PMSTPCOL PEmails

From: Tomkins, James [jetomkins@STPEGS.COM]
Sent: Tuesday, July 28, 2009 7:41 PM
To: Muniz, Adrian; Sosa, Belkys; Dyer, Linda; Wunder, George; Eudy, Michael; Plisco, Loren; Anand, Raj; Foster, Rocky; Joseph, Stacy; Govan, Tekia; Tai, Tom
Subject: RAI Response on 06.02.01.01.C-6
Attachments: U7-C-STP-NRC-090086.pdf

Attached please find a courtesy copy of the letter sent to the NRC in response to the staff question included in RAI letter number 76.

The official paper copy was mailed today according to the letter addressee list.

If you have any questions, please contact Jim Tomkins at (805)-215-6129.

Hearing Identifier: SouthTexas34Public_EX
Email Number: 1523

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Subject: RAI Response on 06.02.01.01.C-6
Sent Date: 7/28/2009 7:41:17 PM
Received Date: 7/28/2009 7:41:31 PM
From: Tomkins, James

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July 28, 2009
U7-C-STP-NRC-090086

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

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

Attached is a response to an NRC staff question included in Request for Additional Information (RAI) letter number 76 related to Combined License Application (COLA) Part 2, Tier 2, Appendix 3B.

The attachment contains the complete response to the RAI question listed below:

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) 972-7206, or Bill Mookhoek at (361) 972-7274.

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

Executed on 7/28/2009

M A McBurnett

Mark McBurnett
Vice President, Oversight and Regulatory Affairs
South Texas Project Units 3 & 4

jet

Attachment:
Question 06.02.01.01.C-6

STI 32509686

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

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RAI 06.02.01.01.C-6:

QUESTION:

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.

RESPONSE:

The revised pool swell heights (pool and froth) provided in COLA Rev. 2 were estimated values selected based on engineering judgment, preliminary assessments, and a publicly available reference from COLA Rev. 0 (NEDO-33372), which indicated an expected increase in pool swell heights. 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 used to determine the loads used for the structural evaluation of components and structures in the wetwell. The calculation of the loads and the wetwell internals structural analysis 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. This methodology will follow the method described in the DCD, but will use a different computer code. Since the pool swell methodology to be used by Westinghouse will be different than that used for the DCD, this departure will require prior NRC approval. The Westinghouse pool swell calculation methodology will be described in Toshiba report UTLR-0005, "ABWR Pool Swell Calculation Methodology Using GOTHIC." This report will include a benchmark against existing available pool swell test data. Comparisons to the DCD analysis show good agreement between the Westinghouse pool swell method results and the existing DCD pool swell results. This report will be submitted to the NRC in September 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.

Similar to COLA Rev. 2, the Westinghouse analysis results show that the maximum pool swell height, peak velocity, maximum bubble pressure and maximum wetwell airspace pressure are greater than the values currently in the DCD.

The following will be included in a future COLA revision: (1) new STD DEP 3B-2 will be added to Part 7 Section 2.3 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 Subsections 3B.4.2.1 and 3B.7, 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 (1) the departure description for new departure STD DEP 3B-2; (2) markups of COLA changes to Appendix 3B Section 3B.4.2.1, Section 3B.7, and Table 3B-1; and (3) changes to Figures 3B-12 and 3B-13. The text that will be changed from COLA Rev. 2 is highlighted with gray shading.

It is noted that the markups in the RAI response supersede those in a prior response to RAI 06.02.01.01.C-6 provided in STPNOC letter U7-STP-NRC-090033, submitted to NRC on April 20, 2009.

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 Subsections 3B.4.2.1 and 3B.7.

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) for a 1/3- 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 wetwell is represented by a subdivided one-dimensional model

- 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 to maximize the air flow into the suppression pool

- ~~*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) All three horizontal vents are combined into a single flow path that has the total flow area of all 3 vents. The bottom of the single modeled vent is located at the physical bottom of the top vent

in the vertical vent pipe.~~*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~~8.8m *above the initial surface will be subjected to impact load by an intact water ligament, where the* ~~*7m*~~~~8.5m~~8.8m *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~~8.8m *and* ~~*10.3m*~~~~11.7m~~12.1m *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~~8.8m *height, and the resulting froth swells to a height of 3.3m.* ~~*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~~12.1m *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~~12.1m 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).*

