REVIEW AND EVALUATION OF THE NUCLEAR REGULATORY COMMISSION SAFETY RESEARCH PROGRAM FOR FISCAL YEAR 1988

A REPORT TO
THE CONGRESS OF THE UNITED STATES OF AMERICA

BY

THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
U.S. NUCLEAR REGULATORY COMMISSION

WASHINGTON, D.C. 20555
FEBRUARY 1987

INTRODUCTION

Our comments below relate to the proposed program-support funding of $103.6 million for the FY 1988 NRC Safety Research Program. These comments are limited chiefly to research that is not being proposed but should be, or in some cases, to research that is proposed but may not be needed.

1. REACTOR SYSTEM SAFETY

1.1 Thermal-Hydraulic Transients

1.1.1 General Comments

Research planned in the thermal-hydraulic area is divided into two general parts. The first is a comprehensive program to improve the understanding of thermal-hydraulic behavior in Babcock and Wilcox (B&W) reactor systems; in its fullest form, this calls for substantial industry support. The second is a more general program of code development and experimental work that does not include direct industry participation. We believe that the emphasis on B&W systems is appropriate and that the industry should provide major support for this program, as has been proposed by the Office of Nuclear Regulatory Research (RES) Staff. It is also important that the NRC maintain a viable program of thermal-hydraulic research into the foreseeable future, including integral testing, separate-effects testing, and code development.

Our comments on the proposed research in the thermal-hydraulic area are given below.

1.1.2 Integral Facilities

RES has developed a comprehensive research plan to address the technical issues and regulatory needs associated with the thermal-hydraulic performance of B&W plants. Central to this plan is the proposal to construct new integral test facilities. Optimum and timely results from these facilities will depend upon financial support from the industry. We support this plan.

1.1.3 Separate Effects

Our February 19, 1986 report to the Congress included the recommendation that the NRC study the complicating effects that water hammer may have on thermal-hydraulic transients. The NRC and the industry have now initiated a cooperative effort in this regard. We support this effort and expect to monitor its progress. Funding levels appear adequate at this time.

The NRC has initiated a program to develop an information base for the complex thermal-hydraulic phenomena involved with the "bleed and feed" process used either to remove core decay heat or to allow controlled depressurization of the primary coolant of a pressurized water reactor (PWR) plant. We believe that subsequent to the development of the information base RES should allocate funding for any additional research found necessary in this area.

1.1.4 Code Development

The NRC has developed a revised Emergency Core Cooling System (ECCS) Rule (10 CFR Part 50, Appendix K - ECCS Evaluation Models) that allows the use of realistic (best estimate) evaluation models to calculate the effects of loss-of-coolant accidents (LOCAs). However, the acceptability of realistic models rests on the development of satisfactory methodology to determine the overall uncertainty associated with these models. A related effort which addresses code applicability and scaling studies also is necessary; such work is either ongoing or planned by RES. We strongly support these efforts. In particular, funding should be assured over the next few years sufficient to allow NRC to obtain the necessary test and analytical data, primarily through the International Code Assessment Program and cooperative international efforts such as the 2D/3D Program.

1.2 Accident Evaluation

The Accident Evaluation Research Program being proposed includes a significant experimental component. We believe that the relationship of this research to the severe accident regulatory issue should be made clearer than it now is. For example, there are three major experimental programs to investigate phenomena that will be encountered (if at all) only after the reactor core has melted and has penetrated the vessel. The experiments are related to containment heating, to core-concrete interaction, and to containment behavior under extreme overpressure.

These areas of research all bear directly on issues relating to containment capability and containment failure modes. Each of these research areas is said to be designed to reduce some of the uncertainties identified in NUREG-0956, "Reassessment of the Technical Bases for Estimating Source Terms." The magnitude of these uncertainties is being estimated in the course of the preparation of NUREG-1150, "Reactor Risk Reference Document." However, in order to plan properly additional research to reduce uncertainties, it would appear that the Office of Nuclear Reactor Regulation (NRR), or some group, should first consider what uncertainties can be tolerated in connection with its regulatory responsibilities. We have not seen evidence of this consideration. We, and we suppose RES as well, must, under the circumstances, try to judge the relevance of the proposed research with insufficient information.

With this caveat we make the comments noted below. These comments do not represent a complete coverage of the Accident Evaluation Research Program. We use them as an example of our conclusion that more consideration needs to be given to what has been learned from the research of the past five years or so, and what uncertainty can be tolerated by the regulators; or, put another way, what are the questions that regulators have encountered or are likely to encounter in dealing with severe accidents that cannot be answered with existing information. With diminishing resources, it is increasingly important that the research be specifically designed to address safety concerns.

- The research on containments under extreme overpressure seems well designed and should produce results that are relevant, and that will contribute to the calibration of codes being developed for a description of containment behavior.

- The work on core-concrete interaction is probably needed, but a more detailed examination of the ways in which this may affect containment failure, as well as the uncertainties attributable to incomplete understanding of the complex phenomena that characterize this interaction, would make it more likely that the research to be done would answer questions that will be encountered by NRR.

