UNITED STATES NUCLEAR REGULATORY COMMISSION
DOCKET NO. 50-150
THE OHIO STATE UNIVERSITY
RENEWED FACILITY LICENSE

License No. R-75

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

   A. The application for renewal of Facility License No. R-75 filed by the Ohio State University (the licensee) dated December 15, 1999, as supplemented on August 21, 2002; August 18, 2005; July 26, 2006; May 22, May 31, September 4, and September 28, 2007; and February 29, 2008 (the application), complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission’s rules and regulations set forth in Title 10, Chapter 1, of the Code of Federal Regulations;

   B. Construction of the Ohio State University Research Reactor (the facility) was completed in substantial conformity with Construction Permit No. CPRR-49 dated February 3, 1960, 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 renewed license can be conducted at the designated location without endangering the health and safety of the public, and (ii) such activities will be conducted in compliance with the rules and regulations of the Commission;

   D. The licensee is technically and financially qualified to engage in the activities authorized by this license in accordance with the rules and regulations of the Commission;

   E. The licensee is a nonprofit educational institution and will use the reactor for the conduct of educational activities, and therefore the licensee is exempt from the financial protection requirement of subsection 170a of the Act;

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

   G. The issuance of this license is in accordance with 10 CFR Part 51, “Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions,” of the Commission’s regulations and all applicable requirements; and

   H. The receipt, possession and use of byproduct and special nuclear materials as authorized by this license will be in accordance with the Commission's regulations in 10 CFR Part 30 and 10 CFR Part 70.

2. Facility License No. R-75 is hereby renewed in its entirety to read as follows:

   A. This license applies to the Ohio State University Research Reactor (the reactor) that is owned by the Ohio State University (the licensee), located on the Ohio State University’s campus in Columbus, Ohio, and described in the licensee’s application, as supplemented.

   B. Subject to the conditions and requirements incorporated herein, the Commission hereby licenses the Ohio State University:

1. Pursuant to subsection 104c of the Act, and Title 10, Part 50, “Domestic Licensing of Production and Utilization Facilities,” of the Code of Federal Regulations (10 CFR Part 50), to possess, use, and operate the reactor as a utilization facility at the designated location in Columbus, Ohio.

2. Pursuant to the Act and 10 CFR Part 70, “Domestic Licensing of Special Nuclear Material,” to receive, possess, and use in connection with operation of the facility:

    a. up to 5.2 kilograms of contained uranium-235 at enrichments less than 20 percent;

    b. up to 30 grams of highly enriched, contained uranium-235 in the form of fission chamber linings, foil targets, and other research applications;

    c. up to 80 grams of plutonium contained in encapsulated plutonium-beryllium sources; and

    d. to possess and use, but not to separate such special nuclear material as may be produced by operation of the reactor.

3. Pursuant to the Act and 10 CFR Part 30, “Rules of General Applicability to Domestic Licensing of Byproduct Material,” to possess and use, but not to separate, except for byproduct material produced in non-fueled experiments, such byproduct material as may be produced by operation of the reactor.

C. This license shall be deemed to contain and is subject to the conditions specified in Parts 20, 30, 50, 51, 55, 70, and 73 of the Commission’s regulations; is subject to all applicable provisions of the Act and rules, regulations, and orders of the Commission now or hereafter in effect; and is subject to the additional conditions specified below:

1. The licensee is authorized to operate the reactor at steady-state power levels up to a maximum of 500 kilowatts (thermal).

2. The technical specifications contained in Appendix A, as revised through Amendment No. 19, are hereby incorporated in the license. The licensee shall operate the reactor in accordance with the technical specifications.

D. This license is effective as of the date of issuance and shall expire at midnight twenty years from the date of issuance.

FOR THE NUCLEAR REGULATORY COMMISSION

/RA/

Eric J. Leeds, Director
Office of Nuclear Reactor Regulation

Enclosure:
Appendix A, Technical Specifications

Date of Issuance: June 18, 2008

APPENDIX A

TO

RENEWED FACILITY OPERATING LICENSE NO. R-75

Technical Specifications

and Bases for

The Ohio State University

Pool-Type Nuclear Reactor

Columbus, Ohio

Docket No. 50-150

June 2008

CONTENTS

1.0 INTRODUCTION

1.1 Scope

This document constitutes the technical specifications for Facility License No. R-75 and supersedes all prior technical specifications. Included are the “specifications” and the “bases” for the technical specifications. These bases, which provide the technical support for the individual technical specifications, are included for information purposes only. They are not part of the technical specifications, and they do not constitute limitations or requirements to which the licensee must adhere.

This document was written to be in conformance with American National Standards Institute/American Nuclear Society (ANSI/ANS)-15.1-1990, “The Development of Technical Specifications for Research Reactors.” The technical specifications include definitions, safety limits, limiting safety system settings, limiting conditions for operation, surveillance requirements, design features, and administrative controls.

1.2 Application

1.2.1 Purpose

These technical specifications have been written specifically for The Ohio State University Research Reactor (OSURR).

The technical specifications represent the agreement between the licensee and the U.S. Nuclear Regulatory Commission (NRC) on administrative controls, equipment availability, and operational parameters.

Specifications are limits, equipment requirements, and administrative requirements for safe reactor operation and for dealing with abnormal situations. They are typically derived from the safety analysis report (SAR) submitted with the application for renewal of Facility License No. R-75, as supplemented. These specifications represent a comprehensive envelope for safe operation. Only those operational parameters and equipment requirements directly related to preserving that safe envelope are listed.

1.2.2 Format

The format of this document is in general accordance with ANSI/ANS-15.1-1990.

1.3 Definitions

Administrative Controls—those organizational and procedural requirements established by the NRC and/or the facility management.

ALARA—as low as is reasonably achievable.

Channel—the combination of sensor, line, amplifier, and output devices that are connected for the purpose of measuring the value of a parameter.

Channel Calibration—an adjustment of the channel such that its output corresponds with acceptable accuracy to known values of the measured parameter. Calibration shall encompass the entire channel, including equipment actuation, alarm, or trip settings, and shall be deemed to include a channel test.

Channel Check—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—the introduction of a signal into the channel for verification that it is operable.

Cold Clean Core—when the core is at ambient temperature and the reactivity worth of xenon is negligible.

Confinement—a closure on the overall facility which controls the movement of air into it and out of it through a controlled path.

Control Rod—a device fabricated from neutron-absorbing material which is used to establish neutron flux changes.

Control Rod Scram Time—elapsed time from the receipt of a safety signal to when a shim/safety rod is fully inserted.

Controlled Area—an area, outside of a restricted area but inside the site boundary, access to which can be limited by the licensee for any reason**.**

Controls—mechanisms used to regulate the operation of the reactor.

Core—the general arrangement of fuel elements and control rods.

Critical—when the effective multiplication factor (k_{eff}) of the reactor is equal to unity.

Excess Reactivity—the amount of reactivity that would exist if all control rods were removed from the core.

Experiment—any operation, or any apparatus, device, or material, installed in or near the core or which could conceivably have a reactivity effect on the core and which itself is not a core component or experimental facility, intended to investigate non-routine reactor parameters or radiation interaction parameters of materials.

Experimental Facility—any structure or device associated with the reactor that is intended to guide, orient, position, manipulate, or otherwise facilitate completion of experiments.

Explosive Material—any material that is given an Identification of Reactivity (Stability) index of 2, 3, or 4 by the National Fire Protection Association in its publication 704-M, "Identification System for Fire Hazards of Materials," or is enumerated in the *Handbook for Laboratory Safety* published by the Chemical Rubber Company in 1967.

Facility—the reactor building including offices and laboratories.

