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AN INTERDEPARTMENTAL CENTER OF
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J. A. BERNARD, JR.
Director of Reactor Operations

August 18, 1995

U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Attn.: Document Control Desk

Subject: Reportable Occurrence 50-20/1995-5, Malfunction of a Shim Blade Drive Mechanism

Gentlemen:

The Massachusetts Institute of Technology hereby submits this ten-day report of an occurrence at the MIT Research Reactor (MITR) in accordance with paragraph 7.13.2(d) of the Technical Specifications. An initial report was made by telephone to NRC Region I on 08/10/95.

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

1. Report No.: 50-20/1995-5

2a. Report Date: 18 August 1995

2b. Date of Occurrence: 9 August 1995

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

4. Identification of Occurrence:

Operation of the reactor without all blades within 2.0 inches of the operating position, MITR Technical Specification No. 3.11.2c.

IE22

5. Conditions Prior to Occurrence:

A rebuilt shim blade drive mechanism, as well as a new magnet and shim blade, were installed in shim blade position #4 on 08/01/95. It was tested satisfactorily in accordance with PM 3.4.1, "Replacement of a Shim Blade, Magnet or Drive Mechanism." The reactor was then started up normally and operation continued until a scheduled reactor shutdown on 08/05/95. At that time there were no indications of any mechanism abnormalities.

6. Description of Occurrence:

The reactor was again started up at 0044 on 08/09/95 after installation of an in-core experiment, the Boiling Coolant Chemistry Loop (BCCL). The estimated critical position (ECP) of 9.05 inches was reached at about 0130 with the reactor still subcritical. In accordance with MITR Procedure 2.3.1, "Normal Reactor Startup," each individual shim blade was verified to be coupled to its magnet drive by driving in each blade sequentially and monitoring the corresponding reduction in neutron levels. After discussion with the Director of Reactor Operations, the reactivity difference was attributed to the BCCL. Startup was continued, with the critical blade position being 9.73 inches, a reactivity difference of 600 mβ.

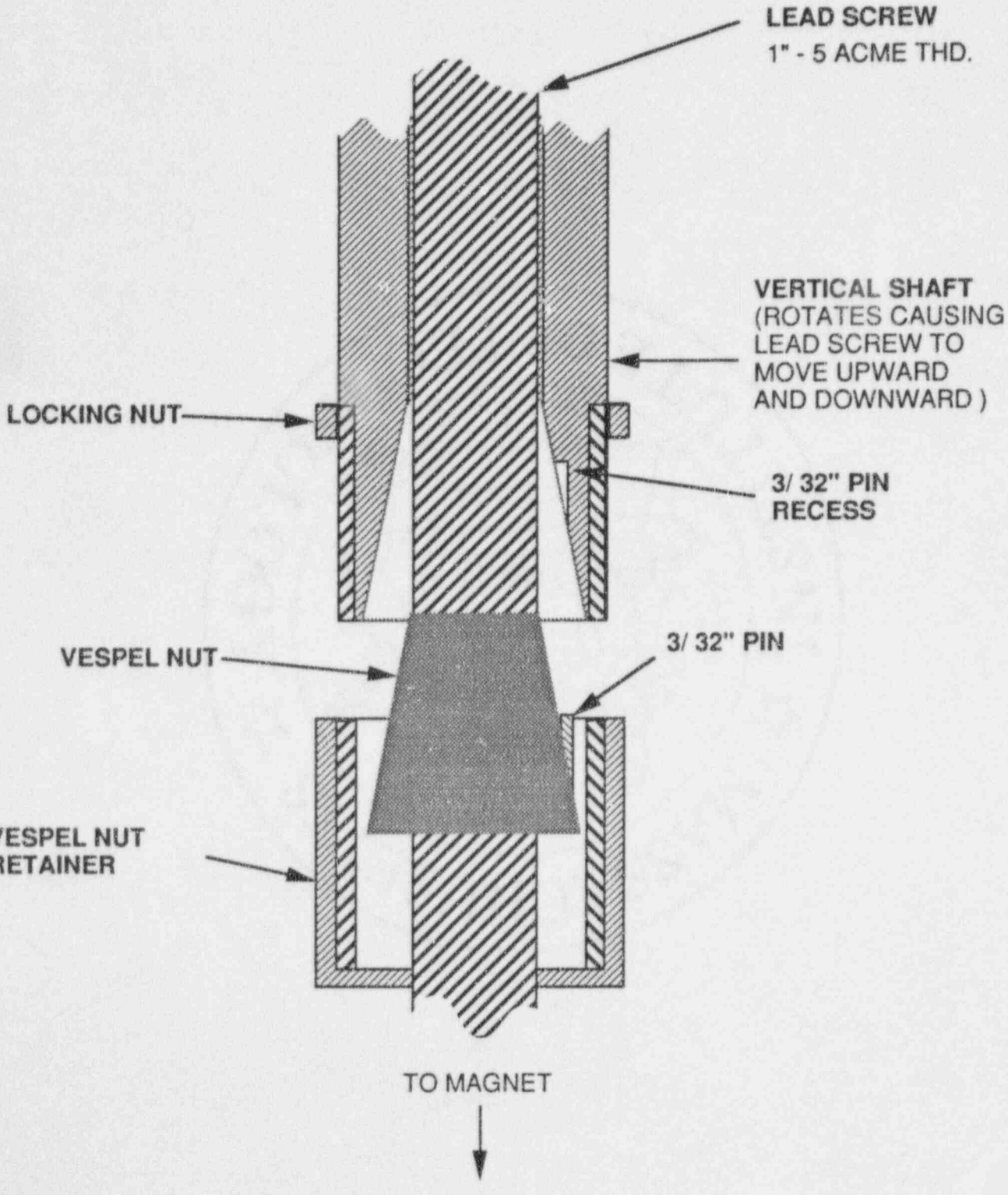
Operation continued until the reactor power was lowered to less than 250 kW at 1807 (operator training was being performed and the reactor was operated at various power levels). It was decided on the morning of 08/10/95 that the scheduled training would also include full startups and shutdowns. Upon driving the blades full in at 1127 it was noticed that the blade #4 indication was 4.25 inches with the blade fully inserted.

