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

UNITED STATES NUCLEAR REGULATORY COMMISSION

UNIVERSITY OF KANSAS

DOCKET NO. 50-148

RENEWAL OF FACILITY OPERATING LICENSE

Amendment No. 14
License No. R-78

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

   A. The application for facility license renewal by the University of Kansas (the licensee) dated March 4, 1980, 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 10 CFR, Chapter I;

   B. Construction of the facility was completed in substantial conformance with Construction Permit No. CPRR-52, dated April 7, 1960, the provisions of the Act, and the rules and regulations of the Commission;

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

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

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

   F. The licensee is a nonprofit educational institution and will use the facility for the conduct of educational activities, and has satisfied the applicable provisions of 10 CFR Part 140, "Financial Protection Requirements and Indemnity Agreements," of the Commission's regulations;

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

H. The issuance of this amended license is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied; and

I. The receipt, possession and use of the byproduct and special nuclear materials as authorized by this amended license will be in accordance with the Commission's regulations in 10 CFR Parts 30 and 70, including Sections 30.33, 70.23 and 70.31.

2. Facility Operating License No. R-78 is hereby amended in its entirety to read as follows:

A. This amended license applies to the light water-moderated and -cooled pool-type nuclear reactor (herein the facility or the reactor) which is owned by the University of Kansas and located on the University's campus in Lawrence, Kansas, and described in the University's application for license dated March 4, 1980, as supplemented.

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

(1) Pursuant to Section 104c of the Act and 10 CFR Part 50 - "Domestic Licensing of Production and Utilization Facilities," to possess, use and operate the reactor as a utilization facility at the designated location in Lawrence, Kansas, in accordance with the procedures and limitations set forth in this amended license.

(2) Pursuant to the Act and 10 CFR Part 70 - "Domestic Licensing of Special Nuclear Material," to receive, possess and use up to 4 kilograms of contained uranium-235 and 80 grams of plutonium contained in encapsulated plutonium-beryllium neutron sources in connection with operation of the reactor, and 9 grams of plutonium 239 in the form of foils for irradiation in the reactor.

(3) Pursuant to the Act and 10 CFR Part 30 - "Rules of General Applicability to Domestic Licensing of Byproduct Materials," (1) to receive, possess and use up to 250 microcuries of strontium 90 and 10 grams of neptunium-237 in connection with operation of the reactor and (2) to possess, but not to separate, such byproduct material as may be produced by operation of the reactor.

(4) Pursuant to the Act and 10 CFR Part 40 - "Domestic Licensing of Source Material," to receive, possess and use up to 50 pounds of uranium-238 (formerly covered by Source Material License No. SUB-546) in the form of fuel plates and foils for irradiation in the reactor facility in accordance with the procedures in the application dated December 28, 1967.

C. This amended license shall be deemed to contain and is subject to the conditions specified in Parts 20, 30, 40, 50, 51, 55, 70 and 73 of 10 CFR, Chapter I, to all applicable provisions of the Act, and to the rules, regulations and orders of the Commission now or hereafter in effect and to the additional conditions specified below:

(1) Maximum Power Level

The University of Kansas may operate the reactor at steady-state power levels not in excess of 10 kilowatts (thermal), and not in excess of 250 kilowatts (thermal) for defined periods of time as specified in the Technical Specifications.

(2) Technical Specifications

The Technical Specifications contained in Appendix A, as revised through Amendment No. 14, are hereby incorporated in the license. The licensee shall operate the facility in accordance with the Technical Specifications.

(3) Physical Security Plan

The licensee shall maintain and fully implement all provisions of the Commission-approved physical security plan, including amendments, and changes made pursuant to the authority of 10 CFR 50.54(p). The approved security plan consists of documents withheld from public disclosure pursuant to 10 CFR 2.790, entitled "Physical Security for the University of Kansas," submitted by letter dated September 15, 1981, as revised October 5, 1981.

3. This amended license is effective as of the date of issuance of this amendment and shall expire at midnight April 7, 1990.

FOR THE NUCLEAR REGULATORY COMMISSION

Darrell G. Eisenhut, Director
Division of Licensing

Enclosure:
Appendix A Technical
Specifications

Date of Issuance: MAY 31 1984

APPENDIX A

Technical Specifications
for the
Nuclear Reactor
Facility License R-78

The University of Kansas
Department of Chemical and Petroleum Engineering
Lawrence, Kansas

March, 1980
Revised April, 1984

1.0 DEFINITIONS

The terms Safety Limit (SL), Limiting Safety System Setting (LSSS), and Limiting Condition of Operation (LCO) are as defined in 50.36 of 10 CFR Part 50.

Channel Calibration - A Channel Calibration is an adjustment of the channel components such that its output responds, within acceptable range and accuracy, to known values of the parameter which the channel measures. Calibration shall encompass the entire channel, including readouts, alarm, or trip.

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

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

Control Rod - A control rod is a rod fabricated from neutron absorbing material which is used to compensate for fuel burnup, temperature, and poison effects. A control rod is magnetically coupled to its drive unit allowing it to perform the safety function when the magnet is de-energized.

Excess Reactivity - The excess reactivity is that amount of reactivity that would be available if all control rods were fully withdrawn.

