Telephone 617 366-9011
TWX
710-390-0739

YANKEE ATOMIC ELECTRIC COMPANY

NRC PUBLIC DOCUMENT ROOM
20 Turnpike Road Westborough, Massachusetts 01581

B.1.2.1

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PROPOSED RULE

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Secretary of the Commission
United States Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Docketing and Service Branch

Dear Sir:

On page 57157 of Volume 43, No. 235 of the December 6, 1978, Federal Register, the USNRC invited public comments pertaining to a proposed acceptance criteria for emergency core cooling systems for light water cooled nuclear power plants. We have reviewed this proposal and submit the attached information for your consideration.

Should you have any questions in regard to this matter, please feel free to contact us.

Very truly yours,

YANKEE ATOMIC ELECTRIC COMPANY

D E Vandenburgh

D. E. Vandenburgh
Senior Vice President

Enclosure

Acknowledged by card. 2/12

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Yankee Atomic Electric Company's Response to the Advanced Notice of Proposed Rulemaking Concerning the Acceptance Criteria for Emergency Core Cooling Systems

Yankee Atomic Electric Company would like to comment on the Advance Notice of Proposed Rulemaking which appeared in the Federal Register on December 6, 1978. Specifically, we should like to respond to two of the five questions posed for comment by the Notice, questions on the quantification of safety margin and the inclusion of new research information in performing ECCS analyses.

In the Advance Notice the Commission has indicated the possibility of modifying Appendix K requirements in two phases. The first phase would remove the criterion of Return to Nucleate Boiling Lockout and the requirement of a steam cooling model for flooding rates below one inch per second. The second phase aims at modifying the fission product decay heat rate and the use of Baker-Just equation for metal/water reaction rates. In addition, the basic performance requirement of keeping clad oxidation below 17% would also be reexamined. The second phase would also consider the assessment of remaining phenomenological uncertainties in LOCA analysis.

We believe that the Commission's proposed actions to modify Appendix K requirements could be steps in the right direction but fall short of what is actually required. Phase I (which we understand should not require public hearings) should be implemented. We would suggest, however, that the basic approach under Appendix K needs to be reconsidered before proceeding with Phase II rulemaking. Specifically, we feel that LOCA /ECCS evaluations should be treated in a manner similar to most of the other evaluations done to ensure the safety and health of the public; "realistic" analyses should be performed and required safety margins established as criteria to be applied to the realistic analyses. Adequate modeling techniques as well as correlations based on the existing data should be utilized in order to predict the event in the most realistic manner. Phase II rulemaking, therefore, should not be a mechanism to modify Appendix K criteria, but rather a way to remove requirements for adequacy from the Code of Federal Regulations. The Nuclear Regulatory Commission should then be able, utilizing whatever technical expertise and peer review it deems appropriate, to decide the adequacy of LOCA calculational models.

The regulations contained in Appendix K of 10CFR50 establish criteria for ECCS performance, describe evaluation models for use in making the calculations of Emergency Core cooling performance, and set forth certain required and acceptable features of evaluation models. The philosophy utilized in establishing criteria for ECCS performance was to identify the major parameters important in characterizing the consequences of a LOCA and to try to simulate the postulated accident in a manner which would yield conservative results.

Plant operation under Appendix K is such that the LOCA/ECCS calculations result in (a) peak clad temperature no more than 2200°F, (b) maximum clad oxidation less than 17%, (c) maximum hydrogen generation of less than 1% of total clad Zircaloy, (d) assurance of coolable geometry, and (e) assurance of long term cooling.

This criteria is based on two broad features:

(1) It set a limit on plant related uncertainties (i.e. power production at 102%, establishment of single failure criteria and containment back pressure minimization).

(2) It identified the physical phenomena which should be considered in evaluating the ECCS performance.

Two different approaches were taken to insure the conservative modeling of these phenomena. In some instances it is permitted to use either the correlations and models given in Appendix K or to use any other model with justifications for their applicability. In other instances specific parameters were identified which had to be considered by the correlations or schemes outlined in Appendix K. These are:

(1) Use of decay heat which is 120% of that predicted by the ANS curve.

