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TUCKER,H.B. Duke Power Co.
RECIP.NAME RECIPIENT AFFILIATION
DENTON,H.R. Office of Nuclear Reactor Regulation, Director
STOLZ,J.F. Operating Reactors Branch 4

SUBJECT: Forwards summary of licensee efforts to resolve NUREG-0737, Item II.K.3.30 re revised small break LOCA methods,Util will support B&W owners group effort to provide integral sys test data,utilizing GERDA test facility.

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August 25, 1982

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Mr. John F. Stolz, Chief
Operating Reactors Branch No. 4

Subject: Oconee Nuclear Station
Docket Nos. 50-269, -270, -287

Dear Sir:

For over three years, Duke and the Babcock and Wilcox Owners Group have been meeting with the NRC Staff and discussing generic issues related to the ECCS analytical codes utilized by B&W. The primary objective has been to adequately resolve the Staff concerns expressed in NUREG-0737, Item II.K.3.30, "Revised Small Break LOCA Methods to Show Compliance with 10 CFR 50, Appendix K". On July 20, 1982, the B&W Owners met with the NRC Staff in an attempt to reach final resolution of this generic issue. The purpose of this letter is to summarize the efforts that have been conducted to date and to clearly state the position of Duke Power Company on this item.

Duke considers that the technical information that has been provided to the Staff over the past three years is sufficient to resolve the concerns identified by the Staff in Action Plan Item II.K.3.30 and assure compliance with 10 CFR 50, Appendix K. However, the NRC Staff has continued to maintain that additional code verification is necessary by means of integral system test data (IST), to assure the adequacy of the codes. While it is not considered a safety issue, the Staff considers that such data are necessary to resolve such issues as recovery of natural circulation, long-term cooling, and the verification of the Abnormal Transient Operating Guidelines (ATOG).

Duke is concerned that the apparent costs of providing IST data may not be justified by the benefits; however, Duke is willing to support an Owners Group effort to provide such data, utilizing the GERDA test facility, when the Staff approves Action Plan Item II.K.3.30 and defines the relevant technical phenomena necessary to be addressed. Such integral test data will be generated in 1983 and testing is planned which addresses natural circulation, interruption of natural circulation, transition to boiler-condenser mode of cooling and long-term cooling. A distinct advantage of the GERDA testing is that test data will become available in early 1983, much sooner than any other alternative.

Duke Power Company recommends that the NRC Staff conduct a technical evaluation of the information previously provided, and summarized in the attachment to this letter, prior to initiating any new discussions on additional test evaluation

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efforts on this issue. Duke does recognize that legitimate safety issues may arise in the future and these will be appropriately addressed. However, Duke does not support discussions on any future testing issues until the Staff defines the relevant technical phenomena.

Very truly yours,

H. B. Tucker, Vice President
Nuclear Production Department

RLG/php
Attachment

cc: Mr. William J. Dircks
Executive Director for Operations
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Mr. Victor Stello
Deputy Executive Director for
Regional Operations and Generic Requirements
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Duke Power Company
Oconee Nuclear Station
Summary of Efforts to Resolve
Action Plan Item II.K.3.30

Background

Following the accident at TMI-2, the NRC required that further small break LOCA analyses be performed and that operator guidelines for managing small break loss of coolant transients be developed. The results of this work were documented by Babcock and Wilcox in the May 7, 1979 "Blue Books". In their review documented in NUREG-0565, the NRC concluded that while there was not a safety concern, certain features of the B&W SBLOCA Evaluation Model required more extensive verification. In general, the recommendations were:

1. Additional code model predictions of Semiscale and LOFT experiments should be performed.

2. The SB LOCA methods should be revised to address their specific concerns. In addition, the licensees should verify the analysis models with appropriate integral system data.

These recommendations were implemented as requirements in NUREG-0737, Item II.K.3.30 and the following describes Duke Power and the B&W Owners Group actions towards resolution of this item.

Discussion

The B&W Owners have taken several actions in responding to these recommendations. In response to recommendation 1, computer code simulations of LOFT tests L3-1[1] and L3-6[2] and Semiscale test S-07-10D[3] were submitted. The B&W simulation results compared well with the test data and the simulations presented by other vendors.

Since configurations tested in Semiscale and LOFT do not reflect all plant designs and arrangements, the acceptance by the Staff of benchmarks by other vendors would seem to be also applicable to B&W benchmarks of the same tests as adequate testing of computer codes used in SB LOCA calculations.