Experiment - An Experiment is an apparatus, device or material, placed in the reactor core, in an experiment facility, or in line with a beam of radiation emanating from the reactor, excluding devices designed to measure reactor characteristics such as detectors and foils.

a. Movable Experiment - A movable experiment is one which may be inserted, removed, or manipulated while the reactor is critical.

b. Secured Experiment - Any experiment, experiment 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 core. The restraining forces must be substantially greater than those to which the experiment might be subjected by hydraulic, pneumatic, or other forces which are normal to the operating environment of the experiment (or by forces which can arise as a result of credible malfunctions).

c. Untried Experiment - is a single experiment or class of experiments that has not been previously evaluated and approved by the Nuclear Reactor Committee.

Experiment Facilities - An Experiment Facility is any structure, device or pipe system which is intended to guide, orient, position, manipulate, control the environment or otherwise facilitate a multiplicity of experiments of similar character.

Measured Value - The Measured Value of a parameter is as it appears on the output of a measuring channel.

Measuring Channel - A Measuring Channel is the combination of sensor, lines, amplifiers, and output devices which are connected for the purpose of measuring the value of a parameter.

Operable - Operable means a component or system is capable of performing its intended function in its normal manner as demonstrated by continued normal functioning in routine reactor operation and satisfactory completion of checks, tests, calibrations according to the specified schedule.

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

Reactivity Worth of an Experiment - The maximum value of the change in reactivity from intended or anticipated changes or credible accidents that alter the position or configuration of the experiment.

Reactor Operating - The reactor is considered to be operating whenever it is not secured nor shutdown.

Reactor Operator - An individual licensed to operate the reactor.

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

Reactor Secured - The reactor is secured when:

a. The core contains insufficient fuel to attain criticality under optimum conditions of moderation and reflection, or

b. The moderator has been removed, or

c. (1) Minimum number of control rods fully inserted as required by Technical Specifications, and

(2) The withdraw buss key switch is in the off position and the key is removed from the lock, and

(3) 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, and

(4) No in-core experiments are being moved or serviced with a reactivity worth exceeding the maximum value allowed for a single experiment or one dollar, whichever is smaller.

Reactor Shutdown - The reactor is shut down when the negative reactivity of the cold, clean core, including the reactivity worths of all experiments is equal to or greater than the shutdown margin.

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 may be rapidly contacted (e.g. by phone, etc.) (3) is capable of getting to the reactor facility within a reasonable time under normal conditions.

Reportable Occurrence - A Reportable Occurrence is any of those conditions described in Section 6.5.3 of this specification.

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

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

Scram Time - is the elapsed time between the instant a limiting safety system set point is reached and the instant that the slowest control rod is fully inserted.

Shall, Should and May - Shall is used to require an action, should is used to recommend an action and may is used to permit an action.

Shutdown Margin - The shutdown margin is the reactivity of the reactor with the two least effective control rods inserted, with the most effective control rod fully withdrawn, with the core cold and Xenon free and with the highest worth moveable experiment in the core in the most reactive state. The shutdown margin assures the reactor is

subcritical.

True Value - The True Value of a parameter is its actual value at any instant.

Unscheduled Shutdown - An Unscheduled Shutdown is any unplanned shutdown of the reactor, after startup has been initiated.

2.0 SAFETY LIMITS AND LIMITING SAFETY SYSTEM SETTING

2.1 Safety limits of reactor operation

2.1.1 Limits of free convection

Applicability - This specification applies to the thermal variables affecting the core.

Objective - To assure fuel cladding integrity and limit inventory of fission products.

Specifications - The maximum reactor power shall be 250 kW but the average power level will be limited to 10 kW. Any one run at power levels above 10 kW will be limited to an integrated energy of 750 kW hrs followed by a recovery period of such duration that the power averaged from the beginning of the run, including shutdown periods will be less than 10 kW. The reactor may be operated at power levels up to 10 kW during the recovery period.

Bases - The average power level is limited to 10 kW to limit the rate of accumulation of fission products in the core. The maximum power level is limited to 250 kW to avoid boiling while the pool temperature is below 120°F. A limit of 750 kW hrs is placed on the integrated energy of power runs above 10 kW as a means of limiting pool water temperature to a maximum of 120°F as specified in 3.7.c.

2.2 Limiting Safety System Setting

2.2.1 Safety Channel Set-points

Applicability - This specification applies to the set-points of the safety channels.

Objective - To insure that automatic action is initiated that will prevent a safety limit from being exceeded.

Specification - The safety channels shall be set to scram at 150% of full power or less and the Linear Channel shall be set to initiate shim rod reversal at 120% full power or less.

Bases - The set points are chosen to avoid boiling in the core during routine operation, and to assure the cladding temperature will be well below the melting point of the cladding.

3.0 LIMITING CONDITIONS FOR OPERATION

3.1 Reactivity Limitations

a. Applicability - These specifications apply to the parameters which describe the reactivity of the core.

b. Objective - The objective is to assure that the reactor can be shutdown even if the control rod worth the most in reactivity is stuck in its fully withdrawn position.

c. Specification - The shutdown margin shall be greater than 0.5% delta k/k and the excess reactivity less than 1.5% delta k/k.

d. Bases - A shutdown margin of 0.5% delta k/k is sufficient to assure reactor shutdown. An excess reactivity limit of 1.5% delta k/k is adequate to assure against melting in the core as defended in Appendix E of the Hazards Summary Report.

3.2 Control and Safety Systems

3.2.1 Scram Time

a. Applicability - This specification applies to scram time.

b. Objective - The objective is to assure a minimum scram time.

c. Specification - The scram time after receipt of a scram signal shall not exceed one second.

d. Bases - A one second scram time will assure prompt initiation of a scram.