Fuel Element, Blank—A core element with no fuel plates. The bottom ends of these elements are closed to minimize coolant flow bypassing core elements with fuel. Also called "Filler Fuel Element."

Fuel Element, Control Rod—a fuel element with less than the full number of plates that is capable of holding a control rod.

Fuel Element, Partial—a fuel element with the full number of plates and less than 100 percent of the nominal fuel element loading.

Fuel Element, Standard—a fuel element with the full number of plates and 100 percent of the nominal fuel element loading.

Fueled Experiment—any experiment that contains uranium-235 or uranium-233 or plutonium-239, excluding the normal reactor fuel elements.

Indicated Value—see Measured Value.

Limiting Conditions for Operation—administratively established constraints on equipment and operational characteristics that shall be adhered to during operation of the facility. These constraints are the lowest functional capability or performance level required for safe operation of the facility.

Limiting Safety System Settings—settings for automatic protective devices related to those variables having significant safety functions. Where a limiting safety system setting is specified for a variable on which a safety limit has been placed, the setting shall be so chosen that automatic protective action will correct the abnormal situation before a safety limit is exceeded.

Measured Value—the value of a parameter as it appears on the output of a channel.

Movable Experiment—one for which it is intended that all or part of the experiment may be moved in relation to the core while the reactor is operating.

NRC—U.S. Nuclear Regulatory Commission.

ONB—onset of nucleate boiling.

Operable—a component or system is capable of performing its intended functions in a normal manner.

Operating—a component or system is performing its intended function.

Protective Action—the initiation of a signal or the operation of equipment within the reactor safety system in response to a variable or condition of the reactor facility having reached a specified limit.

Reactivity Worth of an Experiment—value of the reactivity change that results from the experiment being inserted into or removed from its intended position.

Reactor—the combination of core, permanently installed experimental facilities, control rods, and connected control instrumentation.

Reactor Operating—the reactor is operating whenever it is not secured or shut down.

Reactor Operator—an individual who is licensed to manipulate the controls of the reactor in accordance with Title 10, Part 55, “Operators’ Licenses,” of the *Code of Federal Regulations* (10 CFR Part 55).

Reactor Safety Systems—those systems, including their associated input channels, that are designed to initiate automatic reactor protection or to provide information for initiation of manual protective action.

Reactor Secured—the reactor is secured when either of the following is true:

(1) Either there is insufficient moderator available in the reactor to attain criticality or there is insufficient fissile material present in the reactor to attain criticality under optimum available conditions of moderation and reflection.

(2) The following conditions exist:

a. All shim/safety rods are fully inserted.

b. The console key switch is in the OFF position and the key is removed from the lock.

c. No work is in progress involving core fuel, core structure, installed control rods, or control rod drives unless they are physically decoupled from the control rods.

d. No experiments are being moved or serviced that that have, on movement, a reactivity worth exceeding the maximum value allowed for a single experiment.

Reactor Shutdown—when the reactor is subcritical by at least 1% $\Delta k/k$ in the cold clean core condition.

Regulating Rod—a low reactivity-worth control rod used primarily to maintain an intended power level.

Restricted Area—area to which access is controlled for purposes of protection of individuals from exposure to radiation and radioactive materials.

ROC—Reactor Operations Committee.

Safety Channel—a measuring or protective channel in the reactor safety system.

Safety Limits—limits on important process variables that are found to be necessary to reasonably protect the integrity of the principal physical barriers that guard against the uncontrolled release of radioactivity. The principal physical barrier is the fuel cladding.

SAR—safety analysis report.

Scram—the rapid insertion of the shim/safety rods into the reactor for the purpose of quickly shutting down the reactor.

Secured Experiment—any experiment, experimental facility, or component of an experiment that is held in a stationary position relative to the reactor by mechanical means. The restraining forces must be substantially greater than those to which the experiment might be subjected from the normal environment of the experiment or by forces that can result from credible malfunctions.

Senior Reactor Operator—an individual who is licensed to direct the activities of reactor operators. Such an individual may also operate the controls of the reactor pursuant to 10 CFR Part 55.

Shall, Should, and May—the word "shall" is used to denote a requirement; the word "should" to denote a recommendation; and the word "may" to denote permission, which is neither a requirement nor a recommendation.

Shim/Safety Rods—high-reactivity worth control rods used primarily to provide coarse reactor control. They are connected electromagnetically to their drive mechanisms and have scram capabilities.

Shutdown Margin—the shutdown reactivity necessary to provide confidence that the reactor can be made subcritical by means of the control and safety systems with the most reactive shim/safety rod and the regulating rod in the most reactive position (fully withdrawn) and that the reactor will remain subcritical without further operator action.

Startup Source—a spontaneous source of neutrons which is used to provide a channel check of the startup (fission chamber) channel and to provide neutrons for subcritical multiplication during reactor startup.

Surveillance Time Intervals— maximum allowable intervals listed as follows are to provide operational flexibility only. Established frequencies shall be maintained over the long term.

5 Year	(interval not to exceed 6 years)
Biennial	(interval not to exceed 30 months)
Annual	(interval not to exceed 15 months)
Semiannual	(interval not to exceed 7-1/2 months)
Quarterly	(interval not to exceed 4 months)
Monthly	(interval not to exceed 6 weeks)
Weekly	(interval not to exceed 10 days)
Daily	(shall be done during the same working day)

Any extension of these intervals shall be occasional and for a valid reason.

True Value—the actual value of a parameter.

Unscheduled Shutdowns—any unplanned shutdown of the reactor caused by actuation of the reactor safety systems, operator error, equipment malfunction, or a manual shutdown in response to conditions that could adversely affect safe operation. Excluded are those shutdowns resulting from expected testing operations or planned shutdowns, whether initiated by controlled insertion of control rods or planned manual scrams.

2.0 SAFETY LIMIT AND LIMITING SAFETY SYSTEM SETTINGS

2.1 Safety Limit

Applicability: This specification applies to the melting temperature of the aluminum fuel cladding.

Objective: The objective is to ensure that the integrity of the fuel cladding is maintained.

Specification: The reactor fuel temperature shall be less than 550 °C.

Bases: The melting temperature of aluminum is 660 °C (1220 °F). The blister threshold temperature for uranium-silicide (U_3Si_2) dispersion fuel has been measured as approximately 550 °C (ANL/RERTR/TM-10, October 1987, NUREG-1313). Because the objective of this specification is to prevent release of fission products, any fuel whose maximum temperature reaches 550 °C is to be treated as though the safety limit has been reached until shown otherwise.

2.2 Limiting Safety System Settings

Applicability: This specification applies to the following two items associated with core thermodynamics:

(1) reactor thermal power level
(2) reactor coolant inlet temperature

Objective: To ensure that the fuel cladding integrity is maintained.

Specification:

(1) Reactor safety systems settings shall initiate automatic protective action at or below an indicated reactor power of 600 kilowatts (kW).

(2) Reactor safety systems settings shall initiate automatic protective action so that core inlet water temperature shall not exceed 35 °C.

Bases: The criterion for these safety system settings is established as the fuel integrity. If the temperature of the clad is maintained below that for blister threshold, then cladding integrity is maintained. This is the case for a power level of 600 kW and a core inlet temperature of 35 °C (normal inlet temperature is approximately 20–25 °C). Section 8.4.3.2 of the SAR provides the maximum credible accident analysis. The maximum credible accident assumes steady-state operation at 600 kW and initiation of a scram at 750 kW. The maximum temperature of the cladding reaches 91 °C (SAR Section 8.4.3.3).

3.0 LIMITING CONDITIONS FOR OPERATION

3.1 Reactor Core Parameters

3.1.1 Reactivity

Applicability: These specifications apply to the reactivity condition of the reactor and the reactivity worths of the shim/safety rods and regulating rod under any operating conditions.

