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May 11, 2000

US Nuclear Regulatory Commission
ATTN: Document Control Desk
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Reference: Docket No. 50-186
The Curators of the University of Missouri
License No. R-103

Subject: Docket No. 50-186—Report Regarding Radiation Alarm

**Introduction**

On April 12, 2000 the University of Missouri Research Reactor notified the NRC that, while moving fuel past an area in the fuel pool from which a two-foot by two-foot section of shielding had been removed, a radiation alarm sounded. This occurred within a controlled high radiation area. There were no unintended personnel exposures. This report will describe the activities being carried out when the alarm went off. Immediate corrective actions ameliorated the situation and long-term corrective actions are continuing. These corrective actions are further delineated below.

**Background**

The University of Missouri Research Reactor (MURR) is a 10 MW pressurized light water pool type reactor (A vertical view of the pool is shown in the attached Figure 1). MURR is conducting an in-service maintenance program consisting of various facility inspections, assessments, and upgrades. The University retained the services of a contractor to assist with these activities. An evaluation of the pool liner system, which utilized underwater cameras in the pool, was being completed immediately prior to the area radiation alarm. This pool liner inspection, the first such inspection in 25+ years, is a non-routine maintenance activity.

**Description**

On the afternoon of April 12, 2000 an unscheduled reactor shutdown occurred. A fuel element exchange was required to restart the reactor. With the intent to minimize equipment handling, the Reactor Physicist, who was authorized to do so, made a temporary change to the refueling procedure, thus allowing an irradiated element to be stored in the Z-6 rack adjacent to the area from which the shielding had been removed (See attached Figures 1 and 2). The Reactor Physicist forgot that the shielding was removed from the gamma radiation facility to allow for the pool liner inspection. After the fuel element was inserted in the Z-6 position, a radiation alarm was received from an area radiation monitor located on the beam port floor. The alarm set-point was 0.004 rem/hour and the control room read-out of that alarm was 0.008 rem/hour. Both the Health Physicist and a Reactor Operator Trainee confirmed, visually and by voice, that there were no personnel in the area. A survey of the area by the Health Physicist showed 0.01 rem/hour at the entrance to the beam port floor. The Health Physicist informed the operators of this reading, and the fuel element was moved from the Z-6 position to the Z-2 position. At the front edge of the spent fuel gamma facility a measurement showed radiation levels of 200 rem/hour in the beam. The Health



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Physicist immediately notified the operators who then removed the element from the Z basket and returned it to its original storage position.

**Discussion**

The dose rate was 200 rem/hr where the radiation beam exited the biological shield while the fuel element was located in the Z-2 storage position (See circled A on attached Figure 2). The Health Physicist made a direct measurement of the radiation beam using a Victoreen, Model 470A ion chamber at the location indicated on the diagram. In the same configuration, dose rates were also measured in the containment lobby and an occupied office, both (level 2) located one floor above the gamma irradiation facility. The dose rates in these locations were 0.003 rem/hr and 0.001 rem/hr respectively.

The time that the fuel element was in the gamma irradiation facility was estimated to be 187 seconds. This estimate was arrived at by reenacting the incident during the stand down with all incident participants present and was verified during a subsequent walk through exercise. The fuel element was estimated to be in the Z-6 position for 92 seconds and in the Z-2 position for 95 seconds. No fuel element was used in the reenactment.

No personnel were on the beam port floor at the time of the alarm. Less than five minutes earlier, health physics personnel working on an unrelated project had performed a detailed inspection of the beam port floor and found no one in the area. During the alarm, reactor operations staff observed no one on the beam port floor. After the fuel movement, health physics personnel contacted staff members who frequent the controlled area. None reported being in the area at the time of the alarm. Personal dosimeters were collected for immediate processing from persons who could not be contacted immediately. The results were "minimal" for these personnel. (For sensitivity of the film badges used, "minimal" means less than 0.01 rem.) The extremity monitor for the Health Physicist who measured the radiation beam intensity was processed and the result reported was 0.550 rem.

