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

April 18, 1975

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CORE MELT CONSIDERATIONS FOR FLOATING NUCLEAR POWER PLANTS

While I agree with you that Alternative 1 is untenable, I do not think that the issue you raise can be considered solely within the four corners of the floating plant question. True, we might do as the lawyers suggest and try to treat floating plants specially because of the lack of experience, but this does not seem to me to be a correct position. Moreover, I do not believe that your proposed Alternative 4 really solves the problem.

The licensability of the floating plant depends, it seems to me, on two decisions: (1) Whether the plant - reactor, platform, moorings, breakwater, etc. - are adequately designed, and (2) whether it is alright to put this sort of machine out in the water near the coast.

If only design basis accidents are considered, and if such problems as breakwaters and ship collisions are properly resolved, there is no difference in concept between land reactor safety and floating reactor safety. But this is not by any means the first time that such questions have affected reactor licensing. Indeed, if only design basis accidents and the words of Part 100 were considered, we could allow plants to be built in Burlington for sure, and probably at Edgar and Ravenswood. Yet all these three sites were rejected because they are too close to large populations. One of the rationales for this was the unlikelihood of successful evacuation of large dense populations. However, behind this was another consideration in the backs of everybody's minds that very large accidents are possible and that their possibility, even though they are very improbable, dictates keeping reactors out of highly populated areas.

I believe that the ACRS is correct in asking the FNP applicant to consider accidents worse than the design basis. I believe that NRC should also develop an adequate appreciation whether bad accidents (outside the design basis) would be "catastrophic" in the FNP. Now, unfortunately I don't have a good definition for "catastrophic" or a good definition how low the probability should be before I am willing to accept a "catastrophe". Ideally, one would have at least a comparative Rasmussen-like study. In the real world this is some time off.

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Your Alternative 4 is an attempt to reach some decisions pending the completion of a good safety study for the FNP. I don't see how it can be made viable. Having opened the question about core melt consequences, you can't proceed without an answer in my opinion. The work you propose to get done and the papers you propose to circulate are incomplete, and in a certain way trivial, without an adequate consideration of the core melt problem. I much prefer your Alternative 5 with some rearranged priorities and maybe some intensive work by the applicant. That's what I think Alternative 4 would end up looking like anyway.

There are some other important questions about the floating plant, such as outside power reliability, storms and breakwaters, ship collisions, etc. I think these should be pursued without waiting for the core melt question.

There are lots of plant design details for which a suitable resolution is sure to be available. I question whether doing a lot of work on these at the present time is really worthwhile.

Attached are a draft talking paper on the Rasmussen Study and how it affects Class 9 accidents and also some detailed comments on the materials transmitted to me on March 31st.

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Technical Advisor

Enclosures
1. Dft Talking Paper
   re Rasmussen Study
2. Detailed Comments

DRAFT TALKING PAPER

PRELIMINARY CONSIDERATIONS IN WHAT MIGHT BE

APPROPRIATE TO DO ABOUT THE RASMUSSEN STUDY RESULTS

A. The problem being discussed here is the apparent discrepancy between the safety study and the Regulatory safety goals.

1. The safety study shows a core melt probability of 6×10^{-5}. Although AEC Regulatory has commented that this figure seems too high and has pointed out some of the conservatisms, it does not seem to me very likely that the final study report will have a significantly different number.[1]

2. The current safety design basis and the current rules and regulations governing reactor safety are not expressed in quantitative probabilistic terms. Rather, the concept of "credible" is used to differentiate between postulated accident sequences to be included in the safety design basis and others, not so included because their probabilities are so low that they are "incredible". It can be seen that some notion of probability must be employed even in this formulation in order to distinguish "credible" from "incredible". However, little or no guidance is given in our rules as to what constitutes "credibility".