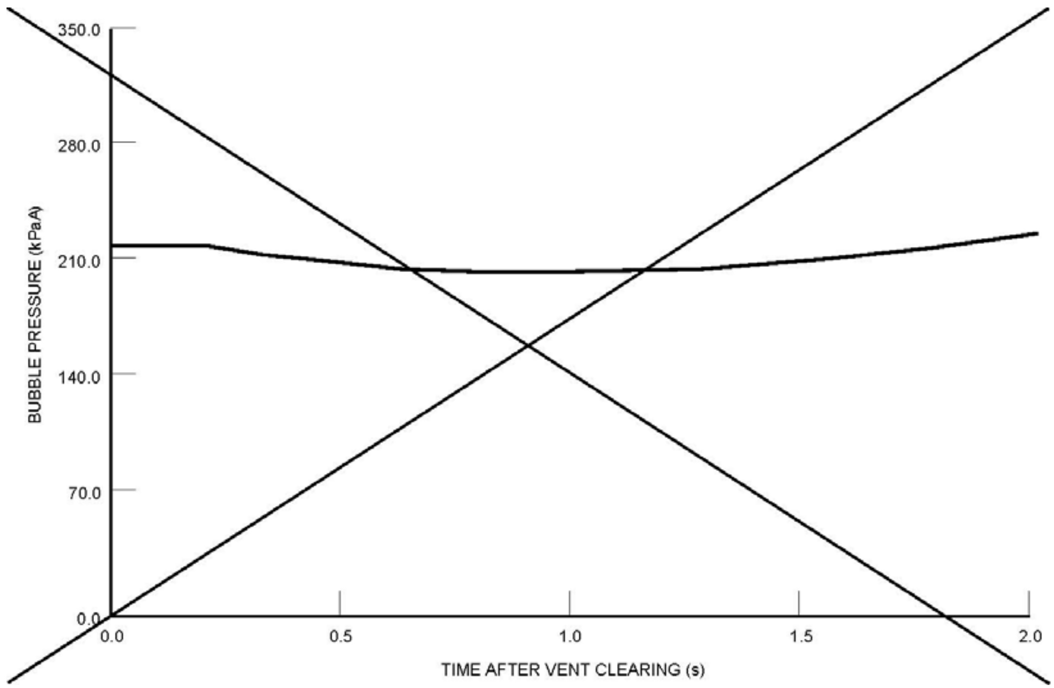
3B.7 References

STD DEP 3B-2

3B-17 "ABWR Pool Swell Calculation Methodology Using GOTHIC," UTLR-0005, Toshiba Corporation, September 2009.

Table 3B-1 Pool Swell Calculated Values

Description	Value
1. Air bubble pressure (maximum)	~~*133.37 kPaG*~~ ~~190.0kPaG~~ 195 kPaG
2. Pool swell velocity (maximum)	~~*6.0 m/s*~~ 10.9 m/s
3. Wetwell airspace pressure (maximum)	~~*107.87 kPaG*~~ ~~155.0kPaG~~ 146 kPaG
4. Pool swell height (maximum)	~~*7m*~~ ~~8.5m~~ 8.8m



