VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

October 29, 1998

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United States Nuclear Regulatory Commission
Washington, D. C. 20555

Serial No. 98-546
NL&OS/GDM R2
Docket Nos. 50-280, 281
50-338, 339
License Nos. DPR-32, 37
NPF-4, 7

Gentlemen:

VIRGINIA ELECTRIC AND POWER COMPANY
NORTH ANNA AND SURRY POWER STATIONS UNITS 1 AND 2
GENERIC LETTER 97-04 – ASSURANCE OF NET POSITIVE SUCTION HEAD FOR EMERGENCY CORE COOLING AND CONTAINMENT HEAT REMOVAL PUMPS
RESPONSE TO A REQUEST FOR ADDITIONAL INFORMATION

Generic Letter (GL) 97-04 requested that licensees review their current design-basis analyses to determine the available net positive suction head (NPSH) for the emergency core cooling and containment heat removal pumps, and then provide specific information regarding the design basis NPSH analyses for these pumps within ninety days. Virginia Electric and Power Company (Virginia Power) provided a response for both North Anna and Surry Power Stations on December 29, 1997 (Serial No. 97-594A).

In a letter dated September 1, 1998, the NRC requested additional information as a result of your review of Virginia Power's response. Specifically, the NRC has requested information that demonstrates how our previous response to GL 97-04, relative to the containment overpressure required to assure adequate NPSH for the emergency core cooling and containment heat removal pumps, compares with Virginia Power's current licensing basis.

Virginia Power summarized the analysis methodology concerning the use of containment overpressure for the determination of NPSH for the emergency core cooling and containment heat removal pumps in the previous response to Generic Letter 97-04 noted above. Furthermore, we have concluded from a review of the relevant correspondence that the methodology to credit containment overpressure is part of the licensing bases for both Surry and North Anna. A specific value for containment overpressure credit in the determination of NPSH for the emergency core cooling and containment heat removal pumps has not been previously provided to the NRC for review and approval. Rather, NRC approval has been directed at verification of

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the adequacy of the methodology used to determine that the available NPSH is greater than the required NPSH for these pumps. Therefore, it is Virginia Power's position that since 1) the methodology for the determination of NPSH for the emergency core cooling and containment heat removal pumps has been previously reviewed and approved by the NRC, 2) the methodology previously approved by the NRC is still being used for NPSH determination at both stations, and 3) the current calculated values of available NPSH for the emergency core cooling and containment heat removal pumps exceed the required NPSH values, the licensing bases for both stations continue to be met. Additional supporting information for this conclusion for North Anna and Surry is provided in the attachment.

If you have any further questions or require additional information, please contact us.

Very truly yours,

James P. O'Hanlon

James P. O'Hanlon
Senior Vice President - Nuclear

Attachment

Commitments contained in this letter: None.

cc: U.S. Nuclear Regulatory Commission
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Mr. R. A. Musser
NRC Senior Resident Inspector
Surry Power Station

Mr. M. J. Morgan
NRC Senior Resident Inspector
North Anna Power Station

COMMONWEALTH OF VIRGINIA)
)
COUNTY OF HENRICO)

The foregoing document was acknowledged before me, in and for the County and Commonwealth aforesaid, today by J. P. O'Hanlon, who is Senior Vice President - Nuclear, 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 this 29th day of October, 1998

My Commission Expires: March 31, 2000.

Maggie McClure
Notary Public

(SEAL)

Attachment 1

Response to Request for Additional Information Related to Generic Letter 97-04
Surry Power Station Units 1 and 2
North Anna Power Station Units 1 and 2

In Reference 1, Virginia Electric & Power Company (Virginia Power) submitted its response to Generic Letter 97-04 (Reference 2). That response provided the requested information concerning the existing analyses of net positive suction head (NPSH) for the low head safety injection (LSHI), inside recirculation spray (IRS) and outside recirculation spray (ORS) pumps at Surry and North Anna Power Stations. The additional information herein responds to the request for additional information contained in Reference 3, which contained the following request:

"The NRC staff has reviewed your response and is concerned that SPS, Units 1 and 2 and NAPS, Units 1 and 2 may not be within its licensing basis because it appears that the containment overpressure needed to assure adequate NPSH is greater than the overpressure previously approved by the NRC staff. ...please provide a response within 60 days discussing how your response to GL 97-04 related to containment overpressure compares with your current licensing basis."

The existing recirculation spray and low head safety injection NPSH analyses for Surry and North Anna Power Stations take credit for containment pressure during the design basis LOCA to provide a part of the available NPSH. The calculation method uses several key modeling and parameter assumptions to obtain a conservative prediction of containment pressure (underestimated) and the sump water temperature (overestimated) transients. The containment response analysis minimizes the energy release to the containment atmosphere and maximizes the energy release to the sump water. This is accomplished by employing conservative modeling (pressure flash model) of the break mass and energy releases in the LOCTIC containment response computer code. Virginia Power summarized the analysis methodology concerning use of containment overpressure in the previous response to Generic Letter 97-04 (Reference 1).

