VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

July 28, 2006

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

Serial No. 06-545
NL&OS/ETS R0
Docket Nos. 50-280/281
License Nos. DPR-32/37

VIRGINIA ELECTRIC AND POWER COMPANY (DOMINION)
SURRY POWER STATION UNITS 1 AND 2
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION AND SUPPLEMENT TO PROPOSED TECHNICAL SPECIFICATION CHANGE AND SUPPORTING SAFETY ANALYSES REVISIONS TO ADDRESS GENERIC SAFETY ISSUE 191

In a letter dated January 31, 2006 (Serial No. 06-014), Dominion requested amendments 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 was submitted as part of Dominion's resolution to NRC Generic Safety Issue 191 (GSI-191), which included a containment reanalysis using the DOM-NAF-3, GOTHIC methodology. While developing a similar plant-specific amendment request for the North Anna Power Station using the DOM-NAF-3 GOTHIC methodology, Dominion discovered that some GOTHIC applications produced less conservative results for calculating available net positive suction head (NPSHa). After further evaluation, it was determined that a similar situation existed within the GOTHIC analysis performed to support the license amendment request for Surry. This GOTHIC methodology issue does not affect the proposed Surry TS changes, but does affect the supporting analyses for calculating NPSHa. Therefore, Dominion has revised the methodology to change the NPSH calculations and is providing the NRC the revised information to complete the review of the proposed TS changes. A description of the GOTHIC application issue and our corrective actions were provided to the NRC in a July 14, 2006 letter (Serial No. 06-544).

In a conference call on June 21, 2006, Dominion notified the NRC of the GOTHIC methodology issue and the impact on the January 31, 2006 submittal and agreed to submit replacement pages for the affected sections. Accordingly, Attachment 1 of this letter contains the replacement pages for the Discussion of Change in the January 31, 2006 submittal. In subsequent e-mails dated July 13 and 14, 2006 and a July 17, 2006 phone call, the NRC requested additional information to complete the review of the proposed amendment. Attachment 2 of this letter provides the requested information.

We have evaluated the original proposed Technical Specification changes with respect to the additional analysis changes provided herein and have determined that the proposed analysis changes do not impact the No Significant Hazards Consideration Determination and the Environmental Assessment previously provided in our January 31, 2006 submittal.

Dominion continues to request 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. It is Dominion's intention to implement the Surry Units 1 and 2 containment analyses with the GOTHIC code (replacing the Stone and Webster LOCTIC computer code) for both units during the Surry Unit 2 refueling outage. Our submittal dated January 31, 2006 and this supplement, included GOTHIC analyses for the current and proposed plant configurations. The current configuration analyses will be applicable to Surry Units 1 and 2 upon NRC approval of the application of the GOTHIC methodology for Surry. In addition, approval of the redefined EAB amendment request (Serial No. 05-601, dated September 13, 2005) and Topical Report DOM-NAF-3 (Serial No. 05-745, dated November 1, 2005) is required prior to or concurrent with approval of this request to support implementation of the proposed Technical Specifications changes and safety analysis revision.

If you have questions or require additional information, please contact Mr. Paul R. Willoughby at (804) 273-3572.

Very truly yours,

Gerald T. Bischof
Vice President – Nuclear Engineering

Attachments: (2)

1. Replacement Pages for the "Discussion Of Change" in the January 31, 2006 Submittal
2. Response to July 13,14 and 17, 2006 Requests for Additional Information

Commitments made in this letter: None

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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 Gerald T. Bischof, who is Vice President – Nuclear Engineering, of Virginia Electric and Power Company. He has affirmed before me that he 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 his knowledge and belief.

Acknowledged before me the 28th day of July, 2006.

My Commission Expires: August 31, 2008

Margaret B. Bennett
Notary Public

(SEAL)

ATTACHMENT 1

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

REPLACEMENT PAGES FOR THE "DISCUSSION OF CHANGE" IN THE JANUARY 31, 2006 SUBMITTAL

(30 replacement pages - revisions identified by lines in right margin)

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

List of Figures

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.

Changes to topical report DOM-NAF-3 were submitted to the NRC in a letter dated July 14, 2006 [27]. The changes revise the selection of spray droplet diameter for NPSH calculations and the NPSH equation to use the fluid density at the pump suction. Revised NPSH analyses have been performed for the LHSI and RS pumps to replace analyses submitted in a letter dated January 31, 2006 [28]. To recover NPSH margin, the input for containment spray (CS) bleed flow to the ORS pump suction was modified to more closely reflect the system performance. The previous analyses assumed a constant 300 gpm throughout the accident for simplicity. In the revised analyses, the CS bleed flow is input as a function of differential pressure between the containment and the RWST (see Table 3.1-1). Dominion has included replacement pages for Attachment 1 of the Reference 28 submittal to reflect the results of the revised NPSH analyses using the changes described. The changes affect the following sections of Attachment 1 from Reference 28:

- Sections 3.1.2 and 3.1.6: The description of spray modeling changes for NPSH analyses is modified to reflect the methodology in Reference 27.
- Table 3.1.1: A footnote was added to Table 3.1-1 to reflect the change to CS bleed flow.
- Section 3.5: The LHSI pump NPSH analyses were revised with the change to the NPSH equation and spray droplet diameter.
- Section 3.6: The RS pump NPSH analyses were revised with the change to the NPSH equation, the spray droplet diameter, and the CS bleed flow.
- Section 3.10: The LHSI pump NPSH margin was changed in the basis for Figure 3.10-1.
- Section 3.11: The containment analysis results table was revised to reflect the NPSH analyses.
- Section 6.0: Two references were added.

Based on Attachment 2, the accumulator nitrogen volume in Table 3.1-1 is corrected.

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 spray modeling assumptions applied in DOM-NAF-3, Section 3.8.2 ensure a conservative spray response that minimizes the containment pressure 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)

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). Analyses are performed using the largest Sauter droplet size and repeated with the Sauter size reduced by a factor of 2. NPSH results are reported from the GOTHIC case that produces the minimum NPSHa.
- 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

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)	419 - 481
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 [5]
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.
5) For the RS pump NPSH analyses, the CS bleed flow is input as a function of differential pressure between the containment and the RWST (C-L in psid). The flow rate varies from 294 gpm (26.8 psid) to 325.6 gpm (–8.6 psid and maintained constant for more negative differential pressures).

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

3.5 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. During 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 18.12 ft occurs just after sump recirculation for a TS SW limit of 95 F. NPSHa increases to a value of 21.7 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 21.8 F higher and the pressure was 1.5 psi higher compared to the 25 F SW case. In the proposed configuration cases, the 95 F SW case had a sump temperature only 11.6 F higher and the pressure was 1.7 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 47.5 F to 70 F, and the minimum NPSHa is 15.73 ft.

While several cases along the air partial pressure limit approach the minimum NPSHa, the analysis at 10.1 psia and 70 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 10.1 psia and 70 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	18.12	19.63
Margin to NPSH required of 13.82 ft	4.30	5.81
Time of minimum NPSHa, sec	2847	2840
Containment pressure, psia	10.32	8.82
Containment vapor pressure, psia	1.16	0.31
Containment liquid temperature, F	164.8	143.0
Containment vapor temperature, F	107.0	66.2
Water level, ft (referenced to –27.58 ft)	4.07	4.04
LHSI pump suction pressure, psia	12.8	11.31
LHSI pump suction vapor pressure, psia	5.33	3.13
Integral energy release, MBtu	668.5	675.7
Integral mass release, Mlbm	2.015	2.008

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	2839.4
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	16.35	16.0	**15.82**	**15.83**	**15.78**	**15.74**	**15.73**	16.08
Margin to NPSH required (13.82 ft), ft	2.53	2.18	2.00	2.01	1.96	1.92	1.91	2.26
Time of minimum NPSHa, sec	2893	2893	2894	2894	2894	2896	2895	2899
Containment total pressure, psia	10.37	10.58	10.69	10.76	10.87	10.97	11.28	12.06
Containment vapor pressure, psia	0.45	0.59	0.66	0.71	0.78	0.85	1.05	1.60
Containment liquid temperature, F	171.0	173.6	174.8	175.2	176.1	176.8	178.7	182.6
Containment vapor temperature, F	77.2	85.1	88.8	90.8	93.9	96.8	103.8	118.2
Water level, ft (referenced to –27.58 ft)	4.09	4.09	4.10	4.10	4.10	4.10	4.11	4.11
LHSI suction pressure, psia	12.86	13.07	13.18	13.25	13.35	13.46	13.74	14.55
LHSI suction vapor pressure, psia	6.14	6.50	6.69	6.76	6.88	7.01	7.30	7.97

* 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, 70 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	1378	1378
IRS pump starts at 57.5% RWST level + 10 seconds to reach full flow	1388	1388
ORS pump starts at 57.5% RWST level + 142 seconds (120 delay, 12 uncertainty, 10 full flow)	1520	1520
RMT occurs at 16.0% RWST level (13.5% setpoint + 2.5% uncertainty) + 2 minutes for valve position changes	2884	2887

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

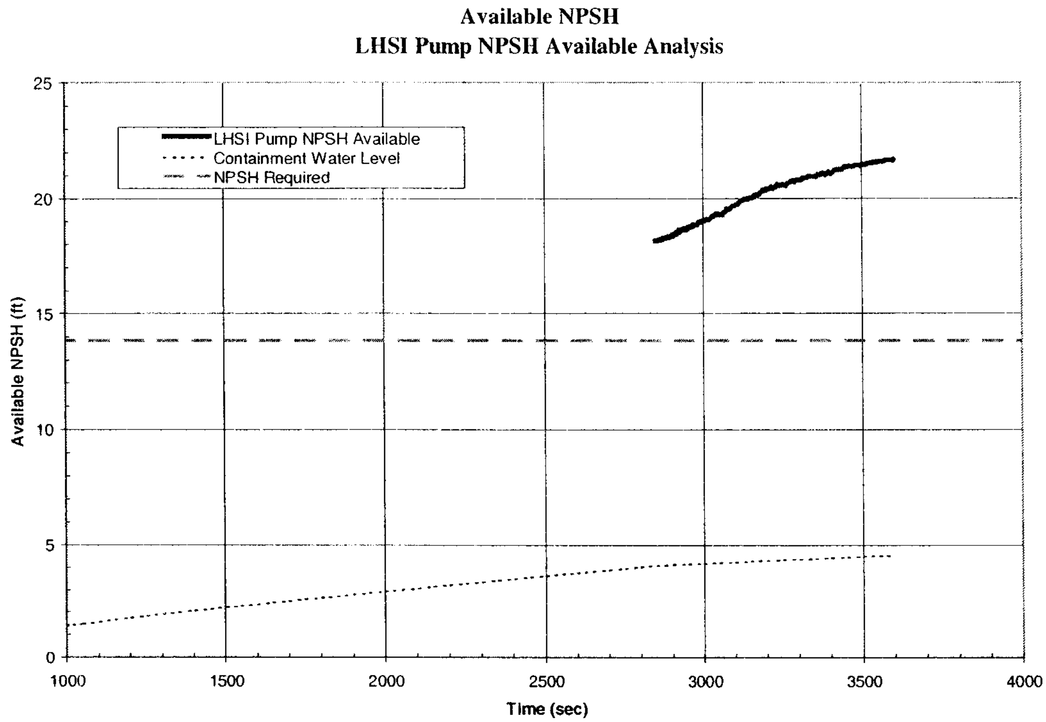


Figure 3.5-2: Containment Pressure from LHSI Pump NPSHa Analysis – Current Configuration

