Han

MAY 1 1986

MEMORANDUM FOR: Mel Silberberg, Chief
Fuel Systems Research Branch
Division of Accident Evaluation

FROM: James T. Han
Fuel System Research Branch
Division of Accident Evaluation

SUBJECT: A SUMMARY OF MARCH 17, 1986 MEETING ON RCS NATURAL CIRCULATION STUDIES

This memo summarizes the subject meeting held on March 17, 1986 in Bethesda, Maryland. Objectives of the meeting were to: (1) introduce to NRR staff the RES-sponsored studies on RCS Natural Circulation under TMLB' (Station blackout with no auxiliary feedwater) accident conditions, and (2) seek comments and suggestions from NRR and RES staff on those studies. RCS Natural Circulation is a NUREG-1150 issue currently under study. This issue has direct impact on other NUREG-1150 issues including direct containment heating, hydrogen generation, melt progression and fission product revaporization. In addition, RCS Natural Circulation will also address the concern on steam generator (SG) tube rupture which may lead to fission product bypass of the containment.

The meeting was started with my presentation on the overview of RCS Natural Circulation. I also discussed briefly our plans to resolve this issue by using the detailed mechanistic codes including MELPROG/TRAC, SCDAP/RELAP5, and COMMIX. Preliminary TMLB' calculations using those codes were presented by NRC contractors from LANL, SNL, INEL, and ANL. The meeting went well with active audience participation. A number of questions and interesting comments were raised. There were about 30 people attending the meeting with one-third of them from NRR and the rest from RES and national laboratories. Enclosed are a meeting agenda, the overview of RCS Natural Circulation, a list of attendees, and two commenting letters from the attendees. A set of meeting handouts is available in my office to anyone interested.

The following is a summary of those comments and concerns which may affect the scope and the course of the RES-sponsored studies on RCS Natural Circulation.

1. It is very difficult to realistically model the natural circulation flow in the SG tubes because we do not know how many tubes will have flow while the rest of the tubes have no flow. SG tube flow is a transient process - some tubes may have upward flow for a while and then flow direction may be reverse or become stagnant. This comment addresses the use of the COMMIX code in modeling the flow in the SG tubes. As a result, we may have to do some parametric study by varying the number of tubes with stagnant flow and making assumptions on flow distribution in the SG.

2. Flow resistance of the cross flow (normal to the axial flow) is important for calculating in-vessel natural circulation. Correlations used in the COMMIX or MELPROG/TRAC code need to be examined for applicability under the natural circulation conditions. I am contacting Westinghouse through NRR to seek any data they may have in this area.

3. Non-symmetric effects among the RCS loop flows need to be considered. This comment is valid especially during the cyclic opening and closing periods of the PORV or SRV of the pressurizer. However, three-dimensional modeling in the MELPROG/TRAC code may be needed to address this non-symmetric multi-loop effects. Currently the code is two-dimensional (with axial and radial dimensions) in the vessel and we do not have immediate plans to make it three-dimensional by adding azimuthal dimension. Resolution of this concern needs further evaluation.

4. Simple experiments have been suggested to assess the above concerns, although we did not have time to discuss what experiments are needed. However, it is also recognized that before we plan any experiments we should examine closely the existing experiments sponsored by EPRI in which the RCS of a PWR is simulated by a 1/7-scale semicircular vessel with two loops attached using either water or sulfur hexafluoride as coolant. I have not received the Westinghouse report on the first-phase experiments from EPRI, and I will certainly distribute it to interested staff members for comments.

5. Decay heat redistribution due to fission product release and deposition should be modeled. For example, fission product deposition in the upper plenum region tends to increase the upper plenum surface temperature. As a result, natural circulation flow in the vessel will be altered. We have the plan to add models to both the SCDAP/RELAP5 and MELPROG/TRAC codes to address this concern.

6. Chemical reactions between the upper plenum steel and steam will produce additional hydrogen and also make the upper plenum hotter. Therefore, the process should be modeled. We will add models to our codes to include this process.

