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

October 27, 1972

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Re: Acceptance Criteria for Emergency Core Cooling Systems for Light-Water-Cooled Nuclear Power Reactors (Docket No. RM-50-1)

Gentlemen:

Pursuant to the Commission's Order of January 26, 1972, and the Hearing Board's Order of September 22, 1972, in the proceeding, the Advisory Committee on Reactor Safeguards herewith submits for filing with the Board its responses to the interrogatories propounded on September 15, 1972, by the Consolidated National Intervenors.

I affirm that the attached answers to Consolidate National Intervenors interogatories are true and correct to the best of my knowledge and belief.

Sincerely,

/s/ C. P. Seiss

C. P. Siess
Chairman

Wash., DC October 28, 1972
Subscribed & sworn to before me this 28th day
of October, 1972 /s/ Ruth G. Davidow
Notary Public, DC
MY COMMISSION EXPIRES JULY 31, 1973

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In the Matter of )
)
ACCEPTANCE CRITERIA FOR EMERGENCY )
CORE COOLING SYSTEM FOR LIGHT- )
WATER-COOLED NUCLEAR POWER REACTORS)

Docket No. RM-50-1

RESPONSES BY THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS TO THE INTERROGATORIES OF THE CONSOLIDATED NATIONAL INTERVENORS

By motion dated September 15, 1972, the Consolidated National Intervenors (CNI) requested an order from the Hearing Board in the above-named proceeding requiring that the Advisory Committee on Reactor Safeguards (ACRS) answer a set of 86 interrogatories.

By Order of September 22, 1972, the Board allowed CNI interrogatories number 1, 2, 3, 9, 54, 56, 59, 61, 63, 67, 68, 75, 76, 83 and 85. Interrogatories 11, 45, and 55 are to be answered within limits or conditionally as specified by the Board's Order. The responses to the fifteen allowed interrogatories plus numbers 11 and 45 follow. The condition set by the Board in approving number 55 was determined to be not satisfied.

INTERROGATORY NO. 1: Does the ACRS believe that the PWR-FLECHT tests can be cited as an experimental demonstration of the effectiveness of the PWR ECCS? Please explain your answer in specific detail.

RESPONSE: No. The PWR-FLECHT tests are not a demonstration of system effectiveness, but are heat transfer tests which provide information for use in developing suitable models. Furthermore, the PWR-FLECHT tests address only that portion of the postulated loss-of-coolant accident designated as the reflood period.

INTERROGATORY NO. 2: Does the ACRS believe that the BWR-FLECHT test ZR-2 can be cited as an adequate demonstration of the effectiveness of the spray cooling system used on boiling water reactors? Please explain your answer in specific detail.

RESPONSE: No. The BWR-FLECHT test designated ZR-2 (correctly Zr-2K), like the PWR-FLECHT tests, is not a demonstration of system effectiveness, but is a heat transfer test which provides information for use in developing suitable models. Furthermore, the BWR-FLECHT tests address only a portion of the functions of the spray cooling system.

INTERROGATORY NO. 3: Does the ACRS believe that the PWR-FLECHT plate-simulated flow blockage tests can be accepted as the definitive basis for understanding the thermal/hydraulic effects of flow blockage in an open lattice pressurized water reactor core during a LOCA. Please explain your answer in specific detail.

RESPONSE: No. Other factors such as the actual core geometry and structural behavior and the redistribution of flow, and their interpretation in the analytical models, need to be considered further.

INTERROGATORY NO. 9: Does the ACRS believe that the quantity of data obtained in the two FLECHT programs is adequate for the purposes to which that data are used in the evaluation models? Please explain your answer in specific detail.

RESPONSE: Yes, for the purpose for which those data are used in the evaluation models. The ACRS believes that the purpose is to provide information for use in the development of empirical models for interim application of the Interim Acceptance Criteria to evaluation of light water reactors of current design. The existing FLECHT data are relatively extensive but the range of parameters covered experimentally is limited. Extrapolation of these data, of necessity, leads to some uncertainty of prediction. Further experimentation and analysis is important and is underway.

