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

February 28, 1986

Dr. Thomas E. Murley, Administrator
Region I
U.S. Nuclear Regulatory Commission
Attn: Mr. R. Sommers, Reactor Inspector
631 Park Avenue
King of Prussia, PA 19406

Subject: Reportable Occurrence 50-20/1986-1, License R-37
Detection of a Blister on a Fuel Plate

Gentlemen:

Massachusetts Institute of Technology hereby submits the 10-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 February 20, 1986.

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

1. Report No: 50-20/1986-1

2a. Report Date: 28 February 1986

2b. Occurrence Date: 19 February 1986

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

4. Identification of Occurrence:

Slightly elevated levels of fission product gases in the air purge that is maintained across the surface of the primary coolant had been observed for several weeks. These elevated levels, were intermittent, normally being present for a few hours following reactor startup. A visual inspection of the core using alternately light and the Cerenkov radiation to illuminate the fuel plates revealed no abnormalities. Detection by a "sipping" process in which one liter samples of coolant are drawn through each fuel element, collected, and counted was not tried at this time because the results would have been inconclusive given the

IE 22

intermittent nature and low magnitude of the elevated gas levels. Following startup at 1914 on 18 February 1986, elevated fission product gas levels were observed. (Note: The reactor was at power for seven minutes. The maximum fission gas level observed during this interval was approximately 11% of MPC.) Power was then reduced in accordance with existing procedures. It was decided to keep the reactor operating but at the reduced power level for several hours in order to generate enough activity so as to be detectable by the "sipping" process. The reactor was shutdown at 0030 on 19 Feb. 1986. All fuel elements were sipped on 19 Feb. 1986. Element MIT-11 was identified as having an abnormally high rate of outgassing. A refueling was then initiated and element MIT-11 was removed from the core. Reactor operation was resumed later on 19 February and fission product gas release levels were observed to be normal.

5. Condition rior to Occurrence:

Element MIT-11 was first inserted in the reactor's B-Ring on 8 Sept. 1981. It remained in-core continuously until 29 March 1982 when it was removed. It was again inserted in the B-Ring on 16 August 1982 and removed on 27 June 1983. It was used in the C-Ring from 25 February 1985 to 1 April 1985 and again from 27 July 1985 to 19 February 1986, the day on which the blister was detected. The element was inverted on 23 Sept. 1985. (Note: Movement of elements between fuel rings, element rotation, and element inversion are standard techniques applied to all MITR fuel elements as a means of minimizing the effect of flux gradients on fuel depletion.) With minor exceptions, the reactor was operated on its normal schedule of 90-100 hours/week of full-power operation during all periods in which element MIT-11 was in the core.

6. Description of the Occurrence:

The fission product gas levels obtained in accordance with standard sampling procedures rose from normal operating levels during the two-three weeks preceding the occurrence. This rise was intermittent. An increase to about 11% of MPC was observed for several minutes on 18 Feb. 1986. All increases were well below the permitted concentrations.

7. Description of Apparent Cause of Occurrence:

The apparent cause of this occurrence is a blister on the surface of one of the outer fuel plates of element MIT-11. The presence of this blister was detected during a visual examination (under water) of the element once it had been removed from the core. (The blister is not visible with the element in the core.)

The blister is about 3/4 inches in width and 3/8 inches in height. It is at the extreme end of the fuel plate in the "dog-bone" region. The area of the fuel plate that now contains the blister is such that it would have been at the lower end of the fuel element (i.e., high flux region) for all of its time in core until 23 Sept. 1985 when element MIT-11 was inverted. Upon inversion, the area now covered by the blister became the upper end of the element (i.e., low flux region). A streak that runs vertically through the center of the blister is visible. The streak is initially quite dark and then somewhat lighter. The cause of this blister can not be determined without the use of hot cells and other special facilities not available at MIT. However, the existence of the dark streak suggests staining of the fuel plate, possibly as the result of an inclusion of foreign material at the blister site or from fission products leaked from the fuel matrix.

A simplified drawing showing the location of the blister on MIT-11 is attached to this report. One copy of a slide showing the blister has been sent to Region I. This slide was taken during the aforementioned visual inspection. The image was taken through twelve feet of water.

It was not possible to determine if the blister also existed on the inside of the fuel plate in question because the element's end adapter blocks the view. All elements adjacent to MIT-11 were removed from the core and their exterior plates visually examined. No abnormalities were found.

8. Analysis of Occurrence:

Quality assurance records on the manufacture of element MIT-11 do not indicate any deviations from the MITR element specifications for the plate on which the blister has formed. Element MIT-11 had been in-core while 41,613.84 MWH of energy were produced. It has 399.87 grams of its original 506 gram loading of U-235 remaining. The point of peak burnup on MIT-11 was 49.09% of the allowed fission density ($1.8 \cdot 10^{21}$ fissions/cc). The element as a whole had only attained 21.0% of the limit. Primary coolant chemistry is carefully monitored. The three parameters measured (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.

Relative to effluent releases, the combination of standard sampling procedures and the existence of procedures for handling any abnormalities in the sampling results means that the problem was quickly diagnosed, identified, and corrected. No significant release occurred.

9. Corrective Action:

The immediate corrective actio consisted of removing element MIT-11 from the core. Fission product gas levels subsequently decreased and are currently what was measured prior to the occurrence. All other in-core elements have been "sipped" and no abnormalitites were found.

