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July 14, 2006

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

Serial No. 06-544
NL&OS/PRW R0
Docket Nos. 50-305
50-336/423
50-338/339
50-280/281
License Nos. DPR-43
DPR-65/NPF-49
NPF-4/7
DPR-32/37

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
SUPPLEMENT TO REQUEST FOR APPROVAL OF
TOPICAL REPORT DOM-NAF-3, GOTHIC METHODOLOGY
FOR ANALYZING THE RESPONSE TO
POSTULATED PIPE RUPTURES INSIDE CONTAINMENT

In a letter dated November 1, 2005 (Serial Number 05-745), Dominion Energy Kewaunee, Inc. (DEK), Dominion Nuclear Connecticut, Inc. (DNC) and Virginia Electric and Power Company (Dominion) requested approval for generic application of Topical Report DOM-NAF-3, "GOTHIC Methodology for Analyzing the Response to Postulated Pipe Ruptures Inside Containment," for Kewaunee Power Station (KPS), Millstone Power Station (MPS), North Anna Power Station (NAPS) and Surry Power Station (SPS), respectively. GOTHIC is a general-purpose, thermal-hydraulics computer code developed by the Electric Power Research Institute for applications in the nuclear power industry. The NRC has approved GOTHIC for use in containment analyses for several U.S. nuclear power plant licensees. In Topical Report DOM-NAF-3, DEK, DNC and Dominion have developed an analytical methodology using GOTHIC for performing licensing basis analyses for the containment response for pressurized water reactors with large, dry containments. Plant specific applications of topical report DOM-NAF-3 will be implemented by DEK, DNC and Dominion according to the requirements of 10 CFR 50.59 for changes to USAR/FSAR/UFSAR evaluation methodologies.

While developing a plant-specific amendment request for the North Anna Power Station using the DOM-NAF-3 GOTHIC methodology, Dominion engineering personnel discovered that some GOTHIC applications produced less conservative results. After further evaluation, it was determined that a similar situation existed with the license amendment request for Surry Power Station provided to the NRC in a letter dated

A001

January 31, 2006 (Serial Number 06-014). In a conference call of June 21, 2006, Dominion notified the NRC of the issues with the GOTHIC analysis methodology in the November 1, 2005 submittal and agreed to provide replacement pages for the affected sections with a description of the basis for change. In addition, Dominion agreed to provide copies of GOTHIC nodalization diagrams for DOM-NAF-3. Dominion considers the GOTHIC nodalization diagrams proprietary information in accordance with the provisions of 10 CFR 2.390(a)(4). Accordingly, Attachment 1 of this submittal contains a description of the changes to the November 1, 2005 submittal. Attachment 2 contains the replacement pages to DOM-NAF-3. Attachment 3 is the application for withholding and affidavit requesting withholding of proprietary information for the GOTHIC nodalization diagrams. The proprietary version of the GOTHIC nodalization diagrams are provided in Attachment 4 and the non-proprietary, redacted version of the GOTHIC nodalization diagrams are provided in Attachment 5.

Dominion continues to request approval of topical report DOM-NAF-3 by September 1, 2006 to support the implementation of license amendments during the Surry Unit 2 fall refueling outage. 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
Dominion Energy Kewaunee, Inc.
Dominion Nuclear Connecticut, Inc.
Virginia Electric and Power Company

Attachments: (5)

1. Description of changes to the November 1, 2005 submittal
2. Replacement pages for the November 1, 2005 submittal
3. Application for Withholding and Affidavit of Gerald T. Bischof
4. GOTHIC Nodalization Diagrams (Proprietary version)
5. GOTHIC Nodalization Diagrams (Non-proprietary, redacted version)

Commitments made in this letter: None

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ATTACHMENT 1

SUPPLEMENT TO REQUEST FOR APPROVAL OF TOPICAL REPORT DOM-NAF-3, GOTHIC METHODOLOGY FOR ANALYZING THE RESPONSE TO POSTULATED PIPE RUPTURES INSIDE CONTAINMENT

DESCRIPTION OF CHANGES TO THE NOVEMBER 1, 2005 SUBMITTAL

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

Dominion submitted topical report DOM-NAF-3, "GOTHIC Methodology for Analyzing the Response to Postulated Pipe Ruptures Inside Containment" to the NRC for review in Reference 1. The report describes the analytical methodology to be used for licensing basis containment response analyses. Recently, Dominion identified an issue with the method for selecting spray drop size for NPSH calculations that requires a change to DOM-NAF-3.