7. RCS Natural Circulation is a very difficult problem, in which thermal-hydraulics is coupled with core melt progression, hydrogen generation due to metal-steam reaction, and fission product release and deposition. As a result, modeling uncertainties are inherently large. We should expect to relax accuracy requirements for the severe accident analysis codes such as MELPROG/TRAC and SCDAP/RELAP5 as compared with thermal-hydraulic codes such as TRAC and RELAP5 for design-basis accident analysis.

We are planning to incorporate the above comments to the extent limited by the funding and time constraints. As part of the code development plan, models are being added to MELPROG/TRAC to account for fission product decay heating on the upper plenum structures (comment no. 5); these improvements will be included in the next MELPROG/TRAC calculation to be completed in six months. New results will be reviewed in another meeting in the fall, and we will find out how much effect these improvements have on the hot leg nozzle temperature, which is predicted in the current preliminary MELPROG/TRAC calculation to be around 1000°C before the vessel bottom head fails for the Surry Plant under TMLB' conditions.

Finally, I would like to thank all attendees - especially W. Lyon of NRR and N. Zuber of RES - for their comments and participation.

/S/

James T. Han
Fuel System Research Branch
Division of Accident Evaluation

Enclosures:
As stated

DIST:

Subj	Curtis:CY
Circ	Shotkin:CY
Chron	Zuber:CY
Branch:RDG	Lyon:CY
Han:RDG:CY	Ernst:CY
Conti:CY	Mitchell:CY
Morris:CY	Chan:CY
Ross:CY	Marino:CY
Minogue:CY	Wright:CY
Denton:CY	Cunningham:CY
Speis:CY	Leung:CY
Rosztoczy:CY	Allen:CY
Eltanila:CY	Palla:CY
Read:CY	

FSRB JH FSRB MS
HAN/dpv SILBERBERG
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MAR 12 1986

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MEMORANDUM FOR: Distribution

FROM: James T. Han
Fuel Systems Research Branch
Division of Accident Evaluation, RES

SUBJECT: INVITATION TO ATTEND A MEETING ON THE STATUS OF TMLB' STUDIES

MONDAY, MARCH 17, 1986
ROOM P-118, PHILLIPS BUILDING
7920 NORFOLK AVENUE, BETHESDA, MARYLAND

You are cordially invited to attend a one-day meeting on the status of PWR TMLB' studies using the detailed mechanistic codes. Results are preliminary. Your participation and comments would be appreciated.

Agenda

Time	Topic	Speaker
8:30 a.m.	Overview	J. Han, NRC
9:00 a.m.	MELPROG Code Introduction	J. Kelly, SNL
9:30 a.m.	2-D MELPROG Calculation for TMLB' in the SURRY Plant	R. Henninger, LANL
10:30 a.m.	BREAK	
10:45 a.m.	MELPROG Insight of NUREG-1150 Issues	J. Kelly, SNL
11:30 a.m.	Discussion	
12:00 noon	LUNCH	
1:10 p.m.	COMMIX Code Applications	V. Shah, ANL
3:00 p.m	SCDAP/RELAP5 Calculation	P. Bayless, INEL
~~2:20~~ 3:20 p.m.	Discussion	
4:00 p.m.	Adjourn	

Original Signed By

James T. Han
Fuel Systems Research Branch
Division of Accident Evaluation
Office of Nuclear Regulatory Research

DAE:FSRB
Han:md
3/11/86

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RCS NATURAL CIRCULATION DURING TMLB' ACCIDENTS IN A PWR - AN OVERVIEW

