VIRGINIA ELECTRIC AND POWER COMPANY
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January 31, 2006

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
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Serial No. 06-014
NL&OS/PRW R0
Docket Nos. 50-280/281
License Nos. DPR-32/37

VIRGINIA ELECTRIC AND POWER COMPANY
SURRY POWER STATION UNITS 1 AND 2
PROPOSED TECHNICAL SPECIFICATION CHANGE AND SUPPORTING SAFETY ANALYSES REVISIONS TO ADDRESS GENERIC SAFETY ISSUE 191

Pursuant to 10 CFR 50.90, Virginia Electric and Power Company (Dominion) hereby requests an amendment to Operating License Numbers DPR-32 and DPR-37 in the form of changes to the technical specifications (TS) for Surry Power Station Units 1 and 2 (Surry), respectively. The proposed change is being submitted as part of Dominion's resolution to NRC Generic Safety Issue 191 (GSI-191). In a letter dated September 1, 2005 (Serial No. 05-212), Dominion identified three commitments that are required to resolve GSI-191 and NRC Generic Letter (GL) 2004-02 for Surry. In that letter, Dominion committed to provide this submittal in December 2005. In a subsequent phone conversation of December 14, 2005, Dominion advised the NRC that due to additional time required to complete the Surry-specific analysis, the proposed technical specification changes would be submitted by January 31, 2006.

These commitments to resolve GSI-191 and GL 2004-02 are addressed by the proposed TS changes and the supporting safety analyses revisions discussed in Attachment 1 of this letter and summarized in the following paragraphs. The marked up and proposed TS pages are provided in Attachments 2 and 3, respectively. Attachment 4 provides the significant hazards consideration and environmental assessment.

The proposed change revises the method for starting the inside and outside recirculation spray (RS) pumps in response to a design basis accident. Currently the Surry RS pumps start by using delay timers that are initiated when the containment pressure reaches the consequence limiting safeguards (CLS) High High set point. The proposed change will result in the start of the RS pumps by a coincident CLS High High pressure and refueling water storage tank (RWST) Level Low. The proposed wording for the revised TS surveillance requirements for the RWST Level Low instrumentation is consistent with Improved Standard Technical Specifications Change Traveler, TSTF-286-A, Revision 2 and NUREG 1431, Westinghouse Owners Group Standard Technical Specifications, Revision 3, March 31, 2004.

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The change revises the Surry containment analyses by converting from the present Stone and Webster LOCTIC computer code to the GOTHIC code. In a letter dated November 1, 2005 (Serial No. 05-745), Dominion submitted Topical Report DOM-NAF-3, which documents the Dominion methodology for analyzing the containment response to postulated pipe ruptures using the GOTHIC code. Attachment 1 of this letter provides the Surry plant-specific applications of the DOM-NAF-3 methodology for changes to the RS pump start method and the containment air partial pressure operating limits in TS Figure 3.8-1. The GOTHIC containment analyses in this request are predicated on approval of Topical Report DOM-NAF-3.

The change includes revisions to the LOCA Alternate Source Term (AST) dose consequences analysis that accommodate the changes to the RS pump start methodology. The changes to the RS pump start methodology results in a short-term increase in air leakage from the containment and a short-term reduction in spray removal of radioactive isotopes from the containment atmosphere. Attachment 1 of this letter also documents the revisions to the LOCA dose consequences analysis including revisions that offset the potential increase in calculated radiological consequences.

In a letter dated September 13, 2005 (Serial No. 05-601), Dominion requested an amendment to the Surry operating licenses to redefine the exclusion area boundary (EAB) as the site boundary in Technical Specification 5.1, Site. The redefined EAB would significantly reduce the design basis accident Atmospheric Dispersion Factor (X/Q) which would consequently reduce the calculated EAB dose consequences for the Updated Final Safety Analysis Report Chapter 14 accidents in future reanalyses. The LOCA analysis in this request is predicated on approval of the redefined EAB amendment request.

Dominion requests NRC staff approval of the proposed TS change and supporting safety analyses revisions by September 1, 2006 in order to implement the changes during the fall 2006 refueling outage for Surry Unit 2 and during the fall 2007 refueling outage for Surry Unit 1 to meet the required implementation schedule for GSI-191/GL 2004-02 resolution. In addition, approval of the redefined EAB amendment request and Topical Report DOM-NAF-3 is required prior to or concurrent with approval of this request.

Dominion has evaluated the proposed TS change and has determined that it does not involve a significant hazards consideration as defined in 10 CFR 50.92. The basis for our determination is provided in Attachment 4. Dominion has also determined that operation with the proposed change will not result in any significant increase in the amount of effluents that may be released offsite and no significant increase in individual or cumulative occupational radiation exposure.

Therefore, the proposed amendment is eligible for categorical exclusion as set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment is needed in connection with the approval of the proposed change.

The proposed change has been reviewed and approved by the Station Nuclear Safety and Operating Committee.

If you have any questions regarding this submittal, please contact Mr. Paul R. Willoughby at (804) 273-3572.

Very truly yours,

Leslie N. Hartz
Vice President – Nuclear Engineering

Attachments: (4)

Attachment 1 – Discussion of Change (Licensing Report)
Attachment 2 – Marked-up Technical Specification Pages
Attachment 3 – Proposed Technical Specifications Pages
Attachment 4 – No Significant Hazards Consideration and Environmental Assessment

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COMMONWEALTH OF VIRGINIA)
)
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The foregoing document was acknowledged before me, in and for the County and Commonwealth aforesaid, today by Leslie N. Hartz, who is Vice President – Nuclear Engineering, of Virginia Electric and Power Company. She has affirmed before me that she is duly authorized to execute and file the foregoing document in behalf of that Company, and that the statements in the document are true to the best of her knowledge and belief.

Acknowledged before me the 31st day of January, 2006.

My Commission Expires: August 31, 2008

Margaret B. Bennett
Notary Public

(SEAL)

ATTACHMENT 1

PROPOSED TECHNICAL SPECIFICATION CHANGE AND SUPPORTING SAFETY ANALYSES REVISIONS TO ADDRESS GENERIC SAFETY ISSUE 191

DISCUSSION OF PROPOSED CHANGE

VIRGINIA ELECTRIC AND POWER COMPANY
SURRY POWER STATION UNITS 1 AND 2

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List of Acronyms and Abbreviations

ADF	Atmospheric Dispersion Factor
AFW	Auxiliary Feedwater
AST	Alternate Source Term
CDT	Containment Depressurization Time
CLS	Consequence Limiting Safeguards
COT	Channel Operational Test
CS	Containment Spray
DEHLG	Double Ended Hot Leg Guillotine
DEPSG	Double Ended Pump Suction Guillotine
DLM	Diffusion Layer Model
DPP	Depressurization Peak Pressure
EAB	Exclusion Area Boundary
ECCS	Emergency Core Cooling System
EPRI	Electric Power Research Institute
EQ	Equipment Qualification
ESF	Engineered Safeguards Features
HHSI	High Head Safety Injection
IRS	Inside Recirculation Spray
LHSI	Low Head Safety Injection
LOCA	Loss of Coolant Accident
MSLB	Main Steam Line Break
NPSHa	Available Net Positive Suction Head
NRC	Nuclear Regulatory Commission
NSSS	Nuclear Steam Supply System
ORS	Outside Recirculation Spray
PCT	Peak Clad Temperature
PWR	Pressurized Water Reactor
RCS	Reactor Coolant System
RMT	Recirculation Mode Transfer
RS	Recirculation Spray
RSHX	Recirculation Spray Heat Exchanger
RWST	Refueling Water Storage Tank
SBLOCA	Small Break LOCA
SG	Steam Generator
SI	Safety Injection
SPS	Surry Power Station
SRP	Standard Review Plan
SW	Service Water
TS	Technical Specifications
UFSAR	Updated Final Safety Analysis Report

1.0 Introduction

This report documents the implementation of changes to the Surry Power Station (SPS) plant safety analyses to support the resolution of NRC Generic Letter 2004-02 [1]. Section 2 describes the changes to the plant licensing bases that are necessary to support the containment sump strainer replacement project. Section 3 summarizes the GOTHIC containment analyses using the methodology in topical report DOM-NAF-3 [3]. GOTHIC analyses were performed for both the current plant configuration and the changes described in Section 2.2 for the RS pump start using RWST level and Section 2.3 for the increase to Technical Specification (TS) containment air partial pressure limits. The GOTHIC analyses represent a change to a UFSAR method of evaluation as defined in 10CFR50.59. Section 4 documents revisions to the LOCA Alternate Source Term (AST) analysis that are required to support the delayed start of the RS pumps and the increase to the containment air partial pressure limits. Section 2.4 describes the licensing basis changes. Section 5 documents the conclusions of the GOTHIC and LOCA AST analyses. References are listed in Section 6.

2.0 Description of Changes

Changes to the SPS licensing bases and Technical Specifications are proposed to support resolution of NRC Generic Letter 2004-02 [1]. In a letter dated September 1, 2005, Dominion (Virginia Electric and Power Company) included three commitments for SPS (numbers 9-11 in Attachment 6) to resolve NRC GL 2004-02 [2]. The commitments are repeated with a brief discussion about how each is resolved in this report.

- *Dominion will report the minimum NPSH margin in the SPS-plant-specific LAR described in Item 2(e).*

  Table 3.11-1 summarizes the minimum NPSH available for the low head safety injection (LHSI), inside recirculation spray (IRS), and outside recirculation spray (ORS) pumps using the GOTHIC containment analysis methodology described in DOM-NAF-3. NPSH margins are reported for two sets of analyses that are described in Section 3. The "proposed configuration" NPSH margins (available NPSH - required NPSH) are the design values for the containment sump strainer project.

- *Dominion will submit the GOTHIC containment analysis methodology with plant-specific analyses that support the proposed changes to TS Figure 3.8-1 and the RS pump start method in December 2005.*

  The GOTHIC containment analysis methodology was submitted to the NRC as topical report DOM-NAF-3 [3] in a letter dated November 1, 2005 [4]. The SPS plant-specific containment analyses in Section 3 apply the topical report methodology without modification to demonstrate compliance with the containment design criteria. The proposed change to start the RS pumps using RWST level is described in Section 2.2. The proposed change to TS Figure 3.8-1 is described in Section 2.3.

- *The planned changes to delay the RS pumps and to modify TS Figure 3.8-1 require a relaxation of the currently approved containment leakage assumptions for SPS.*

  Section 3 describes how the GOTHIC LOCA containment analyses are subatmospheric within one hour, containment pressure peaks slightly lower than 0.5 psig during hours 1-4. The current NRC-approved containment leakage assumption in the LOCA Alternate Source Term (AST) analysis corresponds to a containment pressure of 0.5 psig during hours 1-4. Section 2.4 describes the changes to increase the allowable containment leakage from 0.5 psig to 1.0 psig during the time interval from 1 to 4 hours after the LOCA initiation.

2.1 Implement GOTHIC Containment Analysis Methodology

The current licensing basis analysis methodology for loss of coolant accident (LOCA) containment response is the Stone & Webster LOCTIC computer code that is described in SPS UFSAR Chapters 5 and 6 [5]. The LOCTIC methodology will be replaced with the GOTHIC analytical methodology that is described in topical report DOM-NAF-3 [3]. The topical report was submitted to the NRC for review and approval on November 1, 2005 [4] in advance of this license amendment request. The GOTHIC design analyses summarized in this report have used the topical report methodology without modification. The GOTHIC analyses in Section 3 replace the LOCTIC analyses in SPS UFSAR Chapters 5 and 6 for calculation of the following containment design requirements:

1. LOCA peak containment pressure and temperature,
2. LOCA containment depressurization time,
3. LOCA containment peak pressure following depressurization,
4. Available net positive suction head (NPSHa) for the LHSI pumps, and
5. NPSHa for the ORS and IRS pumps.

Currently, the SPS UFSAR does not include LOCTIC containment response analyses for the main steam line break (MSLB) event. In Section 3.7 of this report, MSLB containment response analyses have been performed with GOTHIC for introduction of explicit code calculations to the SPS licensing bases. Refer to Section 3.7 for details on the current MSLB licensing basis and the GOTHIC containment analyses.

GOTHIC is used to verify that the containment liner temperature is less than the limit using the methodology in Section 3.3.3 of DOM-NAF-3 for LOCA and MSLB events. GOTHIC also can be used to verify equipment temperatures within design limits using the methodology in Section 3.3.4 of DOM-NAF-3. Finally, the minimum containment water level and maximum sump liquid temperatures from GOTHIC NPSH calculations will be used to establish bounding inputs to the sump strainer design. The GOTHIC NPSH analysis methodology in Section 3.8 of DOM-NAF-3 ensures a conservative prediction of minimum containment water level (i.e., accounting for water holdup) and maximum sump liquid temperature. Depressurization analyses are biased to maximize the total pressure and provide a conservative minimum sump water temperature. In conclusion, the GOTHIC methodology for long-term analysis of NPSH and containment depressurization ensures conservative results for component design (e.g., strainer debris head loss and component stress analyses).

2.2 Start RS Pumps on RWST Level Coincident with High High Containment Pressure

SPS is a three-loop Westinghouse PWR with a subatmospheric containment design. The following plant description is taken from Chapters 5 and 6 of the SPS UFSAR. The engineered safeguards features (ESF) that mitigate a LOCA or MSLB event include:

- A safety injection (SI) system that injects borated water into the cold legs of all three reactor coolant loops.
- Two separate low-head safety injection (LHSI) subsystems, either of which provides long-term removal of decay heat from the reactor core.
- Two separate subsystems of the spray system—containment spray (CS) and recirculation spray (RS)—that operate together to reduce the containment temperature, return the containment pressure to subatmospheric, and remove heat from the containment. The RS subsystem maintains the containment subatmospheric and transfers heat from the containment to the service water (SW) system.

The CS system consists of two pumps that start on a Consequence Limiting Safeguards (CLS) High High containment pressure signal and draw suction from the refueling water storage tank (RWST) until the tank is empty. The RS system consists of four independent trains, each with one pump that takes suction from the containment sump. Two inside recirculation spray (IRS) pumps are located inside the containment sump, while two outside recirculation spray (ORS) pumps are located in the Safeguards Building. The RS pumps are started currently using delay timers that are initiated on the CLS High High signal. Each RS train has a recirculation spray heat exchanger (RSHX) that is cooled by SW (on the tube side) for long-term containment heat removal. The SI system consists of two LHSI and three HHSI pumps that draw from the RWST and inject into the RCS cold legs. The SI pumps take suction from the RWST until a low-low level is reached, at which time recirculation mode transfer (RMT) occurs. The RMT function changes the LHSI pump suction from the RWST to the containment sump and the HHSI pump suction from the RWST to the discharge header of the LHSI pumps.

Because the RS and SI systems use the containment sump to demonstrate that design criteria are satisfied, the resolution of NRC Generic Letter 2004-02 affects the IRS, ORS and LHSI pumps. Section 3.7.2.3.2.4 of NEI-04-07 [6] has different requirements for demonstrating adequate pump performance whether the sump strainer is fully or partially submerged when the LHSI and RS pumps are operating. For a fully submerged strainer, the strainer debris head loss must be less than or equal to the NPSH margin. For a partially submerged strainer, the strainer debris head loss must be less than one-half the pool height. Thus, if the strainer submergence height is only 1.0 ft at pump start, then the allowable debris head loss is 0.5 ft. Further, only the wetted strainer surface area can be credited, and these limitations together could impose a very large strainer footprint.

Currently, the SPS RS pumps start using delay timers that are initiated when the containment pressure reaches the CLS High High setpoint. The IRS pumps have a 120-second setpoint and the ORS pumps have a 300-second setpoint. At these start times, the containment water level is predicted to be less than 1 ft in the current UFSAR containment analyses. While there is sufficient NPSH margin for the pumps, the current timer delay setpoints start the RS pumps when the sump strainer is partially submerged. Because the partial submergence requirement may be too restrictive for the sump strainer design, the RS pump start will be delayed until sufficient water level is available in the containment.

Proposed Modification

SPS proposes to start the IRS and ORS pumps on 60% RWST wide range (WR) level coincident with a CLS High High containment pressure signal. The IRS pumps will receive an immediate start signal once the coincidence logic is satisfied. The ORS pumps will start using a 120-second delay timer from the coincident actuation signal. This delay will minimize the impact on emergency diesel generator loading and allow for the IRS system to fill its piping completely, deliver spray to the containment, and reach a stable flow demand on the sump before the ORS pumps start. This method of starting the RS pumps ensures that a reliable mass of liquid has been added to the containment to meet the sump strainer submergence requirements for the range of LOCA break sizes that require the containment sump. The use of RWST WR level to start the RS pumps classifies the new instrumentation as part of the ESF. Thus, the design will include safety-grade instrumentation consistent with UFSAR Section 7.5, "Engineered Safeguards" with surveillances that must be added to the SPS Technical Specifications [7].

Plant Safety Analysis Impact

Delaying the start method of the RS pumps has a potential adverse impact on several design criteria, including post-LOCA containment pressure and temperature, environmental conditions for safety-related equipment inside containment, diesel loading, and dose consequences analyses. The following impacts on the SPS UFSAR safety analyses and design were evaluated.

- Less energy is removed from the containment sump liquid before the LHSI pumps take suction from the containment sump. Therefore, NPSH available for the LHSI pumps decreases. The analysis of the LHSI pump NPSHa is the limiting case for determining the lowest acceptable RWST water level setpoint for RS pump initiation. Section 3.6 demonstrates that the LHSI pumps have sufficient NPSH margin with the proposed change to start the IRS and ORS pumps on 60% RWST WR level.

- The post-LOCA containment pressure and temperature are higher during the period when only the CS system is delivering spray flow to containment. The GOTHIC analyses in Sections 3.3 and 3.4 show the containment pressure and temperature decreasing before the IRS pumps start at approximately 30 minutes (assuming 1 train of safeguards), and the RS pump start increases the depressurization rate. The delayed RS pump start increases the containment depressurization time to subatmospheric conditions. Section 3.4 demonstrates that the containment is subatmospheric in less than one hour for all cases but a depressurization peak pressure greater than 0.0 psig, but less than 0.5 psig, occurs for some design cases. The current LOCA dose consequences analysis assumes a containment leak rate at the TS 4.4 limit of 0.1% of containment volume per day for the first hour of the accident, a conservative leak rate corresponding to 0.5 psig containment pressure for the time interval from 1 to 4 hours, and no leakage after 4 hours (i.e., containment pressure is subatmospheric) [20, Section 2.1.1]. While the containment pressure response is bounded by the current AST analysis assumption for containment leakage, the margin is tight and does not leave room for future issues that could increase containment pressure. Thus, Section 2.4 describes LOCA AST analyses that increase the containment leak rate during the time interval from 1 to 4 hours to a value that corresponds to a pressure of 1.0 psig.

- The delayed RS pump start creates more adverse pressure and temperature conditions for the operation of safety-related equipment inside containment. The GOTHIC analyses in Section 3 created LOCA and MSLB containment pressure and temperature profiles based on the proposed change to the RS pump start. Various break locations, break sizes, and single-failures were considered. Section 3.9 demonstrates that the GOTHIC profiles remain bounded by existing equipment qualification test temperature and pressure data or are acceptable by evaluation. Therefore, the operation of safety-related equipment inside containment during a LOCA or MSLB is not affected adversely by the proposed change to delay starting the RS pumps.

- Starting the RS pumps later can reduce the removal of iodine from the containment atmosphere and potentially increase the release of iodine to the environment during the period when RS is not operating. The current LOCA AST basis credits iodine removal when the RS pumps start. Section 2.4 documents a change to the LOCA AST bases to credit iodine removal from the RS system only after containment spray terminates.

- Currently, the RS pumps start using time delays from the CLS High High signal (2 minutes for IRS and 5 minutes for ORS). Using 60% RWST WR level coincident with CLS High High delays the RS pump start until at least 15 minutes after accident initiation. This pump delay reduces the early loads on the emergency diesel generator. The IRS pumps will receive an immediate start signal once the coincidence logic is satisfied. The ORS pumps will start using a 120-second delay timer from the coincident actuation signal. This delay is sufficient to avoid simultaneous starting of the RS pumps on the same emergency diesel generator. Thus, the proposed change does not have an adverse impact on emergency diesel generator capability.

- NPSH available for the RS pumps increases. Section 3.6 demonstrates how the ORS and IRS pumps have more NPSH margin due to higher containment water levels.

Sections 3 and 4 of this report demonstrate that the SPS safety analyses satisfy the accident analysis acceptance criteria and other design requirements when the RS pumps are started on 60% RWST WR level coincident with a CLS High High actuation and with the proposed containment air partial pressure operating limits in Section 3.10.

Changes to SPS Technical Specifications

The use of RWST WR level to start the RS pumps classifies the new instrumentation as part of the ESF. The allowable setpoint for the ESF function and surveillances must be added to the SPS Technical Specifications [7]. The signals from the RWST WR level channels are used to initiate RMT for the safety injection system. The same level channels will be used for the RS pump start circuitry. RMT occurs when RWST WR level reaches a "Low" setpoint according to current TS nomenclature. Since the RWST level setpoint for initiation of the RS pumps will be a higher value (60%) than the RMT setpoint (13.5%), the TS naming convention will be changed to "RWST Level Low" for the RS pump initiation function and "RWST Level Low-Low" for the RMT function.

The RWST Level Low trip will be designed to de-energize to actuate. The RS pump start will depend on a coincidence of 60% RWST WR level with CLS High High (which is 3-out-of-4 channels energize to actuate), so a spurious de-energization of the RWST level circuits would not cause an unnecessary start of the RS pumps. To be consistent with the RMT function, the RWST Level Low trip will actuate from 2-out-of-4 channels and 1-out-of-2 ESF trains. SPS TS 3.4 requires the RS system to be operable for RCS conditions above 350°F and 450 psig. If the minimum number of operable channels for RWST Level Low is not met, the action is to decrease below 350°F and 450 psig. Operator Action 20 in SPS TS 3.7 is used for ESF instrumentation that de-energize to actuate and is applicable for the RWST Level Low channels. Operator Action 14 is used for ESF Automatic Actuation Logic and Actuation Relays (e.g., functional unit 2c for Containment Spray) and is applicable to the RWST Level Low function.

TS Setting Limit Values for the Surry RWST Level Low initiation can use the requirements of Methods 1 or 2 in ISA-RP67.04.02-2000 [20]. The determination of TS Setting Limit Values used Method 1. There are two Analytical Limits and thus two Setting Limits associated with this new function. The Analytical Limits are $\geq$ 57.50 % WR Level and $\leq$ 62.50 % WR Level. The corresponding TS Setting Limits are $\geq$ 59.00 % WR Level and $\leq$ 61.00 % WR Level from the following analysis. The reader is referred to Figure 2.1-1 for the relationship between the Analytical Limits and the TS Setting Limits.

Adding the Total Loop Uncertainty to the Analytical Limit yields a Minimum Trip Setpoint of 59.28 % WR Level. Adding the Non-COT (Channel Operational Test) error components to the Analytical Limit yields a Minimum Allowable Value of 58.826 % WR Level. The Actual Nominal Trip Setpoint of 60.00 % WR Level is conservative with respect to the Minimum Trip Setpoint. The Actual Allowable Value of $\geq$ 59.00% WR Level is conservative with respect to the Minimum

Allowable Value. The Allowable Value of $\geq$ 59.00% WR Level is based on maintaining a Nominal Trip Setpoint value of 60.00% WR Level. The proposed Allowable Value of $\geq$ 59.00% WR Level is conservative with respect to the calculated value using rack error terms (i.e., COT error terms).

Subtracting the Total Loop Uncertainty from the Analytical Limit yields a Maximum Trip Setpoint of 60.72% WR Level. Subtracting the Non-COT error components from the Analytical Limit yields a Maximum Allowable Value of 61.174% WR Level. The Actual Nominal Trip Setpoint of 60.00% WR Level is conservative with respect to the Maximum Trip Setpoint. The Actual Allowable Value of $\leq$ 61.00% WR Level is conservative with respect to the Maximum Allowable Value. This Allowable Value of $\leq$ 61.00% WR Level is based on maintaining a Nominal Trip Setpoint value of 60.00% WR Level. The proposed Allowable Value of $\leq$ 61.00% WR Level is conservative with respect to the calculated value using rack error terms (i.e., COT error terms).

The statistical combination of the COT and Non-COT error components is provided below and used in Figure 2.1-1 to determine the Minimum/Maximum Trip Setpoints and the Minimum/Maximum Allowable Values.

$$\text{Non-COT}_{error} = SE \pm [EA^2 + PMA^2 + PEA^2 + (SCA+SMTE)^2 + SD^2 + SPE^2 + STE^2 + SPSE^2 + M1MTE^2 + M3MTE^2 + RTE^2]^{1/2}$$

$$\text{Non-COT}_{error} = 0.0 \pm [0.0^2 + 0.0^2 + 0.0^2 + (0.5+0.185)^2 + 0.270^2 + 0.0^2 + 0.972^2 + 0.0^2 + 0.0^2 + 0.150^2 + 0.5^2]^{1/2}$$

$$\text{Non-COT}_{error} = + 1.326 \text{ \% of span}$$

$$COT_{error} = \pm (M1^2 + M3^2 + RD^2)^{1/2}$$
$$COT_{error} = \pm (0.0^2 + 0.5^2 + 1.0^2)^{1/2}$$
$$COT_{error} = \pm 1.118 \text{ \% of span}$$

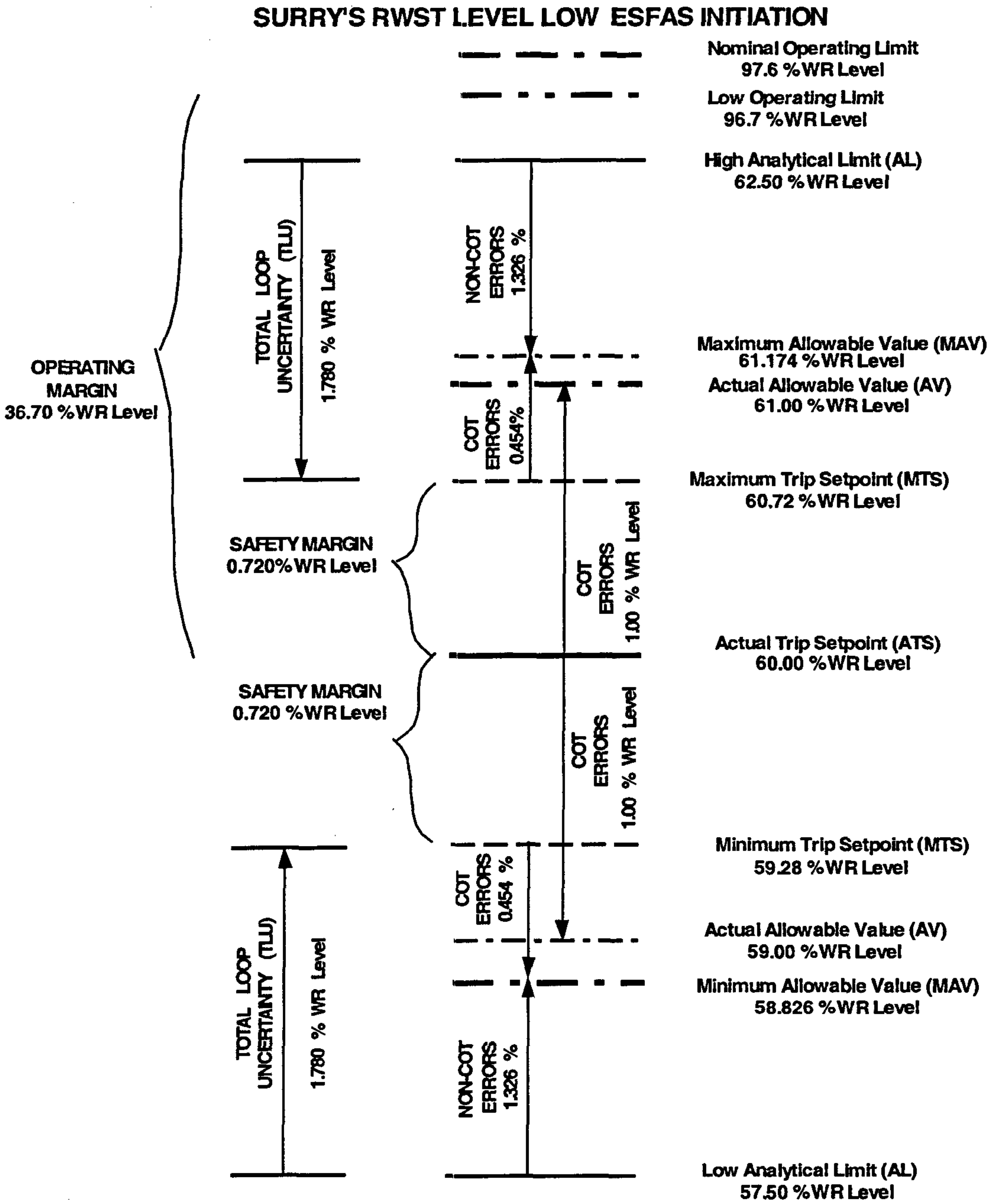
Based on the above evaluations, the following changes to the SPS Technical Specifications are proposed for implementation of the RWST Level Low instrumentation to start the IRS and ORS pumps on 60% RWST WR level coincident with High High containment pressure:

- TS Table 3.7-2: Add the RWST Level Low Coincident with High High Containment Pressure with the requirement for 2-out-of-4 channels to trip and 1-out-of-2 ESF trains to trip. Operator Action 20 is selected for the RWST Level Low channels and Operator Action 14 is selected for the Automatic Actuation Logic. Change the name of functional unit 7a from "RWST Level – Low" to "RWST Level – Low-Low".

- TS Table 3.7-4: Add the RWST Level Low function (coincident with High High Containment Pressure) with allowable setting limits of $\geq$ 59 % and $\leq$ 61% RWST WR level. Change the name of functional unit 9a from "RWST Level – Low" to "RWST Level – Low-Low".

- TS Table 4.1-1: Add the RWST Level Low instrument channels as Channel Description 16 with frequencies of S (shift) for check, R (refueling) for calibration, and Q (quarterly) for test. These are identical to the RMT function (Item 15 in the table). The logic channel testing will be conducted monthly in accordance with Channel Description 26, which applies to the consequence limiting safeguards system logic. Change the name of Channel Description 15a from "RWST Level – Low" to "RWST Level – Low-Low".

Figure 2.1-1: Surry RWST Level Low ESF Initiation



Note: The COT errors shown above are based on ISA-RP67.04.02-2000 and ISA-RP67.04-Part II Method 1 and 2. The COT error embedded in the Total Loop Uncertainty Error is based on Method 2. The COT error determined by the difference between the Actual Trip Setpoint and the Actual Allowable Value is based on Method 1 and is the preferred method.

2.3 Change Containment Air Partial Pressure Operating Limits in TS Figure 3.8-1

The GOTHIC containment analyses for LOCA containment peak pressure (Section 3.2), MSLB containment peak pressure (Section 3.7), and LOCA containment depressurization (Section 3.4) support an increase in the containment air partial pressure upper limit in TS Figure 3.8-1 from 10.3 psia to 11.3 psia. As a result, the TS lower limit will be increased above 9.0 psia to recover LHSI pump NPSH margin that has been reduced by the delayed RS pump start. The proposed TS lower limit linearly decreases from 10.3 psia at 25 F SW to 10.1 psia at 70 F SW then remains constant at 10.1 psia to 95 F SW. Operating margin has also been increased at high SW temperature (from 0.1 psi to 0.2 psi margin at 95 F). The proposed change to TS Figure 3.8-1 and the technical basis for the upper and lower limits are presented in Section 3.10 of this report.

Changes to the TS 3.8 Basis are required to reflect the technical basis for the revised TS Figure 3.8-1. The MSLB peak pressure analysis sets the horizontal upper limit line. The plant changes no longer support a "subatmospheric peak pressure" since some GOTHIC cases produce long-term pressures that exceed 0.0 psig. Therefore, it is proposed to change the description from "subatmospheric peak pressure" to "LOCA depressurization criteria" to reflect the positive pressure after one hour. Also, the minimum air partial pressure is being changed from a constant 9.0 psia to a variable line in order to recover NPSH margin at low SW temperatures. The TS Basis will be revised to reflect the variable lower limit in TS Figure 3.8-1.

