Tennessee Valley Authority, Post Office Box 2000, Decatur, Alabama 35609-2000

August 4, 2006

TVA-BFN-TS-431
TVA-BFN-TS-418

10 CFR 50.90

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Mail Stop OWFN, P1-35
Washington, D. C. 20555-0001

Gentlemen:

In the Matter of	)	Docket Nos. 50-259
Tennessee Valley Authority	)	50-260
	)	50-296

BROWNS FERRY NUCLEAR PLANT (BFN) - UNITS 1, 2, AND 3 - TECHNICAL SPECIFICATIONS (TS) CHANGES TS-431 AND TS-418 - EXTENDED POWER UPRATE (EPU) - RESPONSE TO ROUND 6 REQUESTS FOR ADDITIONAL INFORMATION (TAC NOS. MC3812, MC3743, AND MC3744)

By letters dated June 28, 2004 (ADAMS Accession No. ML041840109) and June 25, 2004 (ML041840301), TVA submitted applications to the NRC for EPU of BFN Unit 1 and BFN Units 2 and 3, respectively. On June 26, 2006, the NRC staff issued the Round 6 requests for additional information (RAIs) (ML061730020 and ML061680031 for BFN Unit 1 and BFN Units 2 and 3, respectively). By letter dated July 6, 2006 (ML061950670), TVA provided a partial response to questions regarding General Electric fuel methods that support the BFN Unit 1 application for EPU. By letter dated July 21, 2006,

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TVA provided an additional partial response to questions regarding credit for containment overpressure. Enclosure 1 to this letter provides responses to the remaining Round 6 RAI questions.

Enclosure 1 reflects the results of an extensive review and re-analysis of low pressure ECCS net positive suction head (NPSH) based on conservative assumptions and methods. Although not part of BFN's licensing basis, NPSH analyses for special events have been performed using the guidance of Regulatory Guide 1.82, Revision 3, which has in the past only been applied to LOCA events. The results conclude that adequate NPSH and containment overpressure are available for the full spectrum of events analyzed.

Note that Enclosure 1 contains information that General Electric Company (GE) considers to be proprietary in nature and subsequently, pursuant to 10 CFR 9.17(a)(4), 2.390(a)(4) and 2.390(d)(1), requests that such information be withheld from public disclosure. Enclosure 2 is a redacted version of Enclosure 1 with the proprietary material removed. Enclosure 2 is suitable for public disclosure. Enclosure 1 contains an affidavit from GE supporting this request for withholding from public disclosure.

Enclosure 3 is a copy of TVA Calculation MDQ0999970046, Rev. 9, "NPSH Evaluation of Browns Ferry RHR and CS Pumps," and Enclosure 4 is a copy of TVA Calculation MDQ099920060011, Rev. 0, "Transient NPSH/Containment Pressure Evaluation of RHR and Core Spray Pumps." These calculations are referenced in this response to the RAI.

TVA has determined that the additional information provided by this letter does not affect the no significant hazards considerations associated with the proposed TS changes. The proposed TS changes still qualify for a categorical exclusion from environmental review pursuant to the provisions of 10 CFR 51.22(c)(9).

A new regulatory commitment is made in this submittal. Enclosure 5 describes the commitment to revise Appendix R fire safe shutdown operating procedures to terminate drywell cooling within two hours of entry into the procedure.

If you have any questions regarding this letter, please contact me at (256)729-2636.

I declare under penalty of perjury that the foregoing is true and correct. Executed on this 4th day of August, 2006.

Sincerely,

William D. Crouch

William D. Crouch
Manager of Licensing
and Industry Affairs

Enclosures:

1. Response to Round 6 Request for Additional Information (Proprietary Information Version)
2. Response to Round 6 Request for Additional Information (Non-Proprietary Version)
3. Calculation MDQ0999970046, Rev. 9, "NPSH Evaluation of Browns Ferry RHR and CS Pumps"
4. Calculation MDQ099920060011, Rev. 0, "Transient NPSH/Containment Pressure Evaluation of RHR and Core Spray Pumps"
5. Commitment Summary

cc (w. Enclosures):
State Health Officer
Alabama Dept. of Public Health
RSA Tower - Administration
Suite 1552
P.O. Box 303017
Montgomery, AL 36130-3017

U.S. Nuclear Regulatory Commission
Region II
Sam Nunn Atlanta Federal Center
61 Forsyth Street, SW, Suite 23T85
Atlanta, Georgia 30303-3415

Mr. Malcolm T. Widmann, Branch Chief
U.S. Nuclear Regulatory Commission
Region II
Sam Nunn Atlanta Federal Center
61 Forsyth Street, SW, Suite 23T85
Atlanta, Georgia 30303-8931

NRC Senior Resident Inspector
Browns Ferry Nuclear Plant
10833 Shaw Road
Athens, Alabama 35611-6970

NRC Unit 1 Restart Senior Resident Inspector
Browns Ferry Nuclear Plant
10833 Shaw Road
Athens, Alabama 35611-6970

Margaret Chernoff, Project Manager
U.S. Nuclear Regulatory Commission
(MS 08G9)
One White Flint, North
11555 Rockville Pike
Rockville, Maryland 20852-2739

Ms. Eva A. Brown, Project Manager
U.S. Nuclear Regulatory Commission
(MS 08G9)
One White Flint, North
11555 Rockville Pike
Rockville, Maryland 20852-2739

General Electric Company

AFFIDAVIT

I, Louis M. Quintana, state as follows:

(1) I am Manager, Licensing, General Electric Company ("GE"), have been delegated the function of reviewing the information described in paragraph (2) which is sought to be withheld, and have been authorized to apply for its withholding.

(2) The information sought to be withheld is contained in Enclosures 1, 4, and 5 of GE's letter, GE-ER1-AEP-06-334, entitled "GE Responses to NRC Request for Additional Information – ACVB-37 and Draft TVA Letter", August 3, 2006. The proprietary information in the Enclosure 1, which is entitled "GE Responses to NRC Request for Additional Information – SWBW-26, 30, 32, 33, and 34", Enclosure 4, which is entitled "Comments on draft TVA letter", and Enclosure 5, which is entitled "Proprietary Review of draft TVA letter", is delineated by a double underline inside double square brackets. Figures and large equation objects are identified with double square brackets before and after the object. In each case, the superscript notation $^{\{3\}}$ refers to Paragraph (3) of this affidavit, which provides the basis for the proprietary determination.

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

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

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

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

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

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

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

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

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

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

(8) The information identified in paragraph (2) above is classified as proprietary because it contains detailed results and conclusions regarding GE methods supporting evaluations of safety-significant aspects of the analysis of expanded power/flow operating domains and reload core designs for a GE BWR utilizing analytical models and methods, including computer codes which GE has developed, obtained NRC approval of, and applied to perform evaluations of transients and accident events in the GE Boiling Water Reactor ("BWR"). The development and approval of these system, component, and thermal-hydraulic models and computer codes was achieved at a significant cost to GE, on the order of several million dollars.

The development of the evaluation process along with the interpretation and application of the analytical results is derived from the extensive experience database that constitutes a major GE asset.

