be available.* ~~*HPCF flow cannot begin until 36 seconds after a break, and then the flow rate is a function of the vessel-to-wetwell differential pressure. Rated HPCF flow is 182 m3/h per system at 8.12 MPaD and 727 m3/h, per system at 0.69 MPaD. Rated RHR flow is 954 m3/h at 0.28 MPaD with shutoff head of 1.55 MPaD. Rated RCIC flow is 182 m3/h with reactor pressure between 8.12 MPaG and 1.04 MPaG, and system shuts down at 0.34 MPaG.*~~ Influence of these systems is minimal since the time interval analyzed for short-term is approximately the same time as the response time of associated systems injections into the RPV.

(8) ~~*The wetwell airspace temperature is allowed to exceed the suppression pool temperature as determined by a mass and energy balance on the airspace.*~~ *The wetwell airspace temperature is allowed to exceed the suppression pool temperature as determined by a mass and energy balance on the airspace.* ~~Not Used~~

(9) Wetwell and drywell ~~wall and~~ *wall and structure heat transfer* ~~are~~~~is~~ *are ignored.*

(10) Actuation of SRVs is modeled.

(11) Wetwell-to-drywell vacuum breakers ~~*are not modeled*~~~~do not open in the short-term response analysis.~~ are modeled.

(12) Drywell and wetwell sprays and RHR cooling mode are not modeled.

(13) ~~*The dynamic backpressure model is used.*~~ Not Used

(14) Initial drywell conditions are ~~0.107 MPa, 57°C~~~~106.5 kPa,~~ *0.107 MPa, 57°C and 20% relative humidity.*

(15) Initial wetwell airspace conditions are ~~0.107 MPa~~~~106.5 kPa~~ *0.107MPa, 35°C and 100% relative humidity.*

(16) ~~The drywell is modeled as a single node. All break flow into the drywell is homogeneously mixed with the drywell inventory.~~ The drywell is modeled as a single node. ~~Not Used~~

(17) ~~Because of the unique containment geometry of the ABWR, the inert atmosphere in the lower drywell would not transfer to the wetwell until the peak pressure in the drywell is achieved. Figure 6.2-5 shows the actual case and the model assumption. Because the lower drywell is connected to the drywell connecting vent, no gas can escape from the lower drywell until the peak pressure occurs. This situation can be compared to a bottle whose opening is exposed to an atmosphere with an increasing pressure. The contents of the lower drywell will start transferring to the wetwell as soon as the upper drywell pressure starts decreasing. A conservative credit for transfer of 50% of the lower drywell contents into the wetwell was taken)~~ Because of the unique containment geometry of the ABWR, the inert atmosphere in the lower drywell would not transfer to the wetwell until the peak pressure in the drywell is achieved. Figure 6.2-5 shows the actual case and the model assumption. Because the lower drywell is connected to the drywell connecting vent, no gas can escape from the lower drywell until the peak pressure occurs. This situation can be compared to a bottle whose opening is exposed to an atmosphere with an increasing pressure. The contents of the lower drywell will start transferring to the wetwell as soon as the upper drywell pressure starts decreasing. A conservative credit for transfer of 50% of the lower drywell contents into the wetwell was taken ~~Not Used.~~

6.2.1.1.3.3.1.2 Assumptions for Long-Term Cooling Analysis

STD DEP 6.2-2

Following the blowdown period, the ECCS discussed in Section 6.3 provides water for core flooding, containment spray, and long-term decay heat removal. The containment pressure and temperature response during this period was analyzed using the following assumptions:

(1) ~~The ECCS pumps are available as specified in Subsection 6.3.1.1.2 (except one low pressure flooder feeding a broken feedwater line, in case of a FWLB).~~ There are two HPCF Systems, one RCIC System, and three RHR Systems in the ABWR. All motor operated pump systems (HPCF and RHR) are assumed to be available. HPCF flow cannot begin until 47 seconds after a break, and then the flow rate is a function of the vessel-to-wetwell differential pressure. Rated HPCF flow is 182 m^3/h per system at 8.12 MPaD and 727 m^3/h, per system at 0.69 MPaD. Rated RHR flow is 954 m^3/h

at 0.28 MPaD with shutoff head of 1.55 MPaD. *A single failure of one RHR heat exchanger was assumed for conservatism.*

(2) The ANSI/ANS-5.1- 2005 *decay heat* plus 2-sigma uncertainty *is used. Fission energy, fuel relaxation heat, and pump heat are included.*

(3) The suppression pool ~~is the only~~ modelled as a *~~heat sink available in the containment system.~~*volume corresponds to the low water level: however, the wetwell airspace volume used corresponds to the suppression pool at the high water level.