Objective: To ensure the capability for safe shutdown of the reactor and that the safety limits are not exceeded.

Specification: With the exception of operations performed solely for determination of reactor reactivity worth values, the reactor shall be operated only if the following five conditions exist:

(1) The reactor core shall be loaded so that the excess reactivity, including the effects of installed experiments, does not exceed 2.6% Δk/k under any operating condition.

(2) The minimum shutdown margin under any operating condition with the maximum worth shim/safety rod and the regulating rod full out shall be no less than 1.0% Δk/k.

(3) All core grid positions internal to the active fuel boundary shall be occupied by a standard, partial, control rod, or blank fuel element or by an experimental facility.

(4) The moderator temperature coefficient shall be negative and shall have a minimum absolute reactivity value of at least 2×10^{-5} Δk/k/°C across the active core at all normal operating temperatures.

(5) The moderator void coefficient of reactivity shall be negative and shall have a minimum value of at least 2.8×10^{-3} Δk/k/1% void across the active core.

Bases:

(1) The maximum allowed excess reactivity of 2.6% Δk/k provides sufficient reactivity to accommodate fuel burnup, xenon buildup, experiments, control requirements, and fuel and moderator temperature feedback (Section 4.2 of the SAR). Also, calculations show that this excess reactivity ensures that the maximum temperature of the surface of the cladding will be well below the blister threshold of the U_3Si_2 fuel during a design-basis accident (SAR Section 8.4.3.2).

(2) The minimum shutdown margin ensures that the reactor can be shut down from any operating condition and remain shut down after cooling and xenon decay, even with the highest worth rod and the regulating rod fully withdrawn.

(3) The requirement that all grid positions be filled during reactor operation ensures that the volume flow rate of primary coolant which bypasses the heat producing elements will be within the range specified in Section 4.8 of the SAR. Furthermore, the possibility of accidentally dropping an object into a grid position and causing an increase of reactivity is precluded.

(4) A negative moderator temperature coefficient of reactivity ensures that any moderator temperature rise will cause a decrease in reactivity. The U_3Si_2 fuel also has a significant negative temperature coefficient of reactivity because of the Doppler broadening of neutron capture resonances in uranium-238, but no credit is taken for this effect in our safety analyses.

(5) A negative void coefficient of reactivity helps provide reactor stability in the event of moderator displacement by experimental devices or other means.

3.1.2 Maximum Power Level

Applicability: This specification applies to the reactor thermal power level.

Objective: To ensure that the fuel cladding integrity is maintained.

Specification: Steady state power level shall not exceed 500 kW thermal.

Basis: Thermal and hydraulic calculations presented in the SAR indicate that the fuel may be safely operated at power levels up to 500 kW.

3.2 Reactor Control and Safety System

3.2.1 Control Rod Scram Time

Applicability: This specification applies to the elapsed time from the receipt of a safety signal to when a shim/safety rod is fully inserted.

Objective: To ensure that the reactor can be shut down within a specified period of time.

Specification: The reactor will not be operated unless the control rod scram time for a fully withdrawn rod for each of the three shim/safety rods is less than 600 milliseconds.

Bases: Control rod scram times as specified ensure that the safety limit will not be exceeded in a short-period transient. Section 8.4.3.3 of the SAR provides the analysis for this.

3.2.2 Maximum Reactivity Insertion Rate

Applicability: This specification applies to the maximum positive reactivity insertion rate by the most reactive shim/safety rod and the regulating rod simultaneously.

Objective: To ensure that the reactor is operated safely and the safety limit is not exceeded as a result of a short period.

Specification: The reactor will not be operated unless the maximum reactivity insertion rate is less than 0.05% Δk/k per second.

Basis: This maximum reactivity insertion rate limit ensures that the safety limit will not be exceeded as a result of a short period generated by a continuous linear reactivity insertion. Section 8.4.3.5 of the SAR describes how the safety system will ensure that the reactivity inserted during a ramp reactivity insertion is bounded by the analysis performed for step reactivity insertions in SAR Sections 8.4.3.1–8.4.3.4, which shows that the safety limit will not be exceeded because of reactivity step insertions.

3.2.3 Minimum Number of Scram Channels

Applicability: This specification applies to the reactor safety system channels.

Objective: To stipulate the minimum number of reactor safety system channels that shall be operable to ensure that the safety limits are not exceeded by ensuring the reactor can be shut down at all times.

Specification: The reactor shall not be operated unless the safety system channels described in the following table are operable:

	Reactor Safety System Component	**Minimum Required**	**Function**
1.	Core H_20 Inlet Temperature	1	Scram if temperature $\geq$ 35 °C
2.	Reactor Thermal Power Level (Safety Channels)	2	Scram if thermal power $\geq$ 600 kW, as indicated on calibrated ionization chamber channels
3.	Reactor Period	1	Scram if period $\leq$ 1 second
4.	Reactor Thermal Power Level/Coolant System Pumps	1	Scram if primary and secondary coolant system pumps not on by $\geq$ 120 kW thermal power
5.	Coolant Flow Rate	1	Scram if coolant system has no flow (primary) by $\geq$ 120 kW thermal power
6.	Pool Water Level	1	Scram if pool level $\leq$ 20 feet (15 feet above core)

	Reactor Safety System Component	Minimum Required	Function
7.	Switches a. Magnet power key switch b. Effluent monitor counter switch c. Effluent monitor compressor power switch d. LOG-N amp calibrate or test mode switch e. Period amp calibrate or test mode switch f. Reactor power-level safety modules (2) calibrate or test mode switch g. Reactor period safety module calibrate or test mode switch	8	Scram if any listed switch is not set properly. Switches to select between operating mode and non-operating mode (e.g., on/off) must be set to operating mode. Switches to select between operating mode and a test or calibrate mode (e.g., norm/test) must be set to operating mode.
8.	Time-Trace Displays a. LOG-N b. Linear Level c. Startup d. Period e. Effluent Monitor	5	Scram if power is lost to any one of the listed time-trace displays
9.	Manual Scrams a. Control Room Console b. Pool Top Catwalk c. BSF Catwalk d. Rabbit/BP Area e. Thermal Column/BP Area	5	Scram upon activation of any one manual scram switch
10.	Neutron-Sensitive Ionization Chambers	4	Scram if bias voltage drops below operational specifications
11.	Safety Setpoints Associated with Time-Trace Display Signals a. Period b. Linear Level c. Startup	3	Scram if any condition listed below is met: $\leq$ 5 seconds $\geq$ 120% of licensed power $\leq$ 2 counts per second (may be bypassed if $K_{eff} < 0.9$)

	Reactor Safety System Component	Minimum Required	Function
12.	Safety System	2	Scram in case of a safety amp fault or if system is discontinuous
13.	Shim/Safety Rod Magnet Current	3	Rod drop will occur for any shim/safety rod that has magnet current $\geq$ 100 ma

Bases:

(1) Ensures safety limit is not exceeded.

(2) Ensures safety limit is not exceeded.

(3) Ensures safety limit is not exceeded.

(4) Ensures coolant system pumps are functional before raising power > 120 kW.

(5) Ensures there is always primary coolant flow when greater than 120 kW.

(6) Ensures there is enough primary coolant for natural convection cooling.

(7) Ensures nuclear instrumentation is in proper mode for operation.

(8) Ensures information is available for observation by the reactor operator during operation and is recorded, if required, as a record of reactor operations.

(9) Ensures that the reactor can be shut down by the reactor operator in the control room or at other locations near experimental facilities if deemed necessary by other reactor staff.

(10) Ensures shutdown if nuclear instrumentation fails.

(11) Ensures backup shutdown capability from short period or high power level. Ensures shutdown if count rate is too low to provide meaningful startup information. The startup interlock may be bypassed if K_{eff} is $\leq$ 0.9.

