UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

DOCKET NO. 50-20

AMENDMENT TO AMENDED FACILITY OPERATING LICENSE

Amendment No. 31
License No. R-37

1. The U.S. Nuclear Regulatory Commission (the Commission) has found that

   A. The application for an amendment to Amended Facility Operating License No. R-37 filed by the Massachusetts Institute of Technology (the licensee) on October 3, 1997, as supplemented on January 14, June 24, July 29, October 20, and November 12, 1999, conforms to the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the regulations of the Commission as stated in Chapter I of Title 10 of the *Code of Federal Regulations* (10 CFR);

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance that (i) the activities authorized by this amendment can be conducted without endangering the health and safety of the public and (ii) such activities will be conducted in compliance with the regulations of the Commission;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public;

   E. This amendment is issued in accordance with the regulations of the Commission as stated in 10 CFR Part 51, and all applicable requirements have been satisfied; and

   F. Prior notice of this amendment was not required by 10 CFR 2.105, and publication of notice for this amendment is not required by 10 CFR 2.106.

2. Accordingly, the license is amended by changes to the Technical Specifications as indicated in the enclosure to this license amendment, and paragraph 2.C.(2) of Amended Facility Operating License No. R-37 is hereby amended to read as follows:

   (2) Technical Specifications

   The Technical Specifications contained in Appendix A, as revised through Amendment No. 31, are hereby incorporated in the license. The licensee shall operate the facility in accordance with the Technical Specifications.

3. This license amendment is effective as of the date of issuance.

FOR THE NUCLEAR REGULATORY COMMISSION

LB Marsh

Ledyard B. Marsh, Chief
Events Assessment, Generic Communications and
Non-Power Reactors Branch
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Enclosure:
Appendix A, Technical
Specifications Changes

Date of Issuance: December 21, 1999

<u>ENCLOSURE TO LICENSE AMENDMENT NO. 31</u>

<u>AMENDED FACILITY OPERATING LICENSE NO. R-37</u>

<u>DOCKET NO. 50-20</u>

Replace the following pages of Appendix A, "Technical Specifications," with the enclosed pages. The revised pages are identified by amendment number and contain vertical lines indicating the areas of change.

Remove	Insert
iii	iii
	iv
1-1	1-1
3-27	3-27
3-37	3-37
3-39	3-39
	6-34 to 6-64

Page

Page

7. ADMINISTRATIVE CONTROLS

1. DEFINITIONS

1.1 Reactor Secured

The overall condition where there is no fuel in the reactor core or all of the following conditions are satisfied:

1. the reactor is shut down,
2. console key switch off and key is in proper custody,
3. no work in progress within the main core tank and/or the fission converter tank involving fuel or experiments, or maintenance of the core structure, installed control blades, or installed control blade drives when not visibly decoupled from the control blade.

1.2 Reactor Shutdown

That condition where all control blades are fully inserted or reactivity condition equivalent to one where all control blades are fully inserted. The reactor is considered to be operating whenever this condition is not met.

1.3 Containment Integrity

Integrity of the containment building is said to be maintained when all isolation system equipment is operable or secured in an isolating position.

1.4 The True Value

The true value of a parameter is its exact value at any instant.

1.5 The Measured Value

The measured value of a parameter is the value of the parameter as it appears on the output of a measuring channel.

Amendment No. 31
December 21, 1999

a. a radiation monitor continually sampling the effluent air stream, which indicates in the control room, shall be operating and capable of automatically closing the building vents. The time for the radiation monitor trip, including sample transit and ventilation damper closing times, shall be less than the time for effluent air to flow from the sampling point to the damper.

b. a radiation monitor in the exhaust stack shall be operating.

c. the tritium concentration in the stack effluent shall be measured so as to provide a monthly average value.

3. Whenever the reactor is operating with secondary cooling water circulating between the reactor building and the cooling towers, a secondary water radiation monitor, which indicates in the control room, shall be operating.

4. Whenever secondary cooling water is flowing through the D_2O heat exchangers and/or the fission converter heat exchanger (if D_2O is used as coolant) to the cooling towers the following shall be provided:

a. the secondary water shall be sampled daily for tritium content.

b. the level of the D_2O dump tank shall be monitored, either by a low level alarm in the control room, or by hourly readings of the dump tank sight glass.

c. the level of the fission converter tank shall be monitored by a low level alarm in the control room or by hourly reading of a local gauge.

5. At least one area radiation monitor, capable of warning personnel on the reactor floor of high radiation levels, shall be operating when the reactor floor is occupied. If one of the five normal area monitors is inoperative, portable instruments will be used to survey work in that area.

a. in the reactor core provided the reactivity is below the shutdown margin given by Specification 3.9-1,

b. in the cadmium-lined fuel storage ring attached to the flow shroud,

c. in the dry storage holes on the reactor top,

d. in the spent fuel storage tank in the basement of the reactor building,

e. in the fuel element transfer flask or other proper shield within the controlled area,

f. in the fission converter tank.

4. Handling of fuel elements: Only one fuel element at a time shall be moved in or out of the reactor core. Not more than four of the MITR fuel elements or the equivalent of two fuel elements including loose plates (maximum of 15 loose fuel plates) shall be outside of the storage areas as designated in items 2 and 3a, b, c, d except during the processes of receiving or shipping fuel from the site in approved containers. In all cases of fuel element storage outside of the reactor core, the value of k_{eff} must be kept less than 0.90. Records of fuel element transfers shall be maintained. Prior to transferring an irradiated element from the reactor vessel to the transfer flask, the element shall not have been operated in the core at a power level above 100 kW for at least four days.