*(4) ~~After 10 minutes, the RHR heat exchangers are activated to remove energy via recirculation cooling of the suppression pool with the RCW System and ultimately to the RSW System. This is a conservative assumption, since the RHR design permits initiation of containment cooling well before a 10 minute period (see response to Question 430.26).~~*After 30 minutes, one RHR heat exchanger is activated to remove energy via recirculation cooling of the suppression pool and one RHR heat exchanger is activated to remove energy via drywell sprays with the RCW System and ultimately to the RSW System.

(5) The maximum service water temperature is assumed to be ~~35~~ 38.5 *°C. This is a conservative assumption that maximizes the suppression pool temperature.*

*(6) The lower drywell flooding ~~of 815m3 was assumed to occur 70 seconds after scram. During the blowdown phase, a portion of break flow flows into the lower drywell. This is conservative, since lower drywell flooding will probably occur at approximately 110 to 120 second time period.~~*is not modeled.

*(7) ~~At 70 seconds, the feedwater specific enthalpy becomes 418.7 J/g (100°C saturation fluid enthalpy)~~*Structural heat sinks are modeled in the containment system.

6.2.1.1.3.3.1.4 Long-Term Accident Responses

STD DEP 6.2-2

In order to assess the adequacy of the containment system following the initial blowdown transient, an analysis was made of the long-term temperature and pressure response following the accident. The analysis assumptions are those discussed in Subsection 6.2.1.1.3.3.1.2.

~~The short-term pressure peak (268.7 kPaG) of Figure 6.2-6 is the peak pressure for the whole transient.~~ Figure 6.2-8 shows temperature time histories for the suppression pool, wetwell, and drywell temperatures. The peak pool temperature (~~96.9~~ [ ]*°C) is reached at ~~15,350~~* [ ] *seconds (~~4.264~~* [ ] *hours) and remains below the 97.2°C limit.*

6.2.8 References

6.2-5 "Implementation of GE NEDO-20533 Methodology with GOTHIC for ABWR Containment Design Analyses," WCAP-17058, Westinghouse Electric Company, LLC, [ ], 2009.

Table 6.2-1 Containment Parameters

Design Parameter	**Design Value**	**Calculated Value**[1]
1. Drywell pressure	*309.9 kPaG*	~~268.7 kPaG~~ ~~240~~ [ ] kPaG
2. Drywell temperature	*171.1°C*	~~170°C~~ ~~161~~ [ ] °C
3. Wetwell pressure	*309.9 kPaG*	~~179.5~~ ~~210.2~~ [ ] kPaG
4. Wetwell temperature		
• Gas Space	~~103.9 °C~~ **104°C**	~~98.9~~ [ ]°C
• Suppression pool	*97.2°C*	~~96.9~~[ ] °C

[1] Calculated values from Ref 6.2-5

B 3.6 CONTAINMENT SYSTEMS

B 3.6.1.1 Primary Containment

APPLICABLE SAFETY ANALYSES

The safety design basis for the primary containment is that it must withstand the pressures and temperatures of the limiting DBA without exceeding the design leakage rate.

The DBA that postulates the maximum release of radioactive material within primary containment is a LOCA. In the analysis of this accident, it is assumed that primary containment is OPERABLE such that release of fission products to the environment is controlled by the rate of primary containment leakage.

Analytical methods and assumptions involving the primary containment are presented in References 1 and 2. The safety analyses assume a nonmechanistic fission product release following a DBA, which forms the basis for determination of offsite doses. The fission product release is, in turn, based on an assumed leakage rate from the primary containment. OPERABILITY of the primary containment ensures that the leakage rate assumed in the safety analyses is not exceeded.

