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Gentlemen:

SUBJECT: ANALYSIS OF CONFORMANCE TO 10 CFR PART 36, "LICENSES AND RADIATION SAFETY REQUIREMENTS FOR IRRADIATORS"

This responds to a letter from T. S. Michaels dated February 4, 1994, requesting a review of the requirements of the subject regulation published on February 24, 1993, and analysis of the applicability at the University of Massachusetts Lowell Reactor (UMLR).

By way of background, the principle facilities used at UMLR for irradiation are the reactor itself and its experimental facilities and the facility called the gamma cave. The gamma cave was constructed as a dry room for bulk irradiation of experiments in air with the reactor as a source. This usage has been described and accepted in the UMLR licensing basis. In 1981, large sources of cobalt-60 were granted to the University. The source use and handling was integrated with operation of the reactor and incorporated as an amendment to Facility Operating License No. R-125 approved by the Nuclear Regulatory Commission on January 15, 1982. Since that date, the Radiation Laboratory staff has performed a large number of irradiations in the gamma cave facility using cobalt-60 sources.

The Radiation Laboratory staff has used the radiation sources safely for many years. A number of safeguards and safety features were initially designed into the facility or added as staff initiatives. The attachment to this letter compares the existing features and operating methods with Part 36 as your letter requested. This review shows that safe use practices for the gamma cave anticipated the safe use regulations promulgated for irradiator licensees in February, 1993. There is one substantial area where aspects of the regulation are not appropriate since all source handling at

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UMLR is done manually in contrast to the automatic source control operated by a mechanism as described in the regulation. The attached analysis points this out.
Safe use of radiation in research and education is the mission of the Radiation Laboratory. This has been demonstrated by over ten years of safe operation of the gamma cave as an irradiation facility. The facility and these features have been licensed under Part 50 as required. Your letter stated that some of the requirements of Part 36 may apply to the gamma cave. It would be useful to know which specific requirements apply and the method of imposition of these requirements.

We would be pleased to discuss the attached analysis of conformance to Part 36 and other aspects of our use of radiation at your convenience.

Sincerely yours,

Lee H. Bettenhausen
Reactor Supervisor

cc: T.S. Michaels, Sr. Project Manager, NRR/ONDB
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Regional Administrator, Region I

REVIEW OF CONFORMANCE TO 10CFR36

FOR USE OF UMLR GAMMA CAVE

AS AN IRRADIATION FACILITY

The regulation is recapitulated in normal type face; the UMLR situation is described in italics.

§36.23 (a) Each entrance to a radiation room must have a door or other physical barrier to prevent inadvertant entry of personnel if the sources are not in the shielded position.

The Gamma Cave has two such barriers - a locked gate barring the access area to the cave and the cave door itself. Further, entrance to the structure containing the cave is controlled in accordance with an NRC - approved Security Plan.

It must not be possible to move the sources out of their shielded position if the door or barrier is open.

The University of Massachusetts Lowell Reactor (UMLR) operation is reversed. Upon unlocking the manual source handling tool, the access barriers are latched closed; if they are not closed, horns and flashing lights are actuated when the handling tool is unlocked by using its permanently attached key.

Opening the door or barrier while the sources are exposed must cause the sources to return promptly to their shielded position.

Again, the UMLR situation is the reverse of this. The presence of radiation in the Gamma Cave area results in electrically actuated piston locks on both the entry barrier and cave door denying entry to the area.

The personnel entrance door or barrier must have a lock that is operated by the same key used to move the sources.

The key to unlock the personnel entrance door is different from the key attached to the source handling tool. If they were the same key, the logic for actuating barrier locking devices while the source handling tool is unlocked for use would be defeated.

The doors and barriers must not prevent any individual in the radiation room from leaving.

There is an override switch to unbolt and exit the area barrier door. However, the Gamma Cave itself is locked closed prior to irradiation. There is a panic alarm switch in the cave by which an individual can signal with flashing red light and horn at the source control area on the pool level.

(b) In addition, each entrance must have an independent backup access control to detect personnel entry while the sources are exposed

If the barrier gate actuator lock was defeated while the sources are exposed, a gate position microswitch causes an audible alarm and flashing red light at both the cave area and the operating area.