(9) Public disclosure of the information sought to be withheld is likely to cause substantial harm to GE's competitive position and foreclose or reduce the availability of profit-making opportunities. The information is part of GE's comprehensive BWR safety and technology base, and its commercial value extends beyond the original development cost. The value of the technology base goes beyond the extensive physical database and analytical methodology and includes development of the expertise to determine and apply the appropriate evaluation process. In addition, the technology base includes the value derived from providing analyses done with NRC-approved methods.

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

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

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

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

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

Executed on this 3rd day of August 2006.

Louis M. Quintana
General Electric Company

ENCLOSURE 2

TENNESSEE VALLEY AUTHORITY
BROWNS FERRY NUCLEAR PLANT (BFN)
UNITS 1, 2, AND 3

TECHNICAL SPECIFICATIONS (TS) CHANGES TS-431 AND TS-418 - EXTENDED POWER UPRATE (EPU) - RESPONSE TO ROUND 6 REQUEST FOR ADDITIONAL INFORMATION (TAC NOS. MC3812, MC3743, AND MC3744)

RESPONSES TO REQUESTS FOR ADDITIONAL INFORMATION

(NON-PROPRIETARY VERSION)

This enclosure provides TVA's response to the remaining questions from the NRC staff's June 26, 2006, Round 6 Requests for Additional Information (ADAMS Accession Nos. ML0617300020 and ML0616800031 for BFN Unit 1 and BFN Units 2 and 3, respectively). Because the same information was requested for all BFN units, the responses to the two sets of NRC Round 6 RAIs are combined below for all three BFN units. The following numbering of the RAI questions and responses corresponds to Unit 1, followed by Units 2 and 3 in the format of "(x/y)."

NRC Request APLA.23/25

For each PRA accident sequence that realistically requires containment accident pressure, describe how much pressure is required and for what period of time.

TVA Response to APLA.23/25

The requested information is provided in the figures included in the response to ACVB.56/54.

NRC Request ACVB.37/35

The term design flow rate is used to describe the core spray pump flow rate and the residual heat removal (RHR) pump flow rate assumed in the NPSH analyses. Define precisely the "design flow rate" in terms of the pump and system curves.

TVA Response to ACVB.37/35

Design flow rates referred to in NPSH evaluations have one of two bases depending upon the particular event analysis. The flow for the short term LOCA and Appendix R events is based upon the system design whereas the long term LOCA, SBO and ATWS analysis are based on operator manual control of the flow.

During review of the NPSH analysis provided previously, it was determined that the values based on system design were not conservative in that minimum design flows were used rather than maximum flows that would be expected for the pump and system curves. This issue is documented in the BFN corrective action program and calculations have been revised to reflect conservative maximum flow values. NPSH analyses for LOCA short term and Appendix R are affected. Revised calculation MDQ0999970046, Revision 9 is provided in Enclosure 3.

In the short term LOCA analysis, RHR and Core Spray systems are assumed to be injecting to the vessel with flow control valves 100% open. In this mode, flow rate is governed by system resistance and the pump curve. The short term LOCA analysis is terminated at 10 minutes when it is assumed that operators take control of ECCS and align the systems for the minimum required pumps, and minimum required flows, which are then utilized in the long term LOCA analysis. Flow rates expected in this mode are also included in Calculation MDQ0999970046, Revision 9 (Enclosure 3).

In the ATWS, SBO, and long term LOCA event analyses, system flow is controlled by the operators using FSAR required flows.

Emergency Operating Instructions (EOIs) direct the operators to throttle flow control valves to maintain flow within limits and also to maintain flow within NPSH limit curves. For RHR in suppression pool cooling, flow for two pump operation is maintained below 13,000 gpm or 6,500 gpm/pump as assumed in the NPSH analysis. For Core Spray, the operator is instructed to maintain flow less than 4,000 gpm and within the NPSH limit curves. For determining adequate NPSH, it is assumed that the operator would reduce flow in response to the NPSH limit curves, but not less than the minimum flow given in the FSAR (i.e., 3,125 gpm). Operation within the NPSH limit curves ensures adequate NPSH for the given plant conditions over a range of flows. These are the values assumed in the long term analysis.

For the Appendix R event, a single RHR pump is assumed to be injecting to the vessel with flow control valves 100% open and a flow path established through the main steam relief valves back to the suppression pool. Flow rate is governed by system resistance and back pressure from the reactor vessel. Flow rates expected in this mode are included in Calculation MDQ0999970046, Revision 9 (Enclosure 3).

The flows utilized in the NPSH analyses are listed in Table ACVB.37/35-1. The results of the revised NPSH analyses using these values are presented in the response to ACVB.56/54.

Table ACVB.37/35-1

Event/Pump Configuration	Previous Flow Used in NPSH Analyses (gpm)	Current Flow Used in NPSH Analyses (gpm)
LOCA Short-term		
• RHR pump LPCI Mode	10,000	10,500
• RHR pump broken loop	11,000	11,500
• CS pump	3,125	4,125
LOCA Long-term		
• RHR pump	6,500	6,500
• CS pump	3,125	3,125
Appendix R		
• RHR pump	6,500	7,200
ATWS		
• RHR pump	6,500	6,500
SBO		
• RHR pump	6,500	6,500

NRC Request ACVB.39/37

Provide the calculations used to determine the containment conditions (drywell, wetwell and suppression pool) for the loss-of-coolant accident (LOCA), Anticipated Transient Without Scram (ATWS), Station Blackout (SBO) and Appendix R Fire events.

TVA Response to ACVB.39/37

The current containment analyses used in evaluating NPSH are included in Calculation MDQ099920060011, Rev. 0, "Transient NPSH/Containment Pressure Evaluation of RHR and Core Spray Pumps," (Enclosure 4).

NRC Request ACVB.40/38

Describe how the proposed crediting of containment accident pressure in determining available NPSH compares with the positions of Section 2.1.1 of Regulatory Guide 1.82, Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident, Revision 3 dated November 2003.

TVA Response to ACVB.40/38

NRC's acceptance of credit for containment overpressure for BFN in September 1999 was based on Revision 2 of Regulatory Guide (RG) 1.82, which does not include the specific regulatory positions of section 2.1.1 of Revision 3. It is not TVA's intent that RG 1.82, Revision 3 become part of BFN's licensing basis. Although RG 1.82 currently only applies to a LOCA, its application in LOCA, SBO, ATWS and Appendix R analyses is discussed below. The following are re-statements of the provisions of RG 1.82 (in boldface type) and how those provisions are addressed in BFN's analyses for NPSH.

2.1.1.1 **ECC and containment heat removal systems should be designed so that adequate available NPSH is provided to the system pumps, assuming the maximum expected temperature of the pumped fluid and no increase in containment pressure from that present prior to the postulated LOCAs. (See Regulatory position 1.1.1.2.)**

The available NPSH for RHR and Core Spray pumps is calculated based upon the maximum water temperature expected for a LOCA, ATWS, SBO and Appendix R events. Increase in containment pressure (containment overpressure (COP)) is credited and addressed under position 2.1.1.2.

