UNITED STATES NUCLEAR REGULATORY COMMISSION

NOTICE OF RENEWAL OF FACILITY OPERATING LICENSE

UNIVERSITY OF MICHIGAN

DOCKET NO. 50-2

The U. S. Nuclear Regulatory Commission (the Commission) has issued Amendment No. 29 to Facility Operating License No. R-28 for the University of Michigan (the licensee) which renews the license for operation of the training and research reactor located in Ann Arbor, Michigan. The facility is a non-power reactor that has been operating at power levels not in excess of two megawatts (thermal). The renewed Operating License No. R-28 will expire twenty years from the date of issuance.

The amended license complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations. The Commission has made appropriate findings as required by the Act and the Commission's rules and regulations in 10 CFR Chapter I. Those findings are set forth in the license amendment. Opportunity for hearing was afforded in the notice of the proposed issuance of this renewal in the Federal Register on January 15, 1985 at 50 FR 2115. No request for a hearing or petition for leave to intervene was filed following notice of the proposed action.

The Commission has prepared a Safety Evaluation Report (NUREG-1138) for the renewal of Facility Operating License No. R-28 and has, based on that report, concluded that the facility can continue to be operated by the licensee without endangering the health and safety of the public.

The Commission also has prepared an Environmental Assessment, dated May 15, 1985, for the renewal of Facility Operating License No. R-28 and has concluded that this action will not have a significant effect on the quality of the human environment. The Notice of Finding of No Significant Environmental Impact was published in the Federal Register on July 26, 1985 at 50 FR 30547.

For further details with respect to this action, see (1) the application for amendment dated November 30, 1984, as supplemented, (2) the Finding of No Significant Environmental Impact, (3) Amendment No. 29 to Operating License R-28, (4) the Commission's related Safety Evaluation Report (NUREG-1138), and (5) the Environmental Assessment. These items are available for public inspection at the Commission's Public Document Room, 1717 H Street, N.W., Washington, D.C. 20555.

Copies of NUREG-1138 may be purchased by calling (202) 275-2060 or (202) 275-2171 or write the Superintendent of Documents, U.S. Government Printing Office, Post Office Box 37082, Washington, D.C. 20013-7982.

Dated at Bethesda, Maryland, this day of .

FOR THE NUCLEAR REGULATORY COMMISSION

Cecil O. Thomas

Cecil O. Thomas, Chief
Standardization & Special
Projects Branch
Division of Licensing

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

ENVIRONMENTAL ASSESSMENT

FOR THE

TRAINING AND RESEARCH REACTOR OF THE

UNIVERSITY OF MICHIGAN

LICENSE NO. R-28

DOCKET NO. 50-2

Description of Proposed Action

This Environmental Assessment is written in connection with the proposed renewal for 20 years of the operating license of the research reactor at the University of Michigan (UM) facility located on the North Campus of the University in Ann Arbor, Michigan, in response to a timely application from the licensee dated November 30, 1984, as supplemented. The proposed action would authorize continued operation of the reactor in the manner that it has been operated since facility license No. R-28 was issued in 1957. Currently, there are no plans to change any of the structures or operating characteristics associated with the reactor during the renewal period requested by the licensee.

Need for the Proposed Action

The operating license for the facility was due to expire in January 1985. The proposed action is required to authorize continued operation so that the facility can continue to be used in the licensee's mission of education and research.

Alternatives to the Proposed Action

As required by Section 102(2)(E) of NEPA (42 U.S.C.A. §4332(2)(E)), the staff has considered possible alternatives to the proposed action. The only reasonable alternative to the proposed action that was considered was not renewing the operating license. This alternative would have led to cessation of operations, with a resulting change in status and a likely small impact on the environment. From the standpoint of environmental impact, there are no appropriate alternatives to the proposed action.

Environmental Impact of Continued Operation

The UM reactor operates in an existing shielded water tank inside an existing single purpose building attached to a multi-purpose building. No new construction is associated with continued operation of the reactor and there is no change in reactor operating conditions or practices. Therefore, this licensing action would lead to no change in the physical environment.

Based on the review of the specific facility operating characteristics that are considered for potential impact on the environment, as set forth in the staff's Safety Evaluation Report (SER)[1] for this action, it is concluded that renewal of this operating license will have an insignificant environmental impact.

Argon-41, a product from neutron irradiation of air during operation, is the principal airborne radioactive effluent from the UM reactor during routine operations. Conservative calculations by the staff, based on the total amount of Ar-41 released from the reactor during a year, predict a maximum potential annual whole body dose of less than 1 millirem in unrestricted areas. Radiation exposure rates measured outside of the reactor facility building are consistent with this computation.

The staff has considered hypothetical credible accidents at the UM reactor and has concluded that there is reasonable assurance that such accidents will not release a significant quantity of fission products from the fuel cladding and, therefore, will not cause significant radiological hazard to the environment or the public.

This conclusion is based on the following:

a) the excess reactivity available under the technical specifications is insufficient to support a reactor transient generating enough energy to cause overheating of the fuel or loss of integrity of the cladding,

b) at a thermal power level of 2 Mw, the inventory of fission products in the fuel cannot generate sufficient radioactive decay heat to cause fuel damage even in the hypothetical event of rapid total loss of coolant, and

c) the hypothetical loss of integrity of the cladding of the maximum irradiated encapsulated fueled experiment will not lead to radiation exposures in the unrestricted environment that exceed guideline values of 10 CFR Part 20.

In addition to the analyses in the SER summarized above, the environmental impact associated with operation of research reactors has been generically evaluated by the staff and is discussed in the attached generic evaluation. This evaluation concludes that there will be no significant environmental impact associated with the operation of research reactors licensed to operate at power levels up to and including 2 MWt and that an Environmental Impact Statement is not required for the issuance of construction permits or operating licenses for such facilities. We have determined that this generic evaluation is applicable to the continued operation of the UM reactor and that there are no special or unique features that would preclude reliance on the generic evaluation.

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1 NUREG-1138, "Safety Evaluation Report Related to the Renewal of the Operating License for the Training and Research Reactor at the University of Michigan.

Agencies and Persons Consulted

The staff has obtained technical assistance from the Los Alamos National Laboratory in performing the safety evaluation of continued operation of the UM facility.

Conclusion and Basis for No Significant Impact Finding

Based on the foregoing considerations, the staff has concluded that there will be no significant environmental impact attributable to this proposed license renewal. Having reached this conclusion, the staff has further concluded that no Environmental Impact Statement for the proposed action need be prepared and that a No Significant Environmental Impact Finding is appropriate.

Dated: May 15, 1985

ENVIRONMENTAL CONSIDERATIONS REGARDING THE LICENSING OF

RESEARCH REACTORS AND CRITICAL FACILITIES

Introduction

This discussion deals with research reactors and critical facilities which are designed to operate at low power levels, 2 MWt and lower, and are used primarily for basic research in neutron physics, neutron radiography, isotope production, experiments associated with nuclear engineering, training and as a part of a nuclear physics curriculum. Operation of such facilities will generally not exceed a 5-day week, 8-hour day, or about 2000 hours per year. Such reactors are located adjacent to technical service support facilities with convenient access for students and faculty.

Sited most frequently on the campuses of large universities, the reactors are usually housed in already existing structures, appropriately modified, or placed in new buildings that are designed and constructed to blend in with existing facilities. However, the environmental considerations discussed herein are not limited to those which are part of universities.

Facility

There are no exterior conduits, pipelines, electrical or mechanical structures or transmission lines attached to or adjacent to the facility other than for utility services, which are similar to those required in other similar facilities, specifically laboratories. Heat dissipation is generally accomplished by use of a cooling tower located on the roof of the building. These cooling towers typically are on the order of 10' x 10' x 10' and are comparable to cooling towers associated with the air-conditioning systems of large office buildings.

Make-up for the cooling system is readily available and usually obtained from the local water supply. Radioactive gaseous effluents are limited to Ar-41 and the release of radioactive liquid effluents can be carefully monitored and controlled. Liquid wastes are collected in storage tanks to allow for decay and monitoring prior to dilution and release to the sanitary sewer system. Solid radioactive wastes are packaged and shipped offsite for storage at NRC-approved sites. The transportation of such waste is done in accordance with existing NRC-DOT regulations in approved shipping containers.

Chemical and sanitary waste systems are similar to those existing at other similar laboratories and buildings.

Environmental Effects of Site Preparation and Facility Construction

Construction of such facilities invariably occurs in areas that have already been disturbed by other building construction and, in some cases, solely within an already existing building. Therefore, construction would not be expected to have any significant effect on the terrain, vegetation, wildlife or nearby waters or aquatic life. The societal, economic and esthetic impacts of construction would be no greater than those associated with the construction of a large office building or similar research facility.

