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Docket Nos.: 50-460, 50-329,  
and 50-330

MEMORANDUM FOR: Brian W. Sheron, Chief  
Reactor Systems Branch  
Division of Systems Integration

FROM: Elinor G. Adensam, Chief  
Licensing Branch No. 4  
Division of Licensing

SUBJECT: SMALL BREAK LOCA METHODS

Attached are copies of three letters received recently on the subject of small break LOCA. Two of them relate to the WNP-1 docket and the third relates to the Midland - 1/2 docket. The letters are utility follow-up to a meeting on this subject held with the staff on July 20, 1982. Licensing Branch No. 4 was not represented at that meeting. However, the attached letter from the Washington Public Power Supply System dated September 9, 1982 is addressed to my attention and requests the NRC staff to provide a preliminary cost benefit analysis.

The B&W Owners Group is pursuing resolution of the SBLOCA issue, which is NUREG-0737 item II.K.3.30, with the staff independent of the WNP-1 and Midland OL licensing proceedings. The attached letters have been sent to NRR in the manner that normal technical submittals in support of the OL license review would be sent. However, LB#4 is not in a position to agree or disagree with the content of the attached nor are we in a position to make the requested commitment on behalf of the staff. It is not clear, based on review of the distribution sheet, that this correspondence has been distributed to the appropriate technical branch, which we believe to be RSB.

The attached letters are forwarded for your action, as appropriate. Please advise the WNP-1 and Midland LPM (R. W. Hernan) if any action by DL is required at this time on these dockets and if any significant actions occur which would affect the licensing process for these plants.

Elinor G. Adensam, Chief  
Licensing Branch No. 4  
Division of Licensing

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A PDR

Enclosures:

As stated

OFFICE	DL:LB#4	DL:LB#4				
SURNAME	RHernan:eb	EAdensam				
DATE	10/1/82	10/1/82				

## Washington Public Power Supply System

P.O. Box 968 3000 George Washington Way Richland, Washington 99352 (509) 372-5000

Docket No. 50-460  
August 25, 1982  
G01-82-0527

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

Attention: E.G. Adensam, Chief  
Licensing Branch No. 4

Subject: NUCLEAR PROJECT NO. 1  
SMALL BREAK LOCA METHODS

On July 20, 1982, the B&W Owners met with the Staff to culminate the continuing dialogue on the scope of the program for resolution of NUREG-0737, Item II.K.3.30, "Revised Small Break LOCA Methods to Show Compliance with 10CFR50, Appendix K." This letter formalizes the proposals made at that meeting.

We will resolve the two separate areas identified by the Staff in the April 16, 1982 meeting. The first, assurance of core cooling (10CFR50, Appendix K), is being evaluated under an ongoing SB LOCA Methods program approved by the Staff. The B&W Owners will continue to address the NUREG-0737, II.K.3.30 Staff issues in the SB LOCA methods program as identified in Attachment #1. The B&W Owners Group has also prepared a number of reports as a result of the recent joint test evaluation with the Staff which are identified in Attachment #2.

The second area deals with the analytical basis for recovery of natural circulation, long term cooling, and operator guidelines and training for these events. B&W Owners propose to benchmark our best estimate codes with Integral System Test (IST) data from the GERDA SB LOCA test facility. This facility was designed to provide better understanding of the longer term response of the B&W system. It will also provide data which will validate ATOG assumptions for those transient periods. The inclusion of GERDA and SRI-II test data should also alleviate the general uneasiness regarding the need for improved understanding of the B&W design which was expressed by the Staff in our meetings. GERDA will provide test data for natural circulation, interruption of natural circulation, the transition to boiler-condenser mode of cooling and the long term cooling of the system. This additional data should provide the Staff with sufficient confidence in the validity of B&W best estimate codes to accept the Owner's program as resolution of II.K.3.30.

The B&W Owners are not willing to commit to an open ended test program, but do recognize that issues may be identified as data is developed which require further evaluation. We propose to evaluate any issues which rise and to take appropriate action for their resolution.

