REED COLLEGE Portland, Oregon 97202-8199

REACTOR FACILITY

March 17, 1992

To: John B. Martin,
NRC Regional Administrator
From: Michael Pollock,
Director, Reed Reactor Facility
Re: Recovery Plan
CC: Phil Qualls, Reactor Inspector, USNRC
Marvin M. Mendonca, Senior Project Manager, USNRC

The attached document is our plan for find the leaking fuel element in our reactor core and recovering from the Unusual Event of November 23, 1991. The plan is based on the instructions in the General Atomic Mechanical Maintenance and Operating Manual for Reed College; on conversations with General Atomic staff; and on other experiences with leaking TRIGA fuel at other facilities, as reported in the proceedings of past TRIGA Users Conferences. It has been reviewed by our own staff, our Reactor Review Committee, and a representative of the National Association of Test, Research, and Training Reactors (TRTR).

We look forward to working with you and your staff as you evaluate this proposal. Please direct any questions or comments to either Michael Pollock, Acting Director, or Paul Terdal, Associate Director, at (503)777-7222.

Michael Pollock,
Acting Director, Reed Reactor Facility

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March 17, 1992

Reed Reactor Facility
Recovery Plan

Introduction:

This report constitutes Reed College's plan to evaluate the fuel cladding leak at the Reed Reactor Facility (license R-112) on November 23, 1991, as described in the NRC Region V's Confirmatory Action Letter of November 25, 1991. Preliminary drafts of this plan have been reviewed by Dr A. G. Johnson of TRTR and by Reed College's Reactor Review Committee. This report describes the preparations that Reed College plans to undertake prior to beginning the search for the leaking fuel element, the process for identifying which fuel element is leaking, and the process for resuming normal operations once the damaged fuel element has been identified and removed from the reactor core.

As has been the case with fuel element leaks at other facilities[1,2], and as is recommended in the documentation provided by the manufacturer[3], it will be necessary to manipulate the reactor control rods and take the reactor critical in order to isolate the leak. It is noted that in the Technical Specifications for the Reed Reactor Facility, section E.4 states:

> *"Any fuel element which exhibits a clad break as indicated by a measurable release of fission products shall be located and removed from service before resumption of routine reactor operations."*

It is our opinion that this requirement does not prohibit operation of the reactor for the purpose of locating the leak.

As per the NRC Region V Confirmatory Action Letter of November 25, 1991, we request concurrence with this plan and with our intentions to operate the reactor as outlined below.

Preparations:

General:

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[1] Bouchey, G. D. and Gage, S. J., "Detection and Location of Leaking TRIGA Fuel Elements," proceedings of the TRIGA Reactor Owner's Seminar, Denver, CC, February 19-20, 1970.

[2] Bennion, J. S., Crawford, K. C., Gansauge, T. C., and Sandquist, G. M., "Identification of Leaking Fuel Elements," proceedings of the Twelfth U.S. TRIGA Users Conference, Austin TX, March 11-14, 1990.

[3] "TRIGA Mark I Reactor Mechanical Maintenance and Operating Manual for Reed College," GA-8605, Gulf General Atomic, 1968. pp 95-97.

A number of preparations will be made before operations to locate the fuel element leak begin in order to address many of the concerns raised by the NRC Inspection of November 24 - November 27[4], and by the staff of the Reed Reactor Facility. Many of these preparations are completed or are in progress. Additional preparations will be required, as per Amendment No. 5 to Facility License No R-112 - Reed College Reactor Facility, which waived the time periodicity requirements for certain Technical Specifications Surveillances.

Concerns from NRC Inspection Report 50-288/91-01:

Paragraph 2.B.g: Safety Rod Motor Control.

"After the SCRAM, the safety control rod motor rotated in the outward direction (and) thus did not reset as required. The safety rod dropped into the core on the trip signal as required. No improper rod movement thus occurred. The licensee felt that the problem was in the balance circuit."

