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

September 24, 1980

Docket No. 50-289

Mr. R. C. Arnold
Senior Vice President
Metropolitan Edison Company
100 Interpace Parkwasy
Parsippany, New Jersey 07054

Dear Mr. Arnold:

SUBJECT: LESSONS LEARNED SHORT-TERM REQUIREMENT 2.1.3.b "INSTRUMENTATION FOR DETECTION OF INADEQUATE CORE COOLING - ADDITIONAL INFORMATION"

The subject item was identified to be reviewed prior to implementation as a Category "B" item of the requirements of "TMI-1 Lessons Learned Task Force Report and Short-Term Recommendations", NUREG-0578.

We understand from the licensees of B&W reactors that B&W has sent to the B&W Owners a report titled "Evaluation of Instrumentation to Detect Inadequate Core Cooling". We have reviewed this report. This report concludes that existing instrumentation adequately satisfies the intended purpose of detecting and responding to inadequate core cooling. However, our review and evaluation concludes that there are major concerns with the conclusions of this report on this subject. Particularly, we believe that there has been insufficient effort to develop a level measurement system which is sufficiently accurate to provide valuable advance warning of the approach to inadequate core cooling.

Our evaluation (enclosed) provides the current NRC position on this subject. Therefore, we require that you develop such an instrumentation system. The acceptance criteria of this instrumentation system is clarified in our letter to you dated September 5, 1980.

We request that you provide within 30 days of receipt of this letter your commitment to develop such an instrumentation system.

Sincerely,

Darrell G. Eisenhut

Darrell G. Eisenhut, Director
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NRC Staff Evaluation

cc w/enclosure:
See next page

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NRC STAFF EVALUATION OF BABCOCK AND WILCOX POSITION REGARDING ADDITIONAL INSTRUMENTATION FOR DETECTION OF INADEQUATE CORE COOLING FOR B&W REACTORS

Introduction

The staff has reviewed information submitted by Babcock and Wilcox (B&W) plant owners in response to the short-term lessons learned item 2.1.3(b) of NUREG-0578(R-1) and the subsequent clarification letter issued by the staff (R-2). The staff position and clarification as presented in R-2 follows:

Position

Licensees shall provide a description of any additional instrumentation or controls (primary or backup) proposed for the plant to supplement those devices cited in the preceding section giving an unambiguous, easy-to-interpret indication of inadequate core cooling. A description of the functional design requirements for the system shall also be included. A description of the procedures to be used with the proposed equipment, the analysis used in developing these procedures, and a schedule for installing the equipment shall be provided.

Clarification

1. Design of new instrumentation should provide an unambiguous indication of inadequate core cooling. This may require new measurements to or a synthesis of existing measurements which meet safety-grade criteria.

2. The evaluation is to include reactor water level indication.

3. A commitment to provide the necessary analysis and to study advantages of various instruments to monitor water level and core cooling is required in the response to the September 13, 1979 letter.

4. The indication of inadequate core cooling must be unambiguous, in that, it should have the following properties:

   a) it must indicate the existence of inadequate core cooling caused by various phenomena (i.e., high void fraction pumped flow as well as stagnant boil off).

   b) it must not erroneously indicate inadequate core cooling because of the presence of an unrelated phenomenon.

5. The indication must give advanced warning of the approach of inadequate core cooling.

6. The indication must cover the full range from normal operation to complete core uncovering. For example, if water level is chosen as the unambiguous indication, then the range of the instrument (or instruments) must cover the full range from normal water level to the bottom of the core.

The staff review to date is based on the information provided in References R-3 and R-4, which are the B&W-developed positions based on their evaluation. Reference R-4 is a report which was sent to the B&W Owners Group in April 1980 and the primary conclusions, i.e., existing instrumentation is adequate for detection of inadequate core cooling, has been endorsed by each of the B&W reactor licensees. These positions developed in R-4 and in individual licensees' responses to Lessons Learned Requirement 2.1.3.b can be summarized as follows:

1. An advance warning of the approach of inadequate core cooling is provided by existing instrumentation which indicates a loss of subcooling in the hot leg.

2. An unambiguous indication of the existence of inadequate core cooling is provided by the incore thermocouples and the hot leg RTDs.

3. Additional instrumentation concepts considered fail to meet at least one of the criteria established by References R-1 and R-2.