The following is more detail on the support for this position.

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## 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 B&W 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 SB LOCA 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 could 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 our 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<sup>1</sup> and L3-6<sup>2</sup> and Semiscale test S-07-10D<sup>3</sup> 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 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.<sup>4</sup>

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 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 main 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 Abnormal Transient Operating Guidelines (ATOG) programs are fully understood. The program was to include the following:

- 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.
- Additional existing experimental data, from separate effects or integral tests, will be identified which address specific technical gaps, if any.
- 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 (10CFR50, 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. At this time the Owners began to develop the program described above for acquiring IST data to benchmark best estimate codes to be used in calculating operator oriented phenomena for ATOG.

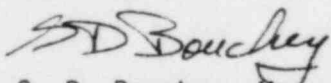
Summary

The B&W Utility Owners are continuing their work to address II.K.3.30 with the SB LOCA Methods Program described to the Staff and with the six reports described in Attachment #2. We further offer to benchmark best estimate codes with GERDA/SRI-II test data to provide better Staff understanding of the concerns in reference 5 which are outside of II.K.3.30. We believe that GERDA is a technically acceptable test facility to address the phenomenon associated with recovery from a small break and offers a unique way to benchmark several of these phenomenon as they interrelate - that is, GERDA is an integral system test focused on the longer term natural circulation phenomena of the B&W design. We 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.

The majority of Staff comments were favorable during and immediately following the presentation. However, a very negative comment was made by the Staff in the July 20 meeting with the Executives. We would be happy to address any technical questions the Staff or their consultants might have regarding GERDA, SRI-II and the test programs at each facility. B&W will be sending you, under separate cover, a description of the GERDA and SRI-II test programs.

We view our IST test program as the final element in addressing issues raised by the Staff during their review of the II.K.3.30 SB LOCA program and as a source of useful data to address other issues. These tests will be used as the bridge in the next logical step towards identifying any residual need for additional or modified test facilities. 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.

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



G. D. Bouchey, Manager  
Nuclear Safety & Licensing

GDB:AGH:mb

cc: CR Bryant, BPA (399)  
RW Hernan, NRC  
FDCC (899)  
ORM (847)

attachments: 3

## 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 Concerning 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-condensable 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-condensable 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

ATTACHMENT #1 (cont'd)

- 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.

Responses to the Eisenhut to Mattimoe letter of March 25, 1982.

1. Interruption of Natural Circulation

● Branch Flow

The effect of preferential steam flow to the hot leg or the RV head has been addressed in the "Bubble Dynamic" report (see Attachment #2). Branch flow was discussed with the Staff in the April 16, 1982 meeting.

● Hot Leg Flow Regime

This was addressed in the Slip model presentation to the Staff on April 16, 1982 and is discussed in the report "Bubble Dynamics" (see Attachment #2).

2. Cold Leg Thermal Shock

The concern over cold leg thermal shock was derived, as we understand, from TRAC computer calculations performed by LASL for the Staff wherein significant cyclic temperature variations were shown in the vicinity of the cold leg ECC injection. We encourage the Staff to have an independent QA performed on these calculations by an organization familiar with the hardware and components of the B&W designed system. If the cyclic behavior is confirmed, programs are already in place to address thermal shock and this item would be included in that effort.

3. Hydraulic Stability Following Accident Recovery

This concern is addressed in the report "Bubble Dynamics" and was discussed with the Staff on April 16, 1982. In addition, the presentation given in that meeting, "Steam Condensation on Steam-Liquid Interface", also addresses the governing phenomenon in the recovery phase.

Other concerns in the March 25 letter were: break isolation, steam generator tube rupture, and cooldown and depressurization following a SBLOCA. These concerns are covered by the ATOG Guidelines and some are specific per plant type. Further discussion on these items is expected but not as a part of 11.K.3.30.