INTERROGATORY NO. 11: Does the ACRS agree with Dr. L. J. Ybarrondo that the use of steady-state CHF and heat transfer correlations in the approved evaluation models is not necessarily conservative? Please explain your answer in specific detail.

RESPONSE: Yes. In the absence of exhaustive experimental data covering the effect of transients of all significant parameters on CHR and heat transfer correlations, it is necessary to agree that use of steady-state correlations, per se, in evaluation models involving transients is not necessarily conservative. However, the ACRS believes it is generally possible to use steady-state correlations in the evaluation models in such manner as to yield conservative results.

INTERROGATORY NO. 45: Does the ACRS believe that research should be performed to investigate the effects of an injection point on accumulator effectiveness? Please explain your answer in specific detail.

RESPONSE: Yes. Research involving effects of injection point of water into steam-water mixture flows under circumstances simulating possible conditions of a LOCA could improve our knowledge of the phenomena involved.

INTERROGATORY NO. 54: Does the ACRS believe that the approved evaluation models always calculate conservatively high estimates for the maximum cladding temperature for the LOCA under consideration? Please explain your answer in specific detail.

RESPONSE: No. The evaluation models include provisions for many detailed input parameters for which judgments must be made which affect the conservatism of the calculated maximum cladding temperature for the LOCA under consideration. However, the ACRS believes that with selection of appropriate values for these parameters and for other design and performance variables, such as peaking factors, cladding temperature can be evaluated in an acceptably conservative manner for an interim period.

INTERROGATORY NO. 56: Does the ACRS believe that the conservatism of the approved evaluation models has been quantified in a meaningful way? Please explain your answer in specific detail.

RESPONSE: No; however, although the degree of conservatism has not been quantified, the ACRS believes that with continuing reevaluation, the conservatism of the approved evaluation models has been sufficient for the interim purposes for which they have been used.

INTERROGATORY NO. 59: Have meaningful confidence limits been established for the approved LOCA transient analysis models? Please explain your answer in specific detail.

RESPONSE: The ACRS is aware of the sensitivity studies, of recent studies to establish integral errors, and of comparisons between evaluation model and best estimate results, but is not aware of any analyses that have established confidence limits as such.

INTERROGATORY NO. 61: Would the ACRS agree that a "conservative" analysis of a LOCA is one that calculates a higher maximum cladding temperature, or integrated time at temperature, than would actually occur in the LOCA under consideration? If the ACRS would not agree, please state its alternative definition. Please explain your answer in specific detail.

RESPONSE: No; we believe such a definition to be inadequate. The ACRS believes that an analysis of a LOCA that calculates a higher maximum cladding temperature than would actually occur in the LOCA is "conservative" with respect to calculation of cladding temperature, but does not necessarily comprise a "conservative" analysis of a LOCA. In a LOCA, there are aspects other than cladding temperature which are important to safety and which require evaluation for determination of conservativeness of the LOCA analysis.

INTERROGATORY No. 63: Hypothetical question: assuming that there are significant areas of uncertainty relative to the effect of maximum cladding temperature of various phenomena during a LOCA, can the "overall conservatism" of a LOCA transient analysis code be established without quantifying the uncertainties involved? Please explain your answer in specific detail.

RESPONSE: No. It is well established that, unless the uncertainties of the individual inputs are known, the uncertainty of the computed value cannot be determined by formal computation.

INTERROGATORY NO. 67: Do you believe that the independent analysis of ECCS effectiveness for PWR's is assisted by the fact that there exist four separate evaluation models and codes therefor? Please explain your answer in specific detail.

RESPONSE: The ACRS interprets an independent analysis to be one made by or for the AEC Regulatory Staff using models and codes derived or justified relatively independently of the development of the vendor models and codes. The ACRS believes that the independent analysis of ECCS effectiveness for PWRs (made by the Regulatory Staff using independently derived models and codes) has been assisted to some degree by the existence of a multiplicity of models and codes.

INTERROGATORY NO. 68: Do you believe that independent analysis of ECCS effectiveness for BWR's is hindered or rendered inadequate because there does not exist a code or evaluation model therefore, except that of General Electric? Please explain your answer in specific detail.