2.1.1.2 **For certain operating BWRs for which the design cannot be practicably altered, conformance with Regulatory Position 2.1.1.1 may not be possible. In these cases, no additional containment overpressure should be included in determination of available NPSH than is necessary to preclude pump cavitation. Calculation of available containment pressure should underestimate the expected containment pressure when determining available NPSH for this situation. Calculation of suppression pool water temperature should overestimate the expected temperature when determining available NPSH.**

BFN cannot practicably be altered to comply with Regulatory Position 2.1.1.1 when licensing basis worst

case assumptions are utilized for analysis. The impact of assuming worst case single failures and bounding values for plant parameters is outlined in the response to SPSB-A.11 contained in TVA to NRC letter dated March 23, 2006 (ML060880460 for Unit 1 and ML060880395 for Units 2 and 3) which demonstrates that in the event of a LOCA, it is not likely that containment overpressure will actually be required in the long term. Design changes necessary to offset the effect of worst case assumptions would involve increasing available head by changing the elevation of major equipment or by decreasing maximum expected torus water temperature by adding significant heat removal capacity. These types of modifications would not be practical.

The amount of containment pressure credited for available NPSH is based upon the amount required to protect the pumps. Containment analyses are performed to determine minimum containment pressure available and ensure margin for the containment pressure required. Assumptions used to calculate containment pressure such as operation of drywell sprays, are chosen to minimize containment pressure and bounding assumptions are used to maximize water temperature.

NPSH analysis assumptions were reviewed to ensure that they were appropriately conservative with respect to determining maximum suppression pool temperature and minimum containment pressure and some non-conservative assumptions were identified in the existing analyses. These assumptions were addressed in the revised analyses (see ACVB.56/54) as discussed below:

CONTAINMENT SPRAY

In the NPSH analysis for special events, assumption of containment spray operation to minimize containment pressure was not previously considered. Containment spray operation would be expected during LOCA and SBO events based upon EOI criteria being met in the event analysis. Procedures applicable to an Appendix R event do not include containment spray and the ATWS event does not reach containment spray initiation criteria if operation of drywell coolers is assumed. Analysis of the LOCA event already included containment spray initiation at the beginning of the long term

(> 10 minutes) analysis when RHR pumps are aligned to the containment cooling mode.

For the SBO analysis, it is assumed that containment spray is initiated at the end of the 4 hour coping period when AC power is assumed to become available. Figures ACVB.56/54-5 and ACVB.56/54-6 show the results of the SBO event with containment spray included.

SERVICE WATER TEMPERATURE FOR CONTAINMENT SPRAY

The effect of containment spray to minimize containment pressure was investigated assuming cold (32°F) service water for the LOCA event long term analysis and the SBO. Operation of containment spray is not anticipated for ATWS and Appendix R events. For the LOCA event with cold service water, no COP is needed at the time the drywell sprays would be used. Therefore, the LOCA event using 95°F service water remains bounding with respect to the minimum NPSH margin.

For the SBO event, assuming that containment spray is initiated at 4 hours when AC power is assumed to be restored, colder service water produced the smallest NPSH margin but significantly reduces the time period for which COP is required. Credit for COP will be based on the 95°F temperature assumption. Figures ACVB.56/54-5 and ACVB.56/54-6 show results for both cases.

CONTAINMENT RESPONSE MODELING

Events analyses to determine peak containment pressures are modeled assuming thermal equilibrium between the suppression pool and the wetwell airspace. However, this assumption is not conservative with respect to minimizing containment pressure. For LOCA, Appendix R, SBO and ATWS events, mechanistic heat and mass transfer between the suppression pool and wetwell airspace is included in the results presented in the response to ACVB.56/54.

2.1.1.3 For certain operating BWRs for which the design cannot be practicably altered, if credit is taken for operation of an ECCS or containment heat removal pump in cavitation, prototypical pump tests should be performed along with post-test examination of the pump to demonstrate that the pump performance will not be

degraded and that the pump continues to meet all performance criteria assumed in the safety analysis. The time period in the safety analysis during which the pump may be assumed to operate while in cavitation should not be longer than the time for which the performance tests demonstrate the pump meets performance criteria.

NPSH evaluations are based on required net positive suction head ($NPSH_R$) values supplied by the pump vendor which provide reduced $NPSH_R$ values and allow some cavitation for short periods of time. These values are based on the pump vendor's development tests for the same model pumps with different impeller sizes tested at reduced NPSH ranging from 1% to 6% head loss. Reduced pump performance continues to meet the applicable safety analysis requirements. The duration for operation with reduced NPSH is considered in the analysis and kept within the time allowed by the pump vendor.

2.1.1.4 **The decay and residual heat produced following accident initiation should be included in the determination of the water temperature. The uncertainty in the determination of the decay heat should be included in this calculation. The residual heat should be calculated with margin.**

Calculation of water temperature for determination of available NPSH in a LOCA event includes heat input from all sources including reactor blowdown, decay heat assuming operation at 102% of licensed power level with uncertainty added (ANSI 5.1 plus 2σ) and pump heat from pumps assumed to be operating for the analysis. Initial power level and decay heat assumptions for ATWS, SBO and Appendix R events are more realistic and do not include decay heat and power level uncertainty. The residual heat is calculated conservatively.

2.1.1.5 **The hot channel correction factor specified in ANSI/HI 1.1-1.5-1994 should not be used in determining the margin between the available and required NPSH for ECCS and containment heat removal pumps.**

The required NPSH utilized in calculations is taken from vendor test results. A hot channel correction factor was not applied.

2.1.1.6 The level of the water in the suppression pool should be the minimum value given in the technical specifications reduced by the drawdown due to the suppression pool water in the drywell and sprays.

LOCA, ATWS, SBO and Appendix R NPSH calculations assume that the suppression pool level is at the minimum level required by Technical Specifications LCO 3.6.2.2 for the purposes of determining elevation head. Drawdown due to water in the sprays and drywell was not previously considered but has now been considered in the revised NPSH calculation MDQ0999970046, Revision 9 (see Enclosure 3). Approximately 4 inches of drawdown are included for LOCA and SBO events due to the holdup effect of loss of coolant to the drywell and drywell spray.

Drawdown is not included for special events:

- For the ATWS event, additional inventory is added to the containment system by HPCI and RCIC operation during the event, containment spray operation is not expected, and significant loss of coolant to the drywell is not involved.
- For the Appendix R event, containment spray operation is not expected and significant loss of coolant to the drywell in not involved.

2.1.1.7 Pipe and fitting resistance and the nominal screen resistance without blockage by debris should be calculated in a recognized, defensible method or determined from applicable experimental data.

The flow resistances in the piping system are developed from recognized hydraulic references *Cameron Hydraulic Data (Westaway and Loomis, 1970) and Flow of Fluids Through Valves, Fittings, and Pipe* (Crane, 1969). Nominal strainer resistance is derived from empirical relations including vendor test results for the suction screen assemblies.

2.1.1.8 Suction strainer screen flow resistance caused by blockage by LOCA-generated debris or foreign material in the containment that is transported to the suction intake screens should be determined using the methods in Regulatory Position 2.3.3.

Flow resistance due to strainer blockage for a LOCA event is based on Revision 2 of RG 1.82 which has similar requirements to Revision 3 regarding strainer blockage and head loss. Strainer debris loading and flow resistance was determined in accordance with Boiling Water Reactor Owners Group Utility Resolution Guidance (BWROG) (URG), NEDO-32686. BFN application of this methodology was reviewed and approved by NRC for BFN Units 2 and 3 in license amendments regarding crediting of containment overpressure for ECCS NPSH calculations dated September 3, 1999. (Unit 1's strainers are the same design as Units 2 and 3.)

2.1.1.9 Calculation of available NPSH should be performed as a function of time until it is clear that the available NPSH will not decrease farther.