3. The growth and increasing respectability of quantitative probabilistic methods has impelled industry and intervenors, as well as the staff, to consider whether and to what extent probability numbers should be considered in safety evaluations. Both on its own hook (in the generation of the ATWS report, WASH 1270) and in response to

contentions and questions from intervenors (proceedings at Zion and Monticello), the staff has stated in various ways some opinions as to what constitutes "credible" and as to what might be suitable quantitative safety goals.

a. In the ATWS report the staff suggests as a safety goal that events with consequences more severe than 10 CFR 100 guidelines should have a frequency no higher than 10^{-3} per year for the USA. Today, with 50 reactor running, that goal translates to 2×10^{-5} per reactor year. In A.D. 2000, with 500 reactors running, the goal would be 2×10^{-6} per reactor year.

b. In testimony at Zion, the staff suggested that the probability of a LOCA with failure of ECCS and substantial breach of containment should be less than 10^{-6} per reactor year with that facility.

c. In a draft Standard Review Plan 2.2.3, an acceptance criterion is proposed for potential accidents caused by hazardous operations off-site such as transportation of explosives in railroads, canals, etc. Such events are to be included in the plant design basics if their probabilities, evaluated realistically at the 50% confidence level, are calculated to be above the range 10^{-7} - 10^{-6}.

4. It seems clear enough that the safety study result, that core meltdown has a frequency of 6×10^{-5}, is somehow in apparent disagreement with the various safety goals suggested recently by the staff in the range 10^{-6} for severe consequences.

B. Does a discrepancy actually exist?

1. It is by no means clear that the core meltdown frequency is as high as 6×10^{-5} per reactor year as given by the study.

   a. The study itself recognizes substantial conservatisms in this estimate. AEC Regulatory, in its comments on the draft study, pointed out that this number seemed high, perhaps by a factor of 10 or more. However, it seems unlikely that the number will be changed significantly in the final study or that any reasonable amount of effort will produce a better number. We are therefore going to have to use this one.

   b. An important result of the study is that the consequences of core meltdown are highly variable and that the most likely consequence is very mild indeed. By contrast, the present Regulatory approach implies that the consequences of i.e.,"incredible" events (not in the design basis) can be and are likely to be extremely severe. In fact, the two approaches to safety evaluation are very different and the apparent "discrepancy" in the frequency of gross core failure cannot and must not be separated from the equally important discrepancy in consequences of such failures. For the single distinction in 10 CFR 100 between credible accidents whose conservative calculation consequences must be within guidelines values and events outside the design basis (Class 9 accidents) whose consequences are not considered, the study substitutes the complete spectrum of accident consequences with the frequency distribution function to go with it.

C. What can we do about the "discrepancy"?

1. We can explain it away as in paragraph B.1.b. above. This is really not very useful by itself, since the discrepancy in numbers will remain to confuse the public and delight the intervenors. Direct and correct explanations tend to sound defensive and unconvincing because of the widely different premises of the two approaches and the apparent ignoring of the less favorable approach. It really isn't le favorable for public risk but appears to be so as far as core meltdown is concerned.

2. The "10^{-6} goal" can be changed. NRC could announce that in view of the insight gained in the safety study and the apparent satisfactory state of public risk shown in the study, the safety goal is now to be 5×10^{-5} per reactor year for severe events. This would have the effect of permitting the design basis of, for example, floods and plane crashes, to be relaxed substantially. The resulting effect on real public safety would not be neglible. A new "discrepancy" would then appear since the relaxation would lead to a new value for core meltdown frequency which I predict would not be consistent with the new safety goal. It is noteworthy that industry reaction to the safety study seems to be in this direction.

3. Improvements in safety could be required to bring the core meltdown frequency down to the order of 10^{-6} per reactor year by AD 2000. This

sounds great and apparently improves public safety, but makes no real sense if the risks shown by the safety study are in fact acceptable. Resources spent in decreasing risks already acceptable are resources wastes. We don't need such a pointless increase in the cost of energy.

4. Change the safety evaluation basis to be more nearly like, or equivalent to, the risk evaluation basis. This is a formidable technical and policy task.

   a. It cannot be accomplished satisfactorily by waving a magic wand and decreeing that the new safety design basis would be a quantitative probabilistic risk evaluation on every nuclear power plant. We do not have, at this time, the technology to accomplish this task, nor the resources, nor the data. The response would be a mad scramble to hire all the fault tree experts in the country with the result a massive and mostly meaningless numbers game. The most important drawback is the lack of real meaning to the numbers thus assembled. This does not mean that the safety study is meaningless (for judging whether nuclear power is unsafe) but just that it is not now valid for making case-by-case licensing decisions.

   b. Some more modest change must be found that preserves the good features of the present system. We know it has good features because the level of risk that has resulted seems satisfactory. We know it needs improvement because of the insights gained in the safety study, and we know that the new basis must be consistent with available technology and a reasonable amount of resources.