Description of the Issue

Section 3.8.2 in DOM-NAF-3 describes the Dominion GOTHIC analysis methodology for calculating available net positive suction head (NPSHa). This methodology was developed for the Surry and North Anna low head safety injection (LHSI) and recirculation spray (RS) pumps, but is an acceptable method for other pressurized water reactors with large, dry containments. Adjustments are made to the GOTHIC containment models to ensure a conservative calculation of NPSHa. DOM-NAF-3, Section 3.8.2 includes the following statement:

> 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. These assumptions ensure that the maximum heat is absorbed by the drops and the effect of sprays on reducing the containment pressure is maximized. Smaller drop size will increase the drop holdup in the atmosphere, which will further reduce the containment pressure.

This model assumption was confirmed to provide a conservative NPSHa for the Surry LHSI pumps for a double-ended pump suction guillotine (DEPSG) break during the development of the topical report methodology. However, the assumption was not validated for all break locations and single failure scenarios for Surry. The topical report was submitted to the NRC on November 1, 2005 [Ref. 1], and the methodology was used for Surry analyses that were submitted on January 31, 2006 [Ref. 2]. While preparing design analyses for North Anna using the DOM-NAF-3 methodology in June 2006, it was discovered that reducing the Sauter droplet size by a factor of 10 was conservative for LHSI pump NPSH analyses using the DEPSG break model but produced less conservative NPSHa results for the RS pumps for double-ended hot leg guillotine (DEHLG) breaks. A subsequent review of the Reference 2 Surry design analyses concluded that the factor of 10 reduction in droplet size can produce less conservative results than the Sauter mean diameter for some, but not all, of the Surry NPSH analyses with GOTHIC.

Subsequently, Dominion performed a detailed investigation of this issue with Numerical Applications, Inc. (NAI), the GOTHIC code vendor. NAI had provided support during the Surry GOTHIC containment model development and had recommended the droplet diameter reduction for NPSH calculations. Reducing the drop size by a factor of 10 gives very small drops, well beyond any uncertainty in the code or spray performance. These small drops lead to drop

concentrations in the atmosphere that are much higher than expected and provide increases in NPSHa, from higher containment pressure, for certain breaks and spray assumptions. For Surry DEHLG breaks, a 10x reduction in spray drop size below the Sauter mean would increase NPSHa. Compared to the pump suction break, the hot leg break has less steam release to the atmosphere with more heat going directly to the pool since all injection flow is forced to pass through the core. The higher steam flow to the atmosphere in the pump suction break results in a slower cooldown rate. A higher fraction of the spray cooling power is needed to absorb the condensation heat, leaving a smaller fraction for sensible heat reduction. It is the sensible heat reduction that is primarily responsible for the containment pressure reduction. The higher cooldown rate for the hot leg break cases make them more sensitive to the effects of increased drop concentration. In the cooldown situation, a high drop concentration from the small drops increases the containment temperature and pressure. The higher containment temperature deposits hotter drops in the pool, which reduces the NPSHa, while the higher containment pressure increases the NPSHa. In the Surry hot leg break analyses, the resulting increase in containment pressure is a more dominant effect than the increase in pool temperature, resulting in a net increase in NPSHa compared to using the Sauter droplet size. This sensitivity was not clear during the methodology development.

Based on our evaluation, a revised methodology for selecting spray droplet size in NPSH calculations is required for DOM-NAF-3. Dominion advised the NRC of this development in a teleconference on June 21, 2006. Dominion stated that it would submit a revised method for selecting spray drop size for NPSH calculations. In addition, Dominion stated that the equation for calculating NPSH would be modified to use the fluid density at the pump suction in order to recover some of the NPSH margin lost to the spray drop issue.