Detection of entry while the sources are exposed must cause the sources to return to their fully shielded position . . .

Since the sources are manually placed in a fixed position at UMLR, this is not physically possible, so entry is prevented.

. . . and must also activate a visible and audible alarm to make the individual entering the room aware of the hazard. The alarm must also alert at least one other individual who is onsite of the entry.

As explained above, visible and audible alarms are actuated upon attempt to open the barrier gate when the sources are exposed.

(c) A radiation monitor must be provided to detect the presence of high radiation levels in the radiation room. The monitor must be integrated with access door locks to prevent room access when radiation levels are high. Attempted access must activate the alarm of (b). The monitor may be located in the entrance, but not in the direct radiation beam.

Such a monitor is provided. There are interlocks to prevent access in the presence of radiation. The access prevention and consequent alarms were discussed in (b) above. The monitor is in the access area, not in the direct beam.

(d) Before the sources move from their shielded position, the source control must automatically activate conspicuous visible and audible alarms. The alarms must give individuals enough time to leave the room before the sources leave the shielded position.

Source movement is done manually. The source handling tool is locked with a restraint and key when sources are not in use. To place a source in the irradiation position, the handling tool must be unlocked, a source rack picked out from the working storage location, and then moved manually under water to the irradiation position. Visible and audible alarms result from the unlocking of the handling tool. Several minutes ensue while the source is picked out of storage and moved to the exposure window, providing ample time for individuals to react to alarms.

(e) Each radiation room of a panoramic irradiator must have a clearly visible and readily accessible control that would allow an individual in the room to make the sources return to their fully shielded position.

As should be clear by now, the process at UMLR is the reverse of this. The radiation room is set up for the experiment, cleared of personnel, secured, and then and only then are radiation sources moved. Additional door and area access control is provided and interlocked with handling tool position and radiation monitoring.

(f) Each radiation room of a panoramic irradiator must contain a control that prevents the sources from moving from the shielded position unless the control has been activated and the door or barrier to the irradiation room has been closed within a preset time after activation of the control.

See the analysis for (e) above.

(g) Each entrance . . . must have a sign . . . "caution Radioactive Material." Panoramic irradiators must also have a sign stating "High Radiation Area" . . .

The entrances to the area and the radiation room have been placarded in accordance with 10CFR20.

(h) If the radiation room . . . has roof plugs or other movable shielding it must not be possible to operate the irradiator unless shielding is in its proper location.

The only movable plugs are small instrument line ports. There is no need for this provision at UMLR.

(i) Underwater irradiators must have a personnel access barrier around the pool which must be locked to prevent access when the irradiator is not attended. There must be an intrusion alarm to detect unauthorized entry.

The pool storage area for gamma sources is the same pool in which the UMLR is located. Access is controlled in accordance with the NRC-approved security plan which includes intrusion alarms.

§36.25 Shielding

(a) The radiation dose in the areas that are normally occupied during operation may not exceed 0.02 mSv/hr at any location 30 cm or more from the wall of the room.

The spaces which could be occupied outside the area barrier do not exceed 0.02 mSv/hr from irradiator source activity.

(b) The radiation dose at 30 cm over the edge of the pool . . . may not exceed 0.02 mSv/hr when the sources are in the fully shielded position.

The over-pool area does not exceed 0.02 mSv/hr.

(c) The radiation dose at 1 meter from the shield of a dry-source-storage irradiator when the source is shielded. . .

This provision is not applicable. The shielded location is in the pool.

§36.27 Fire Protection

(a) The radiation room . . . must have heat and smoke detectors. The detectors must activate an audible alarm. The sources must automatically become fully shielded if a fire is detected.

The radiation room is a steel and concrete vault. The only combustible material present is that being irradiated. The sources are located in a water pool adjacent to the radiation room.

(b) The radiation room . . . must be equipped with a fire extingushing system capable of extingushing a fire without the entry of personnel into the room.

This is not applicable for the reasons above.