The existing analysis approach, which credits a conservative transient analysis for containment overpressure, was first employed during 1977 following notification from the architect/engineer of inadequacies in the analysis and system design of the recirculation spray and low head safety injection subsystems. There were numerous letters between Virginia Power and the NRC during 1977 and 1978 that addressed the analyses and proposed modifications to resolve the NPSH issues for Surry and North Anna. Virginia Power concludes from a review of the correspondence that the NRC staff was aware of Virginia Power's methodology to credit containment overpressure and found these methods acceptable for Surry and North Anna. This methodology of

calculating containment overpressure has continued in use and is the methodology that was used to generate the NPSH results reported in Reference 1.

The following discussion presents key excerpts from NRC Safety Evaluation Reports (SER) which demonstrate approval of the methodology which Virginia Power employs for obtaining a conservative calculation of containment overpressure following a design basis LOCA.

Approval Documentation – North Anna Units 1 and 2

The following is excerpted from Supplement No. 8 of the North Anna Units 1 and 2 SER (Reference 4), which documents NRC approval of the analysis methods and associated system modifications designed to resolve the NPSH issues for North Anna. It describes the evaluation of NPSH analysis methodology and proposed system modifications that occurred after the initial North Anna Units 1 and 2 SER was issued (Reference 5).

"6.2.2 Containment Heat Removal System

Subsequent to the issuance of the Safety Evaluation Report, the applicant reported that it had reevaluated the net positive suction head available to the recirculation spray pumps and low head safety injection pumps based on a more conservative containment analysis. Net positive suction head is the head, or potential energy, available or required to force a given flow into the impeller of a pump. Net positive suction head is affected by containment pressure, sump water vapor pressure, depth of sump water and suction piping resistance to flow.

The revised analysis incorporated analytical techniques and assumptions that were selected to minimize the containment pressure and maximize the containment sump water temperature, thereby minimizing the calculated net positive suction head available to the pumps. The other factors, namely, depth of sump water and suction piping resistance to flow, have a lesser effect on the revised analysis. The analysis showed that the available net positive suction head was less than previously calculated and possibly less than required. Therefore, a recirculation spray pump and a low head safety injection pump were tested by the applicant to determine the performance characteristics of the pumps under conditions of reduced available net positive suction head...

The new containment response analysis submitted by the applicant to determine the containment pressure and sump water temperature response was based on the following:

(1) Thermodynamic State of Liquid and Vapor Phases in Containment

The analytical technique used to determine the distribution of mass and energy in the liquid and vapor regions of the containment following a loss of coolant accident can influence the containment pressure/temperature response. The pressure flash method and the temperature flash method are the two currently used techniques. For the net positive suction head analysis, the applicant used the pressure flash method which assumes that liquid being expelled from the break flashes at the saturation temperature corresponding to the containment total pressure. This maximizes the temperature of the water entering the sump, and is, therefore, conservative. Previously, the containment analytical model assumed that the liquid flashed at the dew point temperature of the containment atmosphere (temperature flash method). The temperature flash method is typically used for peak containment pressure calculations.

(2) Pipe Break Effluent

The pipe break effluent was assumed to be uniformly mixed with the emergency core cooling system injection water spilling from the break. This is an important consideration for postulated cold leg breaks and essentially increases the energy transferred to the sump, with a concomitant increase in the sump water temperature. This assumption does not affect net positive suction head calculations for postulated hot leg breaks since the break effluent is already uniformly mixed. Previously, for cold leg breaks, emergency core cooling system water was assumed to spill directly to the sump without mixing, which resulted in lower calculated sump water temperatures.

(3) Other Assumptions Regarding Input Data

The applicant conducted a number of sensitivity studies to identify the other assumptions that should be used to minimize the calculated available net positive suction head. We have reviewed the results of these sensitivity studies and concluded that the following assumptions used in the analysis will minimize the calculated available net positive suction head:

- *(a) A spray thermal effectiveness of 100 percent was assumed.*
- *(b) A low initial containment pressure and high initial containment temperature were assumed.*
- *(c) A low service water temperature entering the recirculation spray system heat exchangers was assumed.*
- *(d) The containment net free volume was increased by five percent.*
- *(e) Switchover from the injection to the recirculation phase of emergency core cooling system operation was assumed to occur instantly at the low alarm setpoint.*

A sensitivity study was also done to identify the single failure and pipe break location that will give the lowest available net positive suction head for the recirculation spray and low head safety injection pumps. The results of this study indicate that for the recirculation spray pumps, a postulated hot leg double-ended rupture will result in the lowest available net positive suction head, and the available net positive suction head is somewhat insensitive to the single failure assumption. The available net positive suction head for the inside recirculation spray pumps was calculated to be 11.0 feet, and the available net positive suction head for the outside recirculation spray pumps was calculated to be 6.4 feet. The results of the recirculation spray pump test indicate that the net positive suction head required by the pump is less than that calculated to be available, and therefore, is acceptable.