Response:

We believe that this response of the control rod motor indicates that the rod down microswitch failed to trip following the SCRAM. We believe that this resulted from heat expansion of the Safety Control Rod "pull rod" during the operations. During the Startup Checklist, performed prior to operating the reactor for the purpose of determining the source of the fuel leak, we will verify that the Safety Rod SCRAM function performs normally. If maintenance is required, it will be completed before operations begin.

Paragraph 2.C.a: Radiation Monitors

The inspectors advised that the calibrations for the Gaseous Stack Monitor (GSM), Air Particulate Monitor (APM), and Continuous Air Monitor (CAM) were out of date. The inspectors noted that the most recent efficiency calculations for the GSM were incorrect. The inspectors also noted that the APM failed to enter the failsafe mode (by extinguishing the amber light) at the failsafe point marked on the front of the monitor readout.

Response:

Prior to any attempts to operate the reactor for the purpose of locating the source of the fuel leak, the CAM, APM, and GSM will be recalibrated.

Paragraph 2.C.d: Personnel Exposures

The inspectors noted that "...the operators initially responding to the event made four entries into the reactor bay after the initial CAM alarm. These entries were made without respiratory protection...."

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[4] Inspection on November 24 - December 4, 1991 (Report No. 50-288/91-01), conducted by P Qualls, J. Melfi, J. H. Reese of NRC Region V.

Response:

Prior to any attempts to operate the reactor for the purpose of locating the source of the fuel leak, the Reed Reactor Facility will procure respirators equipped with activated charcoal filters for use should radioactive iodine be detected. These will be made available to the facility staff, as needed, along with protective clothing. Only essential personnel will be allowed into the Reactor Bay during operations.

Preparations Required by License Amendment Number 5:

As indicated above, Amendment Number 5 to Facility License No. R-112 - Reed College Reactor Facility waived the time periodicity requirements for Technical Specifications surveillances E.3, F.2, F.9, and F.10. The amendment also stated that "these surveillance requirements must be completed prior to return to routine reactor operations." Some of these surveillances will be completed before the facility staff begins to operate the Reactor Facility for the purposes of locating the source of the fuel element leak, and some will be done after the leak is located but before we resume normal operations:

Technical Specification Paragraph E.3

"Each standard fuel element shall be visually inspected at least once every five years. At least 1/5 of all the fuel elements of the core shall be inspected at yearly intervals. If indication of apparent deterioration or distortion is found, the fuel element(s) shall be removed from the core."

Response:

Each fuel element removed from the core during Step 2 of the process described below will be visually inspected prior to replacing it in the core. After the leaking element is identified, but before we resume normal operations, an inventory will be made of any additional elements which are due for inspection and these inspections will be performed.

Technical Specifications Paragraph F.2

"The control elements shall be visually inspected at least once every two years. If indication of significant distortion or deterioration is found, the element(s) shall be replaced."

Response:

This will be done after the leaking element has been identified, but before we resume normal operations.

Technical Specifications Paragraph F.9.a.

"Verification that all control element drop times are less than one second...."

Response:

This will be done before we operate the reactor for the purpose of locating the leaking fuel element, concurrent with the daily Startup Checklist.

Technical Specifications Paragraph F.9.b

"A functional test of the ventilation system interlocks...."

Response:

The ventilation system interlocks are not related to the reactor control systems. We have been performing functional tests as required by the Technical Specifications. This will be done again before we operate the reactor for the purpose of locating the leaking fuel element.

Technical Specifications Paragraph F.10

"The linear power level channel shall be calibrated at least annually by thermal power calibration."

Response:

Because the procedure for performing a thermal power calibration requires us to operate the reactor for 6 to 8 hours at high power, this should not be done until the leaking fuel element has been located and removed. This will be done after the leaking element has been identified and removed, but before we resume normal operations.

Additional Preparations:

Facility Staffing:

On March 1, 1992, Paul Terdal, a former student and currently a licensed Senior Reactor Operator, was hired as Associate Director for the Reactor Facility on a full time basis.