STD DEP 6.2-2

The maximum allowable leakage rate for the primary containment (La) is 0.5% by weight of the containment air per 24 hours at the ~~maximum~~ calculated *peak containment pressure (Pa) of* ~~0.269~~ ~~MPaG~~ ~~279.6~~240 [ ] kPaG *or* ~~[0.259]~~[ ]*% by weight of the containment air per 24 hours at the reduced pressure of Pt of* ~~[124.1]~~[ ] ~~MPaG~~kPaG *(Ref. 1).*

SURVEILLANCE REQUIREMENTS

SR 3.6.1.1.1

STD DEP 16.3-44

Maintaining the primary containment OPERABLE requires compliance with the visual examinations and leakage rate test requirements of 10 CFR 50, Appendix J (Ref. 3), as modified by approved exemptions. Failure to meet air lock leakage testing (SR 3.6.1.2.1), resilient seal primary containment purge valve leakage testing (SR 3.6.1.3.~~76),] main steam isolation valve leakage (SR 3.6.1.3.13~~*), or hydrostatically tested valve leakage (SR 3.6.1.3.*~~12~~11*) does not necessarily result in a failure of this SR. The impact of the failure to meet these SRs must be evaluated against the Type A, B, and C acceptance criteria of 10 CFR 50, Appendix J. The Frequency is required by 10 CFR 50, Appendix J (Ref.*

3), as modified by approved exemptions. Thus, SR 3.0.2 (which allows Frequency extensions) does not apply.

STD DEP 16.3-45

REFERENCES

1. ~~*DCD Tier 2, Section 6.2*~~. [ ]

2. *DCD Tier 2, Section ~~15.1~~*15.6.

3. *10 CFR 50, Appendix J.*

B 3.6 CONTAINMENT SYSTEMS

B 3.6.1.2 Primary Containment Air Locks

STD DEP 6.2-2

APPLICABLE SAFETY ANALYSES

The DBA that postulates the maximum release of radioactive material within primary containment is a LOCA. In the analysis of this accident, it is assumed that primary containment is OPERABLE, such that release of fission products to the environment is controlled by the rate of primary containment leakage. The primary containment is designed with a maximum allowable leakage rate (L_a) of 0.5% (excluding MSIV leakage) by weight of the containment air per 24 hours at the calculated maximum peak containment pressure (P_a) of ~~0.269 MPaG~~ 240 [ ] kPaG *(Ref. 3). This allowable leakage rate forms the basis for the acceptance criteria imposed on the SRs associated with the air lock.*

B 3.6 CONTAINMENT SYSTEMS

B 3.6.1.4 Drywell Pressure

BASES

The information in this section of the reference ABWR DCD, including all subsections, is incorporated by reference with the following departure.

STD DEP 6.2-2

APPLICABLE SAFETY ANALYSES

Primary containment performance is evaluated for the entire spectrum of break sizes for postulated LOCAs (Ref. 1). Among the inputs to the DBA is the initial primary containment internal pressure (Ref. 1). Analyses assume an initial drywell pressure of 5.20x10^{-3} MPaG. This limitation ensures that the safety analysis remains valid by maintaining the expected initial conditions and ensures that the peak LOCA drywell internal pressure does not exceed the maximum allowable of 0.310 MPaG.

The maximum calculated drywell pressure occurs during ~~the reactor blowdown phase of the DBA, which is determined to be~~ a feedwater line break. The calculated peak drywell pressure for this limiting event is ~~0.269 MPaG 240~~ [ ] kPaG *(Ref. 1).*

Part 7, Section 2.2 Departures from the Generic Technical Specifications

STD DEP 6.2-2, Containment Analysis

Description

This departure updates the containment analysis for the ABWR DCD in ~~two~~ three areas: (1) the modeling of flow and enthalpy into the drywell for the feedwater following a FWLB, ~~and~~ (2) the modeling of the drywell connecting vents for the FWLB and MSLB, and (3) the modeling of decay heat. A more detailed description is shown below.