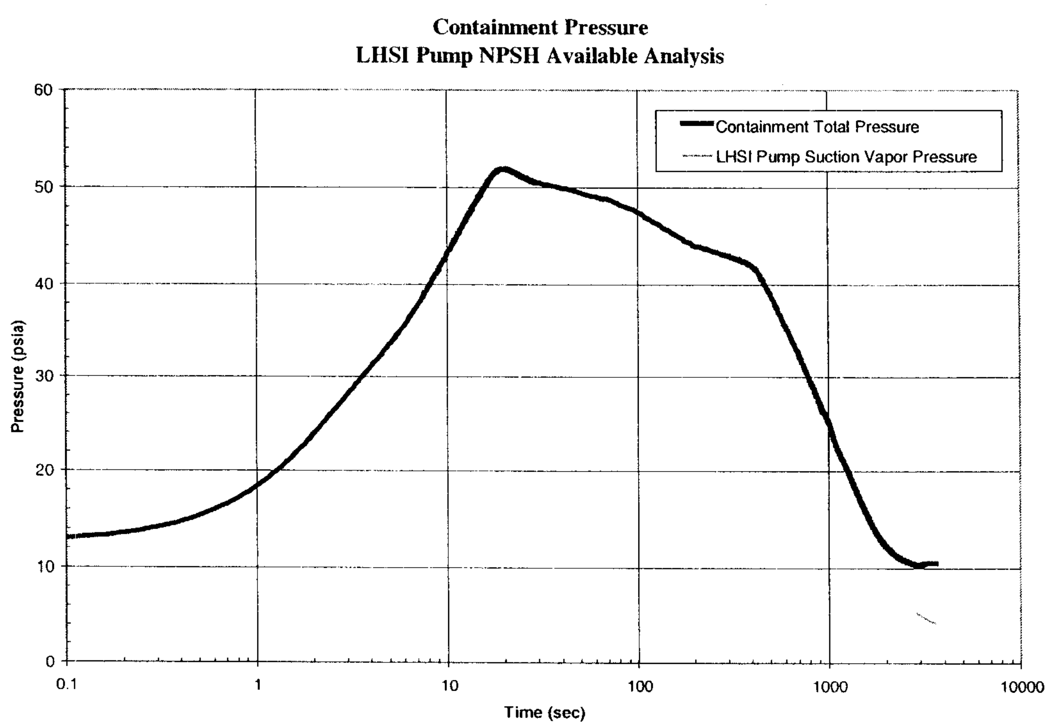


Figure 3.5-3: Containment Temperature from LHSI Pump NPSHa Analysis – Current Configuration

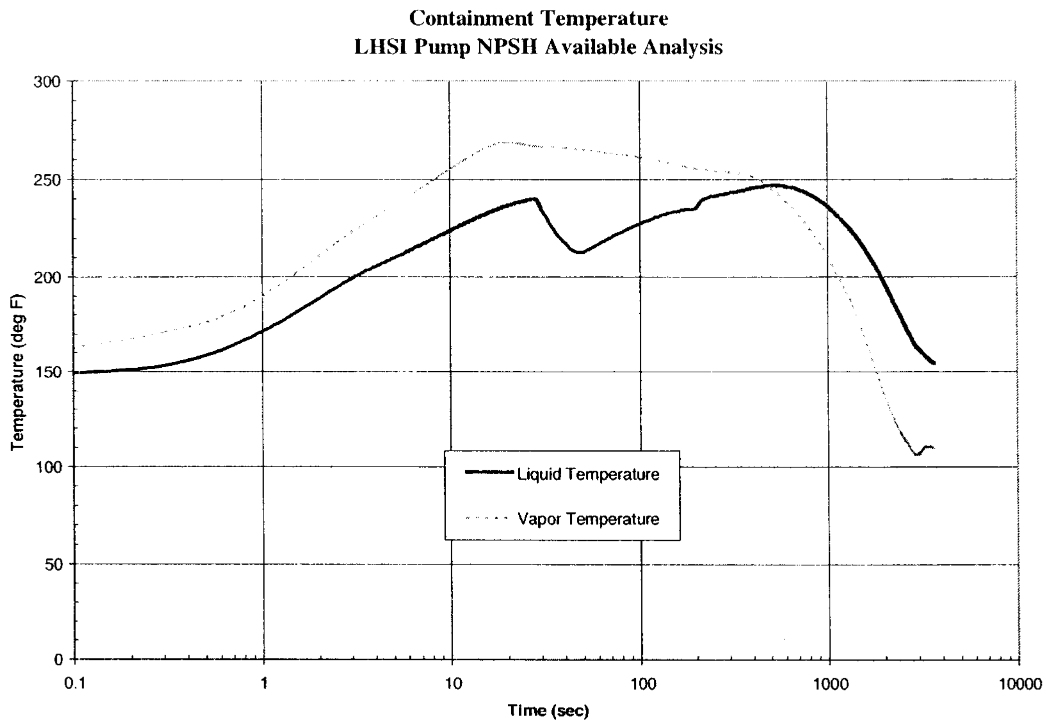


Figure 3.5-4: Total RSHX Heat Rate from LHSI Pump NPSHa Analysis – Current Configuration

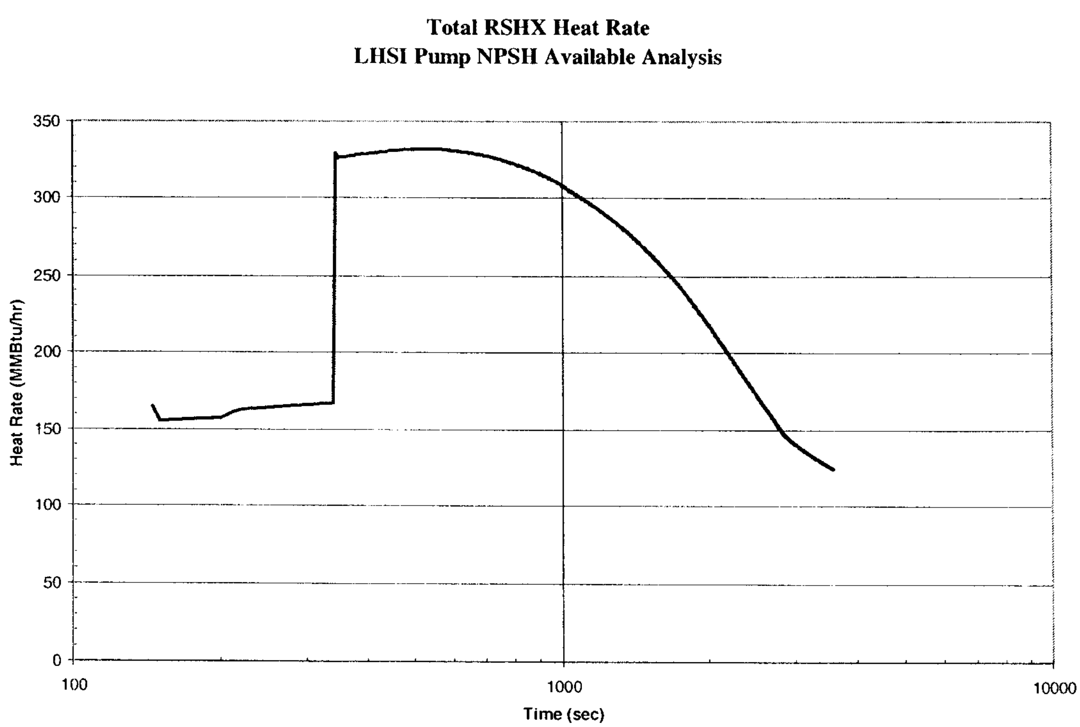


Figure 3.5-5: LHSI Pump NPSHa - Proposed Configuration (10.1 psia, 70 F)

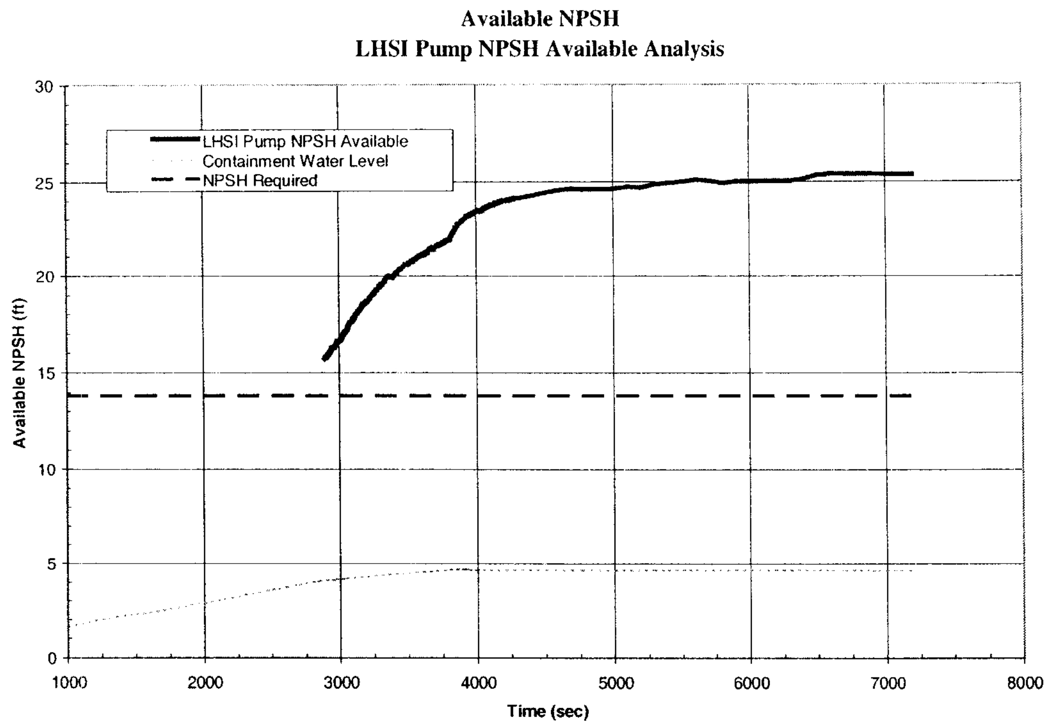


Figure 3.5-6: Containment Pressure from LHSI Pump NPSHa Analysis – Proposed Configuration

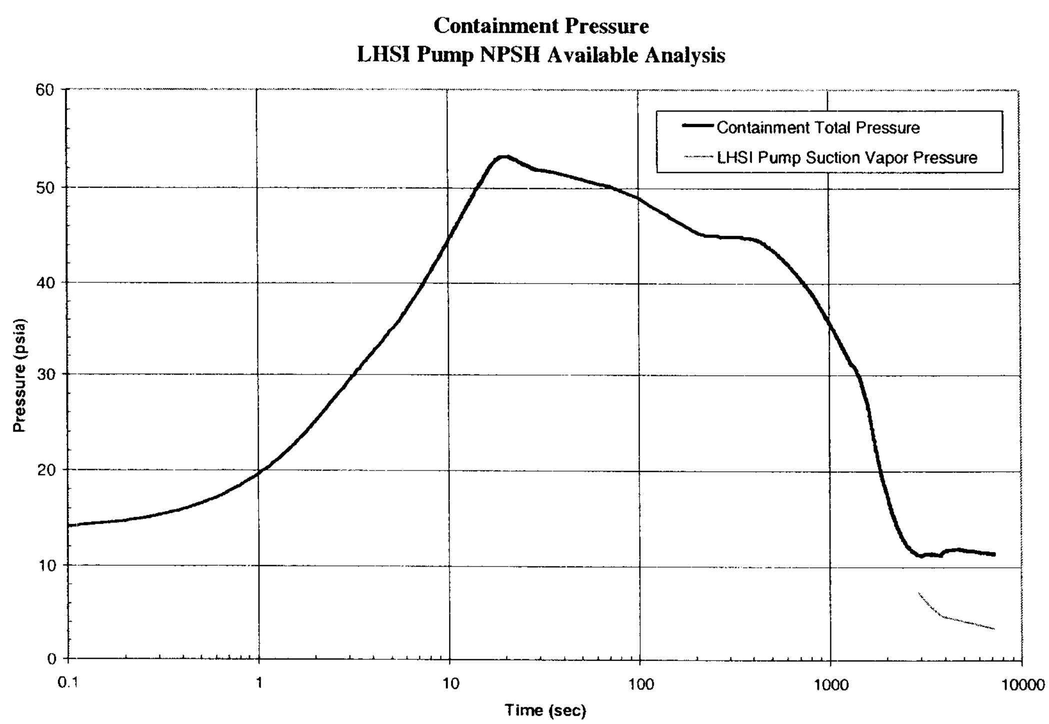


Figure 3.5-7: Containment Temperature from LHSI Pump NPSHa Analysis – Proposed Configuration

