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December 21, 1992

Mr. Samuel J. Chilk
Secretary of the Commission
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Attention: Docketing and Service Branch

Re: Advanced Notice of Proposed Rulemaking: Acceptability of Plant Performance for Severe Accidents; Scope of Consideration in Safety Regulations [57 Fed. Reg. 44513, (September 22, 1992)]

Dear Mr. Chilk:

AECL Technologies has reviewed the subject advance notice of proposed rulemaking. We appreciate the opportunity to review this document and to contribute our views for Staff and Commission consideration. AECL Technologies supports initiation of rulemaking to resolve severe accident issues generally prior to commencement of design certification proceedings to the extent practicable.

Sincerely,

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December 21, 1992

AECL TECHNOLOGIES (AECLT)

COMMENTS ON
THE NUCLEAR REGULATORY COMMISSION'S (NRC)
ADVANCE NOTICE OF PROPOSED RULEMAKING (ANPR)
CONCERNING ACCEPTABILITY OF PLANT PERFORMANCE FOR SEVERE ACCIDENTS; SCOPE OF CONSIDERATION IN SAFETY REGULATIONS
[57 FED. REG. 44,513 (SEPTEMBER 28, 1992)]

I. INTRODUCTION

The ANPR states that one purpose of a severe accident rule would be to "Provide assurance that the performance of future LWRs under severe accident conditions is consistent with assumptions about severe accident performance used in developing new source term information." 57 Fed. Reg. 44,514. To achieve this purpose, AECLT believes that the rule should establish comprehensive requirements applicable to all reactors and that Regulatory Guides should be developed which provide specific guidance concerning ways of meeting the requirements for specific reactor systems or reactor types. These guides should become available in draft form at the time a proposed rule is issued.

Provided herein are AECLT's comments on the ANPR, as well as responses to those questions in the ANPR applicable to Pressurized Heavy Water Reactors (PHWR) such as the CANDU 3 reactor. Since questions 8, 11, 13 and 14 are not applicable to PHWRs, no responses to these questions are provided.

I. GENERAL COMMENTS:

1. The overall criteria for protecting the public from severe accidents should be the same for all water-cooled reactors. A severe accident rule should specify these overall criteria. AECLT believes the format of such a rule should be similar to the format described as Alternative 3 in the ANPR. Adoption of this format would encourage designer flexibility and inventiveness in the incorporation of severe accident prevention and mitigation features to reduce the frequency and consequences of such accidents.

2. The ANPR indicates that the criteria discussed in this ANPR would codify much of the Commission's guidance for general application to all future LWRs. AECLT believes that this guidance would also be applicable to PHWRs. Presently, the NRC is conducting a preapplication review of the CANDU 3 design. In conjunction with NRC's review of CANDU 3 severe accident prevention and mitigation design features, AECLT has prepared at NRC's request, a

comparison of the CANDU 3 features to the NRC Staff's recommended criteria in SECY-90-016, as modified by Commission guidance, concerning severe accident prevention and mitigation in LWR designs. Based on this comparison, AECLT concludes that the CANDU 3 design will conform with the SECY-90-016 recommendations and guidance.

3. The ANPR discusses three potential alternatives for design requirements related to prevention and mitigation of severe accidents. Alternative 1 would prescribe hardware requirements to address risk-significant phenomena. Alternative 2 would require designers to address risk-significant phenomena in the design, but would not prescribe specific hardware requirements. Alternative 3 would specify General Design Criteria to describe the nature of the severe accident challenges as well as associated success criteria. From the description of each alternative in the ANPR, AECLT cannot tell whether the alternatives are intended to be equally comprehensive in scope.

   AECLT believes that, regardless of the format adopted for the severe accident rule, the rule and accompanying guidance concerning implementation of the rule should be comprehensive in scope and should address the following matters: (a) criteria for establishing event sequence frequencies; (b) radiological consequence limits; (c) capacity and reliability of the design feature; and (d) criteria to establish load combinations and environmental conditions. Additionally, implementing regulatory guidance should address redundancy, diversity, power supply, equipment survivability, analytical methods, and acceptance criteria.