As shown in the response to ACVB.56/54, the NPSH analyses for LOCA, ATWS, SBO, and Appendix R are carried out until containment overpressure is no longer needed for adequate NPSH.

NRC Request ACVB.41/39

The units have drywell coolers which operate during normal plant operation. Address whether the drywell coolers are conservatively assumed to continue operation following accident initiation for the LOCA, ATWS, SBO and Appendix R Fire events.

TVA Response to ACVB.41/39

LOCA EVENTS

The DBA-LOCA analyses do not assume operation of the drywell coolers. The drywell coolers are sized to offset the heat loads in the drywell during normal operating conditions with a relatively dry atmosphere. [[

]] In addition, EOIs governing drywell spray operation require shutdown of drywell coolers prior to initiating sprays. Therefore, when drywell sprays are operated, drywell coolers are not a factor.

[[

]] There would be negligible effect of drywell cooler operation on the containment pressure during the blowdown phase of the DBA-LOCA.

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It is therefore judged that the existing DBA-LOCA containment analyses are conservative as performed without modeling drywell cooler operation.

As discussed in TVA's response to NRC Request ACVB.29 in TVA's letter to the NRC dated March 7, 2006 (ML060720248 for Unit 1 and ML060680583 for Units 2 and 3), the stuck open MSRV event is bounded by the LOCA with a peak suppression pool temperature less than calculated for the DBA-LOCA. In this event, reactor vessel coolant makeup would be provided by HPCI/RCIC with suction from the condensate storage tank. As with the LOCA long-term analysis, RHR operation in suppression pool cooling during the stuck open MSRV event would not require containment overpressure at the analyzed peak suppression pool temperature to maintain adequate NPSH. Since containment pressure is not needed for RHR pump NPSH, any reduction in containment pressure due to operation of the drywell coolers would not affect the ability of the RHR pumps to operate in this event.

NON-LOCA EVENTS

In non-LOCA events involving suppression pool heatup without release of steam directly to the drywell or operation of containment spray early in the event, assuming operation of drywell coolers reduces containment pressure and should be considered in NPSH evaluations.

- *APPENDIX R*

  For the Appendix R event, it is not expected that the drywell coolers would be operating in the scenario that produces the minimum set of equipment assumed for this event. However, in the unlikely event that the drywell coolers would survive, the analyses were performed assuming the drywell coolers were in operation during the early stages of this event. Reactor depressurization in this event reduces drywell heat load from the pre-event condition and reduces containment pressure and temperature. Because this assumption may affect current operations, it is documented in the BFN corrective action program. Safe shutdown operating procedures will be revised to terminate drywell cooling within two hours of entry into the safe shutdown procedure. The results shown in the response to ACVB.56/54 include this operator action.

- *SBO*

  For the SBO event, containment spray is assumed after the 4 hour coping period because containment response analysis shows that containment pressure would be in excess of 12 psig when AC power is assumed to be restored and the system could function. Prior to 4 hours, operation of drywell cooling is not possible because AC power is required. EOIs direct the operator to terminate drywell coolers prior to initiating containment spray.

- *ATWS*

  For the ATWS event, it is reasonable to assume that drywell coolers continue operating in their pre-event configuration. Reactor depressurization in this event reduces drywell heat load from the pre-event condition and reduces containment pressure and temperature. Results provided in the response to ACVB.56/54 include the effect of drywell coolers and show that adequate NPSH would be available with a small margin. [[

]] Figures ACVB.41/39-1 and ACVB.41/39-2 represent the effects without and with reactor depressurization, respectively.

FIGURE ACVB.41/39-1: NPSH REQUIREMENTS FOR ATWS (TRACG - NO DEPRESSURIZATION)

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FIGURE ACVB.41/39-2: NPSH REQUIREMENTS FOR ATWS (TRACG - WITH DEPRESSURIZATION)

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NRC Request ACVB.42/40

Section 4.2.5 of the General Electric (GE) Analysis Report, PUSAR states that the NPSH margins were calculated based on conservatively assuming RHR maximum flow rates and containment spray design flow rates in the short term analyses and RHR and containment spray design flow rates in the long term analyses. Describe the design provisions or operator actions that limit the pump flows to these values.

TVA Response to ACVB.42/40

To clarify a point in the NRC Request ACVB.42/40, the PUSAR use of the term CS is Core Spray not containment spray. The flow rates assumed in the analyses and the bases for these values are addressed in the response to ACVB.37/35.

NRC RAI ACVB.47/45

Discuss whether any of the units have features to automatically terminate drywell or wetwell spray. Describe the conditions under which the operator would terminate drywell and/or wetwell spray under accident conditions in accordance with the EOIs. Address those measures put in place to prevent an operator from reducing wetwell pressure below that needed for adequate available NPSH.

TVA Response to RAI ACVB.47/45

This response supersedes the response provided in TVA's letter to the NRC dated July 21, 2006, which incorrectly stated that there were no automatic features or operating procedures which would terminate containment sprays. (This condition is documented in the BFN corrective action program.)

The BFN units have control logic for the drywell and wetwell spray valves that requires drywell pressure to be at or above 1.96 psig before spray paths can be established. In the presence of a sealed-in LPCI initiation signal, the spray paths will isolate automatically if drywell pressure subsequently drops below 1.96 psig. Additionally, the BFN EOIs require the operator to manually terminate sprays before pressure in the area being sprayed drops below 0 psig.

The BFN EOIs contain a CAUTION to the operator that reducing primary containment pressure will reduce the available NPSH for pumps taking suction from the suppression pool, and NPSH limit curves are contained in applicable EOI procedures. It is thus intended that ECCS pump NPSH requirements be considered when

containment sprays are operated. There are no additional NPSH specific conditions specified under which the operator would terminate drywell or wetwell spray. The drywell and wetwell spray approach that will be defined by the EOIs has been used as input to the containment analyses to assure consistency regarding containment spray operation. The containment analyses results demonstrate that following a LOCA, continuous containment spray will not prevent adequate available NPSH.

Unit 1 EOIs are being prepared for restart and will be essentially identical to the Unit 2 and 3 EOIs, reflecting minimal changes only as required for the Unit 1 reactor core and system hardware differences.

NRC Request ACVB.49/47

Address the criteria in the EOIs for initiating drywell and wetwell sprays. Discuss how the timing of the actions resulting from these criteria compares with the 10-minute assumption in the accident analyses for initiating suppression pool cooling. Discuss how the times for initiating drywell and wetwell sprays using the EOI criteria compare with times obtained in simulator training.

TVA Response to ACVB.49/47

The BFN EOIs, consistent with BWR EPGs, provide symptom based guidance to manually actuate containment sprays when containment pressure cannot be maintained below 12 psig or drywell temperature cannot be maintained below 280°F. For LOCA events, drywell sprays are assumed to be initiated at 10 minutes for NPSH evaluation. Actual operator action to initiate containment spray is not delayed by the 10 minute analysis assumption and could occur earlier in conjunction with re-alignment of RHR to the containment cooling mode. It is inherently assumed that initiation of containment spray takes place in conjunction with operators taking manual control after ECCS systems are aligned for the minimum required pumps and minimum required flows.

