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Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555

Subject: Massachusetts Institute of Technology Research Reactor, Docket No. 50-20, License No. R-37, Technical Specification Amendment 31

Dear Sir or Madam:

In October 1997, the original fission converter SER and the associated Technical Specifications were submitted to the NRC. In July 1998, we received a lengthy series of questions on that submission. A response was prepared, discussed with the NRC during a two-day site visit, and submitted to the NRC. That action occurred in January 1999. A second set of thirteen questions was received on May 13, 1999. Our response to the first eleven questions was submitted on June 24, 1999. Questions #12 and #13 were answered separately by requests for amendments for Technical Specifications 3.10 and 6.5.

This letter addresses a slight design change in the fission converter mechanical shutter affecting a statement in the of Technical Specification #6.6.2.5 and subsequent changes in the Fission Converter Safety Evaluation Report. Changes are as follows:

| | |
|---|---|
| TS 6.6.2.5: | Basic change to remove reference of mechanical shutter closing automatically upon loss of electric power. |
| SER Section 6.6: | Modified to include discussion of mechanical shutter actions to take place in the event of loss of power. |
| SER Section 7.3: | Non-safety related instrumentation readout location modified to reflect current design. |

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SER Section 8.5.1: Reactivity worth measurement procedure outlines modified to reflect current planning. Section 8.5.2 was eliminated by incorporating the differential reactivity worth into 8.5.1.

These changes now reflect the final fission converter design.

Sincerely,

Thomas Newton
Reactor Engineer

John A. Bernard, Ph.D
Director

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Basis

The parameters listed in Table 6.6.2.5-1 are monitored by the fission converter safety system. This system automatically initiates converter control shutter closure and/or a reactor scram to assure that the LSSS and safety limits are not exceeded.

The use of emergency power is not essential for the fission converter because loss of power automatically scrams the reactor and thus the fission converter. The water shutter closes by gravity upon power failure. Nevertheless, the information supplied to the reactor operator and fission converter user that the fission converter is shut down will assure personnel radiation safety. The choice of a minimum of one hour is based on TS# 3.7(3).

For forced convection cooling, protection against a fission converter overpower condition is provided by an alarm at 110% of nominal operating power and an automatic CCS closure at the over-power setpoint 275 kW. A reactor scram on fission converter overpower is not needed because the reactor itself will have already scrammed on high power. For natural convection cooling, protection against a fission converter overpower condition is provided by a reactor scram at the reactor power corresponding to the fission converter power 20 kW or less for fission converter operation using natural convection. This different approach is necessary because an overpower condition can occur on the fission converter during natural convection cooling even though the reactor itself is operating within its licensed operating power.

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## 6.6 Loss of Off-Site Electric Power

The MITR-II scrams automatically upon loss of electric power. This in turn would cause a shutdown of the fission converter. Hence, temperature elevations in the fuel and coolant would be small and no boiling would occur in the fuel region [Ref. 6-5]. The water shutter of the fission converter is designed to close automatically in the event of a power failure. The mechanical shutter is not designed to close automatically in the event of loss of electric power. However, if such a loss occurs, the shutter will be manually closed prior to personnel entering the medical room. In the event of partial loss of power during a patient irradiation, the reactor will be manually scrammed, which is sufficient to terminate the irradiation. The medical room door can be operated manually for patient removal.

Emergency power is supplied by the MITR-II emergency power system for selected equipment and instruments such as :

1. Fission converter medical therapy room radiation monitor.
2. Intercom between the fission converter medical therapy room and its associated medical control panel area.
3. Intercom between the fission converter medical control panel area and the reactor control room.
4. Emergency lighting of the fission converter medical therapy room and its associated medical control panel area.
5. Safety channels listed as follows:
    - Primary coolant outlet temperature
    - Coolant level

## 6.7 Loss of Heat Sink

The MITR-II uses two secondary pumps. The reactor will shut down automatically upon low secondary flow (450 gpm for either pump). If the cooling tower heat transfer capacity is lost and the fission converter and the reactor continue to operate, elevated reactor primary coolant outlet temperatures will cause the reactor to scram automatically. High temperature at the fission converter primary coolant outlet will cause the converter control shutter (CCS) to close.

Because the temperatures will increase slowly due to the nature of this transient, the reactor operator also can manually shut down the reactor if deemed necessary.