4. Specifically, in the rule and implementing guidance the following matters should be addressed:

   A. <u>Selection Process for Severe Event Sequences Considered in the Design</u>. The selection process should be based on event frequency. The process would establish the frequency limits to: (1)define the events requiring design changes to reduce their frequency, (2) define the events that require features to mitigate the event's consequences and (3) define events that need not be considered in the design.

   B. <u>Consequence Limits</u>: For each event sequence defined by A(1) and A(2) above (e.g. reactivity events, loss of heat sink at High/Low Pressure), acceptable consequences for the event frequency should be defined on an overall basis (e.g. containment stress and leakage, radiological consequence limits). In addition, a phenomenon acceptance criterion should define the acceptable consequences for each individual phenomenon (e.g. hydrogen, molten fuel, non-condensable gas) associated with the event consistent with the overall acceptance criteria and the design features that produce the phenomenon.

C. Phenomenon Acceptance Criteria: For each phenomenon acceptance criterion, systems/features should be identified which provide the means to mitigate the consequences of the phenomenon.

D. System/Feature Design Criteria: For each system/feature, design criteria should be established for capacity, load combinations, environmental conditions vs time, and reliability. The reliability criteria should include: redundancy, diversity, power supply, separation (from each other and from systems/features whose failures are involved in the severe accident event sequences), and environmental qualifications.

E. System/Feature Demonstration Requirements: For each system/feature, the demonstration analysis/test requirements should be defined. These should include assumptions, acceptance criteria, analytical methods, and test requirements

5. For a criteria-oriented rule, similar to Alternative 3, which AECLT favors, items A and B above should be included in the rule; items C, D, and E above should be included in a Regulatory Guide.

6. Because each reactor type may have some unique requirements, AECLT suggests that the rule be structured in two parts. The first part should present the overall requirements to be met by all reactors. The second part would have separate sections for each reactor type (i.e., Pressurized Water, Boiling Water, Pressurized Heavy Water) PLWR, BLWR, PHWR (i.e. CANDU)). Other reactor types (e.g. sodium and gas cooled reactors) could be added at a later date.

7. A severe accident rule ideally should be of sufficiently comprehensive scope to permit severe accident closure determinations to be made for new designs. AECLT believes that a rule and implementing guidance of the

scope described above in paragraph 4 would permit these determinations to be made. Issues identified in 4 which are not addressed in a severe accident rule will have to be addressed in individual Standard Design Certification rulemakings or in COL proceedings.

8. As discussed in 3 and 4 above, a severe accident rule should specify a cut-off event frequency such that events below this frequency need not be considered in the design and for which further analysis is not required.

NUREG/CR-5368, "Reactivity Accidents" reported the results of analyses of light water reactor reactivity events performed by Brookhaven National Laboratory. For that effort, Brookhaven categorized potential event sequences as being worthy of further analysis, or not. One of the screening criteria used to determine the importance of a sequence for further analysis was whether the sequence required too many low probability events to occur in combination. Brookhaven established a screening methodology with which low probability events could be eliminated from further consideration.

Event sequences with a frequency of less than 1E-7 per reactor year were considered "incredible" and not recommended for further study.

AECLT believes that the generic severe accident rule should codify similar screening criteria.

II. ANSWERS TO NRC'S SPECIFIC QUESTIONS

Question 1

Is a rulemaking addressing severe accident plant performance criteria desirable? If so, why? If not, why not? Would a rule provide better coherence and predictability to the design review and certification processes for future reactor designs or is rulemaking on these issues via individual design certification sufficient?