## Washington Public Power Supply System

P.O. Box 968 3000 George Washington Way Richland, Washington 99352 (509) 372-5000  
Docket No. 50-460  
September 9, 1982  
G01-82-0552

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

Attention: E.G. Adensam, Chief  
Licensing Branch No. 4

Subject: NUCLEAR PROJECT NO. 1  
SMALL BREAK LOCA METHODS

Reference: Letter G.D. Bouchey, Supply System to Harold R. Denton, same  
subject, dated August 25, 1982.

This letter compliments the proposal made in the reference by providing the details of a cooperative evaluation program with the NRC as requested in the July 20, 1982 meeting. The cooperative evaluation program is designed to satisfy the following objectives.

- Provide the capability for rapid response to Staff concerns.
- Support the near term approval by the Staff during their evaluation of our SB LOCA Methods Program (II.K.3.30).
- Expand the test data base for SB LOCA phenomena by providing two-phase IST data to benchmark calculational tools used to predict long term plant performance with an SB LOCA.
- Improve the Staff's knowledge of the B&W plant design and increase their confidence in our prediction of plant performance under various transients.

The cooperative evaluation program outlined in the attachment will lead to the development of priorities for any needed research and the determination of the most cost-effective method of satisfying those priorities identified. This is responsive to the Staff request of July 20, 1982 as we understand it.

The near term test data from GERDA and the long term data from SRI-2 will be evaluated to verify scaling assumptions and predicted loop performance for that facility. The program will also provide a comprehensive data base for code benchmarking by the Staff and the Owners. Such codes should then provide the Staff with more confidence in the analytically predicted behavior of B&W plants.

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Mr. Harold R. Denton  
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G01-82-0552

The GERDA test data would be made available on a proprietary basis to the Staff for their code benchmarking efforts. The data from SRI-2 will be in the public domain.

This proposed program is a prerequisite to further analysis and testing and will provide input into the design, modification, or confirmation of a test facility should the evaluation dictate such a need.

The success of this cooperative program is dependent on all parties striving to reach a common point. The success of this effort, thus is dependent on the commitment of the necessary resources. As a participating B&W Owner, we will obtain the integral systems test data from the German GERDA facility and SRI-2. We expect that the NRC Staff will support the issuance of an SER which will close out II.K.3.30 so that II.K.3.31 work on the operating plants and those plants to be licensed by the NRC Staff will proceed without further diversion of Owner and Staff resources. As stated above, we would offer to provide GERDA data to the NRC Staff at no cost for their use in benchmarking TRAC and RELAP 5 provided that the NRC Staff provide their models of a B&W plant to B&W for quality assurance review. This quality assurance review effort by B&W is expected to be funded by the NRC.

We have selected this approach because it provides near term IST test results from an existing facility representative of the B&W design, as well as longer term two loop data from SRI-2 which will also reflect the B&W design. The program provides an expanded base of knowledge about the B&W design which will aid the Staff in future regulatory actions and will prove invaluable in the decision making process regarding future testing and test facilities.

We feel that testing must be technically justified and that it must be supported by a cost benefit analysis. Changes in the commitments in this letter will be subjected to this test before acceptance by the B&W Owners Group.

We have initiated contact with H. Sullivan of the NRC Staff and established a first meeting date of September 16, 1982. To facilitate the initial steps of the program, we request that the NRC Staff provide the preliminary cost benefit analysis performed by their consultants for various IST alternatives at that time.

Mr. Harold R. Denton  
Page 3  
G01-82-0552

We are reviewing GERDA test specifications and have initiated financial arrangements with the Germans. EPRI has provided a test plan for SRI-2 for your review. We are willing to participate in a joint panel with the NRC as outlined in this letter. This program is one we can support both financially and technically and we invite the NRC to join us in this effort. Your timely concurrence is needed because of the near term financial commitment involved.

If you have any questions, please call.



G.D. Bouchey, Manager  
Nuclear Safety & Licensing

GDB/mb

Attachment: 1

cc: W.J. Dircks, NRC  
V. Stello, NRC  
R.W. Hernan, NRC  
FDCC (899)  
ORM (847)

## ATTACHMENT #1

### TEST ADVISORY GROUP

The Test Advisory Group (TAG) will consist of members from the NRC and Industry whose job will be to evaluate test data which supports the B&W designed NSS and to prepare a cost benefit analysis of any identified future testing needs.