Air Particulate Monitor (APM):

The sampling/detection module for the stack particulate monitor (APM) should be moved from its current location in the reactor room to a location where it will not be influenced by increases in reactor room radiation background. Relocation should also consider shielding the detector in this module. Before the reactor is operated for the purposes of finding the source of the fuel leak, the APM sampling/detection module will be moved out of the Reactor Room and into the exit corridor, as shown in Figure 2, below. A shelf for lead bricks will be installed in the Reactor Room to provide shielding for the detector.

Continuous Air Monitor (CAM):

The CAM air intake is currently located in a pipe trench running from the Reactor Bay to the Mechanical Room. During isolation mode, there is a pressure differential between these two rooms, resulting in a steady current of air from the Mechanical Room to the Reactor Bay. This could affect the CAM readings. The air intake will be moved several feet so that it is out of the path of this stream of air. See Figure 2.

We will also install a new remote readout for the CAM in the control room, where it can be read by a console operator.

Health Physics Precautions:

Following the recommendations in the General Atomic TRIGA Mark I Reactor Mechanical Maintenance and Operating Manual, the reactor pool will be sealed as much as is possible to limit the escape of radioactive gases. This will also maximize the concentration to the CAM. The pool will be covered by a plastic tarp, which will be taped or sealed around the edges; the Rotary Specimen Rack drop tube will be taped shut; and the Central Thimble will be sealed. When manipulating the water sniffer, however, the covers will be opened as needed for ease of handling.

Only essential personnel will be allowed in the Reactor Bay during operations, and personnel time in the bay will be minimized. Full face respirators with charcoal activated filters will be made available, as needed, for facility staff working in the Reactor Bay. Personnel radiation doses will be monitored to ensure that they do not exceed the limits specified in 10CFR20 or in the Reed College Administrative Procedures.

Air Monitoring:

Additional air monitoring capability will be available for this testing period:

1) A low-volume air sampler equipped with a charcoal cartridge for iodine determination will be operated in the reactor bay. Samples will be collected at routine intervals and analyzed for particulate and iodine activity in the room air.

2) An air sampling device for noble gases has been developed which consists of a 1 liter flask and stop-cock. This flask can be evacuated with a vacuum pump and the flask filled with air either from the reactor bay or the stack. The flask can then be sealed and counted for noble gas activity on either a Ge detector or NaI crystal connected to a multichannel analyzer.

3) The Oregon State Health Division, Radiation Control Program, will be informed of testing times so that they may, if they deem it appropriate, collect independent samples outside the facility.

Requalification:

Our Requalification Plan and Procedures submitted to, and approved by the NRC, require operators to spend four hours performing the functions of a licensed reactor operator during each calendar quarter. Concern has been raised about whether operators will be delinquent in requalification requirements if the reactor is not operated until after April 1, 1992. According to our procedures, activities which may be counted towards this four hours include not only actual reactor operation, but also time spent in completion of routine checklists, loading and unloading samples from the reactor, and maintenance of the reactor or any of its systems. We currently have four licensed senior reactor operators who are actively involved in such operations. Reactivity changes (10) must be completed within a reporting year and all operators should meet these requirements easily by the end of this year (September 1, 1992).

Procedure for finding fuel leak:

The procedure outlined below for detection of faulty fuel elements is based on that contained in the TRIGA Mark I Reactor Mechanical Maintenance and Operating Manual for Reed College, with some additions based on similar experiences at other facilities.

Step 1: Operate the Reactor, and Search for Fission Products

In this phase, we will operate the reactor at the lowest power level that will produce a reasonably detectable amount of fission product. The ventilation system will be placed into isolation mode before operations begin. The Startup Checklist will verify proper operation of control rod microswitches noted to have been misadjusted at shutdown on November 23, 1992. Following the advice in the GA Mechanical Maintenance and Operating Manual, and the experience at the University of Utah, we will attempt to use a water "sniffer" (described in more detail below) to track the source of fission products in the pool water to a specific element or region of the core. This sniffer will draw samples of water from the area immediately above the top grid plate past NaI detectors located in the reactor bay. Details on the water sniffer are discussed below.