Environmental Effects of Facility Operation

Release of thermal effluents from a reactor of less that 2 MWt will not have a significant effect on the environment. This small amount of waste heat is generally rejected to the atmosphere by means of small cooling towers. Extensive drift and/or fog will not occur at this low power level.

Release of routine gaseous effluents can be limited to Ar-41, which is generated by neutron activation of air. Even this will be kept as low as practicable by using gases other than air for supporting experiments. Yearly doses to unrestricted areas will be at or below established guidelines in 10 CFR 20 limits. Routine releases of radioactive liquid effluents can be carefully monitored and controlled in a manner that will ensure compliance with current standards. Solid radioactive wastes will be shipped to an authorized disposal site in approved containers. These wastes should not require more than a few shipping containers a year.

Based on experience with other research reactors, specifically TRIGA reactors operating in the 1 to 2 MWt range, the annual release of gaseous and liquid effluents to unrestricted areas should be less than 30 curies and 0.01 curies, respectively.

No release of potentially harmful chemical substances will occur during normal operation. Small amounts of chemicals and/or high-solid content water may be released from the facility through the sanitary sewer during periodic blowdown of the cooling tower or from laboratory experiments.

Other potential effects of the facility, such as esthetics, noise, societal or impact on local flora and fauna are expected to be too small to measure.

Environmental Effects of Accidents

Accidents ranging from the failure of experiments up to the largest core damage and fission product release considered possible result in doses that are less than 10 CFR Part 20 guidelines and are considered negligible with respect to the environment.

Unavoidable Effects of Facility Construction and Operation

The unavoidable effects of construction and operation involve the materials used in construction that cannot be recovered and the fissionable material used in the reactor. No adverse impact on the environment is expected from either of these unavoidable effects.

Alternatives to Construction and Operation of the Facility

To accomplish the objectives associated with research reactors, there are no suitable alternatives. Some of these objectives are training of students in the operation of reactors, production of radioisotopes, and use of neutron and gamma ray beams to conduct experiments.

Long-Term Effects of Facility Construction and Operation

The long-term effects of research facilities are considered to be beneficial as a result of the contribution to scientific knowledge and training. Because of the relatively small amount of capital resources involved and the small impact on the environment, very little irreversible and irretrievable commitment is associated with such facilities.

Costs and Benefits of Facility Alternatives

The costs are on the order of several millions of dollars with very little environmental impact. The benefits include, but are not limited to, some combination of the following: conduct of activation analyses, conduct of neutron radiography, training of operating personnel and education of students. Some of these activities could be conducted using particle accelerators or radioactive sources which would be more costly and less efficient. There is no reasonable alternative to a nuclear research reactor for conducting this spectrum of activites.

Conclusion

The staff concludes that there will be no significant environmental impact associated with the licensing of research reactors or critical facilities designed to operate at power levels of 2 MWt or lower and that no environmental impact statements are required to be written for the issuance of construction permits or operating licenses for such facilities.

APPENDIX A

TO FACILITY LICENSE R-28

TECHNICAL SPECIFICATIONS

DOCKET 50-2

MICHIGAN MEMORIAL PHOENIX PROJECT

THE UNIVERSITY OF MICHIGAN

ANN ARBOR, MICHIGAN

JULY 1985

TECHNICAL SPECIFICATIONS
Ford Nuclear Reactor
Docket 50-2, License R-28
November, 1984

Contents

1.0 DEFINITIONS

Channel Calibration - A channel calibration is an adjustment of the channel such that its output corresponds with acceptable accuracy to known values of the parameter which the channel measures. Calibration shall encompass the entire channel, including equipment actuation, alarm, and trip, and shall be deemed to include the channel test.

Channel Check - A channel check is a qualitative verification of acceptable performance by observation of channel behavior. This verification where possible shall include comparison of the channel with other independent channels or systems measuring the same variable.

Channel Test - A channel test is the introduction of a signal into the channel to verify that it is operating.

Experiment - An experiment, as used herein, is any of the following:

(1) An activity utilizing the reactor system or its components or the neutrons or radiation generated therein;

(2) An evaluation or test of a reactor system operational, surveillance, or maintenance technique;

(3) An experimental or testing activity which is conducted within the confinement or containment system of the reactor;

(4) The material content of any of the foregoing, including structural components, encapsulation or confining boundaries, and contained fluids or solids.

Experimental Facility - An experimental facility is any structure or device which is intended to guide, orient, position, manipulate, or otherwise facilitate a multiplicity of experiments of similar character.

Explosive Material - Explosive material is any solid or liquid which is categorized as a severe, dangerous, or very dangerous explosion hazard in DANGEROUS PROPERTIES OF INDUSTRIAL MATERIALS by N.I. Sax, Third Ed. (1968), or is given an Identification of Reactivity (Stability) Index of 2,3, or 4 by the National Fire Protection Association in its publication 704-M, 1966.

Limiting Conditions for Operation (LCO) - Lowest functional capability or performance levels of equipment required for safe operation of the reactor (10CFR50.36).

Limiting Safety System Setting (LSSS) - Settings for automatic protective devices related to those variables having significant safety functions, and chosen so that automatic protective action will correct an abnormal situation before a safety limit is exceeded (10CFR50.36).

Measured Value - The measured value of a process variable is the value of the variable as indicated by a measuring channel.

Measuring Channel - A measuring channel is the combination of sensor, amplifiers, and output devices which are used for the purpose of measuring the value of a process variable.

Moveable Experiment - A moveable experiment is one which may be inserted, removed, or manipulated while the reactor is critical.

Operable - Operable means that a component or system is capable of performing its intended function in its normal manner.

Operating - Operating means that a component or system is performing its intended function in its normal manner.

Potential Reactivity Worth of an Experiment - The potential reactivity worth of an experiment is the maximum absolute value of the reactivity change that would occur as a result of intended or anticipated changes or credible malfunctions that alter equipment position or configuration.

Reactivity Limits - The reactivity limits are those limits imposed on reactor core excess reactivity. Quantities are referenced specifically to a cold core (nominally 90 F) with the effect of xenon poisoning on core reactivity accounted for if greater than or equal to 0.05% Delta K/K. The reference core condition will be known as the cold, xenon free critical condition.

Reactor Operation - Reactor operation means that the control rods installed in the core are not fully inserted or that the control console key is in the keyswitch. Reactor operation is not considered possible when there are less than six fuel elements loaded on the grid plate.

Reactor Safety System - The reactor safety system is that combination of safety channels and associated circuitry which forms the automatic protective system for the reactor or provides information which requires manual protective action to be initiated.

Reactor Scram - Shutoff of electrical current to the rod holding magnets and subsequent insertion of the rods into the core by gravity.

Reactor Secured - Reactor Secured is defined as follows:

(1) The full insertion of all control rods has been verified;

(2) The control console key is removed; and

(3) No operation is in progress which involves moving fuel elements to or from the core, moving reflector elements to or from the core, the insertion or removal of secured experiments from the core, or control rod maintenance.

Readily Available on Call - Readily available on call shall mean a licensed senior operator shall insure that he can be contacted and is within a reasonable driving time (1/2 hour) from the reactor building when the reactor is being operated by a licensed operator.

Regulating Rod - The regulating rod is a control rod of low reactivity worth fabricated from stainless steel and used to control reactor power. The rod may be controlled by the operator with a manual switch or by an automatic controller.

Removable Experiment - A removable experiment is any experiment, experimental facility, or component of an experiment, other than a permanently attached appurtenance to the reactor system, which can reasonably be anticipated to be moved one or more times during the life of the reactor.

Reportable Occurrence - A reportable occurrence is any of the following:

(1) A safety system setting less conservative than the limiting setting established in the Technical Specifications;

(2) Operation in violation of a limiting condition for operation established in the Technical Specifications;

(3) A safety system component malfunction or other component or system malfunction which could, or threatens to, render the safety system incapable of performing its intended safety functions;

(4) Release of fission products from a failed fuel element;

(5) An uncontrolled or unplanned release of radioactive material from the restricted area of the facility;

(6) An uncontrolled or unplanned release of radioactive material which results in concentrations of radioactive materials within the restricted area in excess of the limits specified in Appendix B, Table 1 of 10CFR20;

(7) An uncontrolled or unanticipated change in reactivity in excess of 0.005 delta K/K;

(8) Conditions arising from natural or man made events that affect or threaten to affect the safe operation of the facility;

(9) An observed inadequacy in the implementation of administrative or procedural controls such that the inadequacy causes or threatens to cause the existence or development of an unsafe condition in connection with the operation of the faciltiy.

Rundown - A rundown is the automatic insertion of the shim safety rods.

Safety Channel - A safety channel is a measuring channel in the reactor safety system.