(12) Ensures all components of the safety system are installed and operational.

(13) Ensures that any control rod exhibiting excess magnet current will be released and fall to the bottom as a result of gravity.

3.3 Coolant System

3.3.1 Pump Requirements

Applicability: This specification applies to the operation of pumps for both the primary and secondary coolant loops.

Objective: To ensure that both pumps are functioning whenever the reactor is operated above 120 kW.

Specification: The reactor will not be operated above 120 kW unless both the primary and secondary coolant pumps are activated and there is flow in the primary coolant loop.

Bases: Having both pumps operating and flow in the primary loop will ensure there is adequate cooling of the primary coolant so the safety limit is not exceeded.

3.3.2 Coolant Level

Applicability: This specification applies to the height of the water in the reactor pool above the core.

Objective: To ensure adequate primary coolant in the reactor pool and sufficient biological shielding above the core.

Specification: The reactor shall not be operated unless there is 20 feet of water in the reactor pool and 15 feet of water above the core.

Bases: With the pool full of water to a level of 20 feet, there is adequate primary coolant for natural convection cooling. With 15 feet of water above the core, there is sufficient shielding at the licensed power level. Section 7.1.1.4 of the SAR discusses this shielding.

3.3.3 Water Chemistry Requirements

Applicability: This specification applies to the purity of the primary coolant water.

Objective: To minimize corrosion of the cladding on the fuel elements and to reduce the probability of neutron activation of ions in the water.

Specification:

(1) The conductivity of the pool water shall not exceed the limit of 2.0 μ mho/cm.
(2) The pH of the pool water shall not exceed 8.0.

Bases: Operation in accordance with these specifications ensures that aluminum corrosion is within acceptable limits and that the concentration of dissolved impurities that could be activated by neutron irradiation remains within acceptable limits.

3.3.4 Leak or Loss of Coolant Detection

Applicability: This specification applies to the capability of detecting and preventing the loss of primary coolant.

Objective: To ensure adequate primary coolant in the reactor pool and sufficient biological shielding above the core when the reactor is operating.

Specification: The pool water level shall be at least 15 feet above the top of the fuel in the core.

Bases: The same system that functions to scram the reactor upon low pool level will also be used as the detection system for this specification. Section 3.2.2.1 of the SAR discusses the design criteria of the cooling system to prevent large losses of pool water caused by siphoning.

3.3.5 Primary and Secondary Coolant Activity Limits

Applicability: This specification applies to the buildup of radioactive materials in the secondary coolant system.

Objective: To ensure a level of radioactive materials low enough so as not to exceed the limits of 10 CFR Part 20, "Standards for Protection against Radiation," if coolant is released to the sanitary sewer system.

Specification: The primary and secondary coolant system shall be monitored for the buildup of radioactivity and analyzed at least semiannually for increase in the concentration of radionuclides.

Basis: The basis for this specification is to ensure releases are legal and consistent with the as low as is reasonably achievable (ALARA) principal.

3.4 Confinement

Applicability: This specification applies to the capability to provide confinement for the reactor building.

Objective: To prevent the exposure of the public to airborne radioactivity exceeding the limits of 10 CFR Part 20 and the ALARA principle.

Specification: The reactor shall not be operated unless the following conditions are met:

(1) exhaust fan operating
(2) with exceptions for ingress and egress, all exterior doors and windows closed

Bases: By having the capability to provide confinement for the reactor building, exposure of the public to airborne radioactivity may be limited to the extent analyzed in the SAR.

3.5 **Ventilation Systems**

3.5.1 Normal Operations

Applicability: This specification applies to ventilation equipment required for normal operations, which is only the exhaust fan.

Objective: To specify needed ventilation equipment for normal operations.

Specification: The exhaust fan shall be operating when the reactor is operating.

Bases: An operating exhaust fan is necessary to meet the requirements for confinement, as specified in Section 3.4.

3.5.2 Emergency Operations

Applicability: This specification applies to ventilation equipment related to emergency operations, which includes all heating, ventilating, and air conditioning systems that exhaust from the restricted area to the outside environment.

Objective: To specify a means to quickly turn off all heating, ventilating, and air conditioning systems that exhaust from the restricted area in order to isolate the building for emergencies.

Specification: Any heating, ventilating, and air conditioning systems that exhaust from the restricted area to the outside environment shall have the capability to be shut off from a single switch in the control room.

Bases: In the unlikely event of an emergency situation involving the release of fission products or other airborne radioactivity, a means must be available for shutting off ventilation fans and rapidly isolating the building. Section 8.4.4 of the SAR includes an analysis of fission product release.

3.6 **Radiation Monitoring Systems and Radioactive Effluents**

3.6.1 Radiation Monitoring

Applicability: This specification applies to the availability of radiation monitoring equipment that shall be operable during reactor operation.

Objective: To ensure that monitoring equipment is available to evaluate radiation levels in restricted and unrestricted areas and to be consistent with the ALARA principle.

Specification:

(1) When the reactor is operating, the building gaseous effluent monitor shall be operating and have a readout and alarm in the control room. It may be used in either the “normal” mode or “sniffer” mode.

(2) When the reactor is operating, the following area radiation monitors (ARMs) shall be operating and have both local and control room readouts and alarms.

a. pool top
b. primary cooling system
c. beam port/rabbit area
d. thermal column area

(3) Portable survey instrumentation shall be available whenever the reactor is operating to measure beta-gamma exposure rates and neutron dose rates.

(4) When required monitors are inoperable, portable instruments, surveys, or analyses may be substituted for any of the normally installed monitors indicated in Section 3.6.1 above for periods of 1 week or for the duration of a reactor run in cases in which the reactor is continuously operated.

Bases:

(1) The gaseous effluent monitor will detect argon-41 levels in the reactor building. During “normal” mode operation, it will sample and monitor air just before it is released from the reactor building. (See SAR Section 6.3.1.) During “sniffer” mode of operation, it may be used for short periods to monitor in and around experimental facilities to determine local argon-41 levels.

(2) The ARMs provide a continuing evaluation of the radiation levels within the reactor building (see SAR Section 3.7) and provide a warning if levels are higher than anticipated.

(3) The availability of survey meters enables the reactor staff to independently confirm radiation levels throughout the building.

(4) In the event of instrument failure, short-term substitutions will enable the safe continued operation of the reactor.

3.6.2 Radioactive Effluents

Applicability: This specification applies to the monitoring of radioactive effluents from the facility.

Objectives:

(1) To ensure that liquid radioactive releases are safe and legal.

(2) To ensure that the release of argon-41 beyond the site boundary does not result in concentrations above the effluent concentration limit for unrestricted areas (see 10 CFR 20.1302, “Compliance with Dose Limits for Individual Members of the Public,” and Table 2 of Appendix B, “Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage,” to 10 CFR Part 20).

(3) To ensure that the release of argon-41 in the restricted area does not result in concentrations above the derived air concentration (DACs).

Specification:

(1) The concentration of radioactive liquids released into the sanitary sewer shall not exceed the limits specified in 10 CFR 20.2003, “Disposal by Release into Sanitary Sewerage.”

(2) The concentration of argon-41 at ground level below the point of release into the unrestricted area shall not exceed the unrestricted area effluent concentration limit (10 CFR 20.1302 and Table 2 of Appendix B to 10 CFR Part 20) when averaged over 1 year or 10 times the effluent concentration limit when averaged over 1 day.

(3) The concentration of argon-41 in the restricted area shall not exceed the DAC when averaged over a 2000-hour work year.

Bases:

(1) Section 6.2 of the SAR includes the basis for this specification.

(2) Section 6.3 of the SAR includes the basis for this specification.