JAMES T. HAN, NRC-RES

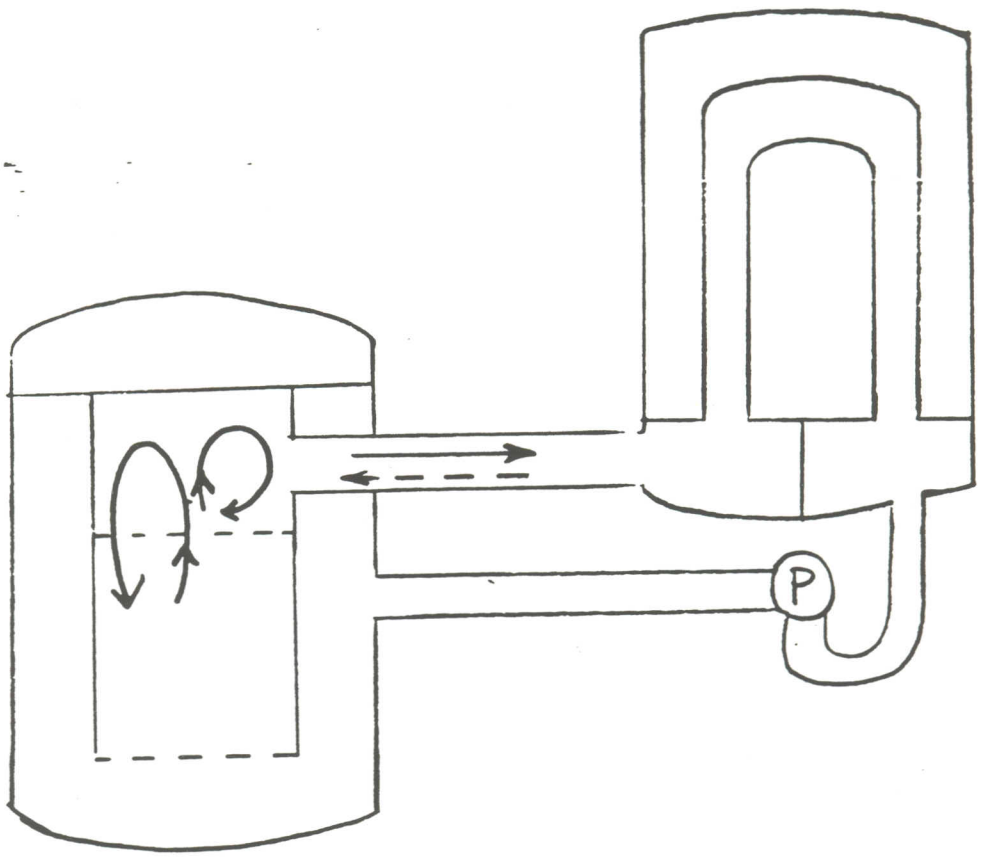
MARCH 17, 1986

BETHESDA, MARYLAND

INTRODUCTION

- TMLB' ACCIDENTS: STEAM GENERATORS BOIL DRY AND REMAIN DRY.
  NO ECCS FLOW
  NO CONTAINMENT SPRAY

- DURING TMLB' ACCIDENTS, MULTI-DIMENSIONAL NATURAL CIRCULATION FLOW CAN EXIST IN A PWR REACTOR VESSEL. COUNTER-CURRENT FLOW MAY ALSO EXIST IN THE HOT LEG WITH THE PRESENCE OF LOOP SEAL.



- MULTI-DIMENSIONAL RCS NATURAL CIRCULATION DURING TMLB' ACCIDENTS IN A PWR IS :
  - A NUREG-1150 ISSUE CURRENTLY BEING STUDIED
  - A NUREG-0956 MAJOR AREA OF UNCERTAINTY RECOMMENDED FOR FURTHER RESEARCH

- THE ISSUE ON RCS NATURAL CIRCULATION WILL HAVE DIRECT IMPACT ON OTHER NRC ISSUES AND CONCERNS INCLUDING:
  - STEAM GENERATOR TUBE RUPTURE
  - DIRECT CONTAINMENT HEATING
  - FISSION PRODUCT RETENTION AND REVAPORIZATION IN RCS
  - MELT PROGRESSION
  - HYDROGEN GENERATION IN THE VESSEL
  - GUIDELINE FOR OPERATOR ACTION