In the ABWR DCD for the FWLB, the maximum possible feedwater flow rate was calculated to be 164% of nuclear boiler rated (NBR) flow, based on the response of the feedwater pumps to an instantaneous loss of discharge pressure. Since the Feedwater Control System would respond to the decreasing reactor pressure vessel (RPV) water level by demanding increased feedwater flow, and there was no FWLB logic/mitigation in the certified ABWR design, this maximum feedwater flow was assumed to continue for 120 seconds. This was based on the following assumptions:

(1) All feedwater system flow is assumed to go directly to the drywell.

(2) Flashing in the broken feedwater line was ignored.

(3) Initial feedwater flow was assumed to be 105% NBR.

(4) The feedwater pump discharge flow will coast down as the feedwater system pumps trip due to low suction pressure. During the inventory depletion period,

the flow rate is less than 164% because of the highly subcooled blowdown. A feedwater line length of 100 meters was assumed on the feedwater system side.

Subsequent to certification, analysis for plant-specific ABWRs revealed that these assumptions were non-conservative.

For the containment analysis, the feedwater system side of the FWLB has been changed using a revised time variant feedwater mass flow rate and enthalpy directly to the drywell airspace. The time histories of the mass flow and enthalpy have been determined from the predicted characteristics of a typical feedwater system. The conservatism of the assumed mass flow and enthalpies will be confirmed after detailed condensate and feedwater designs are complete. In addition, to provide added assurance of acceptable results, safety related FWLB mitigation has been added to the STP 3 & 4 ABWR design which adds safety related instrumentation to sense and confirm a FWLB based on high differential pressure between feedwater lines coincident with high drywell pressure to trip the condensate pumps (Ref. STD DEP T1 2.4-2).

The analysis is further revised to reflect the characteristics of the horizontal vents configuration that had not been modeled in the DCD. The certified DCD model did not properly simulate the horizontal vent portion of the vent system and incorrectly modeled the vent clearing time. The revised STP 3 & 4 ABWR containment analysis has been performed using the drywell connecting vent (DCV) loss coefficients and considering the horizontal vents. The total DCV loss coefficient is based on a summation of losses.

Further analysis done based on ANSI/ANS-5.1 (1994), including the 2-sigma uncertainty, has determined that the decay heat curves used in the DCD based on best estimate ANSI/ANS-5.1 (1979) were non-conservative for long-term analysis. To address this, the decay heat curves used in the revised containment analysis were revised to reflect the ANSI/ANS-5.1 (1979 for short- term and 1995 for long-term) with 2-sigma uncertainty included.

The revised containment analysis uses the GOTHIC code and is documented in WCAP-17058. The analysis uses the same assumptions and inputs that were used in the DCD with consideration of the revised modeling as noted above. The report describes all input assumptions, baselining of the GOTHIC code results to those used in the DCD and all containment time-dependent pressure and temperature results.

The impact of the revised pressure and temperature results on pool swell velocity and height described in Appendix 3B is evaluated in a new departure which is STD DEP 3B-2.

Technical Specification 3.6.1.1, 3.6.1.2, and 3.6.1.4 Bases (Applicable Safety

Analyses) are changed based upon the containment analysis. These changes show the peak containment pressure (Pa) from the containment analysis.

Evaluation Summary

This departure which updates the containment analysis for STP 3 & 4 does not affect Tier 1, Tier 2*, or any operational requirements. However, it does affect the Bases for Technical Specifications 3.6.1.1, 3.6.1.2, and 3.6.1.4 ~~and 3.6.1.6~~ and therefore requires NRC approval.

There is no impact on environmental qualification of equipment due to the higher predicted drywell temperatures and pressures. The qualification of equipment is based on the containment design pressures and temperatures. The calculated containment pressure and temperature for both the FWLB and MSLB remain below the design values.

This departure was evaluated per Section VIII.C.4 of Appendix A to 10CFR part 52 and:

(1) This exemption is not inconsistent with the Atomic Energy Act or any other statute and therefore is authorized by law. The design change and revised containment analysis represents an improvement and therefore will not present an undue risk to the public health and safety. The change does not relate to security and does not otherwise pertain to the common defense and security.