5. Removal of control blades: A control blade may be removed from the core only if the minimum shutdown margin relative to the cold, Xe-free critical condition with the most reactive operable blade and the regulating rod fully withdrawn is 1% $\Delta k/k$ after the control blade has been removed.

It has been calculated that fuel elements when stored in the locations specified in 2b, 2c, 2d, 3b, 3c, 3d, 3e, and 3f will have a calculated effective multiplication (k_{eff}) factor of less than 0.9 under optimum conditions of water moderation.

These specifications are also conservative for criticality safe handling of MITR-I fuel alone or in combination with MITR-II fuel.

The chief additional problems with spent fuel are those of shielding personnel from the emitted fission product gamma rays and preventing melting from afterheat. The shielding requirement is met by utilizing a shielded transfer flask (item 3e) for movements and temporary storage and more permanent shielding as indicated in 3a, b, c, d, and f. The requirement to prevent melting is met by specifying that four days elapse between use of the fuel element in a core operating above 100 kW and removal of the element from the reactor pool. This decay time was determined from experience with the MITR-I combined with a conservative assumption of doubling the power density for the MITR-II.

The specification on removal of control element provides that the stuck rod criteria will always be met, even when one blade is removed for repair. Thus, the reactor still would not go critical on the removal of a second control element.

6.6 Design and Operation of the Fission Converter Facility

Applicability

This specification applies to the operation of the Fission Converter Facility. It does not pertain to the use made of the fission converter beam nor does it apply to the associated medical therapy facility. Use of that facility for the treatment of human patients and/or investigatory studies that involve humans shall be in accordance with the provisions of TS# 6.5 and its associated quality management program.

The provisions of this specification are only applicable if fuel is present in the fission converter tank.

Organization

This specification contains five subsections. These are:

6.6.1 Safety Limits and Limiting Safety System Settings

6.6.2 Limiting Conditions for Fission Converter Operation

6.6.3 Fission Converter Surveillance Requirements

6.6.4 Fission Converter Design Features

6.6.5 Reporting Requirements

Definitions

1. Fission Converter Shutdown

That condition where the converter control shutter is fully inserted or where the reactor is in a shutdown condition. The fission converter is considered to be operating whenever this condition is not met.

2. Fission Converter Secured

The overall condition where there is no fuel in the fission converter or where all of the following conditions are satisfied:

(a) The fission converter is shut down,

(b) The converter control shutter (CCS) control panel key switch is in the off position and the key is in proper custody, and

(c) There is no work in progress within the converter tank involving fuel.

6.6.1 Safety Limits and Limiting Safety System Settings

6.6.1.1 Safety Limits

Applicability

This specification applies to the interrelated variables associated with fission converter thermal and hydraulic performance. These variables are the fission converter neutronic power (P), the steady-state average primary coolant outlet temperature (T_{out}) if under forced convection, the fission converter tank coolant mixing temperature (T_{mix}) if under natural circulation, the fission converter primary coolant flow rate (W_p), and the fission converter primary coolant height above top of the fuel elements in the main tank (H). For forced convection, the fission converter shall contain either ten or eleven fuel elements. For natural convection, the fission converter shall contain eleven fuel elements.

Objective

To establish limits within which the integrity of the fuel clad is maintained.

Specification

1. For forced convection, the point determined by the true values of P, W_p, and T_{out} shall not be above the line given in Figure 6.6.1.1-1 corresponding to the coolant height, H.
2. For natural convection, the coolant height shall be at 2.4 m or higher and the point determined by the true values of P and T_{mix} shall not be above the line given in Figure 6.6.1.1-2.