Change to DOM-NAF-3

With a better understanding of the impact of drop concentration on NPSH, for NPSH analysis the variation in drop size below the Sauter diameter will be limited to a factor of 2 to cover code and spray performance uncertainty. NPSH analyses will be performed using the largest Sauter droplet size. A confirmatory analysis will be performed by reducing the Sauter diameter by 2, which sufficiently covers code and spray performance uncertainty without creating drops too small that may cause excess droplet holdup in the atmosphere. The minimum NPSHa will be obtained from the case that provides the smaller NPSHa. The drop hold-up effect is small for typical, nominal spray drop sizes and very little variation is seen in the range of droplet size from Sauter to one-half Sauter. NPSH analyses are insensitive over this range of droplet size, and the two cases together confirm that the effect of sprays on reducing containment pressure is maximized and that sufficient conservatism is included to address uncertainty in spray performance.

The following changes to DOM-NAF-3 are proposed to revise the spray drop diameter method:

- **Page 24:** The factor of 10 reduction in spray drop size is described. The material is changed to address the spray model conservatism for NPSH calculations without a specific value.

- **Page 43:** Item 2 in the list of adjustments for NPSH analysis will be modified to state:

  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. A confirmatory analysis is performed by reducing the Sauter diameter by 2, which sufficiently covers code and spray performance uncertainty (i.e., variation in nozzle design and orientation, nozzle flow rate and different header elevations) without creating drops too small that may cause excess droplet holdup in the atmosphere. NPSH analyses are relatively insensitive over this range of droplet size, and the two cases together confirm that the effect of sprays on reducing containment pressure is maximized. The minimum NPSHa is reported from the case that provides the smaller NPSHa.

- **Page 63:** Section 4.5 documents the results of the Surry demonstration case for LHSI pump NPSH and mentions the factor of 10 reduction for spray drop size. Sensitivity studies have shown that this GOTHIC case is not sensitive to drop size ranging from the analyzed smallest value (Sauter/10) to the largest Sauter diameter. With the density change to Equation 16, NPSHa would actually increase by 0.4 ft. Because this case merely demonstrates the GOTHIC behavior versus LOCTIC and the reported minimum NPSHa is conservative, the results in Section 4.5 are not changed. The text is modified to address the difference between the assumed drop diameter of Sauter/10 and the revised method in Section 3.8.2.

- **Page 77 and Table 4.7-1:** With the revised method for selecting the minimum drop size for NPSH calculations, the RS pump NPSH sensitivity analyses in Table 4.7-1 were revisited. With spray modeling maximized to reduce containment pressure, there is very little difference in minimum NPSHa for a range of single failures and the full engineered safeguards features (ESF) case that assumes no failure. The previous analyses performed with the factor of 10 reduction had showed a close grouping of results also, with the failure of 1 emergency bus producing the limiting NPSHa. Table 4.7-1 is modified to identify the full ESF case as limiting with a footnote regarding the importance of validating the limiting single failure for the RS pumps for each plant change. Text in Section 4.7 (page 77) is modified also to describe the similarity of results for different scenarios.

Change to the NPSH Calculation Equation

In addition to the change in spray drop modeling, Equation 16 is changed to use the fluid density at the pump impeller. The original methodology included the term ρ_p in the denominator for the rated density for the pump at which NPSH required is specified. The fixed density of 62.3 lbm/ft^3 for 70 F water was used to add conservatism to the NPSH calculation methodology. However, the transient pump suction fluid density is more appropriate and provides some NPSH margin to offset that consumed by the change to the spray drop size. Equation 16 is changed by replacing ρ_p with ρ_s, which is defined as the fluid density at the pump suction. This value is taken from the GOTHIC pump suction volume at the impeller centerline. The following changes to DOM-NAF-3 are proposed.

