NUCLEAR REACTOR LABORATORY
AN INTERDEPARTMENTAL CENTER OF
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

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L. CLARK, JR.
Director of Reactor Operations

May 3, 1984

Director, Region 1, USNRC
ATTN: Mr. Geoffrey Robertson
631 Park Avenue
King of Prussia, PA 19406

Subject: Report of Defect, Part 21, Facility License R-37, Docket 50-20

Dear Sir:

Massachusetts Institute of Technology is forwarding herein information regarding a possible defect in a basic component for the MIT Research Reactor (MITR-II). This report is made pursuant to the requirements of 10 CFR 21.21(b).

The component is a fuel element fabricated in 1982 for the MITR-II by the Atomics International Division of Rockwell International, Energy Systems Group, Canoga Park, California, subcontractor to EG&G-Idaho, Inc., Idaho Falls, Idaho, which is the prime contractor to the U.S. Department of Energy for supply of university research reactor fuel. Subsequent to fabrication, the fuel was stored at the Naval Nuclear Fuels Division of Babcock & Wilcox, Lynchburg, Virginia. It was one of three fuel elements received on April 30, 1984 from B&W.

The defect consists of damage to one of the outside fuel plates of the fuel element. Each element consists of 15 fueled plates swaged into side plates, as indicated in the attached figure. Grooves 0.010" deep, 0.010" wide and 0.010" apart are milled into both surfaces of each plate to form fins, thus increasing heat transfer by nearly a factor of two (please see the figure). Adapters (or nozzles) are welded to each end of the assembly. Immediately upon lifting the top of the shipping container (USA 9134 B( )F) and removing protective padding, it was apparent that one of the elements (#MIT-40) had suffered surface damage on the top fuel plate. The plate showed three indentations, and the edge of the adjacent side plate showed a fourth. The plastic in which the element was bagged showed corresponding impressions.

After removal from its bag, the element was inspected more closely using an optical micrometer and a mechanical depth micrometer. The three areas of plate damage were approximately 1/8" x 1/8", 3/16" x 1/16" and 1/4" x 1/16", and the fins were crushed to depths of approximately 0.005", 0.010" and 0.009" respectively. In the latter two areas, the fins were essentially obliterated. There appeared to be no penetration of the 0.015" cladding below the fins, and wipes taken on the damaged areas revealed no detectable alpha activity.

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In undamaged areas, measurements with the depth micrometer indicated that the plate (tops of the fins) was 0.044-.045" below a plane through the edges of the side plates. This volume is a channel for primary coolant and has a nominal thickness of 0.044", approximately as measured in undamaged regions. In the area within 1"-2" of the crush marks, the plate was bent inwards, measuring 0.067" at the worst point or 0.022-.023" greater than nominal (as indicated in the figure). The coolant gap between the first two fueled plates, nominally 0.078", would become approximately 0.056".

The condition represents a "deviation" as defined in 10 CFR 21.3(e). Whether it is also a "defect" (10 CFR 21.3(d)) is difficult to evaluate. The value of the fin efficiency, η, for MITR-II fuel is 1.9, nearly halving the clad-coolant temperature difference compared to a flat plate surface. η is a factor in the equation referenced in MITR-II Technical Specification 3.1, Core Power Distribution, which states that "The reactor shall not be operated above a power level of 1.0 KW unless.... the core is predicted to operate below incipient boiling at every point in the core by use of (the referenced equation)". Previous calculations with reduced values of η, corresponding to reduced fin heights, (about one-half normal height as opposed to zero height, as is the case here in some of the damaged areas) indicate that the equation is not satisfied for reactor operation at the permissible limiting safety system settings. Prevention of incipient boiling prevents the initiation of flow instability and hence assures that a safety limit will not be exceeded, which is one of the examples given in NUREG 0302, Rev. 1, as a condition that could lead to a "substantial safety hazard" (10 CFR 21.3k). It appears unlikely that the small damaged areas or the local narrowing of a coolant channel would lead to flow instability, but the margin of safety would be reduced, and Technical Specification 3.1 would be violated.

The number of fuel elements of this type (MITR-II) that have been used in the reactor is 74, 44 fabricated by Gulf United Nuclear Fuels Corp., New Haven, Connecticut, and 30 fabricated by Atomics International. An additional three elements have been received from the latter manufacturer and show no damage of this type. Seven more are in storage off-site.

Corrective action will consist of returning the damaged element to B&W for consideration by EG&G-Idaho, B&W and MIT of the possibility of salvaging the presumably 14 good plates for use in another element. No schedule has been developed for this action.

No advice to purchasers or licensees is planned at this time as it is believed that their inspection procedures are adequate to detect defects of this type.

Please contact the writer if further information regarding this matter is needed.

Sincerely,

Lincoln Clark, Jr.

LC/sbs
Enclosure

cc: K. Brown, EG&G-Idaho
O. Harling, MIT-NRL
J. Kelley, B&W
K. Smith, MIT, VP Research
NRC-IE
NRC-SSPE