Amendment No. 31
December 21, 1999

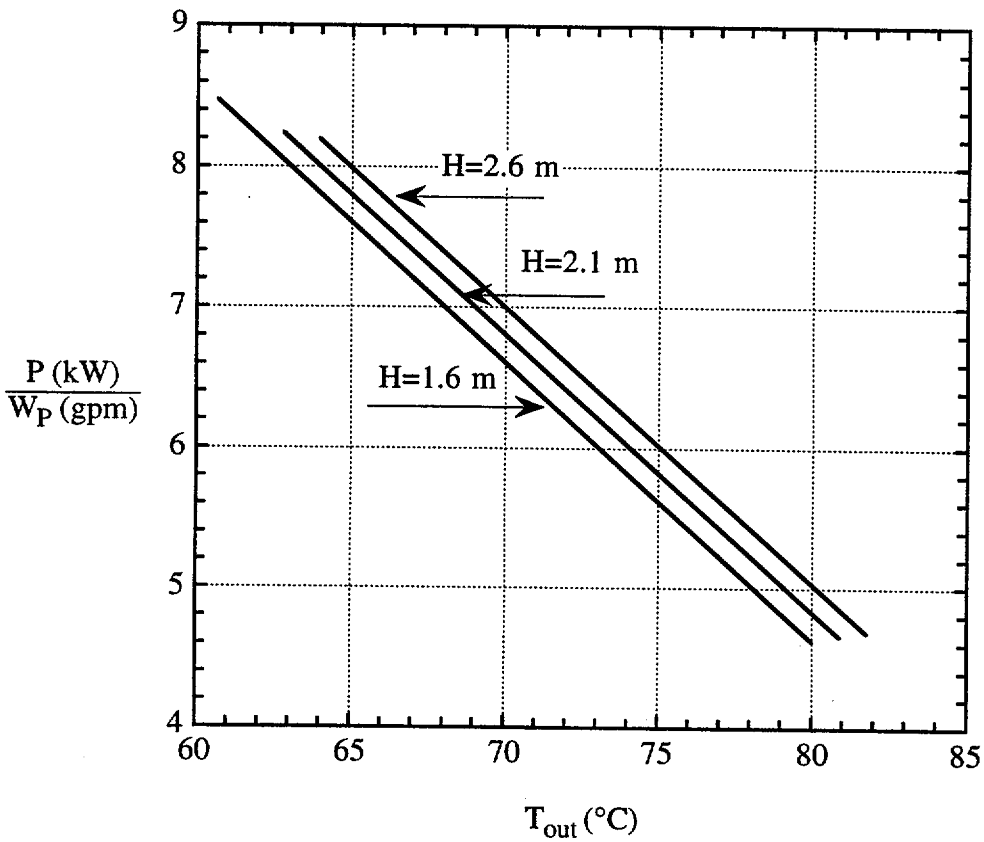

Figure 6.6.1.1-1 Fission Converter Safety Limits for Forced Convection. (for either ten or eleven fuel elements)

Amendment No. 31
December 21, 1999

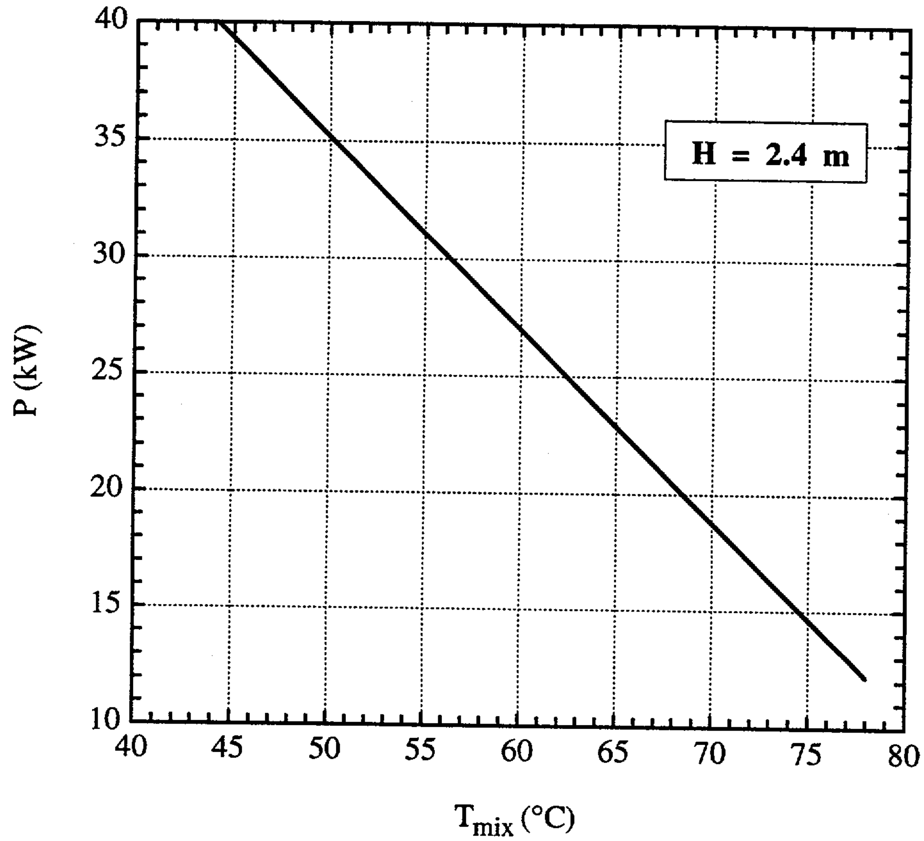

Figure 6.6.1.1-2 Fission Converter Safety Limits for Natural Convection. (for eleven fuel elements only)

Basis

In the MITR SAR it is noted that critical heat flux is a conservative limit beyond which fuel damage may occur from overheating. In addition, the onset of multichannel flow instability (OFI) can lower the burnout heat flux. However, OFI is a complicated phenomenon and the effects of heat flux spatial distributions are not taken into account in the correlations developed for OFI. Onset of significant voiding (OSV), on the other hand, can be more accurately predicted for various heat flux spatial distributions. OSV describes the condition where the bubbles grow larger on a heated surface and detach regularly to the main flow stream. It has been observed experimentally that OSV occurs before OFI. Therefore, OSV is conservatively assumed as the criterion for the safety limits of the fission converter.

OSV was calculated in the Fission Converter Safety Evaluation Report (SER) for the hot channel. Uncertainties because of departure from nominal design specifications, measurement errors, and use of empirical correlations are taken into account in these calculations. The safety limits were evaluated based on the limiting core operating conditions described in TS# 6.6.2.1. Figure 6.6.1.1-1 shows the calculated fission converter safety limits for forced convection for three coolant heights: 2.6 m, 2.1 m, and 1.6 m above the top of the fuel elements. This figure is applicable to either ten or eleven fuel elements.

The purpose of allowing fission converter operation at low power in the absence of forced convection is to facilitate activities such as flux measurements in the fueled region. Natural circulation is achieved by removing the inlet pipes, which are used for forced convection, from the downcomers. Calculations show that the natural circulation is sufficient to dissipate the energy that is generated provided that the limit on the fission converter tank coolant mixing temperature is not exceeded. OSV for natural circulation was calculated for a coolant height of 2.4 m. This coolant height corresponds to the top of the downcomers. The result for eleven elements is shown in Figure 6.6.1.1-2.