An orderly way to proceed would be to:

- Identify all relevant technical phenomenon in codes used to analyze the B&W system and list all current testing support for these phenomena
- Evaluate GERDA and SRI-2 as sources of additional benchmarks for other phenomenon.
- Perform a cost benefit analysis of identified tests and test facilities to address residual phenomenon.

The general approach proposed by the B&W Owners Group is to take advantage of near term available test facilities and test results to decide what if any additional testing is needed.

GERDA will provide data to benchmark relevant phenomenon associated with natural circulation, interruption, and refill with an SB LOCA. SRI-2 is planned to provide two loop data for investigating loop-to-loop instability and S.G. tube ruptures. In addition, B&W designed plants will be starting up within the next two years and the Owners plan to evaluate plant testing as a source of useful two loop data.

The completion of the program proposed by the Owners will provide a reasonable technical basis for the identification of additional testing needs and will supply useful data to confirm or modify the design of additional test facilities.

An outline of the B&W Owners approach to the Test Advisory Group is provided for convenience of review. A schedule has also been prepared to integrate the activities of the Test Advisory Group and related support work to be performed by the Owners to culminate in the preparation of a final report on testing needs to support the B&W designed plant.

## OUTLINE FOR TEST ADVISORY GROUP (TAG) WORK

- Objective:
- Evaluate Testing Needs
  - Develop Cost Benefit of Future Testing

### 1. Members:

- NRRES - Sullivan (Chair)
- B&W Owners Group Analysis Subcommittee
- B&W
- Reactor System Branch
- EPRI

### 2. Scope:

- Develop List of Phenomena that Codes Simulate
- Identify Benchmark Needs
- Evaluate the Acceptability of Current Data
- Evaluate the Acceptability of GERDA/SRI-2/Plant Testing to Satisfy POI
- Identify Possible Ways to Fill Residual Testing Needs and Cost Benefit

Evaluation panel will not manipulate/control GERDA/SRI-2 Testing or Code Benchmarking by the Owners.

### 3. Products:

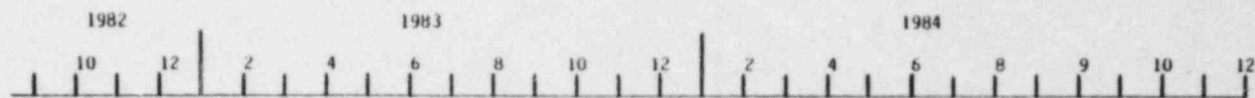
- Listing of Phenomena in Codes that Data Must Support
- Phenomena Supported by Current Information
- Phenomena Supported by GERDA/SRI-2/Plant Testing
- Cost Benefit of Facilities to Address Residual Issues

### 4. Conditions:

- List is Composed of Phenomena, Not Licensing Concerns
- Commitment of Resources by all Participating Parties
- We Will Provide Data to benchmark TRAC. NRC to Agree to Certify a Deck for B&W Plants to Be Approved by B&W
- Reports Must Include All Participants' Positions (i.e. Dissenting Views)