Prior to any action to respond to the SB LOCA issues in NUREG-0565, the B&W Owners Group met with the Staff on December 16, 1980 to obtain a better quantification of the Staff's issues relative to NUREG-0737, Item II.K.3.30. The Staff's issues were specified in the Staff minutes of that meeting (reference 4).

On May 12, 1981, the Owners Group again met with the Staff to present their program designed to address the issues of reference 4. The Staff concluded that eight of the nine issues would be resolved by the implementation of the program presented but that integral system test (IST) data would be required before II.K.3.30 could be signed off by the Staff. Attachment 1 details the response to each of the nine items in reference 4. During the meeting the Staff raised a number of issues over and above those originally quantified as II.K.3.30 issues. Following this meeting and for several months thereafter, a continuing technical dialogue was held between the Owners and the Staff in an effort to obtain and understand a complete list of

specific issues.

Finally, in a meeting on October 23, 1981 with B&W Utility Executives, the Staff identified the issues as uncertainties regarding hot leg "bubble dynamics" during the transition from natural circulation to the boiler-condenser mode.

From that meeting, the Staff agreed to participate in an in-depth review of the then current Babcock & Wilcox Small Break LOCA Methods Program, including the verification base. At the same time the Owners agreed to participate in a joint effort with the Staff to assure that current Small Break LOCA methods and Anticipated Transient Operating Guidelines (ATOG) programs are fully understood. The program was to include the following:

1. Code parameters, models, assumptions, etc., which are important in controlling dynamics of interest will be identified and available experimental data substantiating their validity will be reviewed. This would be done using results of the improved evaluation model in order that the most accurate dynamic response characteristics are reviewed.

2. Additional existing experimental data, from separate effects or integral tests, will be identified which address specific technical gaps, if any.

3. Identify where and how additional experimental data may be obtained, if any is required.

The Owners Group Analysis Subcommittee set a meeting with the Staff for December 16 and 17 to implement this commitment. The Owners came to that meeting prepared to address "bubble dynamics" and the CRAFT code. The Staff expected to be presented with a test program and the meeting ended in an impasse. In a letter to the Staff on February 5, 1982, the Subcommittee again set a meeting to discuss:

-- phenomena of bubble dynamics
-- sensitivity of the system to decay heat, number of HPI pumps, phase slip, and interphase heat transfer
-- discussion of benchmarks

On April 9, 1982, six reports were hand-delivered to the Staff for review prior to the April 16 meeting with the Owners Group. Attachment 2 to this letter provides a brief description of these reports.

In the period between February and April, the Staff again expanded issues outside of II.K.3.30 (reference 5). Since the Owners were involved in an intensive effort to produce documents in response to the identified focused issue of "bubble dynamics", it was not possible to address the items in reference 5 specifically in the April 16 meeting. The presentations in the April 16 meeting were perceived by the Owners as being well received by the Staff and to date no negative comments have been received from the Staff on that meeting. We have since addressed these issues (Attachment 3).

At the conclusion of the April 16 meeting, the issues could clearly be separated into two parts. One part deals with the assurance of core cooling (10 CFR 50,

Appendix K) and the other deals with the analytical basis for recovery of natural circulation, long-term cooling, and operator guidelines and training for these events.

Duke considers that GERDA is a technically acceptable test facility to address the phenomena associated with recovery from a small break and offers a unique way to benchmark several of these phenomena as they interrelate. GERDA is an integral system test which focuses on the longer-term natural circulation phenomena of the B&W design. The Owners provided the Staff with technical presentations on the design of GERDA at the Alliance Research Center on July 7 and followed with a tour of the facility.

Summary

Duke and the B&W Owners Group are continuing with the SBLOCA Methods Program described to the Staff and with the six reports described in Attachment 2. Duke will benchmark best estimate codes with appropriate test data, the preference being with GERDA, in order to provide better Staff understanding of the concerns contained in reference 5 which are outside the scope of Item II.K.3.30. With this commitment made, the Staff should be able to provide formal approval of Action Plan Item II.K.3.30.

Duke considers that the GERDA test data will be the confirmatory data which when provided will address issues raised by the Staff during their review of the II.K.3.30 SBLOCA program and will be a source of useful data to address other issues. We therefore invite the Staff to consider our test program as the means to minimize limited Owner and staff resources while enhancing the knowledge of the B&W system.