Safety Limit (SL) - Limits upon important process variables which are found to be necessary to reasonably protect the integrity of certain of the physical barriers that guard against the uncontrolled release of radioactivity (10CFR50.36).

Secured Experiment - Any experiment, experimental facility, or component of an experiment is deemed to be secured, or in a secured position, if it is held in a stationary position relative to the reactor by mechanical means. The restraint shall exert sufficient force on the experiment to overcome the expected effects of hydraulic, pneumatic, buoyant, or other forces which are normal to the operating environment of the experiment, or of forces which might arise as a result of credible malfunctions.

Shim Safety Rod - A shim safety rod is a control rod fabricated from borated stainless steel which is used to compensate for fuel burnup, temperature, and poison effects. A shim safety rod is magnetically coupled to its drive unit allowing it to perform the function of a safety rod when the magnet is deenergized.

Static Reactivity Worth - The static reactivity worth of an experiment is the absolute value of the reactivity change which is measurable by calibrated control rod comparison methods between two defined terminal positions or configurations of the experiment. For moveable experiments, the terminal positions are fully removed from the reactor and fully inserted or installed in the normal functioning or intended position.

Time Intervals

Annually - 12 to 15 months.

Biannually - 24 to 30 months.

Daily - 24 to 32 hours.

Monthly - 30 to 40 days.

Quarterly - 3 to 4 months.

Semiannually - 6 to 8 months.

Weekly - 7 to 10 days.

True Value - The true value of a process variable is its actual value at any instant.

Unscheduled Shutdown - An unscheduled shutdown is defined as any unplanned shutdown of the reactor caused by actuation of the reactor safety system, operator error, equipment malfunction, or a manual shutdown in response to conditions which could adversely affect safe operation, not to include shutdowns which occur during testing or checkout operations.

2.0 SAFETY LIMITS AND LIMITING SAFETY SYSTEM SETTINGS

2.1 Safety Limits

2.1.1 Safety Limits in the Forced Convection Mode

Applicability:

This specification applies to the interrelated variables associated with core thermal and hydraulic performance in the steady state with forced convection flow. These variables are:

Reactor Thermal Power, P
Reactor Coolant Flow Through the Core, m
Reactor Coolant Inlet Temperature, Ti
Height of Water Above the Top of the Core, H

Objective:

To assure that the integrity of the fuel clad is maintained.

Specification:

(1) The true value of reactor power (P) shall not exceed 4.68 Mw and the true value of flow (m) shall not be less than 900 gpm.

(2) The true value of reactor coolant inlet temperature (T_i) at 2 Mw shall not exceed 116 F.

(3) The true value of water height above the core (H) shall not be less than 18 feet while the reactor is operating.

Bases:

The basis for forced convection safety limits is that the calculated maximum cladding temperature in the bottom of the hot channel of the most compact FNR core (25 elements) will not reach the boiling point of the water coolant.

2.1.2 Safety Limits in the Natural Convection Mode

Applicability:

This specification applies to the interrelated variables associated with core thermal and hydraulic performance in the natural convection mode of operation. These variables are:

Reactor Thermal Power, P
Reactor Coolant Inlet Temperature, Ti
Height of Water Above the Top of the Core, H

Objective:

To assure that the integrity of the fuel clad is maintained.

Specification:

(1) The true value of the reactor thermal power (P) shall not exceed 380 kw.

(2) The true value of the reactor coolant inlet temperature (T_i) shall not exceed 131 F.

(3) The height of pool water above the core (H) shall not be less than 18 feet.

Bases:

The basis for natural convection safety limits is that the calculated maximum cladding temperature in the hot channel of the most compact FNR core (25 elements) will not reach the boiling point of the water coolant at a depth of 18 feet.

2.2 Limiting Safety System Settings (LSSS)

2.2.1 Limiting Safety System Setting in the Forced Convection Mode

Applicability:

This specification applies to the set points for the safety channels monitoring reactor thermal power (P), primary coolant flow (m), height of water above the top of the core (H), and core exit temperature (T_e).

Objective:

To assure that automatic protective action is initiated to prevent a safety limit from being exceeded.

Specification:

(1) The limiting safety system settings for reactor thermal power (P), primary coolant flow through the core (m), height of water above the top of the core (H), and reactor coolant exit temperature (T_e) shall be as follows:

Variable	LSSS
P (Max)	2.4 Mw
m (Min)	900 gpm
H (Min)	19 ft
T_e (Max)	129 F

Bases:

The limiting safety system settings for forced convection assure that automatic protective action will correct the most severe abnormal situation anticipated before a safety limit is exceeded.

2.2.2 Limiting Safety System Settings in the Natural Convection Flow Mode

Applicability:

These specifications apply to the setpoint for the safety channels monitoring reactor thermal power (P), pool water level (H), and pool water temperature (T).

Objective:

To assure that automatic protective action is initiated to prevent a safety limit from being exceeded.

Specifications:

(1) The limiting safety system setting for reactor thermal power (P), height of water above the top of the core (H), and pool water temperature (T) shall be as follows:

Variables	LSSS
P (Max)	100 kw
H (Min)	19 ft
T (Max)	129 F

Bases:

The limiting safety system settings for natural convection assure that automatic protective action will correct the most severe abnormal situation anticipated before a safety limit is exceeded.

3.0 LIMITING CONDITIONS FOR OPERATION

3.1 Reactivity Limits

Applicability:

This specification applies to the reactivity of the reactor core and to the reactivity worths of control rods and experiments. When the reactor is operated with the heavy water reflector tank in place, the limits will not include the static reactivity worth of the tank.

Objective:

To assure that the reactor can be controlled and shutdown at all times and that the safety limits will not be exceeded.

Specification:

(1) The shutdown margin relative to the cold, xenon free critical condition shall be at least .025 delta K/K with all three shim safety rods fully inserted and the regulating rod fully withdrawn and 0.0045 delta K/K with the most reactive shim safety rod and the regulating rod fully withdrawn.

(2) The overall core excess reactivity including moveable experiments shall not exceed 0.038 delta K/K.

(3) The total reactivity worth of all experiments shall not exceed 0.012 delta K/K.

(4) The reactivity worth of each experiment shall be limited as follows:

Experiment	Maximum Reactivity Worth
Moveable	0.0012 delta K/K
Secured	0.012 delta K/K

(5) The reactor shall be subcritical by at least 0.03 delta K/K during fuel loading changes.

(6) Shim safety rods shall not be removed from the core for inspection if the shutdown margin is less than 0.01 delta K/K with the most reactive remaining shim safety rod fully withdrawn.

(7) The reactivity worth of the regulating rod shall not exceed 0.006 delta K/K.

(8) Experiments which could increase reactivity by flooding, shall not remain in or adjacent to the core unless the shutdown margin required in Specification 3.1.(1) would be satisfied after flooding.

Bases:

The shutdown margin required by Specification 3.1.(1) assures that the reactor can be shutdown from any operating condition and will remain subcritical after cooldown and xenon decay even if the rod of the highest reactivity worth should be in the fully withdrawn position.

Specification 3.1.(2) limits the allowable excess reactivity to the value necessary to overcome the combined negative reactivity effects of: (1) an increase in primary coolant temperature from 90 F to 116 F; (2) fission product xenon and samarium buildup in a clean core; (3) power defect due to increasing from a zero power, cold core to a 2 Mw, hot core; (4) fuel burnup during sustained operation for 30 days; and (5) moveable experiments.

Specification 3.1.(3) limits the reactivity worth of experiments to values of reactivity which, if introduced as positive step changes, will not cause fuel melting.

Specification 3.1.(4) limits the individual reactivity worth of experiments to values that will not produce a stable period of less than 30 seconds and which can be compensated for by the action of the control and safety systems without exceeding any safety limits.

Specifications 3.1.(5) and 3.1.(6) provide assurance that the core will remain subcritical during fuel loading changes and shim safety rod maintenance or inspection.

Specification 3.1.(7) assures that failure of the automatic control system will not introduce sufficient excess reactivity to produce a prompt critical condition.

Specification 3.1.(8) assures that the shutdown margin required by Specification 3.1.(1) will be met in the event of a positive reactivity insertion caused by the flooding of an experiment.

3.2 Reactor Safety System

Applicability:

These specifications apply to the reactor safety system and other safety related instrumentation.

Objective:

To specify the lowest acceptable level of performance or the minimum number of acceptable components for the reactor safety system and other safety related instrumentation.

Specification:

The reactor shall not be made critical unless:

(1) The reactor safety systems and safety related instrumentation are operable in accordance with Tables 3.1 and 3.2 including the minimum number of channels and the indicated maximum or minimum setpoints;

(2) All shim safety rods are operable;

(3) The time from the initiation of a scram condition in the scram circuit until the shim safety rods are fully inserted (release-drop time) shall not exceed 500 milliseconds;

(4) Mechanical devices are installed which prevent the lifting of fuel elements through the movement of control rods.