3.2.2 Measuring Channels

a. Applicability - This specification relates to the measuring channels.

b. Objective - The objective is to assure proper availability of signals from reactor instrumentation.

c. Specification - The minimum number and type of measuring channels operable and providing information to the reactor operator required for operation are given as follows:

Linear Power channel

Log N channel

*Log count rate channel

Rod position indicators

*required during startup.

d. Bases - The count rate channel covers the neutron flux range from the source level of 2 cps to 10^5 cps on a logarithmic scale. It enables the operator to start the reactor safely from a shutdown condition, and to bring the power to a level that can be measured by the Log N channel.

The Log N and the Linear Power channel provide redundant information on reactor power from 0.25 W to 250 Kw.

Rod position indicators show the operator the relative positions of control rods and enable rod reactivity estimates to be made.

3.2.3 Safety Channels

a. Applicability - This specification applies to the safety channels.

b. Objective - The objective is to assure proper operation of the safety channels.

c. Specification - The minimum number and type of channels providing automatic action that are required for reactor operation are as follows:

Channel	Function
Safety	Scram, P > 300 kW
Log Count Rate	Inhibit, CR < 2 Cps
	Inhibit, Per < 20 sec
	Reverse, Per < 10 sec
Log N	Reverse, Per < 10 sec
	Scram, P > 375 kW
	Inhibit, Per < 20 sec
	Scram, Per < 2 sec
Linear	Scram, P > 125% of scale
	Reverse, P > 110% of scale
Manual Scram	Scram
Key Switch	Inhibit

d. Bases - The power level scram provides redundant automatic protective action to prevent exceeding the safety limit on

reactor power. The period scram, assisted by the period reverse and rod inhibit, limits the rate of increase in reactor power to values that are controllable without reaching excessive power levels or temperatures. These functions are not limiting safety system settings.

The inhibit on the count rate channel prevents inadvertent criticality during cold startup that could arise from lack of neutron information or from too rapid reactivity insertion by control rods.

The over power reverse provides automatic action to reduce power and minimize the chance of incipient boiling in the core.

Bypass is permitted on those parameters that can be monitored by alternate means if the initiating circuit malfunctions.

The key switch prevents unauthorized operation of the reactor.

3.3 Radiation Monitoring System

a. Applicability - This specification applies to the environmental radiation monitoring apparatus in the reactor bay.

b. Objective - The objective of this specification is to assure proper operation of the environmental radiation monitoring apparatus.

c. Specification

(1) During reactor operation and handling of highly radioactive materials, the reactor bay shall be monitored by at least two of the four area monitors whose locations are listed below:

a. East wall

b. South wall

c. West wall near demineralizer

d. Above the reactor tank

For the reactor to be operated above 10 kW, only the monitor on either the east or south wall may be out of service. The monitors shall provide a readout and a signal which activates the annunciator and 'Radiation Level' warning light on the console.

In the event that fewer than two of the four area monitors are in service, reactor operation at power levels no greater than 10 kW may continue using portable gamma sensitive monitoring devices with the following restrictions:

a. The monitoring devices used must be verified to be operable just prior to first use of the day using a check source.

b. At least two of the areas listed in a. to d. above shall be monitored by the installed and/or the portable monitoring equipment. The portable gamma sensitive detectors shall be monitored continuously during reactor operation and during sample removal.

c. Radiation levels and locations shall be recorded in the log book.

(2) An air monitor shall be placed in the reactor bay at frequent time intervals to determine the amount of radioactivity present in the air.

The reactor bay area shall be continuously monitored if the evaluation of any experiment shows that 25% of the allowable exposure as described in Table I, Appendix B of 10 CFR 20 can be exceeded under accident conditions.

(3) The power level of the reactor shall be limited to a value such that the radiation level at the foot of the drive at the south end of the building will be less than 2 mRem/hr. Whenever a radiation level above 2 mRem/hr exists on the drive, the drive will be posted as a radiation zone to limit free access to the drive.

d. Bases - It is necessary to monitor the radiation in the reactor bay to be able to minimize exposure of individuals to radiation. It is necessary to limit access of the public to areas where the radiation may be above 2 mRem/hr.

3.4 Confinement

a. Applicability - These specifications apply to the ventilation system in the reactor bay.

b. Objective - The objective is to minimize the spread of fire or contaminants.

c. Specification - In an emergency the ventilation fan for the room should be turned off and entry doors kept shut.

d. Bases - Restricting the flow of air should reduce the chances of spreading a fire or contamination.

3.5 Limitations on Experiments

a. Applicability - This specification applies to those experiments in the reactor and its experiment facilities.

b. Objective - The objective is to prevent damage to the reactor or excessive release of radioactive material in the event of an experiment failure and also to prevent the safety limits from being exceeded.

c. Specification - Experiments installed in the reactor shall meet

the following conditions:

(1) The reactivity worth of any individual secured experiment shall not exceed 1.5% delta k/k. The reactivity worth of a movable experiment shall not exceed 0.4% delta k/k and the sum of the absolute worths of all movable experiments shall not exceed 1.2% delta k/k.

(2) The sum of the absolute reactivity worths of all experiments in the reactor and in the associated experimental facilities at the time shall not exceed 1.5% delta k/k. This includes the total potential reactivity insertion which might result from experiment malfunction, accidental experiment flooding or voiding, accidental removal or insertion of experiments.

