May 28, 1985

Docket No. 50-334

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Mr. J. J. Carey, Vice President
Nuclear Group
Duquesne Light Company
Post Office Box 4
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Dear Mr. Carey:

SUBJECT: TMI ACTION ITEM II.K.3.30, "SMALL-BREAK LOCA"
(LICENSING ACTION TAC 45805)

On May 21 1985, the NRC approved the new Westinghouse small-break LOCA model, NOTRUMP, for use in satisfying the TMI Action Item II.K.3.30. The Westinghouse model was documented in the two Topical Reports, WCAP-10079 and WCAP-10054. The Westinghouse Owners Group (WOG) references NOTRUMP as its new licensing small break LOCA model to satisfy the requirements of TMI Action Item II.K.3.30. Our Safety Evaluation of Item II.K.3.30 for members of WOG is enclosed.

It is our understanding that you are a member of the WOG and that NOTRUMP is to be used in the small-break LOCA analysis for the Beaver Valley Unit 1. If this is correct, this completes the TMI Action Item II.K.3.30 for your plant and in accordance with the TMI Action Item II.K.3.31, "Compliance with 10 CFR 50.46", your plant-specific analysis is due within one year of receipt of this letter. Please advise us within 60 days if this is not correct and provide your plans and schedule for completing Items II.K.3.30 and II.K.3.31.

On November 2, 1983 in Generic Letter No. 83-35, the NRC provided clarification and proposed a generic resolution of TMI Action Item II.K.3.31. That is, resolution of II.K.3.31 may be accomplished by generic analysis to demonstrate that the previous analyses performed with WFLASH were conservative. Future plant-specific analysis performed for your plant by Westinghouse for reloads or Technical Specification amendments (those beyond 90 days of the date of this letter) should be calculated with the new code, NOTRUMP.

Sincerely,

/s/ SVarga

Steven A. Varga, Chief
Operating Reactors Branch #1
Division of Licensing

Enclosure:
As stated

cc w/enclosure:
See next page

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SAFETY EVALUATION

TMI ACTION ITEM II.K.3.30 FOR

WESTINGHOUSE PLANTS

REVISED METHOD FOR SB LOCA TO COMPLY WITH 10 CFR 50, APP. K

NUREG-0737 is a report transmitted by a letter from D. G. Eisenhut, Director of the Division of Licensing, NRR, to licensees of operating power reactors and applicants for operating reactor licenses forwarding TMI Action Plan requirements which have been approved by the Commission for implementation. Section II.K.3.30 of Enclosure 3 to NUREG-0737 outlines the Commission requirements for the industry to demonstrate its small-break loss-of-coolant accident (SBLOCA) methods continue to comply with the requirements of Appendix K to 10 CFR Part 50.

The technical issues to be addressed were outlined in NUREG-0611, "Generic Evaluation of Feedwater Transients and Small-Break Loss-of-Coolant Accidents in Westinghouse-Designed Operating Plants." In addition to the concerns listed in NUREG-0611, the staff requested licensees with U-tube steam generators to assess their computer codes with the Semiscale S-UT-08 experimental results. This request was made to validate the code's ability to calculate the core coolant level depression as influenced by the steam generators prior to loop seal clearing.

In response to TMI Action Item II.K.3.30, the Westinghouse Owners Group (WOG) has elected to reference the Westinghoue NOTRUMP code as their new licensing small break LOCA model. Referencing the new computer code did not imply deficiencies in WFLASH to meet the Appendix K requirements. The decision was based on desires of the industry to perform licensing evaluations with a computer program specifically designed to calculate small break LOCAs with greater phenomenological accuracy than capable by WFLASH.

The following documents our evaluation of the WOG response to TMI Action Item II.K.3.30 confirmatory items.

II. SUMMARY OF REQUIREMENTS

NUREG-0611 required licensees and applicants with Westinghouse NSSS designs to address the following concerns:

A. Provide confirmatory validation of the small-break LOCA model to adequately calculate the core heat transfer and two-phase coolant level during core uncovery conditions.

B. Validate the adequacy of modeling the primary side of the steam generators as a homogeneous mixture.

C. Validate the condensation heat transfer model and affects of non-condensible gases.

D. Demonstrate, through noding studies, the adequacy of the SBLOCA model to calculate flashing during system depressurization.

E. Validate the polytropic expansion coefficient applied in the accumulator model, and

F. Validate the SBLOCA model with LOFT tests L3-1 and L3-7. In addition, validate the model with the Semiscale S-UT-08 experimental data.

Detailed responses to the above items are documented in WCAP-10054, "Westinghouse Small Break ECCS Evaluation Model Using the NOTRUMP Code."

III. EVALUATION

The following is the staff's evaluation of the TMI Action Item requirements outlined above.

A. Core Heat Transfer Models

The Westinghouse Owners Group (WOG) referenced the NOTRUMP computer code as their new computer program for small-break loss-of-coolant accident (SBLOCA) evaluation. NOTRUMP was benchmarked against core uncovery experiments conducted at the Oak Ridge National Laboratory (ORNL). These tests were performed under NRC sponsorship. The good agreement between the calculations and the data confirmed the adequacy of the drift flux model used for core hydraulics as well as the core heat transfer models of clad temperature predictions.

The staff finds the core thermal-hydraulic models in NOTRUMP acceptable. This item is resolved.

B. Steam Generator Mixture Level Model

NUREG-0611 requested licensees and applicants with Westinghouse designed NSSSs to justify the adequacy of modeling the primary system of the steam generators as a homogeneous mixture. This question was directed to the WFLASH code. NOTRUMP, the new SBLOCA licensing code models phase separation and incorporates flow regime maps within the steam generator tubes. The adequacy of this model was demonstrated through benchmark analyses with integral experiments, in particular with Semiscale test S-UT-08.