Bases:

Neutron flux level scrams provide redundant automatic protective action to prevent exceeding the safety limit on reactor power. The period scram limits the rate of rise of the reactor power to periods which are manually controllable without reaching excessive power levels or fuel temperatures.

Power-flow coincident scrams provide redundant channels to assure that an automatic loss of flow scram will occur in the event of a loss of flow when the reactor is operating at power levels above 100 kw.

The rod withdrawal interlock on the Log Count Rate channel assures that the operator has a measuring channel operating and indicating neutron flux levels during the approach to criticality.

The core exit temperature auto rundown function and response of the operator to the pool level alarm assure that the reactor will not be operated above the safety limit for core inlet temperature and below the safety limit for pool level.

Table 3.1

REQUIRED SAFETY CHANNELS

Channel	Setpoint	Minimum Number Required	Function
Log Count Rate	2 cps	1	Rod Withdrawal Interlock
Log N Period		1	Wide range power level and input for period scram
Period Safety	5 sec	1	Scram
Level Safety	120%(2.4 Mw)	2	Scram
High Power/No Water Flow	(a) 900 gpm (b) holdup tank isolation valve not fully open (c) holdup tank static pressure 1 psig below full power value	1	Scram $\geq$100 kw
High Power/ Header Down		1	Scram $\geq$100 kw
Header Up/ No Water Flow	900 gpm	1	Scram
Building Exhaust Radiation Level	1 mr/hr	1	Scram
Building Alarm Manual Switch		1	Scram
Manual Scram Switch		1	Scram
Magnet Power Keyswitch		1	Scram
Reactor Coolant Exit Temp.	129 F	1	Auto Rundown
Pool Level	1 foot below pool overflow	1	Auto Rundown
Bridge Not Clamped	When clamps released	1	Scram

Table 3.2

Required Safety Related Instrumentation

Instrumentation	Setpoint	Minimum Number Required	Function
Linear Level Channel	As Required	1	Linear power level measurement and input for the automatic control mode
Power Level Deviation Interlock	95% of control point setting	1	Return reactor to manual control mode if setpoint is reached
Reactor Coolant Inlet Temperature	Not Applicable	1(a)	Provide information for the heat balance determination
Facility Radiation Monitor System (b)			
1. Building Air Exhaust	1(1) mr/hr	1	Alarm, scram, initiate confinement evacuation
2. Reactor Bridge	30(50) mr/hr	1	Alarm
3. NW Column, Beamport Floor	10(50) mr/hr	1(c)	Alarm
4. N Wall, Beamport Floor	5(50) mr/hr	1(c)	Alarm
5. NE Column, Beamport Floor	2(50) mr/hr	1(c)	Alarm
6. Primary Demineralizer (Hot DI)	20(50) mr/hr	1(c)	Alarm

(a) Not required for natural convection operation.

(b) The facility radiation monitoring system consists of 6 radiation detectors which alarm and read out locally, and are recorded in the control room. The normal setpoints for this system are shown. The value in parentheses is the maximum

Table 3.2

Required Safety Related Instrumentation (continued)

setpoint which will be used depending on local conditions. Use of higher than normal setpoints will require approval of the Reactor Manager or the Assistant Reactor Manager. Any reactor staff member may adjust a setpoint lower than the normal value.

(c) Of the detectors labelled 3-6, any one unit may be out of service for a period not to exceed 7 days without requiring reactor shutdown or replacement by a locally alarming monitor with similar range. Should a second of these units require repair, such repair must be completed within 24 hours or the reactor must be shutdown or replacement of the second unit with a locally alarming monitor of similar range is required.

The manual scram button and the magnet power keyswitch provide two methods for the reactor operator to manually shutdown the reactor if an unsafe or abnormal condition should occur and the automatic reactor protection does not function.

The use of the area radiation monitor system assures that areas of the facility in which a high radiation area could exist are monitored.

Specifications 3.2.(2) and 3.2.(3) assure that the safety system response will be appropriate.

3.3 FNR Confinement Building

Applicability:

This specification applies to the FNR confinement building requirements.

Objective:

To minimize the release of airborne radioactive materials from the FNR.

Specification:

(1) The ventilation intake and exhaust dampers, the intake and exhaust ventilating fans, and the dampers in the beamport exhaust system and the room 3103 exhaust hood duct shall automatically close when the radiation level in the building ventilation exhaust duct is 1 millirem/hour or more.

(2) During reactor operation, the following conditions will be administratively controlled:

   a. Personnel access doors will be closed except as necessary for the passage of personnel and/or equipment;

   b. The main equipment access door onto the beamport floor will be opened only long enough to permit the passage of equipment;

   c. The personnel door to the cooling tower area will remain clamped except to permit the passage of personnel and/or equipment to the cooling tower area. The door will remain closed but not clamped until all personnel have left the cooling tower area;

d. The access hatch from grade level to the beamport floor will be sealed closed;

e. The personnel exit door located in the north wall of the building and the door located on the beamport floor which connects to the PML hot cave operating area will be clamped closed.

Bases:

The potential radiation exposure to persons at the operations boundary following an accident releasing fission products within the confinement building has been evaluated. The evaluation used a leakage rate from the confinement building of 10% of the building volume per day, and concluded that the accident doses would be acceptable. Conformance to Specifications 3.3.(1) and 3.3.(2) will assure that the building leak rate will not exceed the leak rate used in the evaluation.

The 1.0 mr/hr setpoint for the facility exhaust radiation monitor provides a mechanism for isolating the building ventilation system in the event of a significant release of radioactive material into the reactor building. This setpoint, for the detector location involved, represents a gamma emitting nuclide concentration of 10^{-3} to 10^{-4} microcuries/cc of building air.

By requiring that the access doors and equipment hatch remain closed, except for brief, attended periods to permit personnel or equipment passage, the integrity of the confinement will be maintained at or below the value assumed in the Hazards Summary Report, and the release of radioactive material will be minimized.

3.4 Primary Coolant Conditions

Applicability:

This specification applies to the limiting conditions for available pool water volume, primary coolant pH, resistivity, radioactivity, and flow distribution.

Objective:

To maintain the primary coolant in a condition to minimize the corrosion of the primary coolant system, fuel clad, and other reactor components, and to assure proper conditions of coolant for normal and emergency requirements.

Specification:

(1) The primary coolant pH shall be maintained between 4.5 and 7.5.

(2) The primary coolant resistivity shall be maintained at a value greater than 200,000 ohm-cm except for periods of time not to exceed 7 days when the resistivity may not be less than 50,000 ohm-cm.

(3) For operation at power levels in excess of 100 kw in the forced convection mode, all grid positions shall contain fuel elements, reflector elements, grid plugs or experimental facilities.

(4) For operation at powers in excess of 1 Mw, the pool gate must be in its storage location.

Bases:

Experience at this and other facilities has shown that the maintenance of primary coolant system water quality in the ranges specified in Specification 3.4.(1) and 3.4.(2) will control the corrosion of the aluminum components of the primary coolant system and the fuel element cladding.

The requirement that all grid positions be occupied will prevent the degradation of flow rates due to flow bypassing the active fueled region through an unoccupied grid plate position.

The requirement that the gate be stored assures that the full volume of the pool water is available to provide cooling of the core during normal operation and in the event of a loss of coolant accident.

3.5 Heavy Water Reflector Tank

Applicability:

This specification applies to the heavy water reflector tank used in the reactor core.

Objective:

To assure that heavy water handling in the heavy water reflector tank does not jeopardize facility and personnel safety.

Specification:

(1) The shutdown margin for the core shall not be less than 0.10 delta K/K whenever heavy water movements which can result in positive reactivity insertions are undertaken.

(2) The tritium content of the heavy water reflector tank shall be no greater than 50 curies.

Bases:

The largest positive reactivity increase that can be produced by replacing light water with heavy water in the heavy water reflector tank is 0.04 delta K/K. Maintaining the reactor shutdown margin at no less than 0.10 delta K/K during heavy water transfers provides adequate margin to assure that the reactor will remain subcritical during heavy water transfers that could add positive reactivity.

The 50 curie limit imposed on the tritium content of the heavy water reflector tank in Specification 3.5.(2) assures that offsite concentrations of tritium in the event of a tank rupture will not exceed the limit established in 10CFR20 for tritium releases to uncontrolled areas.

3.6 **Airborne Effluents**

Applicability:

This specification applies to the monitoring of airborne effluents from the FNR.

