

TECHNICAL SPECIFICATIONS
FOR THE
UNIVERSITY OF ARIZONA
TRIGA RESEARCH REACTOR
FACILITY LICENSE R-52
Amendment 19

This document includes the Technical Specifications and the bases for the Technical Specifications. The bases provide the technical support for the individual Technical Specifications and are included for information purposes only. The bases are not part of the Technical Specifications and they do not constitute limitations or requirements to which the licensee must adhere.

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1.0 DEFINITIONS

Channel - A channel is a combination of sensors, electronic circuits, and output devices connected by the appropriate communications network in order to measure and display the value of a parameter.

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

Channel Check - A channel check is a qualitative verification of acceptable performance by observation of channel behavior. The verification shall include comparison of the channel output with previous readings or performance or with other independent channels or systems measuring the same variable, whenever possible.

Channel Test - A channel test is the introduction of a signal into the channel for verification that it is operable.

Cold Critical - The reactor is in the cold critical condition when it is critical with the fuel and bulk water temperatures the same ($\sim 20^{\circ}\text{C}$).

Decommissioning Activities – Decommissioning activities are the physical dismantlement or permanent removal from service of systems and components described in the SAR. Decommissioning activities, however, do not include the removal of fuel.

Experiment - An experiment is any device or material, not normally part of the reactor, which is introduced into the reactor for the purpose of exposure to radiation, or any operation which is designed to investigate non-routine reactor characteristics.

Experimental Facilities - Experimental facilities are the thermal column, pneumatic transfer systems, central thimble, rotary specimen rack, beam tube, and the in-core facilities.

Limiting Conditions for Operation - Limiting Conditions for Operation (LCO) are administratively established constraints on equipment and operational characteristics which shall be adhered to during operation of the reactor.

Limiting Decommissioning Conditions - Limiting Decommissioning Conditions (LDC) are administratively established constraints on equipment and operational characteristics which shall be adhered to during decommissioning activities.

Limiting Safety System Setting (LSSS) - The LSSS is the actuating level for automatic protective devices related to those variables having significant safety functions.

Manual Mode - The reactor is in the manual mode when the reactor mode selection switch is in the manual or automatic position. In this mode, reactor power is held constant or is changed on periods of approximately one second or longer.

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

Movable Experiment - An experiment is movable when it is intended that all or part of the experiment may be moved in or near the core or into and out of the reactor while the reactor is operating.

Operable - Operable means a component or system is capable of performing its intended function.

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

Pulse Mode - The reactor is in the pulse mode when the reactor mode selection switch is in the pulse position. In this mode, reactor power may be increased on periods less than one second by motion of the transient control rod.

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

Reactor Committee - The group of persons at the University who are assigned responsibility for review and audit of facility operation and review of changes and experiments in accordance with 10 CFR 50.59.

Reactor Operating - The reactor is operating whenever it is not secured or shutdown.

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

Reactor Secured - The reactor is secured when:

- a. It contains insufficient fissile material or moderator present in the reactor, adjacent experiments or control rods, to attain criticality under optimum available conditions of moderation and reflection, or
- b.
 1. The minimum number of neutron absorbing control rods are fully inserted or other safety devices are in shutdown position, as required by technical specifications, and
 2. The console 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 experiments in or near the reactor are being moved or serviced that have, on movement, a reactivity worth of one dollar or more.

Reactor Shutdown - The reactor is in a shutdown condition when sufficient control rods are inserted to assure that it is subcritical by at least \$1.00 of reactivity.

Reportable Occurrence - A Reportable Occurrence is any of the following which occurs during reactor operation:

- a. Operation with actual safety-system settings for required systems less conservative than the limiting safety-system settings specified in Technical Specification 2.2.
- 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 maintenance tests or periods of reactor shutdown.
- d. Any unanticipated or uncontrolled change in reactivity greater than one dollar.
- e. Abnormal and significant degradation in reactor fuel, cladding, or coolant boundary which could result in exceeding of prescribed radiation exposure or release limits.
- f. An observed inadequacy in the implementation of either administrative or procedural controls which could result in operation of the reactor outside the limiting conditions for operation.
- g. Release of radioactivity from the site above limits specified in 10CFR20.