Page 42: Revise Equation 16 and the supporting text with the following insert.

$$NPSH_a = \frac{P_s + \rho_l g[E_s(V_w) - E_c - H\alpha_l] - P_{sat}(T_s)}{g\rho_s} \qquad \text{Equation 16}$$

where P_s is the GOTHIC calculated pressure in the pump suction volume, ρ_l is the liquid density in the sump, E_s is the elevation of the sump surface obtained from the installed correlation or table as a function of V_w (the water volume in the containment), E_c is the elevation of the containment volume, H is the height of the containment volume, α_l the liquid volume fraction in the containment, $P_{sat}(T_s)$ is the saturation pressure at the pump suction temperature, ρ_s is the fluid density at the pump suction.

Method of Changing DOM-NAF-3

Dominion proposes to replace seven pages in DOM-NAF-3 based on the previous technical discussion. The replacement pages to DOM-NAF-3 are included in Attachment 2.

References

1. Letter from Leslie N. Hartz to USNRC, "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," Letter Serial No. 05-745, November 1, 2005.

2. Letter from Leslie N. Hartz 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," Letter Serial No. 06-014, January 31, 2006.

ATTACHMENT 2

SUPPLEMENT TO REQUEST FOR APPROVAL OF TOPICAL REPORT DOM-NAF-3, GOTHIC METHODOLOGY FOR ANALYZING THE RESPONSE TO POSTULATED PIPE RUPTURES INSIDE CONTAINMENT

REPLACEMENT PAGES FOR THE NOVEMBER 1, 2005 SUBMITTAL

DOMINION ENERGY KEWAUNEE, INC.
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SURRY POWER STATION UNITS 1 AND 2

$$A_f = \frac{\alpha_d^s}{\alpha_d} A_f^c = \frac{V}{V_s} A_f^c$$ Equation 12

Since, by assumption in GOTHIC,

$$A_f = \frac{V}{H}$$ Equation 13

where H is the specified height for the containment volume, the height of the containment volume should be set to

$$H = \frac{V_s}{A_f^c}$$ Equation 14

Setting the containment volume height as recommended above has some side consequences that must be considered:

1. It will increase the pool surface area for heat and mass transfer. However, since the effective area of heat and mass transfer is the maximum of the pool area and the surface area defined by the hydraulic diameter ($4V/D_h$), as long as $4V/Dh > A_f$, there is no effect on peak pressure and temperature analyses.

2. For NPSH analysis, the water depth in the containment will have to be adjusted to account for the artificially increased pool area, A_f^c . Sensitivity studies have shown that NPSHa is not sensitive to a reduction in containment height, because the spray modeling assumptions applied in Section 3.8.2 ensure a conservative spray response that minimizes the containment pressure for NPSH analysis (Section 3.8.2).

The spray volume, V_s, is set to the total volume below the spray headers under the assumption that the region interior to the headers is adequately covered by the spray. The deposition area, A_f^c, is set to the total horizontal area at the bottom of the sprayed regions where the sprays are expected to collect. For all calculations, the nozzle spray flow fraction is set to 1.0.

3.8.2 GOTHIC Analysis of NPSH Available

NPSHa is the difference between the fluid stagnation pressure and the saturation pressure at the pump intake. To calculate NPSHa for a given pump, the GOTHIC containment model includes a separate small volume for the pump suction. The volume elevation and height are set so that the mid-elevation of the volume is at the elevation of the pump first-stage impeller centerline. The volume pressure (with some adjustments for sump depth) can then be used in the NPSHa calculation. The temperature in the suction volume provides the saturation pressure. The junction representing piping between the sump and the suction volume reflects the friction and form pressure drop between the sump and the pump suction. The pump suction volume also allows accurate modeling of the mixing of cold water that is injected into the suction of the RS pumps at Surry and North Anna.

The single volume GOTHIC model does not account for geometry details of the sump or the liquid that is held up in other parts of the containment. GOTHIC does calculate the total amount of liquid in the containment. A correlation is used to define the sump depth or liquid level as a function of the water volume in the containment. The correlation accounts for the sump geometry variation with water depth and accounts for the holdup of water in other parts of the containment, as discussed in Section 3.8.3. This correlation is installed in a GOTHIC control variable for use in the NPSHa calculation.