Objective:

To assure that containment integrity is maintained during reactor operation and that the release of airborne radioactive material from the FNR is maintained below the limits established in 10CFR20.

Specification:

(1) The concentration of radioactive materials in the effluent released from the facility exhaust stacks shall not exceed 400 times the concentrations specified in 10CFR20, Appendix B, Table II, when averaged over time periods permitted by 10CFR20.

(2) During operation of the reactor, the following conditions shall be met:

a. The particulate activity monitor and the gaseous activity monitor for the facility exhaust stacks shall be operating. If either unit is to be out of service for more than 24 hours, either the reactor shall be shutdown or the unit shall be replaced by one of comparable monitoring capability;

b. The particulate activity monitor and the gaseous activity monitor for the reactor building shall be operating. Temporary shutdown of these units shall be limited as in specification 3.6.(2).a above;

c. The building exhaust air radiation monitor shall be operating whenever the reactor is in operation as required by Table 3.2 of specification 3.2.

Bases:

The limits established in specification 3.6.(1) incorporate a dilution factor of 400 for effluents released through the exhaust stacks. This dilution factor was calculated from actual FNR site meteorological data and represents the lowest dispersion factor determined and the highest frequency of wind in any sector. Because of the use of the most conservative measured values of wind directional frequency and dispersion factors, this dilution factor will assure that concentrations of radioactive material in unrestricted areas around the FNR site will be far below the limits of 10CFR20.

The requirements of specification 3.6.(2) are considered adequate to assure proper airborne effluent monitoring.

3.7 Liquid Effluents

Applicability:

This specification applies to the monitoring of radioactive liquid effluents from the FNR.

Objectives:

The objective is to assure that exposure to the public resulting from the release of liquid effluents will be minimized.

Specification:

(1) The concentration of radioactive materials in the effluent released from the facility liquid waste system to the city of Ann Arbor sanitary sewer system shall not exceed the concentrations specified in 10CFR20 for releases to sanitary sewer systems.

(2) The amount of liquid discharged shall be limited to the equivalent of 3,000 gallons of liquid at the concentration limit specified in 3.7(1) each day.

(3) Liquids from the facility's radioactive liquid waste system shall not be discharged into the storm drain system.

Bases:

All radioactive liquid effluents are collected in a series of three, 3,000 gallon, coated, steel retention tanks. The liquid waste in the tanks is sampled and analyzed before discharge. When the concentration is less than the limit of 10CFR20, it is discharged to the sanitary sewer system.

Current experience requires discharges of less than 50 tanks per year. During 1970, the North Campus water released into the sanitary sewer system averaged 946,000 gallons per day. This provides a daily dilution factor of 315 for a 3,000 gallon waste tank, which assures that there will be no significant exposure to the public from radioactive waste discharged to the sanitary sewer system.

3.8 **Limitations of Experiments**

Applicability:

This specification applies to experiments installed in the FNR.

Objective:

To prevent damage to the reactor or excessive release of radioactive materials in the event of an experiment failure.

Specification:

(1) Each experiment shall be designed so that the surface temperature shall be below the temperature calculated for the inception of nucleate boiling. Prior to insertion in the reactor, any capsule which is expected to operate with an internal pressure in excess of one atmosphere shall be tested at a pressure twice the calculated maximum pressure.

(2) All experiments which are in contact with reactor coolant shall be either corrosion resistant or encapsulated within corrosion resistant containers.

(3) Explosive materials shall not be placed in the reactor pool.

(4) Neutron radiography of explosives shall be conducted with the explosives contained in a blast proof irradiation container, a prototype of which has been successfully tested and demonstrated not to fail by detonation of at least twice the amount of explosive to be irradiated.

(5) The radioactive material content, including fission products, of any singly encapsulated experiment should be limited so that the complete release of all gaseous, particulate, and volatile components from the encapsulation could not result in doses in excess of 10% of the equivalent annual doses stated in 10CFR20. This dose limit applies to persons occupying unrestricted areas continuously for two hours starting at time of release and restricted areas during the length of time required to evacuate the restricted area.

(6) The radioactive material content, including fission products, of any doubly encapsulated experiment should be limited so that the complete release of all gaseous, particulate, or volatile components from the encapsulation could not result in doses in excess of the equivalent annual doses stated in 10CFR 20. This dose limit applies to persons occupying unrestricted areas continuously for two hours starting at the time of release and restricted areas during the length of time required to evacuate the restricted area.

Bases:

Specifications 3.8.(1) through 3.8.(4) are intended to reduce the likelihood of damage to reactor components and radioactivity releases resulting from experiment failure and serve as a guide for the review and approval of new and untried experiments by faciltiy personnel and the Safety Review Committee.

Neutron radiography is conducted in a vertical beam tube and at horizontal beamports that terminate at the heavy water reflector tank adjacent to the reactor core. In the radiography of explosives, the explosive devices will be contained, during

exposure, inside a blast proof enclosure. The enclosure will not be coupled to the beamtube or beamport and will be constructed to fully contain any blast effects or missiles which might be generated by an accidental detonation.

Specifications 3.8.(5) and 3.8.(6) conform to the regulatory position put forth in Regulatory Guide 2.2 issued November, 1973. The calculations for experiment radioactivity limits are provided in section 14.3 of the SAFETY ANALYSIS.

3.9 **Fission Density Limit**

Applicability:

This specification applies to fission density limits in FNR fuel.

Objective:

To prevent fuel plate swelling which could result in clad rupture and release of radioactive fission products.

Specification:

(1) The FNR fission density limit shall be 1.5×10^{21} fission/cc.

Bases:

The fission density limit is below operational fission densities reached in other operating reactors using the same kind of fuel without failures attributed to the fuel.

An experimental data base which supports the safe use of UAl_x and U_3O_8 fuel in the FNR up to the fission density was derived from irradiation tests performed in the Materials Test Reactor (MTR), the Engineering Test Reactor (ETR), and the Advance Test Reactor (ATR) at the Idaho National Engineering Laboratory, the High Flux Isotope Reactor (HFIR) at the Oak Ridge National Laboratory, and the German Karlsruhe FR2 reactor.

4.0 SURVEILLANCE REQUIREMENTS

4.1 Reactivity Limits

Applicability:

This specification applies to the surveillance requirements for reactivity limits.

Objective:

To assure that the reactivity limits of Specification 3.1 are not exceeded.

Specification:

(1) Shim safety rod reactivity worths shall be measured:

a. Not less than once each calendar year;

b. Whenever the fuel elements in more than three interior core locations are replaced;

c. Whenever the replacement of a fuel element in an interior core location results in an element fuel mass change of more than 10% in that location;

d. Whenever the addition of more than three standard fuel elements to an outer face of the core is made to achieve the desired excess reactivity for the operation of the reactor.

(2) Shim safety rods shall be visually inspected and put through a jig to check for swelling at least annually.

(3) The reactivity worth of those experiments whose safety review indicates a need for such a determination shall be measured prior to the experiment's initial use. That worth shall be verified if core configuration changes occur which could reasonably be expected to cause increases in experiment reactivity worth whereby the experiment worth could exceed the values specified in Specification 3.1.

Bases:

Specification 4.1.(1) will assure that shim-safety rod reactivity worths are not degraded or changed by core arrangements.

Shim safety rod inspections are the single, largest source of radiation exposure to facility personnel. Futhermore, frequent inspections of shim safety rods for swelling over the last ten years have produced no evidence of swelling or cracking. In order to minimize personnel radiation exposure and provide an inspection frequency that will detect early evidence of swelling and cracking, an annual inspection interval was selected for specification 4.1.(2).

The specified surveillance relating to the reactivity worth of experiments will assure that the reactor is not operated for extended periods before determining the reactivity worth of experiments. This specification also provides assurance that experiment reactivity worths do not increase beyond the established limits due to core configuration changes.

4.2 Reactor Safety System

Applicability:

This specification applies to the surveillance of the reactor safety system.

Objective:

To assure that the reactor safety system is operable as required by Specification 3.2.

Specification:

(1) A channel test of the neutron flux level safety channels, period safety channel, log count rate channels, and power-flow coincidence scrams shall be performed:

a. Prior to each reactor startup following a period when the reactor was secured;

b. After a channel has been repaired or deenergized.

(2) A channel calibration of the safety channels listed in Table 3.1, which can be calibrated, shall be performed at least once each calendar year.

(3) A channel check of the neutron flux level safety channels during reactor operation comparing the channel outputs with a heat balance, shall be performed shortly after reaching operating power level and weekly thereafter if the reactor is to be operated at a thermal power level above 500 kw.

(4) The operation of the radiation monitoring system required in Specification 3.2 shall be verified prior to every reactor startup for which safety system channel tests are required as in 4.2.(1). If the system has been repaired, an operation and setpoint verification will be performed prior to use.