The area radiation monitor (a film badge) is located on the east wall of the containment building at the same elevation as the gamma irradiation facility and about 17 feet 2 inches from the face of the biological shield (Figure 2). This badge was submitted for immediate processing. The gamma exposure reported for the area radiation monitor was 1.260 rem. After adjustment for 10 days of normal exposure, 1.230 rem was attributed to the radiation from the fuel assembly.

The beam port floor is designated as a controlled high radiation area. Access to the beam port floor is administratively controlled by a fence with a lock and key entry. An additional administrative control restricts entrance into this area only to staff or researchers trained in appropriate reactions to emergency situations, including the sounding of alarms. Based on this training, it would take on the order of four seconds for an individual to pass through the radiation field while leaving the area, thus resulting in a maximum potential exposure of less than 0.5 rem. This is based on the calculated dose rate of 400 rem/hour with the fuel element in the Z-6 position. The calculated dose was derived from the measured dose rate of 200 rem/hour at the opening of the irradiation facility with the fuel element in the Z-2 position.

The contributory causes of the radiation alarm are as follows: first, a sequence of tasks to perform a non-routine maintenance activity were developed but were not formalized into a Special Maintenance Procedure, which would have provided the formal procedural control

and communication to ensure this event would not occur. Second, there was no requirement to have the revision to the step-by-step fuel handling procedure be reviewed and approved by a second licensed individual. Third, some licensed operators were not aware of significant plant conditions. This lack of awareness was due to the following: a) Lack of a formal approved procedure for this non-routine maintenance activity; and b) Inadequate communications during shift turnover. Some inefficiency in communications between shifts can be attributed to the fact that recruitment for the open Operations Engineer position had not yet been completed.

In summary, the sounding of the alarm resulted from insufficient planning, controls, and coordination of a non-routine in-service maintenance activity with normal operations. MURR is firmly committed to safety, and its Director has repeatedly emphasized safety as the Center's continuing top priority.

Because of MURR's firm commitment to safe operation of the reactor, the Director has temporarily reassigned an experienced senior staff member to the position of Operations Engineer until the recruitment process is completed.
This individual has previously been in the positions of Operations Engineer and Reactor Manager at MURR. We have concluded "shift oversight and control" meets license and technical specification requirements. Our Senior Operators and Reactor Operators are well trained and proficient with normal and emergency operating conditions. We are evaluating whether different criteria should be applied to oversight of a non-routine maintenance activity.

**Corrective Actions**

The following corrective actions have been taken, or are being considered, to ensure that all identified deficiencies are corrected and that the events leading to the sounding of a radiation alarm are not repeated.

*Immediate:*

- Removed the fuel element from the Z basket area, thus immediately ameliorating the high radiation area it caused.
- Administrated a "stand down" to determine how the event happened and the possible direct and contributing causes.
- Established an Incident Response Team responsible for heading the internal review of the incident and recommending corrective actions and procedures.
- Paused all non-routine maintenance activities.

*Interim:*

- Specified that both the Reactor Manager and Health Physics Manager shall authorize all non-routine activity and shall approve all new procedures and all changes to procedures associated with these non-routine activities.
- Issued a Standing Order requiring that the step-by-step fuel movement procedure approved by the Reactor Physicist, or his approved designee, be reviewed and countersigned by a second individual who is licensed as a Senior Reactor Operator.
- Required any revision to the step-by-step fuel movement procedure to be approved by two individuals comprised of any combination of the Reactor Physicist or licensed Senior Reactor Operators.

- Devised a more formal shift turnover status sheet to heighten communication at shift turnover, including unusual plant conditions.
- Assigned an experienced senior staff member to the Operations Engineer position until a permanent replacement can be recruited.

*Long-Term (in progress):*

- Developing procedure screening guidelines for delineating the types and methods of review for procedures prior to being implemented.
- Having external peer review.
- Evaluating oversight and control of non-routine maintenance activities.

