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21 January 1997

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

License No. R-125
Docket No. 50-223

UNIVERSITY OF MASSACHUSETTS LOWELL RESEARCH REACTOR

Sirs:

The attached report is submitted as required by Section 6.6 of the Technical Specifications for the license cited above.

Sincerely yours,

Lee H. Bettenhausen
Reactor Supervisor

cc: Regional Administrator, Region I
T. Dragoun, Region I
T. S. Michaels, Senior Project Manager
Reactor Safety Subcommittee Members
W. Vernetson, TRTR

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UNIVERSITY OF MASSACHUSETTS LOWELL RESEARCH REACTOR

REPORT TO THE U. S. NUCLEAR REGULATORY COMMISSION
AS REQUIRED BY TECHNICAL SPECIFICATION 6.6

BACKGROUND

The University of Massachusetts Lowell Research Reactor (UMLRR), unlike almost all other research reactors, has a welded steel shell containment of 335,000 cubic foot volume complete with two-door pneumatically sealed airlocks for access and quick-acting (less than 2.5 sec per TS 4.4; less than 0.5 sec in practice) large disk-and-seal blast valves for containment isolation. The blast valves are spring loaded to close, air actuated to open using electric solenoid valves as controllers. Open and closed positions are indicated from microswitches located in the ductwork at the open and closed positions of the disks. Four of these valves are 48" in diameter; these valves control and isolate the fresh conditioned air for the reactor building. One is 20" in diameter and is only opened when one or more of the experimental area fans (hot cell, gamma cave, beam ports, pneumatic tubes) is operated; otherwise the valve is closed. One is 12" in diameter and is only open when the emergency exhaust fan is operating. Two conventional 4" diameter valves close when sanitary pipe vents are to be closed. In addition, the ventilation system provides a slight negative pressure in containment during its normal operation.

CHRONOLOGY OF EVENTS

On Friday, December 20, 1996, the gamma cave facility was in use. When the fan was turned off, the containment valve did not close. The open indicating light remained on. An operator made a log entry of this and noted that the valve, designated valve "E", would not close on signal introduction. December 21 was the last day of final examinations and the holidays intervened, so no personnel entries were made into containment until December 27, 1996.

On December 27, a reactor core alteration and a very low power neutron flux measurement was planned to be performed by three operators under the direction of a Senior Reactor Operator. The first log entry of the day indicated valve "E" failure - jammed open. The operators proceeded with the necessary checkouts of radiation monitoring and reactor protection systems. These checkouts were satisfactory. The core configuration changes were made. These involved substitution of two partial fuel elements for graphite reflectors at the core edge and substitution of a fuel element for an experiment holder inside the reflector area. Each of these changes separately had been experimentally accomplished previously, so the check on December 27 was to verify the combined effect and to obtain fast neutron flux data at low power. The core configuration changes were completed in early afternoon. Control blade withdrawal began at 1333 EST. Criticality was reached at 1442. The reactor was then taken to 9 kilowatts (licensed

power level 1 megawatt) to irradiate foils at 1540, the irradiation completed at 1625, and the reactor subsequently shut down and the reactor building secured.

On December 30, telephone discussions between the acting Reactor Supervisor on site and the Reactor Supervisor on vacation resulted in a decision to keep the facility out of operation until the ventilation ductwork could be disassembled and the cause of the open indication on valve "E" determined. Since disassembly of the ductwork required three persons and the next scheduled workday for three persons was January 5, 1997, the facility remained out of operation for this period.

When an operator entered containment on December 31, 1996, the emergency exhaust system was running and its associated valve "D", the 12 inch emergency exhaust valve, indicated open. Containment building pressure permitted shutdown of the emergency exhaust system, but valve "D" could not be closed. The symptoms were identical to those observed on December 20 with valve "E".

