D890615

The Honorable Lando W. Zech, Jr.
Chairman
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Chairman Zech:

SUBJECT: NRC THERMAL-HYDRAULIC RESEARCH PROGRAM

During the 350th meeting of the Advisory Committee on Reactor Safeguards, June 8-10, 1989, we reviewed the NRC's plan for continuing thermal-hydraulic research as related to the design and operation of nuclear power plants. This matter was also considered by our Subcommittee on Thermal Hydraulic Phenomena at a meeting on May 23, 1989. During these meetings, we had the benefit of presentations by representatives of the Office of Nuclear Regulatory Research (RES). We also had the benefit of the documents referenced. The Committee last commented to you on this subject in our report of June 7, 1988.

Thermal-hydraulic research has always been a central and major part of the NRC's research program. Much of the work was inspired by the perceived need to better understand hypothetical large-break loss-of-coolant-accidents (LB-LOCAs) and the performance of emergency core cooling systems (ECCS). Experiments and analytical models, such as the RELAP and TRAC codes, have confirmed compliance with the ECCS rule. Continuing research on LB-LOCAs culminated with a 1988 revision to the ECCS rule which permits licensees to use more accurate means of analysis and makes possible certain safety and operational improvements in existing plants. NRC contractors have demonstrated a methodology that can be used to estimate the magnitude of uncertainty associated with code predictions.

In addition, the experimental information base and the codes have been found useful in assessing and predicting the consequences of transients and small-break loss-of-coolant-accidents (SB-LOCAs) which are now recognized to be much more risk significant than the LB-LOCAs. The codes are also being used to analyze the early stages of severe accident scenarios.

Proposed Research Program

We understand the continuing NRC program in thermal-hydraulic research to have two principal purposes:

- Bring development of the major computer codes to a successful completion.

- Maintain, within the NRC and its contractors, a capability for thermal-hydraulic analysis sufficient to deal with safety and regulatory concerns that might arise in the future. This includes the continuing availability of a cadre of experts.

RES representatives indicated these general purposes would be realized through achievement of several specific objectives:

- The major codes will be maintained indefinitely and some further development will be carried out. The scope and depth of further development seems not to have been decided. Apparently, it will include appropriate reactions to new data from foreign experimental programs and assessments which are expected to continue for some time. It may also include a review and redevelopment of the important constitutive equations in the codes.

- The current experimental programs related to specifics of the Babcock and Wilcox (B&W) nuclear steam supply (NSS) system will be completed. Beyond this, any further experimental programs will be carried out at universities, rather than by the creation or operation of any major facilities at national laboratories. Relatively inexpensive "integral" facilities, of scope similar to the facility now operating at the University of Maryland, are being considered as contrasted with what have been called "separate effects" facilities. These would be mockups of specific NSS systems and of an advanced LWR (600 MWe size) design.

- An expanded program of applications research is planned. Apparently, much of this activity is expected to be in response to issues that arise from experiences with operating plants. But, it will include preparation of input data for several more plant types than are now available to the NRC. This will permit more rapid analysis than would otherwise be possible in response to future safety or regulatory issues. This program may also include exploratory, in-depth studies of a range of possible transients for a variety of plants.

In addition, two other specific program elements were mentioned:

- A further demonstration of the "Code Scaling, Applicability, and Uncertainty" methodology will be carried out for an SB-LOCA with RELAP5/MOD2, similar to that recently completed for an LB-LOCA.

- Improvements will be made to the NSS system process models now incorporated in training simulators at the NRC Technical Training Center. This will permit more accurate simulation of off-normal scenarios for the study of emergency and accident management procedures.

Before commenting on these research proposals, it is pertinent to consider two statements made by the NRC staff at the May 23, 1989 Thermal Hydraulic Phenomena Subcommittee meeting, because the ideas expressed have an influence on our recommendations:

> A representative of the Office of Nuclear Reactor Regulation said, "NRR is not relying extensively on the codes to address current licensing issues."
>
> A representative of RES said, "Codes have now reached an acceptable level of accuracy and maturity... further development is not likely to produce major changes in our understanding of [plant] performance or [accident] consequences."