For the SBO event, criteria for initiating containment sprays will have been met prior to the end of the 4 hour coping period when AC power to operate the pumps is restored. It is conservative to assume that the sprays are operated immediately at the end of 4 hours in conjunction with placing RHR in containment cooling mode.

Containment spray initiation is accomplished in a matter of minutes when the EOI criteria is met. Therefore, the analysis conservatively reflects the effect of containment spray on NPSH.

NRC RAI ACVB.54/52

Table ACVB 22-1 in response to ACVB 22 from the March 7, 2006, letter, states that the licensing basis calculation of NPSH assumes no heat sinks while the realistic calculation does. Address whether the reverse should be true to ensure conservatism. Also, see TVA reply to ACVB 27 and Table SPSB-A.11-2 which states that not crediting heat sinks is conservative.

TVA Response to RAI ACVB.54/52

This response replaces the response provided by letter dated July 21, 2006, by adding the last paragraph below.

Table ACVB.22-1, the response to ACVB.27, and Table SPSB-A.11-2 are based upon the efforts taken to provide re-analyses of the suppression pool temperature response to reflect realistic values. The containment analysis case that produces the peak suppression pool temperature (licensing basis case) assumes no credit for heat sinks. This is conservative as it maximizes suppression pool temperature. The realistic assumption would be to credit heat sinks. Table SPSB-A.11-2 includes some results of analyses with credit for heat sinks.

The containment analysis case that minimizes containment pressure includes credit for heat sinks. This is conservative as it will minimize containment pressure. No effort was taken to re-analyze this containment analysis case with realistic values.

In summary, the analysis that maximizes peak suppression pool temperature assumes no credit for heat sinks which is conservative for this case. The analysis that minimizes containment pressure assumes credit for heat sinks which is conservative for this case.

NRC Request ACVB.56/54

The response to RAI ACVB 18 provided curves of pressures and temperatures for the events crediting containment accident pressure for available NPSH. The curves for ATWS and Appendix R Fire should be extended to provide the total time that containment accident pressure is needed for available NPSH.

TVA Response to ACVB.56/54

To address the discussions provided in TVA responses to ACVB.40/38 and 41/39, NPSH analyses have been re-performed for the LOCA long term, ATWS, Appendix R, and SBO events. Enclosures 3 and 4 are the supporting calculations. Figures ACVB.56/54-1 through 6 show the COP required and COP available for each case as a function of time. These graphs are extended to the time that containment overpressure is no longer needed to provide adequate NPSH.