With the above modeling features in place, the NPSHa is calculated via control variables as

$$NPSH_a = \frac{P_s + \rho_l g\left[E_s(V_w) - E_c - H\alpha_l\right] - P_{sat}(T_s)}{g\rho_s} \qquad \text{Equation 16}$$

where P_s is the GOTHIC calculated pressure in the pump suction volume, ρ_l is the liquid density in the sump, E_s is the elevation of the sump surface obtained from the installed correlation or table as a function of V_w (the water volume in the containment), E_c is the elevation of the containment volume, H is the height of the containment volume, α_l the liquid volume fraction in the containment, $P_{sat}(T_s)$ is the saturation pressure at the pump suction temperature, ρ_s is the fluid density at the pump suction.

Worst case conditions for NPSHa depend on the time that the pumps take suction from the sump. Therefore, the parameter settings that minimize NPSHa may vary depending on the timing for the operation of the pumps. In general, settings that reduce containment pressure and increase the sump water temperature reduce the NPSHa. Section 4.7 lists the input parameter studies that provide the limiting set of conditions for Surry.

The water in the sump comes from three sources: direct deposit of mass from the break, condensate from the conductors, and spray drops. The drops from the blowdown will be very small and at the saturation temperature at the containment steam partial pressure when they enter the sump. After the blowdown, the spillage water from the vessel is directly put in the sump with no heat transfer to the atmosphere or walls and equipment in the containment. This is a conservative approach for NPSH analysis. The condensate is generated at the saturation temperature at the steam partial pressure and added directly to the sump. The heat transfer between the conductors and the condensate on the way to the sump is conservatively neglected. If the spray drops are modeled as recommended below, the drops will enter the sump at the maximum possible temperature. Heat and mass transfer at the sump surface is allowed. GOTHIC's model for heat and mass transfer at a pool is in good agreement with experimental data (e.g., the Grout Mold evaporation experiments [3]). For NPSH analysis, the liquid temperature is greater than the vapor temperature for most of the event, so a minimum pool area is specified to minimize evaporation. With this overall approach, the predicted sump temperature is conservatively high for the duration of the simulation.

The following adjustments are made to ensure a conservative calculation of NPSHa:

1) The heat and mass transfer to the containment heat sinks are expected to be under-predicted using the Direct heat transfer model. This is non-conservative for NPSH analysis. A multiplier of 1.2 applied to the heat transfer coefficient was shown to provide adequate conservatism in the calculation.

2) 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. A confirmatory analysis is performed by reducing the Sauter diameter by 2, which sufficiently covers code and spray performance uncertainty (i.e., variation in nozzle design and orientation, nozzle flow rate and different header elevations) without creating drops too small that may cause excess droplet holdup in the atmosphere. NPSH analyses are relatively insensitive over this range of droplet size, and the two cases together confirm that the effect of sprays on reducing containment pressure is maximized. The minimum NPSHa is reported from the case that provides the smaller NPSHa.

3) A conservative water holdup volume is subtracted from the containment liquid volume to reduce the sump water height. See Section 3.8.3.

4) The upper limit on containment free volume is used.

5) The minimum containment air pressure is used.

6) Conservative assumptions for spray and other system parameters are used in accordance with plant-specific sensitivity studies (Surry results are summarized in Section 4.7).

4.5 GOTHIC Analysis of LHSI Pump NPSH Available

A GOTHIC calculation of LHSI pump NPSHa is compared to the LOCTIC analysis from the Surry UFSAR for a DEPSG break with one train of safeguards and maximum SI flow. The minimum NPSHa occurs at recirculation mode transfer (RMT), when the LHSI pump swaps suction from the RWST to the containment sump. After RMT, NPSHa increases as the containment pressure stabilizes and the sump temperature decreases from the RS heat exchangers removing energy. Thus, it is important that the primary and secondary system energy be removed at a high rate to maximize the sump temperature before RMT. The DEPSG model for containment depressurization from Section 4.4 was biased in accordance with Section 3.8.2 to minimize NPSHa. The spray nozzle drop diameter was reduced by a factor of 10 (which produced the same minimum NPSH as the method specified in Section 3.8.2), the nozzle spray flow fraction was set to 1.0, a multiplier of 1.2 was applied to the conductor heat transfer coefficients, and the upper limit on the containment free volume was used. The containment initial conditions and design inputs were the same as the LOCTIC analysis. Water holdup was excluded because it was not part of the LOCTIC analysis.

