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February 2, 1982
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Office of Nuclear Reactor Regulation
Attn: John F. Stolz, Chief
Division of Licensing
Operating Reactors Branch No. 4
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Sir:

Three Mile Island Nuclear Station, Unit 1 (TMI-1)
Operating License No. DPR-50
Docket No. 50-289
Incore Thermocouple Display (NUREG II.F.2)

In accordance with Item II.F.2(4) enclosed please find our evaluation on the conformance of the Incore Thermocouples with NUREG 0737. This evaluation is supplemented by information contained in the TMI-1 Restart Report (2.1.1.6, Supp. 1 Part 1, questions 17, 39, 39a, 39b, Part 2 questions 93, 95) ASLB Hearing Record on Inadequate Core Cooling, Met Ed letters dated August 17, 1981 (L1L 246) and December 16, 1981 (L1L 348).

Sincerely,

H. D. Hukill
Director, TMI-1

HDH:LWH:vjf

cc: R. C. Haynes
L. Barrett
R. Jacobs

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S1/1

Attachment 1

II.F.2. DESIGN AND QUALIFICATION CRITERIA FOR TMI-1 INCORE THERMOCOUPLES

Item (1) Thermocouples located at the core exit for each core quadrant, in conjunction with core inlet temperature data, shall be of sufficient number to provide indication of radial distribution of the coolant enthalpy (temperature) rise across representative regions of the core. Power distribution symmetry should be considered when determining the specific number and location of thermocouples to be provided for diagnosis of local core problems.

Response See TMI-1 Restart Report 2.1.1.6 and SER (NUREG 0680 of June 16, 1980 Section 2.1.3b).

Item (2) There should be a primary operator display (or displays) having the capabilities which follow:

(a) A spatially oritented core map available on demand indicating the temperature or termperature difference across the core at each core exit thermocouple location.

(b) A selective reading of core exit temperature, continuous on demand, which is consistent with parameters pertinent to operator actions in connecting with plant-specific inadequate core cooling procedures. For example, the action requirement and the displayed temperature might be either the highest of all operable thermocouples or the average of five highest thermocouples.

(c) Direct readout and hard-copy capability should be available for all thermocouple temperatures. The range should extend from 200 F (or less) to 1800 F (or more).

(d) Trend capabibility showing the temperature-time history of representative core exit temperature values should be available on demand.

(e) Appropriate alarm capability should be provided consistent with operator procedure requirements.

(f) The operator-display device interface shall be human-factor designed to provide rapid access to requested displays.

Response Attachment 2 provides the computer functions involving the incore thermocouples.

Item (3) A backup display (or displays) should be provided with the capability for selective reading of a minimum of 16 operable thermocouples, 4 from each core quadrant, all within a time interval no greater than 6 minutes. The range should extend from 200 F (or less) to 2300 F (or more).

Response The Backup Incore Readout system is composed of 16 selected incore thermocouples comprised of 4 in each core quadrant capable of being read in 6 minutes or less by an operator. The range monitored will be from 200°F to 2300°F. (See Figure 2)

Item (4) The types and locations of displays and alarms should be determined by performing a human-factors analysis taking into consideration:

(a) the use of this information by an operator during both normal and abnormal plant conditions,

(b) integration into emergency procedures,

(c) integration into operator training, and

(d) other alarms during emergency and need for prioritizations of alarms.

Response A human factor engineering review has been performed for the incore thermocouple display system. Procedural integration and training is discussed in the TMI-1 Restart Report Supplement 1 Part 1 Question 18, 39 a & b, and Part 2 Question 93.

Item (5) The instrumentation must be evaluated for conformance to Appendix B, "Design and Qualification Criteria for Accident Monitoring Instrumentation", as modified by the provisions of Items 6 through 9 which follow.

Response See items 6 through 9.

Item (6) The primary and backup display channels should be electrically independent, energized from independent station Class 1E power sources, and physically separated in accordance with Regulatory Guide 1.75 up to and including any isolation device. The primary display and associated hardware beyond the isolation device need not be Class 1E, but should be energized from a high-reliability power source, battery backed, where momentary interruption is not tolerable. The backup display and associated hardware should be Class 1E.