D. How can we get started with the necessary reforms?

1. Obviously, the final version of the study must be issued. This will be definitive in the sense that it would take a lot of time and resources to do any better. One hopes that the conservatism of the results will be more carefully appraised, especially as it related to core meltdown probability.

2. The ATWS question will have to be reexamined at least to some extent. A chorus of industry complaints states that the safety study results, as given in the August 74 draft, negate WASH 1270 and the staff's earlier evaluation. We have already initiated (copy attached) a scoping staff study of these apparent disagreements without waiting for the final study draft, which will in turn no doubt have to be studied some more for the same purposes.

3. There is no obvious analogous discrepancy in the area of risk due to external phenomena. The study relied on the adequacy of the regulations i this area. Some further study work would seem to be indicated and was recommended in the AEC Regulatory review. We sha have to see the final study to find out whether there is a problem here or not.

4. In my opinion, the correct approach is the difficult one of reconsidering the present safety evaluation basis in the light of both the methods and t results of the safety study. Some possibilities for this are suggested in paragraph C.4.b. above. Some more detailed ideas would be the subject of a future paper.

5. In the meantime, pending such a study and, if accepted, such reform, the sensible and technically correct and responsible thing to do seems to me to acknowledge the apparent "discrepancy" of paragraph A.4. and to explain it on the basis of differences in approach as discussed in paragraph B.1.b. It might be well if a position paper were prepared on this subject.

DETAILED COMMENTS

Page 1 - The frequency discussed here follows from the assumption that about 1,000 reactors are in operation. Some distinction should be made between today with 50 reactors running and A.D. 2000 with 500 to 1,000 reactors running.

Page 2 - One of the lessons of the Rasmussen study is that most core meltdowns do not have drastic consequences. This puts "catastrophes" further down on the probability scale because of their unlikelihood even if the core melts. The discussion here does not make this distinction and therefore fails to learn an important lesson from the Safety study.

Page 4 - The summary in the last half of this page is more simplistic than the facts. The material in the last three lines, and on top of page 5, neglects entirely the sort of considerations that have led to the rejection of proposals to build reactors at Burlington, Ravenswood and Edgar. Thus, while each word of this discussion is true, it fails to take an important factor into account.

Reactors must be shown to be safe in consideration of all possible occurrences. The spectrum of such occurrences ranges from the trivial to the catastrophic. For occurrences within the design basis the consequences must be shown to be tolerable by conservative evaluations. For postulated events outside the design basis the probability must be shown to be low and acceptable and qualitatively depend on whether the probability is low enough in relation to the consequences. The value of the Safety study is just in that it makes these relationships explicit and quantitative.

Page 5 - We have indeed implied that core meltdown frequency is lower than 10^{-6} per reactor year. This problem is discussed in detail in a separate attachment.

Page 8 - Item 3 has to be demonstrated. It has not been so demonstrated yet in a way that is convincing to me.

Page 9 - The basis for Item 4 is not evident to me. Are there evaluations or calculations that show this in any quantitative way? In particular, the discussion of differences in failure mode between ice condenser containment and the containments studied in Wash 1400 should be substituted or deleted. Similarly, Item 5 seems to contain several unacknowledged conjectures.

Page 12 - I agree with you that Alternative 1 is untenable. Even if I thought it was true, I doubt if an acceptable defense of it could be sold to the board, the courts or the public. I do not believe it is true.

Page 13 - I don't see how we could recommend building a small number of plants with this kind of an open question regarding their safety.

Alternative 3 ignores the problem unacceptably and proposes that the staff be an ostrich.

Page 14 - Alternative 4 - I have commented on this at length in my covering memo.

Page 17 - Alternative 5. I think this is the only course and propose that it be done expeditiously instead of slowly as proposed.

Page 18 - Alternative 6 is what happens if you don't do Alternative 5 with considerable speed. I don't know whether lagoons are a viable alternative for a few years.