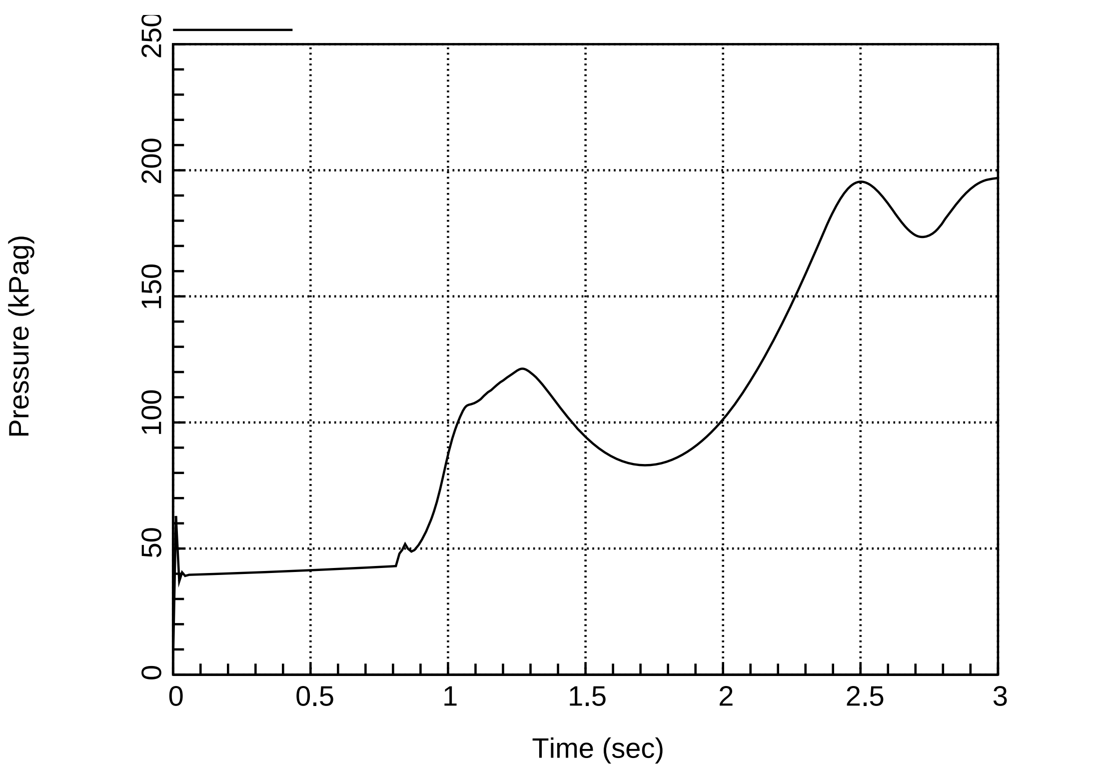


Figure 3B-12 Time History of Air Bubble Pressure

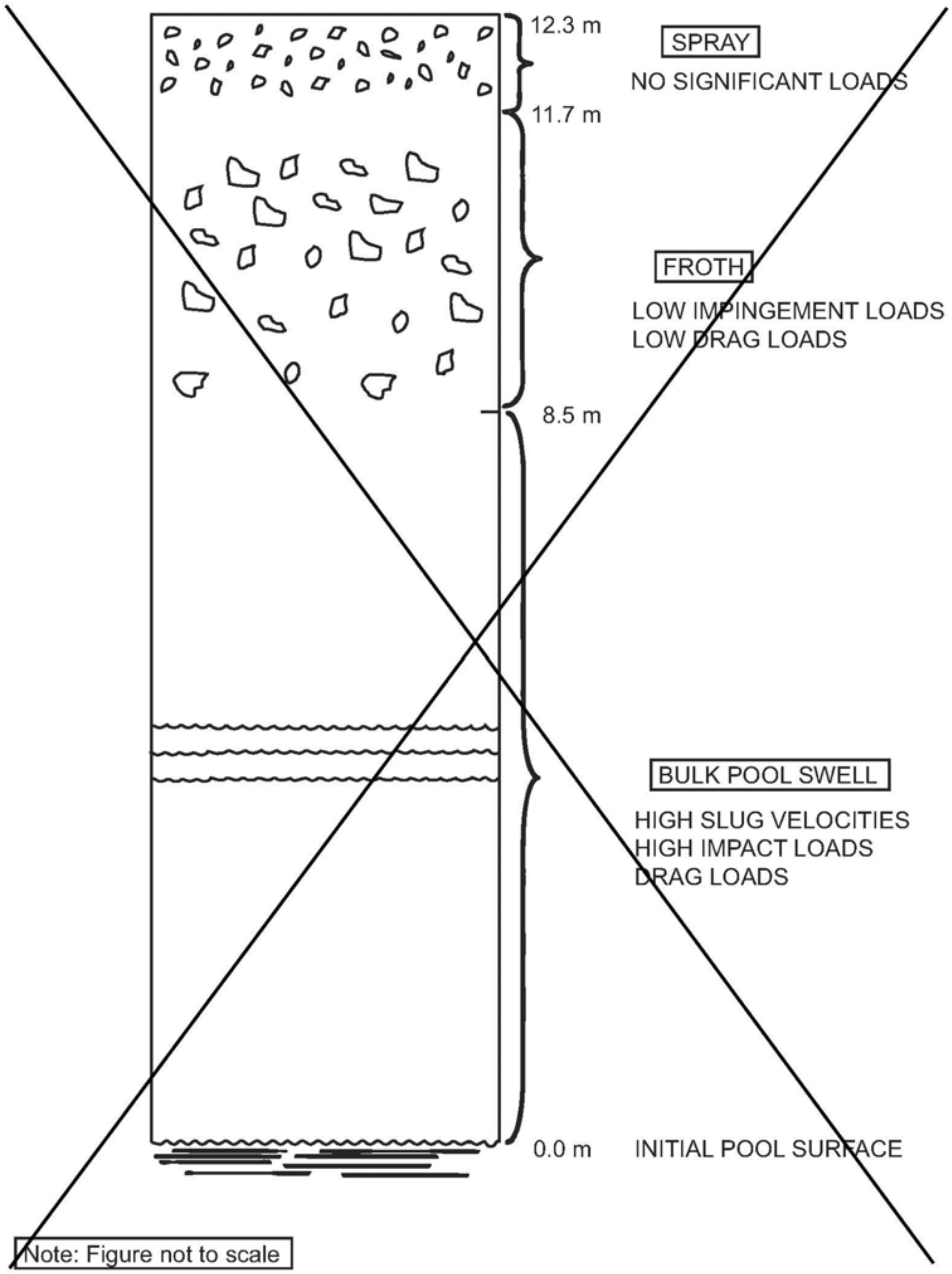