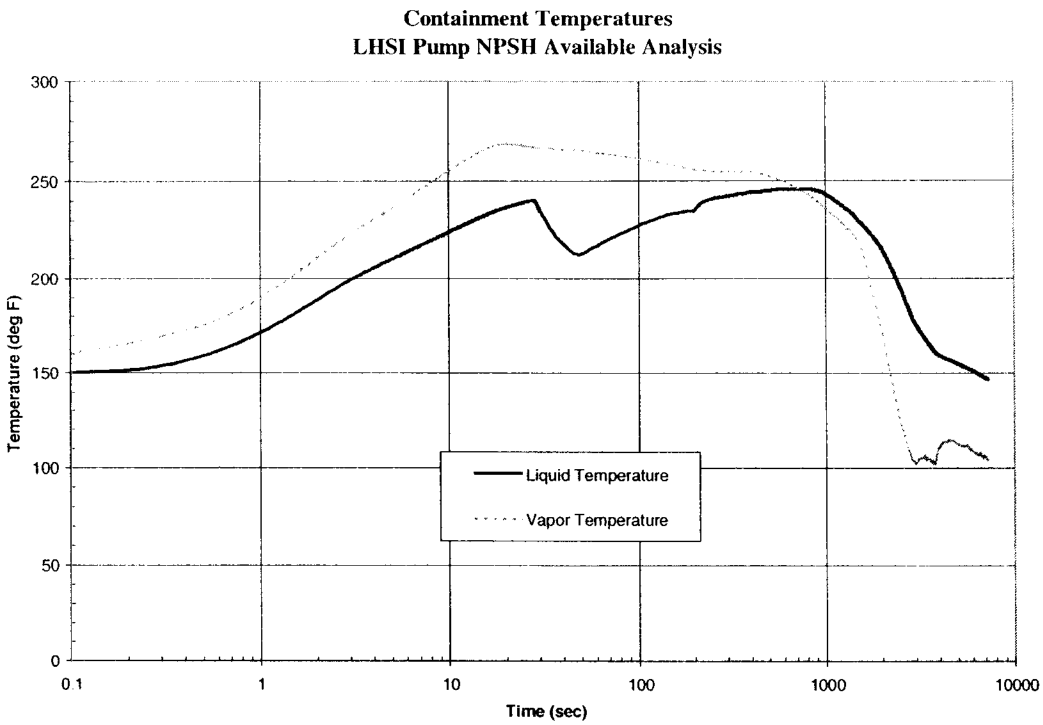
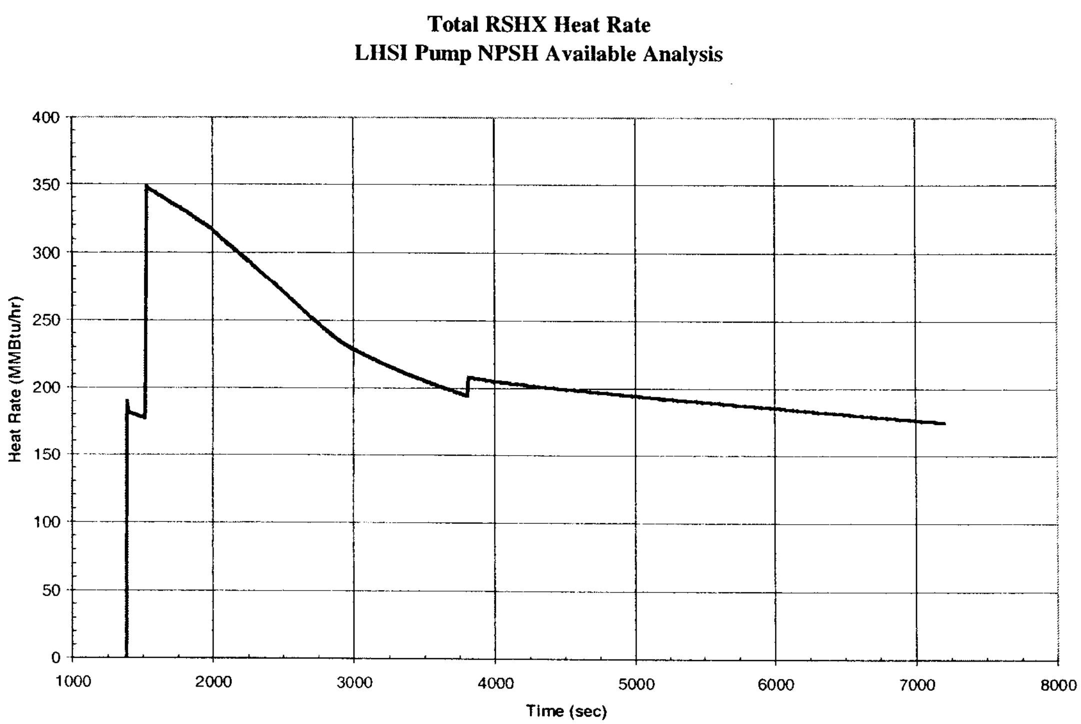


Figure 3.5-8: Total RSHX Heat Rate from LHSI Pump NPSHa Analysis – Proposed Configuration



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). Items 2 and 3 provide more margin for the ORS pump, but this amount is more than offset by the smaller suction friction loss for the IRS pump.

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. 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 for a range of single failures.

<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 10.68 ft for a case with no single failure at 25°F SW. 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 14.03 ft.

Proposed Configuration

Table 3.6-3 compares the results of DEPSG and DEHLG analyses using the proposed plant configuration for three single failure analyses: 1 emergency bus; 1 LHSI pump; and no single failure. The minimum ORS pump NPSHa of 12.88 ft occurs for a DEHLG break with the failure of 1 LHSI pump at 25 F SW (Case 6). This case is limiting by a small amount of NPSH margin compared to a DEPSG break with no failure (Case 1). 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 could produce 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. For cases that assume the failure of 1 LHSI pump, minimum NPSHa occurs 340 seconds later for the DEPSG break (Case 3) than the DEHLG break (Case 6), because it takes 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 0.5 ft at 25 F SW. Table 3.6-4 compares the time sequence of events for the DEHLG and DEPSG break cases with 1 LHSI pump failure.

For operation in Figure 3.10-1, the minimum NPSH margin for the ORS pump is 3.69 ft (Case 6). The limiting ORS pump NPSHa occurs at 25 F SW for all break and single failure combinations. The cold SW produces the most limiting spray temperature for reducing containment pressure. Table 3.6-3 shows NPSH margin increase as SW temperature is increased to 47.5 F (Case 7). Because minimum SW temperature is limiting, 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 6.

The minimum NPSHa for the IRS pump is 15.54 ft from a DEPSG break with full ESF at 70 F SW. The difference in limiting conditions compared to the ORS pump is attributed to the effect that SW temperature has on the IRS pump suction conditions. The ORS pump suction receives cold water directly from the RWST via the CS system, but the IRS pump suction mixes sump water with water returned from the discharge of its RSHX. A low SW temperature removes more energy through the IRS HX and produces colder recirculation flow. The IRS pump NPSHa is penalized as SW temperature decreases below 95 F until it reaches a value at which the colder RSHX discharge temperature provides more of a benefit to the IRS pump suction that it factors into depressurizing the containment. The DEPSG break produces the most limiting set of conditions that minimize NPSHa for the IRS pump, but only by a small amount of NPSH margin. At the time of minimum NPSHa, the DEPSG break has a 9 F higher sump temperature, a 1.2-psi higher containment pressure, and a 0.5-ft higher water level than the DEHLG break. The IRS pump continues to have more NPSH margin than the ORS pump. 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 1.88 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	10.68	14.03
NPSH Required, ft	9.19	10.5
Margin to NPSH Required, ft	1.49	3.53
Time of minimum pump NPSHa, sec	640.1	607.0
Containment pressure, psia	10.48	10.92
Water level, ft (referenced to –27.58 ft)	1.18	1.10
Pump suction pressure, psia	11.89	14.08
Pump suction liquid temperature, F	179.5	184.0
Integral energy, MBtu	358.4	355.3
Integral mass, klbms	863.5	842.9

* 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	640	607
SI recirculation mode transfer	1960.5	1959.4
Transient Termination	2400	2400

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

GOTHIC Case →	1	2	3	4	5	6	7
Break Location	DEPSG	DEPSG	DEPSG	DEHLG	DEHLG	DEHLG	DEHLG
Single Failure	None	1 Bus	1 LHSI	None	1 Bus	1 LHSI	1 LHSI
Initial TS Containment Air Pressure, psia	10.30	10.30	10.30	10.30	10.30	10.30	10.20
Initial Containment Pressure, psia*	12.02	12.02	12.02	12.02	12.02	12.02	11.92
Initial Air Temperature, F	125.5	125.5	125.5	125.5	125.5	125.5	125.5
TS SW Temperature, F	25	25	25	25	25	25	47.5
Results at Time of Minimum NPSHa							
Minimum NPSHa, ft	13.20	13.66	13.35	13.88	13.95	**12.88**	13.51
Margin to NPSHr (9.19 ft), ft	4.01	4.47	4.16	4.69	4.76	**3.69**	4.32
Time of minimum NPSHa, sec	1436	2106	1482	1104	1681	1142	1158
Containment total pressure, psia	11.94	12.22	12.27	11.05	11.53	11.34	11.51
Containment liquid temperature, F	200.9	202.3	202.3	191.7	195.2	196.3	195.8
Containment vapor temperature, F	114.2	118.8	119.5	96.8	106.4	102.7	108.0
Water level, ft (referenced to –27.58 ft)	2.62	3.01	2.57	2.18	2.32	2.11	2.14
ORS pump suction pressure, psia	13.88	14.30	14.18	12.80	13.33	13.06	13.24
ORS pump suction vapor pressure, psia	8.45	8.69	8.69	7.05	7.56	7.74	7.65
ORS pump suction liquid temp, F	185.3	186.6	186.6	177.1	180.2	181.3	180.8
Integral energy release, MBtu	567.7	612.2	566.8	396.1	424.8	394.2	394.6
Integral mass release, Mlbm	1.421	1.600	1.360	1.130	1.243	1.064	1.058

* 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	892	961
ORS pump starts at 62.5% level + 108 seconds	1000	1069
ORS pump minimum NPSHa	1142	1473
RMT occurs at 16.0% RWST level	2145	> 2000
Transient Termination	2400	2000