(5) The radiation monitor system required in Specification 3.2 shall be calibrated not less than once every six months.

(6) Shim safety rod release-drop time shall be measured not less than once each calendar year.

(7) Shim safety rod release-drop time shall be measured whenever the shim safety rod's core location is changed or whenever maintenance is performed which could effect the rod's drop time.

Bases:

Prestartup tests of the safety system channels assure their operability. Annual calibration detects any long term drift that is not detected by normal intercomparison of channels. The channel check of the neutron flux level channels assures that the detectors are properly adjusted to accurately monitor the parameter they are measuring.

Radiation monitors are checked for proper operation in Specification 4.2.(4). Calibration and setpoint verification involve use of a calibration source and significant personnel radiation exposure. It is felt that overall calibration of radiation monitors, which have displayed excellent stability over many years of operation, every six months is adequate to verify the setpoint unless instrument repairs have been made.

The measured release-drop times of the shim safety rods have been consistent since the installation of the boron/stainless steel shim safety rods in 1962. Annual check of these parameters is considered adequate to detect any deterioration which could change the release-drop time. Binding or rubbing caused by rod misalignment could result from maintenance; therefore, release drop times will be checked after such maintenance.

4.3 FNR Confinement Building

Applicability:

This specification applies to the surveillance of the facility openings and dampers.

Objective:

To assure that the condition of the closure devices for the building openings are in satisfactory condition to assure their ability to provide adequate confinement of any airborne radioactivity released into the building.

Specification:

(1) The operation of the dampers described in Specification 3.3.(1) shall be tested for operability whenever complete checkout of the reactor control system is required prior to startup. This operability test will be a portion of the startup checkout list for the facility.

(2) The condition of the following gaskets shall be inspected at intervals not to exceed six months, and the gaskets shall be replaced whenever any evidence of deterioration is found:

a. Building ventilation system intake and exhaust dampers;

b. Personnel access doors;

c. Equipment access doors;

d. Cooling tower access door.

Bases:

The prestart check of the main damper function provides assurance that the automatic function provided by these dampers will be actuated when confinement isolation is required. The semiannual inspection of gasket materials, since these materials are not in a damaging atmoshphere, will provide assurance that the gaskets will perform their function of limiting leakage through these openings in the event of a release of airborne activity into the building.

4.4 Primary Coolant System

Applicability:

This specification applies to the surveillance of the primary coolant system.

Objective:

To assure high quality pool water and to detect the release of fission products from fuel elements.

Specification:

(1) The pH of the primary coolant shall be measured weekly.

(2) The resistivity of the primary coolant shall be measured weekly.

(3) The radioactivity of the primary coolant shall be analyzed biweekly.

(4) A record of pool makeup water shall be maintained to discover significant leakage of primary coolant from the facility.

Bases:

Regular surveillance of pool water quality and radioactivity provides assurance that pH and conductivity changes that could accelerate the corrosion of the primary coolant system would be detected before significant corrosive damage would occur, and that the presence of leaking fuel elements in the reactor is detected.

Routine inspection of makeup water needs over a period of time provides early warning of small pool water leaks.

4.5 Heavy Water Reflector Tank

Applicability:

This specification applies to surveillance requirements regarding the heavy water reflector tank used in the reactor core.

Objective:

To assure that the limits of Specification 3.5 are not exceeded.

Specification:

(1) The shutdown margin required by Specification 3.5.(1) will be verified whenever heavy water transfers as described in that specification are to be made.

(2) The tritium content of the heavy water reflector tank shall be measured not less than once every three months provided the reactor has operated during that period.

Bases:

Actual verification of the shutdown margin required in 3.5.(1) will assure the reactor stays subcritical under all possible circumstances during heavy water transfers.

Reactor experience during the last twenty years with the tritium production rate in the tank supports the conclusion that quarterly tritium analyses are sufficient to prevent violation of Specification 3.5.(2).

4.6 Airborne Effluents

Applicability:

This specification applies to the surveillance of the monitoring equipment used to measure airborne radioactivity.

Objective:

The objective is to assure that accurate assessment of airborne effluents can be made.

Specification:

(1) The building exhaust air radiation monitor shall be calibrated not less than once every six months.

(2) The particulate air monitors shall be calibrated not less than once every six months.

(3) The gaseous activity monitors shall be calibrated for A^{41} not less than once every six months.

(4) The operation of all airborne activity monitors shall be checked daily except when the reactor staff is not present in the facility.

Bases:

Experience with the electronic reliability and calibration stability of the units used the FNR demonstrates that the above periods are reasonable surveillance frequencies.

4.7 Liquid Effluents

Applicability:

This specification applies to the surveillance of the monitoring equipment used to measure the activity in liquid effluents.

Objective:

The objective is to assure that accurate assessment of liquid effluents can be made.

Specification:

(1) The monitoring equipment used to measure the radioactive concentrations in the waste retention tank contents shall be calibrated not less than once every six months.

(2) The contents of every tank released shall be sampled and evaluated prior to its release.

Bases:

Experience with the counting equipment used in measuring the radioactivity in the waste retention tanks suggests that the above period is a suitable calibration frequency.

4.8 Fission Density Limits

Applicability:

This specification applies to the surveillance requirements for fission density limits.

Objective:

To assure that the fission density limits of Specification 3.9 are not exceeded.

Specification:

(1) The fission density of all fuel elements which have uranium 235 burnup shall be calculated at least quarterly.

Bases:

Determination of fission densities on a quarterly basis will ensure that the fission density limits of Specification 3.9 are not exceeded. Fuel element swelling will be kept well below levels which could result in clad rupture and release of radioactive fission products.

5.0 DESIGN FEATURES

5.1 Site Description

The Ford Nuclear Reactor (FNR) is located on the North Campus of the University of Michigan at Ann Arbor, Michigan. The North Campus area is under the administrative control of the Regents of the University of Michigan.

The North Campus is a tract of nearly 900 acres, about 1½ miles northeast of the center of Ann Arbor. It is bounded on the north by Plymouth Road and on the south by Glacier Way. Open land and the Arborcrest Cemetery lie to the east. To the west are University athletic fields, municipal parks and a wooded ridge. The Huron River flows through land bordering the area on the west and south and some marshland lies adjacent to the river on the south.

The reactor building is located near the center of the North Campus area. Development of the North Campus area by the University has been done using the following guidelines:

(1) Only laboratory and research buildings will be constructed within 50 feet of the reactor.

(2) No housing or other buildings containing housing facilities will be erected within 1500 feet of the reactor.

The University of Michigan controls all the land within 1500 feet of the reactor site, with the exception of a small portion of the highway right of way along Glacier Way on the southeast and the Arborcrest Cemetery located 800 feet to the east of the site.

The reactor site consists of all the land 500 feet to the east, 1000 feet to the west and north and 1200 feet to the south. The boundary of this area consists of roadways around the site whose traffic flow can be controlled should such control be desirable.

The reactor restricted area consists of the reactor building and the contiguous Phoenix Memorial Laboratory (PML). The reactor building is the operations boundary and the emergency planning zone.

5.2 Reactor Fuel

The fuel assemblies shall be of the MTR type, consisting of plates containing uranium aluminide (UAl_x) or uranium oxide (U_3O_8) fuel enriched to less than 20% in the isotope U235 clad with aluminum.

The authorized fuel assembly designs are:

Number of Plates	Maximum Plate Loading (g U235)	Maximum Assembly Loading (g U235)
18	9.28±2%	167±2%
9	9.28±2%	84±2%

5.3 Reactor Building

The reactor building is a windowless, four story, reinforced concrete building with 12 inch walls structurally integral with the footings and foundation mats. The building is approximately 69 feet wide x 68 feet long x 70 feet high with approximately 44 feet exposed above grade. The building has the following general features:

(1) The reactor is housed in a closed room designed to restrict leakage.

(2) The reactor room is equipped with a ventilation system designed to exhaust air or other gases present in the building atmosphere into an exhaust stack which exhausts a minimum of 54 feet above ground level.

(3) The ventilation system provides ventilation for certain storage and experimental facilities and exhausts these a minimum of 54 feet above ground level.

(4) The openings into the reactor building are an equipment access door, three personnel doors, an equipment access hatch, air intake and exhaust ducts, room 3103 fume hood exhaust duct, beamport ventilation duct, a sealed north wall door, a door between the hot cave operating face and the beamport floor, and a pneumatic tube system for sample transfer between the FNR and several laboratories in the Phoenix Memorial Laboratory.

5.4 Fuel Storage

(1) Irradiated fuel elements and fueled devices shall be stored in an array which will permit sufficient natural convection cooling by water or air such that the fuel element or fueled device temperature will not exceed 100 C.