We have also done a confirmatory analysis for the single failure and pipe break location that the applicant has identified as giving the lowest available net positive suction head for the recirculation spray pumps. For our confirmatory analysis, we used the CONTEMPT-LT (Mod 26) computer code. The code was modified to permit the analysis to be based on the pressure flash method. The results of our analysis, (i.e., the containment pressure and sump water temperature versus time) are in good agreement with the applicant's results. We, therefore, conclude that the applicant's net positive suction head analysis is acceptable."...

6.3 Emergency Core Cooling System

6.3.3 System Performance Evaluation

"...Section 6.2.2 of this supplement addresses the containment calculations which demonstrate the net positive suction head required to permit proper operation of the low head safety injection pumps."

Approval Documentation – Surry Units 1 and 2

The following is excerpted from Reference 6, which documented NRC approval of the analysis methods and associated interim system modifications and operating restrictions designed to resolve the NPSH issues for Surry Units 1 and 2.

"By letter dated September 12, 1977, the licensee submitted the results of more complete analyses regarding the available net positive suction head for the low head safety injection pumps for interim operation of the plants. The methods used to calculate the containment pressure, containment sump temperature, and available NPSH have been reviewed for the North Anna plant and found to be acceptable. The same methods were used in the calculations for Surry. The licensee has shown acceptable NPSH to be available for the pumps, operating at a discharge flow rate of 3500 gpm, with a minimum service water temperature of 35°F. Based on our review of this information the staff concludes that there will be

adequate NPSH available with a service water temperature of 35°F with the low head safety injection pumps limited to 3500 gpm discharge flow. The licensee's evaluation of long term operation is required to be submitted no later than November 22, 1977."

The following is excerpted from Reference 7, which reaffirmed NRC approval of the analysis methodology and associated final system modifications and Technical Specifications designed to resolve the NPSH issues for Surry Units 1 and 2.

"NPSH and Containment Pressure and Temperature Analyses

During the course of the operating license review of the North Anna Station, the licensee reevaluated the net positive suction head (NPSH) available to the recirculation spray (RS) and low head safety injection (LHSI) pumps based on a more conservative containment analysis. NPSH is the head, or potential energy, available or required to force a given flow into the impeller of a pump. NPSH is affected by containment pressure, sump water vapor pressure, depth of sump water and suction piping resistance to flow. The revised analysis incorporated analytical techniques and assumptions that were selected to minimize the containment pressure and maximize the containment sump water temperature, thereby minimizing the calculated NPSH available to the pumps; the other factors, namely, depth of sump water and suction piping resistance to flow, have a lesser effect on the revised analysis. As a result of the analysis, certain design modifications were found to be necessary to assure the adequacy of the available NPSH for both the RS and LHSI pumps.

The Surry Station, Units 1 and 2 are operating plants with a design similar to that of North Anna. It was determined that in the event of a major loss-of-coolant accident, the vapor pressure of the water in the Surry containment sump which is the source of water for the RS and LHSI pumps during the recirculation phase is higher than the original analyses had indicated. This situation can result in inadequate NPSH for the RS and LHSI pumps at specific times during the recirculation phase of long term core cooling and containment cooling.

By a letter dated August 24, 1977, the licensee proposed interim modifications of the RS and LHSI systems and requested that the Surry Power Station be permitted to operate with the proposed interim modifications until such time as permanent modifications are designed and installed. Based on our review of the information provided by the licensee, we found that the above proposed modifications were acceptable on a interim basis, and by Order dated August 24, 1977, we concluded that until permanent modifications are implemented, operation would not pose an undue threat to the health and safety of the public.

By a letter dated November 22, 1977, and June 30, 1980, the licensee submitted a report, which presents: (1) proposed permanent modifications of the RS and LHSI

systems; and (2) the containment pressure and temperature response analyses and associated NPSH available to the RS and LHSI pumps...

Evaluation

NPSH AND CONTAINMENT ANALYSIS

The calculated pressure in the containment and temperature of the water that accumulates in the containment sumps are important parameters, in regard to available NPSH, in determining the RS and LHSI pump operability following a LOCA. These terms, in combination with the pump static head and associated line friction losses, establish the available NPSH during the transient.

The required NPSH may be reduced by a reduction in the pump flow rate. Alternately, the NPSH available at a given flow rate may be increased by the injection of cold water into the pump suction. The injection of cold water lowers the water temperature at the pump suction and, therefore, lowers the vapor pressure of the water entering the pump. The licensee proposed to utilize both of the above methods to resolve this problem...