FIGURE ACVB.56/54-1: NPSH REQUIREMENTS FOR DBA-LOCA - SHORT TERM

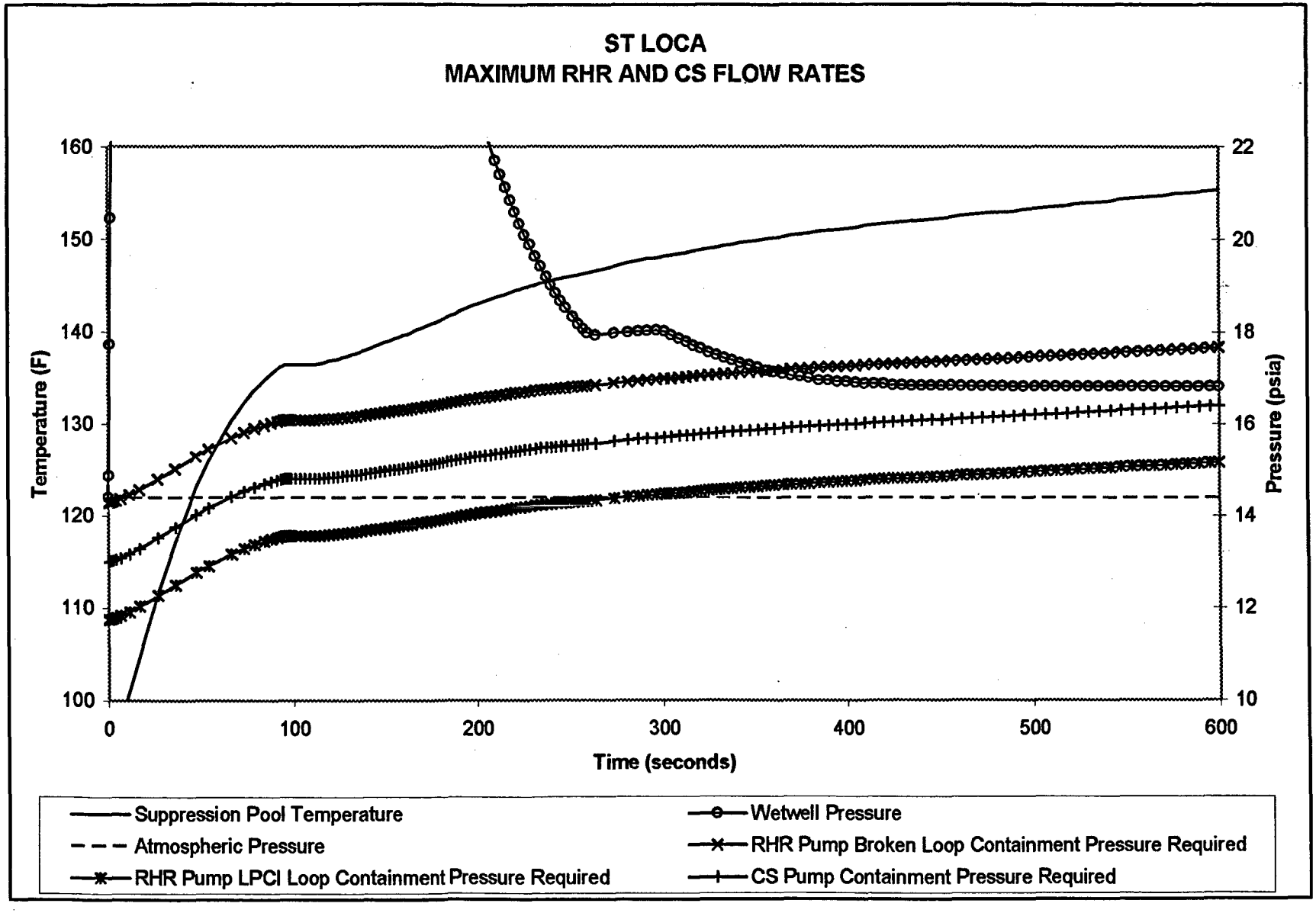


FIGURE ACVB.56/54-2: NPSH REQUIREMENTS FOR DBA-LOCA - LONG TERM

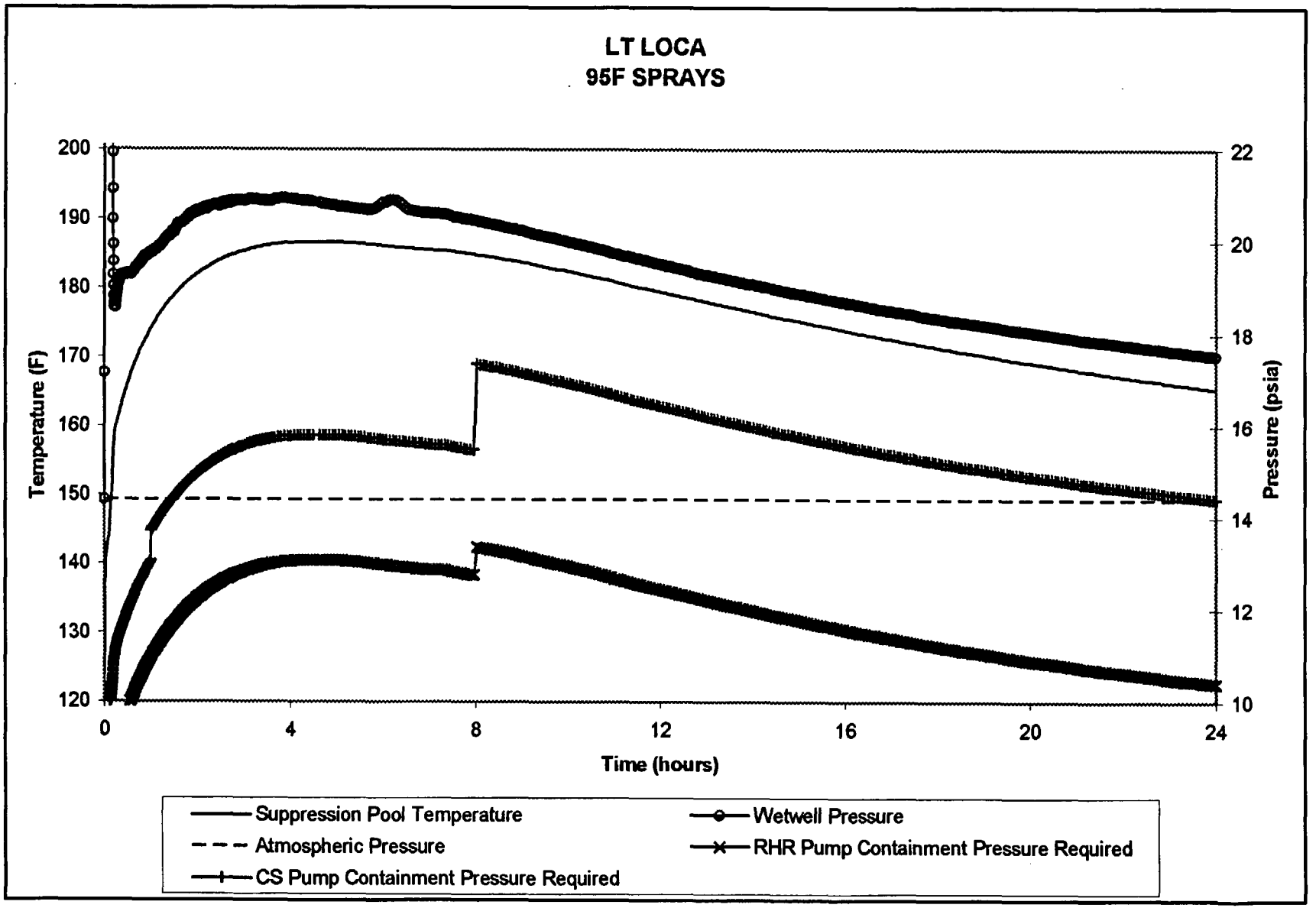