Water Sniffer:

This water sniffer is based on recommendations from General Atomic and the recent experiences at the University of Utah. Water is sampled from each fuel element opening in the top grid plate by placing a small funnel over the top of each element, in turn, and pumping at low volume through a 150 ft section of 1/8" to 1/4" plastic or Tygon tubing. This tubing is then wrapped around a NaI detector, which is connected to a ratemeter and a Multichannel Analyzer, and is used to directly measure the types and quantities of radionuclides in the water. See Figure 1.

The tubing and funnel would be mounted to a light weight aluminum pole, which would be used to position the funnel over the tops of the fuel elements. The reactor would then be operated at a constant power level in order to

produce some leakage. In addition to the principle funnel designed to fit over one fuel element at a time, a larger funnel will be available which would allow for sample water from several elements at once in order to find a general region or the core that is releasing fission products. The individual operating the sniffer would attach one funnel or the other, as needed.

Step 2: Remove suspect fuel element

Once a suspect fuel element or group of fuel elements is identified, the element or elements will be removed one at a time and inspected visually (through the existing periscope or other means) for visible signs of damage. The reactor will not be operated at the power level used in Step 1, with the CAM and the sniffer again used to detect gaseous emissions. If no further emissions are detected, then the reactor power level will be increased to maximum in small increments over time. If no further emissions are detected, then the problem will be considered to be resolved.

If the above steps prove unsatisfactory, then other approaches, such as swapping out elements in groups and operating the reactor until the problems disappear, will be considered by the facility staff to locate the source of the leak.

Resumption of Normal Operations:

After the facility staff has concluded that the problem has been resolved, the staff will report its findings and justify its conclusion to NRC Region V. When NRC Region V has concurred with the findings of the facility staff, we will do the following final preparations before declaring the reactor ready to resume normal operations:

- Fuel Element Inspection of all elements scheduled for this year, as required by Technical Specifications Paragraph E.3, that were not inspected during the process of locating the source of the fuel leak.
- Control Rod Inspection, as required by Technical Specifications Paragraph F.2
- Calibration of all control rods
- Linear Power Calibration, as required by Technical Specifications Paragraph F.10

(see Preparations Required by License Amendment Number 5, above).

After these final preparations have been completed, the reactor will be considered ready to resume routine operations, at the discretion of the Director of the Reed Reactor Facility.

Figure 1: Water Sniffer

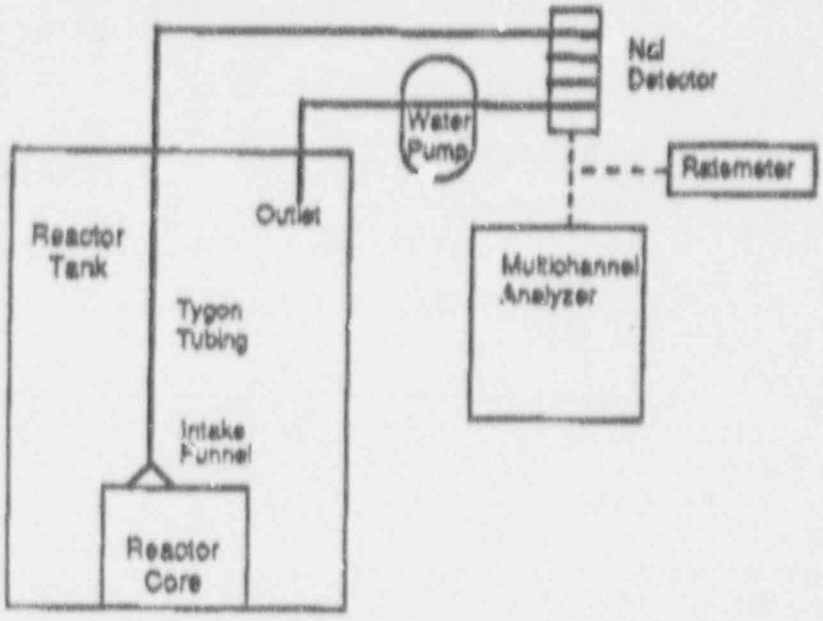

Figure 2: Position of APM, CAM Air Intake