(2) Special circumstance (iv) applies in that this represents a benefit in public health and safety. The ~~more advanced and complete analysis methods~~ incorporation of these modeling changes as well as the use of an analysis method which has been baselined to the certified DCD analysis method provide a more accurate prediction of peak containment conditions post-accident. These results show that the peak containment pressure and temperature conditions calculated following an accident based on these improved analyses are below the design limits. The FWLB mitigation to the ABWR design will provide added assurance that the revised containment analysis results will remain conservative when detailed feedwater and condensate system design and procurement work is completed.

As discussed above, the change satisfies the exemption criteria per the requirements in 10 CFR 52 Appendix A Section VIII.C.4.

RAI 06.02.01.01.C-6:

<u>QUESTION</u>:

STP FSAR Tier 2, Chapter 3, App. 3B, p. 3B-2: 3B.4.2.1 (STD DEP 6.2-2) – Elevations used for determination of the structure loads have been revised, i.e., 7m to 8.5m, and 10.3m to 11.7m. Provide the reference and/or models used to justify these changes.

<u>RESPONSE</u>:

The revised pool swell heights (pool and froth) provided in COLA Rev. 2 are very conservative estimated values selected based on engineering judgment, preliminary assessments, and a publicly available reference from COLA R0 (NEDO-33372), which indicated an expected increase in pool swell heights. (Note: the presentation of the revised pool swell heights in COLA Rev. 2 replaced the DCD values with the estimated values, incorrectly resulting in a statement that these estimated values were calculated). As discussed in this reference, the pool swell calculated heights reported in the certified DCD were based on non-conservative containment pressure inputs to the pool swell analytical model, and correcting these inputs results in higher pool swell heights and changes to pool swell velocity, bubble pressure, and wetwell airspace pressure. It is important to note that the pool swell heights do not have an allowable value or safety limit, and as such changing the pool swell heights, either higher or lower, does not change a margin to any safety limit. The pool swell height and velocity are inputs to the wetwell internals qualification that will be performed as part of the detailed design.

As noted in response to RAI 06.02.01.01.C-1, STD DEP 6.2-2 will be revised, and the pool swell analysis changes incorporated into new departure STD DEP 3B-2. New STD DEP 3B-2 will describe the Westinghouse pool swell methodology. Since the pool swell method to be used by Westinghouse will be a different method than that described in the DCD, this departure will require prior NRC approval. The Westinghouse pool swell calculation method will be described in Westinghouse report WCAP-17065-P, "Westinghouse BWR Pool Swell Calculation Methodology Using GOTHIC." This report will be benchmarked against existing available pool swell test data. Preliminary comparisons to the DCD analysis show good agreement of the Westinghouse pool swell method results with the existing DCD pool swell results. This report will be submitted to the NRC in September 2009, and a supplement providing benchmarking to test data will be submitted by December 2009. STD DEP 3B-2 will also address incorporation of the revised containment pressures that result from the changes described in STD DEP 6.2-2, which affect the pool swell results.

The analysis for pool swell is in progress at this time. Preliminary results indicate that the pool swell results will increase compared to those reported in the DCD, as was expected based upon the COLA R0 reference information. It is expected that the maximum pool swell height, peak velocity, maximum bubble pressure and maximum wetwell airspace pressure will be greater than the values currently in the DCD. The final results will be completed and available for NRC review by June 30, 2009. These final values will also be provided to NRC in an update to this RAI response, to be provided by July 15, 2009.

Consistent with this approach, COLA Rev. 3 will include the following: (1) Part 7 STD DEP 3B-2 will be added to address the revised pool swell analysis methodology and incorporation of revised inputs to the pool swell analysis for the containment P/T updates discussed in STD DEP 6.2-2; and (2) Part 2 Tier 2 Appendix 3B Subsection 3B.4.2.1, Table 3B-1, and Figures 3B-12 and 3B-13 will be revised to reflect updated pool swell methodology and results.