The combined increase to the air partial pressure limits and the delayed start of the RS pumps create analyzed containment pressures that are greater than 0.0 psig after 1 hour for double-ended pump suction guillotine (DEPSG) breaks with one train of emergency safeguards features. Section 3.4 shows the DEPSG break produce a containment pressure that is just below 0.5 psig during the interval from 1 to 4 hours after the event initiation. The GOTHIC analyses predict containment pressures that are less than 0.0 psig after 4 hours. To provide margin for future issues, the containment leakage in the LOCA dose consequences analysis was increased to correspond to 1.0 psig during the interval from 1 to 4 hours (see Section 2.4). As a result, the TS 3.8 Basis is changed from the current analyzed pressure of 0.5 psig to 1.0 psig.

2.4 LOCA Alternate Source Term

Delaying the RS pump start will result in a short-term increase in air leakage from the containment and a short-term reduction in spray removal of radioactive isotopes from the containment atmosphere. To offset the potential increase in calculated radiological consequences and to reflect the delay of the RS pump start, the following changes to the LOCA AST analysis are proposed:

1) Credit for filtration of the Safeguards Building exhaust by the Auxiliary Ventilation Exhaust Filter Trains in the LOCA analysis.

2) Credit for an increase in CS flow rate in the determination of aerosol removal coefficients.

3) Credit for RS iodine removal after CS termination vs. 216 seconds for IRS spray delivery and 415 seconds for ORS spray delivery in the current analysis.

4) Reduction in the containment sprayed volume after CS termination to 18% from 60% in the current basis.

5) ORS pumps will not start before 15 minutes, so ECCS leakage to Safeguards is assumed to start at 15 minutes vs. 415 seconds in the current basis.

6) SI pump will not begin recirculating contaminated sump fluid (Recirculation Mode Transfer or RMT) before 30 minutes, so ECCS leakage to the Auxiliary Building and backleakage to the RWST is assumed to start at 30 minutes vs. 2300 seconds in the current basis.

7) Containment leakage during the time interval from 1 to 4 hours after a LOCA has increased to 0.029 %-volume-per-day vs. 0.021 %-volume-per-day in the current analysis.

8) Credit for an Exclusion Area Boundary (EAB) Atmospheric Dispersion Factor (ADF) of 1.79E-3 sec/m^3 to replace 4.61E-3 sec/m^3 in the current basis. The EAB ADF change was submitted to the NRC and is currently pending approval [21].

Auxiliary Ventilation Exhaust Filter Trains

Operation of the Auxiliary Ventilation Exhaust Filter Trains is specified in Technical Specification 3.22 and the surveillance requirements for the charcoal adsorbers are specified in Technical Specification 4.12. The existing TS surveillance requirements provide assurance that the following filter efficiencies can be credited in the LOCA radiological analyses based upon Dominion's response to GL 99-02 [22, 23]:

- Elemental iodine: 90%
- Methyl (organic) iodine: 70%
- Aerosol (particulate): 99%

CS Flow Rate

Conservative predictions of CS flow rate based upon the LOCA containment depressurization analyses using GOTHIC (Section 3.4) have been incorporated into the determination of aerosol removal coefficients.

RS System Modeling

Previous analyses assumed RS coverage was equal to CS coverage. The design basis for the previous analysis was that the containment was subatmospheric after one hour, but the dose analysis included an extra period of release from 1-4 hours for unspecified future changes to the containment pressure analysis. A review of the RS system indicates that a loss of offsite power, in addition to a single failure (e.g., loss of an emergency diesel generator) will leave two of the four 180-degree semi-circular spray headers with power. However, the arrangement of pumps, headers, and their emergency power supply is such that only 180 degrees of headers will be spraying.

As a result of having as little as 180 degrees of spray coverage after CS is terminated, credit for RS is not taken until that time. Therefore, the start of aerosol spray removal by RS has been changed from 216 to 4100 seconds (1.14 hours) in the containment release model, which is the time of CS termination. Also, after CS is terminated, the sprayed volume is decreased to 18% from 60% and the wetted cross sectional area is decreased to 31% from 100%. The RS spray coverage volume assumption also affected the sprayed and unsprayed split of the containment leak rate, source distribution, and mixing rate after CS is terminated at 1.14 hours.

In the ECCS leakage model, the earliest start times for the RS pumps is 15 minutes based on maximum SI and CS flow rates for two trains. Therefore, ECCS leakage from the ORS system in the Safeguards Building begins at 15 minutes for conservatism.

RMT

RMT is the time that contaminated ECCS leakage from the SI System in the auxiliary building and backleakage into the RWST can begin. The earliest RMT time was changed for conservatism to 30 minutes based on maximum SI and CS flow rates for two trains.

Containment Pressure After 1 Hour

As a result of delaying the RS start, the GOTHIC containment depressurization analysis predicts a small increase in the containment peak pressure between 1 and 4 hours post-LOCA. In order to remain bounding, the containment leakage during the interval from 1 to 4 hours after a LOCA has been increased in the radiological analysis to 0.029 %-volume-per-day from 0.021 %-volume-per-day. The change corresponds to containment pressure increasing from 0.5 psig to 1.0 psig in the radiological analysis.

EAB ADF

Credit is being taken for the revised EAB ADF that was submitted to the NRC in letter serial number 05-601 [21] and is currently pending approval.

3.0 GOTHIC Containment Analyses

GOTHIC will replace the Stone & Webster LOCTIC code as the evaluation methodology in Chapters 5 and 6 of the SPS UFSAR for the containment design requirements described in Section 2.1. This section of the report documents two sets of GOTHIC analyses that were performed to demonstrate acceptable margins to the containment design criteria.

1. **Current Configuration**: The current RS system configuration with delay timers (120 seconds for IRS pumps, 300 seconds for ORS pumps) and the current TS Figure 3.8-1 containment air partial pressure limits were used to demonstrate acceptable margins for the current plant configuration. These analyses are comparable to the LOCTIC analyses currently in SPS UFSAR Chapters 5 and 6. GOTHIC margin improvements with respect to LOCTIC were described in Section 4 of topical report DOM-NAF-3. While some design inputs have changed from the LOCTIC analyses (see Section 3.1.4), transient behavior is similar to the LOCTIC UFSAR analyses. The current configuration analyses establish a set of baseline GOTHIC analysis results to which the proposed configuration cases are compared.

2. **Proposed Configuration**: The proposed configuration assumes two changes from the first set of analyses. First, the RS pumps are started assuming 60% RWST level coincident with a CLS High High containment pressure signal. The IRS pumps start directly from the signal. The ORS pumps start 120 seconds after the actuation signal is reached. Instrument uncertainty is included for the level signal and the timer setpoint. Second, the containment air partial pressure is increased to the values in the proposed revision to TS Figure 3.8-1 that is provided in Section 3.10. The TS containment air partial pressure envelope is established to provide adequate margins to the containment acceptance criteria from the SPS UFSAR (the long-term containment pressure is modified from 0.5 psig to 1.0 psig in accordance with Section 4):

    - LOCA and MSLB containment peak pressure < 45 psig
    - LOCA containment pressure < 1.0 psig from 1-4 hours and < 0.0 psig after 4 hours
    - LOCA containment temperature < 280 F
    - LHSI Pump NPSHa > Required NPSH
    - ORS Pump NPSHa > Required NPSH
    - IRS Pump NPSHa > Required NPSH

3.1 Application of the GOTHIC Methodology

The GOTHIC analyses employ the containment response methodology described in topical report DOM-NAF-3 [3] without modification. Benchmarks to LOCTIC containment response analyses from the SPS UFSAR were presented in Section 4 of DOM-NAF-3. Code differences in the treatment of key phenomena were described in that report. This section reviews the key elements of the SPS GOTHIC models for containment analyses.

3.1.1 Model Geometry

The SPS containment is represented by a lumped control volume. The minimum and maximum free volumes are unchanged from the current analyses; the values are presented in Table 3.1-1. Control volumes are used to model the RWST and piping for the CS, RS and SI systems. Junction elevations, heights, and loss coefficients are input consistent with the guidance in DOM-NAF-3, Section 3.2.1. Nineteen thermal conductors model the containment passive heat sinks for LOCA analyses. For the MSLB event, the ECCS accumulators are modeled as filled tanks with an external thermal conductor.

For LOCA analyses, flow paths model the break through the end of reflood using the vendor's mass and enthalpy data. At the end of reflood, the GOTHIC simplified RCS model is activated. The release from the first set of flow paths is stopped and different flow paths are activated from the RCS. For a DEPSG break, different flow paths model the release from the broken loop cold leg and the broken loop pump suction during post-reflood. For a DEHLG break, different flow paths model the broken hot leg release from the vessel and the broken hot leg connection to the steam generator. A separate flow path and boundary condition inject the accumulator nitrogen into containment for LOCAs (Section 3.2.2 in DOM-NAF-3).

3.1.2 Engineered Safeguards Features

The GOTHIC model includes a flow boundary condition to model the containment spray (CS) pumps. Flow is variable as a function of the RWST level and downstream pressure. Pump heat is added when conservative. Pipe fill time and pump start delays are incorporated into a delay time that passes before the CS pumps deliver flow to the spray headers. A fraction of CS pump flow is diverted to the suction of the ORS pumps using boundary conditions.

Each RS pump is modeled with a flow boundary condition. Constant flow rates are assumed to bound the minimum and maximum delivered flow rates calculated from system analyses. RS pump heat is added when conservative. Trips are used to start the IRS and ORS pumps in accordance with the design description in Section 2.2. Control volumes model the filling of the RS pump discharge piping. Control volumes are used for the RS pump suctions to allow the mixing of bleed injection flow and the accurate calculation of NPSHa at the pump first-stage impeller. Suction friction and form losses are included in the pump suction flow paths to accurately calculate NPSH available at the pump impeller.

Each of the four recirculation spray lines contains a single-pass, shell-and-tube heat exchanger located inside containment between the RS pump and the spray header. Heat exchanger performance is modeled to ensure a conservative prediction of heat removal from the sump for long-term accident analysis. The RSHX model selections in GOTHIC were benchmarked to a detailed heat exchanger design code over the range of accident flow rates and temperatures in the RS and SW systems. The HX models include tube plugging and fouling for analyses where it is conservative. Section 4 of DOM-NAF-3 demonstrated that the GOTHIC RSHX heat rates are comparable to LOCTIC after the containment sump liquid temperatures converge to similar values.

Safety injection is modeled with flow boundary conditions that draw from the RWST and the containment sump. Before the end of reflood, sink boundary conditions remove mass from the RWST consistent with the vendor mass and energy calculation. At the end of reflood, the GOTHIC mass and energy model is activated and boundary conditions inject RWST water into the primary system. When the RWST reaches a low-low level, the RWST boundary conditions are terminated and another boundary condition directs water from the containment sump to the primary system.

Nozzle components are used for each spray line. The Sauter mean diameter was calculated for each spray system in accordance with DOM-NAF-3, Section 3.4.1. For containment integrity analyses, the nozzle spray flow fractions are set to 1.0 and the containment height is reduced using the methodology in Section 3.4.1.2 of DOM-NAF-3. The floor area gives the correct drop volume and surface area exposed to the containment atmosphere. For NPSH analyses, sensitivity studies showed that NPSHa is not sensitive to a reduction in containment height, because the conservative reduction in drop diameter by a factor of 10 makes the spray drops 100% efficient for NPSH analysis. Therefore, the containment height in the NPSH models is input from the containment free volume and the pool surface area.

3.1.3 Containment Passive Heat Sinks

The containment heat sinks are grouped into the following categories.

- Containment structure shell below grade
- Containment structure shell above grade
- Containment structure dome and liner
- Containment structure floor above floor liner
- Containment structure mat below floor liner
- Internal concrete slabs
- Carbon steel inside the containment
- Stainless steel inside the containment
- Accumulator tanks filled with water (MSLB only)

The DOM-NAF-3, Section 3.3, modeling guidelines for nodalizing thermal conductors were applied. The surface area and thickness for concrete structures were taken from the current UFSAR analysis basis. The metal surface area and mass were increased from the current UFSAR minimum inventory based on a comprehensive review of containment metal that concluded that the previous inventory had omitted some structural metal and components. Thermal properties for concrete and steel were obtained from an engineering handbook and are presented in Table 3.1-2. Paint thermal properties from the current LOCTIC analyses were confirmed to be conservative for the SPS paint systems and were not changed. A contact resistance was modeled in the containment liner interface between concrete and carbon steel with a conductance less than 45 Btu/hr-ft^2-F, which is more conservative than the maximum value of 100 Btu/hr-ft^2-F specified in DOM-NAF-3, Section 3.3.1.

Heat transfer options were set consistent with DOM-NAF-3, Section 3.3.2. The Direct heat transfer option with DLM condensation was applied to all containment heat sinks except the sump floor. The Split option was used for the floor to switch the heat transfer from vapor to liquid as the liquid level builds in the basement. The containment walls above grade and the containment dome used a specified external temperature of 95 F with a heat transfer coefficient of 2.0 Btu/hr-ft^2-F. For NPSH analysis, a multiplier of 1.2 was applied to the Direct heat transfer coefficient.

In the LOCA and MSLB peak temperature cases, a 1 ft^2 thermal conductor was added with the thickness of the containment liner and with a 1.2 multiplier on the Direct/DLM heat transfer coefficient to calculate a conservative containment liner temperature response. This is consistent with DOM-NAF-3, Section 3.3.3.

3.1.4 Plant Parameter Design Inputs

During the development of the SPS GOTHIC containment models, all of the containment analysis design inputs were reviewed and some values were revised. As a result, the current configuration analyses presented in this report have different results compared to the benchmark analyses in Section 4 of DOM-NAF-3. Key input changes from the current UFSAR analyses are summarized below. Table 3.1-1 summarizes the range of key input parameters from the SPS GOTHIC containment analyses.

- The minimum surface area for metal heat sinks in containment was increased conservatively based on a revised inventory that was documented in an internal calculation.

- Some of the assumed pump flow rates were revised based on hydraulic analyses of RS, SI, SW and CS system performance. The most significant change was an increase in the minimum CS flow rate. The assumed flow rates are listed in Table 3.1-1.

- The safety analysis assumptions for measurement instrument uncertainty for RWST temperature, SW temperature, and containment air temperature were increased to support a longer interval between RTD calibration/replacement. The assumed uncertainties are included in the parameters in Table 3.1-1.

- The LHSI pump NPSH required was changed to be consistent with an increase in the assumed maximum LHSI flow from 3305 gpm to 3330 gpm. A higher flow rate was analyzed to bound any potential changes that could affect the system hydraulic calculations. The NPSH required test report was reviewed and it was found that the pump can and entrance head losses were being accounted for in both the NPSH required curve and the LOCTIC calculation of NPSHa. Therefore, the NPSH required was baselined to the pump impeller centerline elevation where NPSHa is calculated with GOTHIC. The suction friction losses for the LHSI, IRS, and ORS pumps at maximum flow rate were also revised using hydraulic analyses of the actual system configurations.

- For the pump suction breaks, the end-of-reflood SG secondary side energy was increased to account conservatively for additional energy that was identified in a recent error report from Westinghouse regarding the LOCA mass and energy release analysis documented in WCAP-14083 [8]. Revised inputs were developed for SG secondary pressure, temperature, and liquid fraction at the end of reflood.

3.1.5 Containment Initial Conditions and Instrument Uncertainty

SPS operates with a subatmospheric containment. As such, the selection of initial conditions for each accident analysis is consistent with Table 3.6-2 in DOM-NAF-3. The GOTHIC containment analyses include design inputs for plant parameters that are controlled by Technical Specifications, including containment air partial pressure, containment temperature, RWST temperature, and SW temperature. DOM-NAF-3, Section 3.6, describes how GOTHIC analyses could account for instrument uncertainty on the TS surveillance parameters in one of two ways. In the analyses in this report, instrument uncertainty was deterministically applied to the TS limit to develop a GOTHIC input (Option 1 in DOM-NAF-3). For example, TS limits on containment temperature are 75–125 F and the instrument uncertainty is 0.5 F. Thus, the GOTHIC analysis input range is 74.5–125.5 F. Table 3.1-1 defines the GOTHIC input assumptions for the TS parameters.

3.1.6 NPSH Available and Water Holdup

DOM-NAF-3, Section 3.8.1, described the licensing basis for calculation of NPSHa for the SPS LHSI and RS pumps. A specific value for containment overpressure credit in the determination of NPSH has not been previously provided to the NRC for review and approval. Rather, NRC approval has been directed at verification of the adequacy of the methodology used to determine that the available NPSH is greater than the required NPSH for these pumps. The GOTHIC analysis methodology for NPSH in Section 3.8 of DOM-NAF-3 ensures that an overall conservative calculation is performed to minimize containment pressure and maximize containment sump temperature. DOM-NAF-3, Section 4.4 demonstrated the application of the conservative GOTHIC calculation of LHSI pump NPSHa for SPS, and the containment response compared favorably to the LOCTIC analysis of record.

The NPSHa result from GOTHIC is based on the conditions at the pump first-stage impeller elevation. The difference in elevation between the pump intake and the containment floor is included. Also, the pump suction friction and form losses (including the current clean sump screens) are specified in the junction between the containment and the pump. Therefore, the margin between the GOTHIC-calculated NPSHa and the required NPSH includes all essential elements of the problem except for strainer debris bed head loss, which is calculated external to GOTHIC and compared to the margin between NPSHa and required NPSH.

The SPS NPSH calculations for the LHSI, IRS and ORS pumps employ the following conservative assumptions consistent with DOM-NAF-3, Section 3.8:

- A multiplier of 1.2 is applied to the Direct/DLM heat transfer coefficients for passive heat sinks.
- All of the spray water is injected as droplets into the containment atmosphere (nozzle spray flow fraction of 1) and the Sauter droplet size is reduced by a factor of 10.
- The upper limit on containment free volume is used.
- The minimum containment air pressure is used.
- A minimum sump pool surface area is specified for the containment volume liquid/vapor interface area.
- For pump suction breaks, thermal equilibrium in the broken loop cold leg is forced using a liquid/vapor interface area of 1E+08 ft^2 consistent with DOM-NAF-3, Section 3.5.3.3.2. This promotes thermal equilibrium between any vapor from the downcomer and the SI added to that cold leg, which produces elevated sump temperatures. The SI flow is split between the

downcomer (for the intact cold legs) and the broken loop cold leg using a flow distribution that is conservative compared to a hydraulic analysis of the RCS during a LOCA.

- A conservative water holdup volume is subtracted from the GOTHIC-calculated containment liquid volume to reduce the sump water height. Control variables incorporate the timing of spray system actuation and filling the refueling canal and calculate the total decrement to the GOTHIC containment liquid volume fraction. The corrected liquid volume fraction is then entered into a table of containment water level versus volume to determine the sump level to be used in the NPSHa calculation. For the LHSI pumps, the holdup areas in containment are filled before the pumps draw from the containment sump. The RS pumps start earlier in the accident and the holdup volumes are not filled completely at pump start. In the SPS NPSH analyses, the containment holdup volume includes the following items:

  1) water added to the RS and CS system piping,
  2) water trapped from transport to the containment sump in the refueling canal and reactor cavity,
  3) condensed films on heat structures,
  4) films that form on platforms and equipment when spray is initiated, and
  5) water absorbed in insulation.

  The water level in the NPSH analyses is based on a planned modification to install a drain path between the reactor cavity and the outer containment basement. The NPSH analyses assume this drain for the calculation of the water holdup volume in the reactor cavity and in the determination of containment water level versus liquid volume.

Table 3.1-1: Key Parameters in the Containment Analysis

Parameter	Value
Maximum Core Power (102% x 2546 rated thermal power), MWt	2597
TS Containment Air Partial Pressure, psia	Figure 3.10-1
Containment Air Partial Pressure Uncertainty, psi	+/- 0.25
Containment Temperature, °F (includes 0.5 °F uncertainty)	74.5 – 125.5
Containment Relative Humidity, %	0-100
SW Temperature, °F	24 - 96
RWST Temperature, °F (includes 1.6 °F uncertainty)[1]	32 - 46.6
Accumulator Pressure, psia	585-700
Accumulator Temperature, °F	105
Accumulator Water Volume, ft^3	975-1025
Accumulator Nitrogen Volume, ft^3 (includes uncertainty)	369 - 431
Minimum Service Water Flow Rate with 10% RSHX tube plugging, gpm	7789 at Accident Start[2]
Maximum Service Water Flow Rate with 0% RSHX tube plugging, gpm	10,000[2]
ORS Pump Flow Rate, gpm	3000 – 3300
IRS Pump Flow Rate, gpm	3000 – 3650
LHSI Injection Mode Flow Rate (Single-Train), gpm	2844 – 3264
Maximum LHSI Recirculation Mode Flow Rate (Single-Train), gpm	3330
HHSI Injection Mode Flow Rate (Single-Train), gpm	435 - 528
Minimum CS Bleed Flow Rate to ORS Pump Suction, gpm	300
Minimum IRS Recirculation Flow Rate to Pump Suction, gpm	300
CS Flow Rate, gpm	Variable[3]
IRS Piping Fill Volumes, ft^3	358 - 421.3
ORS Piping Fill Volumes, ft^3	456.5 - 558.1
CS Spray Delivery Delay from CLS signal, sec	59 - 97
LHSI Pump Suction Friction Loss at maximum 1-pump flow, ft	6.8
ORS Pump Suction Friction Loss at maximum flow, ft	7.4
IRS Pump Suction Friction Loss at maximum flow, ft	2.14

Parameter	Value
CLS High High Containment Pressure, psia	27
RWST WR Level for RS Pump Start (60% +/- 2.5% uncertainty)	57.5% - 62.5%
ORS Pump Start Time Delay, seconds (+/-12 second timer uncertainty and 0 or 10 seconds for ramp to full flow depending on which is conservative)	108 - 142
RWST WR Level Setpoint for RMT (13.5% +/- 2.5% uncertainty)	11.0 – 16.0%
Time to complete RMT function, minutes	2 - 3
Minimum RWST volume at accident initiation, gallons	384,000
Current IRS Pump Start Delay, seconds [4]	120 - 142
Current ORS Pump Start Delay, seconds [4]	300 - 340
Minimum containment free volume, ft^3	1,730,000
Maximum containment free volume for NPSHa Analysis, ft^3	1,819,000

1) Minimum RWST temperature of 32 F is assumed for evaluation of the inadvertent CS actuation event. Normal operating range for RWST temperature is 40-45 F.
2) SW minimum flow rate decreases as the intake canal level decreases during the accident. The initial value is specified for a canal level of 23 ft. For maximum flow, a constant 10,000 gpm is assumed throughout the accident (ORS pump NPSHa analyses are not very sensitive to this input).
3) The CS flow rate varies with containment pressure and RWST water level.
4) The current timer setpoints are used for "current configuration" analyses. For cases where late RS pump start is conservative, the values are increased by timer uncertainty of 10% and a pump ramp to full flow of 10 seconds.

Table 3.1-2: GOTHIC Model Heat Sink Material Properties

Material	Temperature deg-F	Density lbm/ft^3	Thermal Conductivity Btu/hr-ft-F	Specific Heat Btu/lbm-F
Carbon steel	70	490	27	0.10
Stainless steel	70	501	9.4	0.12
Concrete	75	142	1.0	0.156
Paint	75	110	0.125	0.10

3.2 Break Mass and Energy Release

3.2.1 LOCA Mass and Energy Releases

The break release methodology in DOM-NAF-3, Section 3.5 is applied. The GOTHIC model assumes a constant drop size of 100 microns for the liquid release from the break until after the blowdown phase, at which time a continuous liquid is assumed. LOCA mass and energy release data through the end of reflood is obtained from WCAP-14083 [8], which is the current licensing basis data for Surry from the core uprate project. WCAP-14083 used the NRC-approved codes and methods documented in WCAP-8264-P-A [9] and WCAP-10325-P-A [10].

During the post-reflood phase, the GOTHIC RCS system model is used to calculate the mass and energy release to the containment. The model was created using the guidelines in DOM-NAF-3, Section 3.5. In fact, the analyses herein use the same RCS model that was used for the SPS demonstration cases in Section 4 of DOM-NAF-3. The end-of-reflood mass and energy distribution in the primary system and steam generator secondary side is acquired from WCAP-14083. The mass and energy release accounts for the transfer of decay heat and the stored energy in the primary and secondary systems to the containment. For the pump suction breaks, the SG secondary stored energy at the end of reflood was increased to add conservatism to address a recent Westinghouse error report.

Lumped volumes are used for the vessel, downcomer, intact loop cold legs, broken loop cold leg (for pump suction breaks), steam generator (SG) secondary side, up flow steam generator tubes and down flow steam generator tubes. Separate sets of loop and secondary system volumes are used for the intact and broken loops with the connections between the broken loop and containment as necessary for the modeled break location. Separate thermal conductors model the core, primary metal, SG tubes, and SG secondary metal.

The decay heat is modeled by specifying a time dependent internal heat generation for the fuel. The 1979 ANS Decay Heat Standard is used consistent with the Westinghouse mass and energy release calculations in WCAP-14083 and DOM-NAF-3, Section 3.5.3.3.1.

The modeling approach outlined above successfully matched the long-term mass and energy release from the NRC-approved methodology employed in WCAP-14083 [8]. This comparison was documented in DOM-NAF-3, Section 4, for hot leg and pump suction breaks. The GOTHIC simplified RCS model ensures that the stored energy in the core, primary metal, and the SG secondary has been released to the containment when the vessel is fully depressurized and the acceptance criteria for containment depressurization and NPSHa are challenged.

3.2.2 MSLB Mass and Energy Releases

The current SPS licensing basis described in UFSAR Section 6.2.2.1.4 does not include a MSLB containment response analysis, so SPS-specific mass and energy release data was not available. Instead of generating SPS-specific data, North Anna mass and energy data from WCAP-11431 [11] was shown to be conservative for SPS based on a comparison of key plant parameters that affect the MSLB mass and energy releases. These parameters include reactor power level, reactor coolant system average temperature, core reactivity parameters, SG secondary liquid mass and pressure, auxiliary feedwater (AFW) flow rates, main feedwater isolation time, main feedwater runout flow rate, main feedwater purge volumes, and AFW termination time.

The North Anna MSLB mass and energy data documented in WCAP-11431 [11] was generated using the NRC-approved methodology from WCAP-8822 [12] and the LOFTRAN computer code [13]. The analysis assumed two single failures: 1) the main steam non-return valve in the ruptured line fails to close, allowing all three SGs to blowdown until closure of main steam isolation valves; and 2) loss of one emergency bus. The NRC reviewed the MSLB mass and energy release data as part of a North Anna license amendment to increase the containment temperature limit. Section 5.3 in Attachment 3 of Reference 14 described the methodology and assumptions. The NRC Safety Evaluation Report was documented in Reference 15.

The GOTHIC MSLB containment response at 0% power produces a more limiting containment peak pressure than the LOCA analysis (Section 3.7). The North Anna mass and energy release analysis assumed 900 gpm AFW flow to the faulted SG and 350 gpm to each of the two intact SGs. The SPS plant design has cavitating venturis in the AFW lines leading to each SG that limit the flow rate to about 350 gpm. The mass difference between the physical limit of 350 gpm and the assumed flow rate of 900 gpm delays the time for the faulted SG to reach dryout. The peak pressure occurs just before dryout, so a higher AFW flow rate releases more energy to the containment and produces a higher peak pressure. Using a lower, SPS-specific AFW flow would produce a smaller break mass release and a lower peak pressure. In this report, the mass release was reduced from 900 gpm to 400 gpm after the faulted SG reaches dryout. This assumption provides a conservative, reasonable long-term containment pressure and temperature response but does not affect the peak pressure, which occurs earlier in the event.

Peak containment temperature occurs for small breaks at 102% power. The WCAP-11431 MSLB mass and energy release analysis assumed 2956 MWt (102% of 2898 MWt), while the SPS rated core power is 2546 MWt [7], or 14% lower than the analyzed reactor power of 2898 MWt (North Anna rated power is 2893 MWt). Therefore, the North Anna break energy is higher than a SPS-specific analysis would provide, and the North Anna data ensures a conservative prediction of containment superheat and duration for SPS.

3.3 LOCA Peak Pressure and Temperature

The peak containment pressure is a function of the initial total pressure and average temperature of the containment atmosphere, the containment free volume, the passive heat sinks in the containment, and the rates of mass and energy released to the containment. The passive heat sinks in the containment are assumed to be at the same initial temperature as the initial average containment atmosphere temperature. Maximizing the initial containment total pressure and average atmospheric temperature maximizes the calculated peak pressure. The LOCA peak containment temperature is obtained from the peak pressure case because the containment atmosphere is saturated.

The double-ended hot leg guillotine (DEHLG) break causes a more limiting blowdown peak pressure than the double-ended pump suction break (DEPSG). The LOCA peak pressure analyses assume maximum initial containment pressure, maximum air temperature, 100% relative humidity, minimum containment free volume, and minimum heat sink surface area. Table 3.3-1 documents the results for GOTHIC calculations that use the current and proposed TS containment air partial pressure limits. The change to the RS pump start method does not affect the LOCA peak pressure and temperature because the peak values occur before the spray systems actuate. The magnitude of the containment peak pressure is governed by the heat transfer to the containment passive heat sinks.

For both cases, the containment peak pressure is less than the containment design limit of 59.7 psia. In addition, the containment vapor temperature and liner temperature remain below 280 F. Figure 3.3-1 compares the GOTHIC containment pressure response for both DEHLG cases. In Figure 3.3-2, the containment vapor temperature from both cases overlap.

The MSLB analysis in Section 3.7 results in a higher peak containment pressure than the LOCA and therefore sets the TS containment air partial pressure maximum allowable value of 11.3 psia in Section 3.10. The maximum initial air partial pressure is independent of SW temperature, because the peak pressure occurs well before SW affects heat removal; therefore, the maximum allowable pressure is a constant line in Figure 3.10-1. The TS upper limit above 70 F SW in Figure 3.10-1 is limited by the depressurization analyses (see Section 3.4). In summary, a maximum operating containment air partial pressure of 11.3 psia ensures that the LOCA peak pressure is less than the design limit of 59.7 psia.

Table 3.3-1: LOCA Peak Pressure and Temperature Analysis Results

	Current Configuration	Proposed Configuration
Initial Conditions		
TS Containment Air Partial Pressure, psia	10.3	11.3
Initial Containment Pressure, psia*	12.52	13.52
Initial Containment Temperature, F	125.5	125.5
Initial Containment Relative Humidity, %	100	100
Results		
Peak Containment Pressure, psia	57.17	58.43
Time of Peak Containment Pressure, sec	17.98	17.98
Peak Containment Vapor Temperature, F	273.0	273.0
Peak Containment Liquid Temperature, F	252.5	252.8

* Includes 0.25 psi uncertainty and 1.97 psia vapor pressure.