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

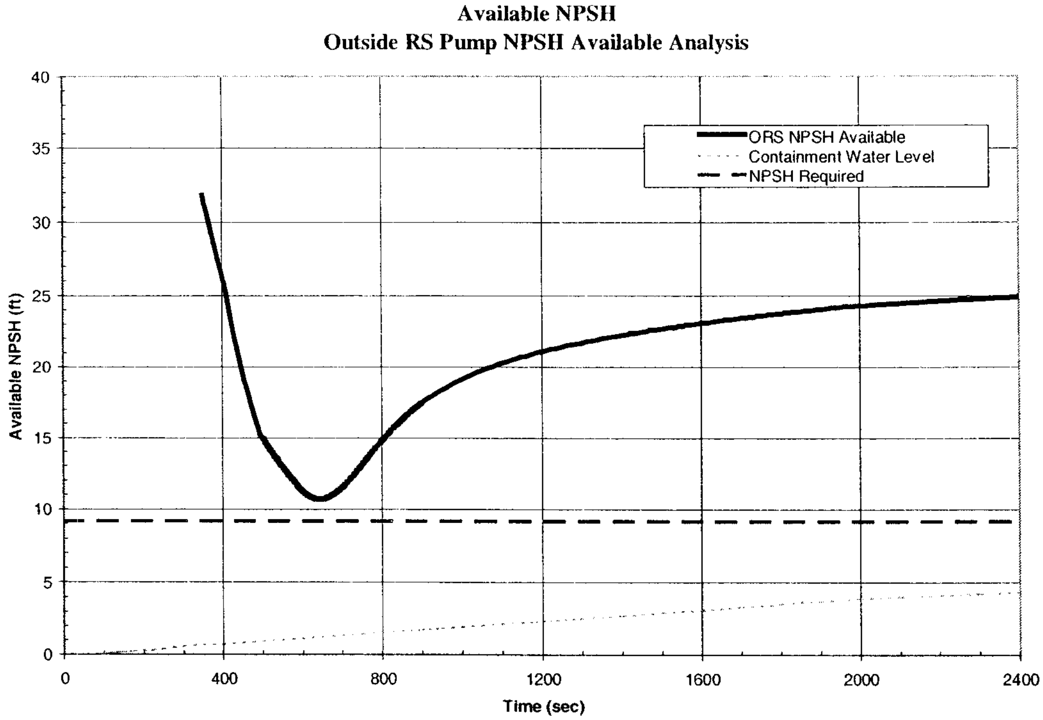


Figure 3.6-2: Containment Pressure from ORS Pump NPSHa Analysis – Current Configuration

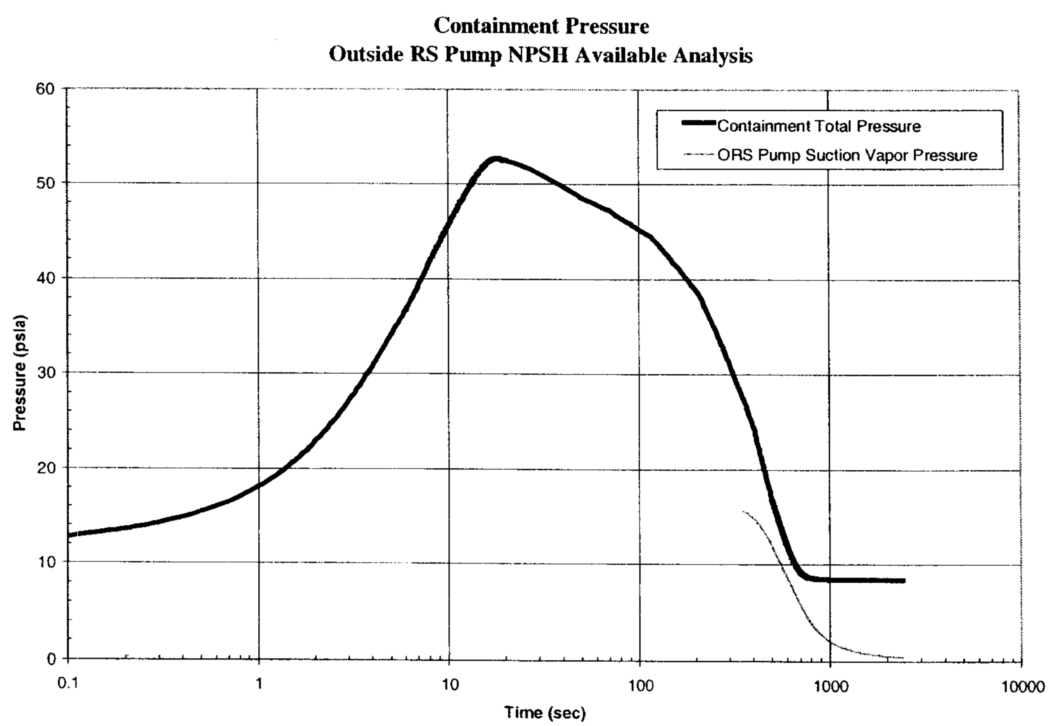


Figure 3.6-3: Containment Temperature from ORS Pump NPSHa Analysis – Current Configuration

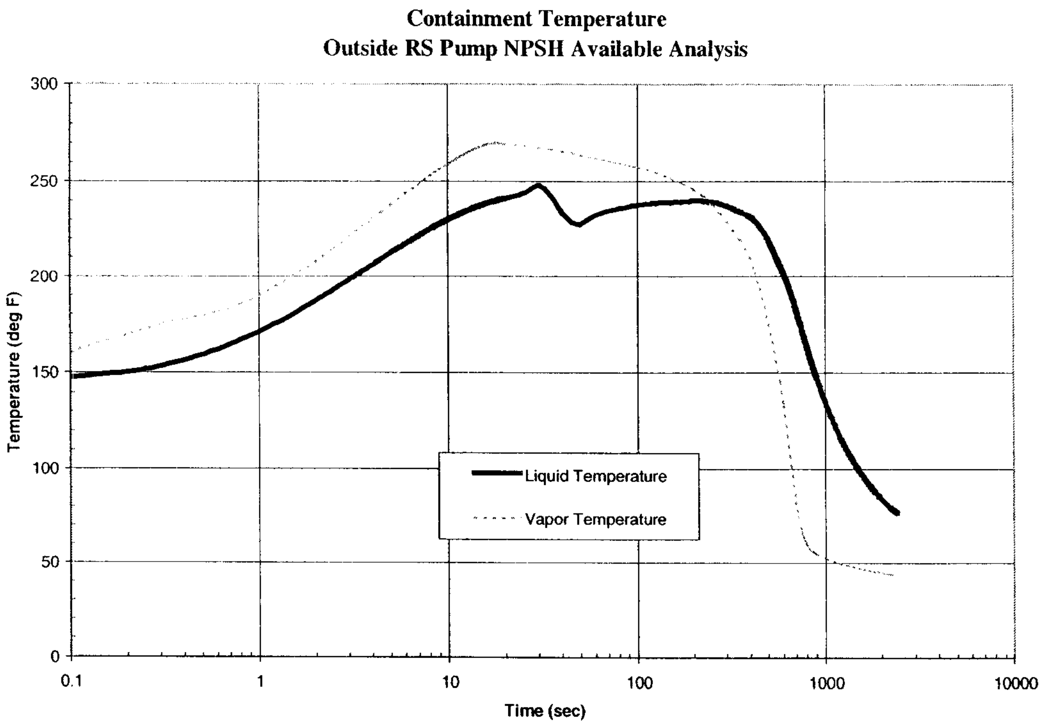


Figure 3.6-4: Total RSHX Heat Rate from ORS Pump NPSHa Analysis – Current Configuration

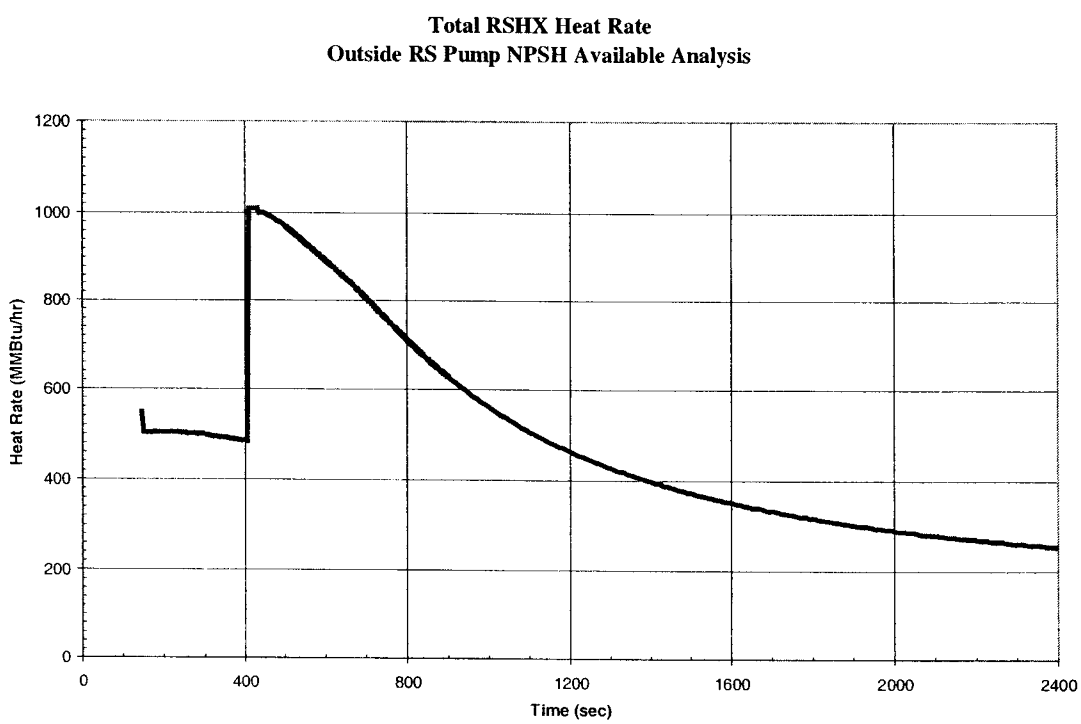


Figure 3.6-5: IRS Pump NPSHa - Current Configuration (9.0 psia, 25 F)

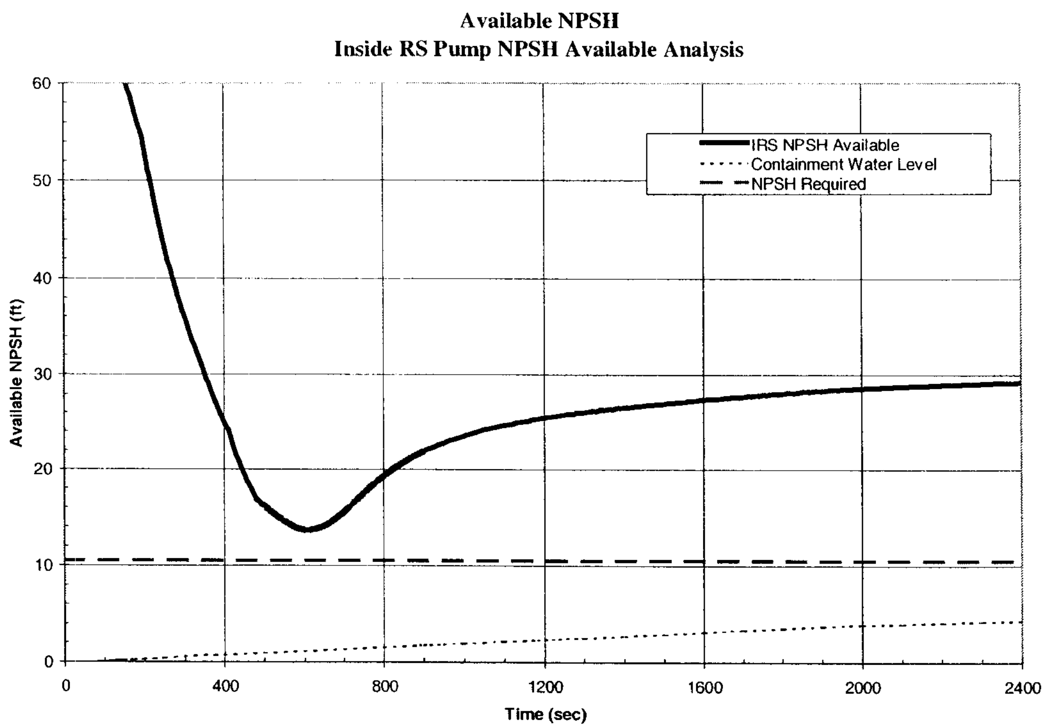


Figure 3.6-6: ORS Pump NPSHa - Proposed Configuration (10.3 psia, 25 F)

