UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

March 13, 1975

Commissioner Gilinsky

Thru: Acting Executive Director for Operations

TECHNICAL ISSUES

Attached you will find, in accordance with your oral request, discussion of some technical issues I believe to be important subjects for Commission consideration, although not necessarily in the immediate future. The list is confined to reactor safety topics.

I have also appended a list of some reactor safety policy issues that have come to my attention in technical reviews.

These enclosures represent my personal views and have not been staffed out with the organizations normally concerned with such matters.

Stephen H. Hanauer
Technical Advisor

Encls
1. Technical Issues
2. Policy Issues

cc: w/encl
Chairman Anders
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Enclosure 1

IMPORTANT TECHNICAL REACTOR SAFETY ISSUES FACING THE COMMISSION NOW OR IN THE NEAR FUTURE

1. Design Objectives and Safety Design Basis for Water Reactors

Although your mother-in-law and your Congressman will tell you that the safety goal is zero risk, we know that this is unattainable-and that some non-zero risk must be accepted in all activities. The social question involving cost/risk/benefit comparisons of the various alternatives that are realistically available needs to be established. The Rasmussen Study made an important first step in quantitative risk evaluation but the technology is not yet available to resolve this question in a completely quantitative way. The study has pointed out a disparity between (a) our present "design basis" safety approach in which all potential accidents are either put into the design basis for complete mitigation or remain outside the design basis and have no safeguards compared to (b) the more realistic viewpoint of a spectrum of accidents each with probability and consequences of its own. Serious consideration should be given to modifying the present all-or-nothing approach in the light of reality.

2. Design Objectives and Safety Design Basis for Non-Water Reactors

For non-water reactors, we have neither the operating experience nor the Safety Study to guide us in developing criteria. The situation is reasonably well in hand for HTGRs, but the potential for autocatalytic positive feedback leading to core nuclear explosions in LMFBRs is creating great uncertainty regarding their design requirements. Calculations of such violent events are increasing in scope and sophistication. However, the results presently depend to a considerable extent on the phenomena postulated to occur. For the near term, the staff has already decided that a core disassembly accident must be part of the licensing design basis. This decision is subject to future revision based on further research that ERDA is convinced will show that such events are so improbable they need not be considered.

Adequate safety must be provided. Too much safety - added safety equipment not actually needed to provide adequate safety - wastes scarce and valuable resources. Attention to improbable severe postulated events tends to short-change more probable but less severe accidents that should be considered.

An important corollary issue is whether the planned LMFBR safety research programs meet the totality of NRC needs.

3. Reliability and the Single Failure Criteria

NRC has not established quantitative reliability criteria for safety-related systems. The operating plants are one of our chief sources of information but we do not know whether the rate of abnormal occurrences now being experienced is a satisfactory one or not. We do know that nuclear unit availabilities and capacities are not satisfactory. We need to find out whether safety system availability is satisfactory and to improve whatever aspects of reliability need improving.

4. Human Performance

Present designs do not make adequate provision for the limitations of people. Means must be found to improve the performance of the people on whom we depend and to improve the design of equipment so that it is less independent on human performance.

The potential for internal and external sabotage constituting a public safety hazard, and the degree to which design and operation needs to take sabotage into account, need to be delineated. Studies now underway should help, but some of the issues are non-technical. In spite of this difficulty, technical criteria are needed.

The relative roles of human operation and automation (both with and without on-line computers) should be clarified. Criteria are needed regarding allowable computerized safety-related functions and computer hardware and software requirements for safety-related applications.

5. Plutonium Dose Criteria

Present accident dose guidelines values are given only for whole-body and thyroid doses. Other dose components (lung, GI tract, bone) should be covered by similar guidelines. A number (or numbers) for plutonium is particularly badly needed and will be particularly hard to establish.

6. Siting

Present criteria for siting are in need of improvement in the following areas:

a. The design basis external events now in use for licensing are founded on various schemes for estimating a "probable maximum" event. We do not have any good way of estimating the return interval or the frequency of the earthquake or flood calculated in this way. Furthermore we are not likely to develop good methods for doing so in the near future because of the short

history (a few hundred years at best) and the long recurrence interval desired (sometimes we talk about a million years). Various developmental methods for estimating frequencies of design basis events, chosen as we choose them, give recurrence intervals substantially shorter than a million years. The lack of knowledge and the desire to be conservative is going to make resolution of this problem very difficult.

