



NUCLEAR REACTOR LABORATORY

AN INTERDEPARTMENTAL CENTER OF
MASSACHUSETTS INSTITUTE OF TECHNOLOGY



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J.A. BERNARD, JR.
Director of Reactor Operations

March 17, 1989

U.S. Nuclear Regulatory Commission
Washington, D.C. 20555
Attn: Document Control Desk

Subject: Reportable Occurrence 50-20/1989-1, Operation with Fewer than
the Required Number of Nuclear Safety Channel Level Scrams

Gentlemen:

Massachusetts Institute of Technology hereby submits this ten-day report of an occurrence at the MIT Research Reactor in accordance with paragraph 7.13.2(d) of the Technical Specifications. An initial report was made by telephone to Region I (Mr. J. Lyash) on March 9, 1989.

The format and content of this report are based on Regulatory Guide 1.16, Revision 1.

1. Report No.: 50-20/1989-1
- 2a. Report Date: 17 March 1989
- 2b. Date of Occurrence: 8 March 1989
3. Facility: MIT Nuclear Reactor Laboratory
138 Albany Street
Cambridge, MA 02139
4. Identification of Occurrence:

A startup of the MIT Research Reactor was conducted on 8 March 1989 with only one operable nuclear safety channel level scram. Technical Specification No. 3.7 requires that there be at least two such operable channels prior to the reactor's being brought critical. Although not satisfying the technical specification requirement, additional protection was available. In particular, there was an alarmed level channel that was operable.

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5. Conditions Prior to Occurrence:

Full power instrumentation and mechanical checklists had been completed in preparation for a scheduled reactor startup. Nuclear safety channel No. 4, which is one of three channels that provide an automatic shutdown signal on high reactor power, had been serviced during the maintenance period that preceded the startup. Accordingly, this channel was considered out-of-commission pending observation of its performance during both the reactor startup and subsequent full-power operation. The other safety level channels are designated as No. 5 and No. 6. (Note: Safety Channels No. 1 - No. 3 are the period safety channels.)

6. Description of Occurrence:

The reactor startup was commenced at 1138 on 8 March 1989 and the reactor attained criticality (50 kW on a 50 second period) at 1209. The reactor power was then raised to 250 kW and held at that power until 1315 when the cooling towers were shifted to the spray mode of operation. A stepwise increase in power was then begun. As part of this process, operators are required to monitor the readings on the safety level channels. While doing this, it was noted that channel No. 5 was not responding properly. Accordingly, the reactor was immediately shut down. The maximum power attained prior to the shut down was not more than 4.0 MW. The reactor was operating in the power range (>1 MW) for 28 minutes. Level safety channel No. 6 was observed to have been operating properly during the entire time.

7. Description of Apparent Cause of Occurrence:

Following the shut down, channel No. 5 was inspected and it was found that its high voltage power supply was switched off. The channel's voltage had been checked and recorded as part of the instrumentation checklist. Hence, it is known that the loss of voltage occurred after completion of the checklist. It is believed that this loss was inadvertent. The switch in question is unique in that it and an associated meter are located within a small recessed panel that is part of the reactor instrument cabinets. Hence, the switch might have been unknowingly tripped by personnel working exterior to those cabinets. The low voltage condition was corrected and the channel was then verified to be operable through performance of the standard checks for nuclear instrumentation. Thus, the immediate cause of this occurrence was the lack of the high voltage power supply to channel No. 5.

A root cause analysis was performed subsequent to the repair of channel No. 5. The purpose in conducting this analysis was to assess the adequacy of the 'low voltage protection' circuit that causes an automatic shutdown in the event of a loss of chamber high voltage or lack of continuity on the chamber signal cables in any of the nuclear safety channels. This circuit was verified

to be operational. However, it was found that the power supply for channel No. 5 was not connected to this circuit. An examination of quality assurance records was then undertaken and it was found that, as part of an approved maintenance action conducted on 24 June 1980, the signal cables for channel No. 5 and another level channel had been interchanged. At the time of the change, it was verified that the detector serving channel No. 5 was neutron sensitive and that cable paths for the various safety channels avoided the possibility of a single failure mode. However, the high voltage power supplies for the two channels were not switched and, as a result, channel No. 5's power supply was not connected to the low voltage protection circuit. (Note: At the time that the original telephone report of this occurrence was made to Region I, it was thought that there was a design deficiency in the low voltage protection circuit. This was not the case.)

8. Analysis of Occurrence:

Level safety channel No. 4 had been declared out-of-commission prior to the reactor startup. Channels No. 5 and No. 6 had been set to provide automatic scrams at the proper setpoint, 5.5 MW. As noted above, channel No. 5 was not capable of performing its intended function. Safety channel No. 6 was observed to be operating properly and would have caused a scram if reactor power had exceeded the setpoint of 5.5 MW. In addition to the safety level channels, there is an alarmed level channel (channel No. 8) that was observed to be operating properly and which would have caused an audible/visual alarm had the reactor power exceeded 5.1 MW. Also, there are tripply redundant scrams on the core outlet temperature, all of which were operable.

It should be noted that it can be shown from the instrumentation checklists and the instrument readings that are taken hourly whenever the reactor is operating, that at no time while the reactor was operating did a low voltage condition exist on channel No. 5 between 1980 and the present occurrence.

9. Corrective Action:

The immediate corrective action consisted of shutting down the reactor and energizing the high voltage power supply to the chamber of safety channel No. 5. The long range corrective action consisted of:

- (1) Calibrating level channel No. 4 and returning it to service. (Action completed, 9 March 1989.)
- (2) Reconfiguring channel No.5 so that it was properly interfaced with the low voltage protection circuit. (Action completed 13 March 1989.)

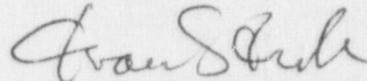
- (3) Examining the power supplies for both of the other level channels and the three period safety channels. Several were found to be improperly connected to the low voltage protection circuit. These deficiencies were corrected. It should be noted that the 'low voltage protection' circuit is not a technical specification requirement and is not a primary means of providing reactor protection. (Action completed 15 March 1989.)
- (4) Instituting a requirement to document the proper interfacing of safety channel power supplies to the low voltage protection circuit whenever a detector or associated cabling is serviced. (Action to be completed 31 March 1989.)

This occurrence was reported to and discussed with a subcommittee of the MIT Reactor Safeguards Committee on March 15, 1989.

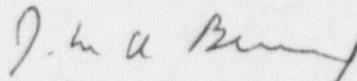
10. Failure Data:

A related occurrence occurred in October 1979. Refer to ROR 50-20/1979-5 dated 19 October 1979.

Sincerely,



Kwan S. Kwok
Superintendent



John A. Bernard, PhD
Director of Reactor Operations

JAB/gw

cc: MITRSC

- USNRC - Region I - Chief,
Reactor Projects Section 1B
- USNRC - Region I - Project Inspector,
Reactor Projects Section 1B
- USNRC - Senior Resident Inspector,
Pilgrim Nuclear Station