6.6.1.2 Limiting Safety System Settings (LSSS)

Applicability

This specification applies to the setpoints for the safety channels monitoring the fission converter neutronic power (P), the steady-state average primary coolant outlet temperature (T_{out}) if under forced convection, the fission converter tank coolant mixing temperature (T_{mix}) if under natural circulation, the fission converter primary coolant flow rate (W_p), and the fission converter primary coolant height above top of fuel elements in the main tank (H). For forced convection, the fission converter shall contain either ten or eleven fuel elements. For natural convection, the fission converter shall contain eleven fuel elements.

Objective

To assure that automatic protective actions will prevent the onset of nucleate boiling in the fission converter fueled region and will thus prevent operating conditions from exceeding the safety limit.

Specification

1. The measured values of the limiting safety system settings on P, W_p, T_{out}, and H for fission converter operation with forced convection shall be as follows:

Variable	**Limiting Safety System Setting**
P	300 kW (max)
W_p	45 gpm (min)
T_{out}	60 °C (max)
H	2.1 m above top of fuel elements (min)

2. The fission converter may be operated at power levels up to 20 kW in the absence of forced convection, provided that the inlet pipes are removed so as to allow natural circulation. The measured values of the limiting safety system settings on P, T_{mix}, and H for fission converter operation with natural circulation shall then be as follows:

Variable	**Limiting Safety System Setting**
P	20 kW (max)
T_{mix}	60 °C (max)
H	2.5 m above top of fuel elements (min)

Basis

The limiting safety system settings (LSSS) are established to allow a sufficient margin between normal operating conditions and the safety limits, so that automatic shut down actions will ensure that the fission converter is maintained in a safe condition during normal operation. Onset of nucleate boiling (ONB) is chosen as the criterion for the LSSS derivation. ONB (also called incipient boiling) defines the condition where bubbles first start to form on the heated surface. Because most of the liquid is still subcooled, the bubbles do not detach but grow and collapse while attached to the wall. LSSS are chosen so that boiling will not occur anywhere in the fueled region as long as the limits are not exceeded.

The ONB is calculated in the Fission Converter SER for the hot channel. Uncertainties because of departure from nominal design specification, measurement errors, and the use of empirical correlations are taken into account in these calculations. The LSSS were evaluated based on the limiting core operating conditions described in TS# 6.6.2.1.

Figure 6.6.1.2-1 shows the result of the fission converter LSSS calculations for a primary coolant flow rate of 45 gpm and a coolant height of 2.1 m for operation with forced convection. The LSSS temperature calculated for 300 kW is 63°C, and hence a primary coolant outlet temperature setting of 60°C is conservative.

For fission converter operation with natural circulation, calculations have shown that the prediction of ONB coincides with that of OSV because of the low flow rate. Therefore, a 5°C margin is added to the safety limit curve to establish the LSSS. This 5°C margin corresponds to about 6 minutes of heat up time in the mixing area with the fission converter at 20 kW and thus provide adequate response time for corrective actions. The resulting LSSS curve is shown in Figure 6.6.1.2-2. The LSSS for fission converter operation with natural circulation is conservatively determined for a maximum power of 20 kW and a maximum coolant mixing temperature of 60°C with a coolant height of 2.5 m.

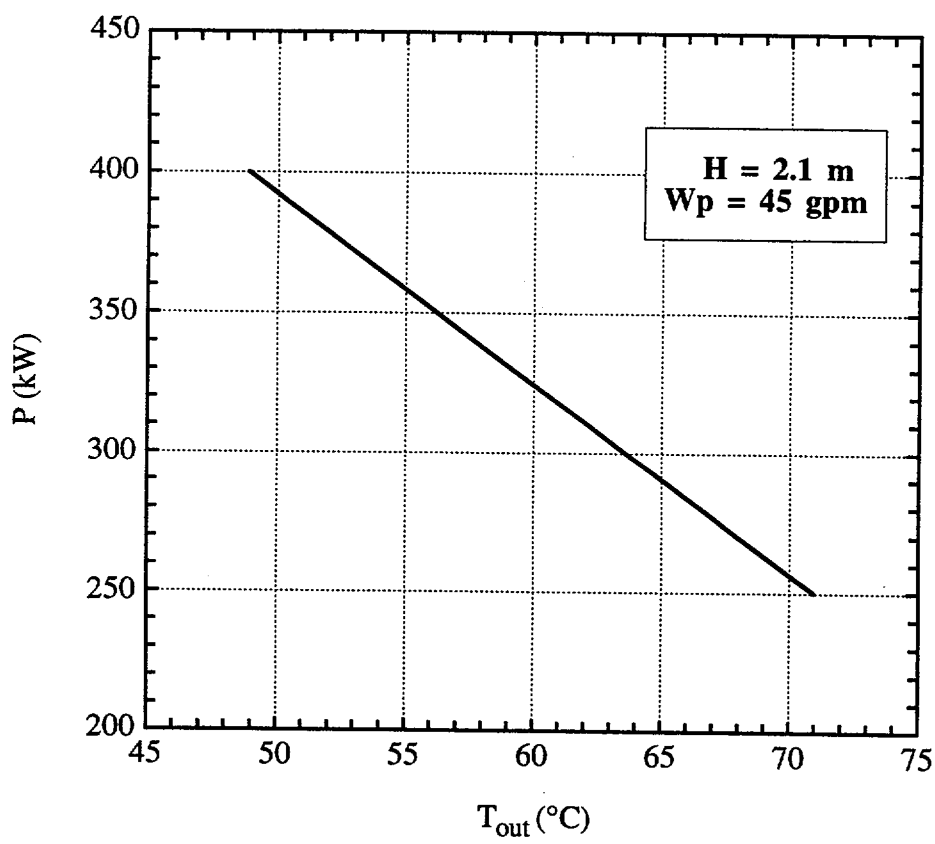

Figure 6.6.1.2-1 Calculated Results for the Fission Converter LSSS for Operation with Forced Convection. (for either ten or eleven fuel elements)