# INTEGRATED SCHEDULE FOR TAG AND OWNERS GROUP ACTIVITIES



▽ SER-1C1

▽ SER-11K. 3. 30

1. SB LOCA Program



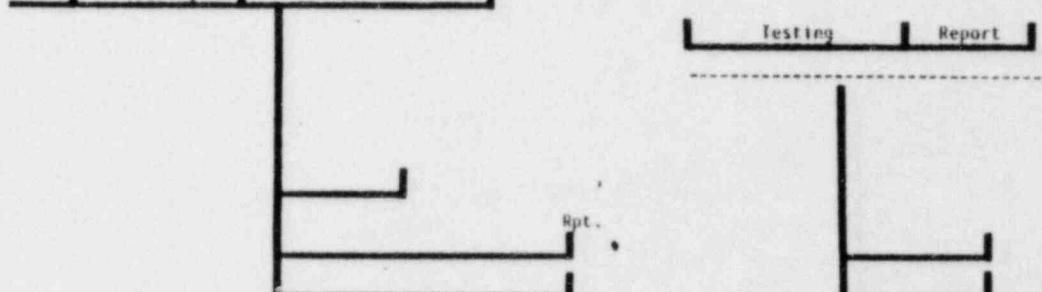
2. IST Data

- GERDA
- SRI-2
- Plant Testing



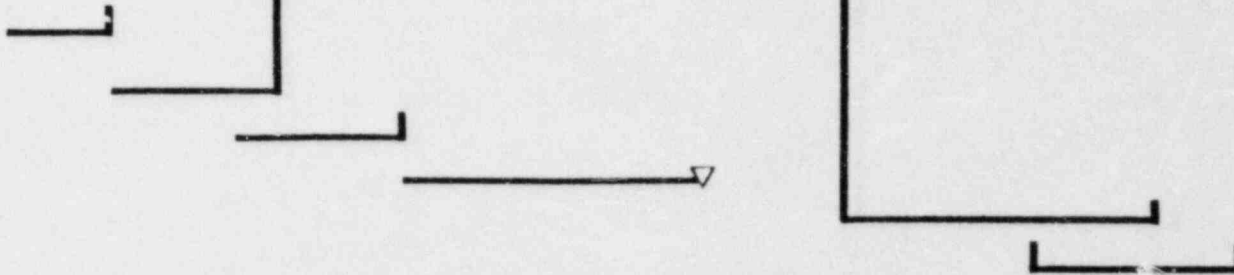
3. Code Benchmarks

- CRAFT (limited) for 11.K.3.31 only
- RELAP-5
- TAC (NRC)



4. Test Advisory Panel

- Approach/List of Phenomena
- Review of Existing Info
- Evaluate GERDA Data
- Interim Report
- Evaluate SRI-2
- Final Report



A-3



Consumers  
Power  
Company

SB LOCA

James W Cook  
Vice President - Projects, Engineering  
and Construction

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August 12, 1982

Harold R Denton, Director  
Office of Nuclear Reactor Regulation  
Division of Licensing  
US Nuclear Regulatory Commission  
Washington, DC 20555

MIDLAND NUCLEAR COGENERATION PLANT  
MIDLAND DOCKET NOS 50-329, 50-330  
REVISED SMALL BREAK LOCA METHODS  
NUREG-0737, ITEM II.K.3.30  
FILE: 0926.2 SERIAL: 18441

On July 20, 1982, the B&W Owners met with the Staff to culminate the continuing dialogue on the scope of the programs for resolution of NUREG-0737, Item II.K.3.30, "Revised Small Break LOCA Method to Show Compliance with 10 CFR 50, Appendix K." This letter formalizes the proposals made at that meeting.

We will resolve the two separate areas identified by the Staff in the April 16, 1982 meeting. The first, assurance of core cooling (10 CFR 50, Appendix K), is being evaluated under an ongoing SB LOCA Methods program approved by the Staff. The B&W Owners will continue to address the NUREG-0737, II.K.3.30 Staff issues in the SB LOCA method program as identified in Attachment #1. The B&W Owners Group has also prepared a number of reports as a result of the recent joint test evaluation with the Staff which are identified in Attachment #2.

The second area deals with the analytical basis for recovery of natural circulation, long term cooling, and operator guidelines and training for these events. B&W Owners propose to benchmark our best estimate codes with Integral System Test (IST) data from the GERDA SB LOCA test facility. This facility was designed to provide better understanding of the longer term response of the B&W system. It will also provide data which will validate ATOG assumptions for these transient periods. The inclusion of GERDA and SRI-II test data should also alleviate the general uneasiness regarding the need for improved understanding of the B&W design which was expressed by the staff in our meetings. GERDA will provide test data for natural circulation, interruption of natural circulation, the transition to boiler-condenser mode of cooling and the long term cooling of the system. This additional data should provide the Staff with sufficient confidence in the validity of B&W best estimate codes to accept the Owners' program as resolution of II.K.3.30.