Response The primary and back-up display channels are electrically independent, separated (1E portion) are energized from independent power supplies. The primary display channel utilizes the plant redundant computers, one of which is supplied from an on-site battery backed power source and the other from a source backed by the diesel generator but which is not a qualified 1E source. The back-up display channel is energized from an on-site, 1E power source. The back-up display and associated hardware will be comprised ultimately of qualified 1E equipment, or electrically isolated. The diesel generator supplies back-up power for the mod comp. During a loss of power, the calculations performed by the ModComp are not available until the diesel restores power. This will be a relative short period of time and incore thermocouple readings may be obtained from the Bailey 855 during this period.

Item (7) The instrumentation should be environmentally qualified as described in Appendix B, Item 1, except that seismic qualification is not required for the primary and associated hardware beyond the isolator/input buffer at a location accessible for maintenance following an accident.

Response The difficulty in meeting this requir ment is only for that portion of the system that is inside the containment (sensors cabling) in that it has to be qualified to temperature, pressures, radiation (normally expected over the equipment qualified life plus most severe DBA) and for the effects of chemical spray system. We are currently planning through analysis and testing to qualify the complete instrumentation channel from the sensor up to and including the R. C. pressure boundary termination and the electrical connectors (Bendix). Discussions with B&W indicate that this portion of the system is qualifiable except that the plant installed Bendix connector may have to be replaced by a comparable connector which will meet the qualification requirement.

The electrical cabling beyond the electrical connector up to the electrical penetration is outside the B&W scope of work and will have to be qualified seperately. The cabling we have used is an alumel/chromel conductors insulated with teflon with an outer jacket of hyplon. The teflon insulation may lose its mechanical integrity at 10^4 rads but should retain its insulation properties up to 10^7 rads. It should be noted that the cabling within the incore instrument guide tube (B&W scope of supply) is different than the remaining cabling inside the containment as ceramic oxide is used as the primary insulator instead of teflon. The incore instrument channel from the reactor vessel to the R. C. pressure boundary is enclosed within Nuclear Class 1 and Seismic 2 tubing. The cables inside the containment are laid in seismically qualified cable trays.

Outside of containment, all cabling and hardware associated with the Backup system will be environmentally and seismic qualified. Electrical isolation devise are provided at all interfaces between the Backup system and the nonqualified portions of primary (plant computer) system. The qualification program is expected to be completed by Cycle 6 refueling.

The thermocouples of TMI-1 are of similar design and materials as to those used in TMI-2 which survived the TMI-2 accident and the post accident period with only a limited number of failures.

Item (8) The primary and backup display channels should be designed to provide 99% availability for each channel with respect to functional capability to display minimum of four thermocouples per core quadrant. The availability shall be addressed in technical specifications.

Response A Tech. Spec. Change Request concerning incore thermocouples is under preparation.

Item (9) The quality assurance provisions cited in Appendix B, item 5, should be applied except for the primary display and associated hardware beyond the isolation device.

Response The Quality Assurance requirement shall be in accordance with the GPU QQA Plan with specific requirements applied. Acceptance testing of the new equipment added by these modifications are in accordance with startup and test procedures written for these modifications.

ATTACHMENT 2

Incore Thermocouple Display Computer Functions

The desired computer functions involving the incore temperature thermocouples are as follows:

1. Determine core exit thermocouple temperature by averaging the five highest valid incore thermocouple readings. The operator can compare this result with Figure 1 to determine if an alarm condition exists.

2. Produce trend plot of core exit thermocouple temperature as determined in #1 versus time.

3. On demand display readings of all incore thermocouples and have the option to delete any malfunctioning thermocouples from being used in any calculation.

4. Compute temperature saturation margin based on the average of the five highest valid incore thermocouples and alarm at less than 20°F margin.

5. Determine mean core exit thermocouple temperature by averaging all of the valid incore thermocouple readings.

6. Determine reactor vessel downcomer temperature with no RC pumps running by averaging the five highest valid incore thermocouple temperature readings and compare this value to saturation temperature at the current RCS pressure. If the average thermocouple reading is more than 100°F subcooled then print an alarm.

7. On demand display a list of the minimum set of 16 incore thermocouple readings, four per quadrant.

8. Provide a display and/or print alarms if any of the minimum set of incore thermocouples have malfunctioned based upon thermocouple validity criteria. NOTE: Isolation Devices for the backup system will partially inhibit the feature since direct continuity checks cannot be performed due to required isolation devices.