This RAI response provides the proposed departure description for new departure STD DEP 3B-2, which will be added to COLA Part 7 Section 2.3.

COLA changes as described above are provided in the following markups. Please note that blanks [ ] are provided where information is not currently available. As noted above, these results will be available by June 30, 2009 and incorporated into an update to this RAI response. This update will be provided to the NRC on or before July 15, 2009. The text that will be changed from COLA Rev. 2 is highlighted with gray shading.

Several changes to Appendix 3B Section 3B.4.2.1, Section 3B.7, and Table 3B-1 are shown in this RAI response.

Changes to DCD Figure 3B-12 will be included in COLA Rev. 3 to reflect the pool swell air bubble pressure time history, which will change as a result of the revised pool swell analysis. Similarly, COLA Rev. 2 Figure 3B-13 will be revised and provided in COLA Rev. 3 to reflect the revised bulk pool swell and froth elevations resulting from the updated pool swell analysis. These changes will also be provided in the July 15, 2009 RAI update.

Part 7 Departures Report

2.3 Tier 2 Departures from DCD Requiring Prior NRC Approval

The following Tier 2 departure requires prior NRC approval under Section VIII.B.5 of 10 CFR 52 Appendix A.

STD DEP 3B-2, Revised Pool Swell Analysis

Description

This departure updates the hydrodynamic loads analysis to incorporate a new analysis method for pool swell compared to the method described in the DCD. It is necessary to revise the pool swell analysis to address the effects of the changes to the containment pressure response for LOCA events as described in STD DEP 6.2-2. The COL applicant no longer has access to the analytical codes described in DCD Section 3B Reference 14, and an alternate method is used to perform the revised pool swell analysis. This alternate method utilizes a calculation approach that is similar to the DCD approach; however, it uses some different assumptions and different analytical software for implementation of the analysis. This change affects Tier 2 Appendix 3B Subsection 3B.4.2.1.

Evaluation Summary

This change does not affect Tier 1, Tier 2*, or operational requirements. This Tier 2 departure is a change from a method of evaluation, as defined in 10 CFR 52 Appendix A Section II.G(2). This alternate method has not been previously approved by the NRC and therefore, per Appendix A Section VIII.B.5.b(8), such a Tier 2 change requires prior NRC approval.

This departure and the required amendment to the application is justified as follows:

(1) This departure will not result in a significant decrease in the level of safety otherwise provided by the design. The departure involves use of an alternate method of evaluation of pool swell. The alternate method is demonstrated to produce similar results to the method described and used in the DCD, by comparing the alternate method results using the DCD inputs to the DCD analysis results. The departure does not change the ABWR design as described in the ABWR DCD. The use of this alternate method to assess the pool swell results for the changes in the containment pressure response provides accurate results that are used as input for the wetwell internals design, and assures that these components will be adequately designed for the appropriate loads. Therefore, the use of the alternate method does not adversely affect the design and thus does not create a condition that would significantly decrease the level of safety otherwise provided by the design.

(2) The departure is necessary to have an approved method to evaluate pool swell loads. The method described in the DCD is no longer available to the COL applicant, and the containment pressure results, which are input for the pool swell analysis, have changed due to the updated analysis as described in STD DEP 6.2-2. As such, this departure is needed to update the DCD and ultimately will contribute to standardization, as this COL application is the R-COLA and will be the basis for S-COLA submittals.

3B Containment Hydrodynamic Loads

The information in this appendix of the reference ABWR DCD, including all subsections, tables, and figures, is incorporated by reference with the following departures.

STD DEP T1 2.4-3

STD DEP 3B-1

STD DEP ~~6.2-2~~ 3B-2 (Table 3B-1, Figures 3B-12, 3B-13)

STD DEP Admin (Figures 3B-21, 3B-24, 3B-26)

As required by Section IV.A.3 of the ABWR Design Certification Rule, the plant-specific DCD must physically include the proprietary and safeguards information referenced in the ABWR DCD. Appendix 3B in the reference ABWR DCD references proprietary information. That proprietary information, has finality in accordance with Section VI.B.2 of the ABWR Design Certification Rule, and does not constitute a supplement to or departure from the reference ABWR DCD.