The staff finds the steam generator model in NOTRUMP acceptable. This item is resolved.

C. Noncondensible Effects On Condensation Heat Transfer

NUREG-0611 requested validation of the condensation heat transfer correlations in the Westinghouse SBLOCA model and an assessment of

the consequences of noncondensible gases in the primary coolant. The condensation heat transfer model used in NOTRUMP is based on steam experiments performed by Westinghouse on a 16-tube PWR steam generator model. For two-phase conditions, an empirical correlation developed by Shah is applied.

The staff finds the condensation heat transfer correlation in NOTRUMP acceptable.

The influences of noncondensible gases on the condensation heat transfer was demonstrated by degrading the heat transfer coefficient in the steam generators. The heat transfer degradation was calculated using a boundary layer approach. For this calculation, the noncondensible gases generated within the primary coolant system were collected and deposited on the surface of the steam generator tubes. The sources of noncondensibles considered were:

(i) Air dissolved in the RWST.
(ii) Hydrogen dissolved in the primary system.
(iii) Hydrogen in the pressurizer vapor space.
(iv) Radiolytic decomposition of water.

With a degradation factor on the heat transfer coefficient, the limiting SBLOCA was reanalyzed for a typical PWR. The WOG, thereby, concluded that formation of noncondensible gases in quantities that may reasonably be expected for a 4-inch cold leg break LOCA presents no serious detriment on the PWR system response in terms of core uncovery or system pressure. What perturbation was observed was minor in nature.

The staff finds acceptable the Westinghouse submittal on the influences of noncondensible gases on design bases SBLOCA events. Our conclusion is based on the limited amount of noncondensible gases available during a design basis SBLOCA event, as well as results obtained from Semiscale experiments which reached similar conclusions while injecting noncondensible gases in excess amount expected during a SBLOCA design-basis event. This item is resolved.

D. Nodalization Studies For Flashing During Depressurization

As a consequence of the staff's experience with modeling SBLOCA events with NRC developed computer codes (in particular the TMI-2 accident), the staff questioned the adequacy of the nodalization in the licensing model to calculate the depressurization of the primary system. The staff therefore requested validation of the Westinghouse Evaluation Model to properly calculate the depressurization expected during a SBLOCA event.

Through nodalization studies and validation of the NOTRUMP licensing model with integral experiments (e.g., LOFT and Semiscale), Westinghouse demonstrated the acceptability of the nodalization and nonequilibrium models.

The staff finds the Westinghouse model acceptable for calculating depressurization during SBLOCA events. This item is resolved.

E. Accumulator Model

WFLASH, the previous Westinghouse small-break loss-of-coolant accident (SBLOCA) analysis code, applied a polytropic gas expansion coefficient of 1.4 to the nitrogen in the accumulators. The WOG was requested to validate this accumulator model in light of data obtained through the LOFT experimental programs for SBLOCAs. Westinghouse reviewed the applicable LOFT data and determined the need to perform full scale accumulator tests. Based upon these tests, Westinghouse modified the polytropic expansion coefficient to a more realistic value. Of interest is Westinghouse's conclusion that the selection of either a high or low expansion coefficient had negligible effect on the calculated peak clad temperature (PCT). This insensitivity is only appropriate to NOTRUMP, with its nonequilibrium assumptions.

The staff finds acceptable the polytropic expansion coefficient in the NOTRUMP code. This item is resolved.

F. Code Validation

Following the Three Mile Island event of 1979, staff analyses with NRC-developed computer codes led to concerns that detailed nodalization was required to simulate realistic systems responses to postulated SBLOCAs. As a consequence, licensees and applicants with Westinghouse plants were requested to validate their licensing tools with integral experiments. In specific, the NRC requested that the computer codes be validated with the LOFT L3-1 and L3-7 experimental data. In addition, the staff also requested that the code be benchmarked with the Semiscale S-UT-08 experimental data.

Westinghouse performed the above benchmark analyses. For the LOFT tests, Westinghouse showed good agreement between the NOTRUMP calculations and the experimental data. For the S-UT-08 test, Westinghouse demonstrated that NOTRUMP did a reasonable job calculating the experimental data. However, this required a more detailed nodalization of the steam generators than used in the licensing model. With the less detailed licensing nodalization, the pre-loop-seal-clearing core level depression phenomenon, as observed in the S-UT-08 data, was not conservatively calculated for very small breaks. However, the calculated peak clad temperature was demonstrated to be higher (more conservative) with the coarse nodalization. The staff, therefore, finds acceptable the NOTRUMP computer code and the associated nodalization for SBLOCA design basis evaluation.

This item is resolved.

IV. CONCLUSION

The Westinghouse Owners Group (WOG), by referencing WCAP-10079 and WCAP-10054, have identified NOTRUMP as their new thermal-hydraulic computer program for calculating small-break loss-of-coolant accidents (SBLOCAs). The staff finds acceptable the use of NOTRUMP as the new Westinghouse licensing tool for calculating SBLOCAs for Westinghouse NSSS designs.

The responses to NUREG-0611 concerns, as evaluated within this SER, have also been found acceptable.

This SER completes the requirements of TMI Action Item II.K.3.30 for licensees and applicants with Westinghouse NSSS designs who were members of the WOG and referenced WCAP-10079 and WCAP-10054 as their response to this item.

Within one year of receiving this SER, the licensees and applicants with Westinghouse NSSS designs are required to submit plant-specific analyses with NOTRUMP, as required by TMI Action Item II.K.3.31. Per generic letter 83-35, compliance with Action Item II.K.3.31 may be submitted generically. We require that the generic submittal include validation that the limiting break location has not shifted away from the cold legs to the hot or pump suction legs.

Principal contributor

J. Guttman

Dated

May, 1985