Figure 3.3-1: Comparison of Containment Pressure from DEHLG Peak Pressure Analysis

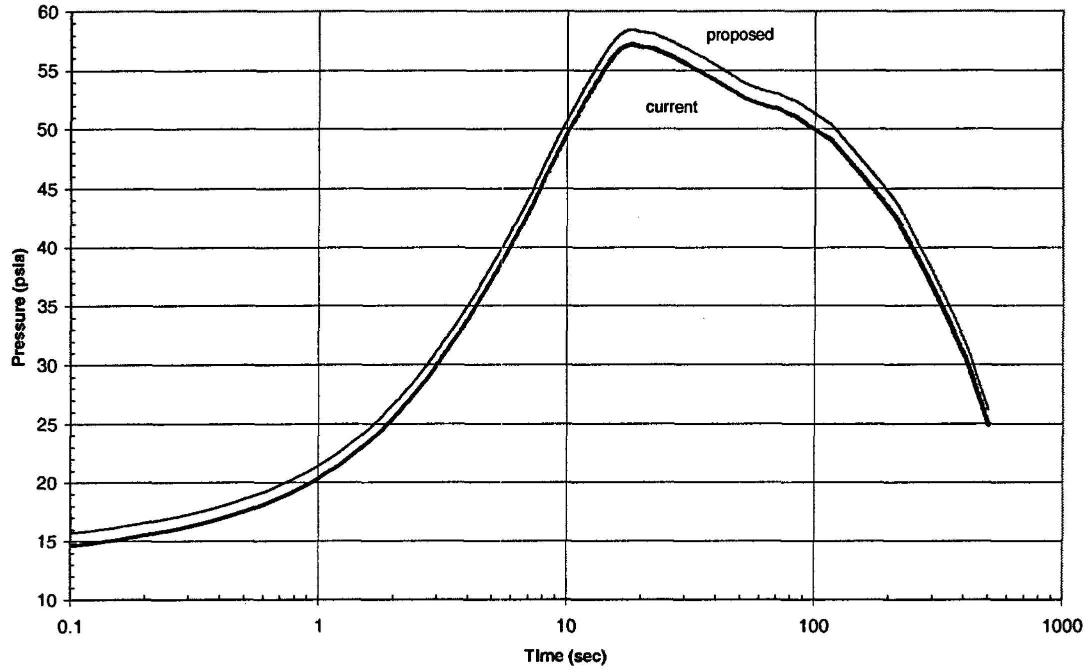
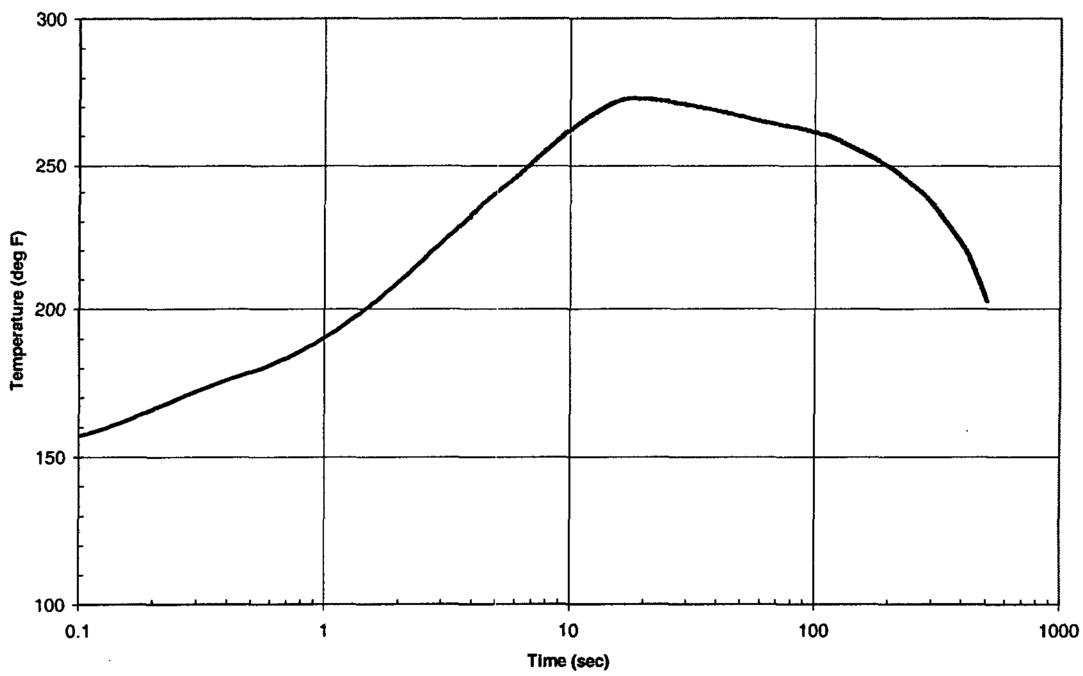


Figure 3.3-2: Containment Vapor Temperature from DEHLG Peak Pressure Analysis



3.4 LOCA Containment Depressurization

The depressurization analysis is performed to show that the containment can be returned to subatmospheric conditions consistent with the assumption for containment leakage in the dose consequences analysis. Currently, the UFSAR depressurization analyses using LOCTIC show that the containment is subatmospheric within one hour and remains subatmospheric thereafter. The current LOCA Alternate Source Term (AST) analysis assumes containment pressure is 0.5 psig from 1-4 hours and subatmospheric pressure after 4 hours [20], but the margin after the first hour has not been used to relax the containment analysis yet.

The time required to depressurize the containment and the capability to maintain it subatmospheric after a double-ended pump suction guillotine (DEPSG) break depends on the design of the containment depressurization systems, SW temperature, and the mass of air in the containment. The DEPSG break is limiting because it has the largest energy release to the containment due to the available energy removal from the SG secondary side. The loss of one emergency bus is the limiting single failure because it provides only one train of spray flow for containment atmosphere cooling. When SW temperature is elevated, it is more difficult to depressurize the containment and containment air partial pressure must be reduced to meet the depressurization limits.

Two analyses are performed to maximize the containment depressurization time (CDT) and the depressurization peak pressure (DPP). CDT represents the time when containment pressure drops below subatmospheric conditions (i.e., 14.7 psia). Maximum containment air temperature is conservative for determining CDT. When the containment spray (CS) pumps are stopped after RWST depletion, only the RS system provides spray flow to the containment and at higher temperatures than the CS system (the maximum RWST temperature is 45 F). Once CS is terminated, the containment pressure increases from subatmospheric conditions until it reaches the DPP, which is limited by the heat removal capacity of the RS system and the air mass in containment. A minimum containment temperature is conservative for the DPP case, because higher initial air mass makes it more difficult to maintain subatmospheric conditions after CS termination. This response is evident in the current UFSAR analyses and in the GOTHIC analyses in this section.

CDT and DPP analyses were performed with GOTHIC for the current and proposed configurations. The limiting case for the current configuration occurs for TS limits of 10.3 psia air partial pressure, 70 F SW, and 75 F air temperature. The containment response is very similar to the CDT benchmark case in Section 4.4 of DOM-NAF-3. Containment pressure reaches subatmospheric conditions at 2367 seconds and the DPP is –1.38 psig at 5134 seconds. The current configuration analyses maintain a subatmospheric containment after one hour.

The proposed changes to the RS pump start method were incorporated and the containment air pressure was increased until sufficient margin was retained to the containment pressure limits imposed by the current LOCA AST analysis (i.e., 0.5 psig from 1-4 hours). The analyses are performed for SW temperatures from 70-95 F using the corresponding TS containment air partial pressure limits in Figure 3.10-1. Below 70 F, the MSLB peak pressure analysis in Section 3.7 sets the TS containment air partial pressure upper limit. Table 3.4-1 summarizes the key results from four final analyses. Case 2 is the limiting analysis at the proposed TS maximum air partial pressure of 11.3 psia and 75 F SW. Case 2 is subatmospheric before 1 hour, has a DPP of 0.22 psig in the 2nd hour after CS termination, and is subatmospheric before 4 hours. Cases 3 and 4 were analyzed at the proposed TS maximum air partial pressure of 10.3 psia and 95 F SW. Case 3 assumed maximum air temperature and resulted in a higher CDT than Case 4 but the DPP was less than 0.0 psig. Case 4 assumed minimum air temperature and resulted in a DPP of 0.45 psig, which is less than the currently analyzed LOCA AST assumption of 0.5 psig. The containment pressure is subatmospheric in less than 4 hours, but the pressure decrease is a slow ramp because of the large air mass associated with the minimum initial containment temperature and the high SW temperature. The statepoint for Case 4 (75 F containment air temperature and 95 F SW temperature) is not a likely operating point, but it represents the most significant challenge to the LOCA containment pressure profile assumed in the AST analysis.

The depressurization analyses set the upper limit in Figure 3.10-1 between 70 F and 95 F SW temperature. The reduction in allowable containment air partial pressure as SW temperature increases is required to meet the LOCA depressurization limits. The analyses in this section demonstrate that, for operation within Figure 3.10-1, the post-LOCA containment pressure is bounded by the pressure used to determine the containment leakage in the dose consequences. However, because the margin from Case 4 is close to the limit, the LOCA AST analysis in Section 4 increases the containment pressure limit to 1.0 psig during the interval from 1 to 4 hours.

Figures 3.4-1 (containment pressure), 3.4-2 (containment vapor and liquid temperature), and 3.4-3 (total RSHX heat rate) compare behavior from the limiting current configuration case (TS limits of 10.3 psia, 75 F air, 70 F SW) and proposed configuration Case 4 (TS limits of 10.3 psia, 75 F air, 95 F SW). The comparison illustrates the effect of delaying the RS pumps for cases initialized at the same containment conditions (although SW temperatures are different). As expected, the lack of RS spray and sump heat removal before 1830 seconds creates higher containment pressures and temperatures. However, the long-term pressures and temperatures are bounded by the assumptions in the LOCA AST analysis. The proposed configuration case has higher sump temperature and higher SW temperature (95 F vs. 70 F), which somewhat offset and create similar RSHX heat rates. The effect of the containment temperature and pressure profiles on safety-related equipment inside containment is addressed in Section 3.9.

Small Break LOCA Containment Depressurization

Changing the RS pump start from timers with fixed delays to an RWST level setpoint encouraged a review of the containment pressure and temperature response for small break LOCAs (SBLOCA). The design basis large break LOCA causes a rapid pressurization of the containment and actuates a CLS High High signal within seconds. The RCS depressurizes quickly below the accumulator pressure and the LHSI pump shutoff head. The LHSI, HHSI, and CS pumps rapidly deplete the RWST inventory, such that the 60% RWST level setpoint is reached in a short period of time. The double-ended RCS pipe ruptures result in a large energy release to the containment and represent the most significant challenge to containment design criteria for peak pressure, peak temperature, and NPSHa for the LHSI and RS pumps. The large break LOCA analyses in this report have used the limiting single failures and ranged the possible pump flow rates to ensure that the most conservative response is obtained.

For SBLOCAs, the RCS pressure may stay above the LHSI pump shutoff head for a significant period of time. For this class of breaks, only the HHSI pumps are available to feed the RCS. If the break is large enough to actuate the CLS High High, then the CS pumps will start and deplete the RWST. However, until the RCS pressure is below the LHSI pump shutoff head, the RWST minimum depletion rate for one train of ESF (1 HHSI pump + 1 CS pump) is less than 3000 gpm and the time to reach the RS actuation setpoint of 60% RWST WR level is extended beyond the large break LOCA analyses in this section. Early in the event (~15 minutes), SBLOCA containment pressures and temperatures are lower than the large break LOCA response, but the SBLOCAs can extend the depressurization because of the slower drawdown of the RWST and release of RCS stored energy. As a result, the containment pressure and temperature profiles beyond one hour may be higher than those for RS pump start using the current timers, and the impact on EQ and the assumed containment leakage for dose consequences must be considered.

The SPS SBLOCA Appendix K analysis for calculation of peak clad temperature (PCT) uses the Westinghouse NOTRUMP computer code to determine the RCS response. The most recent analysis considered cases assuming 2-inch, 3-inch, and 4-inch effective diameter cold leg break sizes [SPS UFSAR Section 15.5.2]. Previous evaluations included a 6-inch break and demonstrated that the PCT from the 6-inch break was less limiting. The 6-inch break produces a more rapid depressurization and accumulator actuation than the smaller breaks. Break mass and energy release data was obtained from the NOTRUMP analyses for 3" and 6" break sizes. Breaks larger than 6" depressurize the RCS quickly, require LHSI flow early in the accident, and reach the RS actuation setpoint in a time frame approaching that of the large break LOCA cases, which have a bounding containment response. Breaks 3" and smaller deplete the RWST slowly and would lead to procedure-driven operator action to depressurize the RCS using the secondary system.

The GOTHIC model for LOCA depressurization was used to predict the time to reach the RS pump start on 60% RWST level. Containment model assumptions were employed to maximize the time to start the RS pumps (e.g., maximum initial RWST volume, RWST level setpoint of 57.5% for RS pump start, and minimum CS and SI flow rates) and maximize containment pressure and vapor temperature (1 train of ESF with minimum flow rates). Cases were analyzed at the proposed TS Figure 3.8-1 statepoints of 70 F SW and 11.3 psia air pressure and 95 F SW and 10.3 psia air pressure.

The GOTHIC simplified RCS model was deactivated and NOTRUMP mass and enthalpy data was entered as a boundary condition to the containment. The data had to be extended to support the duration of the GOTHIC analyses. Starting at 2500 seconds for the 6" break, the break energy was assumed to be only boiled SI based on the large break LOCA decay heat curve and conservative RCS stored energy. The break discharge was limited to vapor only (to hold up containment pressure) with an enthalpy set by the RCS saturation pressure. Energy removal through the SGs was ignored after 2500 seconds for conservatism. The energy release to the containment is conservative compared to expectations (the 6" break NOTRUMP analysis showed primary-to-secondary heat transfer start at ~1200 seconds). For the 3" break, the NOTRUMP mass and energy release at 3000 seconds was extrapolated conservatively.

For the 6" break, the CLS High High containment pressure was reached in about 60 seconds and containment spray was delivered 97 seconds later. The RS pump start signal was reached at around 3000 seconds. Containment pressure at RS pump start was less than 25 psia and drops rapidly. The containment pressure increased after CS termination, but the DPP was only slightly above 0.0 psig. For all cases, containment pressure was subatmospheric in less than 4 hours.

For the 3" break, the CLS High High containment pressure was reached at 340 seconds and containment spray was delivered 97 seconds later. The RS pump start signal was reached at around 3600 seconds. Containment pressure at RS pump start was less than 20 psia and drops rapidly once RS starts. The DPP was well below 0.0 psig. The containment response for the 3" break was clearly bounded by the 6" break.

The purpose of the GOTHIC SBLOCA analyses was to show that the RS pump start signal would be reached early enough to depressurize the containment to within acceptable limits for dose consequences and equipment qualification (EQ). The dose consequences from the SBLOCA were bounded by the large break LOCA. The SBLOCA containment pressure and temperature profiles were also well within the EQ limits. The GOTHIC analyses were conservative in assuming that long-term RCS energy was discharged into the containment atmosphere only. No credit was taken for energy removal from the SGs or for operator action to depressurize the RCS to use the LHSI pumps earlier and drain the RWST faster.

Table 3.4-1: Containment Depressurization Results for Proposed Configuration

	Case 1	Case 2	Case 3	Case 4
Initial Conditions*				
TS Containment Air Partial Pressure, psia	11.3	11.3	10.3	10.3
Initial Containment Total Pressure, psia	13.52	11.97	12.52	10.97
TS Containment Air Temperature, F	125	75	125	75
TS SW Temperature, F	70	70	95	95
Event	**Time (seconds)**			
CLS High High containment pressure	1.89	2.03	2.10	2.26
Containment spray delivers to containment	98.9	99.0	99.1	99.3
IRS pump starts	1796	1758	1792	1758
IRS spray delivered to containment	1873	1833	1867	1832
ORS pump starts	1928	1890	1924	1890
ORS spray delivered to containment	2014	1974	2008	1973
Containment pressure reaches 14.7 psia	3403	**3485**	3362	3358
Switchover to SI recirculation mode	3735	3737	3776	3735
Containment spray pumps stopped	4350	4310	4345	4304
Depressurization peak pressure occurs	5388 (-0.32 psig)	4819 (0.22 psig)	5145 (-0.10 psig)	5121 **(0.45 psig)**
Containment pressure < 14.7 psia permanently	3403	6243	3376	8268

* Analyses include uncertainties of 0.25 psi air pressure, 0.5 F air temperature, and 1.0 F SW temperature. Vapor pressure is 1.97 psia at 125.5 F and 0.42 psia at 74.5 F.

Figure 3.4-1: Comparison of Containment Pressure from DEPSG Depressurization Analysis

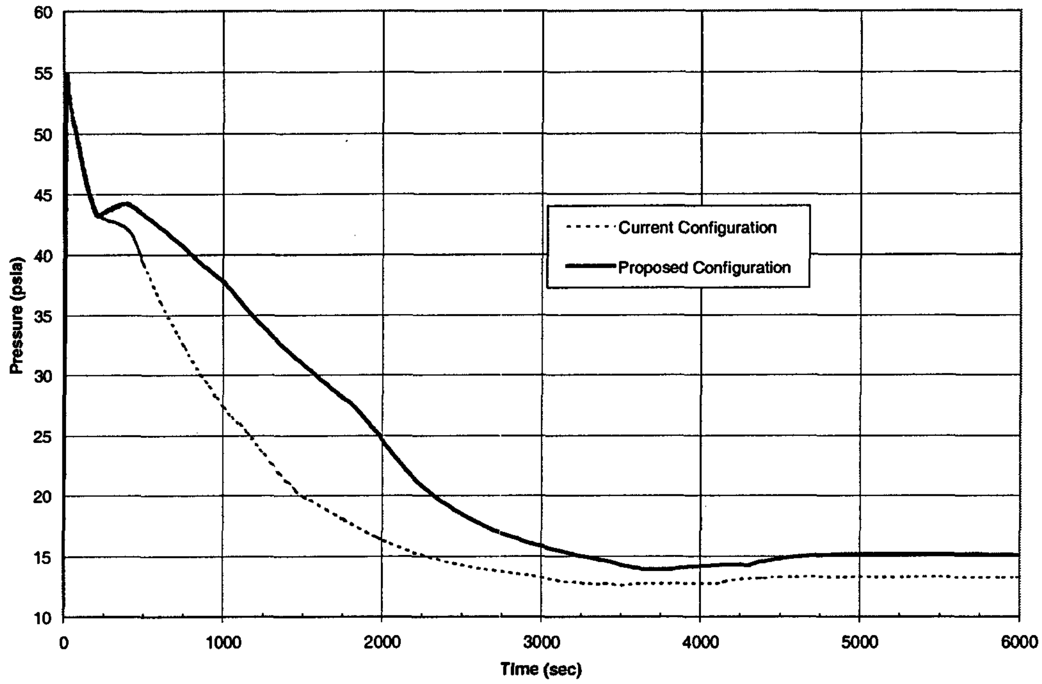


Figure 3.4-2: Comparison of Containment Temperature from DEPSG Depressurization Analysis

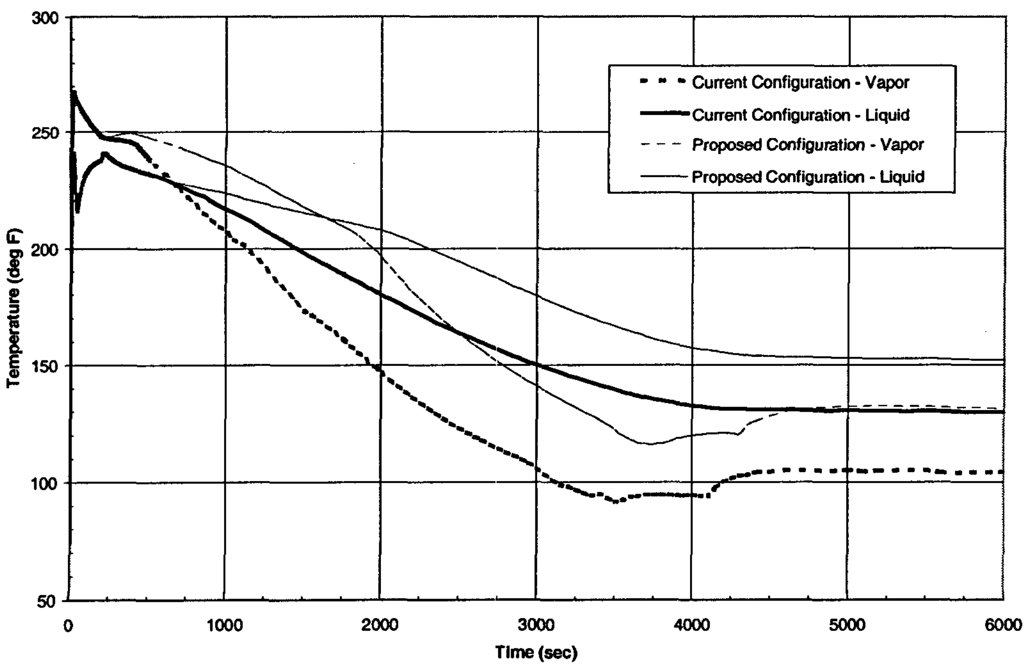
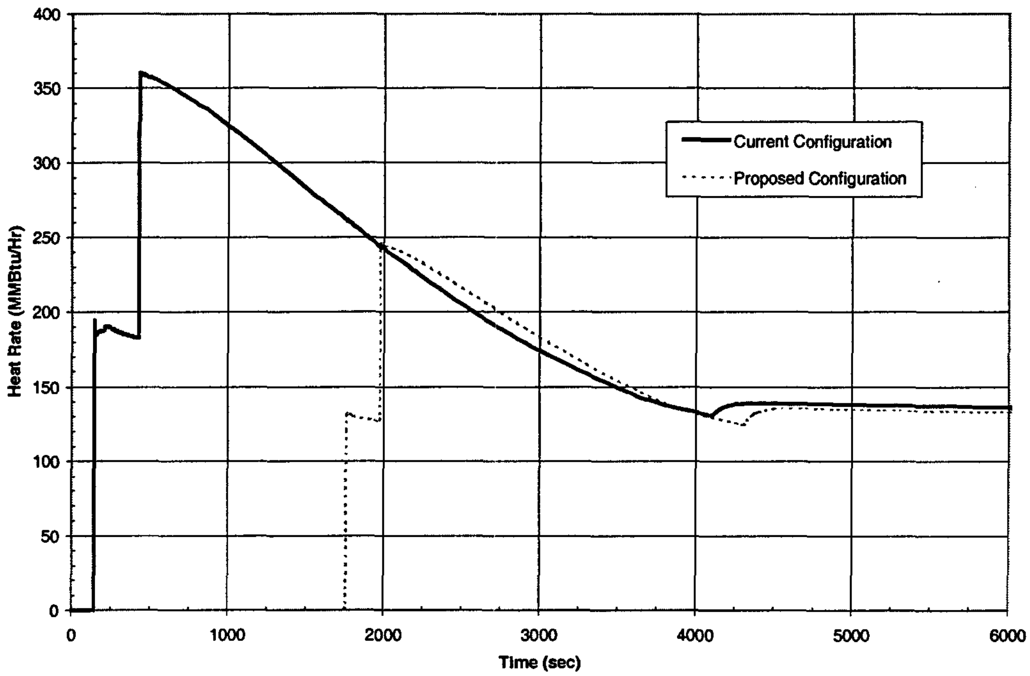


Figure 3.4-3: Comparison of Total RSHX Heat Rate from DEPSG Depressurization Analysis



3.5 LHSI Pump NPSH Analysis

A transient GOTHIC calculation is performed to demonstrate that the LHSI pumps have adequate NPSH throughout the postulated LOCA. The NPSH available (NPSHa) must be greater than the NPSH required at all times during the accident. The difference between available and required NPSH is margin. The calculation of NPSHa with GOTHIC follows the methodology outlined in Section 3.8 of DOM-NAF-3. The DEPSG break provides the limiting LHSI pump NPSH results because it causes the largest energy release to the containment before RMT. For the current configuration, assumptions were based on the matrix of conservative assumptions for the LHSI pump NPSH analysis from DOM-NAF-3, Section 4.7. For the proposed configuration, the effect of delaying the RS pumps encouraged several sensitivity studies to be repeated.

The LHSI recirculation flow rate is conservatively assumed to be 3330 gpm based on one emergency bus as the most limiting single failure. This single failure leaves one LHSI and one HHSI pump, maximizes the pump suction friction loss, maximizes the LHSI pump required NPSH, and minimizes NPSHa. The analyses assume minimum heat sink surface area, minimum RS flow rates, minimum SW flow rate, maximum CS flow rate, maximum SI flow rate, and maximum containment temperature of 125.5 F. The TS range for SW temperature (25 F and 95 F) was analyzed with a 1 F uncertainty.

The NPSH required at maximum LHSI pump flow was revised as part of the GSI-191 project. A review of the original pump NPSH required test report. It was discovered that the pump can and entrance losses were accounted for twice, in the NPSH required from the test and in the suction friction loss in previous containment analysis calculations. The current UFSAR value of 15.6 ft at 3305 gpm is conservative when compared to the revised value of 13.82 ft at 3330 gpm, which is consistent with the LHSI pump test.

<u>Current Configuration</u>

Table 3.5-1 presents the LHSI pump NPSHa analysis results for the current configuration at high and low SW temperatures. The LHSI pump minimum NPSHa of 17.82 ft occurs just after sump recirculation for a TS SW limit of 95 F. NPSHa increases to a value of 21 ft at 3600 seconds. This SW temperature is limiting because the RS pumps are removing sump energy for more than 2500 seconds before RMT (see time sequence of events in Table 3.5-2). Higher SW temperature minimizes the containment energy removal during this long period of RS operation. Figures 3.5-1 (LHSI Pump NPSHa and water level), 3.5-2 (containment pressure and LHSI pump suction vapor pressure), 3.5-3 (containment vapor and liquid temperature), and 3.5-4 (RSHX heat rate) show the performance for the LHSI pump NPSHa analysis at 95 F SW.

Proposed Configuration

Table 3.5-3 summarizes the LHSI pump NPSHa analysis results for the proposed configuration performed at several combinations of SW temperature and containment air partial pressure. Table 3.5-4 provides the time sequence of events for select cases. Delaying the RS pumps reduces LHSI pump NPSHa and made the minimum SW temperature case limiting. The delayed RS pump start reduces the system operating time before RMT from 2500 seconds to less than 1500 seconds. During this shorter window, lower SW temperature brings down the containment pressure quickly but the sump temperature holds up. In the current configuration cases, the 95 F SW case sump temperature was 21 F higher and the pressure was 1.6 psi higher compared to the 25 F SW case. In the proposed configuration cases, the 95 F SW case had a sump temperature only 10 F higher and the pressure was 1.9 psi higher compared to the 25 F SW case. With the shorter RS system operation time before RMT, the SW temperature is less significant than the current configuration.

Section 3.6 shows that the RS pumps have more NPSH margin than the LHSI pump for a containment air partial pressure of 10.1 psia. Therefore, the LHSI pump NPSH cases set the TS limit for minimum containment air partial pressure. The objective was to define TS limits that would provide at least 1.5 ft of LHSI pump NPSH margin for the sump strainer clean and debris bed head loss. Cases analyzed across the SW temperature range at 10.1 psia air pressure showed NPSH margin decrease with decreasing SW temperature. To recover design margin at low SW temperature, the containment air pressure is increased linearly from 70 F SW to 25 F SW to recover margin (see Figure 3.10-1). Table 3.5-3 shows how the increase in air pressure approximately offsets the reduction in SW temperature over the range of 40-60 F, and the minimum NPSHa is 15.4 ft.

While several cases along the air partial pressure limit approach the minimum NPSHa, the analysis at 10.2 psia and 47.5 F SW temperature is declared a limiting case for showing transient behavior. Figures 3.5-5 (LHSI pump NPSHa and water level), 3.5-6 (containment and LHSI pump suction vapor pressure), 3.5-7 (containment vapor and liquid temperature), and 3.5-8 (RSHX heat rate) illustrate the performance of key variables for the LHSI pump NPSHa analysis at 10.2 psia and 47.5 F SW temperature.

Table 3.5-1: LHSI Pump NPSHa Analysis Results - Current Configuration

Initial Conditions	High SW	Low SW
TS Initial Containment Air Partial Pressure, psia	9.0	9.0
Initial Containment Total Pressure, psia	10.72	10.72
Initial Air Temperature, F	125.5	125.5
Relative Humidity, %	100	100
TS SW Temperature, F	95	25
Results at Time of Minimum NPSHa		
Minimum NPSHa, ft	17.82	19.02
Margin to NPSH required of 13.82 ft	4.0	5.2
Time of minimum NPSHa, sec	2847	2840
Containment pressure, psia	10.61	8.93
Containment vapor pressure, psia	1.37	0.36
Containment liquid temperature, F	166.2	145.2
Containment vapor temperature, F	112.3	70.1
Water level, ft (referenced to –27.58 ft)	3.82	3.80
LHSI pump suction pressure, psia	13.05	11.37
LHSI pump suction vapor pressure, psia	5.52	3.32
Integral energy release, MBtu	667.3	674.1
Integral mass release, Mlbm	2.016	2.006

Table 3.5-2: Time Sequence of Events for LHSI Pump NPSHa Analysis
(Current Configuration at 95 F SW)

Event	Time (seconds)
Accident Start	0.0
CLS High High Pressure	2.7
Start SI	22.6
CS flow reaches containment	99.7
IRS pump starts after timer delay	144.7
End of reflood phase	198.5
ORS pump starts after timer delay	342.7
RMT at 16% RWST level + 2 minutes of valve position changes	2841.2
Transient Termination	3600

Table 3.5-3: LHSI Pump NPSHa Analysis Results - Proposed Configuration

Initial Conditions	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8
TS Containment Air Pressure, psia	10.30	10.233	10.20	10.189	10.167	10.144	10.10	10.10
Initial Containment Pressure, psia *	12.02	11.953	11.92	11.909	11.887	11.864	11.82	11.82
TS SW Temperature, F	25	40	47.5	50	55	60	70	95
Results at Time of Minimum NPSHa								
Minimum LHSI NPSHa, ft	15.74	**15.48**	**15.41**	**15.45**	**15.42**	**15.49**	15.72	16.17
Margin to NPSH required (13.82 ft), ft	1.92	1.66	1.59	1.63	1.60	1.67	1.90	2.35
Time of minimum NPSHa, sec	2896	2896	2897	2897	2897	2898	2899	2901
Containment total pressure, psia	10.74	10.96	11.12	11.18	11.29	11.42	11.79	12.6
Containment vapor pressure, psia	0.65	0.8	0.91	0.95	1.04	1.13	1.41	2.0
Containment liquid temperature, F	173.8	176.0	177.1	177.4	178.2	178.8	180.4	184.0
Containment vapor temperature, F	87.3	94.4	98.6	100.1	102.8	105.9	113.5	126.0
Water level, ft (referenced to –27.58 ft)	3.85	3.85	3.85	3.86	3.85	3.86	3.86	3.85
LHSI suction pressure, psia	13.18	13.4	13.56	13.62	13.72	13.86	14.22	15.04
LHSI suction vapor pressure, psia	6.54	6.87	7.06	7.1	7.22	7.32	7.59	8.21

* GOTHIC total containment pressure is TS air pressure – 0.25 psi uncertainty + 1.97 psia vapor pressure for 100% humidity at 125.5 F.