(3) Section 6.3 of the SAR and 10 CFR 20.1003 include the basis for this specification.

3.7 Experiments

3.7.1 Reactivity Limits

Applicability: This specification applies to experiments to be installed in or near the reactor and associated experimental facilities.

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

Specification:

(1) The absolute value of the reactivity worth of any single secured experiment shall not exceed 0.7% $\Delta k/k$.

(2) The absolute value of the reactivity worth of any single movable experiment shall not exceed 0.4% $\Delta k/k$.

(3) The absolute value of the reactivity worth of all movable experiments shall not exceed 0.6% $\Delta k/k$.

(4) The absolute value of the reactivity worth of experiments having moving parts shall be designed to have an insertion rate less than 0.05% $\Delta k/k/s$.

(5) The absolute value of the reactivity worth of any movable experiment that may be oscillated shall have a reactivity change of less than 0.05% $\Delta k/k$.

(6) The total reactivity worth of all experiments shall not be greater than 0.7% $\Delta k/k$.

Bases:

(1) Section 8.4.3.2 of the SAR, which evaluates a step insertion of reactivity from an experiment, includes the bases for specifications 1, 2, 3, and 6.

(2) The bases for specifications 4 and 5 allow for certain reactor kinetics experiments to be performed but still limits the rate of change of reactivity insertions to levels that have been analyzed. Section 8.4.3.2 of the SAR evaluates a step insertion of reactivity from an experiment.

3.7.2 Design and Materials

Specification:

(1) No experiment shall be installed that could shadow the nuclear instrumentation, interfere with the insertion of a control rod, or credibly result in fuel element damage.

(2) All materials to be irradiated in the reactor shall be either corrosion resistant or doubly encapsulated within corrosion-resistant containers.

(3) Explosive materials shall not be allowed in experiments, except for neutron radiographic exposures of items performed outside of the core and experimental facilities. The amount of explosive material contained in capsules used for radiographic exposures shall not exceed 5 grains of gunpowder.

Bases:

(1) Specification 1 ensures that no physical interference with the operation of the reactor detectors, control rods, or physical damage to fuel elements will take place.

(2) Limiting corrosive materials in specification 2 and explosives in specification 3 reduces the likelihood of damage to reactor components and/or releases of radioactivity resulting from experiment failure.

(3) Limiting explosive materials to neutron radiographic exposures done outside of the core and experimental facilities reduces the likelihood of damage resulting from this experimental failure.

4.0 SURVEILLANCE REQUIREMENTS

4.1 Reactor Core Parameters

4.1.1 Excess Reactivity and Shutdown Margin

Applicability: This specification applies to surveillance requirements for determining the excess reactivity of the reactor core and its shutdown margin.

Objective: To ensure that the excess reactivity and shutdown margin limits of the reactor are not exceeded.

Specification:

(1) Whenever a net change in core configuration, for which the predicted change in reactivity is > 0.2% Δk/k, involving grid position is made, both excess reactivity and shutdown margin shall be determined.

(2) Both shutdown margin and excess reactivity shall be determined annually.

Bases: A determination of excess reactivity is needed to preclude operating without adequate shutdown margin. Moving a component out of the core and returning it to its same location is not a change in the core configuration and does not require a determination of excess reactivity.

4.1.2 Fuel Elements

Applicability: This specification applies to surveillance requirements for determining the physical condition of the reactor fuel.

Objective: To ensure that visible deterioration, corrosion, or other physical changes to the fuel elements are detected in a timely manner.

Specification: All fuel elements, both in-core and out, shall be visually inspected at least once every 5 years, by inspecting at least one-fifth of the elements annually.

Basis: If the water purity is continuously maintained within specified limits, it is projected that chemical corrosion of the fuel clad will proceed slowly. However, faults in the basic materials or fabrication could lead to loss of cladding integrity.

4.2 Reactor Control and Safety Systems

4.2.1 Control Rods

Applicability: This specification applies to the surveillance requirements for the shim safety rods and the regulating rod.

Objective: To ensure that all rods are operable.

Specification:

(1) The reactivity worth of the shim safety rods and regulating rod shall be determined annually and before the routine operation of any new core configuration.

(2) Shim safety control rod scram times and drive times and regulating rod drive time shall be determined annually or after maintenance or modification is completed on a mechanism.

(3) The shim safety rods and regulating rod shall be visually inspected annually for indication of corrosion and indication of excessive friction with guides.

Bases: The reactivity worth of the rods is measured to ensure that the required shutdown margin and reactivity insertion rates are maintained. It also provides a means for determining the reactivity of experiments. Measuring annually will provide corrections for burnup, and measuring after core changes ensures that altered rod worths will be known before continued operations.

The visual inspection of the rods and measurements of control rod scram times and drive times are made to ensure that the rods are capable of performing properly. Verification of operability after maintenance or modification of the control system will ensure proper reinstallation.

4.2.2 Reactor Safety System

Applicability: This specification applies to the surveillance requirements for the reactor safety system.

Objective: To ensure that the reactor safety system channels will remain operable and prevent safety limits from being exceeded.

Specification:

(1) A channel check of each measuring channel shall be performed daily when the reactor is operating.

(2) A channel test of each measuring channel shall be performed before each day's operation or before each operation extending more than 1 day.

(3) A channel calibration of the reactor power level measuring channels shall be made annually (linear level and LOG-N).

(4) A channel calibration of the level and period safety channels shall be made annually. Channel tests are done on these before each day's operation.

(5) A channel calibration of the following shall be made annually:

a. core inlet temperature measuring system
b. adequate pool water level indication
c. indication of coolant system pumps operating
d. indication that there is flow in the primary coolant loop

(6) The control room manual scram shall be verified to be operable before each day's operation. All other manual scram switches shall be tested annually.

(7) Other scram channels shall be tested/calibrated annually.

(8) Any instrument channel replacement shall be calibrated after installation and before utilization.

(9) Any instrument repair or replacement shall have a channel test before reactor operation.

Bases: The daily channel tests and checks will ensure that the scram channels are operable. Appropriate annual tests or calibrations will ensure that those long-term functions not tested before daily operation are operable.

4.3 Coolant System

4.3.1 Primary Coolant Water Purity

Applicability: This specification applies to the conductivity of the primary coolant water.

Objective: To ensure high-quality pool water.

Specification: The conductivity and pH of the pool water shall be measured weekly.

Bases: This specification ensures that changes that might increase the corrosion rate are detected in a timely manner and that the concentrations of impurities that might be made radioactive do not increase significantly.

4.3.2 Coolant System Radioactivity

Applicability: This specification applies to the radioactive material in the primary coolant or secondary coolant.

Objective: To identify radionuclides as potential sources of release to the sanitary sewer system.

Specification: Primary and secondary coolant shall be analyzed for radioactivity quarterly and before release.

Bases: Radionuclide analysis of the pool water or secondary coolant allows for the determination of any significant buildup of fission or activation products and helps ensure that radioactivity is not permitted to escape to the tertiary system in an uncontrolled manner.

4.4 Confinement

Applicability: This specification applies to the surveillance requirements for building confinement.

Objective: To ensure that building confinement capability exists.

Specification: A quarterly test shall be made to ensure that the building exhaust fan is operable and all exterior doors and windows have closure capability.

Bases: Quarterly surveillance of this equipment will verify that the confinement of the reactor bay can be maintained if needed.

4.5 Ventilation System

Applicability: This specification applies to the surveillance requirements for the building ventilation system.

Objective: To ensure that the ventilation shutoff functions satisfactorily.

Specification: The shutoff switch for all fans and air conditioning systems shall be tested on a quarterly basis.

Bases: This surveillance will ensure that the building can be isolated quickly if necessary to prevent uncontrolled escape of airborne radioactivity to the unrestricted environment.