Table 7.3 Fission Converter Instrumentation

| **Parameter** | **Instrument** | **Readout Location** | **Alarm** |
|---|---|---|---|
| **Safety Related** | | | |
| Design Power | Neutron Detector | CR | Yes |
| Outlet Temperature | Thermocouple or Equivalent | CR | Yes |
| Coolant Level (Trip Point) | Conductance Level Probe or Equivalent | CR | Yes |
| Primary Flowrate | Orifice Plate or Equivalent | CR | Yes |
| **Not Safety Related** | | | |
| Nominal Operating Power | Neutron Detector | CR | Yes |
| Hx Secondary Flow Rate | Flow Switch | Local or FCCP | Yes |
| Primary Inlet Temperature | Thermocouple or Equivalent | Local or FCCP | No |
| Secondary Outlet Temperature | Thermocouple or Equivalent | Local or FCCP | No |
| Secondary Inlet Temperature | Thermocouple or Equivalent | Local or FCCP | No |
| Cleanup System Temperature | Thermocouple or Equivalent | Local or FCCP | Yes |
| Coolant Conductivity - Ion Column Inlet | Conductivity Probe | Local or FCCP | Yes |
| Coolant Conductivity - Ion Column Outlet | Conductivity Probe | Local or FCCP | No |
| Cleanup System Flowrate | Rotometer or Equivalent | Local or FCCP | No |
| Coolant Level (Indication) | Coolant Level Sensor | Local or FCCP | No |
| Leak Detection | Leak Tape or Equivalent | Local or FCCP | Yes |
| Primary Coolant Pressure (@HX) | Pressure Gauge | Local or FCCP | No |
| Secondary Coolant Pressure (@HX) | Pressure Gauge | Local or FCCP | No |
| Med Room Gamma Monitor | Gamma Detector | CR and MRCP | No |
| Converter Control Shutter Position | Limit Switches | CR and MRCP | Yes |
| Mechanical Shutter Position | Limit Switches | CR and MRCP | No |
| Water Shutter Tank Level | Level Probe | CR and MRCP | No |
| Water Shutter Upper Tank Level | Level Probe | Local | Yes |
| Med Room Door Position | Limit Switches | CR and MRCP | Yes |
| Storage Tank Level | Gauge | Local or FCCP | No |

**MRCP**: Fission Converter Medical Room Control Panel **CR**: Control Room
**FCCP**: Fission Converter Control Panel

### 8.5.1 Estimation of Integral and Differential Reactivity Worth

- Pre-conditions
  1. Fission converter fuel loading complete.
  2. Reactor shutdown with minimal Xenon.
  3. Fission converter heat removal system operable (not required when CCS closed).

- Procedure
  1. Take reactor critical. Level reactor power at a designated low power (e.g., 500 W)
  2. Record critical data. .
  3. Open CCS in small increments.
  4. Calculate the reacticvity worth by comparison of the critical positions obtained in each step.
  5. Repeat steps 2 and 3.

## 8.6 Initial Approach to the Highest Available Fission Converter Operating Power

In this section, a procedure for a stepwise increase to the maximum available fission converter power is summarized. The neutron flux from the MITR determines the fission converter power. The design power of 250 kW corresponds to a reactor power of 10 MW, fresh fuel and light water coolant are used in the fission converter. At present (1997), the maximum operating power for the MITR is 5 MW which will yield a maximum fission converter power of 125 kW. At such time as the MITR's licensed power level is increased to 10 MW, the procedure outlined below will be repeated.

1. The interior of the fission converter facility will be checked to ensure that no foreign objects are present.

2. All process and radiation monitoring systems will be placed in their normal operating condition with non-nuclear instruments calibrated.

3. The converter power will be increased by raising the reactor power in a stepwise manner. Radiation levels and system temperatures will be monitored during each

power increment. This procedure will be repeated until the maximum available operating power is attained.

4. The following measurements will be made:

   a) Temperature Distribution

      The temperature distribution in the fission converter plate will be calculated using the actual fuel loading prior to the initial power ascension. The result of this temperature distribution determination will be used to identify the hot channel and to determine that both the operating limit for power deposition and the nuclear hot channel factor are satisfied (Section 3.4.1). This temperature distribution will be verified by correlating it with the bulk coolant temperature. The latter will be measured.

   b) Process Parameters

      Fission converter primary inlet and outlet temperatures as well as flow rate will be measured. This information will be used to perform a calorimetric.

   c) Radiation Surveys

      Radiation measurements will be made outside the fission converter facility and inside the fission converter medical therapy room via remote monitoring.

   d) Nuclear Instrument Calibration

      The fission converter power will be calculated via a calorimetric. Energy losses because of gamma radiation etc. will be taken into account. The equilibrium neutron count rate associated with the nuclear instrumentation will be measured. Correlation of these count rates with the calorimetric will be used to calibrate the nuclear instruments.

The above procedure for a stepwise increase of the fission converter operating power will be repeated if any one of the following design changes is made:

1. The maximum available operating power is increased,
2. The fission converter primary coolant is changed from $H_2O$ to $D_2O$ (the hot channel factor increases – see Table 2.4 ), or
3. Fresh fuel is used to replace burned fuel.

4. The aluminum block located between the fuel region and the tank wall is removed or replaced by another approved unit.

## References

[8-1] MITR Staff, "MITR-II Startup Report", MITNE-198, Feb. 1977.