CONTAINMENT ANALYSIS FOR THE EVALUATION OF AVAILABLE NPSH

The new containment response analysis submitted by the licensee to determine the containment pressure and sump water temperature response was based on the following.

The analytical techniques used to determine the distribution of mass and energy in the liquid and vapor regions of the containment following a LOCA can influence the containment pressure/temperature response. The pressure flash method and temperature flash method are the two currently used techniques. For the NPSH analysis, the licensee used the pressure flash method which assumes that liquid being expelled from the break flashes at the saturation temperature corresponding to the containment total pressure. This maximizes the temperature of the water entering the sump, and is, therefore, conservative. Previously, the containment analytical model for NPSH analysis assumed that the liquid flashes at the dew point temperature of the containment atmosphere (temperature flash method). The temperature flash method is typically used for peak containment pressure calculations.

The pipe break effluent was assumed to be uniformly mixed with the ECCS injection water spilling from the break. This is an important consideration for postulated cold leg breaks and essentially increases the energy transferred to the sump. This assumption does not affect NPSH calculations for postulated hot leg breaks since the break effluent is already uniformly mixed. Previously, for the NPSH analysis of

postulated cold leg breaks, ECCS water was assumed to spill directly to the sump without mixing, which resulted in lower calculated sump water temperatures.

The licensee conducted a number of sensitivity studies to identify the other assumptions that should be used to minimize the calculated available NPSH. We have reviewed the results of these sensitivity studies and conclude that the following conservative assumptions will minimize the calculated available NPSH:

(1) A spray thermal effectiveness of 100% was assumed:
(2) A low initial containment pressure and high initial containment temperature were assumed.

Sensitivity studies were also done to identify the single failure, break size and pipe break location that will give the lowest calculated available NPSH for the RS and LHSI pumps. The results of these studies indicated that for the RS pumps, a postulated hot leg double-ended rupture will result in the lowest available NPSH, and for the LHSI pumps a postulated pump suction double-ended pipe rupture will result in the lowest available NPSH. The available NPSH for the inside recirculation pumps was calculated to be 15.0 feet, the available NPSH for the outside recirculation pumps was calculated to be 11.9 feet and the available NPSH for the LHSI pumps was calculated to be 17.2 feet. The minimum NPSH required are 8.4 feet for the outside RS pumps; 10.1 feet for the inside RS pumps; and 15.2 feet for the LHSI pumps.

We have performed confirmatory analyses for the pipe break locations that the licensee has identified as giving the lowest available NPSH for the pumps. For our confirmatory analyses, we used CONTEMPT (MOD26) computer code. The code has been modified to permit the analyses to be based on the pressure flash method. The results of our analysis; i.e., the containment pressure and sump water temperature versus time, are in good agreement with the licensee's results. We, therefore, conclude that the licensee's NPSH analysis is acceptable."

References:

1. Letter, James P. O'Hanlon to USNRC, "Virginia Electric and Power Company-Surry Power Station Units 1 and 2, North Anna Power Station Units 1 and 2-Response to NRC Generic Letter 97-04, Assurance of Sufficient Net Positive Suction Head for Emergency Core Cooling and Containment Heat Removal," Serial No. 97-594A, December 29, 1997.

2. Generic Letter 97-04, "Assurance of Sufficient Net Positive Suction Head for Emergency Core Cooling and Containment Heat Removal Pumps," October 7, 1997.

3. Letter from N. Kalyanam and Gordon E. Edison to J.P. O'Hanlon, "Request for Additional Information Related to Generic Letter 97-04 – Surry Power Station (SPS), Units 1 and 2; North Anna Power Station (NAPS), Units 1 and 2 (TAC Nos: MA0050, MA0051, MA0015 and MA0016)," September 1, 1998.

4. Supplement 8 to the Safety Evaluation Report by the Office of Nuclear Reactor Regulation, USNRC, North Anna Power Station-Units 1 and 2, Docket Nos. 50-338 and 50-339, NUREG-0053, December 14, 1977.

5. Safety Evaluation Report by the Office of Nuclear Reactor Regulation, USNRC, North Anna Power Station-Units 1 and 2, Docket Nos. 50-338 and 50-339, NUREG-0053, June 1976.

6. Letter from Robert W. Reid to W. L. Proffitt, forwarding an Order for Modification of License dated October 17, 1977.

7. Letter from Steven A. Varga to J. H. Ferguson, forwarding Safety Evaluation by the Office of Nuclear Reactor Regulation Related to Amendment no. 59, Facility Operating License No. DPR-37, Surry Power Station, Unit No. 2, Docket No. 50-281, August 1, 1980.