4.5.1 Containment Response

Table 4.5-1 compares the sequence of events and Table 4.5-2 compares the results at the time of minimum NPSHa. Figures 4.5-1 through 4.5-4 compare the containment pressure, vapor temperature, liquid temperature, and sump level to LOCTIC results shown as discrete points. The distribution of the energy release into containment is indicated by the containment pressure and temperature response. During the early part of the event (<1000 sec), the GOTHIC sump liquid temperature is considerably less than LOCTIC, the vapor temperature is slightly higher, and the pressure is higher. The LOCTIC pressure flash option models the break liquid as a continuous liquid addition to the sump. GOTHIC break modeling using droplets results in a different containment energy distribution. In general, the LOCTIC pressure flash option causes a very conservative amount of energy to be retained in the sump liquid with less vapor flashed into the air space. This is evident from the very high (> 250 F) LOCTIC sump temperatures that are maintained until almost 1000 seconds even while the RS heat exchangers are removing sump energy. The vapor temperature is slightly less than the GOTHIC values. LOCTIC assumes no interfacial heat transfer between the sump pool and containment atmosphere, which also explains the high liquid temperatures.

For the first few seconds, the LOCTIC vapor temperatures are much higher than GOTHIC. This is due to the lack of a droplet model in LOCTIC, which results in a brief period of superheat. Once the IRS and ORS pumps become effective (200-400 seconds into the event) and the sump liquid is sprayed into the containment, the difference between the model responses becomes less noticeable. At the time of RMT, the GOTHIC sump liquid temperature is about 1 F higher than LOCTIC and the pressure is about 0.7 psi higher. The higher sump temperature provides a relative adverse effect on NPSHa while the increased pressure is a benefit. The sump levels in

4.7 Sensitivity Studies

The conservative assumption for a particular analysis depends on the design requirement that is being verified. Sensitivity studies will be performed for break locations, single failures, and design inputs for each plant-specific GOTHIC containment analysis. Table 4.7-1 documents the results of the studies for Surry's containment analysis criteria. The conclusions are consistent with the current LOCTIC analyses. With LOCTIC, the minimum NPSHa for the ORS and IRS pumps occurs for a case with full engineered safeguards (no single failure). The GOTHIC analyses produce the same minimum NPSHa for the full safeguards case and for other cases with single failures, which emphasizes the need to analyze the single failures for each design effort.

Table 4.7-1 illustrates the breadth of sensitivity analyses that were performed for Surry to confirm the limiting assumptions for the current plant configuration. The results are specific to Surry's current configuration and are not intended to cover all Dominion PWRs, since each station has specific design criteria and engineered safety features that require sensitivity studies. Dominion will perform similar sensitivity studies to define the set of conservative assumptions for each PWR application.

4.8 Summary of Demonstration Analyses

Based on the comparison to LOCTIC, it is concluded that the GOTHIC model selections identified in Section 3 appropriately model the containment response for LOCA and MSLB events. GOTHIC shows similar behavior for containment pressure and temperature to the SWEC LOCTIC code for a DEHLG break with maximum safeguards and a DEPSG break for containment depressurization and LHSI pump NPSHa. GOTHIC predicts lower peak containment pressures because of the DLM condensation model and the break droplet model. The GOTHIC liquid temperature is higher in the short-term, but the RS heat exchangers and the interfacial heat and mass transfer in GOTHIC bring the vapor and liquid phase temperatures close together.