(2) Use of Baker-Just equation for metal/water reaction rates.

(3) Use of Moody's critical flow rates for two-phase flow and $C_D = 1.0$ to 0.6.

(4) Lockout of return to nucleate boiling.

(5) Use of steam-cooling model for flood rates below one inch per second.

(6) Core flow redistribution with only one assembly treated as the hot assembly.

Behind Appendix K criteria is the requirement to ascertain that Emergency Core Cooling Systems will function adequately in the event of a LOCA. Since the physical phenomena involved during a LOCA are very complex and not completely understood, conservatisms are necessary. Unfortunately, under Appendix K, conservatisms are infused into the analysis in such a manner so as to make the LOCA event predictions unrealistic. And, although different parameters are separately treated in a conservative manner, it is difficult to assess the impact on the overall predicton. What is required is to redefine requirements for ECCS safety margin in an integral sense, and to accomplish this in such a way as to be able to relate integral safety margin requirements to material requirements and to present phenomenological uncertainty. Recent experimental and analytical work are now available to accomplish this. The following four steps are proposed which should be pursued <u>before</u> Phase II rulemaking and possible public hearings are opened:

1. <u>Qualification of the "Best Estimate" LOCA/ECCS Models Should be Completed</u>

The focus of ECCS rulemaking should be to replace evaluation models by "Best-Estimate" models. Current Integral tests (LOFT, Semi-Scale etc.) should be used to validate existing "best estimate" approaches. LOCA codes should be improved until they predict the experimental results in a realistic manner.

2. <u>Estimation of the impact of parametric and phenomenological uncertainty on the overall results</u>

Current analytical work (e.g. Response surface techniques) should be continued. This could establish the importance of specific physical parameters in the analysis and the extent to which the final results are controlled by such parameters. This approach should also be used in assessing the care taken in modeling a given phenomena, as well as nodalization and time step sensitivity requirements. The emphasis placed on different research areas may be deduced from this exercise.

3. <u>Re-Examination of the Acceptance Criteria</u>

Recent work performed at ANL[(1)] and at SNL[(2)] show that 2200°F clad temperature and 17% clad oxidation limits set by 10CFR50.46 criteria are very restrictive. Canadian work [(3)] also stresses that the maximum temperature and total oxygen content have little or no effect on the tensile property of Zirc-4 cladding.

In line with items (1) and (2), it is recognized that the criterion for maximum clad temperature and clad oxidation may need to be changed to reflect a change in Zircaloy-4 behavior. A criteria establishing several pairs of temperature and oxidation values may be needed. Research in this area should be completed before Phase II rulemaking proceeds.

4. <u>Re-establishment of Conservatisms</u>

Since we are concerned with modeling a very complex transient, the "Best Estimate" results may not be conservative enough. It is recommended that rulemaking itself establish both safety margin requirements and a mechanism for modifying those requirements as new information becomes available. Prior to rulemaking, however, a process for quantifying safety margin requirements should be in place. Philosophically, one might quantify the Acceptance Criteria set by Item (3) as a distribution. Similarly, the analytical work noted in Item (2) should be used to quantify the relationships between modeling and phenomenological uncertainty on calculated parameters. The effect of uncertainty regarding the initial value of plant parameters could also be assessed utilizing the work in Item (2). This work should precede Phase II rulemaking. Figure 1 is a conceptual view of safety margin definition:

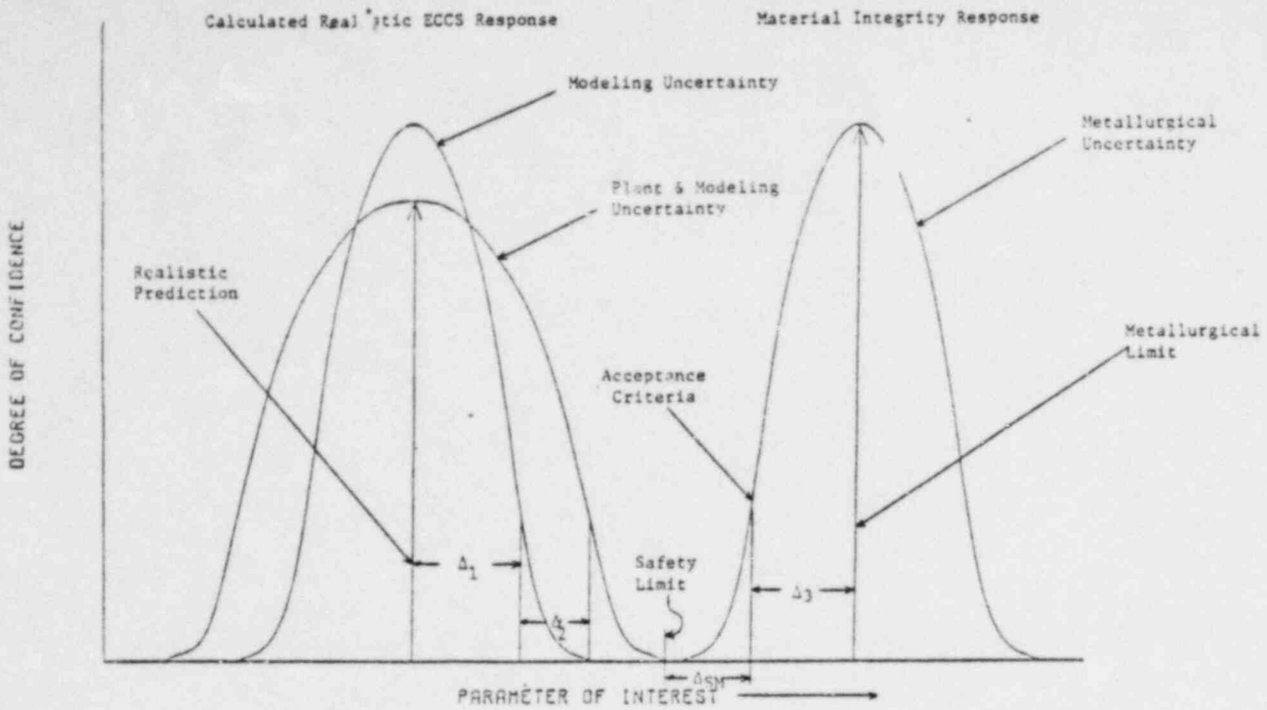

Figure 1
Conceptual View of Safety Margin

Δ_1 = safety margin due to modeling uncertainty
Δ_2 = safety margin due to plant parameters
Δ_3 = safety margin due to metallurgical uncertainty
$SM = \Delta_1 + \Delta_2$

Overall safety margin = $\Delta_1 + \Delta_2$ and should be defined as a confidence level associated with uncertainties in analytical predictions of ECCS response, not as an absolute number. Plant operation shall be maintained such that the realistic prediction of the parameter of interest with ΔSM will not exceed the acceptance criteria limit based on material considerations; or, alternatively, that the realistic prediction not exceed a safety limit determined by subtracting ΔSM from the acceptance criteria. Future work, subsequent to rulemaking, could then be used to modify safety margin requirements and the acceptance criteria directly by redefining the magnitudes of $\Delta 1$ and $\Delta 3$ respectively.

References:

(1) T. F. Kassner, et al; "Zircaloy Cladding Embrittlement, Recommended Criteria", Presented at the Sixth Reactor Safety Research Information Meeting, Nov. 6-9, 1978.

(2) P. D. Parsons, "Zircaloy Cladding Embrittlement in a Loss of Coolant Accident," Presented at the Sixth Reactor Safety Research Information Meeting, Nov. 6-9, 1978.

(3) A. Sawatzky, "Oxygen Embrittlement of Zircaloy-4 Fuel Cladding", Presented at the Sixth Reactor Safety Information Meeting, Nov. 6-9, 1978.