Table 3.5-4: Time Sequence of Events for LHSI Pump NPSHa Analyses - Proposed Configuration

Time reported in seconds	10.2 psia, 47.5 F	10.1 psia, 95 F
Accident Start	0.0	0.0
CLS High High Pressure	2.38	2.41
Start SI	22.6	22.6
CS flow reaches containment	99.4	99.4
End of reflood phase	198.5	198.5
57.5% RWST level reached	1379	1378
IRS pump starts at 57.5% RWST level + 10 seconds to reach full flow	1389	1388
ORS pump starts at 57.5% RWST level + 142 seconds (120 delay, 12 uncertainty, 10 full flow)	1521	1520
RMT occurs at 16.0% RWST level (13.5% setpoint + 2.5% uncertainty) + 2 minutes for valve position changes	2887	2892

Figure 3.5-1: LHSI Pump NPSHa - Current Configuration (9.0 psia, 95 F)

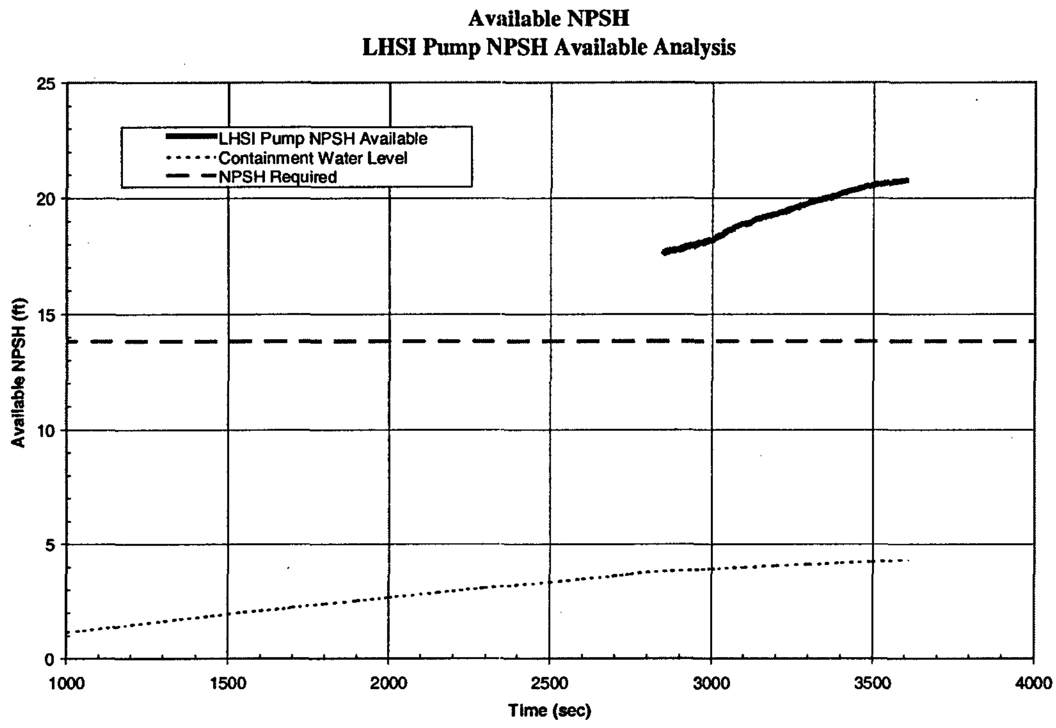


Figure 3.5-2: Containment Pressure from LHSI Pump NPSHa Analysis – Current Configuration

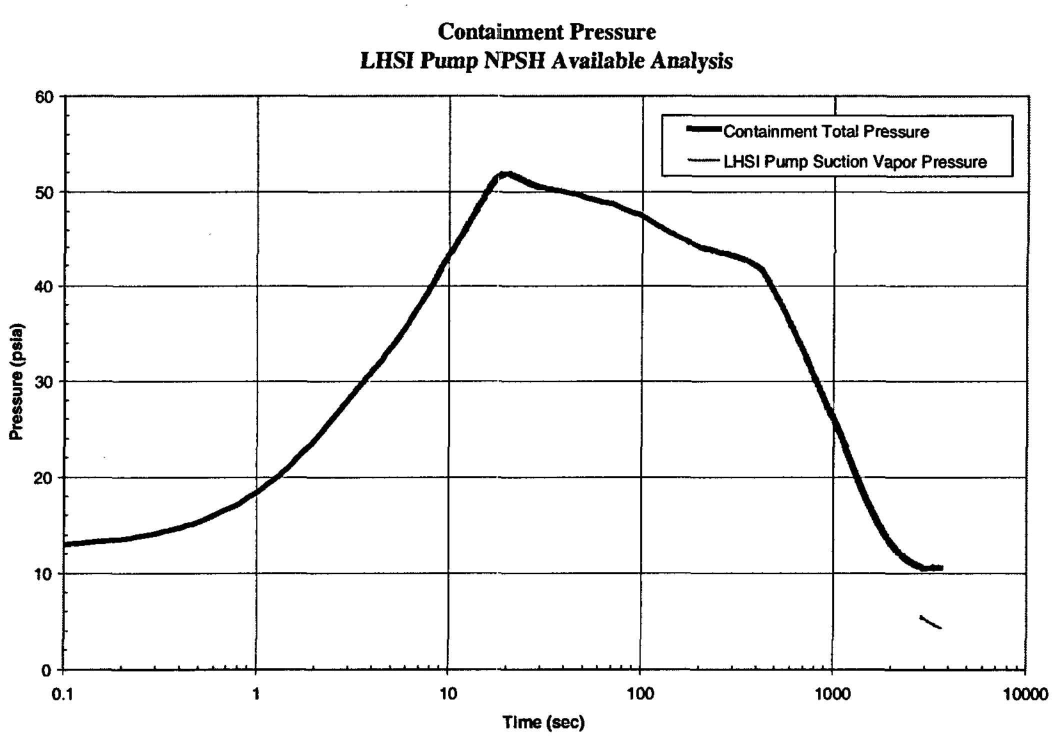


Figure 3.5-3: Containment Temperature from LHSI Pump NPSHa Analysis – Current Configuration

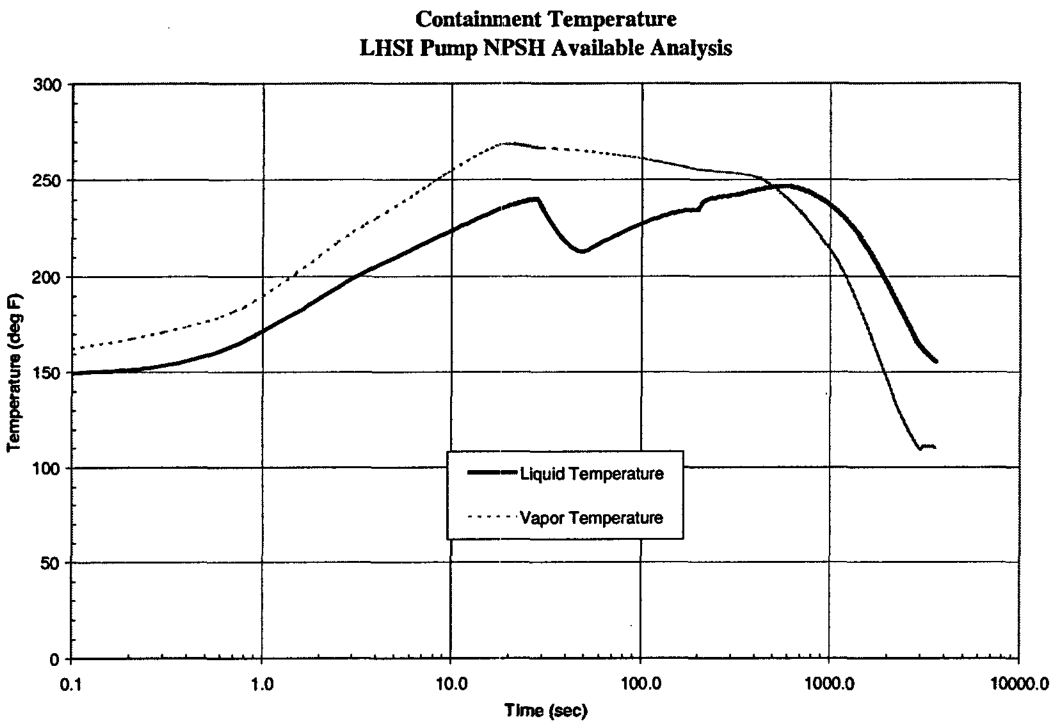


Figure 3.5-4: Total RSHX Heat Rate from LHSI Pump NPSHa Analysis – Current Configuration

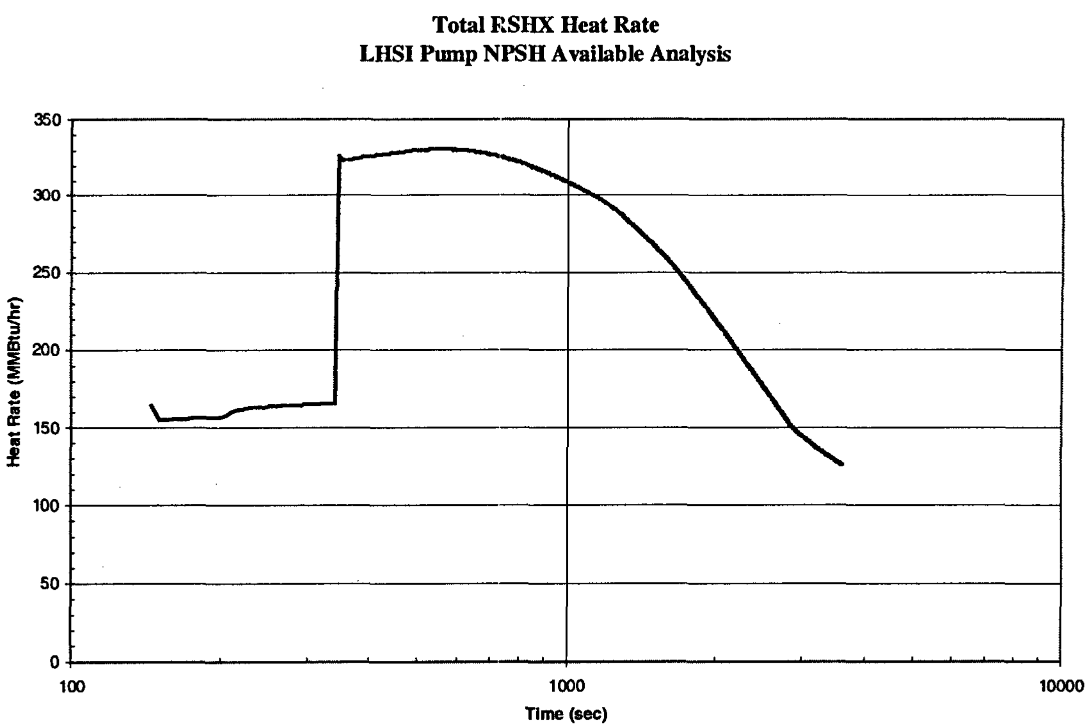


Figure 3.5-5: LHSI Pump NPSHa - Proposed Configuration (10.2 psia, 47.5 F)

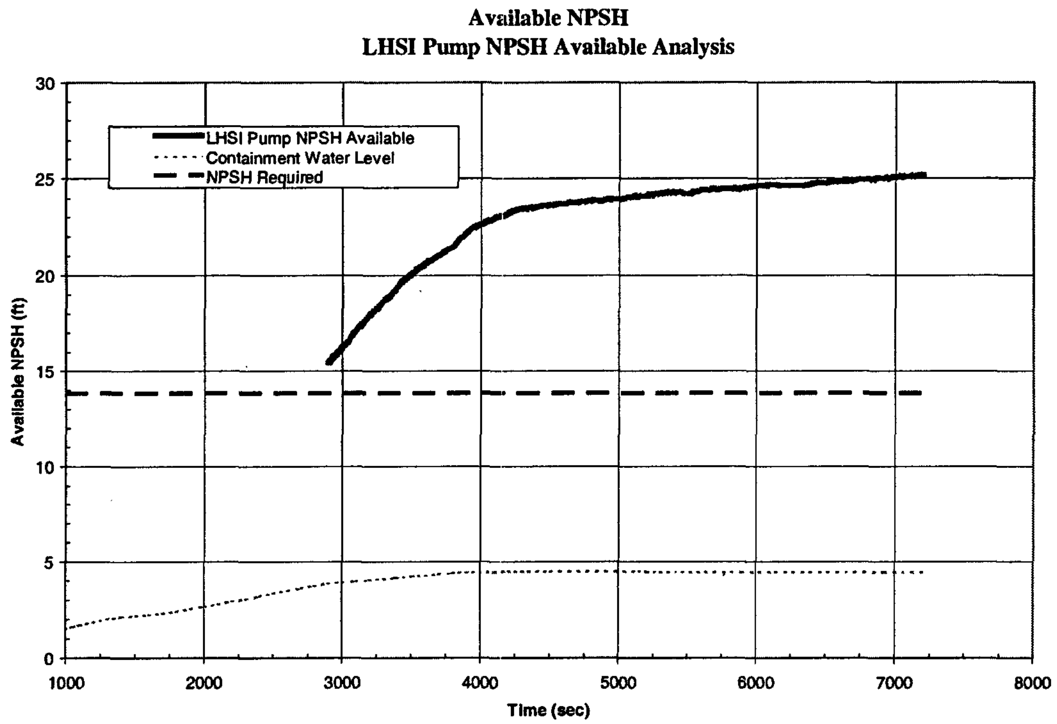


Figure 3.5-6: Containment Pressure from LHSI Pump NPSHa Analysis – Proposed Configuration

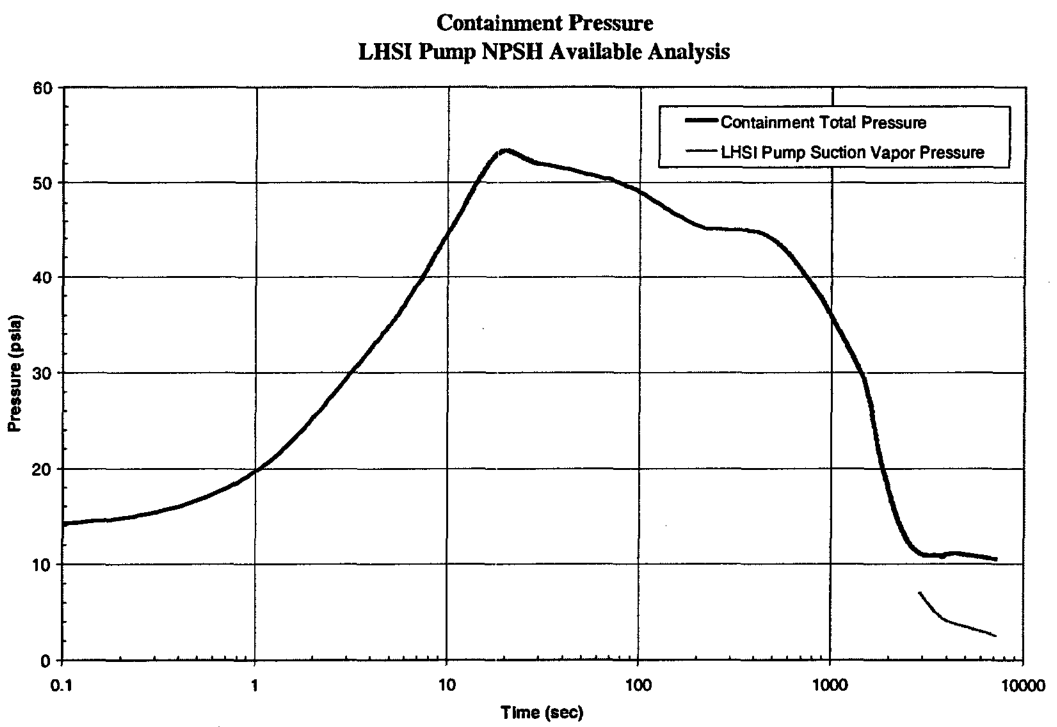


Figure 3.5-7: Containment Temperature from LHSI Pump NPSHa Analysis – Proposed Configuration

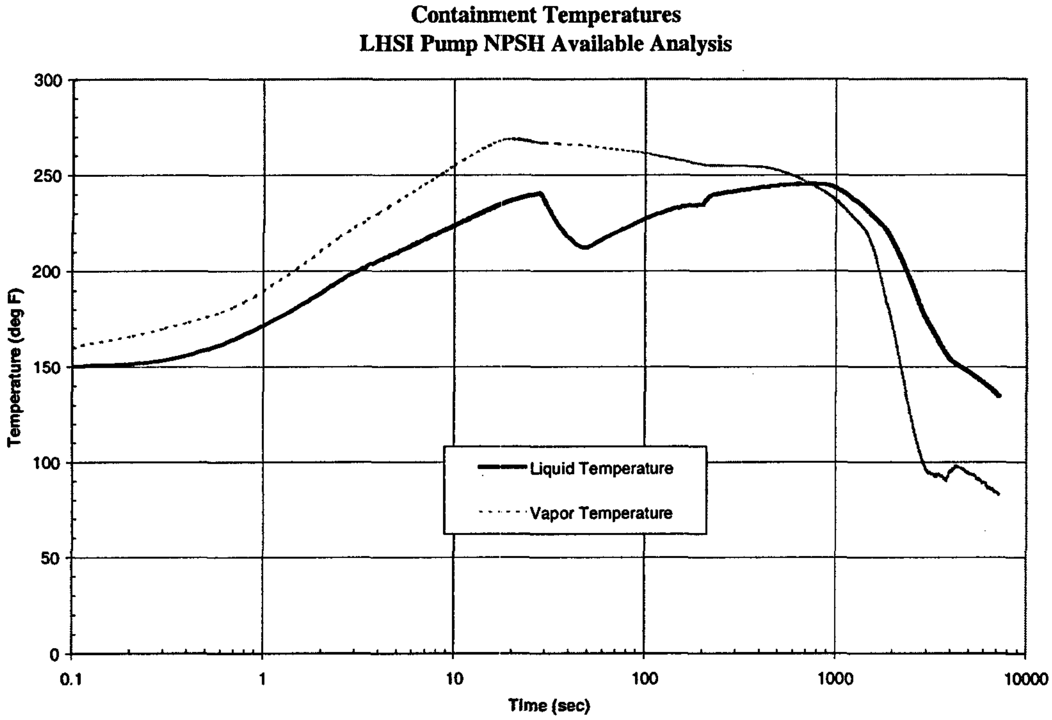
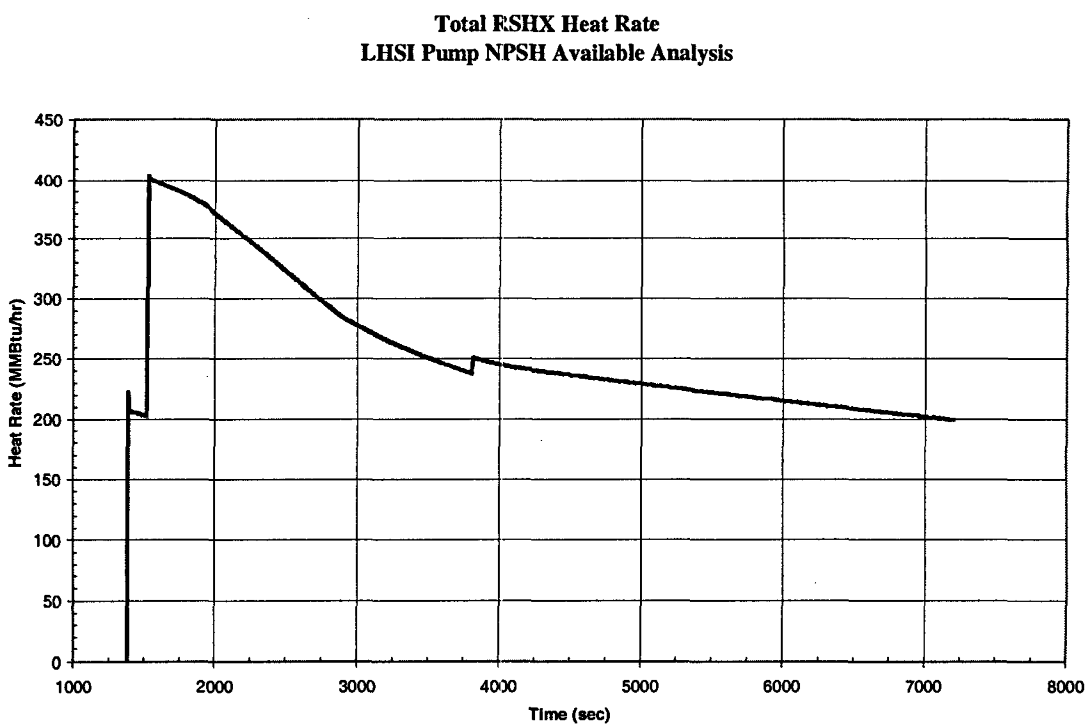


Figure 3.5-8: Total RSHX Heat Rate from LHSI Pump NPSHa Analysis – Proposed Configuration



3.6 RS Pump NPSH Analysis

A transient GOTHIC calculation is performed to demonstrate that the IRS and ORS pumps have adequate NPSH throughout the postulated LOCA. The NPSHa must be greater than the NPSH required at all times during the accident. The difference between available and required NPSH is margin. The calculation of NPSHa with GOTHIC follows the methodology outlined in Section 3.8 of DOM-NAF-3. Section 3.7 demonstrates that the RS pumps are not needed for MSLB mitigation, so only LOCA events are analyzed for RS pump NPSHa.

Analyses are performed separately for the ORS and IRS pumps. Maximum RS pump flow rate is conservative for determining the NPSHa for that pump because it causes the highest suction friction loss and imposes that most restrictive NPSH required. The ORS pump is more limiting than the IRS pump for three reasons: 1) IRS pump suction friction loss is 5.26 ft smaller (2.14 ft versus 7.4 ft for the ORS pump); 2) the ORS pump has 1.2 ft of extra head because the elevation of the pump impeller relative to the floor is –9.0 ft versus -7.8 ft for the IRS pump; and 3) the ORS pump suction receives 300 gpm of 45 F RWST water, while the IRS pump gets 300 gpm of recirculation water from the HX discharge (hotter than the RWST).

The ORS pump required NPSH at 3300 gpm is 9.19 ft, and the IRS pump required NPSH at 3650 gpm is 10.5 ft. The RS pump NPSH cases assume minimum heat sink surface area, maximum SW flow, minimum SW temperature, and maximum initial containment temperature of 125.5 F. For the current configuration, assumptions were based on the matrix of conservative assumptions for the RS pump NPSH analysis in DOM-NAF-3, Section 4.7. For the proposed configuration, the effect of delaying the RS pumps encouraged several sensitivity studies to be repeated. One emergency bus is the limiting single failure for all scenarios. For the current configuration, the DEHLG break is limiting because the mass and energy data maximize the energy in the containment sump early in the accident. For the proposed configuration with delayed RS pump start, DEHLG and DEPSG breaks were analyzed.

<u>Current Configuration</u>

Tables 3.6-1 and 3.6-2 present the RS pump NPSHa analysis results for the current configuration. The ORS pump minimum NPSHa is 11.79 ft. Figures 3.6-1 (available NPSH and water level), 3.6-2 (containment and ORS pump suction vapor pressure), 3.6-3 (containment vapor and liquid temperature), and 3.6-4 (RSHX heat rate) illustrate the performance of key variables for the ORS pump NPSHa analysis. One case was run to minimize IRS pump NPSHa (maximum IRS pump flow and minimum ORS pump flow) and demonstrate that the ORS pump is limiting for the reasons explained above. Figure 3.6-5 shows the transient NPSHa for the IRS pump, which has a minimum NPSHa of 15.55 ft.

Proposed Configuration

Tables 3.6-3 and 3.6-4 compare the results of DEPSG and DEHLG analyses using the proposed plant configuration. The DEPSG has become the limiting break for the ORS pump by a small amount of NPSH margin. The DEPSG break produces a higher long-term energy release to the containment because of the available energy in the SG secondary side. Delaying the start of the RS pumps moves the pump operation into a time period when the DEPSG break energy produces a more limiting set of sump conditions. At the time of minimum NPSHa, the DEPSG case has a higher containment pressure, sump temperature, and water level. The minimum NPSHa occurs almost 9 minutes later than the DEHLG case because it takes that much longer for the spray systems to depressurize the larger energy release and reduce the containment pressure. However, it is important to recognize that the margin difference between the DEHLG and DEPSG breaks is less than 0.7 ft at 25 F SW.

For operation in Figure 3.10-1, the minimum NPSH margin for the ORS pump is 13.5 ft at 10.3 psia and 25 F SW (Case 4). Case 3 has a lower NPSHa at an initial air pressure of 10.1 psia. Thus, the sloped TS limit provides some NPSH benefit at low SW temperature. Figures 3.6-6 (available NPSH and water level), 3.6-7 (containment and ORS pump suction vapor pressure), 3.6-8 (containment vapor and liquid temperature), and 3.6-9 (RSHX heat rate) illustrate the performance of key variables for Case 4.

The DEPSG is also the limiting break for the IRS pump NPSHa. The minimum IRS pump NPSHa is 16.89 ft, an increase from 15.05 ft for the current configuration. The IRS pump continues to have much more NPSH margin than the ORS pump for the reasons explained earlier in this section. Figures 3.6-10 through 3.6-13 show the behavior of key variables from the IRS pump NPSHa limiting case.

For the LOCA analyses in this section, the minimum containment water level is 1.8 ft (above the –27'7" floor elevation) when the IRS pump starts. This water level assumes a conservative holdup volume in containment of about 30,000 gallons and earliest pump start using 2.5% level uncertainty on the trip setpoint.

Table 3.6-1: Results for ORS and IRS Pump NPSHa Analyses (Current Configuration)

	ORS Pump NPSHa	IRS Pump NPSHa
TS Containment Air Partial Pressure, psia	9.0	9.0
Initial Containment Pressure, psia*	10.72	10.72
Initial Air Temperature, F	125.5	125.5
Relative Humidity, %	100	100
TS SW Temperature, F	25	25
ORS pump flow rate, gpm	3300	3000
IRS pump flow rate, gpm	3000	3650
Results		
Minimum Pump NPSHa, ft	11.79	15.55
NPSH Required, ft	9.19	10.5
Margin to NPSH Required, ft	2.60	5.05
Time of minimum pump NPSHa, sec	959.2	918.6
Containment pressure, psia	12.74	13.02
Water level, ft (referenced to –27.58 ft)	1.0	0.93
Pump suction pressure, psia	14.08	16.17
Pump suction liquid temperature, F	188.2	190.5
Integral energy, MBtu	377.5	374.6
Integral mass, klbms	915.9	897.6

* GOTHIC total pressure is TS air pressure – 0.25 psi uncertainty + 1.97 psia vapor pressure.

Table 3.6-2: Time Sequence of Events for RS Pump NPSHa (Current Configuration)

Time in seconds	ORS Pump NPSHa	IRS Pump NPSHa
Accident Start	0.0	0.0
CLS High High Pressure	3.0	3.0
Start SI	22.8	22.8
CS flow reaches containment	62.0	62.0
End of reflood phase	115.8	115.8
IRS pump starts after timer delay	145	145
ORS pump starts after timer delay	343	343
RS pump minimum NPSHa	959	919
SI recirculation mode transfer	3031	3030
Transient Termination	3600	3600

Table 3.6-3: DEHLG and DEPSG ORS Pump NPSH Results (Proposed Configuration)

Case →	1	2	3	4	5	6
Break Location	DEHLG	DEHLG	DEPSG	DEPSG	DEPSG	DEPSG
TS Containment Air Pressure, psia	10.10	10.30	10.10	10.30	10.20	10.10
Initial Containment Pressure, psia*	11.82	12.02	11.82	12.02	11.92	11.82
Initial Air Temperature, F	125.5	125.5	125.5	125.5	125.5	125.5
TS SW Temperature, F	25	25	25	25	47.5	70
Results at Time of Minimum NPSHa						
Minimum NPSHa, ft	13.72	14.17	13.33	**13.5**	13.91	14.95
Margin to NPSH required (9.19 ft), ft	4.53	4.98	4.14	**4.31**	4.72	5.76
Time of minimum NPSHa, sec	1676	1675	2229	2208	2236	2243
Containment total pressure, psia	12.49	12.72	12.95	13.25	13.64	14.43
Containment liquid temperature, F	198.8	199.0	204.3	205.4	206.6	208.4
Containment vapor temperature, F	125.2	125.5	131.6	132.8	138.5	147.7
Water level, ft (referenced to –27.58 ft)	2.07	2.07	2.74	2.71	2.74	2.75
ORS pump suction pressure, psia	14.19	14.41	14.92	15.21	15.60	16.39
ORS pump suction vapor pressure, psia	8.34	8.37	9.27	9.48	9.70	10.04
ORS pump suction liquid temperature, F	184.7	184.9	189.6	190.7	191.7	193.4
Integral energy release, MBtu	424.8	424.7	616.9	613.4	615.1	612.8
Integral mass release, Mlbm	1.242	1.241	1.549	1.535	1.547	1.548

* GOTHIC total pressure is TS air pressure – 0.25 psi uncertainty + 1.97 psia vapor pressure.