**Restatement of the Basis for Report**

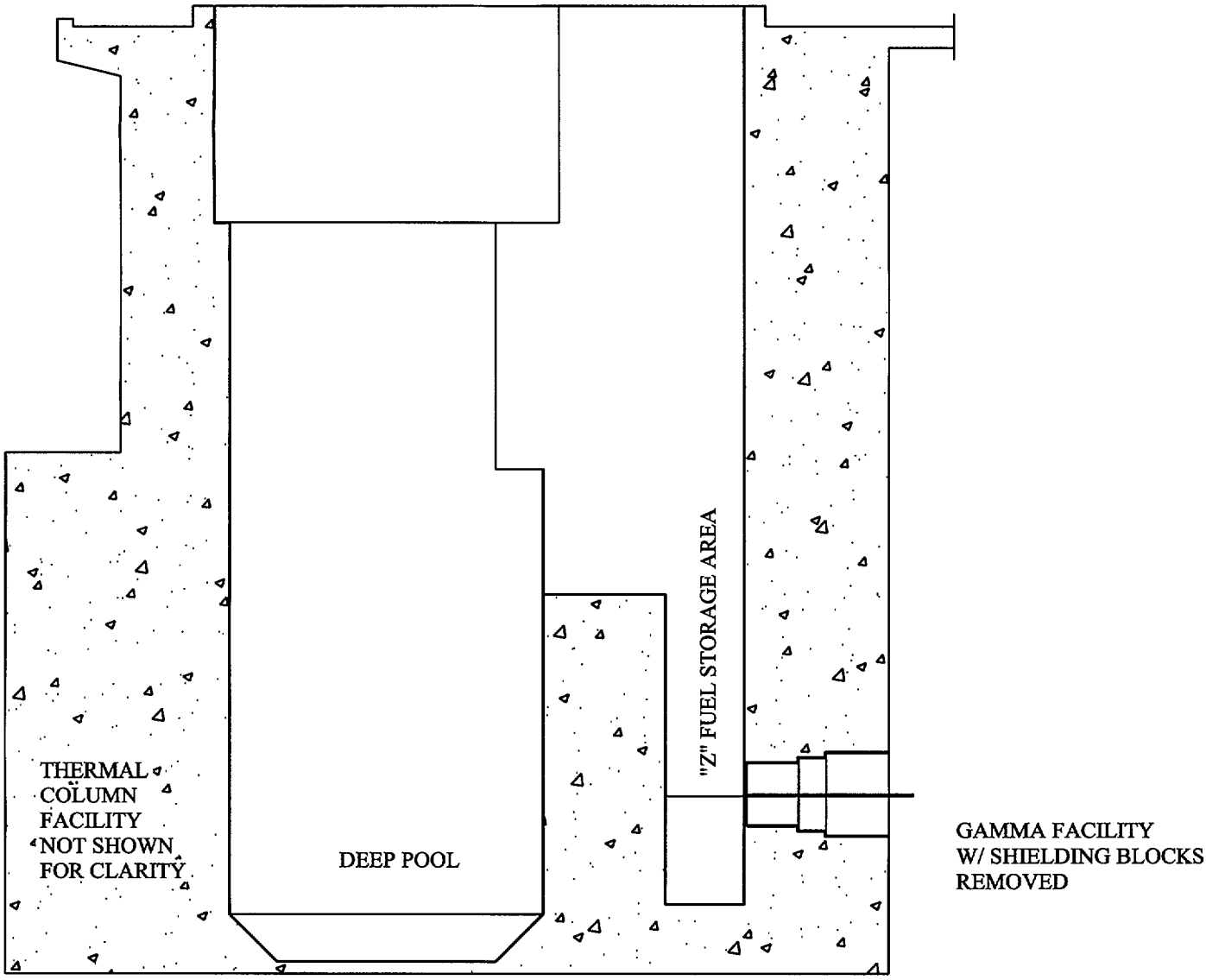
Original communications with the NRC, via telephone on April 12, 2000 and during an on-site inspection on April 14, 2000, were categorized as a required notification for a potential exposure greater than 5 rem. Subsequent evaluation of the area radiation alarm has lead to a determination that administrative controls would have limited personnel exposure time to less than 5 rem. We thereby request to withdraw our report of April 12, 2000.