(3) If estimated worth of experiment is greater than 1% delta k/k, the actual worth shall be measured and recorded at the time of initial insertion of the experiment.

(4) Failure of an experiment shall not lead to a direct failure of a fuel element or other experiments.

(5) Where the possibility exists that the failure of an experiment could release radioactive gases or aerosols to the reactor bay or atmosphere, the quantity and type of material shall be limited such that the airborne concentration of radioactivity averaged over a year will not exceed the limits of Table II of Appendix B of 10 CFR Part 20 assuming 100% of the gases or aerosols escape.

(6) Liquids contained only in breakable containers shall not be irradiated.

(7) All samples of soluble material being irradiated within the

pool shall be encapsulated in a water tight non-breakable radiation resistant container.

(8) All material being irradiated within the thermal column or beamports which is capable of contaminating local areas will be placed in dust proof containers.

(9) Known explosive materials such as gunpowder, dynamite, TNT, or nitroglycerine shall not be irradiated in the reactor or experimental facilities.

d. Bases

(1) The limit on reactivity limits the severity of power excursion. See HSR page 36 (Ref 1). Other restrictions are judged prudent safety measures.

3.6 Fuel

a. Applicability - These specifications apply to the number and condition of the fuel elements in the core.

b. Objective - To ensure that power is distributed in the core among a sufficient number of fuel elements to avoid excessive peak/average ratio, and to avoid excessive release of fission products.

c. Specifications

(1) The number of fuel elements loaded will be such as to assure the k_{ex} is 1.5% or less.

(2) Fuel elements exhibiting release of fission products due to cladding rupture shall, upon positive identification, be removed from the core. An abnormal increase in radiation level at the demineralizer together with detection of fission products in the pool water shall constitute initial evidence of cladding rupture

and require identification of the cause.

(3) The fuel elements shall be MTR type.

d. Bases

(1) This specification limits the number of fuel elements that can be loaded into the core.

(2) There is a normal small and variable amount of fission product release due to uranium contamination in the coolant and on fuel plates. It is thus safe to specify a recognizable and substantial increase in background as a possible indication of cladding rupture.

(3) This specification defines the type of fuel used in the reactor.

3.7 Pool water quality

a. Applicability - This specification applies to the reactor pool water in contact with the fuel elements.

b. Objective - To minimize corrosion of the fuel element cladding, and to prevent the activation of dissolved materials.

c. Specification

(1) The recirculated pool water shall be tested for resistivity before the first reactor start up of the day. Resistivity shall not be below 1 megohm centimeter averaged over a month.

(2) The reactor shall not be operated when water temperature measured at the surface exceeds 120°F.

d. Bases - Water purity is controlled to preserve the integrity of the fuel element. The temperature is limited to prevent boiling.

4.0 SURVEILLANCE REQUIREMENTS

The requirements listed below generally prescribe tests or inspections to verify periodically that the performance of required systems is in accordance with specifications given above. In all instances where the specified frequency is annual, the interval between tests is not to exceed 14 months; when semiannual, the interval should not exceed 7 months; when monthly the interval shall not exceed 6 weeks; when weekly the interval shall not exceed 10 days; and when daily the interval shall not exceed 3 days. Surveillance tests, except those specifically required for safety when the reactor is shut down, may be deferred during reactor shutdown; however, they must be completed prior to reactor startup.

4.1 Safety Channel Calibration

a. Applicability - This specification applies to the safety channel calibration.

b. Objective - The objective is to assure calibration of each safety channel.

c. Specification - A channel calibration of each safety channel shall be performed annually.

d. Bases - Annual calibration is adequate to assure accurate calibration.

4.2 Reactivity Surveillance

a. Applicability - This specification applies to worth and inspection of the control rods and worth of experiments.

b. Objective - The objective of this specification is establish proper surveillance of reactivity.

c. Specification

(1) The reactivity worth of each control rod (including the regulating rod) and the shut-down margin shall be determined whenever operation requires a re-evaluation of core physics parameters. The rod worth will be determined using the reactivity-period or rod-drop methods.

(2) The reactivity worth of an experiment shall be estimated, or measured at low power, before conducting the experiment.

(3) The control rods shall be inspected every ten years or whenever drop times exceeding .9 seconds are observed.

d. Bases - Calibration of control rods provides the basis for measurement of reactivity. Control rod inspection is prudent operation to detect possible dimensional changes.

4.3 Control and Safety System Surveillance

a. Applicability - This specification applies to the control and safety systems.

b. Objective - The objective of this specification is to assure proper calibrations in the control and safety systems.

c. Specification

(1) The scram time shall be measured annually. If a control rod is removed from the core temporarily, or if a new rod is installed, its drop time shall be measured before reactor operation.

(2) A channel check of the power level measuring channels shall be performed daily whenever the reactor is in operation. A channel check before startup is, however, required on any channel receiving maintenance during the shut-down period.

d. Bases - Reactor operating experience indicates a need for annual

measurement of scram time and a need for a daily channel check.

4.4 Radiation Monitoring System

a. Applicability - This specification applies to the calibration of the area monitors.

b. Objective - The objective is to assure proper calibration of the area monitors.

c. Specification - The area monitors shall be calibrated annually The area monitors shall receive a channel check and a setpoint verification daily during reactor operating periods.

d. Bases - Operating experience indicates a need to check area monitors annually and a need for a daily channel check and set point verification.