GOTHIC predicts shorter depressurization times because of the simplified RCS model that mechanistically removes energy from all steam generators, while the FROTH methodology non-mechanistically biases superheated steam flow through the broken loop steam generator. For the LHSI pump NPSHa analysis, GOTHIC predicts a slightly higher sump temperature and containment pressure at the time of minimum of NPSHa. Overall, the long-term containment response is comparable to LOCTIC. The analyses also demonstrate that the simplified RCS model is conservative for calculating post-reflood mass and energy release rates for both DEPSG and DEHLG breaks.

Table 4.7-1: Matrix of Conservative Inputs for Surry GOTHIC Containment Analyses

Note: This table is based on the current plant configuration. Plant modifications can change these results.

Table Key
Min = Assume the **minimum** value for the range of the design input
Max = Assume the **maximum** value for the range of the design input
N/A = **Not Applicable**: the key analysis result occurs after this parameter becomes effective or the component is not part of the containment response (e.g., accumulators for MSLB).
N/S = **Not Sensitive**: the key analysis result is not sensitive to changes in this input parameter.

	LOCA Peak Pressure*	**MSLB Peak Pressure/Temp #**	**Containment Depressurization**	**Subatmospheric Peak Pressure**	**LHSI NPSH**	**ORS NPSH**	**IRS NPSH**
General							
Break Type	DEHLG	1.4 ft^2 for pressure 0.6 ft^2 for temp #	DEPSG	DEPSG	DEPSG	DEHLG	DEHLG
Reactor Power	102%	0% for pressure 102% for temp #	102%	102%	102%	102%	102%
Single Failure	N/A	1 emergency bus	1 emergency bus	1 emergency bus	1 emergency bus	None &	None &
Containment							
Air Pressure	Max	Max / Min #	Max	Max	Min	Min	Min
Temperature	Max	Max	Max	Min	Max	Max	Max
Relative Humidity	100%	100% / 0% #	100%	100%	100%	100%	100%
Free Volume	Min	Min	Min	Min	Max	Max	Max
Heat Sink Surface Area	Min	Min	Min	Max	Min	Min	Min

	LOCA Peak Pressure*	MSLB Peak Pressure/Temp #	Containment Depressurization	Subatmospheric Peak Pressure	LHSI NPSH	ORS NPSH	IRS NPSH
Recirculation Spray							
RS Piping Volume	N/A	N/S	Max	Max	N/S	Min	Min
IRS Flow Rate	N/A	N/S	Min	Min	Min	Min	Max
ORS Flow Rate	N/A	N/S	Min	Min	Min	Max	Min
IRS Recirculation Flow to Pump Suction	N/A	N/S	N/S	N/S	N/S	Min	Min
RS Timer Delay	N/A	N/S	Max	Max	Max	Max	Max
IRS Suction Loss	N/S	N/S	N/S	N/S	N/S	Max	Max
ORS Suction Loss	N/S	N/S	N/S	N/S	N/S	Max	Max
Service Water							
SW Flow Rate	N/A	N/S	Min	Min	Min	Max	Max
SW Temperature	N/A	N/S	Max	Max	Max	Min	Min
HX Tube Plugging/Fouling	N/A	N/S	Max	Max	Max	0	0

* LOCA peak pressure and temperature assumptions are the same per Section 5.2.4.

\# MSLB peak temperature occurs for small breaks and the spectrum is reviewed for any plant parameter change. The peak temperature is obtained by using minimum air pressure and 0% humidity (peak pressure cases assume maximum air pressure and 100% humidity).

& Sensitivity studies have shown that the full ESF case (no single failure) produces the same minimum NPSH as many single failure scenarios. Design studies must evaluate single failure scenarios with the full ESF case.

ATTACHMENT 3

SUPPLEMENT TO REQUEST FOR APPROVAL OF TOPICAL REPORT DOM-NAF-3, GOTHIC METHODOLOGY FOR ANALYZING THE RESPONSE TO POSTULATED PIPE RUPTURES INSIDE CONTAINMENT

APPLICATION FOR WITHHOLDING AND AFFIDAVIT OF GERALD T. BISCHOF

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

APPLICATION FOR WITHHOLDING AND AFFIDAVIT OF GERALD T. BISCHOF

I, Gerald T. Bischof, Vice President – Nuclear Engineering, state that:

1. I am authorized to execute this affidavit on behalf of Dominion Energy Kewaunee, Inc. (DEK), Dominion Nuclear Connecticut, Inc. (DNC), Virginia Electric and Power Company (Dominion).