- Some risk analyses conclude that high-pressure-core-melt sequences may produce enough direct heating of the containment atmosphere to cause early containment failure by overpressure. The proposed research on direct containment heating may be of considerable interest in understanding the interaction of small particles of molten metal with containment atmospheres. However, it is relevant to reactor safety only if sequences which could produce such small particles in PWRs have a sufficiently high probability. It is our opinion that equal effort should be devoted to establishing the likelihood and the effect of direct heating events, since absent such work, the program may well be misdirected. We also recommend that the experimental investigation give first consideration to the possibility of atomizing the required amount of material as well as the effects of containment geometry, and to the presence of water in the subvessel cavity.

1.3 Risk and Reliability

The funding for the Risk and Reliability Research Program continues to be directed away from the development of risk assessment methodology and toward applications. The work in the applications area for the most part consists of software development and plant-specific risk assessment. However, we see some danger that with the current budget constraints, work on applications in support of licensing efforts will be

undertaken at the expense of developmental work. It is important that the developmental work continue.

We recommend that the applications work be coordinated with the eventual user by a systematic process that would encourage the user to be involved in the development of the work product. RES has taken steps to involve the industry and individual licensees in this work. We consider it appropriate that some of this applications effort should be done by the industry or individual licensees rather than by the NRC.

In our previous reports to the Congress and to the Commission, we recommended that:

- The completeness of the current family of plant-specific probabilistic risk assessments (PRAs) should be examined by continued search for possible weaknesses in current probabilistic analyses, e.g., accident paths either not currently evaluated or dismissed as insignificant, which may, on closer scrutiny, prove to be very important to risk.

- An improved evaluation of the entire family of containment designs should be performed.

- Improved methods for factoring uncertainty into decision making should be developed.

The NRC Staff is currently developing methods for implementing the Severe Accident Policy and the Safety Goal Policy. We believe that difficulties are being encountered in part because of the lack of important answers in areas such as those listed above, as well as in the treatment of external events, environmental effects, aging, management quality, and human errors. We recommend that RES initiate additional work in such areas by reprogramming funds in the FY 1987 budget and continue to support this work in FY 1988. If necessary, this should be accomplished by deferring the applications work or finding other sources of support for this work.

1.4 Human Factors

In its recent report to the NRC, "Revitalizing Nuclear Safety Research," the National Research Council's Committee on Nuclear Safety Research has joined the ACRS in criticizing the NRC for not performing any research in the human factors area. A specific study to determine the need for and nature of human factors research is being performed by the National Research Council's Committee on Human Factors. The final report of this Committee is to be provided to the NRC during July 1987. We anticipate that this report will include recommendation for a considerable program of research effort in the human factors area. Plans for beginning such a program should be factored into the budget by RES.

2. ENGINEERING SAFETY

2.1 Electrical Equipment Qualification

No funding for electrical equipment qualification research has been proposed for FY 1988. In our February 19, 1986 report to the Congress, we recommended that this research be continued; contrary to this recommendation, the research was terminated by the NRC at the end of FY 1986.

The objective of this research is to assess the probability of survival and performance of aged electrical equipment when subjected to hostile environmental conditions during and following incidents, including severe accidents, fires, hydrogen burns, seismic events, and credible combinations. The results obtained from this research are important to prevent accidents as well as to mitigate the consequences of accidents, should they occur. We consider the continuation of this work to be vital to the nuclear safety program and again recommend that it be reinstituted and adequately funded.

Four unique test facilities, with a combined cost of over $2 million, were constructed at Sandia especially for this program. To preserve and maintain the existing test facilities and staff experience sufficient to continue and complete the electrical equipment qualification work efficiently, it will be necessary to continue funding this work in FY 1987. Since its inception (about 1976), more than $10 million has been spent on this program. Funds needed to continue and complete the program are approximately $1.5 million in FY 1987 and $0.9 million in FY 1988.

2.2 Effects of Earthquakes on Operating Plants

In our previous reports, we urged that RES establish an integrated program in this area and coordinate closely this work with NRR and ongoing industry work. We believe that this has been accomplished effectively in the Seismic Safety Research Program. We believe that the program is well managed and will, in the near future, produce answers that will help to resolve important issues.

2.3 Primary System Integrity

Cast stainless steel components in the primary system lose ductility with time in service. The implications of this phenomenon for long-term primary system integrity are significant. Appropriate emphasis should be placed on ascertaining the likelihood of flaws resulting from fabrication or from service, and on developing means of assessing conditions under which they could pose significant risk.

3. WASTE MANAGEMENT

3.1 High-Level Waste

Although we are satisfied with most aspects of the research program on high-level wastes, we believe that more attention needs to be directed to related work under way in other countries. This extends beyond the formal agreements for cooperative research that the NRC Staff has developed with selected foreign groups. The Staff should also keep abreast of activities of the Nuclear Energy Agency, Organization for Economic Cooperation and Development, relative to the development of guides for demonstrating, both directly and indirectly, the capabilities of a repository for assuring the safe retention of radioactive wastes.

3.2 Low-Level Waste

We believe that more effort should be directed to studies that will assist the states in ranking and selecting the most appropriate disposal systems for low-level wastes, based on the nature and characteristics of the sites available and associated technological and economic considerations.