FIGURE ACVB.56/54-3: NPSH REQUIREMENTS FOR APPENDIX R

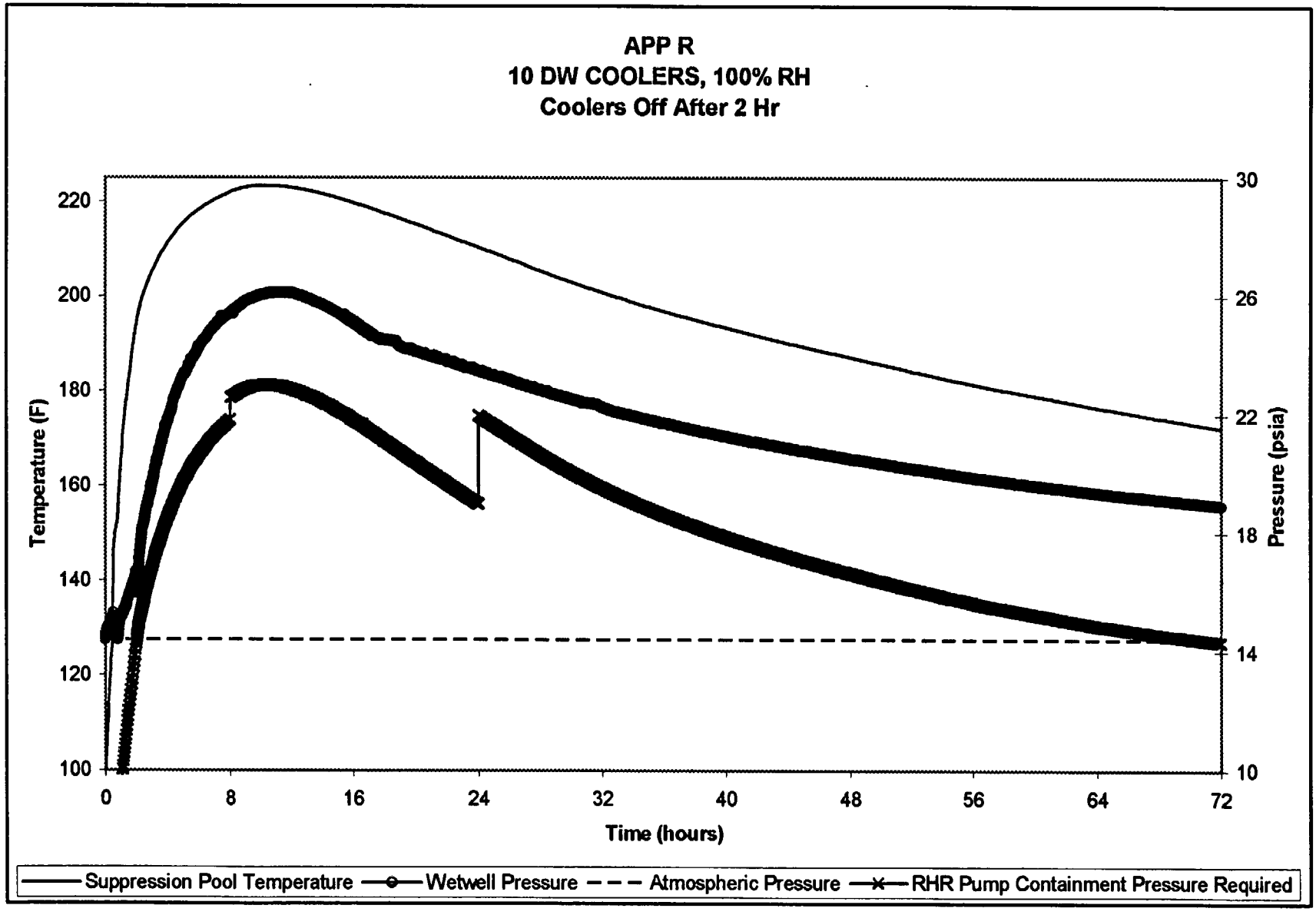


FIGURE ACVB.56/54-4: NPSH REQUIREMENTS FOR ATWS

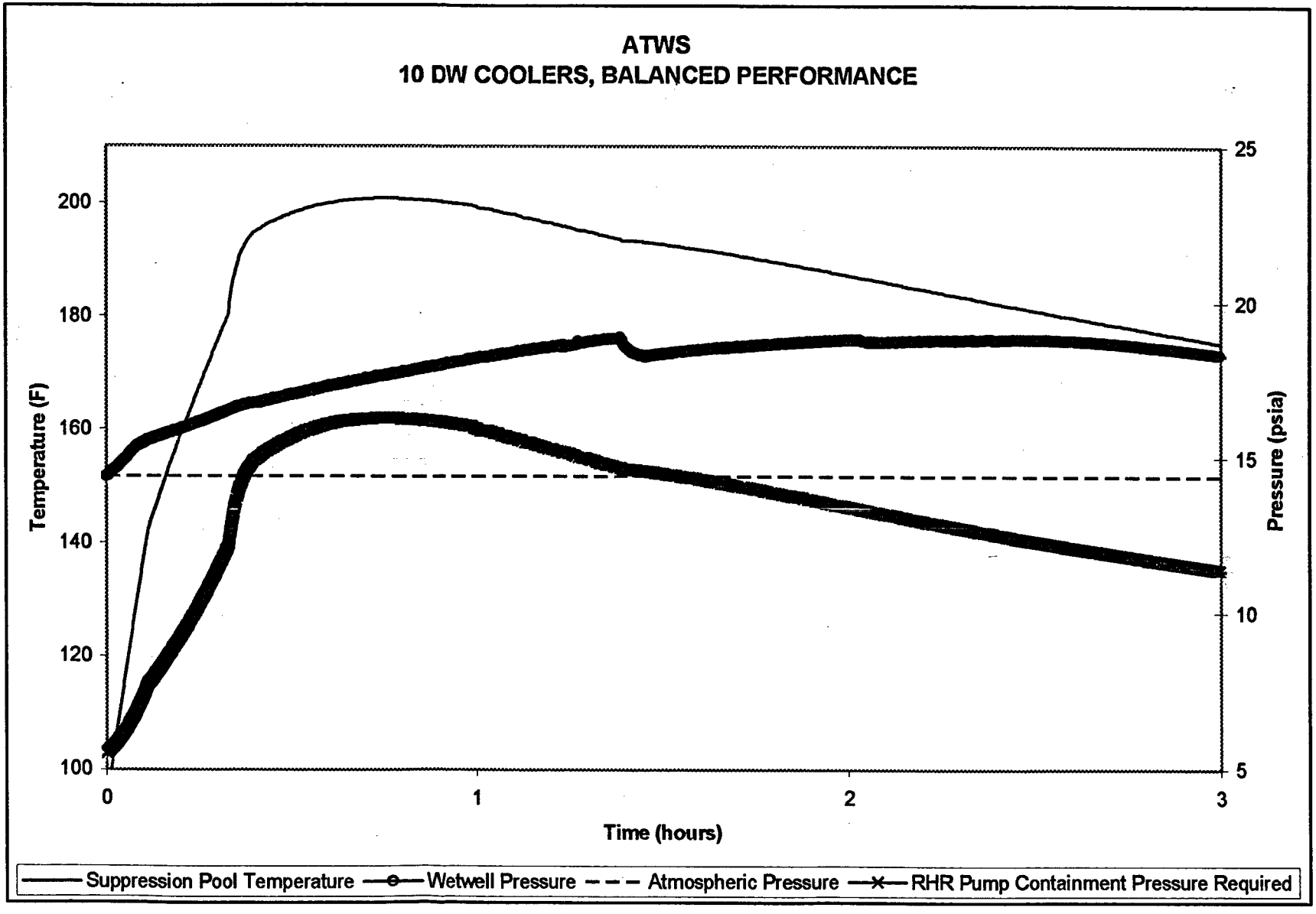


FIGURE ACVB.56/54-5 NPSH REQUIREMENTS FOR SBO (95°F SPRAY)

