ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
UNITED STATES ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

February 10, 1972

Honorable James R. Schlesinger
Chairman
U. S. Atomic Energy Commission
Washington, D. C. 20545

Subject: REPORT ON WATER REACTOR SAFETY RESEARCH

Dear Dr. Schlesinger:

In several previous reports the Advisory Committee on Reactor Safeguards has emphasized the need for high priority for safety research work aimed at gaining a better understanding of the phenomena important to the course of postulated loss-of-coolant accidents (LOCA). In connection with its review of the Interim Acceptance Criteria, the Committee has stated its belief that more work is required on code development, on improved emergency core cooling systems (ECCS), and on safety research oriented to LOCA-ECCS.

The Committee has recently reviewed the general plans of the AEC and the nuclear industry for water reactor safety research. In this review, the Committee had the benefit of a Subcommittee meeting held on December 7-8, 1971, with representatives of the Division of Reactor Development and Technology, the AEC Regulatory Staff, and the nuclear industry.

In this report, the Committee confines its attention primarily to safety research pertinent to LOCA-ECCS. Continuing progress must be made in improving our knowledge in these areas because of the increased number of reactors soon to be operating and because some of these reactors are to operate at higher power densities.

1. The Committee finds that a desirable increase in ECCS-related research by reactor vendors and the AEC has occurred during the past year. Also, it appears that the electric utility industry may in the future take an active role in funding, directing, and applying such research.

   However, the Committee finds that the relative roles and responsibilities of the utilities, the reactor vendors, and the AEC with regard to safety research have not been clearly defined. Further, the Committee finds that, while a Water Reactor Safety Program Plan

document has been published by the AEC, and there are activities in process or planned for modification and augmentation of the plan, there has not yet been formulated a sufficiently specific definition of the national safety research needs for water reactors, including the means and schedules to be used in resolving problems.

The AEC has frequently stated that the ultimate responsibility for safety rests in the hands of the owner, the utility. However, certain safety questions are generic, applying to a class of light-water reactors, or to all light-water reactors. The ACRS believes that responsibility for the solution of such generic questions should be assumed by the nuclear industry. The Committee recommends that the Regulatory Staff assure itself that the overall industrial program is well delineated, is funded and implemented, and is adequate to provide proper assurance of public safety. The ACRS believes also that the AEC should continue to support at a high funding level a continuing light-water reactor safety research program designed to provide independent confirmation of the adequacy of solutions of identified problems and improved engineered safety features. This program would also provide a valuable and important source of expert consultants to the Regulatory groups.

The ACRS recommends that, in the future, the AEC safety research program should reflect more directly in extent and in detail the recommendations and needs of the Regulatory Staff and the ACRS.

2. While the current programs give attention to many problem areas related to ECCS, including those which seek to substantiate more fully the conservative nature of the design bases, the Committee believes that special emphasis should be given to the following areas:

   a. Flow phenomena during system depressurization and emergency coolant injection. Particular attention must be given to the interaction of the injected coolant with the primary coolant in hot and cold legs, in the downcomer annulus and lower plenum, and in the upper plenum. Model tests of suitable size should define the phenomena involved and should provide improved criteria for design and evaluation.

   b. Reflooding rates as affected by steam binding. Model tests of suitable scale should bound system and component flow resistances important to steam binding. Experiments should also characterize designs which enable high reflooding rates.

c. Flow and heat transfer during blowdown. New AEC-funded programs are underway in this area. System effects should be given careful attention.

d. Improved ECCS computer codes. The mathematical modeling of the reactor system should include both improvement in current capabilities and the development of new and improved integrated computer codes which better represent the actual phenomena involved.

e. Fuel rod failure. Experimental programs should be continued to better establish margins of safety related to time-temperature exposures of cladding to steam environments. Experimental programs with bundles of fuel pins, heated electrically or, preferably, with fission heat, should be started to investigate: (1) the effectiveness with which extreme fuel rod temperature transients can be quenched, including transients in which cladding temperatures approach the melting point; and, (2) the extent of Zircaloy-water reactions during such extreme conditions. Additional understanding should be sought of the possible types and magnitudes of loadings that potentially could be imposed upon the cladding during the course of the LOCA. Further definition of the potential effects of extensive flow blockage resulting from rod damage should also be sought.

3. The Committee has in several reports recommended safety research on interactions between water and molten fuel in experiments which simulate the range of accident situations of interest. This matter has not been pursued in recent out-of-pile studies and, while the Power Burst Facility (PBF) may be used to perform some experiments relevant to this matter, the current PBF program is unclear as to the scope or scheduling of such work. Out-of-pile experimental bases should be established for interpretation of the more difficult in-pile experiments; a capability for theoretical analysis of such events should also be developed.

   Although the ACRS has recommended that research and design studies be undertaken on systems which might be capable of coping with a largely molten core, little such work appears to be underway.

4. The Regulatory Staff has need for independent analyses of the various accident conditions considered in safety reviews, including ECCS performance and accident loads on containments and other vital structures.

Implementation requires a stronger program, which would permit an accelerated development of computer codes for use by the AEC. The ACRS recommends that a substantial increase in funds be made available for regulatory support of these activities and for reactor safety experiments which can be initiated in prompt response to items identified in regulatory reviews.

Sincerely yours,

/s/

C. P. Siess
Chairman

References:

1. Water Reactor Safety Research Program Plan, dated February 1970 (WASH-1146)

2. Augmentation Plan for Water Reactor Safety Research Program, dated November 1971

3. Preliminary System Design Description 1-1/2 Loop Semiscale System, dated September 24, 1971