Sincerely,

Edward A. Deutsch
Director

xc: Mr. Alexander Adams, Jr., US NRC
Mr. Craig Bassett, NRC Region II
Dr. Jack O. Burns, MU Vice Provost
Reactor Advisory Committee
Reactor Safety Subcommittee

Figure 1




VERTICAL SECTION THROUGH MURR REACTOR POOL

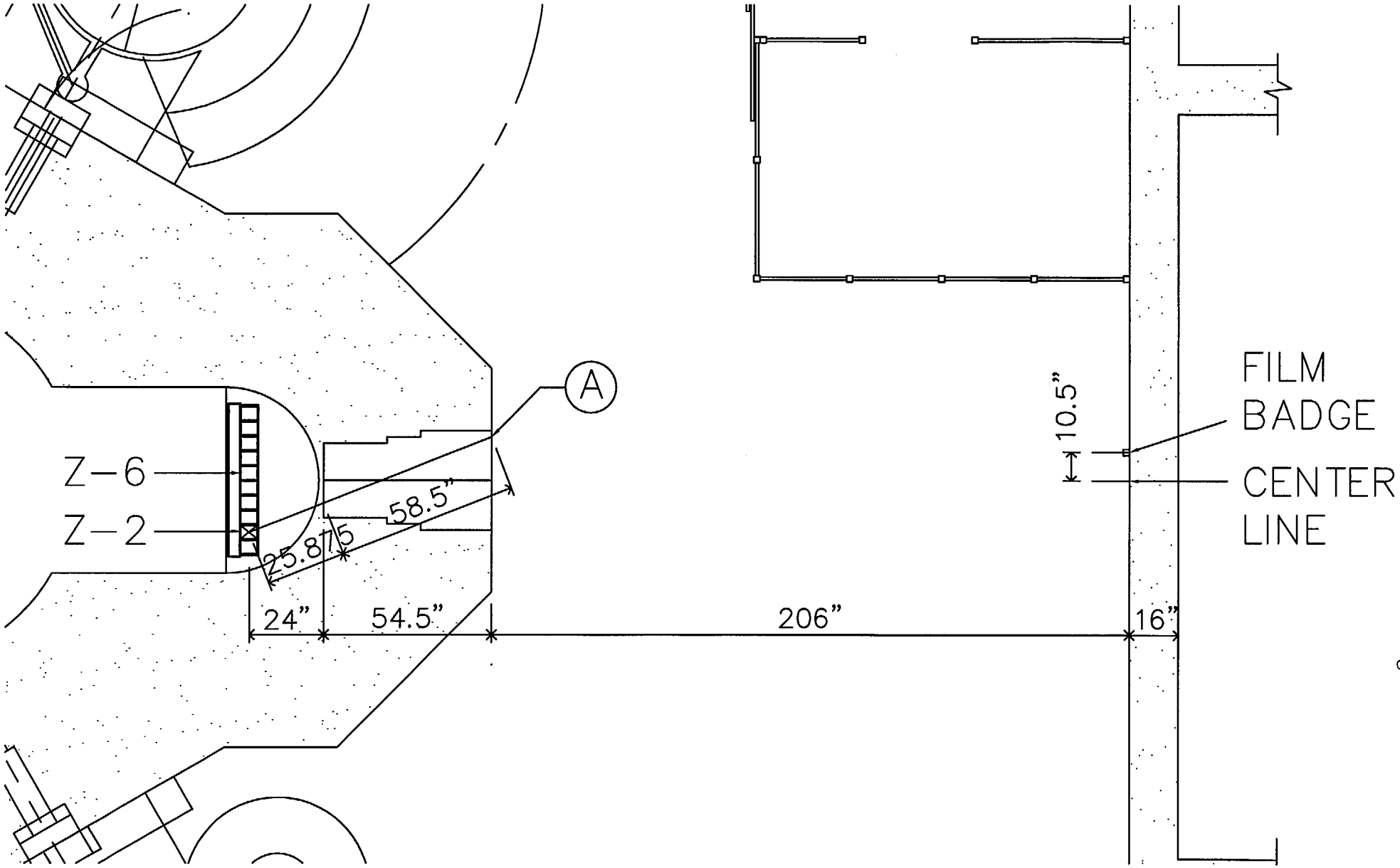



Figure 2