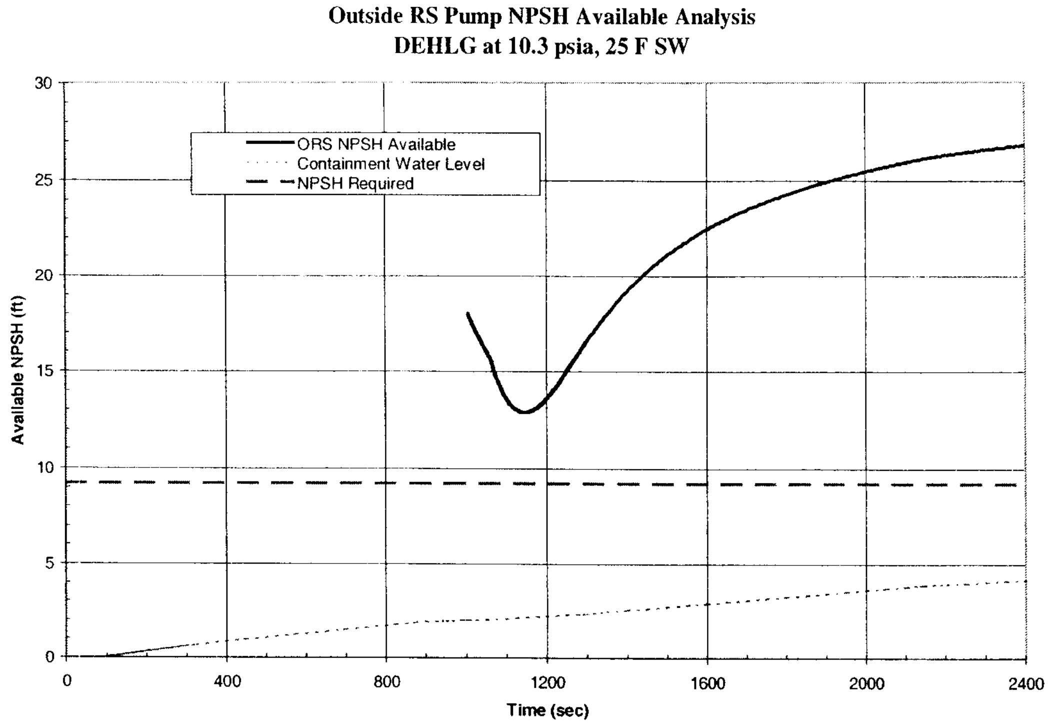


Figure 3.6-7: Containment Pressure from ORS Pump NPSHa Analysis – Proposed Configuration

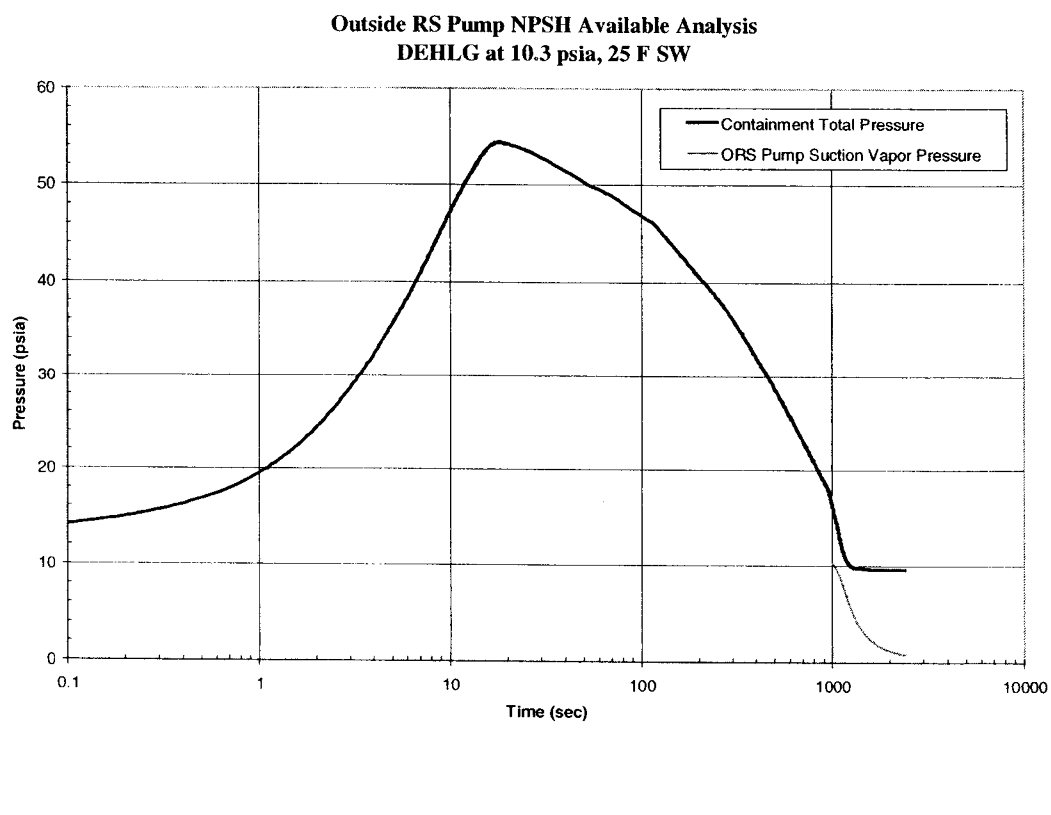


Figure 3.6-8: Containment Temperature from ORS Pump NPSHa Analysis – Proposed Configuration

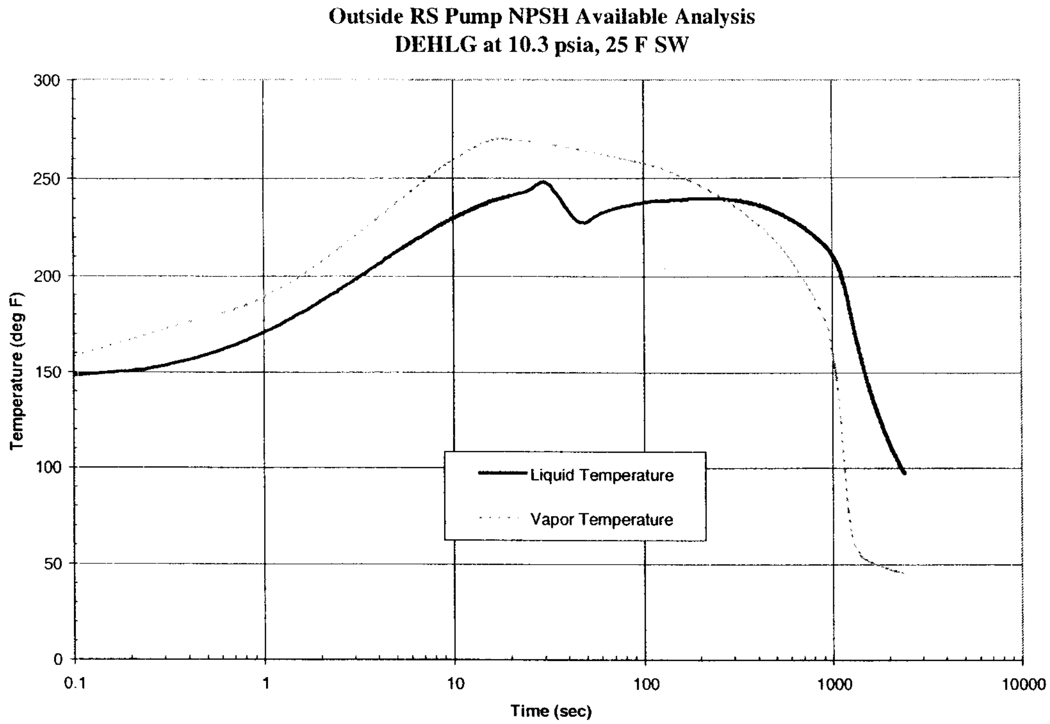


Figure 3.6-9: Total RSHX Heat Rate from ORS Pump NPSHa Analysis – Proposed Configuration