4.5 Reactor Fuel

a. Applicability - This specification applies to the reactor fuel.

b. Objective - The objective of this specification is to assure proper fuel is utilized.

c. Specification - Upon receipt from the fuel vendor, all fuel elements shall be visually inspected and the accompanying quality control documents checked for compliance with specifications.

Each new fuel element will be inspected for damage and flow obstructions prior to insertion into the core.

Incore reactor fuel elements, excluding control rod fuel elements, shall be inspected biannually at intervals not to exceed 30 months. At least 2 elements will be inspected each time such that all full fuel elements are inspected once within ten years.

d. Bases - Use of proper undamaged fuel is necessary for proper reactor operation.

4.6 Sealed Sources

a. Applicability - This specification applies to the sealed sources.

b. Objective - This objective of this specification is to identify defective sources.

c. Specification - The PuBe sealed source shall be leak tested semiannually.

d. Bases - Semiannual leak testing represents prudent testing.

5.0 DESIGN FEATURES

Those design features relevant to operation safety and to limits that have been previously specified are described below. These features shall not be changed without appropriate review.

5.1 Reactor Fuel

Fuel elements shall be of the general MTR type with thin plates containing fuel enriched to about 93% ^{235}U and clad with aluminum. Elements shall conform to these nominal specifications:

Overall size	3 in x 3 in x 35 in
Clad thickness	.020 in
Plate thickness	.060 in
No. of Fuel plates	10 standard element
	5 control rod element
Plate Attachment	Swaged or pinned
Fuel content	167 g ^{235}U/full element

5.2 Control and Safety Systems

Design features of the components of the system 3.2.2, 3.2.3 that are important to safety are given below.

5.2.1 Power Level Safety Channel

The safety channel uses an uncompensated boron-coated ion chamber feeding an amplifer. The amplifier controls electronic switches in the circuit that supplies DC current to each control rod electromagnet. This channel controls and scrams all control rods and is fail safe. The chamber can be changed in position, over a limited range, so as to adjust the scram level.

5.2.2 Power Indicating and Level Safety Channels

For this function two independent measuring channels are provided. Each channel covers reliably the range from about .25W to 250 Kw. Each channel comprises a compensated boron-coated ion chamber feeding an amplifier that controls electronic switches in the DC current that flows through each control rod electromagnet. Each channel controls and scrams all shim rods. Each channel is fail-safe. Each channel indicates power level on a panel meter allowing channel checks to be done during reactor operation. Each chamber can be changed in position, over a limited range, so as to allow the channel reading to be standardized against reactor thermal power. One channel has a logarithmic output indication on both a panel meter and a chart recorder. Rate of change of power information is also derived, in the form of a period, that can produce a fast scram or rod reverse.

5.2.3 Count Rate Channel

A fission chamber is used to supply pulses to an amplifier and logarithmic count rate circuitry. Pulse height discrimination selects pulse amplitudes that correspond to fission events and rejects those

from alpha particles. Count rate on a logarithmic scale is displayed on a panel meter and a chart recorder. The channel covers a range of 1-10^5 cps. The fission chamber is raised when the counting rate approaches or exceeds 10^5 cps. To prevent control rod withdrawal when the neutron count rate information may not be reliably indicated, inhibits are provided on count rate. A scaler is also provided for obtaining accurate values at low count rates if needed (e.g., approach to critical with new fuel or new core configuration).

5.2.4 Neutron Source

For obtaining the reliable neutron information necessary for startup from a cold shut-down condition, a Plutonium-Beryllimum neutron source is provided for insertion into the core as needed. Integrity of the source is checked by periodic wipe tests.

5.3 Rod Control System

5.3.1 Control Rods

Three control rods are provided for the control of core reactivity. These rods contain boron-carbide. Individual integral worths vary from about 1-5% ΔK, depending on position and core configuration. The rods are coupled to drive shafts through electromagnets that allow quick release of the rods. Position indicators on the control console show the extent of withdrawal for each rod. To limit the rate of reactivity increase upon startup, the rod drive speeds are limited to 5 in/min.

5.3.2 Regulating Rod

One control rod serves as the regulating rod for fine control and maintenance of constant reactor power for long periods.

5.4 Cooling System

5.4.1 Primary Cooling System

Core cooling is provided by natural convection through the reactor core. Water flow is from the reactor pool, through the demineralizer, and back to the pool, at a flow rate of approximately 3 gal. per minute.

5.5 Confinement System

The reactor is housed in a building of reinforced concrete with an exterior stone facing and a floor space of approx. 15,000 ft^2. The circulatory fan for the reactor bay has its shut off switches near the control console and is equipped with automatic closure devices.

5.6 Fuel Storage

5.6.1 Fuel Storage and Transfer

The storage pool is located below the floor level of the reactor bay and is capable of storing the complete fuel inventory. The geometry of the storage racks are such k infinity is less than .875 when the complete fuel inventory is stored there under all moderation conditions with water.

6.0 ADMINISTRATIVE CONTROLS

6.1 Organization

6.1.1 Structure

The organization for the management and operation of the reactor facility shall be as a minimum the structure shown in Fig. 1. Job titles shown are for illustration and may vary. Three levels of authority are provided, as follows:

Level 1: Individual responsible for site administration.

Level 2: Individual responsible for the reactor facility licence,

operation, management and daily reactor operations.

Level 3: Reactor operating staff.

The Nuclear Reactor Committee shall report to Level 1.