7. Description of Apparent Cause of Occurrence:

Upon examination of the blade drive, it was determined that the mechanism experienced intermittent slippage when the blade was being withdrawn. No slippage was observed during insertion. Since the drive position indication is coupled with the drive mechanism, the position indication in the control room continued to show a withdrawal even if no actual blade withdrawal occurred due to slippage. A series of ex-core test withdrawals to 10 inches (the approximate critical position) showed consistent slippages of 4 to 6 inches. It should also be noted that with an otherwise even bank height, shim blade #4 being inserted 4.25 inches will result in a reactivity worth effect of 670 mβ, approximately the same worth as the difference between the ECP and the actual critical position.

The drive mechanism was removed on 08/11/95 and disassembled for examination. The suspect components consist of a vertical shaft which is connected to the horizontal drive shaft via a bevel gear. Inserted at the bottom end of the vertical shaft is a vespel nut which is held in position with a 3/32" diameter stainless steel pin (see attached figure). The vespel nut rotates on the lead screw, driving the blade magnet in or out. Examination showed that the pin was worn and that scoring marks were on the inside of the vertical shaft.

DETAIL OF VERTICAL SHAFT, VESPEL NUT, LEAD SCREW ,AND PIN



8. Analysis of Occurrence:

This drive assembly was assembled in accordance with MITR Procedure PM 7.1.1.1, "Shim Blade Drive Mechanism Disassembly and Reassembly Procedures," in mid July of 1995. It is speculated that some time during the assembly the pin was improperly positioned outside of the slot. The friction between the pin and the vertical shaft held the vespel nut in place for some time until the pin began to wear (in about eight days) and slip in the vertical shaft.

It should also be noted that because of the shape of the vespel nut, a downward movement of the vertical shaft would create a greater friction force on the vespel nut and pin, reducing the likelihood of slippage while driving the blade in.

Analysis of the core power distribution shows that operation with one blade 4.75 inches below the average bank height has only a very minor effect. Reactor operation was in compliance with the operating and safety limits at all times.

9. Corrective Action:

The blade drive mechanism assembly procedure, PM 7.1.1.1, will be reviewed and modified to include an extra step with two person verification to ensure that the vespel nut and pin are properly rotated and seated at maximum depth prior to and during tightening of retaining collar and lock ring.

10. Failure Data:

None.

Sincerely,

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MIT Research Reactor

Edward S. Lau, NE
Asst. Superintendent for Operations
MIT Research Reactor

John A. Bernard, Ph.D.
Director of Reactor Operations
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JAB/gw

cc: MITRSC

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NRR/ONDD
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