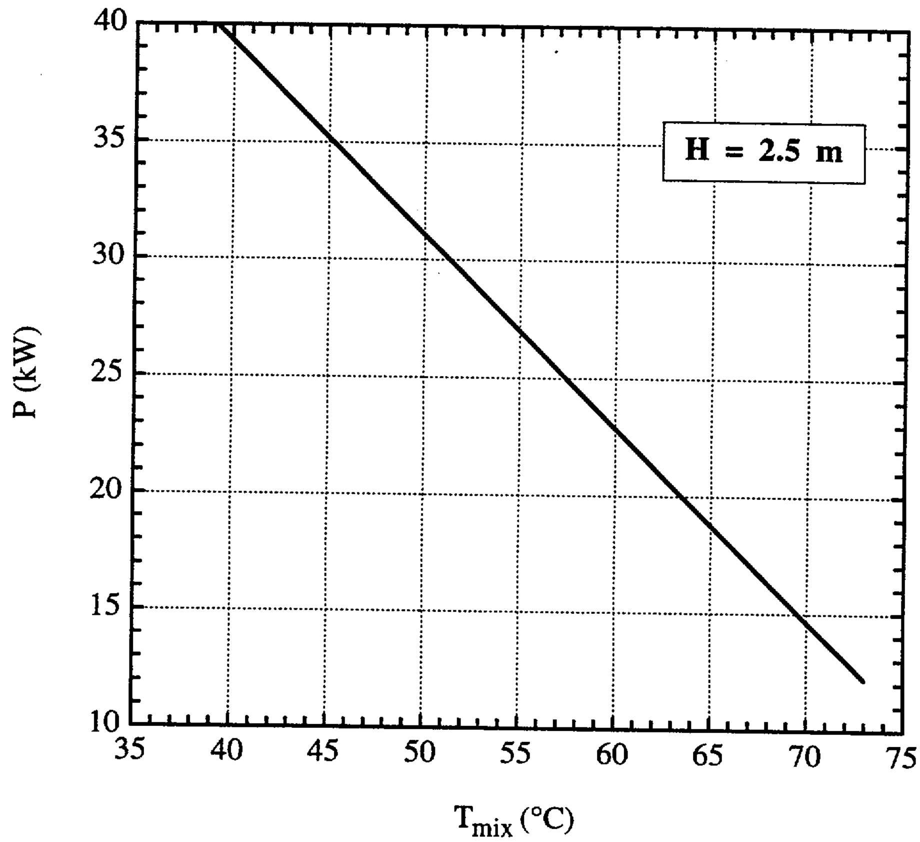

Figure 6.6.1.2-2 Fission Converter LSSS for Operation with Natural Convection (for eleven fuel elements only)

6.6.2 Limiting Conditions for Fission Converter Operation

6.6.2.1 Limiting Operating Conditions for the Fueled Region

Applicability

This specification applies to the fission converter core operating conditions. The variables used to define the core operating conditions are:

- F_p the fraction of the total power deposited in the fueled region (both fuel and coolant),
- F_{HC} the ratio of the maximum power deposited in the hottest fuel plate to the average power per fuel plate,
- F_f the ratio of the primary coolant flow that goes through the fueled region to the total primary coolant flow, and
- d_f the ratio of the minimum flow to the average flow in the coolant channels.

Objective

To assure that the operating parameters are maintained within the bounds that are used to establish the safety limits and the limiting safety system settings of the fission converter.

Specification

1. $F_p \times F_{HC} \leq 1.53$
2. $F_f \times d_f \geq 0.80$
3. After each change in loading of the fueled region which might increase the hot channel factor, an evaluation will be made to ensure that item (1) above is satisfied. A record of these evaluations shall be approved by two licensed SROs.

4. All positions in the fueled region are filled with either a fuel element or another approved unit. TS# 6.6.2.1 (1) and (2), the safety limits, and the LSSS shall be re-evaluated for:

   a. forced convection with other than ten or eleven fuel elements in the fueled region, and

   b. natural convection with other than eleven fuel elements in the fueled region.

5. The maximum fuel burnup shall be limited in accordance with TS# 3.11(2e).

6. The maximum allowed value of k_{eff} for the fueled region shall not exceed 0.90.

7. Fuel elements contained in the fueled region of the fission converter shall be oriented so that the plates are "edge on" towards the MITR core.

8. The fission converter tank lid shall be in place and sealed for operation greater than 20 kW.

Basis

The fission power deposition factor (F_p), the hot channel factor (F_{HC}), the fueled region coolant flow distribution factor (F_f), and the channel flow disparity factor (d_f) are all dependent on the fission converter fueled region design. The specifications (TS# 6.6.2.1(1) and (2)) that describe the limits on these factors are conservatively determined for the fission converter design and provide reasonable margin for deviations. These factors form the basis for the thermal-hydraulic limits calculations and they should be verified during initial startup of the fission converter.