Duke agrees in principle to discussions of integral system testing with NRC Research, as proposed during the July 20, 1982 meeting. However, we do not support the Staff schedule which fixes resolution by October, 1982. Time is needed to perform technical evaluations of test data that the Owners have provided previously to the Staff for review, time is needed for the Staff to define the relevant technical issues, and time is needed to review test data that will become available from GERDA in early 1983.

We intend to provide a follow-up letter within the next few weeks which will provide additional details and milestones which Duke intends to pursue.

References

1. "B&W's Post Test Evaluation of LOFT Test L3-1", Document No. 51-1125988-00, May 1981.

2. "B&W's Best Estimate Prediction of the LOFT L3-6 Nuclear Small Break Test Using the CRAFT 2 Computer Code", Document No. 12-1124993-01, March, 1981.

3. "B&W's Post Test Analysis for Semiscale Test S-07-10D", Document No. 86-1125888-00, May, 1981.

4. Summary of Meeting with the B&W Owners Group Concernig the Abnormal Transient Operating Guidelines (ATOG) Program and TMI Action Item II.K.3.30 Small Break Loss of Coolant Accident Models (December 16, 1980).

5. Letter from Eisenhut to Mattimoe, March 25, 1982, Docket No. 50-312, Subject: Need for Model Verification.

ATTACHMENT #1

Nine areas of concern for II.K.3.30 were identified in the meeting of December 16, 1980 between the Staff and B&W Owners. These concerns are repeated below as found in the minutes of that meeting prepared by Mr. Throm of the Reactor Systems Branch. Owner responses to each concern are also included.

1. NEED TO VERIFY THE CURRENT NON-CONDENSIBLE MODEL AND THE CONSERVATISM OF THE CONDENSATION HEAT TRANSFER RATE IN THE STEAM GENERATOR.

   a) Report has been prepared describing a method to predict the amount of non-condensible gases in the primary system, including gas produced via radiolytic decomposition which may be released during a SBLOCA. This report will be submitted to the NRC in August 1982.

   b) A non-condensible gas heat removal model has been prepared and incorporated into the CRAFT code. This model is described in the revision to the CRAFT Topical Report scheduled for submittal to the Staff in September 1982.

2. NEED TO VERIFY THE NON-EQUILIBRIUM MODEL AND TO JUSTIFY THAT THE AMOUNT OF ECCS WATER INJECTED IS CONSERVATIVE.

   a) Report has been prepared and will be submitted to the Staff in August which justifies the current B&W ECCS evaluation model which utilizes CFT injection into the lower downcomer region.

   b) This work was discussed with the Staff in the technical presentations on December 16, 1981.

3. NEED TO DISCUSS THE PRESSURIZER MODEL AND THE EFFECTS OF A NON-EQUILIBRIUM MODEL.

   a) A non-equilibrium pressurizer model has been incorporated into the CRAFT code. This model will be addressed in the revised CRAFT Topical Report to be submitted to the Staff in September 1982. This model was discussed with the Staff on December 16, 1981.

   b) The surge line model was discussed with the Staff on December 16. The open question from the Staff will be addressed in a written response in September 1982.

4. NEED TO ADDRESS THE FORMATION OF A STEAM BUBBLE IN THE HOT LEG "CANDY CANE". (IS IT A REAL OR CALCULATED PHENOMENON?) EXPERIMENTAL VERIFICATION BELIEVED NECESSARY.

   a) This is addressed in several parts of the SBLOCA Methods Program:

      - System modeling study (steam generator, hot leg, and reactor vessel head)
      - Steam generator and pressurizer model changes

b) The joint NRC/Owners testing evaluation task concentrated on this issue. Documents described in Attachment #2 support the evaluation of this concern, and the report on "Bubble Dynamics" specifically addresses this concern.

5. THE STAFF INDICATED THAT A MECHANISTIC MODEL OF THE STEAM GENERATOR HEAT TRANSFER SHOULD BE DEVELOPED. A BEST ESTIMATE OR VERIFIED CONSERVATIVE MODEL WOULD BE ACCEPTABLE.

   a) The steam generator model has been upgraded and will be described in the revision of the CRAFT Topical Report to be issued to the Staff in September 1982.

   b) Steam generator model was presented to the Staff in the December 16, 1981 meeting.

