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June 4, 1980

United States Nuclear Regulatory Commission
Washington, DC 20555

Attention: Office of Nuclear Reactor Regulation
Mr. Dennis M. Crutchfield, Chief
Operating Reactors Branch #5
Division of Licensing

References: (a) License No. DPR-3 (Docket No. 50-29)
(b) USNRC Letter to YAEC dated April 18, 1980

Subject: TMI Category "A" Item 2.1.3.b - Instrumentation for Detection of Inadequate Core Cooling

Dear Sir:

In accordance with the requirement of paragraph 2.1.3.b of NUREG-0578 as further delineated in the October 30, 1979 H. R. Denton letter, Yankee Atomic Electric Company has conducted an evaluation of instrumentation or controls which could be installed to provide additional indication of inadequate core cooling. As part of this evaluation, we have evaluated several reactor vessel level indication systems. Presented in the following discussion is a summary of the design features of these systems together with our evaluation and conclusions concerning them.

DIFFERENTIAL PRESSURE SYSTEM

Yankee has participated with the Westinghouse Owner's Group in the investigation/development of a differential pressure based reactor vessel level indication system. This system, as proposed by Westinghouse, would provide level indication over two ranges; top of the vessel head to hot leg for narrow range and top of the vessel head to bottom of the vessel for wide range.

Differential pressure measurement is a widely recognized technique for measuring level in pressure vessels. The use of a dual range system provides more accurate information in the range above the hot leg than the use of a wide range system. The range of level above the hot leg is the information of interest to the operator prior to the uncovering of the core. However, due to the physical arrangement of the Yankee Rowe primary coolant system, we have determined that the present Westinghouse system is unacceptable for use.

The wide range indication system requires use of a vessel penetration below the core, e.g. bottom mounted incore instrument conduit. Since Yankee Rowe is equipped with top-entry incore instruments and there are no vessel penetrations below the hot leg, this portion of the system could not be utilized. Therefore, the only portion of the system useful for Yankee Rowe is the narrow range which does not meet the NRC criteria of measuring water level from normal water level (top of vessel) to the bottom of the core.

NEUTRON DETECTION SYSTEM

Yankee has been conducting computer analysis to determine the feasibility of using the existing excore source range neutron detectors to monitor water level in the vessel. The effect of water level on neutron detection was noticed during the TMI-2 accident and our investigation has attempted to quantify neutron detection changes with various water levels in the Yankee Rowe core.

Preliminary results indicate that there will be a definite change in counts per second as water level decreases in the core. Also, this system can indicate boiling within the core prior to loss of vessel head level. However, we feel that this system will not satisfy the intent of the clarified NUREG-0578 requirements and requires further investigation prior to its use.

Due to the physical configuration of the excore neutron detectors, this system will only respond to level changes within the height of the core and will not provide advanced indication of decreasing level in the vessel above the top of the core. Thus, the NRC criteria requiring level measurement from normal water level (top of vessel) to the bottom of the core cannot be met using the excore detectors. Additionally, the system does not directly measure the parameter involved, rather it measures relative (not absolute) numbers of counts-per-second. The accuracy of this system has not been determined, however, due to changes in core activity with time, high accuracy is not expected.

HEATED THERMOCOUPLE SYSTEM

Combustion Engineering (CE) is developing, at the request of its Owner's Group, a heated thermocouple level monitoring system. Although information presented here is from the Owner's Group generic proposal, the basic design is applicable to Westinghouse reactors and CE has been approached relative to the feasibility of designing a system for Yankee Rowe.

This system compares output of two opposed thermocouple junctions, one of which is heated. By comparing the difference between the two it is possible to detect changes in void fraction in the fluid surrounding the probe. Hardware for this system is still in the prototype development stage. While this system does not exhibit the major disadvantage of requiring extension of the vessel boundary, it has serious problems in that it requires insertion of additional, unproven equipment into the reactor internals and may require modifications to the internals. Additionally, it will measure to the nearest foot with approximately 8 percent accuracy, but the burnout of a single thermocouple would decrease the accuracy to greater than 15 percent. Finally, the heated thermocouple probe output must also be interpreted by a microprocessor thereby introducing additional possible inaccuracies and potential failures.

PRESENT CAPABILITY FOR INDICATION OF INADEQUATE COOLING

There is presently installed at Yankee Rowe the following equipment which singly or in combination provides indication of inadequate core cooling.

Core Exit Thermocouples.

Hot Leg and Cold Leg RTD's.

Subcooling Meter.

Main Coolant Pressure and Flow Instruments.

Pressurizer Level and Pressure Instruments.

Reactor Coolant Pump Ammeters.

Steam Generator Level and Pressure Instruments.

Yankee Rowe, unlike many more recent plants, has always utilized incore thermocouples. Readouts from these thermocouples are available from either a direct stripchart recorder, a subcooling meter, or a data logging device, all of which are located on or near the main control board. We have always felt that the core exit thermocouples are the most direct and reliable indication of an approach to inadequate core cooling. If the operators at TMI had direct access to incore thermocouples and utilized them regularly, the prolonged uncovery of fuel at TMI would not have occurred.

We believe the incore thermocouples to be the best method because:

1. They measure the approach to inadequate core cooling (i.e. increasing core temperature) directly.

2. Indication provided by core exit thermocouples is uniform under all conditions, e.g. pumps running, power operation, shutdown. This instills faith in the instrument on the part of the operator.

3. There is sufficient number of thermocouples (25) to verify proper performance during power operation by comparison between different channels.

4. This instrumentation was "originally designed" into the reactor internals, thereby not requiring any additional penetration of the pressure boundary.

5. The indication provided is unambiguous; core exit temperatures above the predetermined level indicate approach to inadequate cooling.

6. The information provided is easy to interpret.

7. The indication is provided when it is needed most, during the approach to inadequate cooling, not after inadequate cooling has occurred.

8. The accuracy of the core exit thermocouples is greater than 2 percent.

Yankee feels that the core exit thermocouples, when combined with the other instrumentation listed, provide the information required to determine the approach to and the existence of inadequate core cooling.

CONCLUSION

We feel that those systems available for installation at this time to measure reactor vessel water level for Yankee Rowe are still in the experimental stages of development and that the information provided by them would not result in a measurable increase in the safety to the general public. At this time, we do not propose to install any further instrumentaton to monitor inadequate core cooling. We are continuing our analysis of source range neutron detector response to changes in water level. In addition, we are continuing to evaluate the work of the Owners Groups.

If any new reactor vessel water level systems or any of the present systems prove to be acceptable for Yankee Rowe, we will submit a description for your review.

We trust this information is satisfactory; however, if you have any questions, please contact us.

Very truly yours,

YANKEE ATOMIC ELECTRIC COMPANY

R L Smith

R. L. Smith
Licensing Engineer

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