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The B&W Owners are not willing to commit to an open ended test program, but do recognize that issues may be identified as data is developed which require further evaluation. We propose to evaluate any issues which arise and to take appropriate action for their resolution.

The following is more detail on the support for this position.

### 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 B&W 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 SB LOCA 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 NUREC-0737, Item II.K.3.30 and the following describes our 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<sup>1</sup> and L3-6<sup>2</sup> and Semiscale test S-07-10D<sup>3</sup> 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 the meeting.<sup>4</sup>

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 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 main 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:

- 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.
- Additional existing experimental data, from separate effects or integral tests, will be identified which address specific technical gaps, if any.
- 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. At this time the Owners began to develop the program described above for acquiring IST data to benchmark best estimate codes to be used in calculating operator oriented phenomena for ATOG.

### Summary

The B&W Utility Owners are continuing their work to address II.K.3.30 with the SB LOCA Methods Program described to the Staff and with the six reports described in Attachment #2. We further offer to benchmark best estimate codes with GERDA/SRI-II test data to provide better Staff understanding of the concerns in Reference 5 which are outside of II.K.3.30. We believe that GERDA is a technically acceptable test facility to address the phenomenon associated with recovery from a small break and offers a unique way to benchmark several of these phenomenon as they interrelate - that is, GERDA is an integral system test focused on the longer term natural circulation phenomena of the B&W design. We 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.

The majority of Staff comments were favorable during and immediately following the presentation. However, a very negative comment was made by the Staff in the July 20 meeting with the Executives. We would be happy to address any technical questions the Staff or their consultants might have regarding GERDA, SRI-II and the test programs at each facility. B&W will be sending you, under separate cover, a description of the GERDA and SRI-II test programs.

We view our IST test program as the final element in addressing issues raised by the Staff during their review of the II.K.3.30 SB LOCA program and as a source of useful data to address other issues. These tests will be used as the bridge in the next logical step towards identifying any residual need for additional or modified test facilities. 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.

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

*James W. Cook*

JWC/LSG/fms

CC RJCook, Midland Resident Inspector  
 RHernan, US NRC

DBMiller, Midland  
 RWHouston, Washington

## 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 Concerning 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-condensable 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-condensable 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

ATTACHMENT #1 (cont'd)

- 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 test at Ocone 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?

## ATTACHMENT #2 (cont'd)

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.

### ATTACHMENT #3

Responses to the Eisenhut to Mattimoe letter of March 25, 1982.

#### 1. Interruption of Natural Circulation

##### ● Branch Flow

The effect of preferential steam flow to the hot leg or the RV head has been addressed in the "Bubble Dynamic" report (see Attachment #2). Branch flow was discussed with the Staff in the April 16, 1982 meeting.

##### ● Hot Leg Flow Regime

This was addressed in the Slip model presentation to the Staff on April 16, 1982 and is discussed in the report "Bubble Dynamics" (see Attachment #2).

#### 2. Cold Leg Thermal Shock

The concern over cold leg thermal shock was derived, as we understand, from TRAC computer calculations performed by LASL for the Staff wherein significant cyclic temperature variations were shown in the vicinity of the cold leg ECC injection. We encourage the Staff to have an independent QA performed on these calculations by an organization familiar with the hardware and components of the B&W designed system. If the cyclic behavior is confirmed, programs are already in place to address thermal shock and this item would be included in that effort.

#### 3. Hydraulic Stability Following Accident Recovery

This concern is addressed in the report "Bubble Dynamics" and was discussed with the Staff on April 16, 1982. In addition, the presentation given in that meeting, "Steam Condensation on Steam-Liquid Interface", also addresses the governing phenomenon in the recovery phase.

Other concerns in the March 25 letter were: break isolation, steam generator tube rupture, and cooldown and depressurization following a SBLOCA. These concerns are covered by the ATOG Guidelines and some are specific per plant type. Further discussion on these items is expected but not as a part of 11.K.3.30.