6. AS PART OF THE ADDITIONAL SYSTEMS VERIFICATION NEEDED, THE FOLLOWING SEMISCALE AND LOFT TESTS SHOULD BE CONSIDERED: SEMISCALE S-07-10D, LOFT L3-1, L3-5, AND L3-6.

   a) The Owners considered the above tests and provided the Staff post test evaluations of L3-1, L3-6, and S-07-10D (References 1, 2, and 3 to this letter).

7. THE OVERALL THERMAL-HYDRAULIC BEHAVIOR OF THE CORE DURING UNCOVERY SHOULD BE VERIFIED AGAINST APPLICABLE EXPERIMENTAL DATA, PARTICULARLY THE RECENT ORNL DATA.

   a) ORNL data has been used to show that the current application of the Ditters-Boelter correlation is conservative. Data was discussed with the Staff on December 16, 1981, and a report will be provided to the Staff in August 1982.

8. THE INFLUENCE OF METAL HEAT ON THE SYSTEM PRESSURE RESPONSE, PARTICULARLY ON THE TIME OF ECCS INJECTION, WAS IDENTIFIED AS AN AREA OF CONCERN AND SHOULD BE SHOWN TO BE PROPERLY CONSIDERED IN THE ANALYSIS MODELS.

   a) The B&W ECCS Evaluation Model currently accounts for metal heat and no change needs to be made.

9. THE BREAK FLOW MODEL NEEDS TO BE CONFIRMED. THE USE OF COMBINED MODELS WITH VARIOUS DISCHARGE COEFFICIENTS APPLIED TO THEM NEEDS TO BE COMPARED TO A BEST ESTIMATE MODEL TO DEMONSTRATE CONSERVATISMS.

   a) The existing leak discharge model has been found to produce results which are similar to yet still conservative with respect to those obtained with the best estimate model.

   b) The work was discussed with the Staff on December 16, 1981 and the report will be provided to the Staff in August 1982.

ATTACHMENT #2

Documents prepared and submitted to the Staff from the B&W Owners' participation in the joint test evaluation task with the NRC.

"The GERDA Test Facility"

This report was prepared in fulfillment of the October 23 commitment by B&W.

"CRAFT 2 Prediction of ARC Loss-of-Feedwater Test", 12-1132544-00, April 1982

This report shows that the revised steam generator model adequately predicts the temporal response of key once-through steam generator parameters after a complete loss of feedwater.

"Auxiliary Feedwater Penetration", 12-1132513-00, April 1982
"Auxiliary Feedwater Axial Flow Distribution", 12-1132543-00, April 1982

The first report describes the calculation model and testing basis for the penetration of the auxiliary feedwater in the OTSG, and the second report uses this model and shows how the axial flow distribution was derived from FOAK testing at Oconee 1.

"Benchmarks for AFW Models", 12-1132555-00, April 1982

This report contains the benchmark results of the AFW models against actual plant data from four plant transients. The ability to predict plant response following loss of offsite power for the extreme conditions under which the AFW system will function is demonstrated in this report.

"Bubble Dynamics", 12-1132565-00, April 1982

This report is focused on the main phenomenological aspects of steam in the hot leg "U" bend and addresses test data and engineering evaluation used to understand "bubble dynamics". Based upon the focused Staff concern on the dynamics of a trapped steam bubble in the inverted U-bend of the hot legs, two issues were identified:

1. During the blowdown portion of the transient, does the code properly predict the formation of the steam bubble and its resultant interruption in natural circulation?

2. During the system refill phase of the transient, how does the trapped steam bubble behave?

In addressing these issues, a review of the calculated plant response was performed in order to assess the controlling phenomena. As a result of that review, it was determined that the governing phenomena were:

1. Interruption in Natural Circulation

   - Spatial heat transfer in the steam generator
   - Distribution of steam flow from the core
   - Phase slip within the hot leg
   - Steam condensation in the steam generator

2. System Recovery Phase

   - Steam condensation on steam-liquid interface

Test data supporting the modeling of these phenomena has been evaluated and reported in the documents listed above. Further understanding of the plant response is provided in a qualitative assessment of plant behavior to various input and modeling assumptions contained in this report. It is clear that the concern on the interruption of natural circulation is a byproduct of the Appendix K assumption on HPI flow. Using the single failure assumption of Appendix K, it is shown in this report that phase slip modeling is important to the development of the plant response. Phase slip modeling is a part of the current SBLOCA Methods Program. The adequacy of current phase slip modeling was shown in the evaluation of test data discussed in the April 16 meeting with the Staff and summarized in this report.