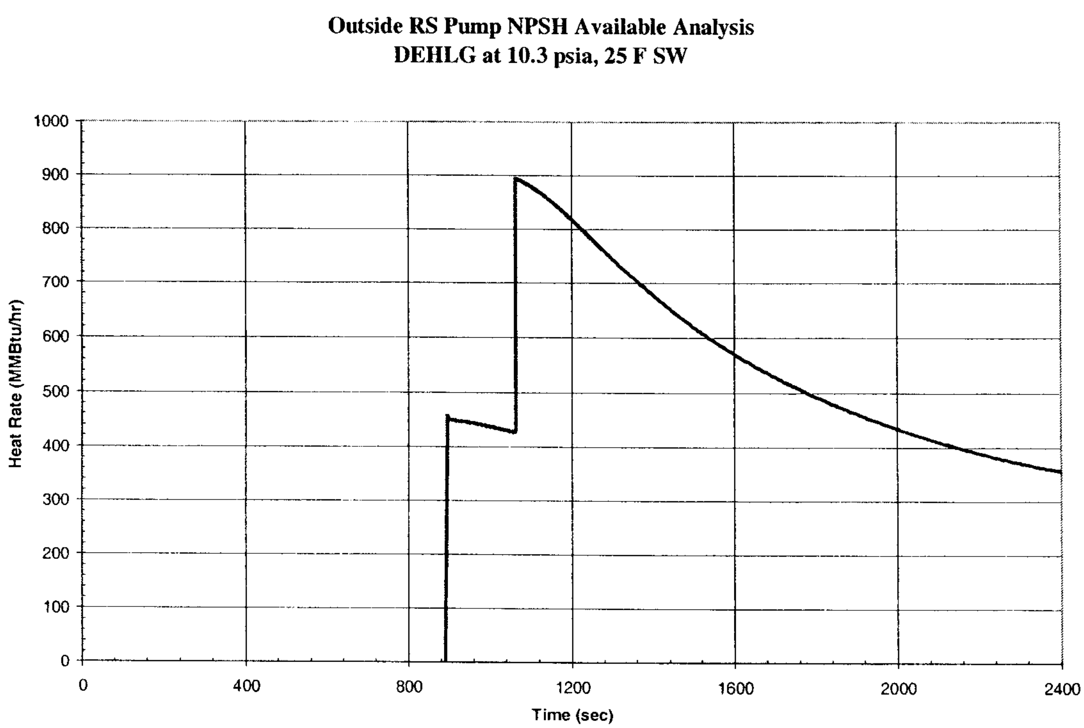


Figure 3.6-10: IRS Pump NPSHa - Proposed Configuration

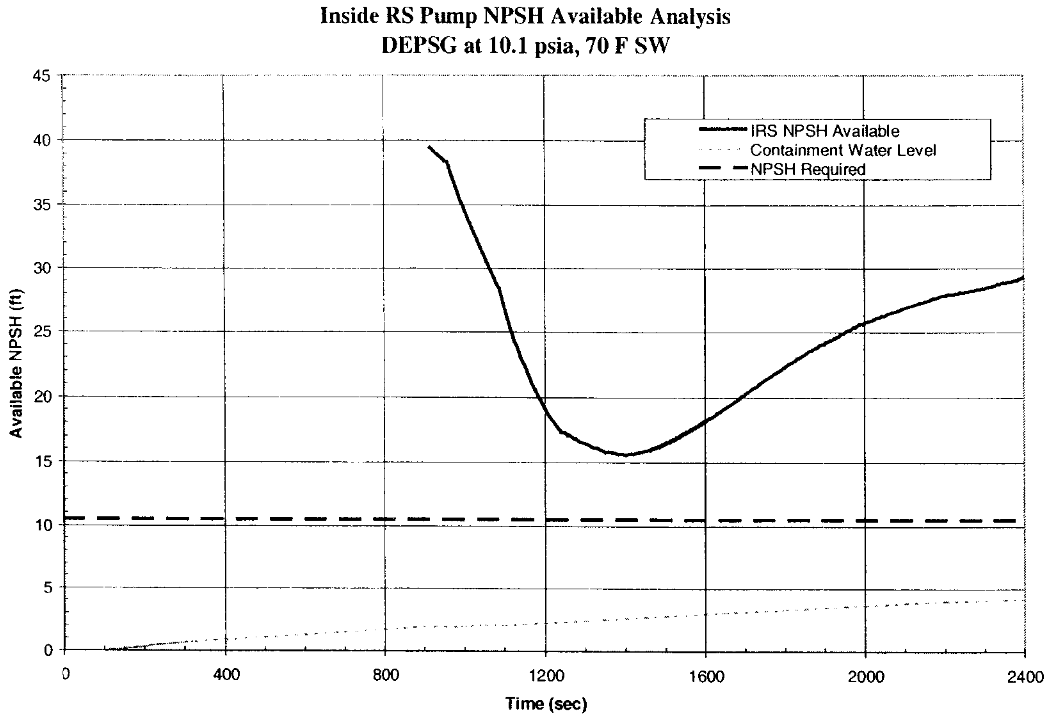


Figure 3.6-11: Containment Pressure from IRS Pump NPSHa Analysis – Proposed Configuration

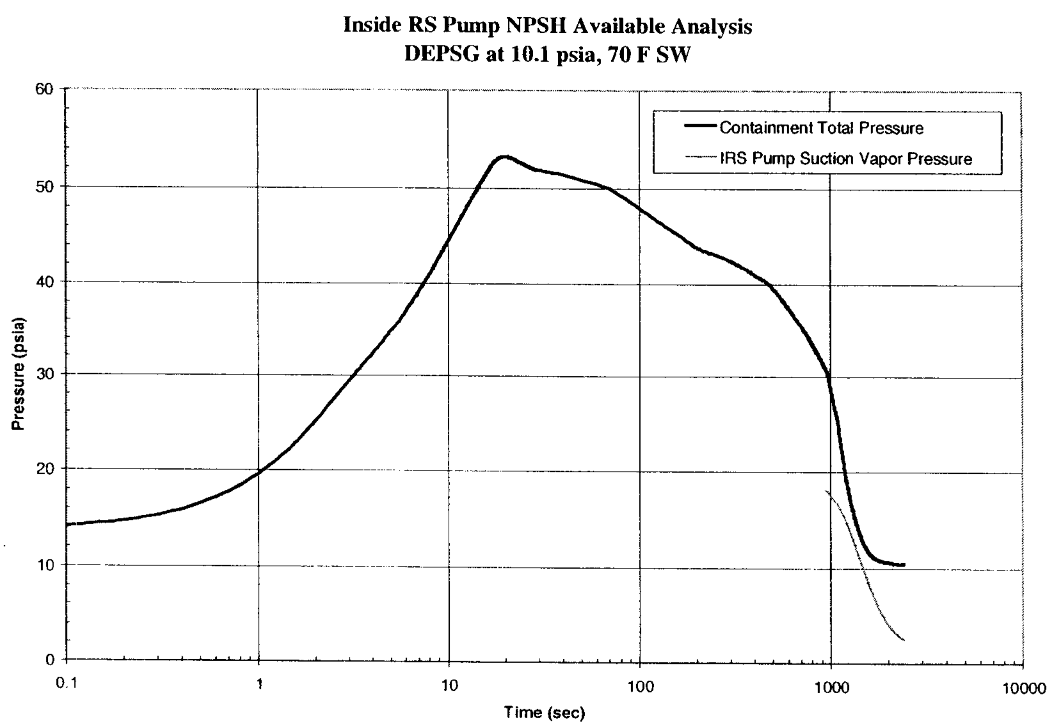


Figure 3.6-12: Containment Temperature from IRS Pump NPSHa Analysis – Proposed Configuration

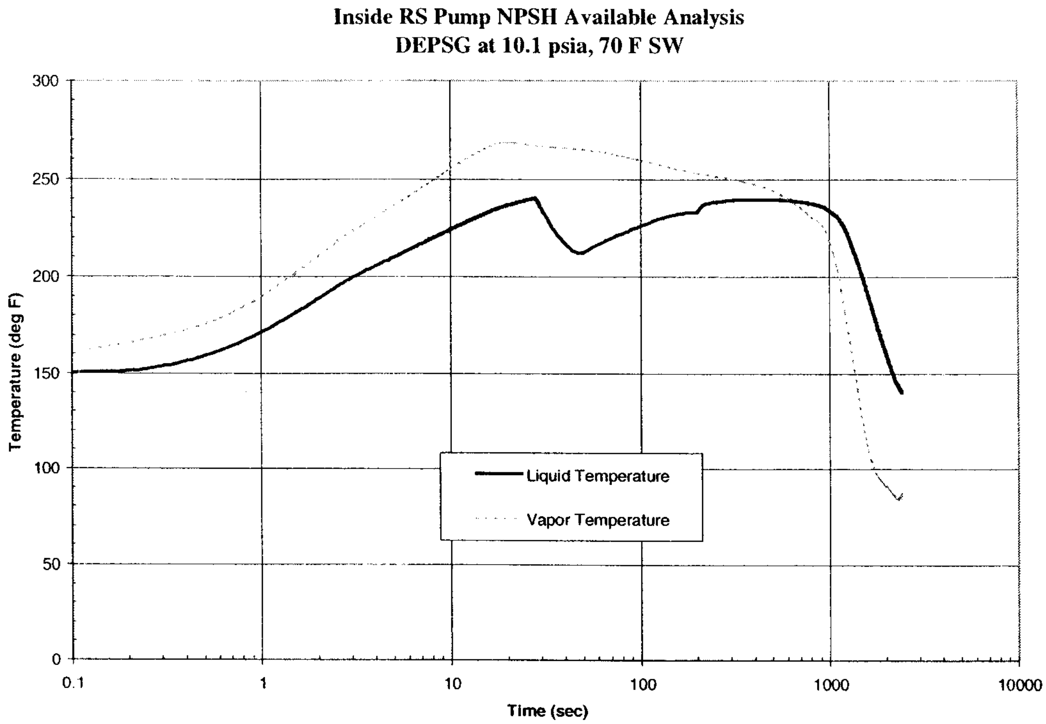
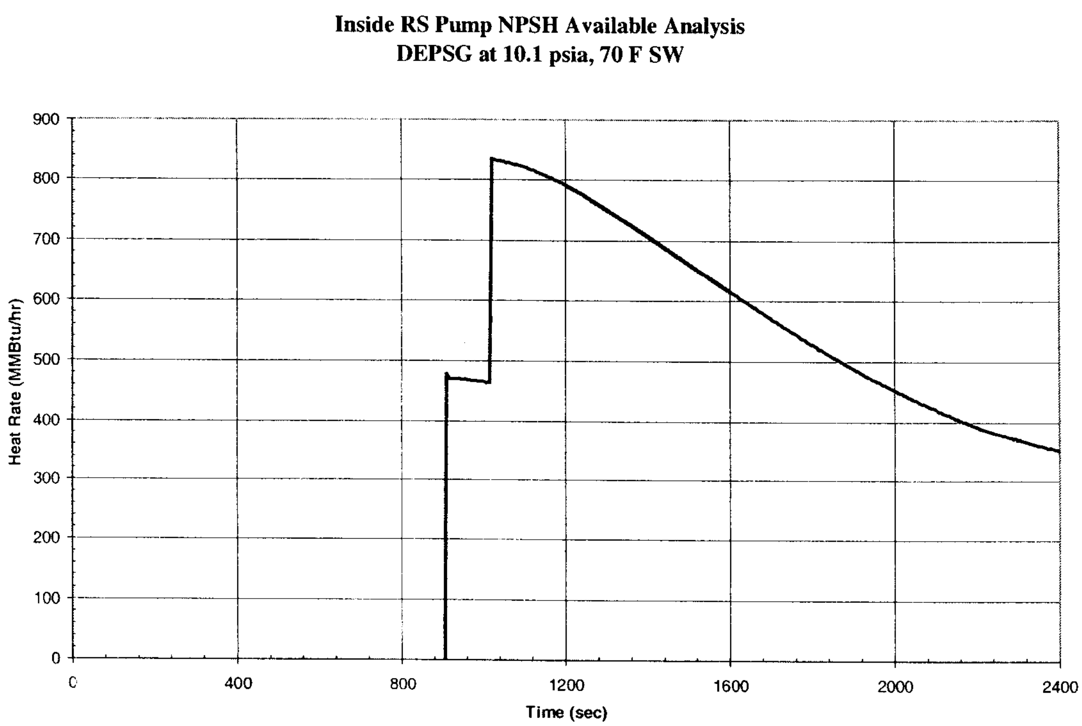


Figure 3.6-13: Total RSHX Heat Rate from IRS Pump NPSHa Analysis – Proposed Configuration



3.10 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 1.9 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).

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 the IRS pump NPSH available (Section 3.6)
- Single failure of 1 LHSI pump became the limiting single failure for ORS pump NPSH available (Section 3.6)
- Minimum SI flow rate is limiting for the DPP case (Section 3.4)
- Reduced 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	18.12 ft	15.73 ft
ORS Pump NPSH	9.19 ft at 3300 gpm	10.68 ft	12.88 ft
IRS Pump NPSH	10.5 ft at 3650 gpm	14.03 ft	15.54 ft

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

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.

27. Letter from Gerald T. Bischof (Dominion) to USNRC, "Supplement to Request for Approval of Topical Report DOM-NAF-3, GOTHIC Methodology for Analyzing the Response to Postulated Pipe Ruptures Inside Containment," Serial No. 06-544, July 14, 2006.

28. Letter from Leslie N. Hartz (Dominion) to USNRC, "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," Serial No. 06-014, January 31, 2006.