ACRS Recommendations

We agree with the general objective of the research program to maintain, within the NRC and its contractors, a capability for thermal-hydraulic analysis sufficient to deal with safety and regulatory concerns that might arise in the future. Also, we agree with the general level of funding projected for the next several years. However, we believe there is too much emphasis on further development of the existing codes in the planned program. Maintenance of the needed NRC capability is more a matter of ensuring the availability of a cadre of experienced and expert analysts and access to the general body of experimental data, than it is of improving or even ensuring the availability of large systems codes. The Committee reiterates its comments in the report of June 7, 1988, that "marginal improvements that could be made [in the codes] over the next few years by extrapolating the recent levels of development work will not be sufficient to attain a significantly higher plateau of code accuracy and validation."

To accomplish this general purpose, we recommend a program of four primary elements:

(1) Code Development

Maintain the present large system codes, TRAC-PF1/MOD1, RELAP5/MOD2, TRAC-BWR, and RAMONA-3B, for an indefinite period. Limit improvements only to those required by: (a) the discovery of important errors or (b) crucial new information from the foreign experimental and assessment programs or the B&W testing program. Do not undertake major new restructuring or "zero-based" improvements to the constitutive equations or numerical algorithms in these codes. We are not convinced by the arguments given for the need to develop TRAC-PF1/MOD2 and RELAP5/MOD3. It is our view that the proposed modifications will not substantially improve the codes.

Instead, consideration should be given to the development of a new type of systems code that will be more useful for analysis of extended plant transients involving interactions of plant systems. The Committee also made this recommendation in its June 7, 1988 report. TRAC and RELAP were originally designed to analyze the LB-LOCA, a rapid and severe reactor transient, in great detail. There is a need for a more empirical and efficient analytical tool. We envision a code that would be able, for example, to make a rapid and sufficiently accurate analysis of the power oscillations observed last year at the LaSalle County Station, Unit 2 plant. Such a code would be more akin to advanced simulator codes than to TRAC and RELAP. The BWR code (HIPA) now in use at Brookhaven National Laboratory is an example of the type of code we are suggesting.

(2) Experimentation

The staff proposal to develop relatively inexpensive "integral" test facilities at universities is sound. We see this as consistent with our recommendation for a new type of systems code. We agree that it would be inappropriate to build several such facilities at one time. A gradual approach is warranted. The first such new facility might be one that would incorporate features of the advanced LWR designs. Also, it will be better to completely assess the benefit that has been obtained from tests with the University of Maryland facility mentioned above.

In addition, a small program to deal with more fundamental research should be maintained. These are experiments of the sort that have been previously called "separate effects" tests. An effort should be made to develop a consensus among experts as to which particular phenomenon should be investigated. At this time, we suggest consideration be given to the investigation of:

- o fluid-elastic instability related to vibration of tubes in U-tube steam generators,
- o departure from nucleate boiling with oscillating flow and power in BWRs,
- o dynamic instabilities and loads on valves.

(3) Data Analysis

A major effort is needed to organize data from test programs into a useful form other than the large systems codes. In particular, with the 2D/3D, ROSA-IV, and the B&W test programs all coming to closure, measures are needed to ensure that these expensive and valuable bodies of data are preserved and used. In addition, older data from, for example, the FIST and FLECHT programs can be of greater value if they are effectively organized into more useful forms.

(4) Applications Research

A program in this area should include three elements:

- o Analysis of transients indicated to be of interest as a result of plant operating experience.
- o Preparation of input data decks for several classes of plants so that turnaround time for analyses in response to experience is shortened.
- o Analysis of transients that are indicated by PRA or other sources of information to be of particular interest, but which are not presently well understood. We suggest the following for consideration:
    - feed and bleed scenarios
    - secondary depressurization scenarios.

Finally, we suggest that RES broaden its perspective as to what other research in the thermal sciences should be included in its program, rather than being limited to the traditional scope of concerns in thermal-hydraulic areas. We suggest that it include studies of a broad range of thermal and fluid transport issues related to reactor safety.

ACRS Members William Kerr and Forrest Remick did not participate in the review of this matter.

Sincerely,

David A. Ward
Acting Chairman

References:

1. U.S. Nuclear Regulatory Commission, draft SECY Paper: "Status and Plans for Thermal Hydraulic Research Conducted by the Office of Nuclear Regulatory Research," provided to the ACRS in May 1989
2. U.S. Nuclear Regulatory Commission, NUREG-1252: "Nuclear Power Plant Thermal-Hydraulic Performance Research Program Plan," Office of Nuclear Regulatory Research, July 1988

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