9. Provide an option to substitute any pre-selected alternate incore thermocouple for any of the minimum set thermocouples that fail.

10. A trend plot of any thermocouple reading versus time is provided from the time of the demand forward.

11. Provide capability to easily redefine the entire minimum set of incore thermocouples if this became necessary due to multiple failures during operation.

12. Provide a spatially oriented core map on demand indicating temperature across the core at each core exit thermocouple location. A core map of all incore thermocouples is planned for later 1982.

13. Allow printing in hard copy of any data displayed. (Range of 200°F - 2300°F.)

Figure 1 CORE EXIT THERMOCOUPLE TEMPERATURE FOR INADEQUATE CORE COOLING

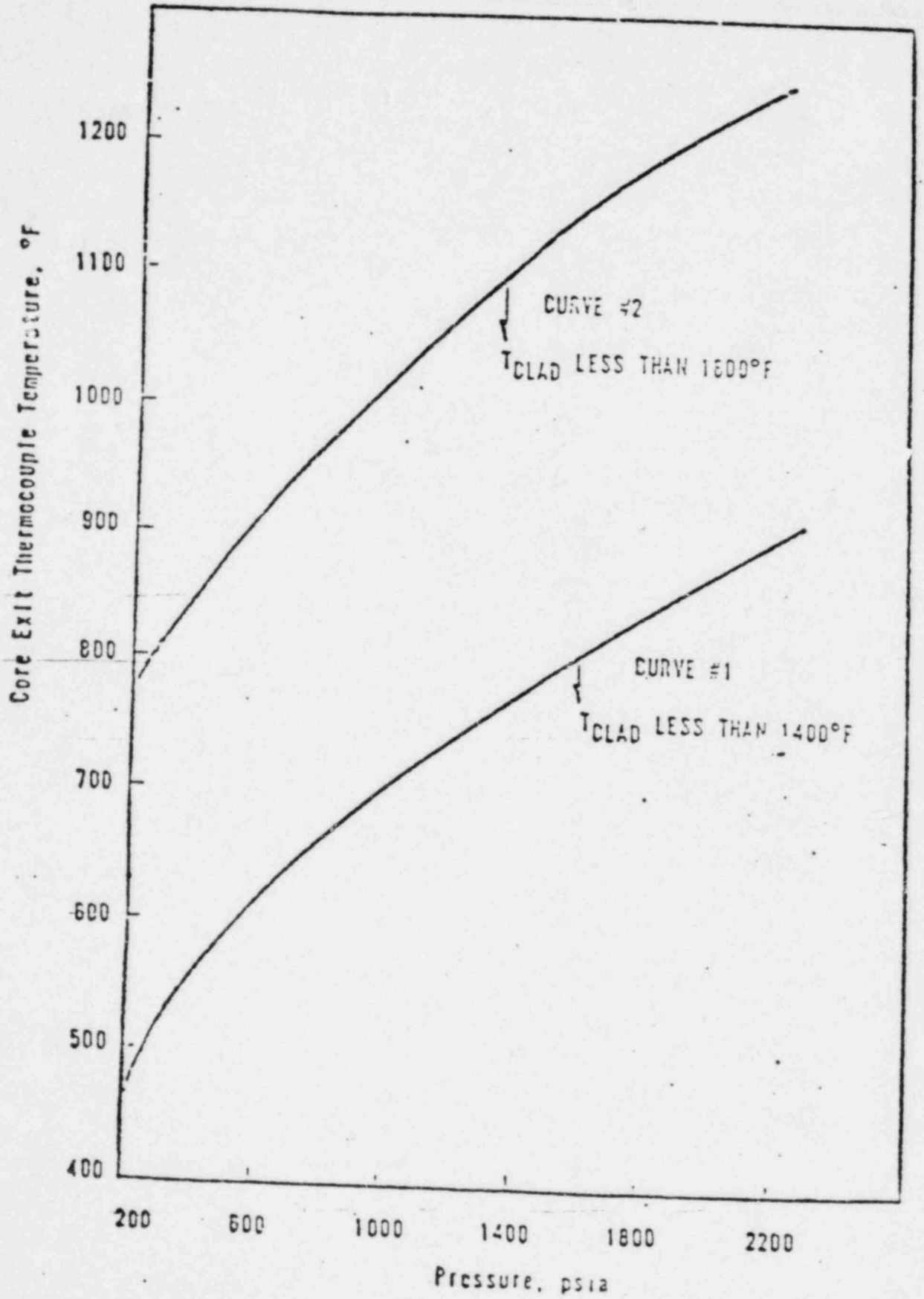
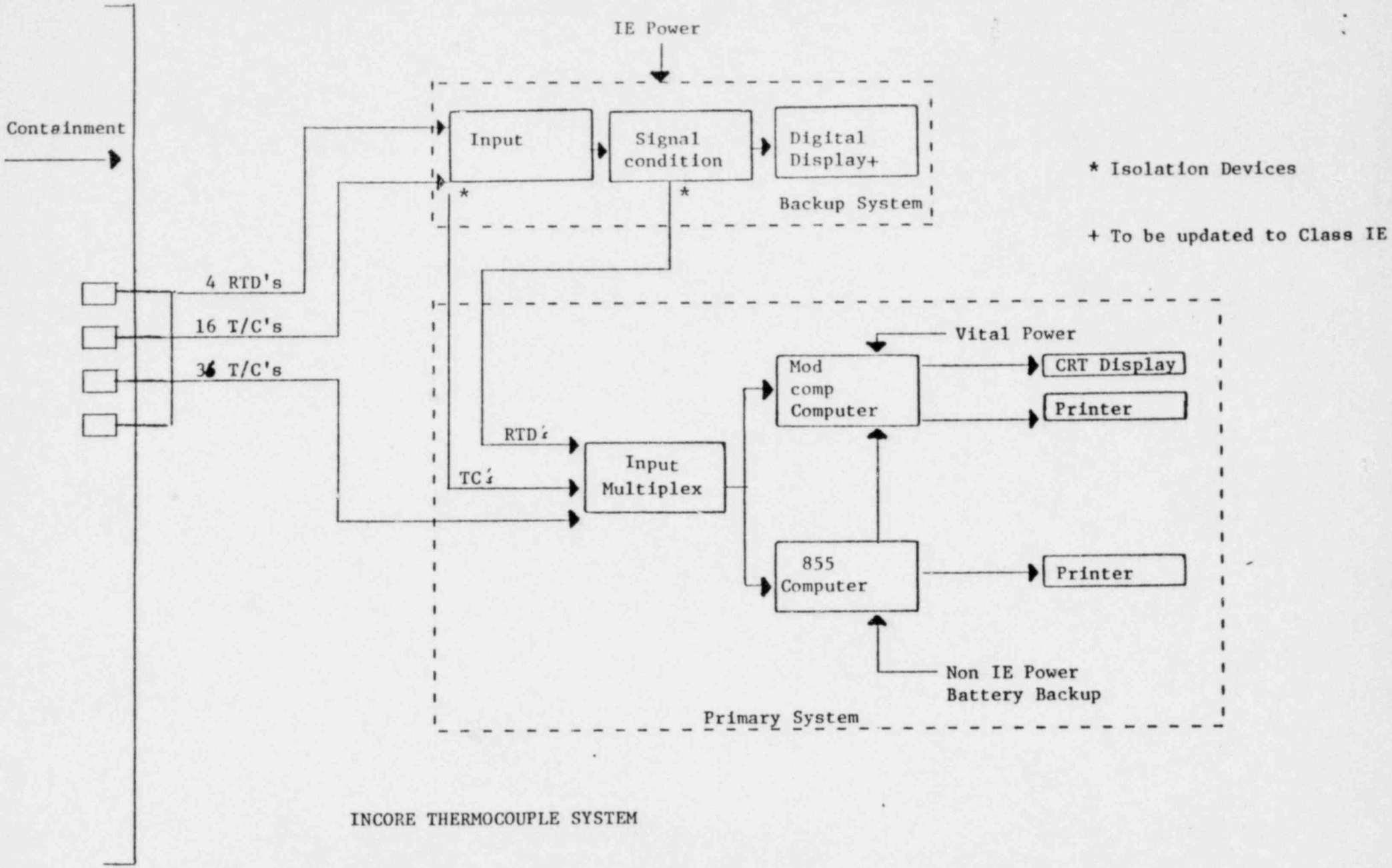


FIGURE 2



INCORE THERMOCOUPLE SYSTEM