Response 1

AECLT believes a rule establishing generic severe accident criteria and plant performance criteria to prevent and to mitigate severe accidents is desirable. AECLT prefers that the rule be in the format described by Alternative 3 in the ANPR. As discussed in comment #4 above, the rule should establish the event frequency bounds, design criteria and radiological consequences associated with severe accidents. These criteria should be independent of reactor type. Such a rule would provide predictability in the certification process. It would provide assurance to the public that the individual design certifications would be consistent with respect to degree of protection provided from severe accidents.

The rule should be supplemented by Regulatory Guide(s) which identify the phenomena identified to date, the acceptable systems/features to cope with phenomena, and the acceptance criteria for such systems.

The supporting Regulatory Guide(s) should be issued at the same time as the rule.

Question 2

Would a new rule in 10 CFR part 50, concerning plant performance for severe accidents, as discussed in the three alternatives, provide a bas s for revising the requirements on Emergency Planning Zones for future LWRs? If so, why? If not, why not?

Response 2

The three alternatives discussed in the ANPR do not address the offsite radiological consequences of a severe accident; therefore, they do not provide an adequate basis for revising the requirements on Emergency Planning Zones. As discussed in our Answer to Question 1, AECLT believes that the severe accident rule should address such consequences. If the rule does so, the rule would provide a basis for EPZ simplification for all future reactors (both LWRs and PHWRs) encompassed by the rule's scope.

Question 3

One option for an overall containment performance criterion that has been considered is that the conditional failure probability of the containment should be less than approximately one in ten. Two of the alternatives use a deterministic surrogate that states that the containments should remain leak tight for a period of approximately 24 hours following the onset of core damage and after that time remain a barrier against the uncontrolled release of radioactivity when faced with challenges from the more likely severe accident phenomena. Is this criterion a suitable substitute for the conditional containment failure probability of one in the ten? If so, explain why. If not, explain why not. Is a period of approximately 24 hours an appropriate time frame? Is its degree of conservatism appropriate considering uncertainties and defense-in-depth? If not, what alternative would be appropriate? What other criteria (probabilistic or deterministic) might be considered?

Response 3

Because of the wide range of the types of challenges to containment that may result from severe accident events, the NRC should not specify any specific criteria for evaluating these challenges in the rule. Instead, general criteria concerning event frequency and radiological consequences should be in the rule. Design specific criteria should be in the Regulatory Guides. The applicant should provide the traditional justification for the analysis of containment performance during severe accident events.

Question 4

Alternative 2 would require extensive reliance on analytical tools that calculate the affects of severe accident phenomena. Are there analytical tools that are sufficiently developed and adequate to allow effective implementation of such a phenomena-based rule? If so, what are they, and for what phenomena could they be used? How would alternative 2 be implemented? For example, should the codes and input parameters be approved by NRC? Should acceptance criteria be codified or put in a regulatory guide?

Response 4

Alternative 2 may dampen innovative approaches to the prevention and mitigation of severe accidents. Alternative 3 would not be so dependent on the state of technology and so difficult to change to incorporate the results of ongoing research programs.

Question 5

Should future LWR containment designs include features beyond those described in alternative 1 to prevent/mitigate severe accidents? If so, what are they?

Response 5

AECLT believes that Alternative 1 is unnecessarily restrictive. By codifying specific design requirements based on current knowledge, Alternative 1 does not allow for alternative designs. This is an impediment to innovation based upon increased understanding of alternative technologies. Alternative 3 would codify the acceptance criteria and permit innovative designs to meet those criteria.

Question 6

Alternatives 2 and 3 specify phenomenological severe accident challenges that should be considered in the design. Alternative 1 is based upon the same phenomena/challenges. Are there other severe accident phenomena/challenges that should be considered? What should the criteria for deciding whether a severe accident phenomena or challenge is likely and should be considered? Should the challenges be specified in more detail (for example, specifying the amount of hydrogen generation) or is a general statement of the challenge more desirable?

Response 6

As discussed above in General Comment 4, the criteria for deciding whether a phenomena or challenge should be considered in the design should be based on the event sequences to be considered in the design and the phenomena they produce. This requires a systematic review of the plant for potential events and an analysis of their event frequency and their phenomena. As discussed above in General Comment 8, AECLT believes that phenomena associated with event frequencies less that 1E-7 should not have to be considered.