Safety limits and limiting safety system settings of the fission converter described in TS# 6.6.1 are derived based on eleven fuel elements in the fueled region. Calculations showed that the same SL and LSSS curves (Figures 6.6.1.1-1 and 6.6.1.2-1) can be used for forced convection operation with ten fuel elements. However, there is a significant effect on the SL and LSSS curves for natural convection operation with other than eleven fuel elements. Therefore, these limits shall be re-evaluated for natural convection operation if other than eleven fuel elements are to be used.

The maximum fuel burnup density is chosen in accordance with TS# 3.11(2e). This limit was developed based on the MITR fuel design.

The effective multiplication factor (k_{eff}) for the fission converter was calculated in the SER for different combinations of coolant and fuel element U-235 content using the Monte Carlo N-Particle (MCNP) code. The k_{eff} values calculated for a D_2O cooled system are 0.268 for partially spent MITR-II fuel and 0.344 for fresh MITR-II fuel. For an H_2O cooled system, the k_{eff} calculated values are 0.514 and 0.618 for partially spent and fresh MITR-II fuel, respectively. Because the k_{eff} predicted is much smaller than unity, a criticality accident is not credible. The criterion of a k_{eff} less than 0.90 was chosen because it is in accordance with TS# 3.10 (4) for fuel storage locations.

Calculations show that the power peaking in the hot channel would be unacceptable if the elements were to be rotated so that fuel plates were facing the MITR. Therefore, administrative procedures will be used to ensure that fuel elements are loaded with an "edge-on" orientation.

Operation of the fission converter without the top shield lid in place is allowed for power levels up to 20 kW. Calculations in the fission converter SER have shown that the estimated dose rate at that power level is 450 mR/h at the coolant surface with a coolant height of 2.4 m. This dose rate is not in excess of those occasionally encountered during certain maintenance operations, and it has been demonstrated that administrative actions can provide adequate controls under such conditions. Adequate controls will be instituted during such experiments to prevent excessive personnel exposure.

6.6.2.2 Maximum Allowed Reactivity Addition from the Converter Control Shutter

Applicability

This specification applies to the reactivity worth of the converter control shutter.

Objective

To ensure that the integrity of the MITR fuel is maintained during operation of the fission converter.

Specification

1. The reactivity worth of the converter control shutter shall be determined in the initial startup testing of the fission converter and verified annually thereafter.
2. The reactivity worth of the converter control shutter shall be in accordance with TS# 6.1.

Basis

MITR Technical Specifications provide several approaches for limiting the reactivity associated with an experimental facility. MITR Technical Specification 6.1 imposes limits depending on whether the experiment is classified as moveable, non-secured, or secured. Accordingly, this approach is used for the fission converter. The reactor's routine controls can be used to negate any reactivity insertion that results from opening of the converter control shutter, provided that the reactivity is less than the limit specified for a movable experiment.

6.6.2.3 Fission Converter Fuel Element Security, Storage, and Handling

Applicability

This specification applies to the security, storage, and handling of the fission converter fuel elements.

Objective

To assure that the fueled elements will be properly stored and handled in a manner to protect the safety of reactor personnel.

Specification

1. All fuel elements used in the fission converter fueled region shall be maintained self-protecting. Calculations or measurements documenting self-protection shall be approved by two licensed SROs.
2. Fission converter fuel elements shall be stored in accordance with the provisions of TS# 3.10(1) and either (2) or (3) as applicable.
3. Prior to transferring an irradiated element from the fission converter tank to the transfer cask, the operating history for the element shall be in compliance with any one of the following three requirements:
   (a) Continuous operation at or below 50 kW for the four days prior to refueling.
   (b) A maximum operating time of 4.8 hours per day at or below 250 kW during the four days prior to refueling.
   (c) A maximum burnup of 436 kWh per fuel element during the four days prior to refueling.

Basis

TS# 3.10(4) specifies that prior to transferring an irradiated element, that fuel element shall not have been operated in the reactor core at a power level above 100 kW for at least four days. This requirement can not be translated directly to the fission converter because of the different numbers of elements in the reactor core and in the fission converter. Alternatively, an equivalent power history is used for the fission converter.

A study was conducted in the SER to calculate the fuel plate temperature during fuel element removal. It was assumed that the fission converter was operated continuously at its maximum operating power of 250 kW until four days prior to removal of the fuel element. During those four days, operation was as described in the specification. It was also assumed that all heat transfer was by radiation alone during the fuel transfer. The maximum clad temperature was calculated to be 313°C which is well below the Al-6061 softening temperature of 450 °C.

6.6.2.4 D_2/H_2 Concentration and Recombiner Operation

Applicability

This specification applies to the D_2 or H_2 gas concentration in the helium cover gas blanket over the fission converter tank, and to the operation of the recombiner system. In the event that the fission converter is operated without its top shield lid, this specification is not applicable.

Objective

To prevent a flammable concentration of either D_2 or H_2 gas in the helium blanket.

Specification

1. The D_2 concentration in the helium blanket shall not exceed 6 volume percent if D_2O is used as the primary coolant in the fission converter.
2. The H_2 concentration in the helium blanket shall not exceed 6 volume percent if H_2O is used as the primary coolant in the fission converter.
3. The recombiner shall be operated for a minimum of 5 hours per month in any month during which the fission converter was operated.
4. In the event that the recombiner is not operable, fission converter operation may be continued provided that D_2/H_2 samples are taken weekly, and that the D_2/H_2 concentration in the helium blanket does not exceed 2 volume percent.