6.1.2 Responsibility

Responsibility for the safe operation of the reactor facility shall be within the chain of command shown in Figure 1. Management levels in addition to having responsibility for the policies and operation of the reactor facility shall be responsible for safeguarding the public and facility personnel from undue radiation exposures and for adhering to all requirements of the operating license and technical specifications. In all instances responsibilities of one level may be assumed by designated alternates or by higher levels, conditional upon appropriate qualifications.

6.1.3 Staffing

a. The minimum staffing when the reactor is not secured shall be:

(1) A licensed Reactor Operator in the control room.

(2) A second person present at the reactor facility.

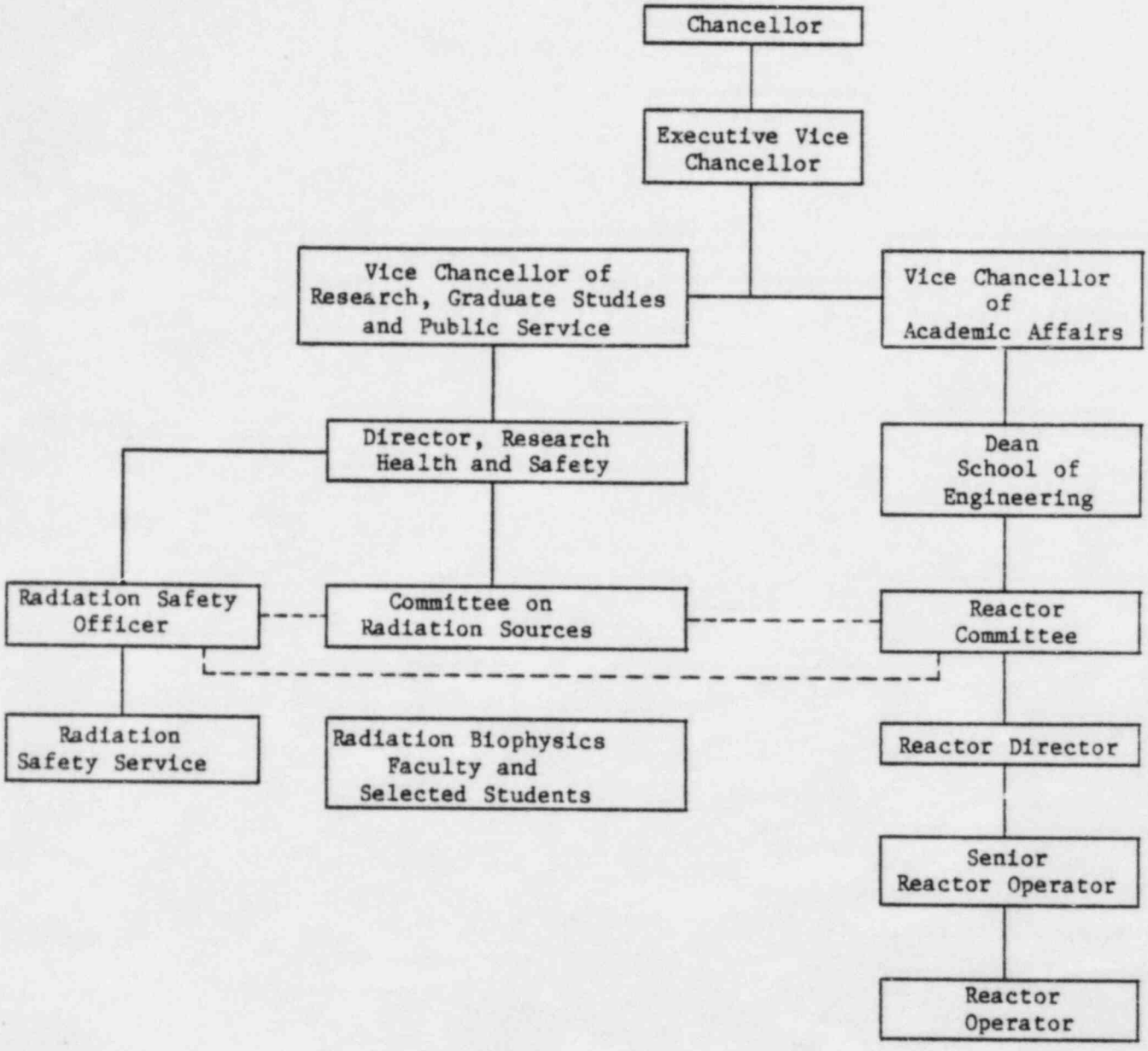

Figure 1. Organization Structure

(3) A licensed Senior Reactor Operator shall be readily available on call.

(4) A member of the operating shift shall be designated by Level 2 management as knowledgeable in radiation control.

b. Events requiring the presence of a Senior Operator:

(1) All fuel-element or control-rod alternations within the reactor core region.

(2) Relocations of any experiments with reactivity worth greater than 0.4%.

(3) Recovery from unplanned or unscheduled shutdowns unless they are of a type excluded by the Level 2 authority.

Such exclusions shall be posted in the control room or placed in the appropriate procedures. Furthermore, the presence of a senior operator at the facility shall not be required during recovery from unplanned or unscheduled shutdown or significant reduction in power in instances which result from:

1. Electrical power interruptions from internal or external failures exclusive of power supply failures of the reactor instrumentation control and safety systems;
2. False signals, which, in the opinion of the Senior Operator, were properly verified to be false and to have resulted from monitoring, experimental, or control equipment, or from personnel inadvertence; and
3. Intentional shutdowns made by the Reactor Operator which are not related to the safety of the reactor;

provided that prior to the initiation of such recovery, the Senior Operator shall be notified of the shutdown of power

reduction, and shall determine that the shutdown was caused by one of the enumerated occurrences, and shall determine that his presence at the facility during recovery is not required.