RESPONSE: The ACRS interprets an independent analysis to be one made by or for the AEC Regulatory Staff using models and codes derived or justified relatively independently of the development of the vendor models and codes. Capability for independent analysis of BWR-ECCS effectiveness has not been available until recently. The ACRS does not believe that this circumstance resulted from the fact that there was only one BWR vendor code or evaluation model.

INTERROGATORY NO. 75: Please list those aspects of each of the approved evaluation models that the ACRS does not believe to be presently proven to be conservative. Please explain your answer in specific detail.

RESPONSE: The ACRS takes the view that items in the approved evaluation models are proven to be conservative when fully confirmed by experimental evidence and supporting analytical studies. On this basis, the following representative items are considered not proven to be conservative, and are undergoing investigation:

Analytical models and numerical methods.

Amount of initial stored energy in the fuel.

Treatment of phase separation and nonequilibrium effects.

Treatment of loop resistances.

Treatment of hot channel flow, including flow blockage and flow redistribution.

Treatment of break flows.

Treatment of decay heat.

Transient critical heat flux and heat transfer.

Treatment of clad ductility.

PWRs - Distribution of injected water.

Reflooding rates, reflood heat transfer, and carryover.

BWRs - Level swell.

Spray heat transfer.

While the above aspects are considered not proven to be conservative, the ACRS nevertheless believes that they can be handled in such manner that there is reasonable assurance that, with appropriate use of the Interim Acceptance Criteria and other applicable design and evaluation criteria, water reactors of current design can be operated without undue risk to the health and safety of the public.

INTERROGATORY NO. 76: Please list each item, matter or analysis not required to be done by each approved evaluation model which you believe should be required. Please explain your answer in specific detail.

RESPONSE: The Committee believes that the following representative additions and improvements should be made to the current evaluation models and their applications, on a reasonable time scale:

Analyses should be required of variance, systematic errors, and range of applicability of experimental data used to establish basic inputs, where practical.

Appropriate sensitivity studies should be made for key input parameters.

The use of values judged to be conservative should be required explicitly in the evaluation models for key parameters, such as heat transfer cooefficients.

Best estimate analyses, using most probably values for input parameters, also should be made.

Standard problems should be used to test each evaluation model.

Greater use should be made of means of confirming the numerical accuracy and internal logic of computer code calculations.

Suitable provisions should be included for the effects of flow blockage in the core.

Analyses for small breaks, using models approved for these break sizes, should be required in all cases, and appropriate safety limits for these breaks should be established.

Allowance for fuel densification and related effects should be included.

An acceptability limit based on time-at-temperature effects on clad ductility should be considered.

An approved independent evaluation model for BWRs should be made available.

As noted in the answer to Interrogatory No. 75, continuing studies are in progress. The results of these studies should be used to improve the evaluation models.

ADDITIONAL REMARKS BY MEMBER DAVID OKRENT: The design basis for the Dresden 3 reactor and succeeding BWR plants has been that either the core spray or the low pressure coolant injection (LPCI) mode alone should cool the core adequately in the event of a loss-of-coolant accident. I believe this diverse and redundant design basis to be important and that there should therefore be an approved evaluation model for the LPCI mode alone for BWR's.

I also recommend that in the future each evaluation model include, as practical, detailed justification of the physical assumptions and numerical methods employed in the model.

INTERROGATORY NO. 83: Would the ACRS agree that the Interim Policy Statement does not provide a uniform level of conservatism for all plants? Please explain your answer in specific detail.

RESPONSE: The ACRS believes that the Interim Policy Statement probably does not provide a uniform level of conservatism for all plants. However, the Committee believes that such uniformity is not essential.

INTERROGATORY NO. 85: Would the ACRS agree that the 0.8 core flow redistribution factor is arbitrary? If you would not agree, state the basis upon which you believe it not to be arbitrary. Is the 0.8 factor clearly supported by applicable experimental results? Please cite relevant results and please explain your answer in specific detail.

RESPONSE: The ACRS agrees that the 0.8 core flow redistribution factor is arbitrary. Continuing studies of flows under conditions postulated for the LOCA suggest that core redistribution factors may, under some circumstances, be either smaller or greater than 0.8. Thus, the handling of hot channel flow needs to be studied further.