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

November 19, 1963

Honorable Glenn T. Seaborg
Chairman
U. S. Atomic Energy Commission
Washington, D. C.

Subject: REVIEW OF REACTOR SAFETY RESEARCH PROGRAM

Dear Dr. Seaborg:

The Advisory Committee on Reactor Safeguards has reviewed all major portions of the reactor safety research program being sponsored by the Division of Reactor Development. Comments concerning various aspects of this program have been transmitted to you in letters dated August 1, 1963, December 31, 1962 and August 30, 1962.

Additional comments, representing the Committee's thoughts on the conduct of the overall program, are contained in the attached letter to the General Manager.

Sincerely yours,

/s/ D. B. Hall

D. B. Hall
Chairman

Attachment:
Letter to AEC General Manager, dated November 19, 1963,
Subject: Review of Reactor Safety Research Program.

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
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November 19, 1963

A. R. Luedecke
General Manager
U. S. Atomic Energy Commission
Washington, D. C.

Subject: REVIEW OF REACTOR SAFETY RESEARCH PROGRAM

Dear General Luedecke:

In its letter of August 1, 1963, the Advisory Committee on Reactor Safeguards stated an intent to comment further on the Reactor Safety Research Program. Some additional comments, which are now transmitted, represent views of the Committee on the area of research that requires the greatest emphasis, with some discussion of the bases for these views.

The Committee believes that it is of primary importance to determine to what extent engineered safeguards can be relied on in relaxing reactor site restrictions.

In the light of present knowledge, it seems unlikely that general principles will render incredible the possibility that high power nuclear reactors can have large power excursions, or that they can have substantial core meltdown. Therefore, it must be expected that the safety analysis for locating and designing nuclear reactors will continue to assume such accidents to be possible, even if only remotely so.

Reactor accidents leading to temperatures and pressures representative of nuclear weapons can be considered incredible on physical grounds. Also, reducing the direct radiation effects of nuclear excursions to tolerable levels seems to pose no insuperable design problems. Primary attention will have to be given to potential release of fission products to the environment.

In such a release, fission products would usually have to pass through several stages of protection before being a public hazard. These are indicated by the successive transitions:

1. Release from the fuel element to the reactor vessel;

2. Release from the reactor vessel to the containment or confinement; and

3. Release from the containment or confinement to the external environment.

The Committee considers the fundamental goals of an adequate safety research program with respect to fission product release to be establishing the significance and reliability of each of these barriers and determining the extent to which they attenuate such release.

Research conducted so far has led to an adequate estimate of the fractional release of fission products from molten uranium and uranium oxide fuel. This work should be extended to other fuels showing promise.

Establishing upper limits for release fractions from the vessel to the containment or confinement, and from the containment or confinement to the atmosphere, seems more difficult. As stated in the Committee letter of August 1, 1963, environmental conditions will influence the results. An important research area needed to obtain good estimates of plate-out or deposition is the identification of the chemical and physical form of the fission products released during possible accidents. If the form of the fission product release is known, deposition temperatures, chemical reaction rates, agglomeration rates, and settling rates can be estimated. The conditions of current experimental release studies are often not those expected during accidents. The program should concentrate on fuels, atmospheres, and experimental conditions of relevance to reactor accidents. The safety research program should be strengthened in this area.

Large scale tests such as LOFT are not expected to contribute significantly to basic understanding of the phenomena mentioned above. They will show only what happens in the specific cases tested. When sufficient basic research has been performed on the physical and chemical processes important to plate-out and deposition, prediction of the result of a large scale experiment becomes feasible. At this point,

proof tests such as LOFT may make a contribution. It is doubtful that experiments done with the Nuclear Safety Pilot Plant will by themselves provide the upper limits relevant to large scale core meltdowns in real reactor vessels.

As indicated in our letter of August 1, 1963, the determination of decontamination factors for air cleaning systems and similar devices under actual conditions of release to the atmosphere is an important research area.

Some of the other major studies that will elucidate the probability and severity of accidents and hence the chances of fission product release are the following:

1. Research on the probability of gross rupture of primary pressure vessels and other pressurized components is needed. Information is needed on methods to protect the containment or confinement from possible missiles.

2. Further studies of the brittle-ductile transition of steels are needed. The effects of radiation, radiation rates, radiation under stress, and welding variables on the brittle-ductile transition phenomenon need further exploring. The results need to be analyzed both in terms of fracture stress and energy absorption. More information on the change of energy absorption and crack propagation with irradiation rate would be useful.

3. The SPERT-I destructive test on November 5, 1962, showed evidence of an unexpected threshold phenomenon that increased the destructiveness of a nuclear excursion. The nature of this phenomenon should be clarified. The existence of other threshold phenomena should be watched for in subsequent SPERT-type destructive tests on water cooled systems.

Recent renewed emphasis on the long range role of large fast breeder reactors points up the need for a well developed, long term, comprehensive research program on the safety of such reactors. A strong research program started now should develop information very useful to the first generation of very large fast reactors. Some of the matters carrying special safety implication are as follows: The Doppler coefficient; reactivity effects due to coolant voids and fuel movement;

the mode of fuel element failures, including foaming and slumping; unstable boiling of sodium during a transient; the stability and safety in the presence of positive coefficients.

The Committee wishes to reiterate its view that the Reactor Safety Research Program promises to be of great significance toward establishing how far engineered safeguards may be relied on in easing reactor site problems.

Sincerely yours,

/s/ D. B. Hall

D. B. Hall
Chairman