3B.4.2.1 Pool Boundary Loads

STD DEP 3B-2

~~STD DEP 6.2-2~~

ABWR Pool Swell Loads

ABWR pool swell response calculations to quantify pool swell loads were based on a simplified, one dimensional analytical model. The model was qualified against test data from the Pressure Suppression Test Facility (PSTF) 1/3-for a scaled Mark III pressure suppression system geometry. The methodology is similar to*~~, same as~~ that reviewed and accepted by the staff (NEDE-21544P/NUREG-0808) for application to Mark II plants.~~This analytical model was qualified against Mark II full-scale test data.~~ The ABWR* pressure suppression system *design* is similar to the Mark III design. The main difference is the smaller gas space above the suppression pool in the ABWR. This difference is accounted for in the analytical model for the pressure suppression system. *~~utilizes a confined wetwell airspace similar to that in Mark II design, but its vent system design is quite different than that in Mark II design. The ABWR vent system design utilizes horizontal vents similar to that in Mark III design. Therefore, recognizing this difference in vent system design, additional studies comparing model against Mark III horizontal vent test data were performed to assure adequacy of the model for application to ABWR.~~*

Model Vs. Mark III Horizontal Vent Test Data

Test data used to qualify the analytic model was taken from 1/3-scale tests for a Mark III geometry. The submergence to pool width ratio was representative of conditions in an ABWR. The GOTHIC code was used to model the Mark III tests. The model was designed to bound the test data. The test data used in the model comparison, and the modeling approach, are fully described in Reference 3B-17. ~~*Model input/ assumptions used in predicting Mark III test data for model comparison were the same as prescribed in NEDE-21544P. Mark III horizontal vent system features were modeled in the following manner:*~~ The major modeling assumptions were:

- ~~*Pool swell water slug was approximated by a consistent thickness equal to top vent submergence*~~

- The ~~*Drywell*~~ drywell *pressure transient* ~~*and vent clearing times*~~ was specified using data from the tests ~~*input based on test data*~~

- Pressure losses between the measured pressure in the drywell and the weir wall region were ignored

- ~~*Vent flow area increased in order with the clearing of middle and bottom vents*~~ A single horizontal vent, having the full combined open area of the three horizontal vents, was modeled at the elevation of the top vent

~~*Test data used for model comparison were taken from full-scale and sub-scale tests, and they were representative of ABWR submergence to pool width ratio. The test data used in model comparison are listed in Table 3B-8.*~~

Comparison results, summarized in Reference 3B-17 ~~*Table 3B-9 and sample results shown graphically in Figures 3B-9 and 3B-10, demonstrate that the model over predicts the horizontal vent test data. These comparison results*~~ *demonstrate and assure adequacy of the model for calculating ABWR pool swell response.*

Pool Swell Loads

Pool swell response calculations were done using the same modeling approach and assumptions that were used in the qualification against the 1/3 scale Mark III test data. The model is fully described in Reference 3B-17.~~*analytical model described above. Reference 3B-14 provides a detailed description of the model. The modeling scheme for calculations was consistent with that used for model vs. test data comparison. For an added conservatism in model predictions, water slug surface area occupied by the air bubble was taken as 80% of the total pool surface area in pool swell response calculations.*~~

The model includes ~~*In modeling and simulating the pool swell phenomenon,*~~ the following assumptions ~~*were made*~~:

(1) Noncondensable gases are assumed to behave as an ideal gas.

(2) After the vent clearing, only noncondensable gases flow through the vent system.

(3) The flow rate of noncondensable gases through the vent system is calculated assuming one-dimensional flow under adiabatic conditions and considering the pipe friction effects with possible choking at the vent exit.

(4) The noncondensable gases contained initially in the drywell are compressed isentropically.

(5) *The temperature of bubbles* is forced to near thermal equilibrium with the pool. ~~*(noncondensable gas) in the pool is taken to be the same as that of the noncondensable gases in the drywell (from (4)).*~~

(6) ~~*After the vent clearing, pool water of constant thickness above the top horizontal vent outlet is accelerated upward.*~~The built-in interfacial drag models in GOTHIC are used to predict the bubble expansion and the acceleration of the water above the vents, including differential velocity in the air and water phases resulting in thinning of the slug as it rises.