Basis

Recombination of the disassociated D_2/H_2 and O_2 is accomplished by circulating the helium from above the fission converter tank through a recombiner.

The concentration limit of D_2/H_2 in helium blanket is obtained from TS# 3.3(1), in which the concentration is conservatively determined from extrapolation of flammability limits.

6.6.2.5 Fission Converter Safety System

Applicability

This specification applies to the operability of the fission converter safety channels.

Objective

To assure that adequate automatic protective actions are provided by the safety channels during operation of the fission converter.

Specification

1. The fission converter shall not be operated unless the safety channels listed in Table 6.6.2.5-1 are operable.
2. Emergency power with the capacity to operate the equipment listed in Table 6.6.2.5-2 of this specification shall be available whenever the fission converter is operating and shall be capable of operation for at least one hour following a loss of normal power to the facility.
3. There shall be an alarm at 110% or less of the fission converter's nominal operating power for fission converter operation using forced convection. The fission converter's nominal operating power shall be determined in accordance with TS# 6.6.4.8. This alarm shall not exceed 275 kW.
4. There shall be a reactor scram at the reactor power corresponding to the fission converter power 20 kW or less for fission converter operation using natural convection.

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.

Table 6.6.2.5-1 Minimum Required Safety Channels for Fission Converter Operation

Channel	Automatic Action	Setpoint Range	Min. No. Required
Operation with Forced Convection Flow			
Primary Flow Rate	Reactor Scram* and Converter Control Shutter Closure	≥ 45 gpm	1
Power	Converter Control Shutter Closure	≤ 300 kW	1
Outlet Temperature	Converter Control Shutter Closure	≤ 60 °C	1
Coolant Level	Reactor Scram* and Converter Control Shutter Closure	≥ 2.1 m	1
Manual Reactor Minor Scram from the Fission Converter Medical Control Panel	Reactor Scram*	N/A	1
Operation without Forced Convection Flow			
Power	Reactor Scram ** and Converter Control Shutter Closure	≤ 20 kW	1
Outlet Temperature	Converter Control Shutter Closure	≤ 60 °C	1
Coolant Level	Reactor Scram* and Converter Control Shutter Closure	≥ 2.5 m	1
Manual Reactor Minor Scram from the Fission Converter Medical Control Panel	Reactor Scram*	N/A	1

* Not required if fission converter is in either a shutdown or a secured condition.

** For natural convection operation only and not required if fission converter is in either a shutdown or a secured condition.

Table 6.6.2.5-2 Minimum Equipment to be Supplied by Emergency Power

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.	Outlet temperature and coolant level channels listed in Table 6.6.2.5-1.

6.6.2.6 Fission Converter Primary Coolant Quality Requirements

Applicability

This specification applies to the pH, conductivity, and activity of the fission converter primary coolant.

Objective

To control corrosion of the fission converter fuel and primary coolant loop structure, and activation of impurities and leakage of fission products in the fission converter primary coolant.

Specification

1. The pH of the fission converter primary coolant shall be kept between 5.5 and 7.5, except as noted in provision (4) below.
2. The conductivity of the fission converter primary coolant shall be kept less than 5 μmho/cm at 20°C, except as noted in provision (4) below.
3. Any gross β-γ sample activity that exceeds the average of the previous monthly values (normalized by power) by a factor of three or more shall be investigated to determine the cause.
4. Operation of the fission converter with the pH or conductivity outside the limits given in (1) and (2) above is permitted provided:
    a. the pH is between 5.0 and 8.0,
    b. any increase in conductivity is not the result of a chloride ion concentration in excess of 5 ppm,
    c. sampling of the fission converter coolant is done at least once every eight hours, and
    d. the pH band specified in provision (1) is re-established within 48 hours.

    Otherwise, the fission converter shall not be operated.

Basis

The purpose of pH monitoring is to ensure corrosion on the fission converter fuel and the primary coolant loop structure is maintained within an acceptable limit. The fission converter fuel cladding and the fission converter tank are made of aluminum alloy. A portion of the primary coolant loop is constructed of stainless steel. Lower pH will reduce aluminum alloy corrosion and oxide film formation on the fuel surface and higher pH is favored to control stainless steel corrosion. Thus a pH range between 5.5 and 7.5 is selected for the fission converter primary coolant.

Electrical conductivity is also monitored to control purity of the fission converter primary coolant. A conductivity limit of 5 μmho/cm has been traditionally adopted by research reactors.

The criterion that gross β-γ activity three times in excess of the average value be investigated is in accordance with industry practice for the detection of incipient fuel failure. In order for this criterion to be applied with a consistent basis, only samples that have similar power histories should be compared.

Operation with out-of-specification chemistry is acceptable for short intervals. The important factors are pH and the absence of a high chloride concentration. A high conductivity by itself is not of concern.

6.6.3 Fission Converter Surveillance Requirements

Applicability

This specification applies to the surveillance of safety systems whose operation is important to fission converter safety.

Objective

To assure the reliability of the instrumentation important for safe operation of the fission converter.

Specification

1. The following instruments or channels for the fission converter safety system will be tested at least monthly and each time before startup of the reactor if the reactor has been shut down more than 16 hours and if the fission converter facility will be used within that reactor operating period. The monthly requirement may be omitted if the fission converter facility will not be used during that month.