b. Our population siting criteria are indefinite at best. The applicant is required to study population distributions around a site and to project them for the life of the plant which, of course, he can do only very crudely, but our criterion for population distribution surrounding the plant are very vague. Recent attempts to be more quantitative in this area met with great resistance from the industry and from the old AEC. They tend to be over-simplified, but I believe we could do better than has been done. A related problem is our present total lack of control over what goes in near the plant after the site is approved. We have some vague words about the licensee's responsibility to stay informed about subdivisions, ammunition plants, LNG terminals and other post construction materialization of things that would have made the site unacceptable if known before licensing. Someday some operating reactor is going to have a new neighbor of a really abominable kind and we are going to have trouble coping with it.

c. I believe we are not being serious enough about siting alternatives that may offer substantial safety improvements. An obvious example is underground siting about which we are just starting a study in RES.

7. Degree of Detail and Realism in Safety Evaluations

The great improvement in computer codes available for use in analyzing the course and consequences of postulated accidents has rather naturally led to a corresponding increase in the depth and detail of Regulatory review of these accidents. On the face of it this is a good thing. It leads to better technical understanding and increased realism in evaluations. But is overall safety review enhanced by such detailed examination of certain design basis accidents? It is at least arguable that a broad brush treatment, with plenty of arbitrary conservatisms, gives at least as much safety with a lot less work on everybody's part. A recent and obvious example is the new ECCS regulation, which specifies in gory detail exactly how these calculations are to be made. There are many arguments for and against use of such details and the subject is about right for reopening, in my opinion.

A related subject is the very large increase in the capability of the NRC staff to make independent calculations in many accident areas. This has proved to be invaluable in increasing the staff's technical understanding and should be continued even if some of the details are recognized as too detailed for licensing.

8. Fuel Performance

The performance of light water reactor fuel in normal service has been disappointing to say the least. One would have thought that by this time fuel technology would be well developed. The appearance of such difficulties as densification, hydriding, hot pellets, and the recent incident at Dresden where a transient, well within all limits, resulted in unexpected fuel failures - all tell us that fuel technology is not in as good a state as we thought. The related technology of establishing fuel damage limits under accident conditions is even less well established, principally because PBF is so many years late.

9. Pu Recycle

This is not primarily a reactor problem. The reactor aspects seem to me to be adequately in hand.

REACTOR SAFETY POLICY ISSUES

1. Internal Quality Assurance

We are not taking our own medicine with regard to a quality assurance program in Reg. We do not have a quality assurance organization, independent of the line, reporting to higher management and we have very little auditing and QA in the line. If 10 CFR 50, Appendix B, is good stuff, then it should be applied to the NRC organization. This must be applied to the quality of our product - safety decisions - as well as the quantity and timeliness of our output.

2. Making Better, Faster and More Generic Decisions

Our recent record is mixed. A good example is ATWS and a bad example is turbine missiles, about which we seem not to be able to make up our minds. Future technical safety review should not be endless and mindless repetition of what we have been doing for the past couple of years but rather consolidation into general decisions and general principles, better identification of what is truly important (risk evaluation?), and increasing automation of routine evaluations.

3. Stabilization of Regulation Requirements and Standardization of Designs

Our recent reviews of the standardized designs that have been submitted and recent discussions on standardization (and piggy-back) show the following:

a. The standardization designs submitted are not consolidations of previous experience. The proposed standard designs include a large number of "improvements" not yet actually designed. So, these first standard CPs will be based on a bunch of promises, even more than recent custom CPs.

b. New information from design and operating experience and safety research programs, and new insights as a result of this experience and research have pointed the way to improvements in safety that seem worthwhile and in some cases necessary. The pace and guidelines of the standard reviews has not permitted implementation of these, so they are hanging over our heads as a serious threat to standardization.

c. As a result of a. and b. and of the long time lag between today's bunch of promises and construction and operation of standard plants, more attention needs to be paid to the execution of standardization over the next several years and stabilization of Reg requirements.

4. Too Many Surprises

This is closely related to Item 3. In the past couple of years surprises have come both from operating experience and from improved understanding by both Reg and the industry of safety problems we thought were put to bed. An obvious example is all the trouble we had with ECCS evaluation models. Innovation by applicants will continue to generate surprises. We must develop methods for dealing with these surprises, in cases and generically, without having a fire drill each time.

The New York Times 2/16/76

10.

Safety of Breeder Reactors Questioned

By DAVID BURNHAM
Special to The New York Times

WASHINGTON, Feb. 15—A leading Government expert has said that possible "core nuclear explosions" in experimental reactors that the Government expects to be built all over the United States "is creating great uncertainty regarding their design requirements."