Table 3.6-4: Time Sequence of Events from ORS Pump NPSHa Analyses (Proposed Configuration)

Time reported in seconds	DEHLG 10.3 psia, 25 F	DEPSG 10.3 psia, 25 F
Accident Start	0.0	0.0
CLS High High Pressure	2.62	2.36
Start SI	22.8	22.6
CS flow reaches containment	61.6	61.4
End of reflood phase	115.8	198.5
IRS pump starts at 62.5% level	1242	1291
ORS pump starts at 62.5% level + 108 seconds	1350	1399
ORS pump minimum NPSHa	1675	2208
RMT occurs at 16.0% RWST level	3046	3108
Transient Termination	3600	3600

Figure 3.6-1: ORS Pump NPSHa - Current Configuration (9.0 psia, 25 F)

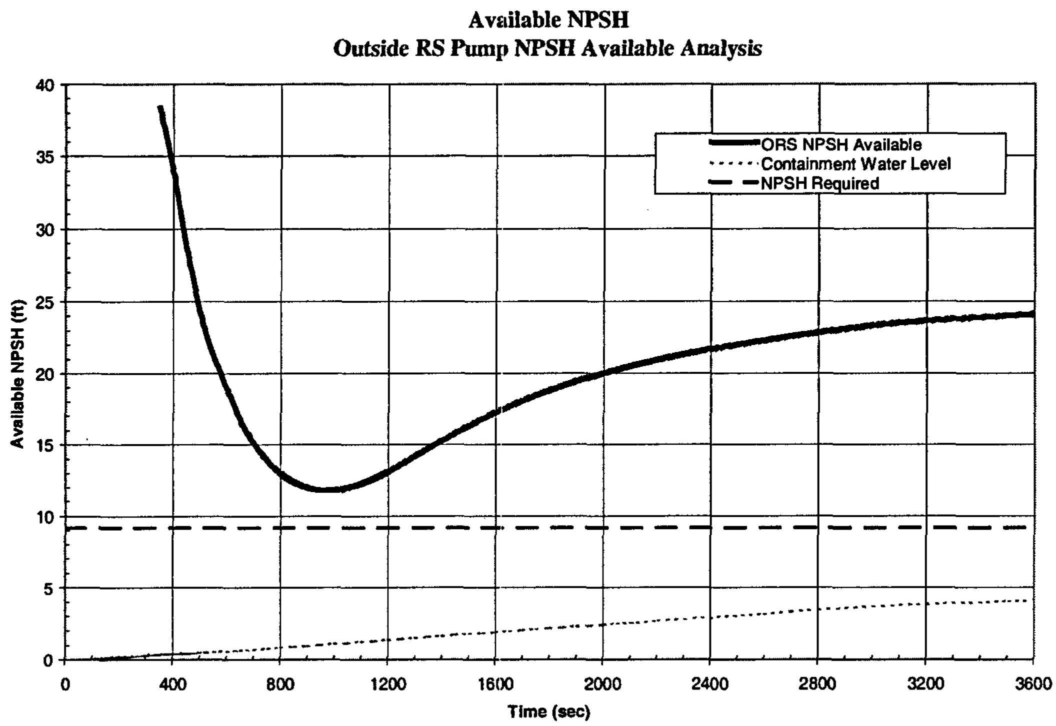


Figure 3.6-2: Containment Pressure from ORS Pump NPSHa Analysis – Current Configuration

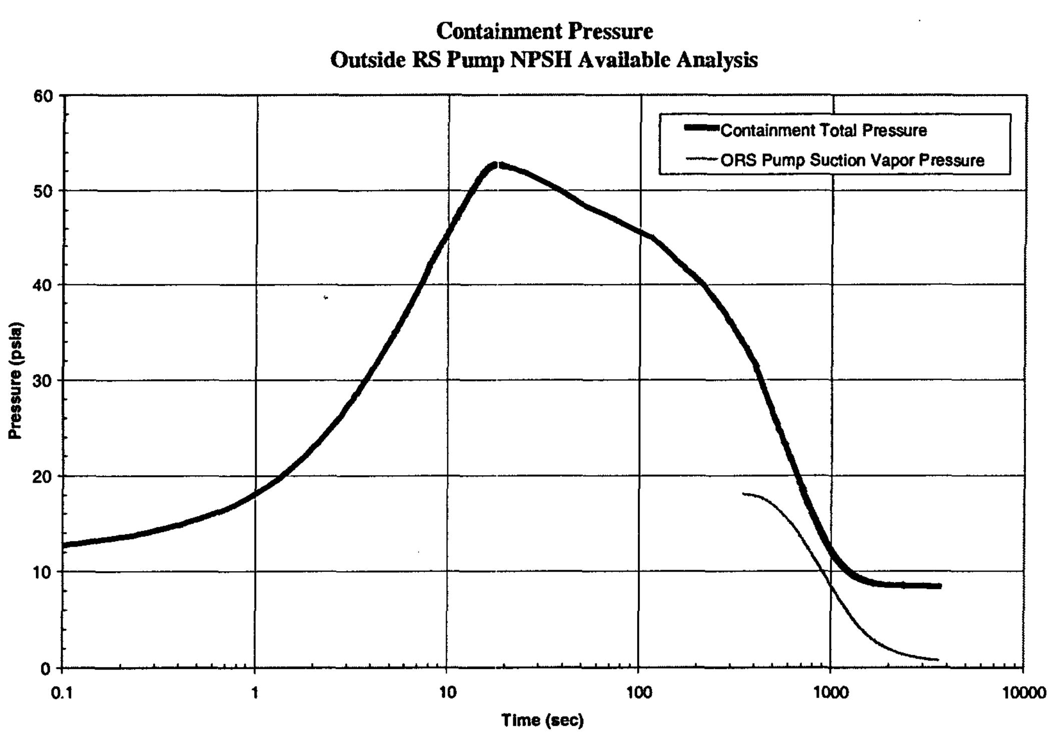


Figure 3.6-3: Containment Temperature from ORS Pump NPSHa Analysis – Current Configuration

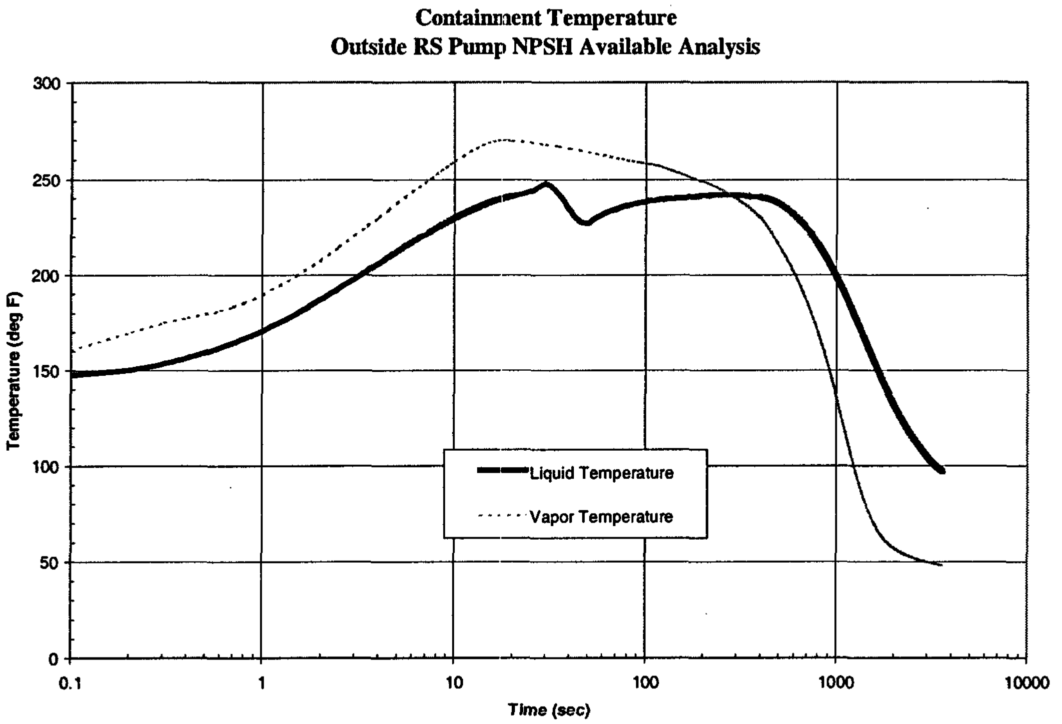


Figure 3.6-4: Total RSHX Heat Rate from ORS Pump NPSHa Analysis – Current Configuration

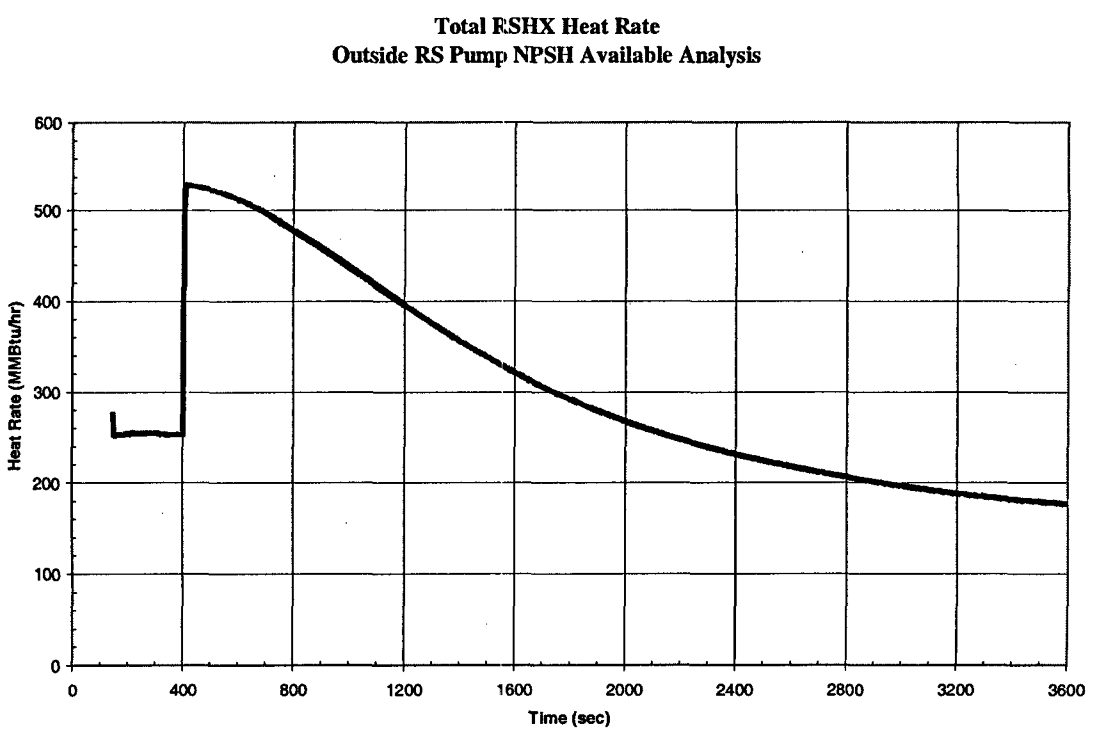


Figure 3.6-5: IRS Pump NPSHa - Current Configuration (9.0 psia, 25 F)

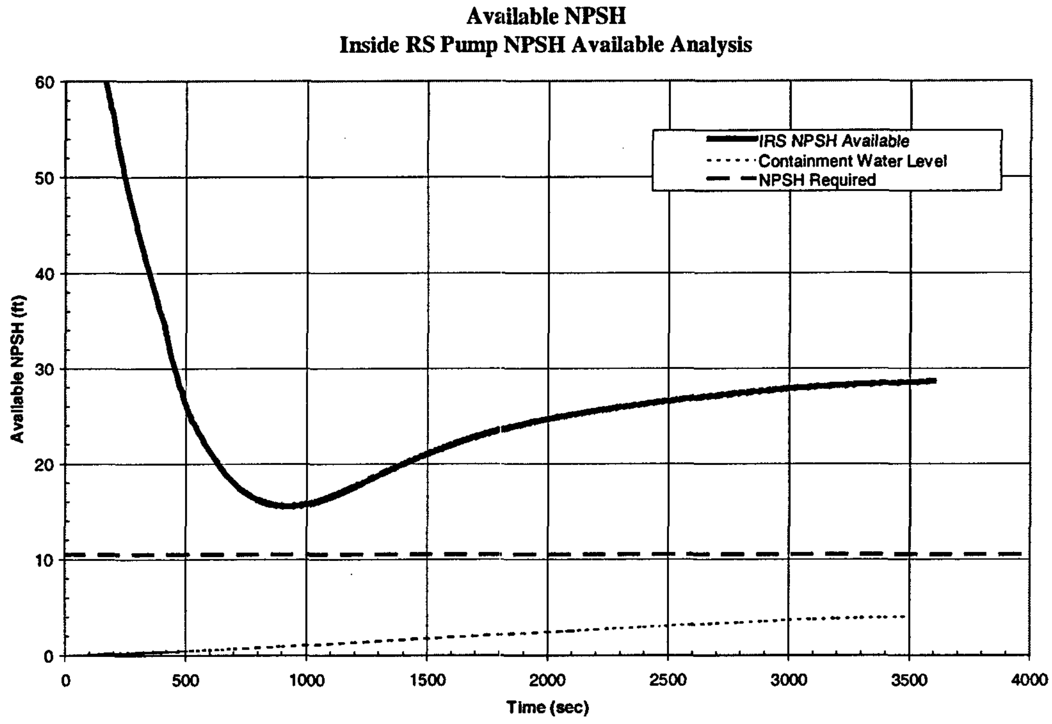


Figure 3.6-6: ORS Pump NPSHa - Proposed Configuration (10.3 psia, 25 F)

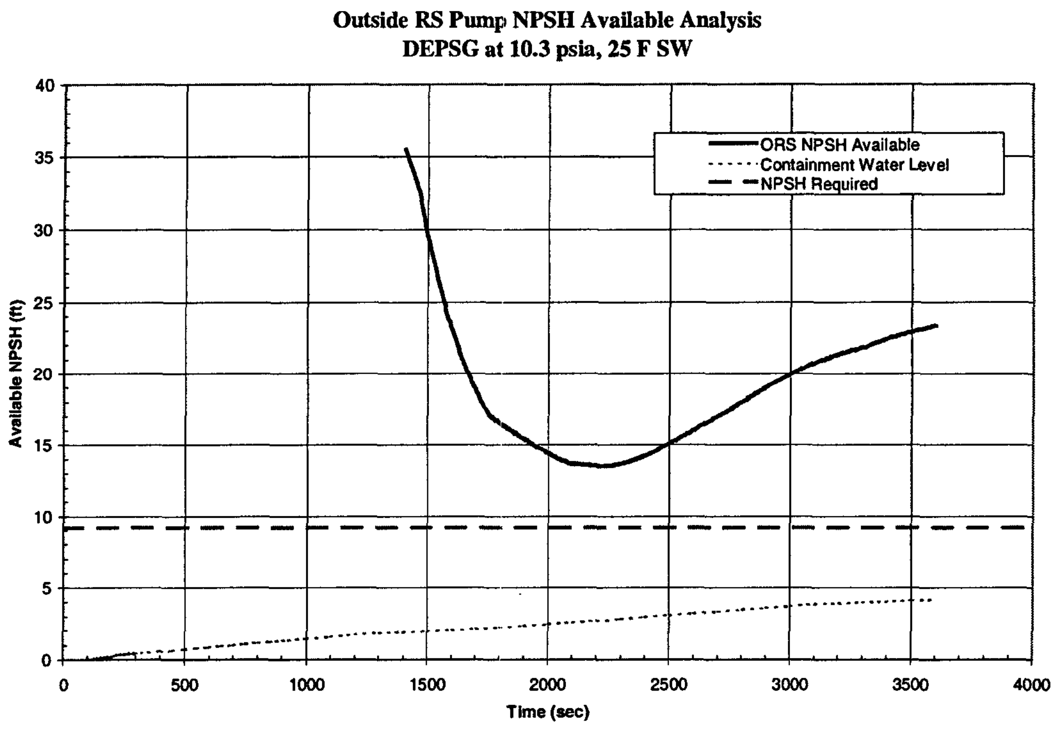


Figure 3.6-7: Containment Pressure from ORS Pump NPSHa Analysis – Proposed Configuration

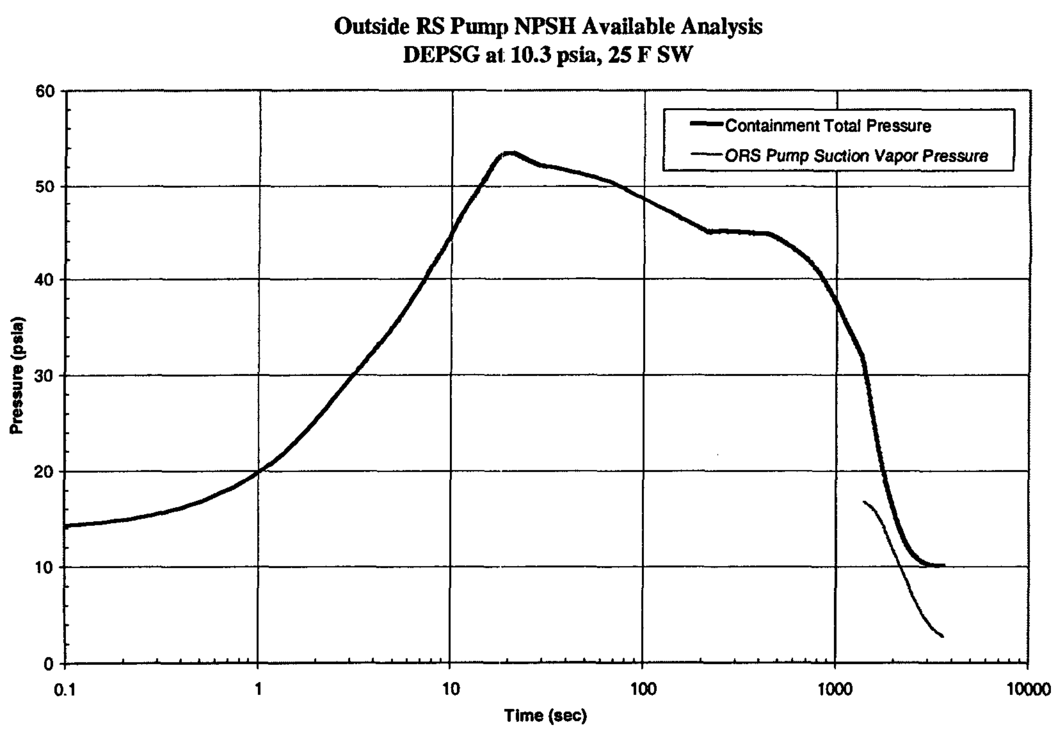


Figure 3.6-8: Containment Temperature from ORS Pump NPSHa Analysis – Proposed Configuration

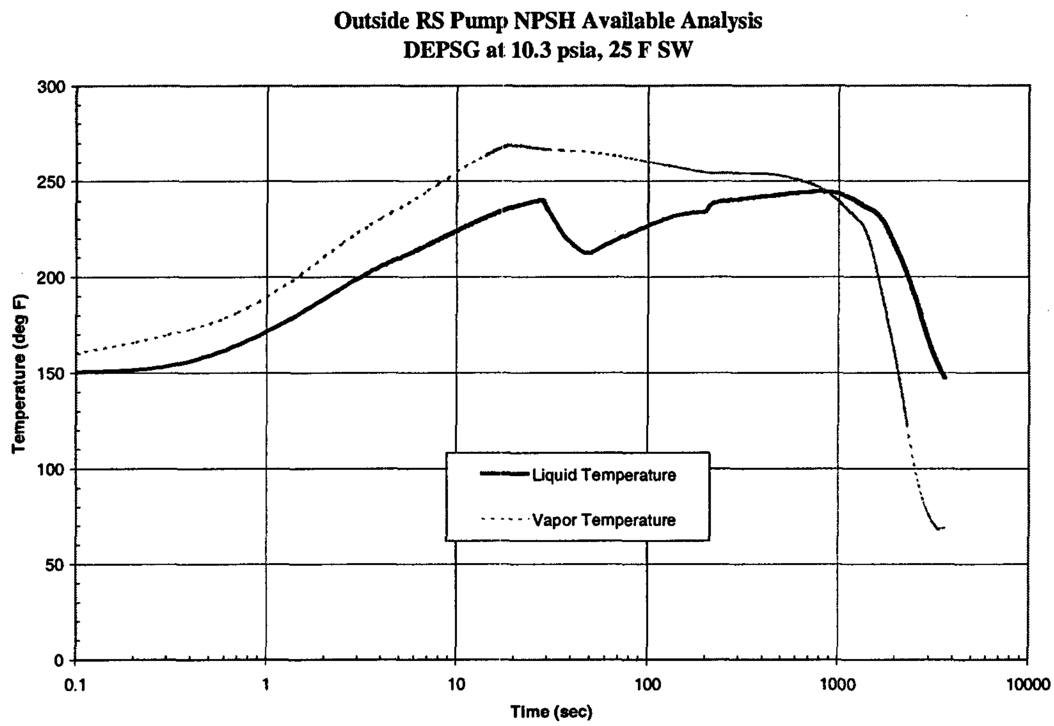


Figure 3.6-9: Total RSHX Heat Rate from ORS Pump NPSHa Analysis – Proposed Configuration

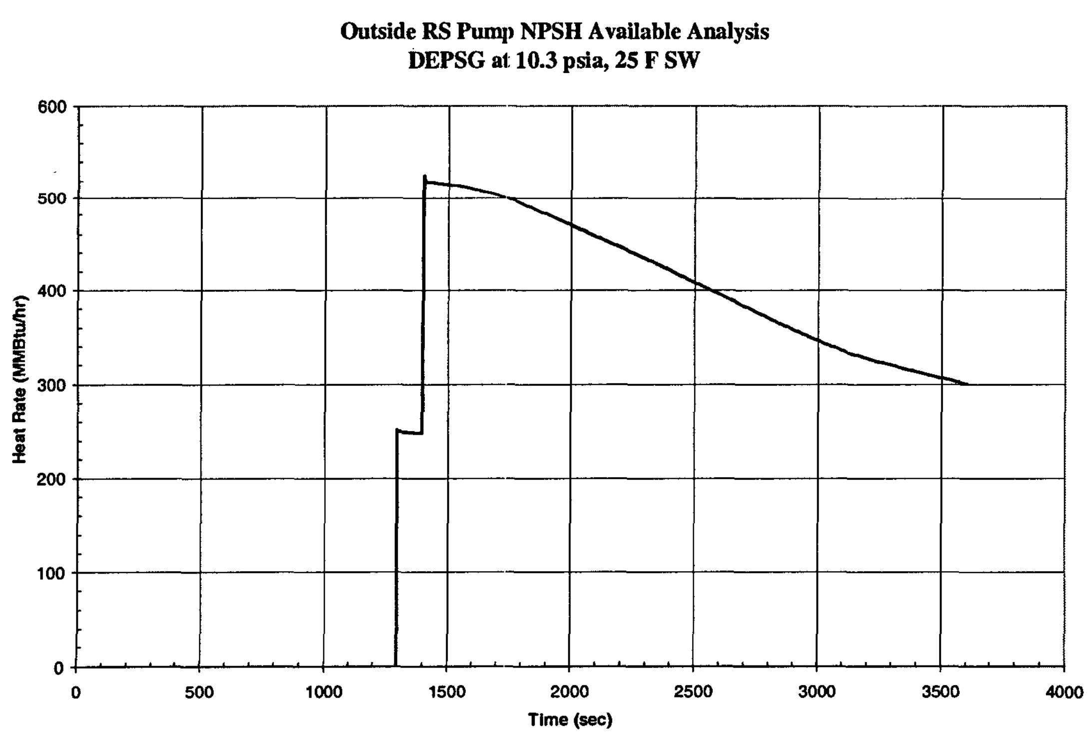


Figure 3.6-10: IRS Pump NPSHa - Proposed Configuration

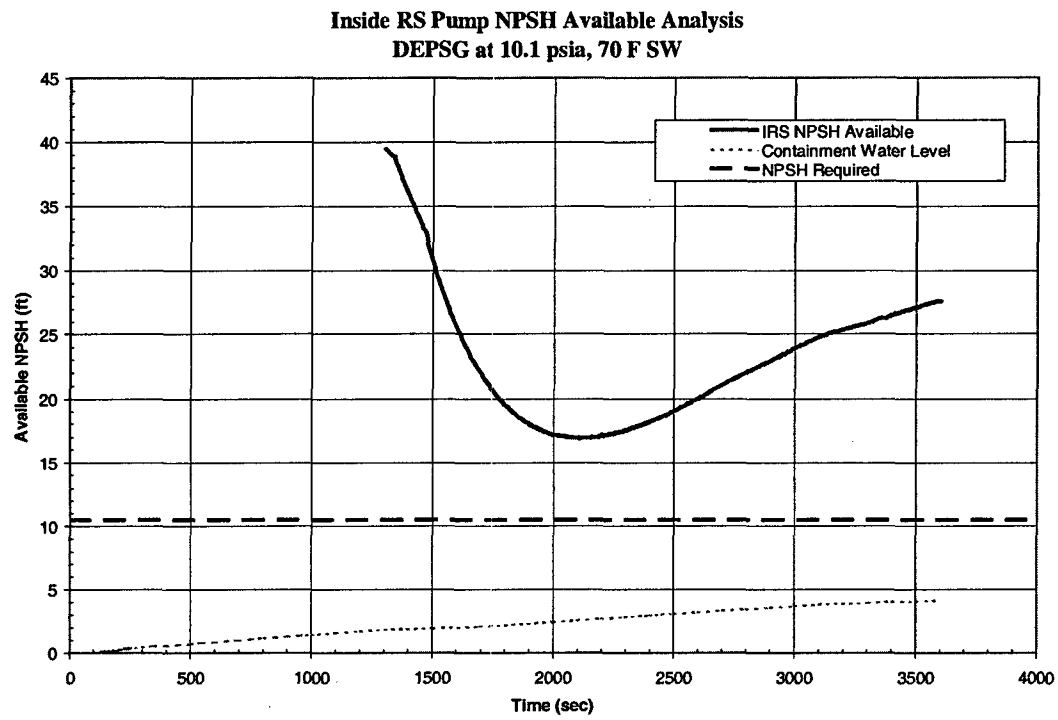


Figure 3.6-11: Containment Pressure from IRS Pump NPSHa Analysis – Proposed Configuration

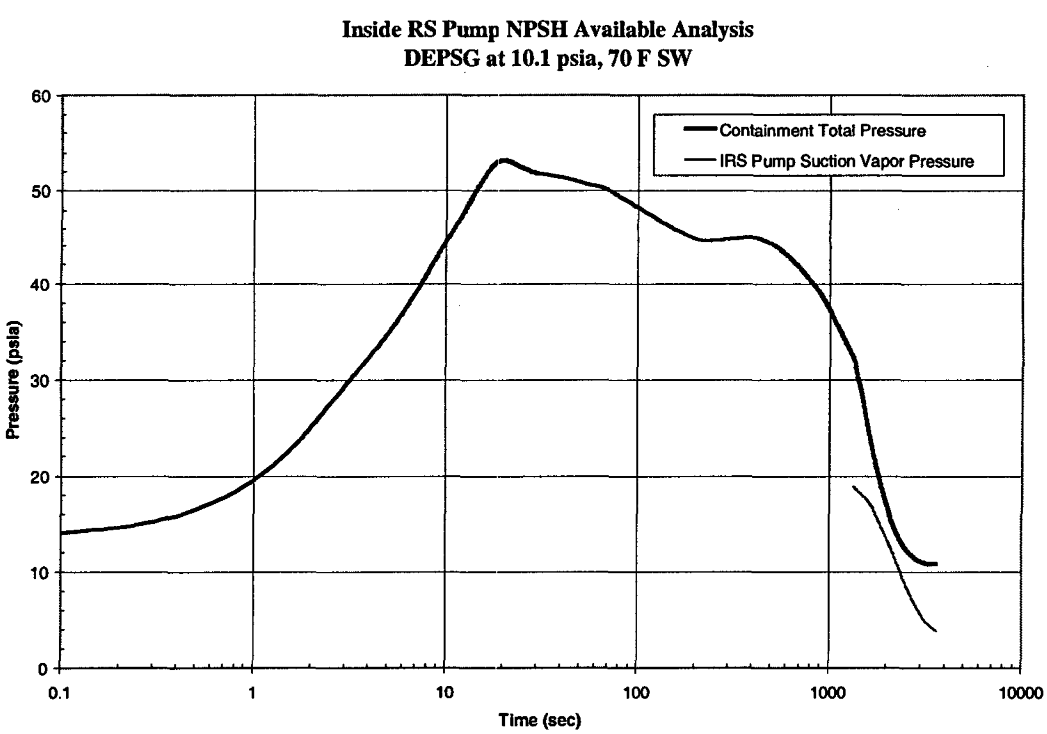


Figure 3.6-12: Containment Temperature from IRS Pump NPSHa Analysis – Proposed Configuration

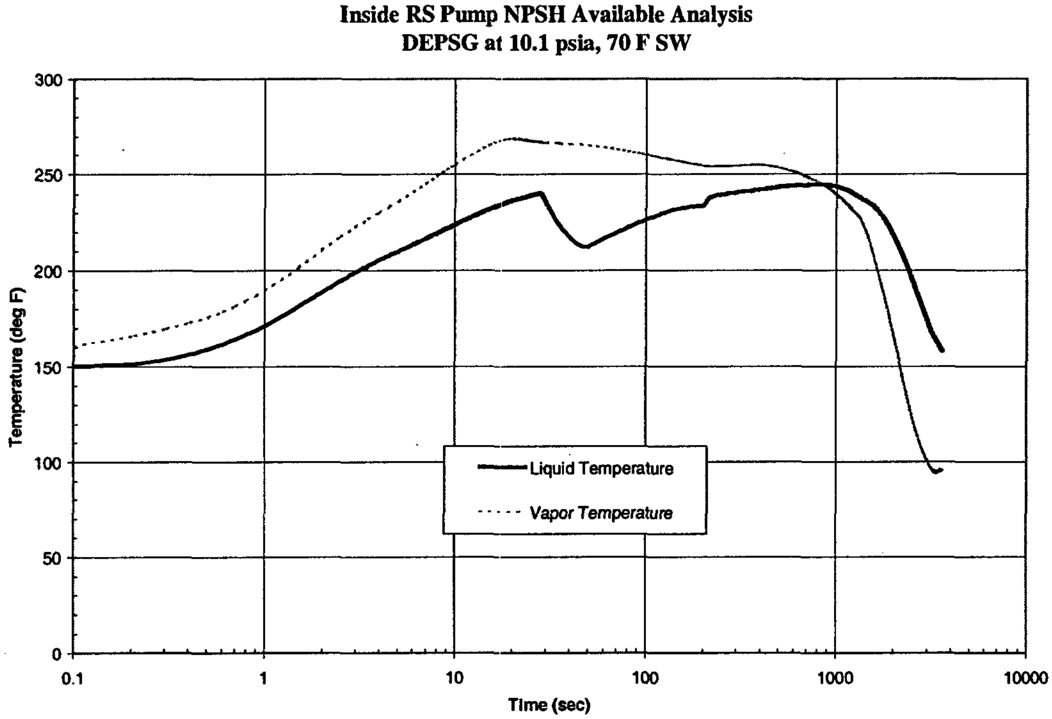
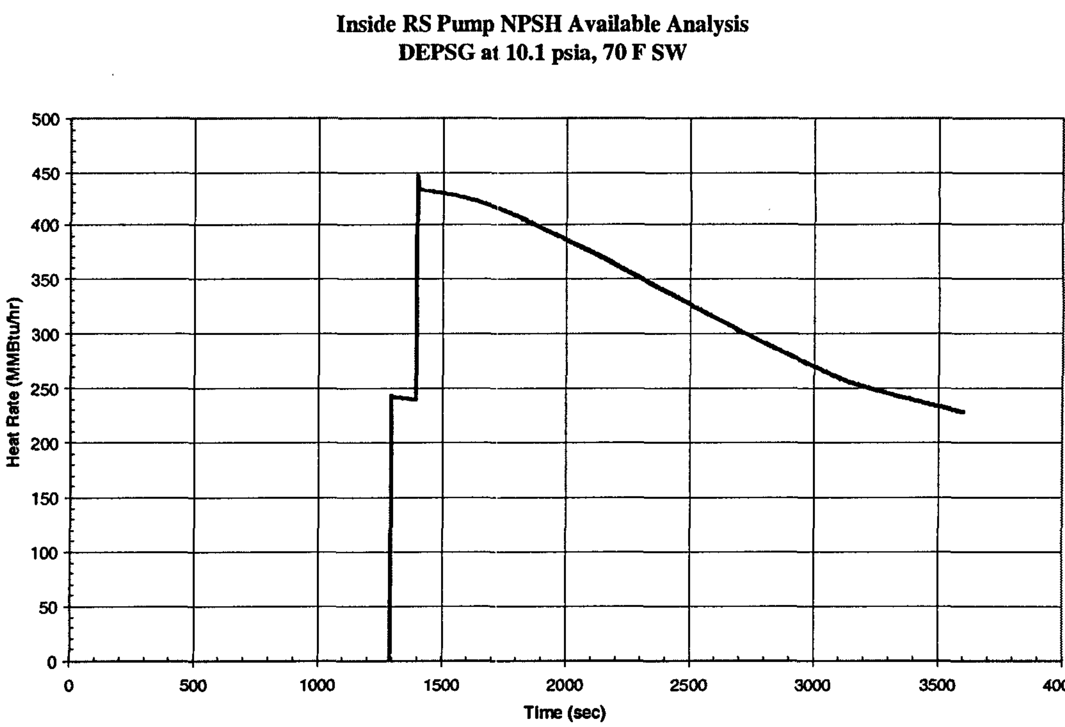


Figure 3.6-13: Total RSHX Heat Rate from IRS Pump NPSHa Analysis – Proposed Configuration



3.7 MSLB Peak Pressure and Temperature

SPS UFSAR Section 6.2.2.1.4, "Steam-Line Break Protection" [5] documents the licensing basis for MSLB containment response. Currently, the SPS licensing basis does not include an explicit MSLB containment response calculation. Instead, SPS UFSAR Section 6.2.2.1.4 includes the following basis information:

1) The SPS MSLB containment response is bounded by a Beaver Valley MSLB analysis;
2) The SPS LOCA pressure and temperature response is more limiting than the Beaver Valley MSLB analysis;
3) Transient temperature and pressure behavior for containment design is established from analysis of design basis large break LOCA.
4) LOCA temperature transient results are used for post-accident equipment qualification as allowed by IE Bulletin 79-01B and its supplements. Enclosure 4 to IE Bulletin 79-01B states that for a PWR MSLB inside containment, "equipment qualified for a LOCA environment is considered qualified for a MSLB environment in plants with automatic spray systems not subject to disabling single component failures." The Surry spray systems meet this condition.

This basis was submitted to the NRC in Reference 16 and confirmed in the Safety Evaluation Report for the license amendment to reduce the SPS boron injection tank boron concentration [17]. The NRC also reviewed the MSLB containment response licensing bases as part of the SPS core uprate submittal. The NRC SER for the SPS core uprate included a review of the above bases in Section 3.3.2 [18].

It is desired to separate from the Beaver Valley comparison and implement a SPS-specific MSLB containment response analysis capability using the GOTHIC analytical methodology in topical report DOM-NAF-3. This change would allow explicit analysis of the MSLB containment response to support plant changes (such as the proposed increase in containment air partial pressure). The existing SPS licensing basis for analysis of MSLB containment pressure and temperature response will be replaced with the GOTHIC calculations described in this section.

As described in Section 2.2, North Anna MSLB mass and energy release data from Reference 11 was confirmed to be conservative for SPS and was applied in this analysis. Section 4.6 of DOM-NAF-3 demonstrated the performance of the SPS GOTHIC containment model using North Anna mass and energy data from nine combinations of core power and break size (from small split breaks to the largest double-ended rupture). The analysis demonstrated the peak containment pressure occurs for a 1.4 ft^2 break at 0% power and the peak containment temperature occurs for a 0.6 ft^2 break at 102% power, consistent with the North Anna LOCTIC MSLB analyses.

GOTHIC analyses in this section do not credit the recirculation spray system. This precludes the need to demonstrate adequate RS pump performance during a MSLB event. The limiting single failure in the containment model is the loss of an emergency bus, leaving one CS pump available with minimum flow and maximum time to deliver spray to containment.

