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VRA-89-757

Mr. W. R. Cartwright, Vice President
Nuclear Operations
Virginia Power
Innsbrook Technical Center
5000 Dominion Boulevard
Glen Allen, Virginia 23060

Dear Mr. Cartwright:

Virginia Power
North Anna Units 1 and 2
ECCS Flow Inconsistencies

The following attachment deals with an inconsistency which has been found between the plant ECCS configuration assumed in the input to the Westinghouse supplied loss-of-coolant accident (LOCA) analyses used to demonstrate compliance with the requirements of 10CFR50.46, and the configuration currently allowed in the technical specifications. In the event of a LOCA, the safety injection (SI) flow rates from the emergency core cooling system (ECCS) may be lower than the flow rates assumed in the LOCA analyses. A review of the potential effects on the calculation of the safety injection flow used in the large break and small break LOCA ECCS analyses indicates that the analysis results may incur a penalty for the peak cladding temperature (PCT) calculation.

After careful review, it has been determined that this inconsistency constitutes a "Defect" in Westinghouse supplied safety analyses which are part of the bases to the technical specifications. As defined in 10CFR21, a Defect is a condition or circumstance involving a basic component that could contribute to the exceeding of a safety limit, as defined in the technical specifications for operations issued pursuant to 10CFR50. A basic component, as defined in 10CFR21, includes the safety analyses performed as part of the bases to the technical specification.

The actual ECCS configuration, as defined by technical specifications and periodic tests, may result in flow rates which are less than those used in the LOCA analyses to demonstrate compliance with the requirements of 10CFR50.46. This problem was discovered while performing revised LOCA analyses, and has been investigated by Westinghouse to determine applicability and impact. Westinghouse does not believe that a substantial safety hazard (as defined in 10CFR21.3) exists. However, an unreviewed safety question may exist.

because, until each plant's ECCS configuration and analysis assumptions are reviewed, it cannot be determined if the margin of safety as defined in the basis for the technical specification has been reduced. Information is being provided such that you may perform this review.

Should you have any questions or require further information, please contact me.

A separate letter has been sent pertaining to Surry (VPA-89-580).

Very truly yours,

Donald R Beynon

D. R. Beynon, Jr., Manager
Customer Projects Department
Virginia Area

Attachment
HT/5459G

cc: W. R. Matthews
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ATTACHMENT

## BACKGROUND

In calculating the current analysis of record Westinghouse LOCA ECCS flow performance, the following assumptions were made to determine minimum injection flow.

1) The Charging/SI pump runout was established at the maximum flow specified by Westinghouse. System resistance calculations were based on the vendor rated pump performance at the runout flow rate. The corresponding system resistance remained constant through the remaining plant operation.

2) The resistance in each injection branch line was such that equal flow would exist in each branch line for the same backpressures (that is, each Charging/SI injection line would have equal flow at the same backpressure).

3) One Charging/SI injection line was assumed to spill and be lost for core cooling.

4) The Charging/SI pumps were degraded uniformly by 5% of the developed head at the design point.

5) The Charging/SI flow passing through the reactor coolant pump seal injection line was assumed to be lost.

6) The amount of seal injection flow was based on an assumed system resistance.

For North Anna Units 1 and 2, the following assumptions were applied in calculating ECCS flow rates.

Charging/SI pump runout head/flow = 1800 ft/650 gpm

Charging/SI injection line flow imbalance = 10 gpm

Charging/SI seal injection flow at runout = 65 gpm

Charging/SI pump degradation = 589 ft

Based on a review of these assumptions, and Westinghouse's understanding of your plant configuration, three issues have been identified which are discussed below.

## ISSUE 1

As previously stated, the RCP seal injection flow at runout conditions was assumed to be 65 gpm. This corresponds to a specific seal injection line system resistance, which is used in generating ECCS flows for LOCA analyses. As long as the actual resistance is equal to or greater than that used in the calculation, this assumption is met or exceeded. This assumption is verified by Standard Technical Specification (STS) 3.4.6.2.e, which compares measured seal injection flow at normal RCS pressure to a calculated value based on the analysis resistance.

In reviewing your technical specifications and Westinghouse ECCS flow calculations, it has been determined that the North Anna technical specification value of 30 gpm is inconsistent with the ECCS flow calculations. The seal injection piping resistance associated with the technical specification is less than that assumed in the calculations; therefore, additional Charging/SI flow would be pumped through the seal injection line. For a large beak LOCA, this potentially could result in pump runout and/or a reduction of flow injected into the core. For a small break LOCA a reduction of flow injected into the core would result.