A REVIEW OF CURRENT STUDIES ON RCS NATURAL CIRCULATION

- EPRI : CODE DEVELOPMENT AND INTEGRATION OF CORMLT, PSAAC, AND RAFT
  - 1/7 - SCALE EXPERIMENTS USING WATER AND SF_6
  - USING THE COMMIX CODE AT ANL TO MODEL THE EXPERIMENTS ABOVE
- IDCOR : USING EPRI/W EXPERIMENTS TO ASSESS IN-VESSEL NATURAL CIRCULATION MODEL IN THE MAAP CODE
- NRC :
  - W. LYON MEMO AND MEETING ON MAY 4, 1984
  - COOPERATION BETWEEN RES AND NRR STAFF TO ADDRESS THE ISSUE ON RCS NATURAL CIRCULATION
  - WORK PERFORMED BY THEOFANOUS ET AL.
  - WORK PERFORMED AT NATIONAL LABS INCLUDING LANL, INEL, SNL, AND PNL
  - SASA PROGRAM

- A Summary of NRC-Sponsored Detailed Mechanistic Code Calculations and Structural Integrity Studies to Address "RCS Natural Circulation"

Code Used	Purpose	Status
TRAC-PF1	Calculating upper plenum natural circulation using MARCH-supplied boundary conditions at core exit. Results were provided to BMI-2104 team at BCL.	8/84
COBRA-NC	Calculating in-vessel natural circulation assuming intact core geometry and using MARCH-supplied boundary conditions. Results were compared with MELPROG/TRAC calculations prior to core degradation.	3/85
TRAC-PF1	Calculating in-vessel natural circulation assuming intact core geometry. Results were compared with MELPROG/TRAC calculations prior to core degradation.	1/86
MELPROG/TRAC	Calculating in-vessel natural circulation up to vessel failure. No fission product release and retention, hydrogen generation calculated.	1/86
MELPROG/TRAC	Same calculation as above but including fission product release and retention. Calculation will proceed to some point after vessel failure.	8/86
COMMIX	Scoping calculations to investigate multi-dimensional natural circulation flow in the vessel and in the hot leg piping. Results will be used to provide guidance to both MELPROG/TRAC and SCDAP/RELAP5 in modeling flow split in hot leg and steam generator tubes.	8/86
MELPROG/TRAC	Based on COMMIX results, the entire RCS is modeled for TMLB' sequences. All important phenomena will be included.	3/87
SCDAP/RELAP5	Based on COMMIX results, the entire RCS is modeled for TMLB' sequences prior to vessel failure. Results will be compared with the MELPROG/TRAC calculations.	3/87
Analyses and simple experiments to determine the RCS structural integrity based on the temperature and pressure loading calculated by both MELPROG/TRAC and SCDAP/RELAP5. An estimated uncertainty band of the structure temperature will be included in the analyses.		3/87

* Date shown is for first calculation completed. More calculations will follow if deemed necessary.

CONCLUSION

RCS NATURAL CIRCULATION IS CURRENTLY BEING STUDIED. NRC RECOGNIZES THE IMPORTANCE OF THIS ISSUE AND HAS RESEARCH PROGRAMS IN PLACE TO ADDRESS IT. HOWEVER, ADEQUATE FUNDING MUST BE CONTINUED AND TECHNICAL EXPERTISE MUST BE MAINTAINED AT KEY LABORATORIES.

RCS NATURAL CIRCULATION MEETING

March 17, 1986
Bethesda, Maryland

NAME	OFFICE	TELEPHONE
JAMES HAN	RES	301/427-4460
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HERBERT S. ISBIN

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March 22, 1986

To: Dr. Mel Silberberg
From: Herb Isbin

I am enclosing a brief account of my impressions of the March 17, 1986 meeting, organized by Dr. James T. Han, to discuss the status of the TMLB' Studies.