ATTACHMENT 2

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

RESPONSE TO JULY 13, 14 AND 17, 2006 REQUESTS FOR ADDITIONAL INFORMATION

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

July 13, 14 and 17, 2006 Requests for Additional Information on Virginia Electric and Power Company's Surry Power Station, Units 1 and 2, License Amendment Request on Proposed Technical Specification Change and Supporting Safety Analyses Revisions to Address Generic Safety Issue 191 Dated January 31, 2006 (TAC Nos. MC9724 and MC9725)

NRC Question 1 (July 13, 2006 e-mail)

NRC Office of Nuclear Reactor Regulation's Office Instruction No., LIC-101, "License Amendment Review Procedures," Revision 3, dated February 9, 2004, instructs the staff to include a regulatory evaluation section in the safety evaluation on license amendment requests (LARs) and the industry has agreed to provide this information in LARs. (See the Nuclear Energy Institute issued white paper entitled "Standard Format for Operating License Amendment Requests from Commercial Reactor Licensees," dated August 24, 2001 (Agencywide Documents Access and Management System Accession No.: ML013390222)). The licensee's LAR does not provide an applicable regulatory requirements/criteria section, which is a part of a regulatory evaluation, for the staff's review and consideration. Please provide a regulatory requirements/criteria section for review by the staff.

Dominion Response

The regulatory requirements and standards applicable to the requested change are the following:

- 10 CFR 50.49, Environmental Qualification Of Electrical Equipment Important To Safety For Nuclear Power Plants

- 10 CFR 50.67, Alternate Source Term

  Sections 3.0 and 4.0 (of Attachment 2 of the January 31, 2006 submittal) conclude that the proposed change will continue to comply with these regulatory requirements.

The GDC included in Appendix A to 10 CFR Part 50 did not become effective until May 21, 1971. The Construction Permits for Surry Units 1 and 2 were issued prior to May 21, 1971; consequently, these units were not subject to GDC requirements. (Reference SECY-92-223 dated September 18, 1992.) However, the plant was designed to meet the intent of the draft GDC.

- *Criterion 38--Containment heat removal.* "A system to remove heat from the reactor containment shall be provided. The system safety function shall be to reduce rapidly, consistent with the functioning of other associated systems, the containment pressure and temperature following any loss-of-coolant accident and maintain them at acceptably low levels."

  There are no changes to the Recirculation Spray System design that impact this general design criterion. Section 3.0 (of Attachment 2 of the January 31, 2006 submittal) concludes that the proposed change will continue to comply with this regulatory requirement.

- *Criterion 41--Containment atmosphere cleanup.* "Systems to control fission products, hydrogen, oxygen, and other substances which may be released into the reactor containment shall be provided as necessary to reduce, consistent with the functioning of other associated systems, the concentration and quality of fission products released to the environment following postulated accidents, and to control the concentration of hydrogen or oxygen and other substances in the containment atmosphere following postulated accidents to assure that containment integrity is maintained.

  Each system shall have suitable redundancy in components and features, and suitable interconnections, leak detection, isolation, and containment capabilities to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) its safety function can be accomplished, assuming a single failure."

  There are no changes to the Recirculation Spray System design that impact this general design criterion. Section 3.0 (of Attachment 2 of the January 31, 2006 submittal) concludes that the proposed change will continue to comply with this regulatory requirement.

- *Criterion 50--Containment design basis.* "The reactor containment structure, including access openings, penetrations, and the containment heat removal system shall be designed so that the containment structure and its internal compartments can accommodate, without exceeding the design leakage rate and with sufficient margin, the calculated pressure and temperature conditions resulting from any loss-of-coolant accident. This margin shall reflect consideration of (1) the effects of potential energy sources which have not been included in the determination of the peak conditions, such as energy in steam generators and as required by § 50.44 energy from metal-water and other chemical reactions that may result from degradation but not total failure of emergency core cooling functioning, (2) the limited experience and experimental data available for defining accident phenomena and containment responses, and (3) the conservatism of the calculational model and input parameters."

  There are no changes to the Recirculation Spray System or Containment design that impact this general design criterion. Section 3.0 (of Attachment 2 of the January 31, 2006 submittal) concludes that the proposed change will continue to comply with this regulatory requirement.

- *IEEE-279 Standard, Nuclear Power Plant Protection Systems,* August 1968.

  The changes to the Recirculation Spray System actuation circuitry design meet this design standard. Section 2.0 (of Attachment 2 of the January 31, 2006 submittal) concludes that the proposed change will continue to comply with design standard.

There are no changes to the Containment System and Recirculation Spray System design or operation or the containment analysis method such that compliance with any of the above regulatory requirements and standards would come into question. The analysis completed to support the changes ensures the containment will continue to meet the applicable regulatory requirements. The plant will continue to comply with all applicable regulatory requirements.

In conclusion, based on the considerations discussed above, (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

NRC Question 2 (July 13, 2006 e-mail)

Section 3.5, LHSI Pump NPSH Analysis, of the licensee's submittal states the following:

> The NPSH required at maximum LHSI pump flow was revised as part of the GSI-191 project. During [*sic*] a review of the original pump NPSH required test report, [sic] 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.

(a) Please explain what you mean by "the pump can."

(b) It is not clear to the staff how "the pump can and entrance losses were accounted for twice" during testing. Were these losses included in the measured of NPSH required? Please explain and provide pages of the pump report on correction of the error.

Dominion Response

The LHSI pump consists of a motor, pump column, and impeller housing. The motor is located at the top of a metal container shaped in the form of a cylinder. The pump column and impeller housing are contained inside the cylinder. This cylinder has approximate dimensions of 2 feet in diameter and 50 feet in length. This cylinder is mostly embedded in concrete. Suction piping to the LHSI pump enters the cylinder approximately 5 feet above the impeller centerline. The LHSI pump discharges at the top of the cylinder. The metal cylinder, which contains the LHSI pump column and impeller housing, is called the LHSI "pump can".

Section 3.5 of the submittal states "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." This sentence was not intended to imply that the losses were accounted for twice "during testing." The original test instrumentation used in the NPSH required tests was positioned to take data at a location where the pump can and entrance losses would be included in the measured test data. However, a true NPSH required is defined at the pump impeller centerline. Thus, the pump can and entrance losses should be removed from the original test results to develop an NPSH required value that is compared to the NPSH available from the containment analysis. This adjustment is reflected in the LHSI pump NPSH required value of 13.82 ft at the pump impeller centerline for a pump flow rate of 3330 gpm. In the design analysis, the pump can and entrance losses have been incorporated into models for system piping flow head losses. In previous containment analyses, the pump can and entrance losses were included in both the system flow design analysis and the NPSH required value because of the NPSH required test instrument arrangement. Thus, these losses had been accounted for twice in the overall results. No changes were made to the NPSH required test report. Correction of the improper accounting of the pump can and entrance losses was documented in an internal engineering analysis, which identifies the adjustment to the NPSH required.

NRC Question 4 (July 13, 2006 e-mail)

Section 3.1.2, Engineered Safeguards Features, of the licensee's submittal states the following:

> 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.
>
> As stated in an email from Mr. Paul R. Willoughby of Dominion to Mr. Steven Raul Monarque of NRC, dated June 21, 2006, and subsequently discussed on the same day during a teleconference between the licensee and NRC, the drop diameter is to be reduced by a factor of 2 instead. How does this change affect the above conclusion on the effect of containment height on NPSH analysis?

Dominion Response

There is no change to the conclusion. The GOTHIC NPSH analyses are not sensitive to a reduction in containment height with the NPSH model assumptions in DOM-NAF-3, Section 3.8.2 (e.g., minimum pool area for the containment volume L/V interface area) that minimize the containment pressure. Changing the containment height merely complicates the GOTHIC water level by widening the pool area and requires additional adjustments to be made to correct for the proper pool area. For simplicity, the containment height is not reduced for NPSH analyses. Attachment 1 to this letter includes replacement text for Section 3.1.2 that is consistent with the proposed change for selecting spray droplet size in DOM-NAF-3.

NRC Question 5 (July 13, 2006 e-mail)

Section 3.1.4, Plant Parameter Design Inputs, of the licensee's submittal states that "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." Please provide the reference and the old and new minimum surface area for metal heat sinks in containment.

Dominion Response

The below table compares the metal heat sink minimum surface area from the GOTHIC analysis to the existing LOCTIC containment analysis values (Surry UFSAR, Revision 37, Table 5.4-17). During the Surry GOTHIC analysis effort, it was discovered that the LOCTIC analyses had omitted a significant amount of containment metal for conservatism. While the current UFSAR heat sink inputs provide acceptable LOCA containment response results with LOCTIC and GOTHIC, the GOTHIC MSLB analyses produced containment pressures above the design limit. Section 3.7 of Attachment 1 in our letter dated January 31, 2006, explains the current MSLB analysis basis and how Surry-specific MSLB analysis had not been performed with LOCTIC. MSLB analyses with LOCTIC would have identified the need to include the additional metal mass for steam condensation and heat removal to obtain acceptable containment pressures. A new metal heat sink inventory was documented based on the current plant configuration and nominal metal heat sink surface areas were calculated in groups by conductor thickness. The nominal surface areas were reduced by 5% for conservatism to generate minimum surface areas for input to the GOTHIC containment analyses. The table below compares the GOTHIC and LOCTIC inputs by metal type and thickness. All carbon steel and galvanized metal heat sinks include a 0.006-inch paint layer.

In a teleconference on July 19, 2006, the NRC and Dominion agreed that the internal calculation does not need to be submitted, as long as the data and justification for change are provided. The requested information is provided in the following table.

Conductor Description	GOTHIC Analysis		Current LOCTIC Analysis	
	Surface Area, ft^2	Thickness, in	Surface Area, ft^2	Thickness, in
Stainless Steel Group 1	7,180	0.25	16,968	0.306
Stainless Steel Group 2	11,290	0.42	N/A	N/A
Stainless Steel Group 3	488	1.53	N/A	N/A
Galvanized Metal	86,459	0.066	26,769 (cable tray, conduit) 26,573 (grating) 27,167 (ducts)	0.066 0.094 0.018
Carbon Steel Group 1	7,192	0.236	35,520 8,690	0.250 0.152
Carbon Steel Group 2	66,345	0.439	4019	0.529
Carbon Steel Group 3	7,454	0.906	3803	0.984
Carbon Steel Group 4	2,414	1.70	8928	1.535
Carbon Steel Group 5	7,000	2.90	193	2.532
Total Surface Area	194,822		158,630	

NRC Question 6 (July 13, 2006 e-mail)

Section 3.1.4 of the licensee's submittal states that "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." However, Table 3.1-1 lists containment spray flow rate as a variable and a footnote to the table states that it varies with containment pressure and refueling water storage tank water level. Please provide the containment spray flow rate used in the analysis.

Dominion Response

The table below provides the minimum containment spray (CS) pump flow rate in gallons per minute (gpm) versus C-L, where C is containment pressure (psig) and L is the RWST level above the CS pump centerline elevation. The minimum flow rate curve bounds each of the four CS trains at Surry Units 1 and 2. The minimum flow rate of 2006 gpm at 26.9 psid corresponds to the most adverse CS pump start conditions with the containment at the design pressure and the RWST level at the Technical Specification minimum. Once CS is actively spraying the containment, the containment pressure and RWST level decrease. Because each accident analysis can produce a different containment pressure profile and RWST drawdown rate, the CS pump flow rate versus time varies with each analysis.

C-L, psid	Minimum CS Pump Flow, gpm
-49.0	2708
-4.0	2708
14.0	2281
26.9	2006

NRC Question 7 (July 13, 2006 e-mail)

Table 3.1-1 of the licensee's submittal lists the accumulator nitrogen volume as between 369 to 431 ft^3, which includes uncertainty. What is the value of uncertainty used? Correspondingly, the accumulator water volume used for the calculation as listed in the table does not include uncertainty. What is the uncertainty of water volume and why is it not included?

