

# CERTIFIED

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS  
JOINT T/H PHENOMENA/DHRS SUBCOMMITTEE MEETING MINUTES  
IDAHO FALLS, IDAHO  
AUGUST 28-30, 1990

10/24/90  
by  
I. Catton

ACRS-2718

RELAP5/MOD-3 CODE  
AUGUST 28, 1990

## PURPOSE

The purpose of the meeting is to discuss the details of the modifications made to the RELAP5/MOD-3 Code as specified in the MOD-3 Version.

## ATTENDEES

### ACRS

I. Catton	Chairman
D. Ward	Member
W. Ken	Member
J. Carroll	Member
C. Michelson	Member
P. Davis	Consultant
V. Schrock	Consultant

### NRC

L. Shotkin, RES
N. Blumberg, RES

## INEL

S. Noff  
C. Miller  
R. Riemke  
G. Johnsen  
R. Schultz  
M. Ortiz  
C. Allison

## Meeting Highlights, Agreements, and Requests

1. Dr Catton, (Subcommittee Chairman), noted the following opening comments:
  - o The Chairman noted the recent receipt of a SECY Paper (SECY 90-269) that announced the completion of the

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thermal hydraulic (T/H) code development program. He indicated that he is in agreement with RES's intent, but differs in the basis for the decision. In his opinion, the development program has reached the point of diminishing returns and further effort will not be useful.

- o The following items should be addressed during the meeting discussions:
  - a. Discussion or reference to the tests performed to demonstrate proper convergence for the time advancement scheme.
  - b. How can one relate the finely noded developmental assessment problems to the (more coarsely noded) plant calculations?
  - c. Where can the rationalization be found for the modeling of the wall heat flux splits made in the code?
  - d. Has INEL prepared a report to account for the so-called "fin effect" vis-a-vis the external thermocouples used in the LOFT L2-5 test? This information is needed for the developers of best-estimate codes.
- 2. Dr. L. Shotkin (RES) provided opening remarks on the RELAP5 code. In response to the above items, he noted the following: For Item "a", RES has asked INEL to prepare a "QA" document on the RELAP5 numerics. For Item "d", a draft report is under review. If Items "b" and "c" are not addressed today, RES will provide the associated documentation to the Subcommittee.

Dr. Shotkin noted the development history for RELAP5, the code developers involved, and the funding history. RES noted that the ACRS concerns with the MOD-2 version were addressed in the development plan for MOD-3. Figure 1 lists the improvements made to MOD-3. In response to a request from Professor Schrock, Dr. Shotkin said he would provide reports detailing these model improvements to Mr. Boehnert for distribution to the Subcommittee.

RES preceded to address the concern cited at an earlier T/H Phenomena subcommittee meeting (November 14, 1989), regarding the choice of "off-take" model used in MOD-3. Specifically, a concern was raised regarding the rationale for choosing the Ardron-Bryce model versus the UC-Berkley model. Essentially, the argument advanced was that the model chosen (Ardron-Bryce - A-B) is technically adequate and meets regulatory requirements.

There was extensive Subcommittee discussion. The Subcommittee was unable to determine to its satisfaction the meaning of the term "meets regulatory requirements" which RES used, in part, to justify use of the A-B model. Professor Schrock noted that RES obtained the A-B model at no cost, and in his opinion, this model is flawed.

3. There was a presentation on the documentation available for the RELAP5 code. Dr. Catton again raised the issue of bridging the gap between fine-nodded developmental assessment calculations and coarsely-nodded plant calculations. INEL (G. Johnsen) agreed this information is lacking in the draft reports provided the Subcommittee, but is available in other nodalization reports. It was also noted that another (forthcoming) volume of code documentation will instruct the user how to node the code for a plant calculation.
4. R. Riemke (INEL) showed examples of the basic performance for RELAP5/MOD-3 and results of convergence studies. Riemke's central points were that code-to-data comparisons have defined the convergence limits of the code, and the use of the CSAU methodology and results of on-going ICAP (International Code Assessment Program) assessments define the level of accuracy.

Dr. Catton indicated that the information presented shows there is a lack of rationale for the nodalization scheme used in the code, and INEL needs to document this rationale. Further, discussion of the interphase drag model nodalization study led Dr. Catton to note that INEL needs to provide information on the prediction of temperature vs void fraction to assure the model is correctly predicting the data. He also noted that the information shown indicates there is a problem with the prediction of precursor cooling.

5. The MOD-3 code's range of applicability was discussed by G. Johnsen (Figure 2). MOD-3 can model "almost all" PWR Chapter 15-type accidents up to the point of cladding melt, exclusive of severe accidents. Mr. Carroll noted that the Diablo Canyon licensee found RELAP5 helpful in sorting out a problem associated with the plant's turbine load rejection system.