4.6 Radiation Monitoring Systems and Radioactive Effluents

4.6.1 Effluent Monitor

Applicability: This specification applies to the surveillance requirement of the effluent monitor.

Objective: To ensure that the effluent monitor is operational and provides accurate effluent readings.

Specification: The effluent monitor shall have a channel calibration annually, and a channel test before each day's operation.

Bases: The calibration will ensure that effluent release estimates are accurate, and the test will ensure that the monitor is operable whenever the reactor is operating.

4.6.2 Area Radiation Monitors

Applicability: This specification applies to the area radiation monitoring equipment.

Objective: To ensure that radiation monitoring equipment is operable whenever the reactor is operating.

Specification: A channel test of the ARMs shall be completed before each day's operation, and a channel calibration shall be completed annually.

Bases: Calibration annually will ensure the required reliability, and a check on days when the reactor is operated will detect obvious malfunctions in the system.

4.6.3 Portable Survey Instrumentation

Applicability: This specification applies to the portable survey instrumentation available to measure beta-gamma exposure rates and neutron dose rates.

Objective: To ensure that radiation survey instrumentation is operable whenever the reactor is operating.

Specification: Beta-gamma and neutron survey meters shall be checked with a source for operability quarterly and shall be calibrated annually.

Bases: Checks with a source will detect obvious detector deficiencies, and an annual calibration will ensure reliability.

5.0 DESIGN FEATURES

5.1 Site and Facility Description

5.1.1 Facility Location

The reactor and associated equipment is housed in a building at 1298 Kinnear Road, Columbus, Ohio, located on the West Campus of The Ohio State University. The minimum free air volume of the building housing the reactor will be greater than or equal to 70,000 cubic feet (ft^3). There is an exhaust fan with dampers providing control of the release of airborne radioactivity.

5.1.2 Controlled and Restricted Area

The fence surrounding the reactor building shall describe the controlled area. The restricted area, as defined in 10 CFR Part 20, shall consist of the reactor building.

5.2 Reactor Coolant System

5.2.1 Primary Coolant Loop

Natural convective cooling is the primary means of heat removal from the core. Water enters the core at the bottom and flows upward through the flow channels in the fuel elements.

5.2.2 Secondary and Tertiary Coolant Loops

The secondary coolant loop removes heat from the primary coolant. The secondary coolant (ethylene glycol and water) passes through two separate heat exchangers to remove heat if necessary. Heat is removed from the first by an outside fan-forced dry cooler. City water flow through the secondary side of an additional heat exchanger makes up the tertiary loop. It provides additional cooling for the secondary coolant.

5.3 Reactor Core and Fuel

Up to 30 positions on the core grid plate are available for use as fuel element positions. Control rod fuel elements occupy four of these positions and one is reserved for the central irradiation facility flux trap. Several arrangements for the cold, clean, critical core have been investigated. Approximately 18 standard fuel elements, in addition to the control rod fuel elements, are currently required. Partial elements, blank elements, and graphite elements may be utilized in various combinations to achieve the proper excess reactivity.

The reactor fuel is plate-type U_3Si_2, with a uranium-235 enrichment of less than 20 percent. Standard fuel elements have a total of 16 fueled plates and 2 outer aluminum plates. The control rod fuel elements have inner fuel plates removed to allow the control rods to enter. Aluminum guide plates are on the inside of this gap. The outer two plates for each control rod assembly are fueled. Partial elements are also available with 25, 40, 50, and 60 percent of the nominal loading of a standard element. These partial fuel elements are prefabricated by the vendor with fixed numbers of plates.

(1) References: NUREG-1313
ANL/RERTR/TM-10
ANL/RERTR/TM-11

5.4 Fuel Storage

The fuel storage pit, located below the floor of the reactor pool and at the end opposite from the core, shall be flooded with water whenever fuel is present and shall be capable of storing a complete core loading. When fully loaded with fuel and filled with water, K_{eff} shall not exceed 0.90, and natural convective cooling shall ensure that no fuel temperatures reach a point at which onset of nucleate boiling is possible.

5.5 Fuel-Handling Tools

All tools designed for or capable of removing fuel from core positions or storage rack positions shall be secured when not in use by a system controlled by the supervisor of reactor operations or the senior reactor operator on duty.

6.0 ADMINISTRATIVE CONTROLS

6.1 Organization

6.1.1 Structure

The Ohio State University Research Reactor is a part of the College of Engineering administered by the Engineering Experiment Station. Figure 6.1 illustrates the organizational structure.

6.1.2 Responsibility

The Director, Engineering Experiment Station (Level 1), is the contact person for communications between the NRC and The Ohio State University.

The Director, Nuclear Reactor Laboratory (Level 2), will have overall responsibility for the management of the facility.

The Associate Director (or Manager, Reactor Operations) (Level 3) shall be responsible for the day-to-day operation and for ensuring that all operations are conducted in a safe manner and within the limits prescribed by the facility license and technical specifications. During periods when the associate director is absent, his/her responsibilities are delegated to a senior reactor operator (Level 4).

6.1.3 Staffing

(1) The following shall be the minimum staffing when the reactor is not secured:

a. A certified reactor operator shall be in the control room.

b. A second designated person shall be present at the facility complex able to carry out prescribed written instructions. Unexpected absence for as long as 2 hours to accommodate a personal emergency may be acceptable provided immediate action is taken to obtain a replacement.

c. A senior reactor operator shall be readily available on call. “Readily available on call” means an individual who (1) has been specifically designated and the designation known to the operator on duty, (2) keeps the operator on duty informed of where he/she may be rapidly contacted and the phone number, and (3) is capable of getting to the reactor facility within a reasonable time under normal conditions (e.g., 30 minutes or within a 15-mile radius).