Dominion Response

The accumulator nitrogen volumes in the GOTHIC analysis are based on an uncertainty of 6 ft^3 in accumulator water volume, which is conservative with respect to the channel statistical accuracy that is equivalent to 4.8 ft^3. Since only nitrogen is modeled in the GOTHIC containment response analysis (the water volume is included in the NSSS vendor's mass release data before the end of reflood), Table 3.1-1 indicates that uncertainty was applied to develop the nitrogen volume input for GOTHIC.

The water volume range of 975-1025 ft^3 in Table 3.1-1 is consistent with Technical Specification 3.3.A.2.a. The T.S. water volume range, the 6 ft^3 uncertainty in water volume, and the total accumulator volume of 1450 ft^3 were used to develop nitrogen volumes for input to GOTHIC. For containment depressurization analyses, the maximum nitrogen addition (minimum initial water) is 481 ft^3 (1450 ft^3 – 975 ft^3 + 6 ft^3 uncertainty). For NPSH analyses, the minimum nitrogen addition (minimum initial water) is 419 ft^3 (1450 ft^3 – 1025 ft^3 – 6 ft^3 uncertainty).

During the review of this question, the nitrogen volume entries in Table 3.1-1 were found to be inconsistent with the design inputs cited above. The GOTHIC analyses used the correct values, but Table 3.1-1 included values that were 50 ft^3 lower than the analysis design inputs. Table 3.1-1 in Attachment 1 of this letter has been revised to reflect the analysis range of 419-481 ft^3.

NRC Question 8 (July 13, 2006 e-mail)

Section 3.2.1, LOCA Mass and Energy Releases, of the licensee's submittal states that "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." Please describe this change.

Dominion Response

In October 2005, Westinghouse issued a letter to Surry identifying potential issues in the LOCA mass and energy release analysis documented in WCAP-14083. Two issues with main feedwater (MFW) were not considered and may have not been adequately modeled in the Surry LOCA mass and energy release analysis: 1) the continued addition of MFW after a reactor trip; and 2) the addition of purged MFW following auxiliary feedwater (AFW) initiation resulting in the displacement of the resident liquid from piping into the steam generators (SGs). The additional MFW increases the SG secondary side energy at the end of reflood, which is an initial condition for the GOTHIC long-term mass and energy release model. At the time Dominion was notified by Westinghouse, the potential issues required additional evaluation to determine if sufficient margins were included in the LOCA mass and energy release analysis to offset any additional energy from MFW. Pending completion of a more detailed evaluation it was decided to add conservatism to the GOTHIC analyses in order to address the concern and still support completion of the analyses for submittal to the NRC on the committed schedule. Conservatism was added to the pump suction break models by increasing the SG secondary side liquid mass (by increasing the liquid fraction) and total energy (by increasing pressure and temperature) to account conservatively for the MFW addition after reactor trip and from AFW purge. Because the SG secondary side energy is idle in the hot leg break analyses, no change was made to those models.

In March 2006 (after the Surry GOTHIC analyses had been submitted), a final evaluation of the issue concluded that the Surry LOCA mass and energy release analysis did model MFW after reactor trip correctly and that the MFW purge volume was offset by other conservatisms in the analysis. Thus, the additional SG secondary side energy that was included in the Surry GOTHIC analyses was an unnecessary conservatism.

NRC Question 9 (July 13, 2006 e-mail)

Section 3.2.1 of the licensee's submittal states that "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." Please explain how the RCS model is setup to release the stored energy when the vessel is fully depressurized and the acceptance criteria for containment depressurization and NPSHa are challenged and why this is conservative.

Dominion Response

Section 3.5.3.3 in topical report DOM-NAF-3 describes the construct of the GOTHIC simplified RCS model. The RCS model communicates with the containment so that the stored energy is removed from the RCS and SG secondary with decreasing containment pressure. Thus, when the vessel pressure drops to 14.7 psia, the stored energy in the RCS and SG secondary above 212°F (but not for the event of a hot leg break) has been released to the containment. The transient energy release for a pump suction break is illustrated in Figures 4.5-6 through 4.5-9 in DOM-NAF-3. In Figure 4.5-7, the SG secondary side temperature is 432°F at the end of reflood. The GOTHIC RCS model is activated and the SG secondary side liquid temperatures drop quickly as the primary side pressure decreases and energy is transferred across the SG tubes. The broken loop SG has a higher energy release rate early because of a higher steam flow compared to the intact SGs. At 3230 seconds (the time of LHSI pump recirculation mode transfer and minimum NPSHa), the vessel liquid (cell 1) and primary metal are at ~214°F (Figure 4.5-8), which is the saturation temperature at the vessel (cell 1) pressure of 15.2 psia. At this same time, the SG secondary liquid temperature is ~200°F. Thus, the primary and SG secondary available energy has been released to the containment at the time of minimum NPSHa for the LHSI pumps.

The GOTHIC mass and energy release model ensures that available stored energy is removed as containment pressure decreases. When the vessel is fully depressurized with the containment depressurization, the RCS and SG secondary stored energy above the saturation temperature has been released to the containment. This method is conservative for NPSH analyses because a higher energy release to the containment produces a higher sump temperature and a lower NPSHa. This method is conservative for containment depressurization analyses because a higher energy release produces a longer depressurization time. This relationship was shown in Section 4.4.2 of topical report DOM-NAF-3 with a sensitivity study that slowed the energy release from the intact loop SGs. The containment depressurization time decreased by 200 seconds when the integral energy release to containment was reduced by 40 MBtus.

NRC Question 10 (July 13, 2006 e-mail)

Section 3.6 RS Pump NPSH Analysis, of the licensee's submittal states the following:

> 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).
>
> It is not clear to the staff how the ORS pump is more limiting than the IRS pump because reason 1 supports this argument but reasons 2 and 3 counter it. Please explain.

Dominion Response

The referenced description could have been clearer and should have stated that the ORS pump is more limiting when considering all three effects together. Items 2 and 3 provide more margin for the ORS pump, but this amount is more than offset by the smaller suction friction loss for the IRS pump. The objective was to show that the IRS pump is less limiting when considering all of the head loss factors that affect each pump.

NRC Question 1 (July 14, 2006 e-mail)

Section 2.3, Change Containment Air Partial Pressure Operating Limits in TS Figure 3.8-1, of the licensee's submittal states that "The GOTHIC containment analyses for 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." However, the same section also states that "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." This appears to contradict the first statement because GOTHIC analysis does not support a subatmospheric peak pressure. Please explain this apparent discrepancy.

Reference 1 (Reference 24 of the submittal), dated July 31, 2001, states that you had proposed to change the acceptance criteria for design basis LOCA containment integrity analyses from "containment must be depressurized to less than atmospheric within 1 hour" to "containment must be depressurized to 0.5 psig within 1 hour and to subatmospheric pressure within 4 hours" even before performing GOTHIC analyses supporting the present license amendment request. Please explain why the proposed change from 'subatmospheric peak pressure' to 'LOCA depressurization criteria' was not made at that time.

Reference 1 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.

Dominion Response

The proposed change in terminology from 'subatmospheric peak pressure' to 'LOCA depressurization criteria' was not made in the July 31, 2001, submittal because the containment analyses continued to limit the containment pressure to less than 0.0 psig after one hour. As we stated on page 17 of the letter dated July 31, 2001, regarding the increase in containment leakage after the first hour, "The proposed changes are intended to provide potential future flexibility by utilizing a portion of the margin that was made available by application of the AST analysis methodology." There was no intent at the time to make changes that would produce a post-LOCA containment pressure that would take advantage of the 0.5 psig allowance from the period from 1 to 4 hours after the LOCA. Therefore, the Basis for Technical Specification 3.8 maintained the subatmospheric peak pressure requirement for the containment analyses.

The transition to the GOTHIC methodology by itself does not produce containment pressures above 0.0 psig beyond 1 hour (see the current configuration analyses in Section 3.4 of our submittal). Delaying the RS pump start and increasing the containment air partial pressure limits together produce containment pressure peaks between 0.0 and 0.5 psig during the period from 1 to 4 hours after the LOCA. The GOTHIC containment pressure profiles are bounded by the current LOCA Alternate Source Term analysis, which assumes containment leakage corresponding to a containment pressure of 0.5 psig during the period from 1 to 4 hours following a LOCA. Now that the containment design basis calculations show a positive containment pressure after 1 hour, the use of the term 'subatmospheric peak pressure' is not accurate for all accident analysis cases. As a result, we propose to change the description in the Technical Specification 3.8 Basis.

NRC Question 2 (July 14, 2006 4-mail)

The following questions are regarding the proposed changes to Technical Specifications Figure 3.8-1 (a plot of air partial pressure versus service water temperature):

2.1 The current figure has a note "acceptable operation below this line" with an arrow pointing to a line. This apparently indicates that there is no lower bound of pressure. However, the new figure has lower bounds to the pressure and the corresponding note states that "acceptable operation inside the lines." Please explain the need and the significance of a lower bound pressure.

2.2 Please explain or provide a reference on what accident analysis determines each line on the proposed figure.

Dominion Response 2.1

Technical Specifications (TS) Figure 3.8-1 shows a minimum containment air partial pressure of 9.0 psia. In addition, the TS 3.8 Basis stipulates an LCO action if containment pressure decreases below 9.0 psia. The TS was approved with License Amendment 203 for the Surry core power uprate in 1995 [Reference 18 in our submittal dated January 31, 2006]. Section 3.3.1 of the NRC Safety Evaluation Report in that letter states, "The Surry containment is maintained at a subatmospheric air partial pressure between 9.0 and 10.3 psia consistent with TS Figure 3.8-1 depending upon the cooldown capability of the Engineered Safeguards equipment."

The minimum TS limit for containment air partial pressure is used as an initial condition (with allowance for instrument uncertainty) for calculation of NPSH available for the RS and LHSI pumps, MSLB peak temperature, containment pressure from an inadvertent containment spray (CS) system actuation, and containment pressure for LOCA peak clad temperature calculations. NPSH available calculations use the minimum air pressure to minimize the containment overpressure credit (DOM-NAF-3, Sections 3.6 and 3.8). The MSLB peak temperature analysis is most limiting at minimum pressure with low relative humidity, which creates the maximum superheat temperature in the containment atmosphere. An inadvertent CS actuation depressurizes the containment, so the minimum air partial pressure is an initial condition for verification of the design limits for the containment liner and base mat. To be consistent with the plant safety analyses, operation is not allowed below the minimum pressure limit in the TS.

Dominion Response to 2.2

Section 3.10 in our submittal dated January 31, 2006, describes the accident analysis that sets each limit in the proposed TS Figure 3.8-1.

NRC Question (received by phone on July 17, 2007)

In Section 3.9, how did you confirm the new accident profile was enveloped by the test conducted on the existing environmentally qualified equipment?

Dominion Response

Composite pressure and temperature profiles were developed that bounded the LOCA and MSLB pressure and temperature profiles from GOTHIC. The composite profiles were compared to the test reports for all environmentally qualified equipment inside containment, and it was concluded that the environmentally qualified equipment inside containment are qualified for the GOTHIC accident analysis profiles for pressure and temperature.

Additional NRC Question from July 13, 2006 e-mail

Generic Letter No. 83-11, "Licensee Qualification for Performing Safety Analyses in Support of Licensing Actions," outlines NRR practice regarding licensee qualification for performing safety analyses in support of licensing actions. In this regard please provide the following information:

(a) Confirm that GOTHIC users are qualified to use the code by training, procedures, and guidelines;
(b) Confirm that GOTHIC is maintained under a qualified quality assurance program; and
(c) Confirm that you have a program to review and dispose the GOTHIC error reports, which are issued from time to time by Electric Power Research Institute, the developer of GOTHIC.

(Per discussion with the NRC staff this question was answered in the GOTHIC Topical (DOM-NAF-3) submittal and does not require a response.)