NUCLEAR REACTOR LABORATORY

AN INTERDEPARTMENTAL CENTER OF
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

O.K. HARLING
Director

138 Albany Street Cambridge, Mass. 02139
(617) 253-4211

L. CLARK, JR.
Director of Reactor Operations

May 26, 1988

Director of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Mail Station P1-137
Washington, D.C. 20555

Subject: Reportable Occurrence 50-20/1988-1, Detection of an Incipient Fuel Element Failure

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 of this occurrence was made by telephone to Region I on May 12, 1988 to Mr. J. Kaucher. (Note: This report concerns the detection of an incipient fuel clad defect. Submission of this 10-day report was delayed relative to our telephone report because of the need to perform additional tests to confirm our analysis.)

The format of this report is based on Regulatory Guide 1.16, Revision I.

1. Report No: 50-20/1988-1

2a. Report Date: 26 May 1988

2b. Occurrence Date: 11 May 1988 (Problem Suspected)
16 May 1988 (Analysis Confirmed)

3. Facility: MIT Nuclear Reactor Laboratory
138 Albany Street
Cambridge, MA 02139

4. Identification of Occurrence:

A regularly scheduled refueling was conducted on 9-10 May 1988. This refueling entailed both the introduction of new fuel elements to the core and the rotation/inversion of partially spent elements in order to equalize fuel burnup. One of the elements scheduled for inversion was number MIT-12 which had been in core position C10. Upon inverting element MIT-12 a dark spot was observed between two of the fuel plates. This spot was visible

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when backlighted by the Cerenkov radiation. It was not viewable using normal lighting. (Note: Part of the standard MITR core inspection procedure is to observe all fuel channels using only Cerenkov radiation as a source of illumination.) It was not possible to determine if the dark spot was a foreign object lodged between the fuel plates or if it was an incipient clad defect. No abnormal activity had been detected in the reactor's core purge gas prior to the refueling. In an effort to identify the origin of the dark spot, water samples were drawn from the element using the MIT Reactor's standard "sipping" procedure. These were then counted for activity. The activity in the sample from MIT-12 was above that of the controls, but still well within the range of normal statistical variation. It was then decided that the dark spot might be a foreign object. Accordingly an effort was then made to dislodge it gently using a thin aluminum metal strip. This effort was unsuccessful. The refueling was then completed which included retaining element MIT-12 in core. The reactor was taken to 100 kW for one hour with the objective of generating sufficient short-lived fission product activity so that a clad defect would be detectable via the sipping process. The fission product gas level in the reactor's core purge gas was monitored, as always, during this period. No abnormalities were observed. The reactor was then shut down and, after a thirty minute wait, both element MIT-12 and several control elements were again sipped. The iodine activity from element MIT-12 was approximately three times that of the controls. Element MIT-12 was then removed from the core. Further sipping analysis was performed on 16 May 1988. This confirmed the abnormal activity associated with element MIT-12.

5. Conditions Prior to Occurrence:

Element MIT-12 was first inserted in the reactor's A-Ring on 18 January 1982. It then followed the standard MITR refueling pattern of partial burnup in the A or B-Ring, transfer to temporary storage ex-core, and then insertion in the C-Ring until fully depleted. MIT-12 was placed on the C-Ring on 2 February 1987 and remained there continuously until the time of the occurrence.

6. Description of the Occurrence:

No increase in the fission product gas level was observed either prior to or during this occurrence.

7. Description of Apparent Cause of Occurrence:

The apparent cause of this occurrence is a small blister on one of element MIT-12's fuel plates. This blister is only visible when the element is in the inverted position and then only when backlighted with Cerenkov radiation.

8. Analysis of Occurrence:

Quality assurance records on the manufacture of element MIT-12 do not indicate any deviations from the MITR specifications. Element MIT-12 had been in-core while 69,449 MWH of energy were produced. It has 343.77 grams of its original 506 gram loading of U-235 remaining. The point of peak burnup on MIT-12 was 71.51% of the allowed fission density (1.8×10^{21} fissions/cc). The element as a whole had attained 32.1% of the limit. Primary coolant chemistry is carefully monitored. The three parameters measure (pH, chloride, conductivity) have generally been as specified. The few deviations that have occurred were too brief and of too low a magnitude to have caused this occurrence.

9. Corrective Action:

The immediate corrective action consisted of removing element MIT-12 from the core. Fission product gas levels were normal prior to the occurrence and have remained normal. The clad failure was detected and addressed during its incipient stage.

10. Failure Data:

A cladding failure occurred to a "4M" series element in June 1979. Refer to ROR #50-20/79-4 dated 2 July 1979 and #50-20/79-4A dated 26 Novemer 1980. Excess outgassing occurred in an "MIT" series element in September 1983, in July 1985, in February 1986 and in October 1986. Refer to ROR #50-20/83-2, #50-20/85-2, 50-20/86-1, and 50-20/86-2. The current failure is the least severe of those noted. ("MIT" series fuel was made by Atomics International. The "4M" series was made by Gulf Atomic. Currently, fuel is being procured from Babcock and Wilcox.)

Operating experience with fuel from all manufacturers has been good, except as noted below. Of 43 elements made by Gulf Atomic, 42 elements (630 plates) have been permanently discharged from the core after peak burnup approached the license limit. The other 4M series element failed in 1979 as reported earlier, at an average burnup of 32.5%. Average burnups on the Gulf Atomic fuel are in the range 42-44%. Of the 36 elements made by AI and subsequently used in the MITR core, four elements (60 plates) have achieved the maximum permissible burnup and have peak fission densities of 1.58×10^{21} fissions/cc and average burnups of 37.4%. Twenty-seven other AI series elements (405 plates) now in use have peak fission densities in the range $0.07\text{-}1.53 \times 10^{21}$ fissions/cc. As previously reported, four other AI series elements were previously discharged due to excess outgassing.

The failure of this fifth AI element means that five plates from a total of 540 plates have now exhibited excessive outgassing. Because of the sensitivity of MITR-II monitoring equipment, radiation releases have been insignificant.

Fuel for the MIT Research Reactor is currently being manufactured by the Babcock and Wilcox (B&W) Company. Three elements (45 plates) have been in core since 15 September 1987 and have achieved peak fission densities in the range of $0.12\text{-}0.14 \cdot 10^{21}$ fissions/cc. Three other B&W elements were introduced during the refueling on 10 May 1988.

Sincerely,

Kwan S. Kwok
Assistant Superintendent

John A. Bernard, Ph.D
Superintendent

Lincoln Clark, Jr.
Director of Operations

JAB/CRH

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