6.1.4 Selection and Training of Personnel

The selection, training, and requalification of personnel shall meet or exceed the requirements of Appendix A of 10 CFR Part 55 and be in accordance with the requalification plan approved by the Commission.

6.1.5 Review and Audit

The independent review and audit of reactor facility operations shall be performed by a qualified person designated by the Nuclear Reactor Committee.

6.1.5.1 Composition and Qualifications

The Nuclear Reactor Committee shall be composed of a minimum of 5 members. The members shall collectively provide a broad spectrum of expertise in science and engineering. Members and alternates shall be appointed by and report to the Level 1 authority. They may include the Reactor Director and Radiation Safety Officer. Qualified and approved alternates may serve in the absence of regular members.

6.1.5.2 Charter and Rules

The committee shall function under the following operating rules:

a. Meetings shall be held not less than semi-annually or more frequently as circumstances warrant consistent with effective monitoring of facility activities.

b. A quorum shall consist of not less than one half the membership, where the operating staff does not constitute a majority.

c. Sub-groups may be appointed to review specific items.

d. Minutes shall be kept, and shall be disseminated to members and

to the Level 1 authority within one month after the meeting. The Committee shall appoint one or more qualified individuals to perform the Audit Function.

6.1.5.3 Review Function

The following items shall be reviewed by the review group or a subgroup thereof:

a. Determinations that proposed changes in equipment, systems, tests, experiments, or procedures do not involve an unreviewed safety question.

b. All new procedures and major revisions there to having safety significance, proposed changes in reactor facility equipment, or systems having safety significance.

c. Tests and experiments in accordance with section 6.3.

d. Proposed changes in technical specifications, license, or charter.

e. Violations of technical specifications, license, or charter. Violations of internal procedures or instructions having safety significance.

f. Operating abnormalities having safety significance, and audit reports.

g. Reportable occurrences listed in section 6.5.3.

6.1.5.4 Audit Function

The audit function shall include selective but comprehens e examination of operating records, logs, and other documents. Where necessary, discussions with responsible personnel shall take place. In no case shall the individual or individuals conducting the audit be immediately responsible for the area being audited. The following

items shall be audited:

a. The conformance of facility operations to the technical specifications and applicable license or charter conditions, at least once per calendar year (interval not to exceed 18 months).

b. The retraining and requalification for the operating staff, at least once every other calendar year (interval not to exceed 30 months).

c. The results of actions taken to correct deficiencies occurring in reactor facility equipment, systems, structures, or methods of operations that affect reactor safety, at least once per year (interval not to exceed 18 months).

d. The reactor facility Security Plan and implementing procedures at least once every other calendar year (interval not to exceed 30 months).

Deficiencies uncovered that affect reactor safety shall immediately be reported to the Level 2 authority. A written report of the findings of the audit shall be submitted to the Level 2 authority and the Nuclear Reactor Committee members within 90 days after the audit has been completed.

6.2 Procedures

There shall be written procedures for, and prior to, initiating any of the activities listed in this section. The procedures shall be reviewed by the Nuclear Reactor Committee and approved by Level 2 or designated alternates, and such reviews and approvals shall be documented. Several of the following activities may be included in a single manual or set of procedures or divided among various manuals or procedures.

a. Startup, operation, and shutdown of the reactor.

b. Fuel loading, unloading, and movement within the reactor.

c. Routine maintenance of major components of systems that could have an effect on reactor safety.

d. Surveillance tests and calibrations required by the technical specifications or those that may have an effect on reactor safety.

e. Personnel radiation protection, consistent with applicable regulations.

f. Administrative controls for operations and maintenance and for the conduct of irradiations and experiments that could affect reactor safety or core reactivity.

g. Implementation of the Security Plan.

Substantive changes to the above procedures shall be made only after documented review by the Nuclear Reactor Committee and approval by Level 2 or designated alternates. Minor modifications to the original procedures which do not change their original intent may be made by the Level 2 authority. Temporary changes to the procedures that do not affect reactor safety may be made by a Senior Reactor Operator and are valid for a period of one month. Such temporary changes shall be documented and reported to Level 2 or designated alternate.

6.3 Experiment Review and Approval

a. All new experiments or classes of experiments that could affect reactivity or result in release of radioactive materials shall be reviewed by the Nuclear Reactor Committee. This review shall assure that compliance with the requirements of the license,

technical specifications, and applicable regulations has been satisfied, and shall be documented.

b. Prior to review, an experiment plan or proposal shall be prepared describing the experiment including any safety considerations.

c. Review comments of the Nuclear Reactor Committee setting forth any conditions and/or limitations shall be documented in Committee minutes and submitted to Level 2 authority.

d. All new experiments or classes of experiments shall be approved in writing by Level 2 or designated alternates prior to their initiation.

e. Substantive changes to approved experiments shall be made only after review by the Nuclear Reactor Committee and written approval by Level 2 or designated alternates. Minor changes that do not significantly alter the experiment may be approved by the Level 2 authority.

f. Approved experiments shall be carried out in accordance with established approved procedures.