2. DEK, DNC and Dominion are submitting nodal diagrams associated with its GOTHIC containment analysis that contain proprietary commercial information that should be held in confidence by the NRC pursuant to the policy reflected in 10 CFR §§ 2.390(a)(4) because:

   a. This information is being held in confidence by DEK, DNC and Dominion.

   b. This information is of a type that is held in confidence by DEK, DNC and Dominion, and there is a rational basis for doing so because the information contains sensitive commercial information concerning DEK, DNC and Dominion containment analysis methodology.

   c. This information is being transmitted to the NRC in confidence.

   d. This information is not available in public sources and could not be gathered readily from other publicly available information.

   e. Public disclosure of this information would create substantial harm to the competitive position of DEK, DNC and Dominion by disclosing confidential DEK, DNC and Dominion internal containment analysis methodology information to other parties whose commercial interests may be adverse to those of DEK, DNC and Dominion. Furthermore, DEK, DNC and Dominion have expended significant engineering resources in the development of the information. Therefore, the use of this confidential information by competitors would permit them to use the information developed by DEK, DNC and Dominion without the expenditure of similar resources, thus giving them a competitive advantage.

3. Accordingly, DEK, DNC and Dominion request that the designated document be withheld from public disclosure pursuant to the policy reflected in 10 CFR §§ 2.390(a)(4).

Dominion Energy Kewaunee, Inc.
Dominion Nuclear Connecticut, Inc.
Virginia Electric and Power Company

[signature]
Gerald T. Bischof
Vice President – Nuclear Engineering

COMMONWEALTH OF VIRGINIA

COUNTY OF HENRICO

Subscribed and sworn to me, a Notary Public, in and for the County and State above named, this 14TH day of July, 2006.

[signature: Vicki L. Hull]
Notary Public

My Commission Expires 5/31/10

(SEAL)

ATTACHMENT 5

SUPPLEMENT TO REQUEST FOR APPROVAL OF TOPICAL REPORT DOM-NAF-3, GOTHIC METHODOLOGY FOR ANALYZING THE RESPONSE TO POSTULATED PIPE RUPTURES INSIDE CONTAINMENT

GOTHIC NODALIZATION DIAGRAMS (NON-PROPRIETARY, REDACTED VERSION)

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

GOTHIC Nodalization Diagrams for DOM-NAF-3 (Non-Proprietary Version)

In the below reference, the NRC requested that Dominion submit the GOTHIC nodalization diagrams for the Surry demonstration cases provided in Section 4 of DOM-NAF-3. This attachment presents the GOTHIC diagrams from the topical report LOCA cases in Sections 4.3 through 4.5. Tables are provided to summarize the model volumes and boundary conditions.

Reference: Letter from Stephen Monarque (USNRC) to David A. Christian (Dominion), "North Anna Power Station, Unit Nos. 1 and 2, Surry Power Station, Unit Nos. 1 and 2, Kewaunee Power Station, and Millstone Power Station, Unit Nos. 2 and 3 – Request for Additional Information (RAI) on Proposed Topical Report DOM-NAF-3 (TAC Nos. MC8833, MC8834, MC8835, MC8836, MC8831, and MC8832)," April 28, 2006.

[ ]

GOTHIC Diagram for DEHLG Break (DOM-NAF-3, Section 4.3)

GOTHIC Diagram for DEPSG Break for Containment Depressurization
(DOM-NAF-3, Section 4.4)

GOTHIC Diagram for DEPSG Break for LHSI Pump NPSH (DOM-NAF-3, Section 4.5)

GOTHIC Diagram for DEPSG RCS Model for LHSI Pump NPSH (DOM-NAF-3, Section 4.5)