The discussion of the possibility of such an accident in the fast breeder reactor, a source of power that the Ford Administration and most nuclear officials feel is essential to the continued growth of nuclear energy, was contained in a report written last March 13 by Dr. Stephen H. Hanauer, one of the most senior technical experts on the staff of the Nuclear Regulatory Commission.

"This would be nothing like an atomic bomb but would involve a vast release of energy," Dr. Hanauer said when asked to comment on his report, entitled, "Important Technical Reactor Safety Issues Facing the Commission Now or in the Near Future."

Other experts, both favoring and opposed to nuclear energy, agreed that the kind of accident referred to by Dr. Hanauer would not lead to the physical destruction of the area surrounding a fast breeder reactor.

Such an accident, however, most agreed, could lead to the breaching of the reactor's massive containment capacity and the injection into the atmosphere of vaporized plutonium. A further concern was that liquefied plutonium might somehow reach underground sources of drinking water.

Cancer Fears Involved

Extremely small amounts of plutonium, the basic fuel of the fast breeder, have been shown to cause lung and other types of cancer.

Dr. William Hannum, a senior official in the Energy Research and Development Administration, which as of June will have spent $2.69 billion developing the fast breeder, said in an interview that Dr. Hanauer's use of the term "core nuclear explosion" was "technically incorrect—we call it an energetic core disruption."

Dr. Hannum added that the fast breeder reactor's design was such that scientists in his agency were convinced that "core dispersal could be contained without violating the seals of the reactor vessel."

In a recent paper calling for more research on this question, however, four scientists at the agency's Los Alamos scientific laboratory wrote: "Present methods for analyzing hypothetical core disruptive accidents cannot show conclusively that such accidents do not lead to the rupture of the pressure vessel."

"Plutonium is so toxic that the accidental release to the atmosphere of several hundred grams of this material would be a matter of serious concern," the scientists said. Noting that each liquid metal fast breeder reactor may contain more than 2,000 pounds of plutonium, they argued that the release of as little as "0.01 percent of the available plutonium may be cause for alarm."

Because the fast breeder is designed to create more fuel than it burns, it is seen as essential to the long-term use of nuclear reactors.

"Without the breeders," Dr. Hannum said, "we can tap only 1 percent of the potential of uranium, and uranium thus would be equivalent to our oil reserves, which are running out. With the breeder, the power potential within existing uranium reserves can be increased 50 to 80 times."

Dr. Hannum said the Government believed that within 50 years the United States would be dotted with "hundreds of breeder reactors." Ground leveling for the first demonstration model of the fast breeder reactor is scheduled to begin at a site on the Clinch River in Tennessee later this year.

Dr. Hanauer, in his March 13 report to Victor Gilinsky, a member of the Nuclear Regulatory Commission, wrote that "the potential for autocatalytic positive feedback leading to core nuclear explosions in liquid metal fast breeder reactors is creating great uncertainty regarding their design requirements."

Dr. Hanauer's memorandum was one of 61 reports placed in the commission's public document room last week after it had been cited by Robert A. Pollard, a commission project manager, to support his argument that the commission "suppresses the existence of unresolved safety questions and fails to resolve these problems prior to allowing reactors to operate."

Mr. Pollard has submitted his resignation to the commission to go to work for the Union of Concerned Scientists, an organization opposed to present nuclear policy.

In his report, Dr. Hanauer discussed a number of questions that have been raised recently by critics outside the commission, such as three nuclear officials of the General Electric Company who quit two weeks ago to work against nuclear power in California.

The three men stressed their concern that nuclear reactors were unforgiving of human failure. Dr. Hanauer made the same point when he said that present reactor "designs do not make adequate provisions for the limitations of people."

"Means must be found," he said, "to improve the performance of the people on whom we depend and to improve the design of equipment so it is less dependent on human performance."

He added that "the potential for internal and external sabotage constituting a public safety hazard, and the degree to which design and operation need to take sabotage into account, need to be delineated."

On the subject of where reactors could be safely situated, Dr. Hanauer said many of the commission's guidelines "are indefinite at best."

"We have some vague words about the nuclear reactor licensee's responsibility to stay informed about subdivisions, ammunition plants, liquefied natural gas terminals and other post-construction materialization of things that could make a site unacceptable if known before licensing," Dr. Hanauer wrote.

"Some day some operating reactor is going to have a new neighbor of a really abominable kind and we are going to have trouble coping with it."

Enclosure 2