§36.29 Radiation Monitors

(a) Irradiators with automatic product conveyor systems . . .

Not applicable.

(b) Underwater irradiators that are not in a shielded radiation room must have a radiation monitor over the pool to detect abnormal radiation levels. The monitor must have an audible alarm and a visible indicator at entrances to the personnel access barrier. . .

The pool is shared by the reactor. A complete radiation monitoring system monitors the entire reactor building with local and remote readout and alarms and automatic actuations. More specifically, a local radiation monitor with local readout and alarm connected to the facility monitoring system is located above the cobalt-60 source storage area over the pool. A central alarm and indicator station is in the facility control room *adjacent to the access barrier. Further, the gamma cave monitor (§36.23(c) above) would detect abnormal radiation and provide audible and visual indication at the personnel access area. Other radiation monitors for the pool and reactor building would also respond to abnormal radiation readings.*

§ Control of Source Movement

(a) The mechanism that moves the sources must require a key to actuate. Actuation . . . must cause an audible signal to indicate that sources are leaving the shielded position. Only one key may be in use at any time and only operators or facility management may possess it.

The source handling tool is secured by a cable and key lock which meets these controls.

The key must be attached to a portable radiation survey meter by a chain or cable. The lock for source control must be designed so that the key may not be removed if the sources are in an unshielded position. The door to the radiation room must require the same key.

As discussed often, the manual source movement controls accomplish the intent of this part of the regulation, but in reverse fashion. When the source handling tool is unlocked from its secure location and sources are being moved, the result is mechanical locking of both the area access gate and radiation room door. This key is permanently attached to the source handling tool. Using this key to gain entry to the radiation room would defeat its purpose, so a second key is used to unlock and access the radiation room.

(b) The console of a panoramic irradiator must have a source position indicator . . .
(c) The control console . . . must have a control . . .
(d) Each control must be clearly marked . . .

There is no control console. Source movement is done manually.

§36.33 Irradiator Pools

(a) Irradiator pools must either:
(1) Have a watertight stainless steel liner . . . or
(2) Be constructed so that there is a low likelihood of substantial leakage.

The UMLR pool is an aluminum lined reinforced concrete pool.

(b) . . . Irradiator pools must have no outlets more than 0.5 meter below the normal low water level . . .
(c) A means must be provided to replenish water losses.
(d) A visible indicator must be provided . . . to indicate level.
(e) . . . must be equipped with a purification system.

The irradiator pool also contains the UML Reactor. These are all provided. A description can be found in NUREG-1139, the Safety Evaluation Report for facility license renewal.

(f) A physical barrier, such a a railing or cover, must be used around or over irradiator pools . . .

Railings are used at work stations such as the gamma cave window and the reactor bridge. The pool wall extends more than two feet above the floor and forms its own physical barrier.

(g) If long-handled tools or poles are used . . . the radiation dose rate may not exceed 0.02 mSv/hr.

As stated in the analysis for 36.25(b), dose rates are less than this.

§36.35 Source Rack Protection

Not applicable.

§36.37 Power Failures

(a) *Not applicable*

(b) The lock on the door of the radiation room may not be deactivated by a power failure.

The interlock system is a part of the radiation monitoring system which receives emergency power in event of normal power failure.

§36.51 Training

The operators of the irradiation facility are NRC licensed Senior Reactor Operators. One other individual has qualified as Radiation Technician through a training and qualification process containing the elements of this regulation and is authorized to operate the irradiation facility as part of his normal job function.

§36.53 Operating and Emergency Procedures

Since the radiation room is operated as one of several experiment facilities at UMLR, its operation in normal and emergency circumstances is integrated into the reactor procedures. There are specific procedures for movement of cobalt sources, source receipt and inventory, and radiation and contamination surveys. Procedure revision is conducted in accordance with 10CFR50.59 and administrative controls in Technical Specifications.

§36.55 Personnel Monitoring
§36.57 Radiation Surveys

The radiation protection program is the same program conducted for the reactor facility and university broad by-product licenses. It encompasses the elements given in Part 36.

§36.59 Detection of Leaking Sources

The leakage detection program is part of the reactor pool monitoring program as required by facility Technical Specifications which exceed Part 36 requirements.