INEL noted that assessment activities are on-going using test data from the ROSA-IV facility. Dr. Catton said these assessment results should appear in the code documentation reports. Dr. Shotkin indicated that this information will be part of the final ICAP assessment report. Dr. Catton suggested that RES synthesize the ICAP assessment results.

Figure 3 lists the major limitations of MOD-3.

6. R. Schultz (INEL), discussed the assessment program for MOD-3. Three items were discussed: (1) Assessment based on known solutions (e.g. water faucet problem); (2) developmental assessment; and (3) the ICAP effort.

The Subcommittee questioned the reason for performing Item 1 above. INEL noted this is a test of the fidelity of the void fraction model; Dr. Shotkin said that the MOD-0 version of the code could not successfully calculate the faucet problem.

The developmental assessment program includes 31 problems (10 phenomenological, 16 separate-effects, and 5 integral). Examples from each were shown. INEL noted that the code models can be changed during developmental assessment, but are frozen for independent assessment. Four "grades" are used to judge agreement between the code and data: "Excellent", "Reasonable", "Minimal", and "Insufficient" (Figure 4). Mr. Davis noted that INEL didn't use this system in the assessment report provided the Subcommittee. INEL said this system is only used for the independent, or final, assessment which is on-going. In response to Dr. Kerr, Dr. Shotkin said the code models must rate a "E" or "R" to be acceptable.

As a result of further discussion of the assessment matrix, the following points were noted:

- o Professor Schrock objected to the use of a discharge coefficient in the two phase flow model. INEL was unable to provide a rationalization for the use of this coefficient.
- o Based on the results shown at this meeting, the fidelity of the stratification model used in RELAP5 was also called into question by the Subcommittee.
- o Assessment results showed a discrepancy in the code's void fraction model. INEL was unable to provide a reason for the model discrepancy.
- o Professor Schrock noted that the code cannot be used to calculate countercurrent flow, absent an investigation of the flooding rate for the particular geometry of interest. Dr. Catton suggested that this point be included in the Users Guide.

Assessment of the MOD-3 version of RELAP5 by the ICAP is now underway.

7. Dr. M. Ortiz (INEL) described the on-going CSAU process to determine the uncertainty associated with a RELAP5/MOD-3 small-break (SB) LOCA calculation. This work compliments the

demonstration of the CSAU methodology for a large-break LOCA calculation performed with TRAC-PFI/MOD2. The goal is to determine the uncertainty associated with use of a best-estimate code.

As with the TRAC demonstration, the CSJ methodology is being followed. In response to Dr. Catton, Dr. Ortiz said the Technical Program Group (TPG) performing this study has not yet received the code documentation; hence, the effort has been slowed. Figure 5 gives details of the specific SB LOCA scenario selected. A lowered-loop B&W plant is being modeled.

To date, the TPG has completed the ranking procedure for the important phenomena to be used in the analysis. A list of the eight phenomena selected is given in Figure 6.

8. Dr. R. Shumway (INEL), responded to Dr. Catton's request for information on the details of the model used to partition wall energy between gas and liquid. He noted, in response to questions from Dr. Catton, that the film-boiling correlation used to model the heat transfer to the fluid is insufficient and requires improvement.
9. Details of the RELAP/SCDAP code were provided. This code is designed to model severe accidents. Dr. Shotkin provided details on the development history and associated funding (Figure 7). No further major development work for LWR applications is planned. DOE and NRC are extending the code development for use on production and advanced commercial reactors respectively.

Mr. C. Allison (INEL) discussed the code status. RELAP/SCDAP has detailed models for system response from accident initiation up to failure of the RCS (or accident termination). Figure 8 shows the interactive modeling used. The code's capabilities are given in Figure 9. Both discrete structures and debris beds can be modeled. The transfer of heat from a molten pool to debris is also modeled.

The code has been validated using data from: TMI-2, LOFT severe fuel damage (SFD) tests, and numerous overseas bundle damage progression tests. The SFD tests were particularly helpful. Modeling work is underway to study the failure mechanisms for the reactor vessel lower head.

10. In closing remarks, Dr. Shotkin made the following points:
  - o Development of RELAP5 is complete with release of the MOD-3 version.
  - o MOD-3 will be independently assessed by the ICAP through 1991.

- o Following this, a long-term maintenance program called CAMP (code applications and maintenance program) will allow maintenance of the code. CAMP will be an international follow-up to the ICAP.
- o RELAP5/SCDAP development will continue for ~ 2-3 years, albeit at a modest funding level.

11. Future Subcommittee Action(s)

Dr. Catton will report the results of this meeting to the ACRS during its September 1990 meeting. The Subcommittee Chairman may provide some recommendations to the ACRS for inclusion in the next research report centering on advice to assure an orderly close-out of this code program.