3.7.1 MSLB Peak Pressure Analysis

The maximum containment peak pressure occurs for the 1.4 ft^2 break at 0% power because it has the highest SG liquid mass and results in the largest mass release to the containment before the faulted SG dries out. Two cases were analyzed for the current and proposed TS maximum air pressure limits. Table 3.7-1 compares the results and shows that both cases result in a peak pressure less than the design limit of 59.7 psia. Table 3.7-2 shows the time sequence of events for the case with the proposed TS air partial pressure limit of 11.3 psia. Figures 3.7-1 and 3.7-2 show the containment pressure and temperature predictions for the same case. The atmosphere remains superheated for a very short time, returning to saturation within 10 seconds from the time of the break. The containment temperature and pressure peaks occur about 20 seconds before SG dryout, when condensation and the CS system overcome the steam release rate. Containment pressure drops rapidly once operator action terminates AFW to the faulted SG at 30 minutes, which stops the steam release to the containment.

The GOTHIC MSLB response produces a more limiting containment peak pressure than the LOCA analysis in Section 3.3. The main conservatism is the assumption for AFW flow rate in the North Anna mass and energy release analysis. The North Anna analysis assumes 900 gpm AFW flow to the faulted SG and 350 gpm to each of the two intact SGs. SPS has cavitating venturis in the AFW lines leading to each SG that limit the flow rate to about 350 gpm. The mass difference between the physical limit of 350 gpm and the assumed flow rate of 900 gpm delays the time for the faulted SG to reach dryout, more energy is released to the containment, and a higher peak pressure is realized. SPS-specific lower AFW flow rates would lead to a smaller mass release from the break and a lower peak pressure. For the MSLB analyses in this report, the mass release is reduced from 900 gpm to 400 gpm after the faulted SG reaches dryout. This assumption provides a conservative, but reasonable long-term containment pressure and temperature response for SPS but does not affect the containment peak pressure and temperature, which occur earlier in the event.

The maximum initial air partial pressure is independent of SW temperature, because the RS system is not assumed to operate. Therefore, the maximum allowable TS air partial pressure is a constant line on Figure 3.10-1 until the containment depressurization analyses limit the curve (see Section 3.4). In summary, a maximum operating containment air partial pressure of 11.3 psia ensures that the MSLB peak containment pressure will be less than the design limit of 59.7 psia.

3.7.2 MSLB Peak Temperature Analysis

The maximum peak temperature occurs for the 0.6 ft^2 break at 102% power. This break has a saturated steam release at an enthalpy of about 1200 Btu/lbm for the entire accident. Minimum air partial pressure, maximum containment air temperature, and 0% humidity are conservative. Two cases were analyzed for the current TS air partial pressure limit of 9.0 psia and the proposed TS minimum air partial pressure limit of 10.1 psia (Section 3.10). Table 3.7-3 compares the analysis results. The increase in air pressure causes an increase in containment peak pressure but reduces the containment peak temperature. Figures 3.7-3 and 3.7-4 show the containment pressure and vapor temperature predictions for the proposed configuration case. The containment temperature peaks at 31 seconds when the break flow is reduced suddenly by the isolation of the non-faulted SGs from the steam line header. The vapor temperature decrease starting at 101 seconds is driven by the delivery of containment spray to the atmosphere. Containment pressure drops rapidly once operator action terminates AFW to the faulted SG at 30 minutes, which stops the steam release to the containment. Section 3.9 describes the evaluation for the GOTHIC-predicted superheat conditions on safety-related equipment inside containment.

The analyses included an additional 1 ft^2 thermal conductor to determine a conservative containment liner temperature response in accordance with Section 3.3.3 of DOM-NAF-3. The conductor used a 1.2 multiplier on the Direct/DLM heat transfer coefficient. The peak liner temperature for the proposed configuration was 251.1 F at 490 seconds, so the sustained superheat does not adversely affect the containment liner.

Table 3.7-1: Results from MSLB Containment Peak Pressure Analyses

	Current Configuration	Proposed Configuration
TS Containment Air Partial Pressure, psia	10.3	11.3
Initial Containment Pressure, psia *	12.52	13.52
Initial Air Temperature, F	125.5	125.5
Relative Humidity, %	100	100
Results		
Peak containment pressure, psia	58.12	59.48
Time of peak containment pressure, sec	215.7	215.7
Peak containment temperature, F	274.3	274.4
Time of peak containment temperature, sec	213.6	213.7

* GOTHIC total pressure is TS air pressure + 0.25 psi uncertainty + 1.97 psia vapor pressure.

Table 3.7-2: Time Sequence of Events from MSLB Peak Pressure Analysis – Proposed Configuration

	Time, seconds
Accident start	0.0
CLS High High containment pressure	4.2
Start SI	27.9
CS delivered to containment	101.2
Containment peak pressure	215.7
Faulted SG dryout	235.0
AFW terminated	1800
Transient Termination	7200

Table 3.7-3: Results from MSLB Containment Peak Temperature Analyses

	Current Configuration	Proposed Configuration
TS Containment Air Partial Pressure, psia	9.0	10.1
Initial Containment Pressure, psia *	8.75	9.85
Initial Air Temperature, F	125.5	125.5
Relative Humidity, %	0	0
Results		
Peak containment temperature, F	324.5	318.9
Time of peak containment temperature, sec	30.6	31.1
Peak containment pressure, psia	45.9	47.4
Time of peak containment pressure, sec	412.5	412.1

* GOTHIC containment pressure = TS air pressure – 0.25 psi uncertainty (no vapor pressure)

Figure 3.7-1: Containment Pressure from 1.4 ft^2 MSLB Peak Pressure Analysis - Proposed Configuration

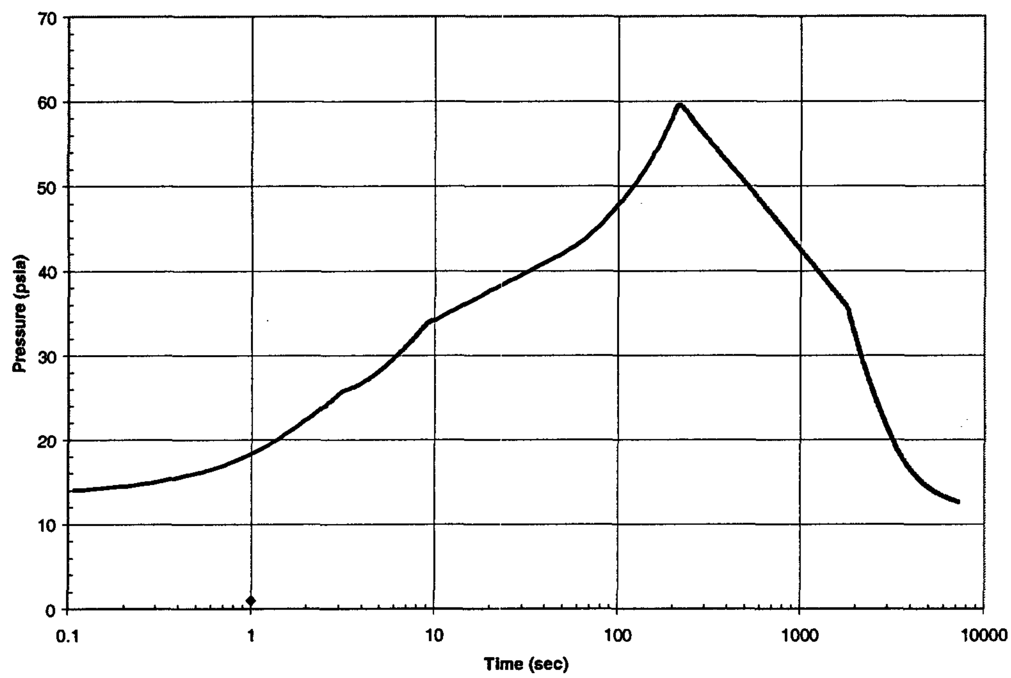


Figure 3.7-2: Containment Temperature from 1.4 ft^2 MSLB Peak Pressure Analysis - Proposed Configuration

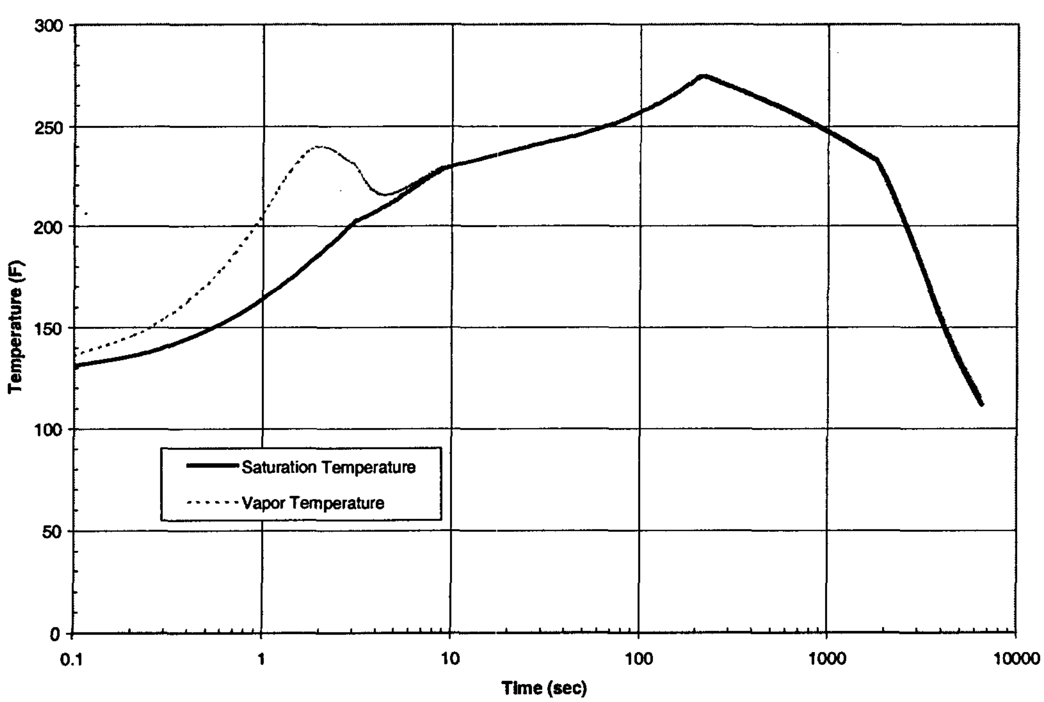


Figure 3.7-3: Containment Pressure from 0.6 ft^2 MSLB Peak Temperature Analysis - Proposed Configuration

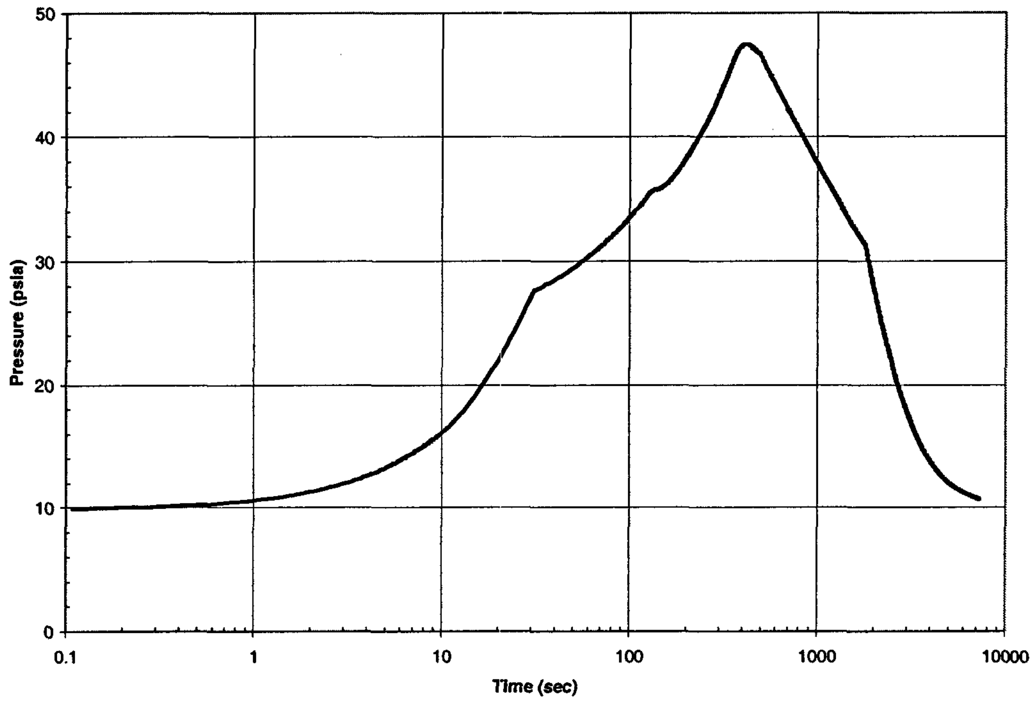
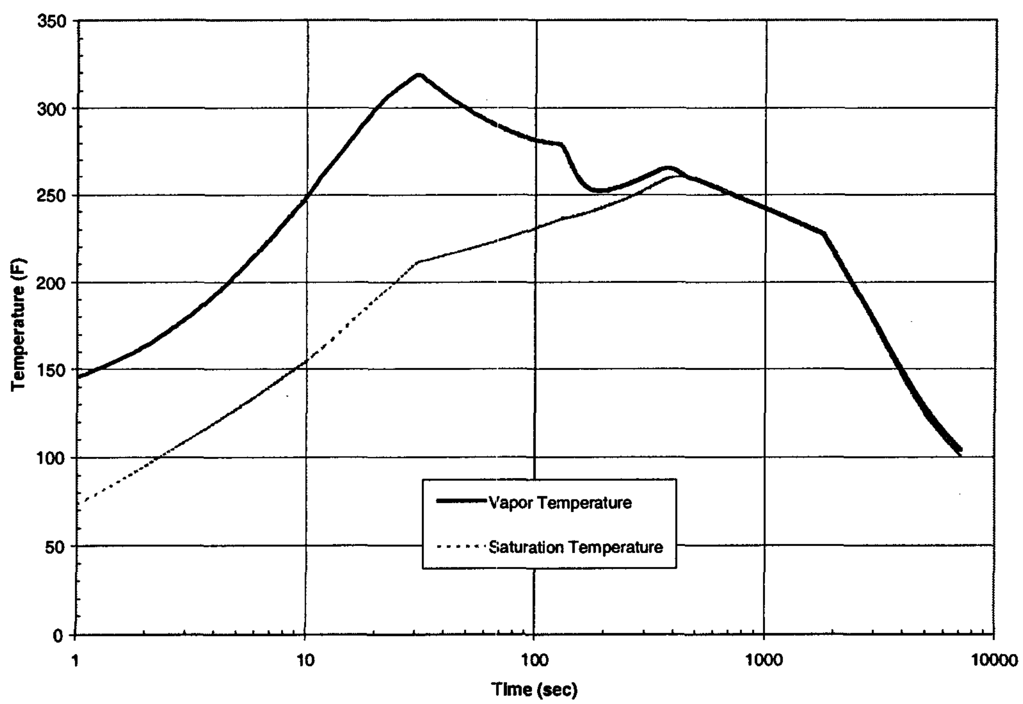


Figure 3.7-4: Containment Temperature from 0.6 ft^2 MSLB Peak Temperature Analysis - Proposed Configuration



3.8 Inadvertent CS Actuation Event

SPS UFSAR Section 5.3.4.3 describes the containment response using the CONTEMPT4/MOD5 code for an inadvertent CS actuation analysis. The analysis was initiated at the TS minimum air partial pressure and credited operator action to show that the containment mat liner pressure limit of 8.0 psia (TS 5.2) is not reached. The proposed change to increase the TS containment air partial pressure minimum limit from 9.0 to 10.1 psia (Section 3.10) provides sufficient operating margin to eliminate the containment response analysis and the time critical operator action for the inadvertent CS actuation event. The UFSAR analysis is replaced with an application of the equation of state for an ideal gas (Charles' Law). This methodology is identical to the application in North Anna UFSAR, Section 6.2.6.3.

Minimum air partial pressure (P_1)	9.85 psia	TS limit of 10.1 psia – 0.25 psi uncertainty
Maximum bulk air temperature (T_1)	125.5 F	TS limit of 125 F + 0.5 F uncertainty
Minimum RWST temperature (T_2)	32 F	Bounding minimum value
Saturation pressure at T_2 (P_{sat})	0.09 psia	ASME Steam Tables at 32 F

Using Charles' Law for the air partial pressure (temperatures converted to Rankine), the final pressure in containment is calculated:

$$P_{total} = P_{air} + P_{vapor} = \frac{T_2}{T_1} P_1 + P_{sat}(T_2) = \frac{(460+32)(10.1-0.25)}{(460+125.5)} + 0.09 = 8.37 \text{ psia}$$

For an inadvertent CS actuation starting at the TS minimum air partial pressure of 10.1 psia and TS maximum air temperature of 125 F, the containment liner meets the following criteria without operator action to terminate CS.

- Minimum containment pressure is greater than the bottom mat liner internal design pressure of 8.0 psia.
- Minimum containment pressure is greater than the containment shell and dome internal design pressure of 3.0 psia.

3.9 EQ Envelope Verification

Delaying the RS pump start and operating at higher containment air pressures affects the LOCA and MSLB pressure and temperature profiles. In this report, GOTHIC containment pressure and temperature profiles were generated for LOCA peak pressure (Section 3.3), MSLB peak pressure and temperature (Section 3.7), and LOCA depressurization (Section 3.4). The GOTHIC pressure and temperature profiles were not bounded by the existing environmental zone description (EZD) equipment qualification (EQ) envelopes, which were based on past LOCA analysis results. The EQ test reports were reviewed and new pressure and temperature EQ envelopes were developed that sufficiently bound the GOTHIC LOCA and MSLB pressure and temperature profiles in this report.

In conclusion, the EQ status of equipment inside containment is not affected by the revised containment temperature and pressure profiles resulting from delaying RS pump start and increasing the containment air partial pressure limits in accordance with Figure 3.10-1.

3.10 Proposed TS Limits for Containment Air Partial Pressure vs. SW Temperature

Sections 3.3 through 3.7 describe GOTHIC containment analyses that support an increase to the TS operating domain for containment air partial pressure. This increase is possible because of the margin gain in accident peak pressure from using GOTHIC instead of LOCTIC. A proposed change to Surry TS Figure 3.8-1 is provided as Figure 3.10-1. This operating domain maintains the current limits of 25-95 F for SW temperature and 75-125 F for containment air temperature. Allowable limits for containment air partial pressure are defined by the following restrictions:

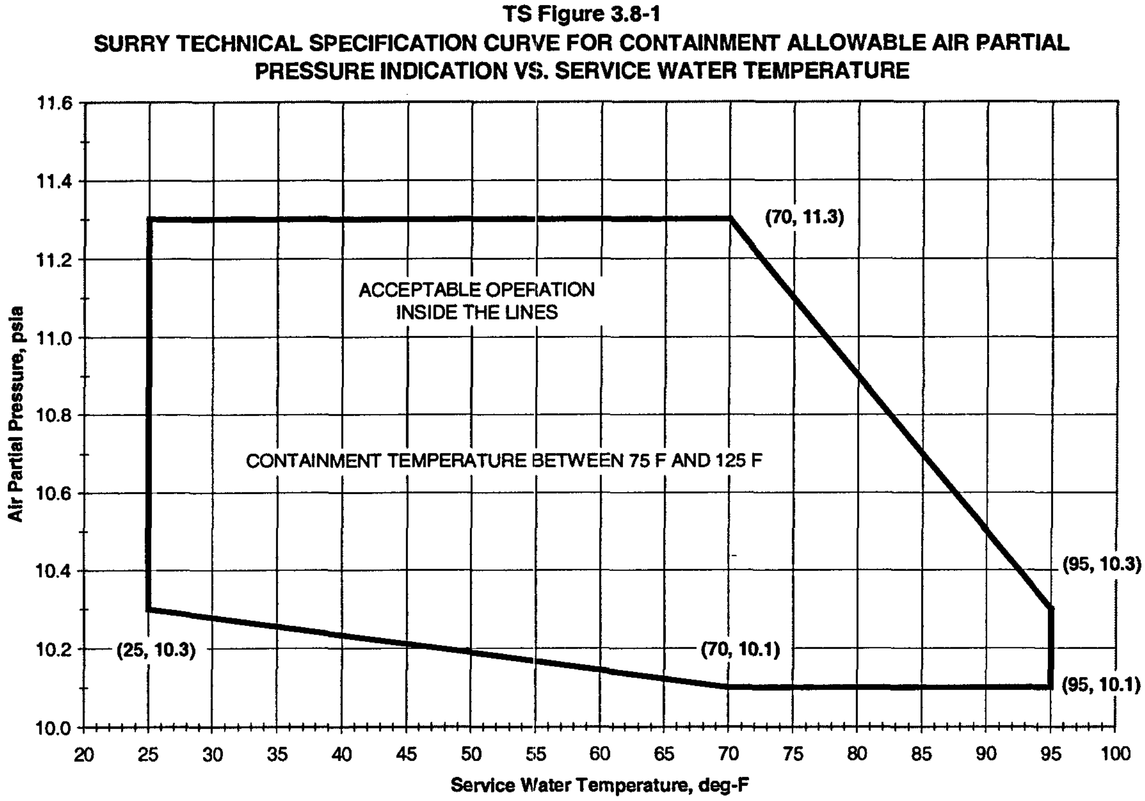
- The MSLB peak pressure analysis limits the maximum operating air partial pressure to 11.3 psia. The LOCA peak pressure in Section 3.3 is less than the MSLB peak pressure in Section 3.7. The MSLB analysis sets the TS upper limit between 25 F and 70 F SW temperature.

- The containment depressurization analyses in Section 3.4 set the TS upper limit from 11.3 psia at 70 F SW to 10.3 psia at 95 F SW. The allowable air pressure decreases with increasing SW temperature because it is more difficult to depressurize the containment at higher SW temperature. To meet subatmospheric requirements, the initial air partial pressure is limited to 10.3 psia at 95 F SW.

- The LHSI pump NPSH analyses set the lower limit on air partial pressure (the RS pumps use the same assumptions but have more NPSH margin). At the same air partial pressure, the NPSH analyses are limiting at 25 F SW. Therefore, the TS lower limit is sloped below 70 F to recover LHSI pump NPSH margin. The proposed lower limit in Figure 3.10-1 ensures at least 1.6 ft of NPSH margin across the entire SW temperature range.

This operating domain accounts for 0.25 psi instrument uncertainty for air partial pressure. For example, the MSLB peak pressure analysis assumes an initial total pressure of 13.52 psia (11.30 psia TS maximum air pressure + 0.25 psi uncertainty + 1.97 psia vapor pressure at 125.5 F and 100% relative humidity).

Figure 3.10-1: Containment Air Partial Pressure versus Service Water Temperature (Proposed TS Figure 3.8-1)



3.11 Summary of Containment Analysis Results

Table 3.11-1 summarizes the GOTHIC containment analysis results for the current and proposed plant configurations. The results for the proposed configuration demonstrate that all containment analysis acceptance criteria are met for operation in the allowable region of Figure 3.10-1 starting the RS pumps on 60% RWST WR level coincident with CLS High High containment pressure. Table 3.11-1 includes a LOCA containment pressure limit of 1.0 psig during the interval from 1 to 4 hours based on the revised LOCA AST analysis in Section 4 of this report. GOTHIC MSLB temperatures greater than 280 F do not adversely impact the operation of safety-related equipment inside containment. LOCA transient pressure and temperature profiles will continue to be used for post-accident equipment qualification (refer to the licensing basis in Section 3.7).

The limiting direction of key GOTHIC inputs for each SPS containment acceptance criterion was reported in Section 4.7 of DOM-NAF-3. Some of the sensitivities were repeated based on the proposed change to the RS pump start and the sloped minimum curve in the proposed TS Figure 3.8-1. The following parameters have changed as described in previous sections of this report.

- DEPSG became the limiting break for ORS and IRS pumps NPSH available (Section 3.6)
- Minimum SI flow rate is limiting for the DPP case (Section 3.4)
- Minimum SW temperature is limiting for LHSI pump NPSH available (Section 3.5)
- 70 F SW temperature is limiting for IRS pump NPSH (Section 3.6)

Surry TS 4.4, Containment Tests, requires a Type A containment integrated leak test in accordance with 10 CFR 50 Appendix J. The maximum integrated leakage rate is limited to 0.1% by weight of containment air per 24 hours at the calculated LOCA peak pressure. The most recent SPS Type A tests initialized the containment pressure greater than 44.46 psig, the current LOCA peak containment pressure reported in UFSAR Table 5.4-19. The GOTHIC-calculated LOCA peak pressure is 58.43 psia (43.73 psig) for the proposed TS maximum operating air partial pressure of 11.3 psia. The GOTHIC LOCA peak pressure is less than the current UFSAR result used in the test procedure; therefore, the implementation of the change to TS Figure 3.8-1 is bounded by the most recent Type A tests.

Table 3.11-1: GOTHIC Containment Analysis Results

Acceptance Criterion	Design Limit	Current Configuration	Proposed Configuration
LOCA Peak Pressure	59.7 psia	57.17 psia	58.43 psia
LOCA Peak Temperature	280 F	273.0 F	273.0 F
MSLB Peak Pressure	59.7 psia	58.12 psia	59.48 psia
MSLB Peak Temperature*	280 F	324.5 F	318.9 F
Containment Depressurization Time	< 1.0 psig at 1 hour	2357 sec to < 0.0 psig	3485 sec to < 0.0 psig
Depressurization Peak Pressure	< 1.0 psig 1-4 hours	-1.38 psig	+0.45 psig
LHSI Pump NPSH	13.82 ft at 3330 gpm	17.82 ft	15.41 ft
ORS Pump NPSH	9.19 ft at 3300 gpm	11.79 ft	13.50 ft
IRS Pump NPSH	10.5 ft at 3650 gpm	15.55 ft	16.89 ft

* Refer to Section 3.9 for the disposition of superheat MSLB conditions.

4.0 Revised LOCA AST Analysis

Delaying the RS pump start will result in a short-term increase in air leakage from the containment and a short-term reduction in spray removal of radioactive isotopes from the containment atmosphere. As discussed in Section 2.4, to offset the potential increase in calculated radiological consequences and to reflect the delay of the RS pump start, the following changes to the design basis LOCA AST analysis [Reference 24] are proposed:

1) Credit for filtration of the Safeguards Building exhaust by the Auxiliary Ventilation Exhaust Filter Trains in the LOCA analysis.
2) Credit for an increase in CS flow rate in the determination of aerosol removal coefficients.
3) Credit for RS iodine removal after CS termination vs. 216 seconds for IRS spray delivery and 415 seconds for ORS spray delivery.
4) Reduction in the containment sprayed volume after CS termination to 18% vs. 60% in the current basis.
5) ORS pumps will not start before 15 minutes, so ECCS leakage to Safeguards is assumed to start at 15 minutes vs. 415 seconds in the current basis.
6) SI pump will not begin recirculating contaminated sump fluid (Recirculation Mode Transfer or RMT) before 30 minutes, so ECCS leakage to the Auxiliary Building and backleakage to the RWST is assumed to start at 30 minutes vs. 2300 seconds in the current basis.
7) Containment leakage during the time interval from 1 to 4 hours after a LOCA has increased to 0.029 %-volume-per-day vs. 0.021 %-volume-per-day in the current analysis.
8) Credit for an Exclusion Area Boundary (EAB) Atmospheric Dispersion Factor (ADF) of 1.79E-3 sec/m^3 vs. 4.61E-3 sec/m^3 in the current basis. The EAB ADF was submitted to the NRC in letter serial number 05-601 [21] and is currently pending approval.

The remainder of the LOCA AST analysis is unchanged from Section 3.1 of Attachment 1 to Reference 24 and the response to NRC Question #8 contained in the Enclosure to Reference 24.

4.1 Changes in Containment Pressure and Leakage Assumptions

The containment leak rate for the first hour is modeled in accordance with Regulatory Guide 1.183 at 0.1% of the containment volume per day. Subsequent to the first hour after the LOCA, the current design basis analysis models the leakage at 0.021% volume per day for the next 3 hours assuming a pressure of 0.5 psig. Containment leakage is modeled as terminating at 4 hours based on containment being subatmospheric thereafter. The revised design basis models containment leakage as 0.029% volume per day during hours 1 through 4 based on assuming a pressure of 1.0 psig with leakage terminating after the fourth hour. This pressure profile is intended to bound the LOCA depressurization analysis described in Section 3.

The correlation between containment pressure and leak rate was presented in Section 3.1.5.1 of Attachment 1 to Reference 24. In Reference 20, the NRC staff disagreed that the containment could be modeled in the manner described in Section 3.1.5.1 of Attachment 1 to Reference 24, but concluded that leak rate modeled was conservative relative to the predicted containment pressure. Table 4.1-1 summarizes the postulated short-term increase in containment leakage:

Table 4.1-1: Containment Leak Rate Assumption

Time Period	Current Containment Pressure Assumption (psig)	Revised Containment Pressure Assumption (psig)	Current Containment Leak Rate Assumption (%/day)	Revised Containment Leak Rate Assumption (%/day)
0-1 hours	Decreasing to 0.5 psig	Decreasing to 1.0 psig	0.1	0.1
1-4 hours	0.5 psig	1.0 psig	0.021	0.029
> 4 hours	Subatmospheric	Subatmospheric	0.0	0.0

4.2 Changes in Containment Spray Removal Coefficients

With the delay in the start of the RS pumps, credit is taken for containment spray alone for removing radioactive isotopes from the containment atmosphere in the first 1.14 hours. After 1.14 hours, containment spray is assumed to be terminated and credit is taken only for the recirculation spray pumps for spray removal.

Table 4.2-1 presents the CS and RS system characteristics necessary to determine spray flux versus time using the 47'-4" elevation of the operating deck to determine the drop height. The CS flow rates in Table 4.2-1 represent an increase from the values presented in Reference 25. The CS flow rates were conservatively selected to be lower than the CS flow values determined from the GOTHIC LOCA depressurization analyses in Section 3.4.

Table 4.2-1: Spray System Characteristics

Containment Spray Dome headers:	**Containment Spray Crane Wall Headers:**
Elevation 142'-5" & 143'-9"	Elevation 95' -6"
815 gpm (100 – 700 sec)	1080 gpm (100 – 700 sec)
850 gpm (700 – 2000 sec)	1100 gpm (700 – 2000 sec)
1015 gpm (2000 – 3600 sec)	1210 gpm (2000 – 3600 sec)
1090 gpm (3600 – 4100 sec)	1270 gpm (3600 – 4100 sec)
Inside Recirculation Spray headers:	**Outside Recirculation Spray Headers:**
Elevation 93'-5" & 94'-5"	Elevation 93'-5" & 94'-5"
2700 gpm (4100 sec – 30 days)	3000 gpm (4100 sec – 30 days)

4.2.1 Description of Containment Volumes

The Containment volume is 1.863E6 ft^3 and the Containment cross sectional area at the operating deck is 1.25E4 ft^2. For the first 1.14 hours, only the Containment Spray System is assumed to be operating. After 1.14 hours, it is assumed that only the Recirculation Spray System is in operation. Thus, the assumptions in Table 4.2-2 are made for the sprayed/unsprayed volumes and the area of the wetted cross section.

Table 4.2-2: Time Dependent Sprayed/Unsprayed Containment Fractions

Time Period (hrs)	Sprayed	Unsprayed	Wetted Cross Section
0-1.14	60%	40%	100%
1.14-4	18%	82%	31%

4.2.2 Aerosol Spray Removal Coefficients

The revised spray aerosol removal coefficients were calculated using the equations given in NUREG/CR-5966. To simplify the modeling of the spray headers, both the CS dome headers are modeled at the elevation of 142'5" and the 5 remaining headers—4 RS headers and CS crane wall header—are modeled at the elevation of 93'5". The operations deck in the containment is at an elevation of 47'4" and all fall heights are calculated relative to the operations deck. Table 4.2-3 contains the existing aerosol removal coefficients. Revised aerosol removal coefficients were developed as discussed below.