§36.61 Inspection and Maintenance
(a) The licensee shall perform inspection and maintenance checks that include . . .

(1) *Operability of the access control system is determined by execution of the Security Plan for access to the facility itself and (nearly) daily checkouts of the radiation monitoring system and its interaction with gamma cave area and cave door interlocks.*

(2) *The source position is determined by manual manipulation and verified visually with each use.*

(3) *Operability of the radiation monitor for contamination by the cobalt sources is determined as part of the radiochemistry quality control to assure compliance with Technical Specifications on pool water.*

(4) *Operability of the over-pool monitor is checked (nearly) daily as part of the radiation monitoring system checkout.*

(5) *There is no conveyor system or exit monitor.*

(6) *Since source manipulation is manual, there is no emergency source return control.*

(7) *Leak tightness of the pool is determined by daily and weekly visual inspections and water inventory balances.*

(8) *As explained in the response to §36.27, there are no fire detection or suppression systems in the gamma cave.*

(9) and (10) *Technical Specifications on pool water level assure replenishment and operability of water level alarms*

(11) *The Security Plan implementation assures operable intrusion alarms or compensatory actions.*

(12) *Not applicable.*

(13) *Not applicable.*

(14) *See (7) above.*

(15) *Condition of electrical wiring is checked as part of the routine radiation monitoring system operation and condition.*

(16) *Technical Specification requirements on pool water conductivity assure performance .*

(b) Malfunctions and defects found during inspection and maintenance checks must be repaired without undue delay.

A preventative and corrective maintenance program is in place for the facility.

§36.63 Pool Water Purity

(a) Pool water maintained below 20 microsiemens per centimeter.
(b) Measure conductivity no less frequently than weekly.

Technical Specifications require maintaining the conductivity of the pool water 5 micromhos per centimeter or less averaged over a month.

§36.65 Attendance during operation

(a) Both an irradiator operator and at least one other individual, who is trained on how to respond and prepared to promptly render assistance . . .

UMLR operating procedures require a supervisor present when sources are being moved by an individual.

§36.67 Entering and leaving the radiation room

(a) Upon first entering the radiation room . . . the irradiator operator shall use a survey meter to determine that the source has returned to its fully shielded position. The operator shall check the functioning of the survey meter with a radiation check source prior to entry.

The operator does use a portable survey meter to confirm that the source has been returned to its fully shielded position. The survey meter is part of the radiation instrument inventory and is checked and calibrated in accordance with that program. In addition, there are two fixed monitors in the facility radiation monitoring system which would respond and alarm if the cave door were opened (despite the interlocks and latches which keep the door locked in the presence of radiation) and a source had not been returned to its shielded position.

(b) Before exiting from and locking the door to the radiation room . . . the operator shall:

(1) Visually inspect the entire radiation room to verify that no one else is in it; and

(2) Activate a control in the radiation room that permits the sources to be moved from the shielded position only if the door to the radiation room is locked within a preset time after setting the control

The operator does check the room in accordance with facility operating procedures to assure no one else is present. The room is 8 feet by 7 feet so this check is not difficult. The cave door is then 'osed and locked manually, the area secured and the gate closed before sources are moved. As stated earlier, unlocking the source handling tool then actuates a second lock bolt on both the cave door and the area gate.

(c) During a power failure, the area around the pool of an underwater irradiator may not be entered without using an operable . . .radiation survey meter unless the over-the-pool monitor . . . is operating with backup power.

The radiation monitoring system which includes the over-the-pool monitor is connected to an emergency power supply.

§36.69 Irradiation of explosive or flammable materials

Technical Specifications prohibit introduction of explosive materials into experimental facilities without authorization from NRC. While no similar prohibition exists for flammable materials, some, such as paraffin and bottled gases, are prohibited by facility Standing Order and other *flammable materials are controlled in accordance with good industrial practices.*

§36.81 Records and retention periods

Record requirements are governed by Part 50 and Technical Specifications.

§36.83 Reports

Reporting requirements are governed by Part 50 and Technical Specifications.