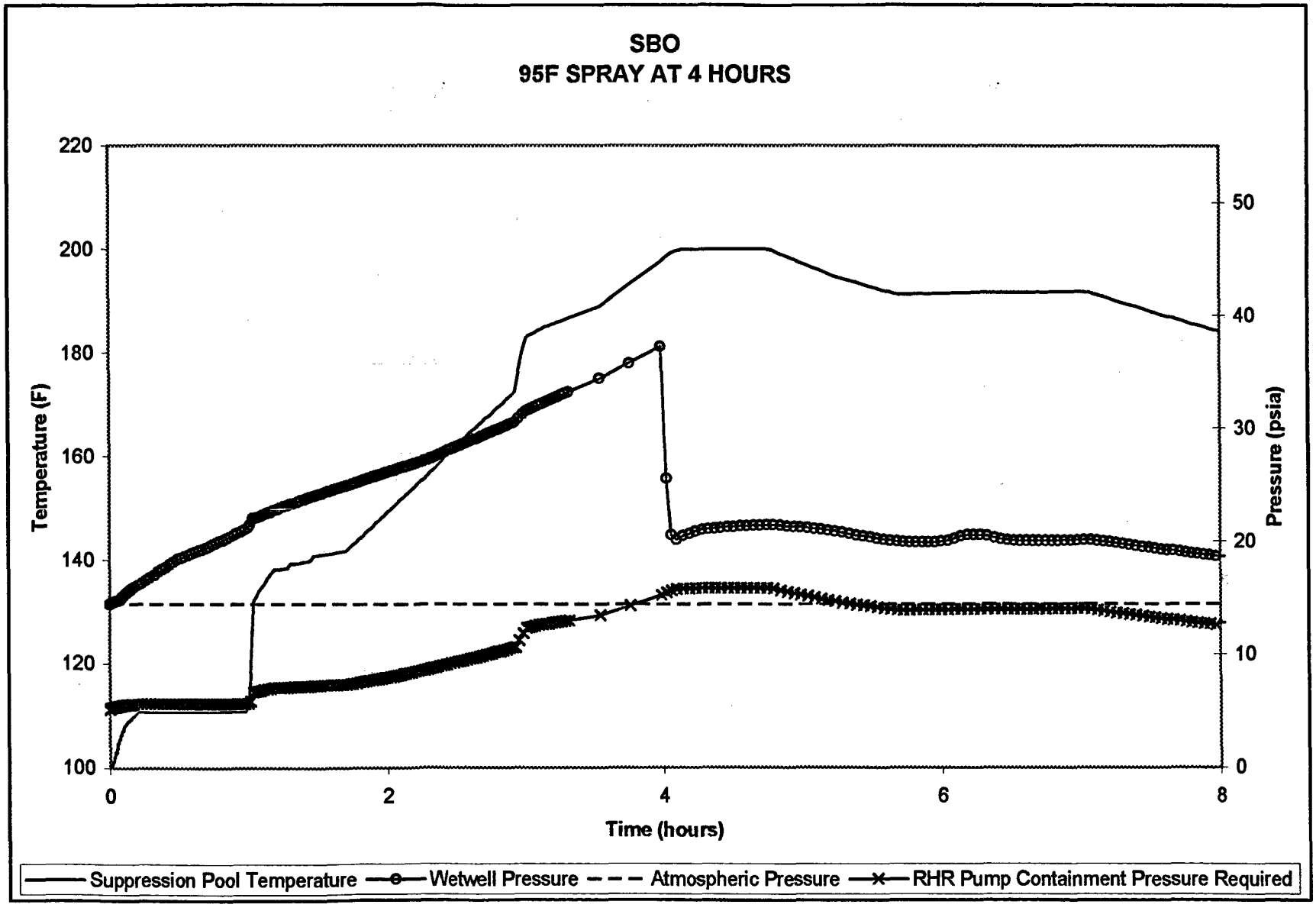
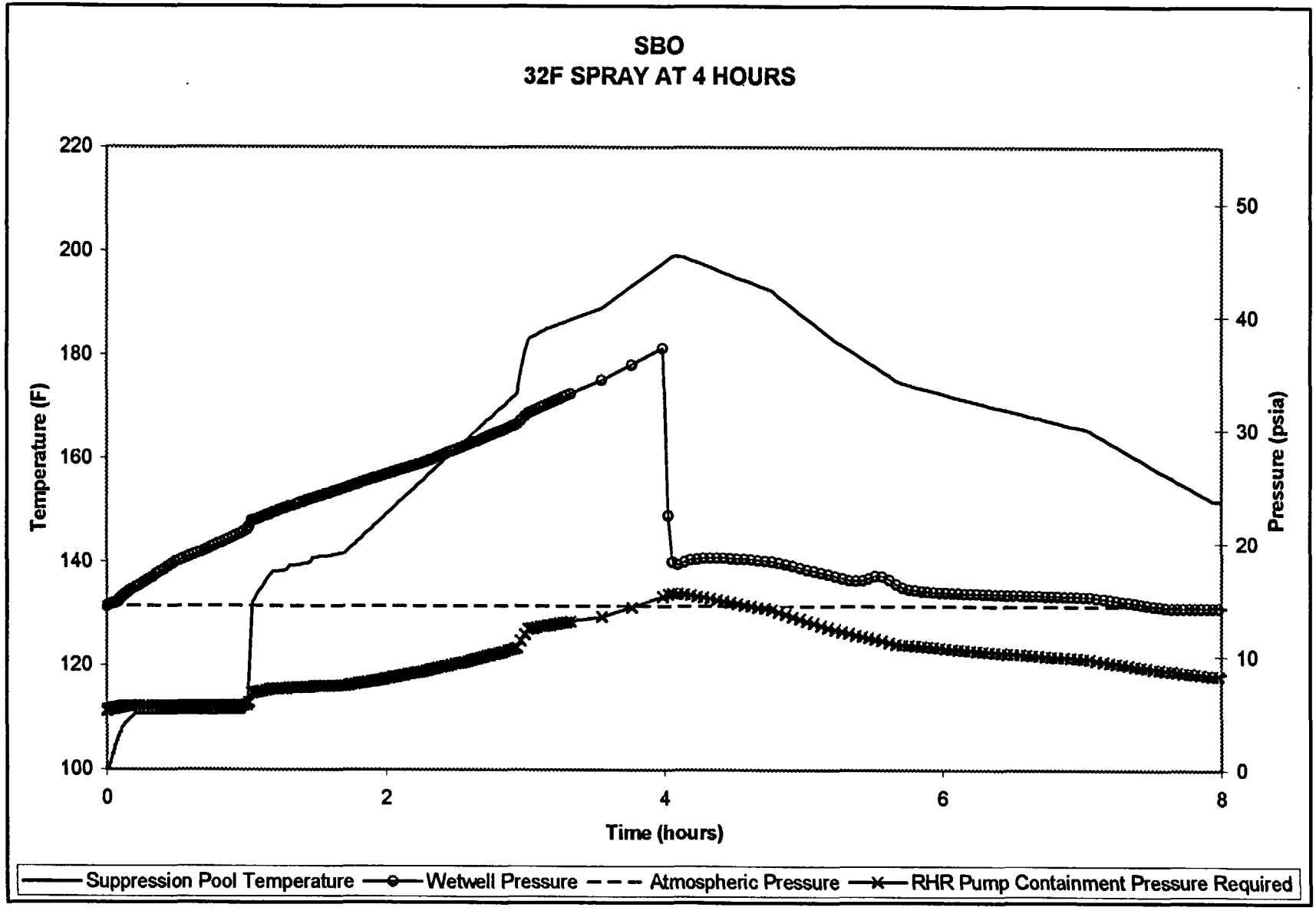


FIGURE ACVB.56/54-6: NPSH REQUIREMENTS FOR SBO (32°F SPRAY)



NRC Request ACVB.58/56

In Table 6 of Calculation MD-Q0999-970046, Rev.8, provided in the March 23, 2006, response, the NPSH required (NPSHR) of the RHR pumps varies even when the pumps have the same flow rate. The CS pumps, all with the same flow rate, also have the same value of NPSHR. Explain why the NPSHR varies even when the pumps have the same flow rate.

TVA Response to ACVB.58/56

Each of the Core Spray and RHR pumps at BFN was tested by the manufacturer for reduced suction head which was used to determine NPSHR as a function of flow. The variation in NPSHR values for RHR in calculation MDQ0999970046 R8 reflects different test results obtained for the various RHR pumps. The values do not vary for the Core Spray pumps because NPSH test data was not as detailed; therefore, a single value was used for all pumps.

RHR and Core Spray pump NPSH requirements have been reviewed by the pump vendor and are now specified as a function of time duration for the type of pump and flow rate. Updated values are used in place of those previously provided in MDQ0999970046, Revision 8. The revised information is reflected in the calculations provided in Enclosures 3 and 4.

ENCLOSURE 3

TENNESSEE VALLEY AUTHORITY
BROWNS FERRY NUCLEAR PLANT (BFN)
UNITS 1, 2, AND 3

TECHNICAL SPECIFICATIONS (TS) CHANGES TS-431 AND TS-418 - EXTENDED POWER UPRATE (EPU) - RESPONSE TO ROUND 6 REQUEST FOR ADDITIONAL INFORMATION (TAC NOS. MC3812, MC3743, AND MC3744)

CALCULATION MDQ0999970046, REVISION 9
NPSH EVALUATION OF BROWNS FERRY RHR AND CS PUMPS

(SEE ATTACHED)

ENCLOSURE 4

TENNESSEE VALLEY AUTHORITY
BROWNS FERRY NUCLEAR PLANT (BFN)
UNITS 1, 2, AND 3

TECHNICAL SPECIFICATIONS (TS) CHANGES TS-431 AND TS-418 - EXTENDED POWER UPRATE (EPU) - RESPONSE TO ROUND 6 REQUEST FOR ADDITIONAL INFORMATION (TAC NOS. MC3812, MC3743, AND MC3744)

CALCULATION MDQ099920060011, REVISION 0
TRANSIENT NPSH/CONTAINMENT PRESSURE EVALUATION OF RHR AND CORE SPRAY PUMPS

(SEE ATTACHED)

ENCLOSURE 5

TENNESSEE VALLEY AUTHORITY
BROWNS FERRY NUCLEAR PLANT (BFN)
UNITS 1, 2, AND 3

TECHNICAL SPECIFICATIONS (TS) CHANGES TS-431 AND TS-418 - EXTENDED POWER UPRATE (EPU) - RESPONSE TO ROUND 6 REQUEST FOR ADDITIONAL INFORMATION (TAC NOS. MC3812, MC3743, AND MC3744)

COMMITMENT SUMMARY

TVA will revise the BFN Appendix R fire safe shutdown operating procedures to terminate drywell cooling within two hours of entry into the procedure.