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

APR 13 1979

MEMORANDUM FOR: D. Ross, Deputy Director
Division of Project Management
Office of Nuclear Reactor Regulation

FROM: W. V. Johnston, Chief
Fuel Behavior Research Branch
Division of Reactor Safety Research
Office of Nuclear Regulatory Research

SUBJECT: FUEL EXPERTS MEETING ON CONDITION OF THE TMI CORE

A meeting of nuclear fuel experts was held on April 12 to update the estimates of the damage to the TMI core and to consider its effect on the desirability of moving to natural convection cooling of the core. The Experts Group consisted of the following persons: J. S. Tulenko, B&W; R. DeMars, B&W; T. Kassner, ANL; R. A. Proebstle, GE; K. A. Jordan, W; R. Duncan, CE; T. Fernandez, EPRI; T. Buhl, NRC; R. Meyer, NRC; W. Johnston, NRC, Chairman. Additional attendees included L. Rubenstein, NRC; C. Berlinger, NRC; M. Tokar, NRC; R. Majors, ACRS Staff and T. Mott, TEC.

Summary

The group concluded that although the core is badly damaged, essentially all of the fuel has remained in the core and that the overall packing density of the settled portion is not expected to exceed 70%. Therefore, shutting off the RC pumps should not seriously threaten further damage to the reactor. It was further concluded that the thermocouples (Tc's) located in the upper end fittings are the most important indicator of core condition during transition to natural convection cooling. If feasible, the addition of a γ spectrometer to monitor the activity of the loop coolant for new fission products released during the transition to natural convection cooling will provide an independent alert to possible difficulties.

Two questions were considered: Is a pump trip likely to lead to an unsafe condition? and What signals will indicate undesirable conditions in the core?

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Summary of Core Status

Summaries of amount of damage to the core based upon measurements or calculations of fission gas release, hydrogen produced by zircaloy oxidation, coolant analysis, coolant boil-off rates, incore and excore instrumentation were presented by J. Tulenko and R. Meyer. A relatively large pressure drop across the core is inferred by TH calculations. If the pressure drop is real, blockage must also exist in the peripheral assemblies (perhaps by ballooning). The shift in location and magnitude of the high reading core Tc's following the pump trip on April 6 was believed to indicate either a change in the core flow path through more heavily damaged sections of the core to a redistribution of debris surrounding some of the thermocouple beads. An alternate explanation for the change in Tc temperature distribution patterns was presented by T. Mott of TEC. He suggested that the Tc temperature difference may be due to non uniform flow distributions caused by operation of a single pump rather than non uniformity within the damaged region of the core. Due to this non uniform flow distribution portions of the core may already be experiencing similar cooling to that expected during natural convection. Mott estimates smaller core pressure drop and suggests the B&W estimates may include substantial external pressure drops.

The group visualizes the core as consisting of a heavily damaged region resembling an inverted bell extending across nearly the full width of the top of the core and reaching down about five - six feet into the core at the center and a less damaged remainder of the core. In the heavily damaged region, 100% oxidation of the zircaloy and loss of a regular geometry is expected. The guide tubes and poison rods are damaged similarly to the cladding. Spacer grids should be located at or near their original locations. The important coolability conclusions are that although some settling may have taken place, the overall packing density of the settled portion is not expected to be greater than 70% and that 85% to 98% of the fuel and cladding from this region is believed to have remained in the "core" region including the upper end fitting. The remainder of the core is less damaged although considerably oxidized. The original flow geometry is probably retained although the rods may be twisted or warped and broken in a few places and the spacer grids may have collected some loose debris.

The above conditions should not preclude satisfactory achievement of natural convection flows.

What should be monitored to determine undesirable changes in the core during the transition to natural convection cooling? The temperature distribution of the core exit thermocouples are the most important condition monitoring signals. The group believes that all exit Tc's should be continuously tracked and recorded. B&W suggested the following criteria for remaining in natural convection cooling: No more than 2 Tc's above 800°F and at least 10 Tc's below Tsat. There were some reservations among the group about allowing so many Tc's to read above Tsat (as many as 39) and radiolysis was an expressed concern. There was a lot of discussion but no concensus on how many interior Tc's should be permitted to exceed Tsat. Tc's in peripheral assemblies should not exceed Tsat.

The following table summarizes the available instrumentation and its possible application to monitoring core condition.

Detector	Event-Core Overheating Criteria	Basis
1. Exit Tc's	Limit no. in film boiling Limit no. above 800°F	Not to exceed previous core damage, reverse procedure.
2. RTD Hot leg Cold leg	Maintain positive ΔT across core.	No flow reversal permitted.
3. Ion chambers γ and N	Void formation If +, record for future interpretation, watch Tc's.	Ambiguous signal since some local superheat may be permitted.
4. Noise detection	If + indicates bubbles in core or loop, check Tc's, SG.	Same as above.
5. System Pressure	If increasing, system effects Branch should review this.	Not direct indication of core condition, but for gas bubble formation detection.
6. Pressurizer Level	Same as above.	Same as above.
Additional Detection - Feasibility needs to be established.		
γ spectroscopy of coolant via sampling line	Increasing activity of Xe, I_2	Overheated core alert for major error in procedure.
H_2O analysis on line monitor	Boron, O_2, H_2	Core criticality and chemistry control radiolysis and H_2 content control.

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Note to M. Aycock

The attached should have the following distribution and should also be telefaxed to Stello at the site.

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