Figure 3B-13 Schematic of the Pool Swell Phenomenon

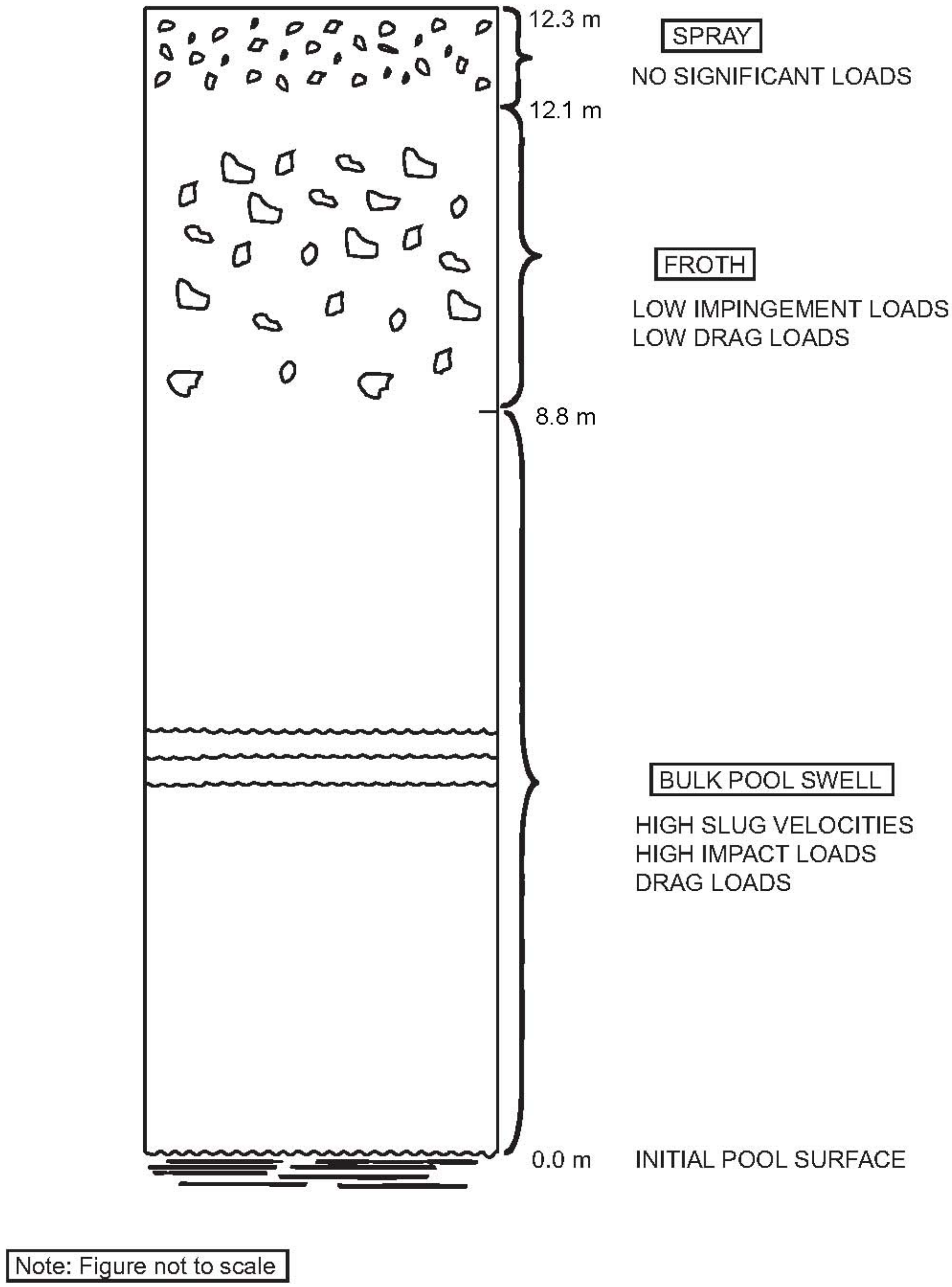


Figure 3B-13 Schematic of the Pool Swell Phenomenon