Question 7

For what reason (e.g. not a risk significant phenomena, not a cost effective solution) would any of the criteria proposed in the three alternatives not be fully applicable to passive designed LWRs?

Response 7

Alternative 1 may be design-dependent, as may Alternative 2. Alternative 3 would be independent of specific reactor designs and, therefore, would be applicable to passive designs.

Question 9

If a design includes the capability to rapidly depressurize the primary system, should it also be required to have a reactor cavity design and/or a reactor vessel support structure capable of mitigating and accommodating a high pressure melt ejection?

Response 9

The need for either preventing or accommodating a high pressure melt ejection should be established on the frequency limit for the events, that should be considered in design. If the frequency limit can be met or exceeded with system(s) that prevent this event, it should not be necessary to accommodate the event.

It is more prudent to design to prevent this event rather than design to accommodate this event. The design of preventive systems, (i.e. depressurization systems, power supply, feedwater, etc.) is straightforward. The design of accommodation systems is speculative because the conditions of the high pressure melt ejection are uncertain.

Question 10

Should future LWR designs include an on-line instrumentation system that monitors containment atmosphere for gross leakage to reduce the risk from an inadvertent bypass of containment function? Would application of this system be sufficient basis to modify leak rate testing requirements under 10 CFR part 50, Appendix J, "Primary Reactor Containment Leakage Testing for Water-Cooled Power Reactors."

Response 10

In the CANDU 3 design, containment air pressure and temperature, along with other data, are monitored while the plant is operating to provide a timely indication of any gross breach of containment.

The provision of a gross leakage monitoring system should be a sufficient basis to modify the requirements of Appendix J.

Question 12

Should equipment provided only for severe accident prevention or mitigation be subject to (a) the same requirements as design basis equipment (e.g. redundancy/diversity, power supply, environmental qualification, inclusion in plant Technical Specifications, maintenance priority, quality assurance); or (b) lesser standards (e.g., reduced design margins or the regulatory guidance found in appendices A and B of Regulatory Guide 1.155, "Station Blackout?"). If lesser standards, what standard would be appropriate?

Response 12

The question appears to suggest only two alternatives for requirements; however, there is a third alternative that considers the nature of the design feature, its safety function and the conditions under which it should operate.

The requirements for severe accident prevention or mitigation equipment/features should be appropriate for the specific feature, the time-history of the conditions associated with the event, and the desired reliability goal for the equipment/feature. For example, the hydrogen igniter system, depressurization systems and heat removal systems would have different requirements from the reactor cavity and basemat.

Question 15

The containment performance objective discussed in Alternatives 1 and 2(i.e. containment shall provide a barrier against the release of radioactive material for a period of approximately 24 hours following the onset of core damage) represents a level of safety for a 3800 Mwt plant cited in accordance with 10 CFR part 100 approximately three orders of magnitude below the Commission's Safety Goal Policy Statement. It could be argued that a future LWR design meeting this objective through analyses and the incorporation of design features need not consider the addition of other features, since these other features would be directed at even more highly unlikely severe accident phenomena and sequences which could be considered "remote and speculative" under the National Environmental Policy Act (NEPA) and 10 CFR part 51. Therefore, would the codification and compliance with such a containment performance objective be sufficient to also define a point of truncation and serve as the basis for an amendment to 10 CFR part 51 eliminating the need for further review of SAMDA's for future LWRs under 10 CFR part 51?

Response 15

Regardless of the rule format (Alternative 1, 2 or 3), the rule should be sufficiently definitive to eliminate the need for further review of SAMDAs for future LWRs and PHWRs under 10 CFR Part 51. The approach described in General Comment 4 is of sufficient scope to permit severe accident closure under NEPA for designs meeting the requirements. The rule should include a determination to that effect so that the issue cannot be raised successfully in a design certification or COL proceeding.

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