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

November 20, 1974

Honorable Dixy Lee Ray
Chairman
U. S. Atomic Energy Commission
Washington, D. C. 20545

Subject: REPORT ON WATER REACTOR SAFETY RESEARCH

Dear Dr. Ray:

At its 175th meeting on November 14-16, 1974, the Advisory Committee on Reactor Safeguards completed a report on certain aspects of the water reactor safety research programs and needs. In its review the Committee had the benefit of a Reactor Safety Research Subcommittee Meeting on July 23-24, 1974, of the Emergency Core Cooling System (ECCS) Subcommittee on September 28, 1974, and of Subcommittee meetings on generic matters and applications, and of an Information Meeting held by the Reactor Safety Research Division (RSR) on September 19-20, 1974. The ACRS has most recently reported on facets of water reactor safety research in its letters of February 10, 1972, and March 20, 1969, in its letters on ECCS Acceptance Criteria of January 7, 1972, and September 10, 1973, and in its testimony to the Joint Committee on Atomic Energy of September 27, 1973, June 22, 1971, and April 5, 1967. In this report, the Committee will go into some detail on matters pertaining to the loss of coolant accident (LOCA) and take up some other subjects more generally.

LOCA-ECCS

In its previous reports the ACRS has consistently emphasized safety research oriented to LOCA-ECCS and has strongly encouraged the understanding and development of improved emergency core cooling systems. In the period following our Report on Water Reactor Safety Research of February 10, 1972, the AEC reactor safety research program has been reorganized, redirected and augmented, and a substantial industry-sponsored program through the Electric Power Research Institute (EPRI) has been initiated. Vendor sponsored research and development programs have been continued. Problem areas and needs in safety research have been more effectively defined by the Regulatory Staff and RSR. Programs being undertaken are responsive to such needs, though some, because of their complexity and expanded requirements, now appear to have significantly extended schedules for completion. Other programs, such as testing a larger scale reactor coolant pump, have been discussed, but not yet funded. The programs for LOFT, Semiscale and Power Burst Facility (PBF) have encountered significant delays, and the plenum fill experiment will require a substantial increase in funding to achieve the current objectives.

A balance between research seeking basic understanding of the phenomena involved and research directed toward empirical correlations suitable for application in nuclear reactor power plants is being sought by RSR. It appears to the Committee that in the future greater emphasis on gaining a basic understanding would be appropriate. The Committee finds the programs of RSR to be well conceived and is impressed with the influx of technical experts into the management and programmatic work. The varied experimental programs will require periodic reviews so as to ensure that they are structured to obtain compatible and mutally supportive goals. The Committee supports the RSR requests for its expanding programs.

As noted in its February 10, 1972 report, 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 yet been sufficiently clearly defined. More specifically, it is not clear that industry, as an entity, has developed a comprehensive program of scope and schedule commensurate with the need. The role of architect-engineers in safety research warrants examination. Clarification of the roles and responsibilities should be pursued to insure that needed programs will have the appropriate attention and funding priorities.

RSR has through its review groups and through its coordinators, a good representation of the expertise from the AEC, industry, national laboratories, and the universities. Since the ACRS has not seen reports of the review groups and coordinators, it is at this time unable to comment on the effectiveness of these bodies in shaping meaningful programs. For some of the programs, more attention should be given to assuring that a proper mix of analytical and experimental efforts will be brought to bear on specific problems, that the working groups will not be isolated from one another, and that the influence of personnel experienced in reactor systems will be included. The Committee emphasizes the importance of strong analytical support of complicated experiments.

The Committee also notes the progress being made by the AEC in furthering international exchange and participation programs. These are significant steps in advancing reactor safety and are to be encouraged.

The AEC safety programs include studies of alternate and advanced ECCS concepts. The flexibility of the LOFT and semiscale facilities provides some opportunities for experimental investigations. The Committee believes that much more should be done on improved ECCS concepts, including conceptual design work and analytical studies using improved codes, and the input of the experimental studies to investigate how ECCS performance might be optimized. The studies should also include assessments on the overall reliability of the ECCS and what additional measures, if any, need to be taken.

The RSR advanced code development program has been extended from one to three contractors. The Committee concurs in obtaining a broader-based participation for technical input into the AEC's advanced code, Reactor System Transient (RST). The RST code is to have the capability of utilizing inputs based upon realistic estimates, as well as conservative estimates, so that safety margins can be more quantitatively determined. Special effort is needed to develop analytical predictive methods for realistic evaluations. Major benefits from a successful RST code would be in resolving questions relating to the significance of modeling techniques and parameters, and in allowing the use of scaled experiments in place of full-scale tests.

The Committee emphasizes the need to assure the adequacy of the current LOCA-ECCS research plans in the following areas:

a. system effects in blowdown of BWR's
b. PWR pump overspeed for a postulated downstream break
c. heat transfer and flow during reflooding
d. processes involving counter flow of different phases

Also, the effects that steam generator tubes with degraded properties have on the course of events in a LOCA-ECCS require further attention.

Additional Topics

The Committee has on several occasions in the past recommended a vigorous research program to investigate various facets of fuel element behavior, including power-flow mismatches, the potential for fuel-failure propagation, and the better establishment of acceptable limits. The Power Burst Facility has long been intended as a major in-reactor tool for such work and its proper use should receive priority. A necessary program of development of tools for theoretical analysis of fuel element behavior in transients and accidents has been initiated, but much additional progress is required to obtain the needed prediction capability. Out-of-reactor tests such as fuel-coolant interaction experiments should receive careful consideration as possible means of facilitating understanding of PBF experiments. Also, additional experimental and theoretical knowledge of the microscopic behavior and effects of fission gases in transients should be sought so that the understanding of the behavior of irradiated fuel in transients can be placed on a sounder footing.

The Committee supports the RSR program of continuing probabilistic accident studies. Consideration should be given to those risk assessments which may need further experimental and analytical study to more firmly establish a better understanding and to reduce uncertainties. The Committee reiterates its previous recommendations for research into phenomena involved in core meltdown, including the mechanisms, rate and magnitude of radioactive releases and the study of means of retaining molten cores or ameliorating

the consequences. In this connection, more knowledge of the possibility and extent of steam explosions in the presence of large quantities of molten fuel and steel is of particular importance.

The Committee recognizes the value of the RSR programs in "Metallurgy and Materials," "Fuel Behavior," and "Environmental and Siting." The Committee acknowledges the contributions from the AEC Heavy Section Steel Technology Program in Fracture Mechanics, Fatigue, Irradiation Effects and Inspection and Monitoring. In this regard, the Committee notes its recommendations and interest in improved means for nondestructive testing, in increased understanding of pneumatic failure, in the adequacy of experimental information in all categories relevant to the safety of new pressure vessel steels, and in the study of concepts of withstanding or ameliorating the effects of pressure vessel rupture.

With regard to "Environmental and Siting," the Committee particularly wishes to emphasize the need for improved understanding of earthquake causes, probabilities, magnitudes, and effects.

The Committee recognizes there are three principal sources of funding for reactor safety research: The AEC, Electric Power Research Institute, and the reactor vendors. Within the framework of total available funds, it is essential that programs be optimized. Further efforts are desirable to assure that priorities on the use of available R&D resources are appropriately assigned and to establish whether additional funding is needed.

A final comment relates to the availability of safety-related information. AEC and EPRI programs are in the public domain. The ACRS recommends a policy of increased disclosure of safety-related information and suggests that reactor vendors reevaluate their proprietary categories in an attempt to place as much information as possible in the public domain.

Sincerely yours,

W. R. Stratton

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Chairman