Instrument, Channel, or Interlock	**Functional Test**
Primary coolant flow	Automatic converter control shutter closure and reactor scram
Power level	Automatic converter control shutter closure
Primary coolant outlet temperature	Automatic converter control shutter closure
Fission converter tank coolant level	Automatic converter control shutter closure and reactor scram

2. The following instruments used in the fission converter facility shall be calibrated and trip points verified when initially installed, any time the instrument has been repaired, and at least annually:

a. Neutron flux level channel,

b. Primary coolant flow channel,

c. Primary coolant outlet temperature channel, and

d. Fission converter tank coolant level channel.

3. The neutron flux level channel and a fission converter primary system heat balance shall be checked against each other at least annually and when design changes in the reactor and/or the fission converter are made that may affect the existing calibration result.

4. The pH and gross β-γ activity of the fission converter primary coolant shall be determined at least monthly. The conductivity of the fission converter primary coolant shall be determined either by a continuous on-line instrument or a monthly sample. The tritium content of the coolant shall be determined quarterly if D_2O is used as the fission converter primary coolant.

Basis

The specifications for functional tests, calibrations, and primary coolant sampling adhere to current MITR practice.

The annual frequency for performance of the calorimetric was chosen because the fission converter's power is a function of the MITR's power and the burnup of the fission converter fuel. The latter will occur very slowly. Hence, the annual performance of a calorimetric is sufficient to detect any change in fission converter power production.

Experience with the MITR primary and D_2O systems has shown that an out-of-specification chemistry condition is extremely rare. Heat fluxes present in the fission converter are too low to contribute to fuel cladding degradation in the event of out-of-specification chemistry. Continued operation of the fission converter is thus permitted.

6.6.4 Fission Converter Design Features

Applicability

This specification applies to the design of the fission converter tank, fueled region, and primary coolant system.

Objective

To assure compatibility of the fission converter design features with the present safety evaluation.

Specification

1. The fission converter primary coolant system can utilize either H_2O or D_2O coolant.
2. All materials that are in contact with primary coolant, including those of the converter tank, shall be aluminum alloys, stainless steel, or other materials that are chemically compatible with H_2O and D_2O coolant, except for small non-corrosive components such as gaskets, filters, and valve diaphragms.
3. The fueled region of the fission converter may consist of up to eleven fuel elements of a type described in TS# 5.2(1).
4. The fueled region of the fission converter may contain sample assemblies provided that they conform to the requirements of TS# 6.6.2.1(4). Design of the sample assemblies shall also conform to the following criteria:
    a. they shall be secured either by a mechanical device or by gravity to prevent movement during fission converter operation,
    b. materials of construction shall be radiation resistant and compatible with those used in the fission converter fueled region and primary coolant system,

c. sufficient cooling shall be provided to insure structural integrity of the assembly and to preclude any boiling of the primary coolant, and

d. the size of the irradiation thimble shall be less than 16 square inches in cross section.

5. The removable aluminum block shall be installed in the fission converter tank unless calculations to show compliance with TS# 6.6.2.1 (1), (2), and (6) have been performed for another configuration. Other configurations could include but are not limited to a block of a different material, the absence of the block, or a combination of a solid material and coolant.

6. The pumps and other components of the fission converter's primary cooling system shall be located so as to prevent uncovering of the fission converter fuel elements as a result of siphoning.

7. The following interlocks shall be installed in order to prevent fission converter operations under abnormal conditions:

   a. Interlock that prevents opening of the converter control shutter without the fission converter primary flow scram operable (forced convection operation only).

   b. Interlock that prevents opening of the converter control shutter without the fission converter coolant level scram operable.

   c. Interlock that automatically closes the water and mechanical shutters when the medical room control panel key switch is turned to the OFF position.

   d. Interlock that ensures the CCS will close automatically when the CCS control panel key switch is in the OFF position.

   e. Interlock that prevents startup of the MIT Research Reactor unless the CCS is in the fully closed position.

8. The fission converter's nominal operating power for the given combination of MITR licensed power, fission converter coolant (H_2O or D_2O), and U-235 content

of the fission converter fuel shall be estimated prior to initial use and confirmed during initial use.

Basis

The two materials specifications are in keeping with those imposed on the design of the MITR. The specifications on fuel type and sample assemblies impose the same criteria as used for the MITR.

Design criteria for the sample assemblies were adopted from the existing specification for the MITR in-core sample assemblies TS# 5.2.2.

Removing or replacing the movable aluminum block with other material may cause a different power distribution as well as changing k_{eff}. Therefore, any change in configuration shall be evaluated to show compliance with existing technical specifications.

6.6.5 Reporting Requirements

Applicability

This specification applies to the reporting requirements and the contents of the initial startup tests of the fission converter system.

Objective

To assure that adequate management controls are available for safe operation of the fission converter.

Specification

1. A written report to the Document Control Desk, USNRC, Washington, D.C shall be made within 90 days after completion of the startup testing of the fission converter that is required upon receipt of a new facility license or an amendment to the license authorizing an increase in fission converter power level. This report shall describe the measured values of the operating conditions or characteristics of the reactor under the new conditions, including:
   a. An evaluation of facility performance to date in comparison with design predictions and specifications; and
   b. A reassessment of the safety evaluation submitted with the license application in light of measured operating characteristics when such measurements indicate that there may be substantial variance from prior evaluation.
2. The startup report shall include the following items:
   a. calculation of k-effective for the initial fuel loading,
   b. measurements and comparison to prediction of flow disparity,

c. determination and comparisons to prediction of nuclear hot channel factor, and

d. fission converter power measurements and calibrations.

Amendment No. 31
December 21, 1999