Table 4.2-3: Current Combined CS and RS Aerosol Removal Coefficients[1]

Time (hours)		Removal Coefficient (hr^{-1})
From	To	
0.0278	0.06	3.40
0.06	0.115	7.92
0.115	0.194	12.5
0.194	1.14	12.8
1.14	1.80	9.47
1.80	1.90	6.04
1.90	2.02	4.22
2.02	2.51	2.25
2.51	4.38	1.23
4.38	6.48	1.10
6.48	8.61	1.08
8.61	720.0	1.08

1. Table 3.1-5 of Reference 24 and Table 14.5-8 of the UFSAR

NUREG/CR-5966 [Page 173] presents the following equations for aerosol removal rate for the 10th percentile level:

$$\ln\left(\lambda_{m_f=0.9}\right)=5.5750+(0.94362)\ln Q-(7.327\text{E}-7)QH^2-(6.9821\text{E}-3)Q^2H+(3.555\text{E}-6)Q^2H^2$$

$$\frac{\lambda_{m_f}}{\lambda_{m_f=0.9}}=\left[0.1108-(0.00201)\log_{10}Q\right]\left[1-\left(\frac{m_f}{0.9}\right)^{0.8945}\right]+\left(\frac{m_f}{0.9}\right)^{0.8945}$$

Where λ is the removal rate, $\mathbf{m_f}$ is the mass fraction remaining in the containment, H is the spray drop height, and Q is the spray water flux, calculated by dividing the spray flow rate by the wetted cross-sectional area of the containment. The wetted cross sectional area of containment is 1.25E4 ft^2 when the CS system is in operation (360° spray coverage) and 3.88E3 ft^2 when only the RS system is in operation (180° spray coverage). The first equation above is used to calculate the removal rate corresponding to a mass fraction of 0.9. Using this value in the second equation yields the removal for a given value of mass fraction. Since the removal rate is dependent on drop height and spray rate, the spray headers have different removal rates. For the dome headers, drop height and spray flux are calculated as follows using input from Table 4.2-1:

H = (142'5") – (47'4") = 95.1 ft = 2.90E3 cm

Q = (815 gpm) (0.13368 ft^3/gal) / (1.25E4 ft^2) (30.48 cm/ft) / (60 sec/min) = 4.43E-3 cm/sec (100 – 700 sec)
Q = (850 gpm) (0.13368 ft^3/gal) / (1.25E4 ft^2) (30.48 cm/ft) / (60 sec/min) = 4.62E-3 cm/sec (700 – 2000 sec)

Q = (1015 gpm) (0.13368 ft^3/gal) / (1.25E4 ft^2) (30.48 cm/ft) / (60 sec/min) = 5.51E-3 cm/sec (2000 – 3600 sec)
Q = (1090 gpm) (0.13368 ft^3/gal) / (1.25E4 ft^2) (30.48 cm/ft) / (60 sec/min) = 5.92E-3 cm/sec (3600 – 4100 sec)

Table 4.2-4 shows the CS dome header removal rates, assuming the mass fraction remains at 0.9. The last two columns indicate the time step during which the removal rate is in effect. The 2.78E-02 hours corresponds to the 100 second start time for CS. The 1.14 hours corresponds to 4100 seconds and is the time at which the CS flow is terminated upon emptying the RWST.

Table 4.2-4: CS Dome Header Aerosol Removal Coefficients

	Q	H	Removal Constant (hr^{-1})			Time (hr)	
m_f	(cm/sec)	(cm)	$\lambda_{mf=.9}$	$\lambda_{mf}/\lambda_{mf=.9}$	λ_{mf}	From	To
9.00E-01	4.43E-03	2.90E+03	1.54E+00	1.00E+00	1.54E+00	2.78E-02	1.94E-01
9.00E-01	4.62E-03	2.90E+03	1.60E+00	1.00E+00	1.60E+00	1.94E-01	5.56E-01
9.00E-01	5.51E-03	2.90E+03	1.89E+00	1.00E+00	1.89E+00	5.56E-01	1.00E+00
9.00E-01	5.92E-03	2.90E+03	2.01E+00	1.00E+00	2.01E+00	1.00E+00	1.14E+00
9.00E-01	0.00E+00	2.90E+03	0.00E+00	0.00E+00	0.00E+00	1.14E+00	7.20E+02

For the RS headers and CS crane wall headers the fall height is modeled as follows:

H = (93'5") – (47'4") = 46.1 ft = 1.40E3 cm

As with the dome headers above, a time-dependent Q value is calculated for each of these lower headers using the flow rates for containment spray crane wall headers and recirculation spray headers from Table 4.2-1. As mentioned above, the wetted cross sectional area of containment decreases to 3.88E3 ft^2 when only the RS system is in operation and in order to conservatively simplify spray modeling RS is not credited until CS flow terminates at 4100 seconds.

CS crane wall header spray flux:
Q = (1080 gpm) (0.13368 ft^3/gal) / (1.25E4 ft^2) (30.48 cm/ft) / (60 sec/min) = 5.87E-3 cm/sec (100 – 700 sec)
Q = (1100 gpm) (0.13368 ft^3/gal) / (1.25E4 ft^2) (30.48 cm/ft) / (60 sec/min) = 5.98E-3 cm/sec (700 – 2000 sec)
Q = (1210 gpm) (0.13368 ft^3/gal) / (1.25E4 ft^2) (30.48 cm/ft) / (60 sec/min) = 6.57E-3 cm/sec (2000 – 3600 sec)
Q = (1270 gpm) (0.13368 ft^3/gal) / (1.25E4 ft^2) (30.48 cm/ft) / (60 sec/min) = 6.90E-3 cm/sec (3600 – 4100 sec)

RS header spray flux: (5700 gpm = 3000 gpm ORS + 2700 gpm IRS)
Q = (5700 gpm) (0.13368 ft^3/gal) / (3.88E3 ft^2) (30.48 cm/ft) / (60 sec/min) = 9.99E-2 cm/sec(4100 sec – 30 days)

Table 4.2-5 shows the RS and CS wall header removal rates. As in Table 4.2-4, the CS start and stop times are reflected in Table 4.2-5. NUREG/CR-5966 [Page 170] recommends that for a volume with continuing source, the removal constant associated with a mass fraction of 0.9 be used until the time-dependent source terminates. Hence, the mass fraction is assumed to remain at 0.9 from the start of the sprays until the end of the early in-vessel release phase at 1.8 hr. After this phase, the removal rate is adjusted stepwise by varying the mass fraction. The duration of time, t, required to change from a mass fraction m_{f0} to m_{f1} is determined using the following formula:

$$m_{f1} = m_{f0}e^{-\lambda t}$$
$$t = \ln(m_{f0}/m_{f1})/\lambda$$

For example, as seen in Table 4.2-5, it takes 0.04 hr (1.80 to 1.84 hr) to reduce the iodine mass fraction from 0.9 to 0.5. During this time step, the removal rate is assumed to be constant at 16.1 hr^{-1}.

Table 4.2-5: RS and CS Crane Wall Header Aerosol Removal Coefficients

	Q	H	Removal Constant (hr^{-1})			Time (hr)	
m_f	(cm/sec)	(cm)	$\lambda_{mf=.9}$	$\lambda_{mf}/\lambda_{mf=.9}$	λ_{mf}	From	To
9.00E-01	5.87E-03	1.40E+03	2.05E+00	1.00E+00	2.05E+00	2.78E-02	1.94E-01
9.00E-01	5.98E-03	1.40E+03	2.09E+00	1.00E+00	2.09E+00	1.94E-01	5.56E-01
9.00E-01	6.57E-03	1.40E+03	2.28E+00	1.00E+00	2.28E+00	5.56E-01	1.00E+00
9.00E-01	6.90E-03	1.40E+03	2.38E+00	1.00E+00	2.38E+00	1.00E+00	1.14E+00
9.00E-01	9.99E-02	1.40E+03	2.53E+01	1.00E+00	2.53E+01	1.14E+00	1.80E+00
5.00E-01	9.99E-02	1.40E+03	2.53E+01	6.37E-01	1.61E+01	1.80E+00	1.84E+00
3.00E-01	9.99E-02	1.40E+03	2.53E+01	4.45E-01	1.12E+01	1.84E+00	1.88E+00
1.00E-01	9.99E-02	1.40E+03	2.53E+01	2.37E-01	5.99E+00	1.88E+00	2.07E+00
1.00E-02	9.99E-02	1.40E+03	2.53E+01	1.29E-01	3.25E+00	2.07E+00	2.77E+00
1.00E-03	9.99E-02	1.40E+03	2.53E+01	1.15E-01	2.90E+00	2.77E+00	3.57E+00
1.00E-04	9.99E-02	1.40E+03	2.53E+01	1.13E-01	2.86E+00	3.57E+00	4.37E+00
1.00E-50	9.99E-02	1.40E+03	2.53E+01	1.13E-01	2.85E+00	4.37E+00	7.20E+02

The removal rates for the dome headers and the lower headers are combined from Tables 4.2-4 and 4.2-5 above to yield effective removal rates for all the sprays. The revised aerosol spray removal coefficients are summarized below in Table 4.2-6.

Table 4.2-6: Revised Combined CS and RS Aerosol Removal Coefficients

Time (hr)		λ_{mf}
From	To	(hr^{-1})
2.78E-02	1.94E-01	3.59E+00
1.94E-01	5.56E-01	3.69E+00
5.56E-01	1.00E+00	4.16E+00
1.00E+00	1.14E+00	4.40E+00
1.14E+00	1.80E+00	2.53E+01
1.80E+00	1.84E+00	1.61E+01
1.84E+00	1.88E+00	1.12E+01
1.88E+00	2.07E+00	5.99E+00
2.07E+00	2.77E+00	3.25E+00
2.77E+00	3.57E+00	2.90E+00
3.57E+00	4.37E+00	2.86E+00
4.37E+00	7.20E+02	2.85E+00

4.2.3 Elemental Iodine Spray Removal Coefficient

Equations from Standard Review Plan (SRP) 6.5.2, Revision 2 and Revision 1 were used to evaluate the impact on the assumption of a removal coefficient of 10 hr^{-1} with a maximum decontamination factor of 200, respectively. Using the SRP methodology, the current assumptions remain bounding.

The elemental iodine spray removal coefficient was calculated for CS operation using the following equation from SRP 6.5.2, Revision 2 (1982) page 6.5.2-10.

$\lambda = (6\ K_g\ T\ F) / V\ D$
where,
λ = Elemental iodine removal coefficient,
K_g = Gas-phase mass - transfer coefficient, (7.5 cm/sec)
F = Volumetric flow rate of spray pump,
T = Drop fall time (Ratio of height to velocity, terminal velocity 400 cm/sec)
V = Containment free volume,
D = Mean diameter of spray drop, (1000 μm)

The CS system sprays from the dome headers and from the crane wall headers and the water falls to the operating floor. The dome headers are at an elevation of 143 ft and the crane wall headers are at an elevation of 95.5 ft and the operating floor is at 47.33 ft. The CS water drops 95.67 ft (2916 cm) from the dome headers to the operating floor and 48.17 ft (1468 cm) from the crane wall headers to the operating floor. The flow from the dome headers is a minimum of 825 gpm or 52,000 cm^3/sec [3785 cm^3/gallon]. The flow from the crane wall headers is a minimum of 1080 gpm or 68,100 cm^3/sec.

The containment free volume is 1.863E6 ft^3. Of this volume only 60% is modeled as being sprayed by the CS system. Therefore, the volume input is 1.863E6 x 0.60 or 1.118E6 ft^3 (3.165E10 cm^3). The inputs for the CS system yield an elemental iodine spray removal coefficient of 32 hr^{-1}, as determined below.

$$\lambda = \frac{(6 * 7.5 \text{ cm/sec} \div 400 \text{ cm/sec} * [2916 \text{ cm} * 52{,}000 \text{ cm}^3\text{/sec} + 1468 \text{ cm} * 68{,}100 \text{ cm}^3\text{/sec}] * 3600 \text{ sec/hr})}{3.165\text{E}10 \text{ cm}^3 * 1000 \text{ µm} * 1\text{E-}4 \text{ cm/µm}}$$

Similarly, the RS system sprays from 93.45 ft to the operating floor, a drop of 46.12 ft (1406 cm), the flow from the RS headers is a minimum of 5700 gpm or 359,500 cm^3/sec. The inputs for the RS system yield an elemental iodine spray removal coefficient of 65 hr^{-1}. Hence, the CS and RS elemental iodine spray removal coefficient calculations substantiate the use of an elemental iodine spray removal coefficient of 10 hr^{-1}.

From SRP Section 6.5.2, Revision 1 (1981), page C-10, the equation for the maximum elemental iodine decontamination factor (DF) is

$$DF = 1 + (Vs / Vc) * H$$

where,

H = equilibrium iodine partition coefficient (5000)

Vs = volume of liquid in the containment sump (5.83E4 ft^3)

Vc = containment net free volume less Vs (1.863E6 ft^3)

However, only 18% of the containment is modeled as being sprayed after CS termination at 1.14 hours. The DF cutoff is applied after the end of the early in-vessel period (1.8 hours) and is therefore only applied to the 18% of the containment that is sprayed. Also, a more conservative result is obtained if Vs is not subtracted from Vc. Therefore, the containment net free volume used in this equation is 0.18 x 1.863E6 cubic feet. Substituting these values into the above equation yields

DF = 1 + (5.83E4 cubic feet / (0.18 x 1.863E6 cubic feet)) x 5000 = 870

In the worst case, assuming a full safeguards response that enabled all RS trains to actuate, the containment sprayed region would increase to 37%, which would decrease the maximum elemental iodine DF to 424. The calculated maximum elemental iodine decontamination factors substantiate the use of the maximum allowable DF of 200, which results in a elemental iodine spray removal cutoff at 2.33 hours as documented in Reference 24.

4.3 Changes to Atmospheric Dispersion Factors

Credit is being taken for the revised Exclusion Area Boundary Atmospheric Dispersion Factor of 1.79E-3 sec/m^3, which was submitted to the NRC and is currently pending approval [21].

4.4 Credit for Auxiliary Building Filtration and Summary of ECCS Leakage Modeling

A significant contributor to the total LOCA radiological dose calculation is the assumed ECCS leakage from the ECCS system components and the ECCS back leakage to the RWST. The ECCS components that are potential sources are located in the auxiliary and safeguards buildings.

The auxiliary and safeguards buildings are equipped with two Auxiliary Ventilation Exhaust Filter Trains. Each train is equipped with a HEPA filter and charcoal adsorber assembly. In the current AST design basis analysis [Reference 24], the Auxiliary Ventilation Exhaust Filter Trains were conservatively assumed to have a 0% filter efficiency for filtration of ECCS leakage and ECCS back leakage to the RWST. However, operation of the Auxiliary Ventilation Exhaust Filter Trains is specified in Technical Specification 3.22 and the surveillance requirements for the charcoal adsorbers are specified in Technical Specification 4.12. The current surveillance requirements provide assurance that the following filter efficiencies can be credited in the LOCA radiological analyses:

- Elemental iodine: 90%
- Methyl (organic) iodine: 70%
- Aerosol (particulate): 99%

The RWST vent is routed to the safeguards building sump, which is within the boundary of the auxiliary building ventilation exhaust system. The flow rate from the RWST to the environment is conservatively bounded by 1000 cfm. The ventilation arrangements allow filter credit to be applied to the portion of the ECCS leakage that occurs in the Safeguards Building (primarily Outside Recirculation Spray) and to the RWST backleakage. Table 4.4-1 summarizes the sequence of events for ECCS leakage and ECCS backleakage to the RWST.

Table 4.4-1: Sequence of Events for ECCS Leakage and RWST Backleakage

Time Period	ECCS filtered[1] leakage (cc/hour)[2]	ECCS unfiltered leakage (cc/hour)[2]	RWST filtered[1] back leakage (cc/hour)[2]	Comments
0 – 0.25 hours	0	0	0	
0.25 – 0.5 hours	0	1928	0	earliest start of the RS system
0.5 – 720 hours	1928	7672	12,000	earliest RMT

1) <u>Key Operator Action</u>: Auxiliary Ventilation Exhaust Filter Train alignment to the Safeguards Building is automatic coincident with the SI signal. However, the potential exists for alignment to be blocked by the Refueling Mode switches even though these switches are no longer required to mitigate the consequences of the fuel handling accident. Therefore this action is assumed to be a manual operator action that must be completed by RMT.

2) Values listed are twice the potential ECCS leakage rates to the environment specified in UFSAR Tables 6.2-6 and 6.3-2 and twice the RWST allowable back leakage specified in UFSAR Section 14.5.5.2.

It has been confirmed that the assumption of 10% evolution from the ECCS leakage and RWST back leakage is still conservative for the revised containment analysis.

4.5 Revised Radiological Results

Table 4.5-1 presents the revised design basis LOCA radiological dose results with the changes in assumptions as described in Sections 4.1 through 4.4. The analysis results are less than the regulatory dose limits.

Table 4.5-1: Revised Design Basis LOCA Dose Results

	Control Room (Rem TEDE)	Exclusion Area Boundary (Rem TEDE)	Low Population Zone (Rem TEDE)
Total Dose Consequences including contributions from containment, ECCS and RWST leakage	3.9	15.6	3.5
10 CFR 50.67 dose limits	5	25	25

5.0 Conclusions

This technical report demonstrates that the proposed safety analysis acceptance criteria are satisfied for the plant licensing basis changes outlined in Section 2. The specific changes for Surry Power Station are:

- Start IRS pumps on 60% RWST WR level coincident with High High containment pressure
- Start ORS pumps on 60% RWST WR level coincident with High High containment pressure plus 120-second delay time
- Incorporate the instrumentation and surveillance requirements for the RWST Level Low ESF function for RS pump start into the Technical Specifications.
- Replace the containment air partial pressure operating limits in TS Figure 3.8-1 with Figure 3.10-1 in this report.
- Replace the LOCTIC containment analysis methodology in SPS UFSAR Chapters 5 and 6 with the GOTHIC analysis methodology from topical report DOM-NAF-3.
- Change the LOCA AST licensing bases as documented in Sections 2.4 and 4.
- Revise the containment pressure limit from 0.5 to 1.0 psig during the time interval from 1 to 4 hours after the LOCA initiation.

The containment analyses were performed with the GOTHIC analytical methodology described in topical report DOM-NAF-3 [3], which was submitted to the NRC for generic review and approval on November 1, 2005 [4]. The LOCA AST analyses assume the EAB ADF that was submitted on September 13, 2005 [21].

The containment analysis margins for the proposed plant changes are summarized in Section 3.11. Adequate margin to the acceptance criteria is demonstrated. With the changes described in Section 2.4, the LOCA AST analysis results in Table 4.5-1 show margin to the 10 CFR 50.67 limits for dose consequences. The AST analyses and revised technical bases must be submitted to the NRC for review and approval.

6.0 References

1. NRC Generic Letter 2004-02: Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors, September 13, 2004.

2. Letter from David A. Christian (Dominion) to NRC, "Dominion Energy Kewaunee, Inc., Dominion Nuclear Connecticut, Inc., Virginia Electric and Power Company, Kewaunee Power Station, Millstone Power Station Units 2 and 3, North Anna Power Station Units 1 and 2, Surry Power Station Units 1 and 2, Response to NRC Generic Letter 2004-02: Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors," serial number 05-212, September 1, 2005.

3. Topical Report DOM-NAF-3, Revision 0, "GOTHIC Methodology for Analyzing the Response to Postulated Pipe Ruptures Inside Containment," October 2005.

4. Letter from Leslie N. Hartz (Dominion) to NRC, "Dominion Energy Kewaunee, Inc. (DEK), Dominion Nuclear Connecticut, Inc. (DNC), Virginia Electric and Power Company (Dominion), Kewaunee Power Station, Millstone Power Station Units 2 and 3, North Anna Power Station Units 1 and 2, Surry Power Station Units 1 and 2, Request for Approval of Topical Report DOM-NAF-3, GOTHIC Methodology for Analyzing the Response to Postulated Pipe Ruptures Inside Containment," serial number 05-745, November 1, 2005.

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7. Surry Power Station Technical Specifications.

8. WCAP-14083, Revision 0, "Virginia Power Surry Power Station Units 1 and 2 Containment LOCA Mass and Energy Release Analyses for Core Uprating Engineering Report," May 1994.

9. WCAP-8264-P-A, Revision 1, "Westinghouse Mass and Energy Release Data for Containment Design," August 1975. (WCAP-8312-A is a Non-Proprietary version).

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11. WCAP-11431, Revision 0, "Mass and Energy Releases Following a Steam Line Rupture for North Anna Units 1 and 2," February 1987.

12. WCAP-8822-P, "Mass and Energy Releases Following a Steam Line Rupture," September 1976, with Supplements 1 (WCAP-8822-S1-P-A) and 2 (WCAP-8822-S2-P-A) both dated September 1986. (WCAP-8860 is the Non-Proprietary version).

13. WCAP-7907-P-A, "LOFTRAN Code Description," April 1984.

14. Letter from W.L. Stewart (Virginia Power) to NRC, "Virginia Electric and Power Company, North Anna Power Station Units 1 and 2, Proposed Technical Specifications Change," Serial No. 87-385, March 2, 1988.

15. Letter from Leon B. Engle (NRC) to W. R. Cartwright (Virginia Power), "North Anna Units 1 and 2 – Issuance of Amendments Re: Containment Upper Limit Temperature (TAC Nos. 67535 and 67536)," December 14, 1988.

16. Letter from W. L. Stewart (Virginia Power) to Harold R. Denton (NRC), "Supplement to an Amendment to Operating Licenses DPR-32 and DPR-37, Proposed Reduction in Boron Concentrations, Surry Power Station Units 1 and 2," Serial No. 521B, November 30, 1983.

17. Letter from Joseph D. Neighbors (NRC) to W. L. Stewart (Virginia Power), "Safety Evaluation by the Office of Nuclear Reactor Regulation Related to Amendment No. 95 to Facility Operating License No. DPR-32 and Amendment No. 94 to Facility Operating License No. DPR-37 - Virginia Electric and Power Company, Surry Power Station, Unit Nos. 1 and 2 - Docket Nos. 50-280 and 50-281," February 24, 1984.

18. Letter from Bart C. Buckley (NRC) to J. P. O'Hanlon (Virginia Power), "Surry Units 1 and 2 – Issuance of Amendments Re: Uprated Core Power (Serial No. 94-509) (TAC Nos. M90364 and M90365)," August 3, 1995.

19. ISA-RP67.04.02-2000, "Methodologies for the Determination of Setpoints for Nuclear Safety Related Instrumentation."

20. Letter from Gordon E. Edison (NRC) to David A. Christian (Dominion), "Surry Units 1 and 2 – Issuance of Amendments Re: Alternate Source Term (TAC Nos. MA8649 and MA8650)," March 8, 2002.

21. Letter from L. N. Hartz (Dominion) to NRC, "Virginia Electric and Power Company, Surry Power Station Units 1 and 2, Proposed Technical Specifications Change, Redefinition of Exclusion Area Boundary", Serial No. 05-601, September 13, 2005.

22. Letter from William R. Matthews (Dominion) to NRC, "Virginia Electric and Power Company, Surry Power Station Units 1 and 2, Response to Request for Additional Information, Revised Proposed Technical Specification Change and GL 99-02 Response Clarification on Laboratory Testing of Nuclear-Grade Activated Charcoal," Serial No. 00-552, December 7, 2000.

23. Letter from Gordon E. Edison (NRC) to David A. Christian (Dominion), "Surry Units 1 and 2 – Issuance of Amendments Re: Charcoal Filter Testing (TAC Nos. MA7867 and MA7868)," May 14, 2001.

24. Letter from Eugene S. Grecheck (Dominion) to USNRC, "Virginia Electric and Power Company, Surry Power Station Units 1 and 2, Response to Request for Additional Information, Alternate Source Term - Proposed Technical Specification Change," Serial No. 01-037A, July 31, 2001.

25. Letter from W. R. Matthews (Dominion) to USNRC, "Virginia Electric and Power Company, Surry Power Station Units 1 and 2, Request for Additional Information, Alternate Source Term - Proposed Technical Specification Change," Serial No. 00-123A, August 28, 2000.

26. NUREG-0800, Standard Review Plan Section 6.5.2, Revision 1 (1981), page C-10 and Revision 2 (1988), page 6.5.2-10.

ATTACHMENT 2

PROPOSED TECHNICAL SPECIFICATION CHANGE AND SUPPORTING SAFETY ANALYSES REVISIONS TO ADDRESS GENERIC SAFETY ISSUE 191

MARKED-UP TECHNICAL SPECIFICATION PAGES

VIRGINIA ELECTRIC AND POWER COMPANY
SURRY POWER STATION UNITS 1 AND 2

Basis

The spray systems in each reactor unit consist of two separate parallel Containment Spray Subsystems, each of 100 percent capacity, and four separate parallel Recirculation Spray Subsystems, each of 50 percent capacity.

Each Containment Spray Subsystem draws water independently from the refueling water storage tank (RWST). The water in the tank is cooled to 45°F or below by circulating the water through one of the two RWST coolers with one of the two recirculating pumps. The water temperature is maintained by two mechanical refrigerating units as required. In each Containment Spray Subsystem, the water flows from the tank through an electric motor driven containment spray pump and is sprayed into the containment atmosphere through two separate sets of spray nozzles. The capacity of the spray systems to depressurize the containment in the event of a Design Basis Accident is a function of the pressure and temperature of the containment atmosphere, the service water temperature, and the temperature in the refueling water storage tank as discussed in the Basis of Specification 3.8.

Each Recirculation Spray Subsystem draws water from the common containment sump. In each subsystem the water flows through a recirculation spray pump and recirculation spray cooler, and is sprayed into the containment atmosphere through a separate set of spray nozzles. Two of the recirculation spray pumps are located inside the containment and two outside the containment in the containment auxiliary structure.

With one Containment Spray Subsystem and two Recirculation Spray Subsystems operating together, the spray systems are capable of cooling and depressurizing the containment to 0.5 (1.0) psig in less than 60 minutes and to subatmospheric pressure within 4 hours following the Design Basis Accident. The Recirculation Spray Subsystems are capable of maintaining subatmospheric pressure in the containment indefinitely following the Design Basis Accident when used in conjunction with the Containment Vacuum System to remove any long term air inleakage. The radiological consequences analysis demonstrates acceptable results provided the containment pressure does not exceed 0.5 (1.0) psig (from 1 hour to 4 hours) and is maintained less than 0.0 psig (after 4 hours).

TABLE 3.7-2 (Continued)
ENGINEERED SAFEGUARDS ACTION
INSTRUMENT OPERATING CONDITIONS

Functional Unit	Total Number Of Channels	Minimum OPERABLE Channels	Channels To Trip	Permissible Bypass Conditions	Operator Actions
3. AUXILIARY FEEDWATER (continued)					
e. Trip of main feedwater pumps - start motor driven pumps	2/MFW pump	1/MFW pump	2-1 each MFW pump		24
f. Automatic actuation logic	2	2	1		22
4. LOSS OF POWER					
a. 4.16 kv emergency bus undervoltage (loss of voltage)	3/bus	2/bus	2/bus		26
b. 4.16 kv emergency bus undervoltage (degraded voltage)	3/bus	2/bus	2/bus		26
5. NON-ESSENTIAL SERVICE WATER ISOLATION					
a. Low intake canal level	4	3	3		20
b. Automatic actuation logic	2	2	1		14
6. ENGINEERED SAFEGAURDS ACTUATION INTERLOCKS - Note A					
a. Pressurizer pressure, P-11	3	2	2		23
b. Low-low T_{avg}, P-12	3	2	2		23
c. Reactor trip, P-4	2	2	1		24
7. RECIRCULATION MODE TRANSFER					
a. RWST Level - Low (LOW)	4	3	2		25
b. Automatic Actuation Logic and Actuation Relays ← INSERT #1	2	2	1		14

Note A - Engineered Safeguards Actuation Interlocks are described in Table 4.1-A

INSERT #1 for TS 3.7, Table 3.7-2

	Total Number Of Channels	Minimum OPERABLE Channels	Channels To Trip	Permissible Bypass Conditions	Operator Actions
8. RECIRCULATION SPRAY					
a. RWST Level - Low Coincident with High High Containment Pressure	4	3	2		20
b. Automatic Actuation Logic and Actuation Relays	2	2	1		14

TABLE 3.7-4
ENGINEERED SAFETY FEATURE SYSTEM INITIATION LIMITS INSTRUMENT SETTING

No.	Functional Unit	Channel Action	Setting Limit
6	AUXILIARY FEEDWATER		
	a. Steam Generator Water Level Low-Low	Aux. Feedwater Initiation S/G Blowdown Isolation	≥ 14.5% narrow range
	b. RCP Undervoltage	Aux. Feedwater Initiation	≥ 70% nominal
	c. Safety Injection	Aux. Feedwater Initiation	All S.I. setpoints
	d. Station Blackout	Aux. Feedwater Initiation	≥ 46.7% nominal
	e. Main Feedwater Pump Trip	Aux. Feedwater Initiation	N.A.
7	LOSS OF POWER		
	a. 4.16 KV Emergency Bus Undervoltage (Loss of Voltage)	Emergency Bus Separation and Diesel start	≥ 2975 volts and ≤ 3265 volts with a 2 (+5, -0.1) second time delay
	b. 4.16 KV Emergency Bus Undervoltage (Degraded Voltage)	Emergency Bus Separation and Diesel start	≥ 3830 volts and ≤ 3881 volts with a 60 (±3.0) second time delay (Non CLS, Non SI) 7 (±0.35) second time delay (CLS or SI Conditions)
8	NON-ESSENTIAL SERVICE WATER ISOLATION		
	a. Low Intake Canal Level	Isolation of Service Water flow to non-essential loads	23 feet-6 inches
9	RECIRCULATION MODE TRANSFER		
	a. RWST Level-Low	Initiation of Recirculation Mode Transfer System	≥ 11.25% ≤ 15.75%
10	TURBINE TRIP AND FEEDWATER ISOLATION		
	a. Steam Generator Water Level High-High	Turbine Trip Feedwater Isolation	≤ 80% narrow range

— INSERT # 2 —

INSERT #2 to TS 3.7, Table 3.7-4

No.	Functional Unit	Channel Action	Setting Limit
11	RWST Level Low (coincident with High High Containment Pressure)	Recirculation Spray Pump Start	≥ 59% ≤ 61%

(3) assuring that environmental conditions will not preclude access to close the valves and 4) that this administrative or manual action will prevent the release of radioactivity outside the containment.

The Reactor Coolant System temperature and pressure being below 350°F and 450 psig, respectively, ensures that no significant amount of flashing steam will be formed and hence that there would be no significant pressure buildup in the containment if there is a loss-of-coolant accident. Therefore, the containment internal pressure is not required to be subatmospheric prior to exceeding 350°F and 450 psig.

The allowable value for the containment air partial pressure is presented in TS Figure 3.8-1 for service water temperatures from 25 to 95°F. The RWST water shall have a maximum temperature of 45°F.

The horizontal UPPER limit line in TS Figure 3.8-1 is based on ~~LOCA~~ MSLB peak calculated pressure criteria, and the sloped line is based on LOCA ~~subatmospheric peak pressure~~ DEPRESSURIZATION criteria FROM 70°F TO 95°F SERVICE WATER TEMPERATURES.

If the containment air partial pressure rises to a point above the allowable value the reactor shall be brought to the HOT SHUTDOWN condition. If a LOCA occurs at the time the containment air partial pressure is at the maximum allowable value, the maximum containment pressure will be less than design pressure (45 psig), the containment will depressurize to 0.5 1.0 psig within 1 hour and less than 0.0 psig within 4 hours. The radiological consequences analysis demonstrates acceptable results provided the containment pressure does not exceed 0.5 1.0 psig for the interval from 1 to 4 hours following the Design Basis Accident.

If the containment air partial pressure cannot be maintained greater than or equal to ~~9.0 psia~~ THE MINIMUM PRESSURE IN FIGURE 3.8-1, the reactor shall be brought to the HOT SHUTDOWN condition. The shell and dome plate liner of the containment are capable of withstanding an internal pressure as low as 3 psia, and the bottom mat liner is capable of withstanding an internal pressure as low as 8 psia.