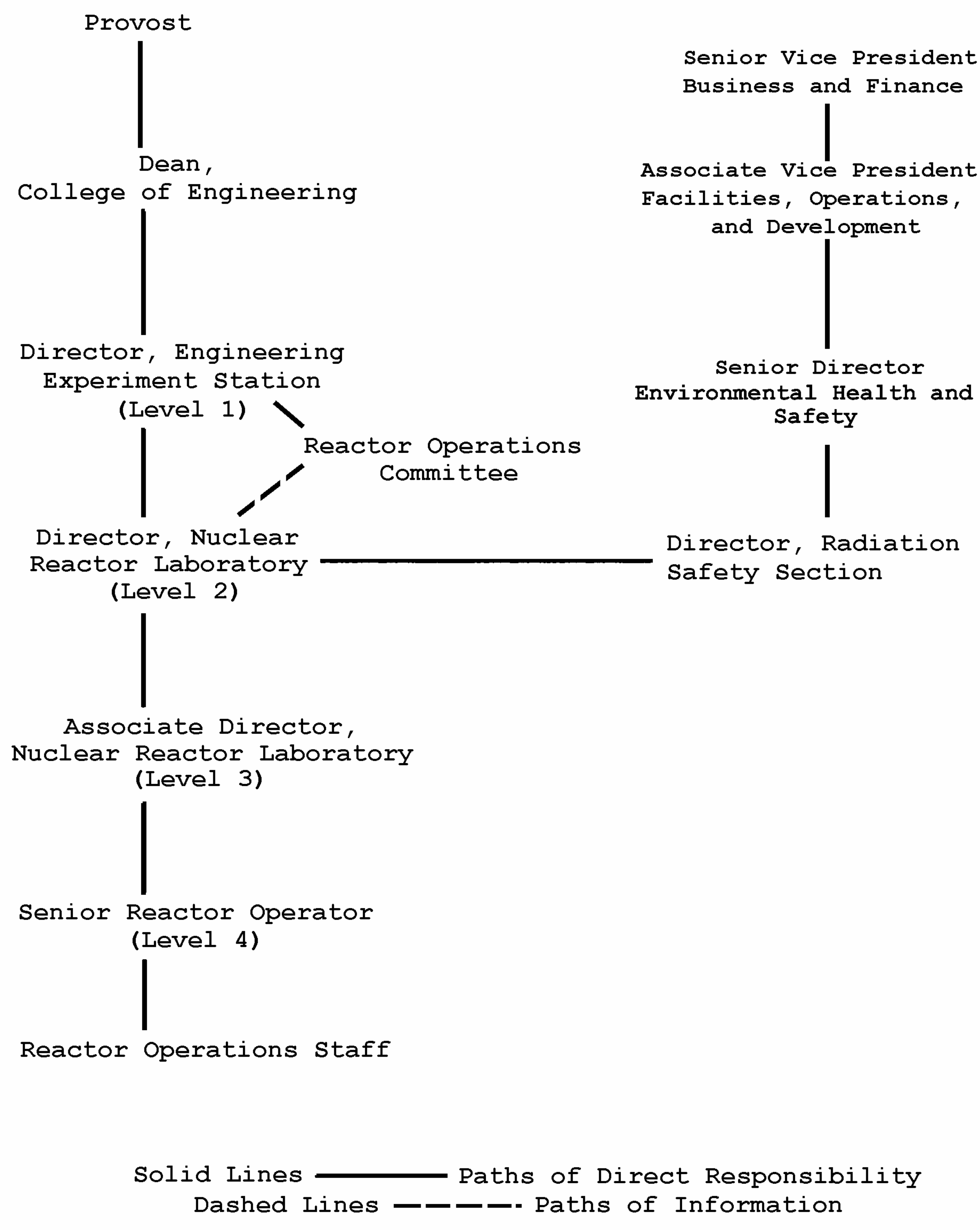

Figure 6.1 Administrative Organization

(2) A list of reactor facility personnel by name and telephone number shall be readily available in the control room for use by the reactor operator. The list shall include the following:

a. management personnel
b. radiation safety personnel
c. other operations personnel

(3) The following events require the presence at the facility of a senior reactor operator:

a. initial startup and approach to power

b. all fuel or control-rod relocations within the reactor core region

c. recovery from an unplanned or unscheduled shutdown (these instances require documented verbal concurrence from a senior reactor operator)

6.1.4 Selection and Training of Personnel

The selection, training, and requalification of operations personnel shall meet or exceed the requirements of American National Standard, ANSI/ANS-15.4-1988, "Selection and Training of Personnel for Research Reactors."

6.2 Review and Audit

There shall be a reactor operations committee (ROC) for independent review of the safety aspects of reactor operations to ensure that the facility is operating in a manner consistent with public safety and within the terms of the facility license.

A member or members of this committee or another qualified person or persons shall audit safety aspects of reactor operations as described in Section 6.2.4 of this document.

6.2.1 Composition and Qualifications of the Reactor Operations Committee

The ROC shall be composed of a minimum of three members who should collectively represent a broad spectrum of expertise in appropriate fields (i.e., having professional backgrounds in engineering, physical, biological, or medical sciences, as well as knowledge of and interest in applications of nuclear technology and ionizing radiation). Members and alternates shall be appointed by and report to Level 1 management. Individuals may be either from within or outside the operating organization. Qualified and approved alternates may serve in the absence of regular members.

6.2.2 Reactor Operations Committee Meetings

ROC functions shall be conducted in accordance with the following four items:

(1) Meetings shall be held at least once per calendar year and more frequently as circumstances warrant, consistent with effective monitoring of facility activities.

(2) A meeting quorum shall consist of at least one-half of the membership where the operating staff does not constitute a majority.

(3) The ROC may appoint a subcommittee from within its membership to act on behalf of the full committee on those matters that cannot await the next meeting. The ROC shall review the actions taken by the subcommittee at the next regular meeting.

(4) Meeting minutes shall be distributed to ROC members before the next meeting and shall be reviewed at the next meeting.

6.2.3 Review Function

The ROC shall review the following eight items:

(1) determination that proposed changes in equipment, systems, tests, experiments, or procedures do not require a license update, as described in 10 CFR 50.59, “Changes, Tests and Experiments”

(2) all new procedures and major revisions thereto having safety significance and proposed changes in reactor facility equipment or systems having safety significance

(3) all new experiments or classes of experiments that could affect reactivity or result in the release of radioactivity

(4) proposed changes in technical specifications or license

(5) violations of technical specifications or license and violations of internal procedures having safety significance

(6) operating abnormalities having safety significance

(7) reportable occurrences listed in Section 6.6.2 of this document

(8) audit reports

A written report or minutes of the findings and recommendations of the review group shall be submitted to Level 1 management and ROC members in a timely manner after the review has been completed.

6.2.4 Audit Function

The audit function shall include selective (but comprehensive) examination of operating records, logs, and other documents. Discussions with cognizant personnel and observations of operations should be used as appropriate. In no case shall the individual immediately responsible for an area perform an audit in that area. The following four items shall be audited:

(1) facility operations for conformance to the technical specifications and license, at least once per calendar year (interval between audits not to exceed 15 months)

(2) the requalification program for the operating staff, at least once every other calendar year (interval between audits not to exceed 30 months)

(3) the results of action taken to correct those deficiencies that may occur in the reactor facility, equipment, systems, structures, or methods of operations that affect reactor safety, at least once per calendar year (interval between audits not to exceed 15 months)

(4) the reactor facility emergency plan and implementing procedures at least once every other calendar year (interval between audits not to exceed 30 months)

Deficiencies found that affect reactor safety shall be reported immediately to Level 1 management. A written report of audit findings should be submitted to Level 1 management and the full ROC within 3 months of the audit's completion.

6.3 Procedures

6.3.1 Reactor Operating Procedures

Written procedures, reviewed and approved by the director, or his/her designee, and reviewed by the ROC, shall be in effect and followed. The procedures shall be adequate to ensure the safety of the reactor, but should not preclude the use of independent judgment and action, should the situation require such. All new procedures and changes to existing procedures shall be documented by the NRL staff and subsequently reviewed by the ROC. At least the following eight items shall be covered:

(1) startup, operation, and shutdown of the reactor

(2) installation, removal, or movement 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 cooling system leaks, and abnormal reactivity changes

(4) emergency conditions involving potential or actual release of radioactivity including provisions for evacuation, re-entry, recovery, and medical support

(5) preventive and corrective maintenance procedures for systems that could have an effect on reactor safety

(6) periodic surveillance of reactor instrumentation and safety systems, area monitors, and radiation safety equipment

(7) implementation of the emergency plan, reactor operator training and requalification requirements, and the security requirements of 10 CFR 73.67, “Licensee Fixed Site and In-Transit Requirements for the Physical Protection of Special Nuclear Material of Moderate and Low Strategic Advantage”

(8) personnel radiation protection

6.3.2 Administrative Procedures

Procedures shall also be written and maintained to ensure compliance with Federal regulations, the facility license, and commitments made to the ROC or other advisory or governing bodies. As a minimum, these procedures shall include the following:

(1) audits
(2) special nuclear material accounting
(3) operator requalification
(4) recordkeeping
(5) procedure writing and approval

6.4 Experiment Review and Approval

6.4.1 Definitions of Experiments

Approved experiments are those that have previously been reviewed and approved by the ROC. They shall be documented and may be included as part of the procedures manual. New experiments are those that have not previously been reviewed, approved, and performed. Routine tests and maintenance activities are not experiments.