(2) All reactor fuel elements and fueled devices shall be stored in a geometric array which assures subcriticality. The array spacings will be based on the experimental results reported in ORNL-CF-58-9-40 for storage array experiments performed with ORR and BSR fuel elements.

6.0 ADMINISTRATIVE CONTROLS

6.1 Organization

(1) The organizational structure of the University of Michigan relating to the Ford Nuclear Reactor (FNR) shall be as shown in Figure 6.1.

(2) The FNR Reactor Manager shall be responsible for the safe operation of the FNR. He shall be responsible for assuring that all operations are conducted in a safe manner and within the limits prescribed by the facility license, including the technical specifications and operating procedures. During periods of his absence, his responsibilities are delegated to the Assistant Reactor Manager.

(3) In all matters pertaining to the operation of the plant and these technical specifications, the FNR Reactor Manager shall report to and be directly responsible to the Director, Michigan Memorial-Phoenix Project.

(4) Qualifications, FNR Reactor Manager: Minimum qualifications for the FNR Reactor Manager shall be a bachelor's degree and at least four years of reactor operating experience in increasingly responsible positions. Years spent in graduate study may be substituted for operating experience on a one for one basis up to a maximum of two years. Within six months after being assigned this position, the Reactor Manager shall apply for an NRC senior operator license if he does not already hold one.

(5) A health physicist who is organizationally independent of the FNR operations group shall be responsible for radiological safety at the facility.

(6) A licensed operator or licensed senior operator pursuant to 10CFR55 shall be present in the control room whenever the reactor is in operation as defined in these specifications. The minimum operating crew will be composed of two individuals, at least one of which will be so licensed.

(7) A licensed senior operator shall be present or readily available on call at any time the reactor is in operation.

(8) The identity of and method for rapidly contacting the licensed senior operator on duty shall be known to the reactor operator at any time that the reactor is in operation.

(9) Licensed senior operators or operators are not required to be present in the facility when the reactor is secured.

(10) All licensed operators at the facility shall participate in an approved operator requalification program as a condition of their continued assignment of operator duties.

6.2 Review and Audit

(1) A Safety Review Committee (SRC) shall review reactor operations and advise the Director, Michigan Memorial-Phoenix Project, in matters relating to the health and safety of the public and the safety of facility operations.

(2) The Safety Review Committee shall have at least eight members of whom no more than the minority shall be from the line organization shown in Figure 6.1 or administratively report to anyone in that line organization below the Vice President for Research. The Committee shall be made up of University staff and faculty who shall collectively provide experience in reactor engineering, instrumentation and control systems, radiological safety, and mechanical and electrical systems.

(3) The Committee shall meet at least semiannually.

(4) The quorum shall consist of not less than a majority of the full committe and shall include the chairman or his designated alternate.

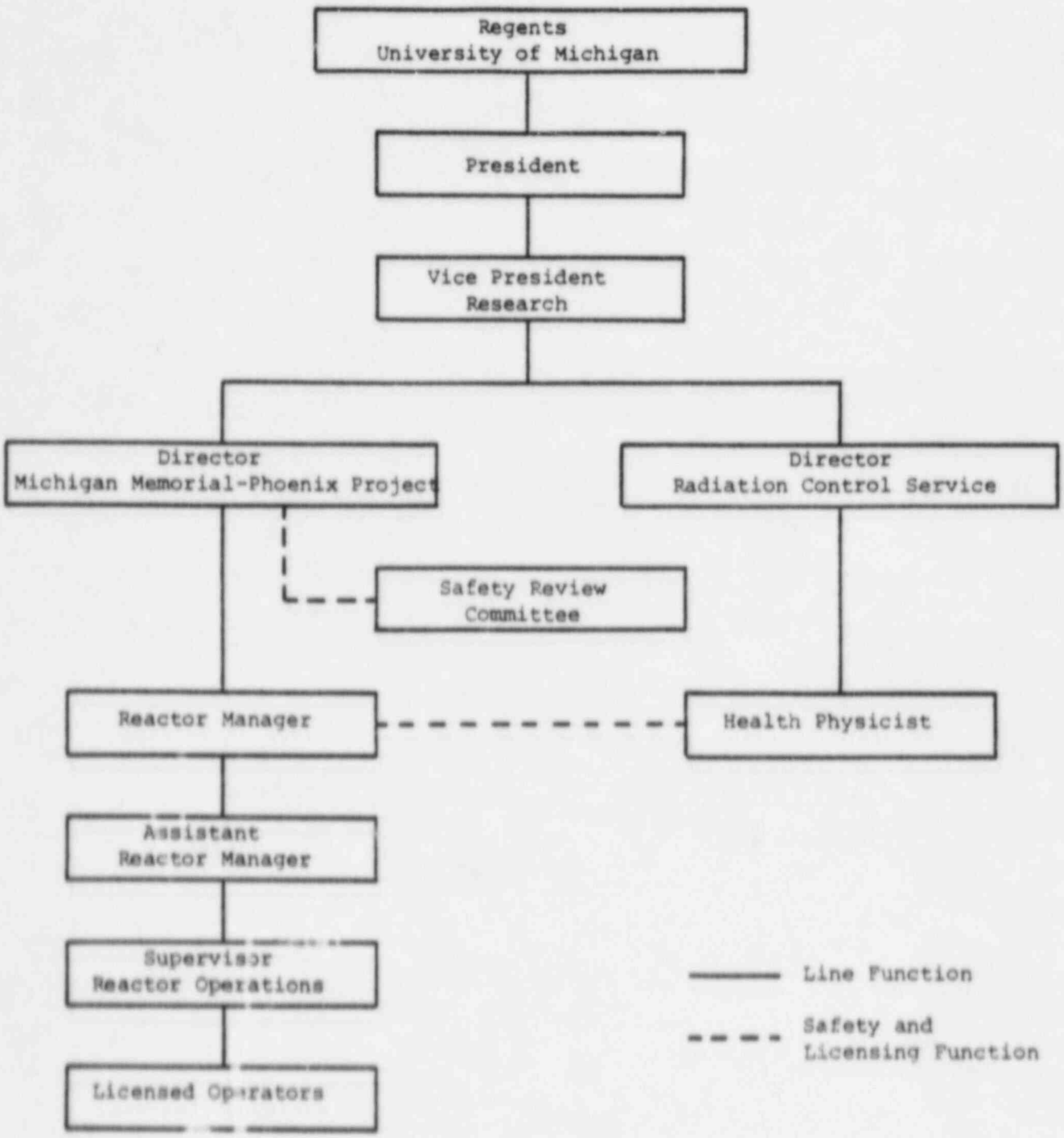
(5) Five votes are required to approve those changes, experiments, and tests which require specific SRC approval. Votes may be cast at SRC meetings or via individual polling of members.

(6) Minutes of each Committee meeting shall be distributed to the Director, Michigan Memorial-Phoenix Project, all Safety Review Committee members, and such others as the chairman may designate.

(7) The Safety Review Committee shall:

a. Review and approve proposed experiments and tests utilizing the reactor facility which are significantly different from tests and experiments previously performed at the FNR. In

Figure 6.1 Organization Chart for the Ford Nuclear Reactor



the event of a disagreement over approval of an experiment between the Committee and the Reactor Manager, the matter shall be referred to the Director, Michigan Memorial-Phoenix Project for resolution.

b. Review reportable occurrences.

c. Review and approve proposed standard operating procedures and proposed changes to standard operating procedures. This requirement pertains to those procedures prepared pursuant to Section 6.4 of these specifications.

d. Review and approve proposed changes to the technical specifications and proposed amendments to the facility license and review proposed changes to the facility made pursuant to 10CFR50.59(c).

e. Review the audit report provided by the consultant for reactor operations.

(8) A consultant will be retained by the University of Michigan to perform an annual audit of reactor operations and the safety of facility operations. The consultant shall be selected by the Director, Michigan Memorial-Phoenix Project and shall be an individual presently or recently engaged in the management of a research or test reactor of comparable power level and type. He shall provide a report on the conclusions drawn from that audit to the Director, Michigan Memorial-Phoenix Project. The Director shall provide the members of the Safety Review Committee with copies of this report.

(9) The consultant for operations shall:

a. Audit reactor operations and reactor operational records for compliance with internal rules, procedures, and regulations and with license provisions including technical specifications;

b. Audit existing standard operating procedures for adequacy and to assure that they achieve their intended purpose in light of any changes since their implementation;

c. Audit plant equipment performance with particular attention to operating anomalies, reportable occurrences, and the steps taken to identify and correct their causes.

6.3 Action to Be Taken in the Event of a Reportable Occurrence

In the event of a reportable occurrence, as defined in these technical specifications, the following action shall be taken:

(1) The FNR Reactor Manager shall be notified of the occurance. Corrective action shall be taken to correct the abnormal conditions and to prevent its recurrence.