On January 5, 1997, the ventilation ductwork for valve "E" was disassembled. The valve pneumatic piston actuator was then removed and disassembled. The threaded joint of the valve piston and the air piston head had failed in that the threads had pulled out of the piston head. On the morning of January 6, 1997, the ductwork and valve "D" were disassembled. The failure was also at the threaded joint, but in this case the threads on the piston rod had failed. This was reported at a meeting of the Reactor Safety Subcommittee held on January 6, 1997. The events were then reported to Region I of the USNRC.

CORRECTIVE ACTIONS

Short Term:

The piston to piston head threads were repaired. For valve "E", a thread insert kit was used to repair the piston head. The air actuator was rebuilt with a manufacturers repair kit. For valve "D", a spare piston rod replaced the one with stripped threads. The solenoid air valve in the valve "D" system stuck during testing and was rebuilt with a manufacturer's kit satisfactorily. The rebuilt valve operators were replaced and functionally tested satisfactorily. A valve closure time test showed closure times less than 0.5 seconds.

A contributing problem was a previous history of faulty position indication for several valves in the "open" position; there has been only one minor problem of "closed" indication. To insure operator confidence in the "open" position indication of valve "E", the mount for the microswitch was modified to assure open indication. The previous problem with a stuck microswitch on valve "A" occurred on October 17 and was repaired on November 6, 1996.

Reactor operation on December 27, 1996, without assurance that a failed containment isolation valve is in the closed (isolated) position is contrary to Technical Specification 3.5. The operators involved did not make the connection between the open indication for valve "E" and log entry of a jammed open valve and the fact that TS 3.5 prohibited reactor operation in this condition. All licensed operators attended a training session on January 9, 1997. The events described above were reviewed in detail and the requirements of TS 3.5 and all of the indications and information necessary to assure operability of the containment and emergency exhaust system were discussed.

Changes to the reactor operations procedure for reactor system checkout were approved by the Reactor Safety Subcommittee on January 14, 1997, and have been made. The changes to

the procedure and the companion checkout form add specific line items to verify that the ventilation system is operable and the emergency exhaust system is operable per TS 3.5. These lines have been added to the procedure and the form just prior to the point where the operator signs that the checkout is complete, an independent operator reviews and signs the checkout, and the responsible senior reactor operator approves reactor startup by signature.

Long Term:

Since the threaded joint of operator piston and piston head failed on both valves using a two-and-a-half inch air actuator eleven days apart and this threaded joint failed on valve "D" in July, 1995, new air actuators for this application will be obtained. The design weakness will be taken into account in the specification and procurement of replacement actuators. Six to nine months will be needed for this effort. New actuators will be installed shortly after receipt.

These corrective actions were reviewed and discussed by the Reactor Safety Subcommittee on January 7 and 14, 1997. The corrective actions were approved, as was the resumption of power operations. The subcommittee reviewed the substance of this report and urged its timely submittal.

SAFETY IMPLICATIONS OF EVENT

There were no safety implications of the actual event. No measurable radiation levels resulted from the low power operation. The Technical Specification for building pressure less than atmospheric, TS 4.4.1, was met even with valve "E" stuck open. The recorded building-to-atmosphere pressure difference was -0.1 inches water. This has been a typical value with valves "D" and "E" closed.

The potential safety implication of reactor operation with valve "E" stuck open would be a release rate considerably greater than the 10% of building volume per day for an event generating a positive pressure in the reactor building. The pathway for release under this hypothesis would be from the building around the experimental facilities doors and vent spaces into the exhaust duct. The 20 inch diameter exhaust duct leads to the building stack at midheight; releases from the exhaust duct would be mixed with the 15,000 cfm forced stack air flow and dispersed from the 100 foot high stack.

The integral whole body dose *inside containment* for the analyzed accident, a complete release of fission products from one fuel plate, is 29 rem and a week of exposure commits 366 rem to the thyroid. The atmospheric dispersion from the stack and any protective actions taken would significantly reduce doses outside containment, whether the isolation valves are fully effective or not. Many of the calculations used in the safety analyses of Chapter 9 of the Final Safety Analysis Report for UMLRR do not take account of containment leakage rates and compute doses in containment to demonstrate the safety of reactor operation.