6.4.2 Approved Experiments

All proposed experiments utilizing the reactor shall be evaluated by the experimenter and a licensed senior reactor operator to ensure compliance with the provisions of the utilization license, the technical specifications, 10 CFR Part 20, and 10 CFR Part 50, “Domestic Licensing of Production and Utilization Facilities.” If, in the judgment of the senior reactor operator, the experiment meets with the above provisions, is an approved experiment, and does not constitute a threat to the integrity of the reactor, it may be approved for performance. When pertinent, the evaluation shall include considerations of the following four items:

(1) the reactivity worth of the experiment

(2) the integrity of the experiment, including the effects of changes in temperature, pressure, or chemical composition

(3) any physical or chemical interaction that could occur with the reactor components

(4) any radiation hazard that may result from the activation of materials or from external beams

6.4.3 New Experiments

Before performing an experiment not previously approved for the reactor, the experiment shall be reviewed and approved by the ROC. Committee review shall consider the following three items:

(1) the purpose of the experiment
(2) the procedure for the performance of the experiment
(3) the safety evaluation previously reviewed by a licensed senior reactor operator

6.5 Required Actions

6.5.1 Action To Be Taken in the Event a Safety Limit Is Exceeded

(1) The reactor shall be shut down, and reactor operations shall not be resumed until authorized by the NRC.

(2) The safety limit violation shall be promptly reported to the director of the reactor laboratory.

(3) The safety limit violation shall be reported by telephone to the NRC within 24 hours.

(4) A safety limit violation report shall be prepared. The report shall describe the following:

a. applicable circumstances leading to the violation including, when known, the cause and contributing factors

b. effect of the violation upon reactor facility components, systems, or structures and on the health and safety of personnel and the public

c. corrective action to be taken to prevent recurrence

(5) The report shall be reviewed by the ROC and shall be submitted to the NRC within 14 working days, and any follow-up report shall be submitted to the NRC when authorization is sought to resume operation of the reactor.

6.5.2 Action To Be Taken in the Event of a Reportable Occurrence

A reportable occurrence is any of the following seven conditions:

(1) operating with any safety system setting less conservative than stated in these specifications

(2) operating in violation of a limiting condition for operation established in Section 3.0 of these specifications

(3) safety system component malfunctions or other component or system malfunctions during reactor operation that could, or threaten to, render the safety system incapable of performing its intended function

(4) an uncontrolled or unanticipated increase in reactivity in excess of 0.4% $\Delta k/k$

(5) an observed inadequacy in the implementation of either administrative or procedural controls, such that the inadequacy could have caused the existence or development of an unsafe condition in connection with the operation of the reactor

(6) abnormal and significant degradation in reactor fuel and/or cladding, coolant boundary, or confinement boundary (excluding minor leaks), where applicable, that could result in exceeding prescribed radiation exposure limits of personnel and/or the environment

(7) any uncontrolled or unauthorized release of radioactivity to the unrestricted environment

In the event of a reportable occurrence, the following four actions shall be taken:

(1) The reactor conditions shall be returned to normal, or the reactor shall be shutdown, to correct the occurrence.

(2) The director of the reactor laboratory shall be notified as soon as possible and corrective action shall be taken before resuming the operation involved.

(3) A written report of the occurrence shall be made which shall include an analysis of the cause of the occurrence, the corrective action taken, and the recommendations for measures to preclude or reduce the probability of recurrence. This report shall be submitted to the director and the ROC for review and approval.

(4) A report shall be submitted to the NRC in accordance with Section 6.6.2 of these specifications.

6.6 Reports

Reports shall be made to the NRC as described in the following sections.

6.6.1 Operating Reports

An annual report shall be made by September 30 of each year to the NRC Document Control Desk (if on paper, the signed original), with a copy to the appropriate NRC Regional Office, in accordance with 10 CFR 50.4, "Written Communications," providing the following seven information items:

(1) a narrative summary of operating experience (including experiments performed) and of changes in facility design, performance characteristics, and operating procedures related to reactor safety occurring during the reporting period

(2) a tabulation showing the energy generated by the reactor (in kW hours) and the number of hours the reactor was in use

(3) the results of safety-related maintenance and inspections and the reasons for corrective maintenance of safety-related items

(4) a table of unscheduled shutdowns and inadvertent scrams, including their reasons and the corrective actions taken

(5) a summary of the safety analyses performed in connection with changes to the facility or procedures, which affect reactor safety, and performance of tests or experiments carried out under the conditions of 10 CFR 50.59

(6) a summary of the nature and amount of radioactive gaseous, liquid, and solid effluents released or discharged to the environs beyond the effective control of the licensee as measured or calculated at or before the point of such release or discharge

(7) a summary of radiation exposures received by facility personnel and visitors, including the dates and times of significant exposures

6.6.2 Special Reports

(1) A telephone or telegraph report of the following shall be submitted as soon as possible, but no later than the next working day, to the appropriate Regional Office:

   a. any accidental offsite release of radioactivity above authorized limits, whether or not the release resulted in property damage, personal injury, or known exposure

   b. any exceeding of the safety limit as defined in Section 2.1 of these specifications

   c. any reportable occurrences defined in Section 6.5.2 of these specifications

(2) A written report shall be submitted within 14 days to the NRC Document Control Desk (if on paper, the signed original), with a copy to the appropriate Regional Office, in accordance with 10 CFR 50.4, of the following:

a. any accidental offsite release of radioactivity above permissible limits, whether or not the release resulted in property damage, personal injury, or known exposure

b. any exceeding of the safety limit as defined in Section 2.1 of these specifications

c. any reportable occurrence as defined in Section 6.5.2 of these specifications

(3) A written report shall be submitted within 30 days to the NRC Document Control Desk (if on paper, the signed original), with a copy to the appropriate Regional Office in accordance with 10 CFR 50.4, of the following:

a. any substantial variance from performance specifications contained in these specifications or in the SAR

b. any significant change in the transient or accident analyses as described in the SAR

c. changes in personnel serving as the Director, Engineering Experiment Station, Reactor Director, or Reactor Associate Director

(4) A report shall be submitted within 9 months after initial criticality of the reactor or within 90 days of completion of the startup test program, whichever is earlier, to the NRC Document Control Desk (if on paper, the signed original), with a copy to the appropriate Regional Office, upon receipt of a new facility license, an amendment to the license authorizing an increase in power level, or the installation of a new core of a different fuel element type or design than previously used.

The report shall include the measured values of the operating conditions or characteristics of the reactor under the new conditions and comparisons with predicted values, including the following:

a. total control rod reactivity worth
b. reactivity worth of the single control rod of highest reactivity worth
c. minimum shutdown margin both at ambient and operating temperatures
d. excess reactivity
e. calibration of operating power levels
f. radiation leakage outside the biological shielding
g. release of radioactive effluents to the unrestricted environment

6.7 Records

Records or logs of the items listed below shall be kept in a manner convenient for review and shall be retained for as long as indicated.

6.7.1 Records To Be Retained for a Period of at Least 5 Years

(1) normal plant operation
(2) principal maintenance activities
(3) experiments performed with the reactor
(4) reportable occurrences
(5) equipment and component surveillance activity
(6) facility radiation and contamination surveys
(7) transfer of radioactive material
(8) changes to operating procedures
(9) minutes of ROC meetings

6.7.2 Records To Be Retained for at Least One Requalification Cycle

Regarding retraining and requalification of licensed operations personnel, the records of the most recent complete requalification cycle shall be maintained at all times the individual is employed.

6.7.3 Records To Be Retained for the Life of the Facility

(1) gaseous and liquid radioactive effluents released to the environment

(2) fuel inventories and transfers

(3) radiation exposures for all personnel

(4) changes to reactor systems, components, or equipment that may affect reactor safety

(5) updated, corrected, and as-built drawings of the facility

(6) records of significant spills of radioactivity, and status

(7) annual operating reports provided to the NRC

(8) copies of NRC inspection reports, and related correspondence