(2) A report of such occurrence shall be made to the Safety Review Committee; the Director, Michigan Memorial-Phoenix Project; and the Nuclear Regulatory Commission in accordance with Section 6.6.(2).a. The report shall include an analysis of the causes of the occurrence, the effectiveness of corrective actions taken, and recommended of measures to prevent or reduce the probability of consequences of recurrence.

6.4 Operating Procedures

Written procedures, including applicable check lists, reviewed and approved by the Safety Review Committee shall be in effect and followed for the following operations:

(1) Startup, operation and shutdown of the reactor;

(2) Installation and removal of fuel elements, control rods, experiments and experimental facilities;

(3) Actions to be taken to correct specific and foreseen potential malfunctions of systems or components, including responses to alarms, suspected primary coolant system leaks, and abnormal reactivity changes;

(4) Emergency conditions involving potential or actual release of radioactivity, including provisions for evacuation, reentry, recovery, and medical support;

(5) Maintenance procedures which could have an effect on reactor safety;

(6) Periodic surveillance of reactor instrumentation and safety systems, area monitors, and continuous air monitors;

(7) Facility security plan;

(8) Radiation protection procedures.

Substantive changes to the above procedures shall be made only with the approval of the Safety Review Committee. Temporary changes to the procedures that do not change their original intent may be made with approval of the FNR Reactor Manager or the Assistant Reactor Manager. All temporary changes to the procedures shall be documented and subsequently reviewed by the Safety Review Committee.

6.5 Operating Records

(1) The following records and logs shall be prepared and retained by the licensee for at least five years:

a. Normal facility operation and maintenance;

b. Reportable Occurrences;

c. Tests, checks, and measurements documenting compliance with surveillance requirements;

d. Records of experiments performed;

e. Records of radioactive shipments;

f. Operator requalification program records (the five year period will commence after termination of the assignment of the operator to operative duties);

g. Facility radiation and contamination surveys.

(2) The following records and logs shall be prepared and retained by the licensee for the life of the facility:

a. Gaseous and liquid waste released to the environs;

b. Offsite environmental monitoring surveys;

c. Radiation exposures for all FNR personnel;

d. Fuel inventories and transfers;

e. Updated, corrected, and as built facility drawings;

f. Minutes of Safety Review Committee meetings.

6.6 Reporting Requirements

The following information shall be submitted to the USNRC in addition to the reports required by Title 10, Code of Federal Regulations. All written reports shall be addressed to the U. S. Nuclear Regulatory Commission, Attn: Document Control Desk, Washington, D. C. 20555 with a copy to the Administrator, Region III.

(1) Annual Operating Reports

A report covering the previous year shall be submitted by March 31 of each year. It shall include the following information.

a. Operations Summary

A summary of operating experience having safety significance occurring during the reporting period.

1) Changes in facility design.

2) Performance characteristics (e.g., equipment and fuel performance).

3) Changes in operating procedures which relate to the safety of facility operations.

4) Results of surveillance tests and inspections required by these technical specifications.

5) A brief summary of those changes, tests, and experiments which required authorization from the commission pursuant to 10CFR50.59(a).

6) Changes in the plant operating staff serving in the following positions:

(a) FNR Reactor Manager;

(b) Health Physicist;

(c) Safety Review Committee members.

b. Power Generation

A monthly tabulation of the thermal output of the facility during the reporting period.

c. Shutdowns

A listing of unscheduled shutdowns which have occurred during the reporting period, tabulated according to cause, and a brief discussion of the actions taken to prevent recurrence.

d. Maintenance

A discussion of corrective maintenance, excluding preventive maintenance, performed during the reporting period on safety related systems and components.

e. Changes, Tests, and Experiments

A brief description and a summary of the safety evaluation for those changes, tests, and experiments which were carried out without prior commission approval, pursuant to the requirements of 10CFR50.59(a).

f. Radioactive Effluent Releases

A statement of the quantities of radioactive effluents released from the plant.

1) Gaseous Effluents

(a) Gross Radioactivity Releases

(1) Total gross radioactivity in curies, primarily noble and activation gases.

(2) Average concentration of gasesous effluents released during normal steady state operation averaged over the period of reactor operation.

(3) Maximum instantaneous concentration of noble gas radionuclides released during special operations, tests, or experiments.

(4) Percent of technical specification limit.

(b) Iodine Releases

(Required if iodine is identified in primary coolant samples, or if fueled experiments are conducted at the facility.)

(1) Total iodine radioactivity in curies by nuclide released, based on representative isotopic analyses performed.

(2) Percent of MPC.

(c) Particulate Releases

(1) Total gross beta and gamma radioactivity released in curies excluding background radioactivity.

(2) Gross alpha radioactivity released in curies excluding background radioactivity. (Required if the operational or experimental program could result in the release of alpha emitters.)

(3) Total gross radioactivity in curies of nuclides with half lives greater than eight days.

(4) Percent of MPC for particulate radioactivity with half lives greater than eight days.

2) Liquid Effluents

(a) Total gross beta and gamma radioactivity released in curies excluding tritium and average concentration released to the unrestricted area or sanitary sewer averaged over period of release.

(b) The maximum concentration of beta and gamma radioactivity released to the unrestricted area.

(c) Total alpha radioactivity in curies released and average concentration released to the unrestricted area averaged over the period of release. (Required if the operational or experimental program could result in the release of alpha emitters.)

(d) Total volume in ml of liquid waste released.

(e) Total volume in ml of water used to dilute the liquid waste during the period of release prior to release from the building to the sanitary sewer system.

(f) Total radioactivity in curies, and concentration averaged over the period of release by nuclide released, based on representative isotopic analyses performed for any release from a waste storage tank whose contents have a concentration in excess of 9×10^{-4} microcuries/cc.

(g) Percent of technical specification limit for total radioactivity from the site.

g. Environmental Monitoring

For each medium sampled:

1) Number of sampling locations and a description of their location relative to the reactor.

2) Total number of samples.

3) Number of locations at which levels are found to be significantly higher than the remaining locations.

4) Highest, lowest, and the annual average concentrations or levels of radiation for the sampling point with the highest average and the location of that point with respect to the site.

5) The maximum cumulative radiation dose which could have been received by an individual continuously present in an unrestricted area during reactor operation from:

(a) Direct radiation and gaseous effluent;

(b) Liquid effluent.

6) If levels of radioactive materials in environmental media, as determined by an environmental monitoring program, indicate the likelihood of public intakes in excess of 1% of those that could result from continuous exposure to the concentration values listed in Appendix B, Table II, 10CFR20, estimates of the likely resultant exposure to individuals and to population groups and assumptions upon which estimates are based.

7) If significant variations of offsite environmental concentrations with time are observed, correlation of these results with effluent release shall be provided.

h. Occupational Personnel Radiation Exposure

A summary of annual radiation exposures greater than 500 mrem (50 mrem for persons under 18 years of age) received during the reporting period by facility personnel including faculty, students, or experimenters.

(2) Non-Routine Reports

a. Reportable Occurrence Reports

Notification shall be made within 24 hours by telephone and telegraph to the Director of the appropriate Regional Inspection and Enforcement Office followed by a written report within 14 days to the U. S. Nuclear Regulatory Commission, Attn: Document Control Desk, Washington, D. C. 20555, with a copy to the Director of the Regional Inspection and Enforcement Office in the event of a reportable occurrence, as defined in Section 1.0. Telegraph notification may be sent on the next working day in the event of a reportable occurrence during a weekend or holiday period. The written report of a reportable occurrence, and, to the extent possible, the preliminary telephone and

telegraph notification shall:

1) Describe, analyze, and evaluate safety implications:

2) Outline the measures taken to assure that the cause of the condition is determined;

3) Indicate the corrective action including any changes made to the procedures and to the quality assurance program taken to prevent repetition of the occurrence and of similar occurrences involving similar components or systems;

4) Evaluate the safety implications of the incident in light of the cumulative experience obtained from the record of previous failure and malfunctions of similar systems and components.

b. Unusual Events

A written report shall be forwarded within 30 days to the U. S. Nuclear Regulatory Commission, Attn: Document Control Desk, Washington D. C. 20555, with a copy to the Director of the Regional Inspection and Enforcement Office in the event of:

1) Discovery of any substantial errors in the transient or accident analyses or in the methods used for such analyses, as described in the safety analysis or in the bases for the technical specifications;

2) Discovery of any substantial variance from performance specifications contained in the technical specifications and safety anaylysis.

3) Discovery of any condition involving a possible single failure which, for a system designed against assumed failures, could result in a loss of the capability of the system to perform its safety function.