4. Additional instrumentation is not needed since necessary operator actions for management of the accident will be taken based on existing indicators.

Staff Conclusions

The staff views concerning the cited positions and supporting submittals follow:

1. Advance Warning - The staff does not agree that an indication of loss of hot leg subcooling provides advance warning of inadequate core cooling. While loss of subcooling is a useful early alert, it will also occur for severe overcooling transients which do not threaten core uncovery leading to inadequate core cooling.

   The staff considers the core to be in a state of inadequate core cooling whenever the two phase froth level falls below the top of the core and the core heatup is well in excess of conditions that have been predicted for calculated small break scenarios for which some core uncovery with successful recovery from the accident have been predicted. Possible indicators of such a condition are core exit superheat temperature and/or the rate of coolant loss or level drop prior to core uncovery and the extent and duration of uncovery.

   Instrumentation to provide advanced warning of this condition must indicate a loss of primary coolant inventory by level or other means after loss of subcooling has occurred. The time available for corrective action and/or interpretation of the scenario while the system is being depleted of coolant above the top of the core would be significant in comparison to the time from the start of inadequate core cooling until core damage occurs. While we recognize the difficulties inherent in the development of a highly accurate level indicating system, the referenced reports do not provide evidence of any substantial effort to develop and calibrate a system which is sufficiently accurate to provide an unambiguous indication of coolant loss that would serve as a valuable advance warning to the operator. In fact, a staff review of available LOFT and Semiscale data during large and small break loss of coolant tests (L1-4, L3-1, L3-2, S-07-10, S-06-4, S-SB-P1C, S-SB-P7, S-SB-2A) and comparison to calculated values of measurable parameters (e.g., differential pressure) lead the staff to believe that correlation of measurable parameters to the advent of inadequate core cooling is feasible.

2. ICC Indicators - The staff agrees that core exit thermocouples can provide evidence that inadequate core cooling is occurring. However, plans and criteria for qualification of this instrumentation for post-accident conditions need to be addressed if the core exit thermocouples are to be included in the final system.

3. The staff agrees that the individual methods considered in the referenced reports appear to be deficient in one or more of the criteria of the staff position. However, combinations of the methods do provide the information required for a system which has the potential to satisfy the staff criteria. It is probable that additional data processing and display equipment would be needed to aid in the interpretation of the available information through appropriate correlations or by integration of necessary data. For example, an acceptable level measurement system above the core coupled with in-core thermocouple data properly correlated in terms of level or equivalent condition of core uncovery could be displayed in a manner to satisfy the full range indication criterion.

4. The staff finds the position that additional instrumentation is not needed because necessary operator actions will be taken based on existing indicators to be unacceptable. If all actions available to the operator have been taken and the system is continuing to lose coolant due to equipment malfunction or some unknown system condition, the operator should be clearly informed of the situation. It is probable that additional actions such as detection and correction of the unknown malfunction or initiation of system depressurization to utilize low pressure coolant injection sources could be taken by the operator if circumstances warranted such action. Even if operator actions are not keyed directly to level indication, the information derived from such an indicator would be valuable in assisting the operator and supporting emergency operations staff to assess the situation and to prepare for those actions required upon indication of the existence of inadequate core cooling.

In summary, the staff finds the positions developed by the licensees of B&W designed reactors to be unacceptable. The owners of B&W designed reactors should provide an acceptable response to the Inadequate Core Cooling requirement (R-1 & R-2), including a schedule for installation, testing and calibration, and implementation of any proposed new instrumentation or information displays.

References

R-1 NUREG-0578, "TMI-2 Lessons Learned Task Force Status Report and Short-Term Recommendations," USNRC, July, 1979.

R-2 Enclosure 1 to letter, H. R. Denton to all operating nuclear power plants, "Discussion of Lessons Learned Short-Term Requirements," October 30, 1979.

R-3 "Analysis Summary in Support of Inadequate Core Cooling Guidelines for a Loss of RCS Inventory," B&W.

R-4 B&W Letter SC-68, "Report on Additional Instrumentation to Detect Inadequate Core Cooling," April 8, 1980, Amendment No. 18 to the TMI-1 Restart Report, Metropolitan Edison w/attachment, "Status Report on Additional Instrumentation to Detect Inadequate Core Cooling."