To assess the discrepancy between the RCP seal injection line resistance assumed in the generation of ECCS flows for LOCA analyses and the RCP seal injection line resistance associated with the technical specification, an evaluation was performed, based on a representative plant, to determine the possible charging/SI flow reduction.

Based on a parametric study, pump runout would be no higher than an additional 15 gpm. Westinghouse believes that if this runout had occurred, that the Charging/SI pump would have operated without any safety-related problems. This engineering judgment is based on evaluations performed on similar plants.

For the large break LOCA transient the ECCS flow reduction to the core would be less than 10 gpm. Because the reduction in flow is small relative to accumulator and RHR pumped flow, no large break LOCA penalty is expected.

For the small break LOCA transient the ECCS flow reduction to the core would be less than 10 gpm. The small break LOCA analysis is more sensitive to reductions in the Charging/SI pumped flow than the large break LOCA analysis because the Charging/SI pump is the only pump which injects during the small break LOCA transient. Since the Charging/SI pump is the only pump which injects during the small break LOCA transient a reduction in flow from the pump can result in an increased calculated peak clad temperature. Evaluations performed on similar plants have shown a peak clad temperature increase of approximately 32°F for ECCS flow reductions of this magnitude.

Note that for secondary side breaks, pump runout is not a concern, due to higher RCS backpressure.

Therefore, it is Westinghouse's judgment that no safety-related equipment damage would have occurred, and that the small break LOCA analysis could incur a peak clad temperature increase of 32°F. For ECCS flow reductions of this magnitude no increase in the calculated peak clad temperature for the large break LOCA analysis is expected.

Based on the current seal injection line resistance used in the ECCS calculation, the corresponding seal injection technical specification value would be below normal RCP requirements. Therefore, it is unlikely that a valid technical specification could be established.

To rectify this situation, Westinghouse recommends that the Charging/SI ECCS performance be re-calculated based on the current technical specification. This could be done in conjunction with core reload analyses or some other program to increase ECCS operating flexibility.

## ISSUE 2

As noted, a system resistance is calculated based on the actual original Charging/SI pumps runout head/flow. Some utilities have informed Westinghouse that this resistance is periodically decreased. This is done to restore the original runout flow after a degradation in the pump head. By reducing overall system resistance, a resulting decrease in the flow delivered to the core could result for some LOCAs.

The reason for this effect is somewhat subtle. The system resistance is reduced by decreasing injection line resistance (using the throttle valves). For some small break LOCAs, two lines deliver flow to the core at the prevailing RCS pressure, and one line spills to containment pressure. The flow in each branch line is proportional to the square root of differential head divided by branch line resistance. The spilling line has a significant differential head (essentially pump discharge pressure less containment pressure). Thus as the injection line resistance is decreased, flow out of the spilling line increases, and the flow through the injection lines decreases, relative to the original system resistance.

An assessment of the effect of representative flow reductions was performed in conjunction with issue 3. Refer to that discussion for possible LOCA analyses impact.

To insure the validity of the ECCS flow performance assumptions, the hydraulic resistance associated with the Charging/SI pump runout conditions listed previously should be confirmed. If the resistance is lower, it should be restored to maintain the validity of the ECCS analyses or the effect on the LOCA analyses should be determined.

## ISSUE 3

The current Westinghouse ECCS flow calculations assume that the flow through each Charging/SI pump branch line is within 10 gpm of each other with no backpressure. However, it is known that many plants operate with higher allowed imbalance in these branch lines. If not supported by an analysis, this additional branch line imbalance could result in increased spill flow and decreased flow injected to the core.

If the total system resistance is assumed to be constant and if the line assumed to spill has a decreased resistance (from that assumed in the analysis), then the injecting lines must have an increased resistance. This results in decreased flow injected to the core, and increased spill flow. The relative decrease in injected flow is greater for the small break LOCA than for the large break LOCA. This is because RCS backpressure is higher for small breaks, resulting in higher pump discharge pressure. This forces proportionally more flow out the line spilling to containment pressure.

To assess the potential combined effect of items 2 and 3, it was assumed that the maximum flow imbalance between the Charging/SI lines was equal to or less than 10 gpm. It was also assumed that the maximum pump degradation was equal to or less than 5 percent of the design pump head and that the system resistances were set at the specified runout flow, with a maximum pump degradation of 5 percent. These assumptions reduced the total Charging/SI flows as modelled in a representative LOCA analysis by as much as 8 percent. The impact for North Anna would be less, since 10 gpm imbalance has been incorporated in the current calculations.