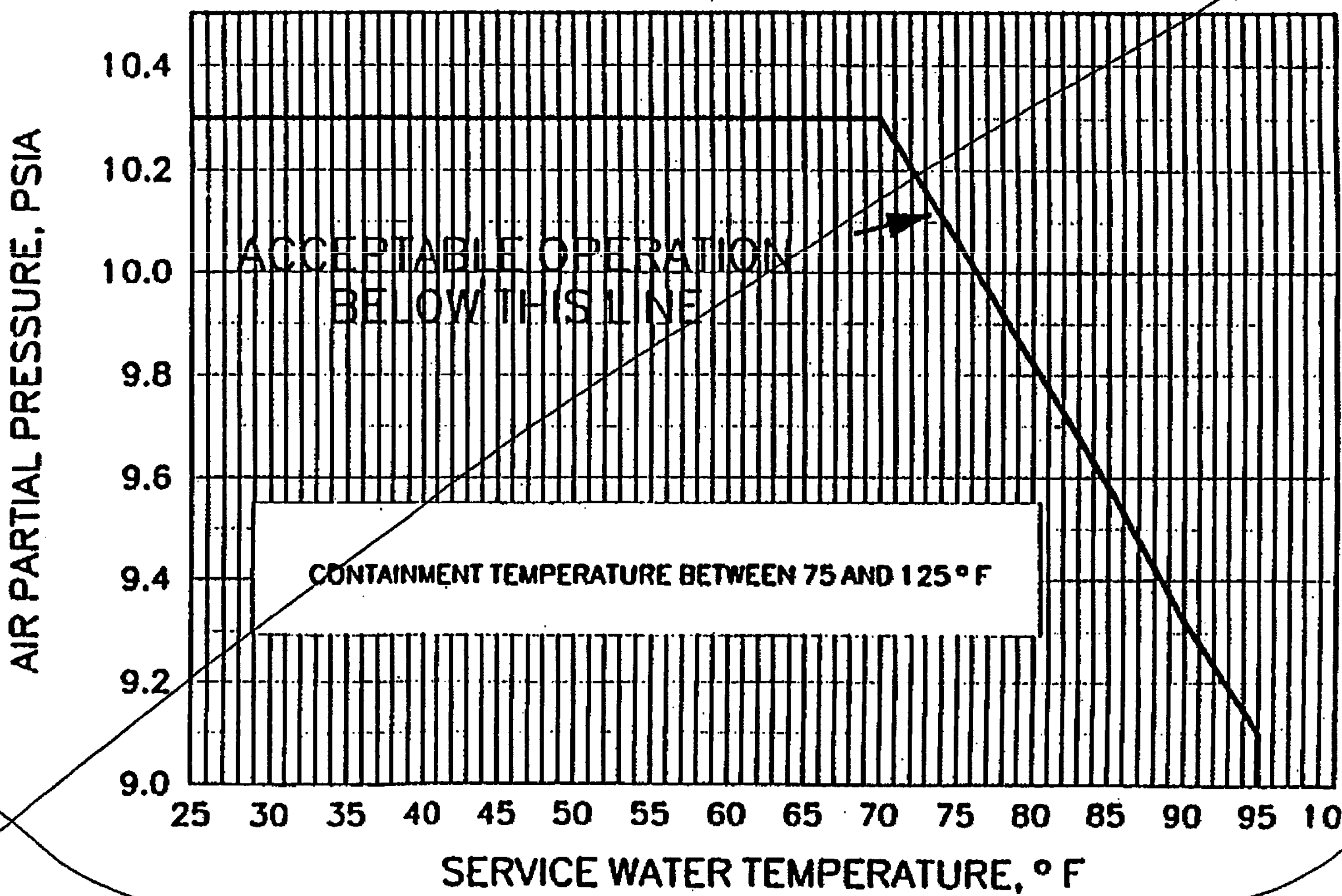
<u>References</u>

UFSAR Section 4.2.2.4	Reactor Coolant Pump
UFSAR Section 5.2	Containment Isolation
UFSAR Section 5.2.1	Design Bases
UFSAR Section 5.2.2	Isolation Design
UFSAR Section 5.3.4	Containment Vacuum System

TS FIGURE 3.8-1

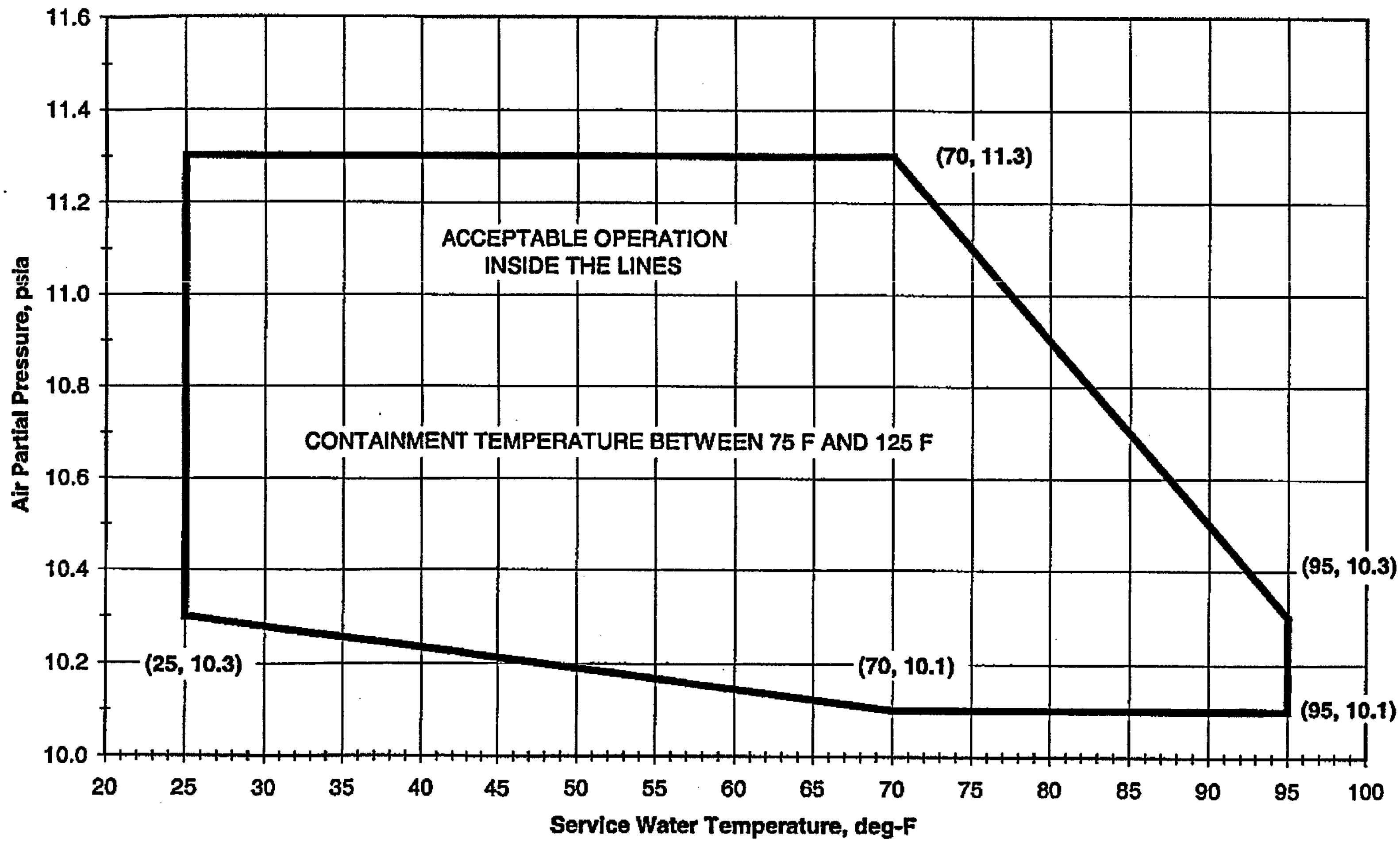
SURRY TECHNICAL SPECIFICATION CURVE

MAX CONTAINMENT ALLOWABLE AIR PARTIAL PRESSURE INDICATION VS. SW TEMP



INSERT #4 to TS 3.8: Replace Figure 3.8-1 with the below figure (Figure 3.10-1 in technical report NE- 1460

TS Figure 3.8-1
SURRY TECHNICAL SPECIFICATION CURVE FOR CONTAINMENT ALLOWABLE AIR PARTIAL PRESSURE INDICATION VS. SERVICE WATER TEMPERATURE



If the requirements of Specification 3.19.B.1, 3.19.B.2, or 3.19.B.3 are not met within 48 hours after achieving HOT SHUTDOWN, both units shall be placed in COLD SHUTDOWN within the next 30 hours.

Basis

Following a design basis accident, the containment will be depressurized to 0.5 psig in less than 1 hour and to subatmospheric pressure within 4 hours. The radiological consequences analysis demonstrates acceptable results provided the containment pressure does not exceed 0.5 psig for the interval from 1 to 4 hours following the Design Basis Accident. Beyond 4 hours, containment pressure is assumed to be less than 0.0 psig, terminating leakage from containment. The main control room is maintained at a positive differential pressure using bottled air during the first hour, when the containment leakrate is greatest.

The main control room is contained in the control room pressure boundary or envelope, which is defined in the Technical Specification 3.23 Basis.

The control room pressure boundary is permitted to be opened intermittently under administrative control without declaring the boundary inoperable. The administrative control must provide the capability to re-establish the control room pressure boundary. For normal ingress into and egress from the pressure boundary, the individual entering or exiting the area has control of the door.

TABLE 4.1-1(Continued)
MINIMUM FREQUENCIES FOR CHECK, CALIBRATIONS AND TEST OF INSTRUMENT CHANNELS

	Channel Description	Check	Calibrate	Test	Remarks
10.	Rod Position Bank Counters	S(1,2) Q(3)	N.A.	N.A.	1) Each six inches of rod motion when data logger is out of service 2) With analog rod position 3) For the control banks, the benchboard indicators shall be checked against the output of the bank overlap unit.
11.	Steam Generator Level	S	R	Q	
12.	Deleted				
13.	Deleted				
14.	Deleted				
15.	Recirculation Mode Transfer				
	a. Refueling Water Storage Tank Level-Low - LOW	S	R	Q	
	b. Automatic Actuation Logic and Actuation Relays	N.A.	N.A.	M	
16.	Deleted REPLACE WITH INSERT #3				
17.	Reactor Containment Pressure-CLS	*D	R	Q(1)	1) Isolation valve signal and spray signal
18.	Deleted				
19.	Deleted				
20.	Deleted				
21.	Deleted				
22.	Steam Line Pressure	S	R	Q	

INSERT #3 to TS 4.1, Table 4.1-1

	Channel Description	Check	Calibrate	Test	Remarks
16	Recirculation Spray Pump Start				
	a. RWST Level - Low	S	R	Q	

Serial No. 06-014
Docket Nos. 50-280/281

ATTACHMENT 3

PROPOSED TECHNICAL SPECIFICATION CHANGE AND SUPPORTING SAFETY ANALYSES REVISIONS TO ADDRESS GENERIC SAFETY ISSUE 191

PROPOSED TECHNICAL SPECIFICATION PAGES

VIRGINIA ELECTRIC AND POWER COMPANY
SURRY POWER STATION UNITS 1 AND 2

Basis

The spray systems in each reactor unit consist of two separate parallel Containment Spray Subsystems, each of 100 percent capacity, and four separate parallel Recirculation Spray Subsystems, each of 50 percent capacity.

Each Containment Spray Subsystem draws water independently from the refueling water storage tank (RWST). The water in the tank is cooled to 45°F or below by circulating the water through one of the two RWST coolers with one of the two recirculating pumps. The water temperature is maintained by two mechanical refrigerating units as required. In each Containment Spray Subsystem, the water flows from the tank through an electric motor driven containment spray pump and is sprayed into the containment atmosphere through two separate sets of spray nozzles. The capacity of the spray systems to depressurize the containment in the event of a Design Basis Accident is a function of the pressure and temperature of the containment atmosphere, the service water temperature, and the temperature in the refueling water storage tank as discussed in the Basis of Specification 3.8.

Each Recirculation Spray Subsystem draws water from the common containment sump. In each subsystem the water flows through a recirculation spray pump and recirculation spray cooler, and is sprayed into the containment atmosphere through a separate set of spray nozzles. Two of the recirculation spray pumps are located inside the containment and two outside the containment in the containment auxiliary structure.

With one Containment Spray Subsystem and two Recirculation Spray Subsystems operating together, the spray systems are capable of cooling and depressurizing the containment to 1.0 psig in less than 60 minutes and to subatmospheric pressure within 4 hours following the Design Basis Accident. The Recirculation Spray Subsystems are capable of maintaining subatmospheric pressure in the containment indefinitely following the Design Basis Accident when used in conjunction with the Containment Vacuum System to remove any long term air inleakage. The radiological consequences analysis demonstrates acceptable results provided the containment pressure does not exceed 1.0 psig (from 1 hour to 4 hours) and is maintained less than 0.0 psig (after 4 hours).

TABLE 3.7-2 (Continued)
ENGINEERED SAFEGUARDS ACTION
INSTRUMENT OPERATING CONDITIONS

Functional Unit	Total Number Of Channels	Minimum OPERABLE Channels	Channels To Trip	Permissible Bypass Conditions	Operator Actions
3. AUXILIARY FEEDWATER (continued)					
e. Trip of main feedwater pumps - start motor driven pumps	2/MFW pump	1/MFW pump	2-1 each MFW pump		24
f. Automatic actuation logic	2	2	1		22
4. LOSS OF POWER					
a. 4.16 kv emergency bus undervoltage (loss of voltage)	3/bus	2/bus	2/bus		26
b. 4.16 kv emergency bus undervoltage (degraded voltage)	3/bus	2/bus	2/bus		26
5. NON-ESSENTIAL SERVICE WATER ISOLATION					
a. Low intake canal level	4	3	3		20
b. Automatic actuation logic	2	2	1		14
6. ENGINEERED SAFEGAURDS ACTUATION INTERLOCKS - Note A					
a. Pressurizer pressure, P-11	3	2	2		23
b. Low-low $T_{avg,}$ P-12	3	2	2		23
c. Reactor trip, P-4	2	2	1		24
7. RECIRCULATION MODE TRANSFER					
a. RWST Level - Low-Low	4	3	2		25
b. Automatic Actuation Logic and Actuation Relays	2	2	1		14
8. RECIRCULATION SPRAY					
a. RWST Level - Low Coincident with High High Containment Pressure	4	3	2		20
b. Automatic Actuation Logic and Actuation Relays	2	2	1		14

Note A - Engineered Safeguards Actuation Interlocks are described in Table 4.1-A

TABLE 3.7-4

ENGINEERED SAFETY FEATURE SYSTEM INITIATION LIMITS INSTRUMENT SETTING

No.	Functional Unit	Channel Action	Setting Limit
6	AUXILIARY FEEDWATER		
	a. Steam Generator Water Level Low-Low	Aux. Feedwater Initiation S/G Blowdown Isolation	≥ 14.5% narrow range
	b. RCP Undervoltage	Aux. Feedwater Initiation	≥ 70% nominal
	c. Safety Injection	Aux. Feedwater Initiation	All S.I. setpoints
	d. Station Blackout	Aux. Feedwater Initiation	≥ 46.7% nominal
	e. Main Feedwater Pump Trip	Aux. Feedwater Initiation	N.A.
7	LOSS OF POWER		
	a. 4.16 KV Emergency Bus Undervoltage (Loss of Voltage)	Emergency Bus Separation and Diesel start	≥ 2975 volts and ≤ 3265 volts with a 2 (+5, -0.1) second time delay
	b. 4.16 KV Emergency Bus Undervoltage (Degraded Voltage)	Emergency Bus Separation and Diesel start	≥ 3830 volts and ≤ 3881 volts with a 60 (±3.0) second time delay (Non CLS, Non SI) 7 (±0.35) second time delay (CLS or SI Conditions)
8	NON-ESSENTIAL SERVICE WATER ISOLATION		
	a. Low Intake Canal Level	Isolation of Service Water flow to non-essential loads	23 feet-6 inches
9	RECIRCULATION MODE TRANSFER		
	a. RWST Level-Low-Low	Initiation of Recirculation Mode Transfer System	≥ 11.25% ≤ 15.75%
10	TURBINE TRIP AND FEEDWATER ISOLATION		
	a. Steam Generator Water Level High-High	Turbine Trip Feedwater Isolation	≤ 80% narrow range
11	RWST Level Low (coincident with High High Containment Pressure)	Recirculation Spray Pump Start	≥ 59% ≤ 61%

(3) assuring that environmental conditions will not preclude access to close the valves and 4) that this administrative or manual action will prevent the release of radioactivity outside the containment.

The Reactor Coolant System temperature and pressure being below 350°F and 450 psig, respectively, ensures that no significant amount of flashing steam will be formed and hence that there would be no significant pressure buildup in the containment if there is a loss-of-coolant accident. Therefore, the containment internal pressure is not required to be subatmospheric prior to exceeding 350°F and 450 psig.

The allowable value for the containment air partial pressure is presented in TS Figure 3.8-1 for service water temperatures from 25 to 95°F. The RWST water shall have a maximum temperature of 45°F.

The horizontal upper limit line in TS Figure 3.8-1 is based on MSLB peak calculated pressure criteria, and the sloped line from 70°F to 95°F service water temperatures is based on LOCA depressurization criteria.

If the containment air partial pressure rises to a point above the allowable value the reactor shall be brought to the HOT SHUTDOWN condition. If a LOCA occurs at the time the containment air partial pressure is at the maximum allowable value, the maximum containment pressure will be less than design pressure (45 psig), the containment will depressurize to 1.0 psig within 1 hour and less than 0.0 psig within 4 hours. The radiological consequences analysis demonstrates acceptable results provided the containment pressure does not exceed 1.0 psig for the interval from 1 to 4 hours following the Design Basis Accident.

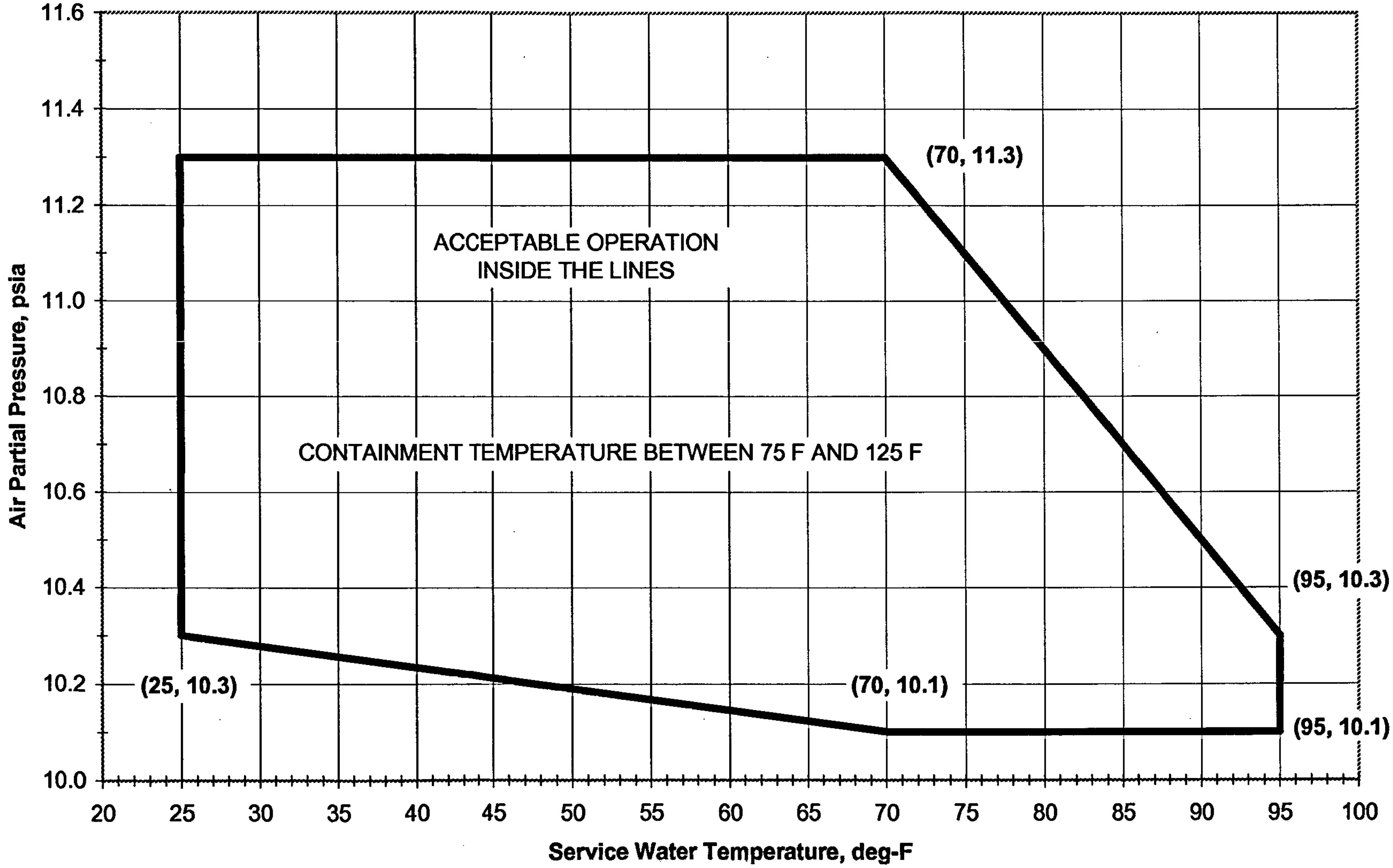
If the containment air partial pressure cannot be maintained greater than or equal to the minimum pressure in Figure 3.8-1, the reactor shall be brought to the HOT SHUTDOWN condition. The shell and dome plate liner of the containment are capable of withstanding an internal pressure as low as 3 psia, and the bottom mat liner is capable of withstanding an internal pressure as low as 8 psia.

References

UFSAR Section 4.2.2.4	Reactor Coolant Pump
UFSAR Section 5.2	Containment Isolation
UFSAR Section 5.2.1	Design Bases
UFSAR Section 5.2.2	Isolation Design
UFSAR Section 5.3.4	Containment Vacuum System

TS Figure 3.8-1

SURRY TECHNICAL SPECIFICATION CURVE FOR CONTAINMENT
ALLOWABLE AIR PARTIAL PRESSURE INDICATION VS. SERVICE WATER TEMPERATURE



Amendment Nos.

If the requirements of Specification 3.19.B.1, 3.19.B.2, or 3.19.B.3 are not met within 48 hours after achieving HOT SHUTDOWN, both units shall be placed in COLD SHUTDOWN within the next 30 hours.

Basis

Following a design basis accident, the containment will be depressurized to 1.0 psig in less than 1 hour and to subatmospheric pressure within 4 hours. The radiological consequences analysis demonstrates acceptable results provided the containment pressure does not exceed 1.0 psig for the interval from 1 to 4 hours following the Design Basis Accident. Beyond 4 hours, containment pressure is assumed to be less than 0.0 psig, terminating leakage from containment. The main control room is maintained at a positive differential pressure using bottled air during the first hour, when the containment leakrate is greatest.

The main control room is contained in the control room pressure boundary or envelope, which is defined in the Technical Specification 3.23 Basis.

The control room pressure boundary is permitted to be opened intermittently under administrative control without declaring the boundary inoperable. The administrative control must provide the capability to re-establish the control room pressure boundary. For normal ingress into and egress from the pressure boundary, the individual entering or exiting the area has control of the door.

TABLE 4.1-1(Continued)

MINIMUM FREQUENCIES FOR CHECK, CALIBRATIONS AND TEST OF INSTRUMENT CHANNELS

	Channel Description	Check	Calibrate	Test	Remarks
10.	Rod Position Bank Counters	S(1,2) Q(3)	N.A.	N.A.	1) Each six inches of rod motion when data logger is out of service 2) With analog rod position 3) For the control banks, the benchboard indicators shall be checked against the output of the bank overlap unit.
11.	Steam Generator Level	S	R	Q	
12.	Deleted				
13.	Deleted				
14.	Deleted				
15.	Recirculation Mode Transfer				
	a. Refueling Water Storage Tank Level-Low-Low	S	R	Q	
	b. Automatic Actuation Logic and Actuation Relays	N.A.	N.A.	M	
16.	Recirculation Spray Pump Start				
	a. RWST Level-Low	S	R	Q	
17.	Reactor Containment Pressure-CLS	*D	R	Q(1)	1) Isolation valve signal and spray signal
18.	Deleted				
19.	Deleted				
20.	Deleted				
21.	Deleted				
22.	Steam Line Pressure	S	R	Q	

ATTACHMENT 4

PROPOSED TECHNICAL SPECIFICATION CHANGE AND SUPPORTING SAFETY ANALYSES REVISIONS TO ADDRESS GENERIC SAFETY ISSUE 191

NO SIGNIFICANT HAZARDS CONSIDERATION AND ENVIRONMENTAL ASSESSMENT

VIRGINIA ELECTRIC AND POWER COMPANY
SURRY POWER STATION UNITS 1 AND 2

NO SIGNIFICANT HAZARDS CONSIDERATION AND ENVIRONMENTAL ASSESSMENT

No Significant Hazards Consideration

The proposed changes to the Surry technical specifications and licensing basis support the resolution of NRC Generic Safety Issue 191 (GSI-191), Assessment of Debris Accumulation on PWR Sump Performance and NRC Generic Letter 2004-02, Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors. Four changes are proposed as part of the requested amendment:

1) Replace the UFSAR evaluation methodology for analyzing the response to postulated pipe ruptures inside containment, including loss of coolant accident (LOCA) and main steam line break events, with the GOTHIC evaluation methodology in Dominion Topical Report DOM-NAF-3. The change to GOTHIC from the current LOCTIC code provides margins in LOCA peak containment pressure and other accident analysis results.

2) Increase the TS 3.8 containment air partial pressure limits based on the GOTHIC containment analyses.

3) Change the method of starting the recirculation spray (RS) pumps from timers after consequence limiting safeguards (CLS) High High containment pressure to the refueling water storage tank (RWST) Level Low coincident with CLS High High. This change provides adequate water level to submerge the containment sump strainer and meets all safety analysis acceptance criteria. The proposed amendment modifies the Surry technical specifications surveillance requirements to verify that each RS pump automatically starts on a CLS test signal after receipt of an RWST Level Low coincident with CLS High High containment pressure. A plant modification associated with the proposed change to the technical specifications is required to install new RS pump start circuitry.

4) Change to the LOCA AST analysis basis to demonstrate acceptable dose consequences for the increased air partial pressure limits and account for the modification to RS pump start.

Dominion has reviewed the requirements of 10 CFR 50.92 as they relate to the proposed changes to the Surry Power Station Units 1 and 2 technical specifications and licensing basis and has determined that a significant hazards consideration does not exist. The basis for this determination is as follows:

1. Does the proposed license amendment involve a significant increase in the probability or consequences of an accident previously evaluated?

   No.

   The proposed changes include a physical alteration to the RS system to start the inside and outside RS pumps on RWST Level Low coincident with CLS High High containment pressure. The RS system is used for accident mitigation only, and changes in the operation of the RS system cannot have an impact on the probability of an accident. The other changes do not affect equipment and are not accident initiators. The RWST Level Low instrumentation will comply with all applicable regulatory requirements and design criteria (e.g., train separation, redundancy, single failure). Therefore, the design functions performed by the RS system are not changed.

   Delaying the start of the RS pumps affects long-term containment pressure and temperature profiles. The environmental qualification of safety-related equipment inside containment was confirmed to be acceptable, and accident mitigation systems will continue to operate within design temperatures and pressures. Delaying the RS pump start reduces the emergency diesel generator loading early during a design basis accident, and staggering the RS pump start avoids overloading on each emergency bus. The reduction in iodine removal efficiency during the delay period is offset by changes to other assumptions in the LOCA dose analysis. The net impact is a reduction in the predicted offsite doses and control room doses following a design basis LOCA.

   The UFSAR safety analysis acceptance criteria continue to be met for the proposed changes to the RS pump start method, the proposed TS containment air partial pressure limits, the implementation of the GOTHIC containment analysis methodology, and the changes to the LOCA dose consequences analyses. Based on this discussion, the proposed amendments do not increase the probability or consequence of an accident previously evaluated.

2. Does the proposed license amendment create the possibility of a new or different kind of accident from any accident previously identified?

   No.

   The proposed change alters the RS pump circuitry by initiating the start sequence with a new RWST Level Low signal instead of a timer after the CLS High High pressure setpoint is reached. The timers for the outside RS pumps will be used to sequence pump starts and preclude diesel generator overloading. The RS pump function is not changed. The RWST Level Low instrumentation will be included as part of the engineered safeguards features (ESF) instrumentation in the Surry TS and will be subject to the ESF surveillance requirements. The design of the RWST Level Low instrumentation complies with all applicable regulatory requirements and design criteria. The failure modes have been analyzed to ensure that the RWST Level Low circuitry can withstand a single active failure without affecting the RS system design functions. The RS system is an accident mitigation system only, so no new accident initiators are created.

   The remaining changes to the containment analysis methodology, the containment air partial pressures, and the LOCA AST analysis basis do not impact plant equipment design or function. Together, the changes assure that there is adequate margin available to meet the safety analysis criteria and that dose consequences are within regulatory limits. The proposed changes do not introduce failure modes, accident initiators, or malfunctions that would cause a new or different kind of accident. Therefore, the proposed changes do not create the possibility of a new or different kind of accident from any accident previously identified.

3. Does the proposed license amendment involve a significant reduction in a margin of safety?

   No.

   The changes to the actuation of the RS pumps and the increased containment air partial pressure affect the containment response analyses and the LOCA dose analysis. Analyses have been performed that show the containment design basis limits are satisfied and the post-LOCA offsite and control room doses meet the required criteria for the proposed changes to the containment analysis methodology, the RS pump start method, the TS containment air partial pressure limits, and the LOCA AST bases. Therefore, the proposed amendment does not involve a significant reduction in a margin of safety.

Environmental Assessment

The proposed change meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9) as follows:

(i) The amendment involves no significant hazards consideration.

As described above, the proposed TS change does not involve a significant hazards consideration.

(ii) There is no significant change in the types or significant increase in the amounts of any effluents that may be released offsite.

Delaying the start of the RS pumps affects long-term containment pressure and temperature profiles. However, the accident mitigation systems will continue to operate within design temperatures and pressures. The reduction in iodine removal efficiency during the delay period is offset by changes to other assumptions in the LOCA dose analysis. The net impact is a reduction in the predicted offsite dose. The remaining changes to the containment analysis methodology, the containment air partial pressures, and the LOCA AST analysis basis do not impact plant equipment design or function. Therefore, there is no significant change in the types or amount of any effluents that may be released offsite.

(iii) There is no significant increase in individual or cumulative occupational radiation exposure.

Delaying the start of the RS pumps affects long-term containment pressure and temperature profiles. However, the accident mitigation systems will continue to operate within design temperatures and pressures. The reduction in iodine removal efficiency during the delay period is offset by changes to other assumptions in the LOCA dose analysis. The net impact is a reduction in the predicted control room dose. The remaining changes to the containment analysis methodology, the containment air partial pressures, and the LOCA AST analysis basis do not impact plant equipment design or function. Therefore, there is no significant change in the individual or cumulative occupational radiation exposure.

Based on the above assessment, Dominion concludes that the proposed change meets the criteria specified in 10 CFR 51.22 for a categorical exclusion from the requirements of 10 CFR 51.22 relative to requiring a specific environmental assessment or impact statement by the Commission.

Conclusion

The proposed change - the change to GOTHIC from the current LOCTIC code, the increase in the TS 3.8 containment air partial pressure limits, the change to the method of starting the RS pumps from timers to the RWST level, and the changes to the LOCA AST analysis basis - provides additional margin to support the resolution of NRC GSI-191 and NRC Generic Letter 2004-02. The proposed change has no adverse safety impact and does not significantly affect radiological dose consequences to the public or to plant workers.