(7) *Friction between* the *pool water and the pool boundary* ~~*and fluid viscosity are*~~ is *neglected.*

(8) *Noncondensable gas*~~*es present*~~ *in the wetwell airspace* ~~*are*~~ ~~*assumed*~~ is compressed by the rising water. For predicting the maximum slug velocity, the air space is assumed to be in thermal equilibrium with the pool to minimize the air space pressure. For predicting the maximum bubble and air space pressure, the air space is assumed to be thermally isolated from the pool.~~*to undergo a polytropic compression process during the pool swell phase.*~~

(9) Heat transfer to the pool and air space boundaries is ignored. ~~*For conservative estimates, a polytropic index of 1.2 will be used for computing the pool swell height and pool swell velocity, and an index of 1.4 for computing pressurization of the wetwell airspace.*~~

(10) ~~*For added conservatism, pool swell velocity obtained in (9) above will be multiplied uniformally by a factor of 1.1 in defining impact/drag loads.*~~ The air bubble is constrained to rise in an area that is 80% of the full pool area.

Structures located between 0 and ~~*7m*~~~~8.5m~~[ ]m *above the initial surface will be subjected to impact load by an intact water ligament, where the* ~~*7m*~~~~8.5m~~[ ]m *value corresponds to the calculated maximum pool swell height. The load calculation methodology will be based on that approved for Mark II and Mark III containments (NUREG-0487 and NUREG-0978).*

Structures located at elevations between the ~~*7m*~~~~8.5m~~[ ]m *and* ~~*10.3m*~~~~11.7m~~[ ]m *will be subjected to froth impact loading. This is based on the assumption that bubble breakthrough (i.e., where the air bubbles penetrate the rising pool surface) occurs at* ~~*7m*~~~~8.5m~~[ ]m *height, and the resulting froth swells to a height of* ~~*3.3m*~~[ ]m. ~~*This froth swell height is the same as that defined for Mark III containment design and this.*~~This *is considered to be conservative for the ABWR design. Because of substantially smaller wetwell gas space volume (about 1/5th of the Mark III design), the ABWR containment is expected to experience a froth swell height substantially lower than the Mark III design. The wetwell gas space is compressed by the rising liquid slug during pool swell, and the resulting increase in the wetwell gas space pressure will decelerate the liquid slug before the bubble break-through process begins. The load calculation methodology will be based on that approved for the Mark III containment (NUREG-0978).*

As shown in Figure 3B-13 the gas space above the ~~*10.3 m*~~~~11.7m~~[ ]m *elevation will be exposed to spray condition* ~~*including*~~ which is expected to induce *no significant loads on structures in that region.*

As drywell air flow through the horizontal vent system decreases and the air/water suppression pool mixture experiences gravity-induced phase separation, pool upward *movement stops and the "fallback" process starts. During this process, structures between the bottom vent and the ~~10.3m~~~~11.7m~~[ ]m elevation can experience loads as the mixture of air and water fall past the structure. The load calculation methodology for ~~the~~ defining such loads will be based on that approved for Mark III containment (NUREG-0978).*

3B.7 References

STD DEP 3B-2

3B-17 "Westinghouse BWR Pool Swell Calculation Methodology Using GOTHIC," WCAP-17065-P, Westinghouse Electric Company, LLC, [ ] 2009.

Table 3B-1 Pool Swell Calculated Values

Description	Value
1. Air bubble pressure (maximum)	~~*133.37 kPaG*~~ ~~190.0kPaG~~ [ ] kPaG
2. Pool swell velocity (maximum)	~~*6.0 m/s*~~ [ ] m/s
3. Wetwell airspace pressure (maximum)	~~*107.87 kPaG*~~ ~~155.0kPaG~~ [ ] kPaG
4. Pool swell height (maximum)	~~*7m*~~ ~~8.5m~~ [ ]m