A representative evaluation of the effect of the reduced ECCS flows due to Charging/SI line imbalance and reduced system resistance on the large break LOCA analysis was performed. Typically it is assumed that the ECCS pumped flow spills to 0 psig containment pressure. However calculated containment pressure during a large break LOCA transient is significantly higher. If credit is taken for the the higher calculated containment pressure the flow reduction in HHSI and charging/SI pumps will be more than compensated for by the increase in injected RHR flow. Thus no increase in the calculated peak clad temperature is expected.

An assessment of the effect of the reduced charging/SI flow was also made for the small break LOCA transient. It was determined that flow reductions of this magnitude have resulted in small break LOCA peak clad temperature penalties of approximately 88°F for similar plants. Again, because 10 gpm flow imbalance is already considered, the PCT penalty due only to reduced resistance is expected to be lower.

There are several alternatives if your plant is operating outside of a 10 gpm balance for injection lines for the Charging/SI pumps.

1) Restore flow balance such that flows are within 10 gpm in each systems' branch line, with no backpressure.

2) A test procedure can be developed to allow larger imbalances. This would be done by decreasing the amount the pumps could degrade. This would insure that the current ECCS flow performance is met.

3) A third option, which could be done in conjunction with relaxing system resistance requirements, would be to develop revised ECCS flow performance, based on a higher selected branch imbalance. This new ECCS performance would have to be included in your LOCA analyses.

## CONCLUSIONS

In summary, three issues have been discussed which could reduce the ECCS flow delivered to the core in the event of a LOCA. The amount of flow degradation and ultimate PCT effect depends on the actual plant configuration.

Issue 1 discussed how actual plant seal injection flow may vary from that assumed in the generation of ECCS flows as used in the LOCA analyses. In developing the ECCS flows for the North Anna Units 1 and 2 licensing basis LOCA analyses it was assumed that the seal injection flow at runout conditions was 65 gpm which is inconsistent with the 30 gpm seal injection flow limit at normal RCS pressure. An assessment of the discrepancy was made on a representative basis which determined that the small break LOCA analysis results could incur a penalty of 32°F. Since the flow reduction associated with this issue is relatively small, no large break LOCA penalty is expected. Westinghouse recommends that the Charging/SI ECCS flow rates be calculated to quantify the effect.

Issues 2 and 3 discussed how total system resistance and injection line imbalance may vary from that assured in the generation of ECCS flow as used in the LOCA analyses. For North Anna Units 1 and 2 the current licensing basis LOCA analysis is based on ECCS flows which were developed using the following assumptions:

Charging/SI pump runout head/flow = 2850 ft/650 gpm

Charging/SI injection line flow imbalance = 10 gpm

Charging/SI pump degradation = 290 ft

Because Westinghouse does not have plant specific data on the above listed parameters, it was not possible to generate a bounding peak clad temperature penalty. However, in order to assess the magnitude of possible peak clad temperature effects, Westinghouse performed an evaluation on a representative basis.

ECCS flows were developed using the assumptions of a maximum flow imbalance of 10 gpm and that system resistance was set at the specified runout flow with a maximum pump degradation of 5 percent. If for North Anna Units 1 and 2 the actual ECCS configuration is within these assumptions, then the PCT penalty for the small break LOCA analysis will be on the order of 88°F with no expected penalty for the large break LOCA analysis. If the actual plant configuration is not within the assumptions discussed above the peak clad temperature penalties may be larger.

To insure the ECCS flow performance assumptions are met, the hydraulic resistance associated with the Charging/SI pump runout conditions listed previously should be confirmed. If the resistance is lower, it should be restored or the effect on the LOCA analyses should be determined.

As previously mentioned, there are several alternatives if your plant is operating outside of a 10 gpm balance for the Charging/SI injection lines.

1) Restore flow balance such that flows are within 10 gpm in each systems' branch line, with no backpressure.

2) A test procedure can be developed to allow small imbalances. This would be done by decreasing the amount the pumps could degrade. This would insure that the current ECCS flow performance is met.

3) A third option, which could be done in conjunction with relaxing system resistance requirements, would be to develop revised ECCS flow performance, based on a selected branch imbalance. This new ECCS performance would have to be included in your LOCA analyses.

In conclusion, Westinghouse recommends that you review your plant configuration, to insure that it is consistent with ECCS analyses assumptions. In the longer term, you may want to consider adding operational flexibility.