10. Failure Data:

A cladding failure occurred to a "4M" series element in June 1979. Refer to ROR #50-20/79-4 dtd. 2 July 1979 and #50-20/79-4A dated 26 November 1980. Excess outgassing occcurred in an "MIT" series element in Sept. 1983 and in another in July 1985. Refer to ROR #50-20/83-2 and #50-20/85-2. The current failure was less severe than the one in 1979. ("MIT" series fuel was made by Atomics International. The "4M" series by Gulf Atomic.) The existence of a gradual and a slight increase in the fission product levels in the MITR's primary coolant was reported to Region I as a matter of information on 17 Aug. 1982. One element, MIT-21, was identified as being suspect at that time. MIT-11 was in the core during part of 1982 but not during the months in which the elevated fission product gas levels were detected.

Operating experience with fuel from both manufacturers has been good, except as noted below. Of 43 elements made by Gulf Atomic, (35 elements, 525 plates) have been permanently discharged from the core after peak burnup approached the license limit. Seven other elements (105 plates) are still in use. One 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%. (Note: It was incorrectly stated in ROR #50-20/85-2 that 41 of the Gulf Atomic elements had been permanently discharged.) Of the 36 elements made by AI and now in use, three elements (45 plates) have peak fission densities of 1.58×20^{21} f/cc, average burnup 37.4%. 33 other elements now in use (495 plates) have peak fission densities in the range $0.14\text{-}0.97 \times 10^{21}$ f/cc.

On the basis of the above experience, the failures are very likely fabrication defects and not generic problems.

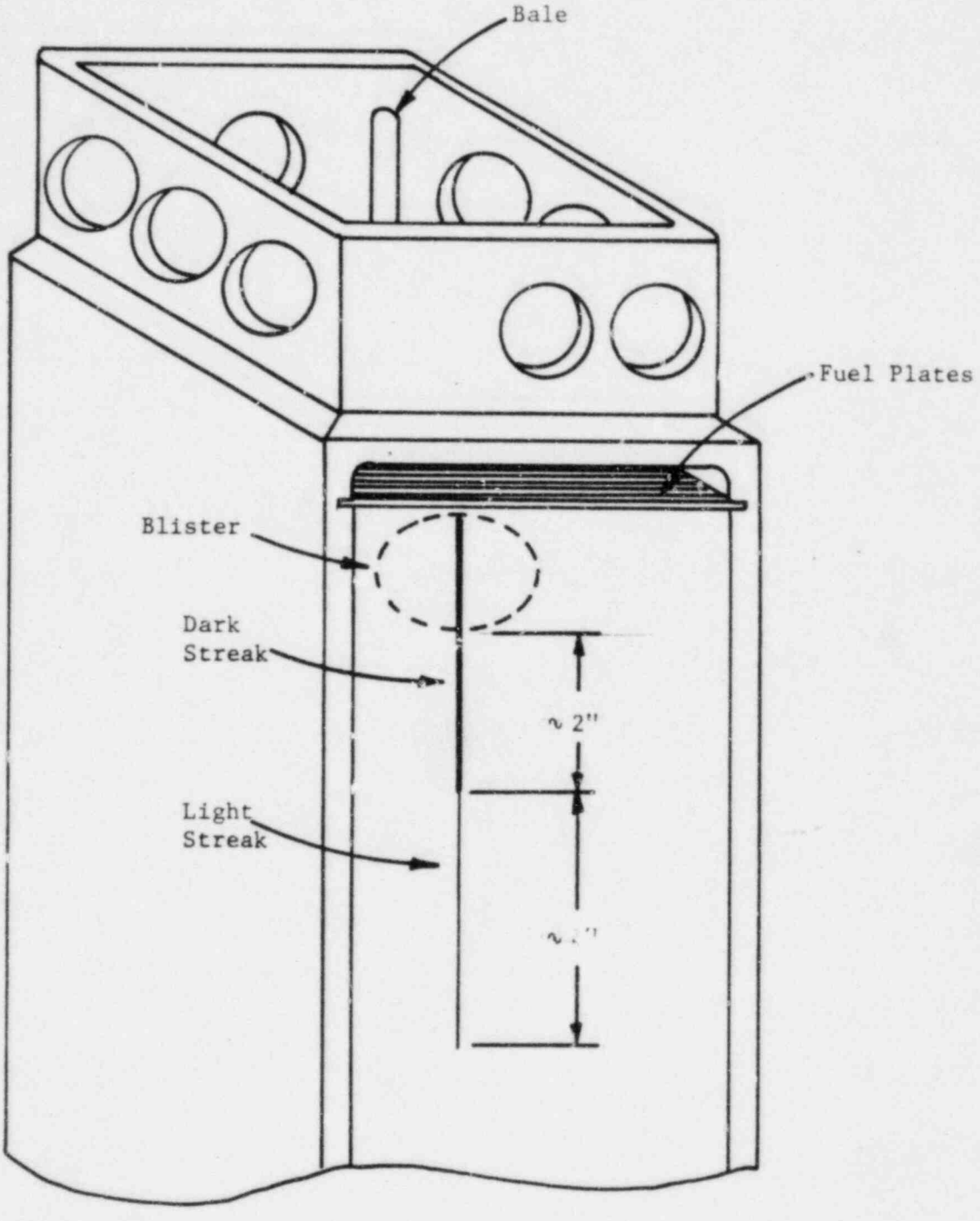
Sincerely,

John A. Bernard, Ph.D
Superintendent

Lincoln Clark, Jr.
Director of Operations

JAP/gw

cc: MITRSC
USNRC-OMIPC
USNRC-DMB



Schematic of Fuel Element MIT-11 Showing Blister