6.4 Required Actions

6.4.1 Action to be taken in Case of Safety Limit Violation

a. The reactor shall be shutdown, and reactor operations shall not be resumed until authorized by the Commission.

b. The safety limit violation shall promptly be reported to the Level 1 authority or designated alternates.

c. The safety limit violation shall be reported to the Commission in accordance with section 6.5.2.

d. A safety limit violation report shall be prepared. The report

shall describe the following:

(1) Applicable circumstances leading to the violation.

(2) Effect of the violation upon reactor facility components, systems, or structures.

(3) Corrective action to be taken to prevent recurrence.

The report shall be reviewed by the Nuclear Reactor Committee. A follow-up report describing extant activities shall be submitted to the Commission when authorization is sought to resume operation of the reactor.

6.4.2 Action to be taken in the event of an occurrence as defined in section 6.5.2, a-1, 3:

a. Corrective action shall be taken to return conditions to normal; otherwise, the reactor shall be shutdown and reactor operation shall not be resumed unless authorized by the Level 2 authority or designated alternates.

b. All such occurrences shall be promptly reported to the Level 2 authority or designated alternates.

c. All such occurrences where applicable shall be reported to the Commission in accordance with section 6.5.3.

d. All such occurrences including action taken to prevent or reduce the probability of a recurrence shall be reviewed by the Nuclear Reactor Committee.

6.5 Reports

In addition to the requirements of applicable regulations, reports shall be made to the Commission as follows:

6.5.1 Operating Reports

Routine annual reports covering the activities of the reactor facility

during the previous calendar year shall be submitted to the appropriate NRC Office within 3 months following the end of each prescribed year. Each annual operating report shall include the following information:

a. a narrative summary of reactor operating experience including energy produced by the reactor.

b. the unscheduled shutdowns including, where applicable, corrective action taken to preclude recurrence but excluding those of the types listed in Sect. 6.1.3.b(3) above.

c. Tabulation of major preventive and corrective maintenance operations having safety significance.

d. Tabulation of major changes in the reactor facility procedures, and new tests and/or experiments significantly different from those performed previously and which are not described in the Hazards Summary Report, including conclusions that no unreviewed safety questions were involved.

e. The results of any environmental surveys performed outside the facility.

f. A summary of significant (above 500 mRem) radiation exposures received by facility personnel and visitors in any one year including the dates and times of significant exposures.

6.5.2 Special Reports (Reportable Occurrences)

a. There shall be a report not later than the following working day by telephone and confirmed by telegraph or similar conveyance to the Commission to be followed by a written report within 14 days of any of the following:

(1) Release of radioactivity from the reactor above allowed

limits.

(2) Violation of Safety Limits.

(3) Any of the following:

(a) Operation with actual safety-system settings less conservative than the limiting safety-system settings specified in the Technical Specifications.

(b) Operation in violation of Limiting Conditions for Operation established in the Technical Specifications.

(c) A reactor safety system component malfunction which renders or could render the reactor safety system incapable of performing its intended safety function unless the malfunction or condition is discovered during tests or periods of reactor shutdowns.

(Note: Where components or systems are provided in addition to those required by the Technical Specifications, the failure of the extra components or systems is not considered reportable provided that the minimum number of components or systems specified or required perform their intended reactor safety function.)

(d) An unanticipated or uncontrolled change in reactivity greater than or equal to 1% $\Delta k/k$.

(e) Abnormal and significant degradation in reactor fuel, and/or cladding, coolant boundary, or containment boundary (excluding minor leaks) where applicable which could result in exceeding prescribed radiation-exposure limits of personnel and/or environment.

(f) An observed inadequacy in the implementation of

administrative or procedural controls such that the inadequacy causes or could have caused an unsafe condition with regard to reactor operations.

b. A written report within 30 days to the Commission of:

(1) Permanent changes in the facility organization structure

(2) Significant changes in the transient or accident analysis as described in the Hazards Summary Report.

6.6 Records

Records of the following activities shall be maintained and retained for the periods specified below. The records may be in the form of logs, data sheets, or other suitable forms. The required information may be contained in single, or multiple records, or a combination thereof. Recorder charts showing operating parameters of the reactor for unscheduled shutdown and significant unplanned transients shall be maintained for a minimum period of two years.

6.6.1 Records to be Retained for a Period of at least Five Years or for the Life of the Component Involved whichever is Smaller.

a. Normal reactor facility operations (including scheduled and unscheduled shutdowns). Note: Supporting documents such as checklists, log sheets, etc. shall be maintained for a period of at least two years.

b. Principal maintenance operations.

c. Reportable occurrences.

d. Surveillance activities required by the Technical Specifications.

e. Reactor facility radiation and contamination surveys where required by applicable regulations.

f. Experiments performed with the reactor.

g. Special Nuclear Materials (SNM) inventories, receipts, and shipments.

h. Approved changes in operating procedures.

i. Records of meeting and audit reports of the Nuclear Reactor Committee.

j. Sealed Source leak test results.

6.6.2 Records to be Retained for at Least One Requalification Cycle or for the length of Employment of the Individual whichever is Smaller.

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

6.6.3 Records to be Retained for the Lifetime of the Reactor Facility:

(Note: Annual reports may be used where applicable as records in this section)

a. Gaseous and liquid radioactive effluents released to the environs.

b. Off-site environmental-monitoring surveys required by the Technical Specifications.

c. Radiation exposure for all personnel monitored.

d. Updated drawings of the reactor facility.

7.0 REFERENCES

1. Hazards Summary Report (July, 1959)