Control Rod - A control rod is a device fabricated from neutron absorbing material or fuel which is used to establish neutron flux changes and to compensate for routine reactivity losses. A control rod may be coupled to its drive unit allowing it to perform a safety function when the coupling is disengaged.

Transient Rod - The transient rod is a control rod with scram capabilities that is capable of providing rapid reactivity insertion to produce a pulse.

Safety Limit - A Safety Limit is a limit on an important process variable which is found to be necessary to reasonably protect the integrity of certain of the physical barriers which guard against the uncontrolled release of radioactivity. The principal physical barrier is the fuel element cladding.

Secured Experiment - A Secured Experiment is 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 by hydraulic, pneumatic, buoyant, or other forces which are normal to the operating environment of the experiment, or by forces which can arise as the result of credible malfunctions.

Shall, Should, and May - The word "shall" is used to denote a requirement, the word "should" denotes a recommendation, and the word "may" denotes permission, neither a requirement nor a recommendation.

Shutdown Margin - Shutdown Margin is the reactivity existing when the most reactive control rod is fully withdrawn from the core and the other control rods are fully inserted into the core.

Time Interval - The average over any extended period for each surveillance time item shall be the normal surveillance time; e.g., for a two-year interval, the average shall not exceed two years.

- a. Biennially - at two-year intervals (interval not to exceed 30 months)
- b. Annually - at one-year intervals (interval not to exceed 15 months)
- c. Semiannually - at 6-month intervals (interval not to exceed seven and one-half months)
- d. Quarterly - at 3-month intervals (interval not to exceed four months)
- e. Monthly - at one-month intervals (interval not to exceed six weeks)
- f. Weekly - at seven-day intervals (interval not to exceed ten days)
- g. Daily - (must be done during the calendar day)

Any extension of these intervals shall be occasional and for a valid reason shall not affect the average as defined.

Untried Experiment - An untried experiment is any experiment not previously performed in this reactor.

2.0 SAFETY LIMITS AND LIMITING SAFETY SYSTEM SETTINGS

2.1 Safety Limit - Fuel Temperature

Applicability

This specification applies to the reactor fuel temperature

Objective

The objective is to define a fuel temperature below which it can be predicted with confidence that no damage to the fuel elements will occur.

Specification

The temperature of the fuel shall not exceed 1000°C under any conditions of operation.

Basis

The recommended limiting design basis parameter for TRIGA fuel is the fuel temperature. A fuel temperature safety limit of 1150°C for stainless-steel-clad U-ZrH_{1.65} TRIGA fuel is recommended as a design value to preclude the loss of clad integrity when the clad temperature is below 500°C (Simnad, GA Report E-117-833, The U-Zr H Alloy: Its Properties and Use in TRIGA Fuel, Feb. 1980, p. 4-1). The criterion for assuring the integrity of a TRIGA fuel element at the University of Arizona is that the fuel temperature be maintained below 1000°C, which is well below the recommended value. It has been shown by analysis and by measurements on other TRIGA reactors that a power level of 1000 kW corresponds to a peak fuel temperature of approximately 400°C. Pulsing with a reactivity input of \$3.25 will give a peak fuel temperature of approximately 460°C.

3.0 LIMITING CONDITIONS FOR OPERATION AND LIMITING DECOMMISSIONING CONDITIONS

3.1 Reactivity Limits

Applicability

These specifications apply to the reactivity condition of the reactor.

Objective

The objective is to assure that the reactor shall be shut down at all times and to assure that the safety limit will not be exceeded.

Specifications

The reactor shall not be operated.

Basis

The safety limit cannot be exceeded if the reactor is not operated.

3.2 Reactor Instrumentation

Applicability

This specification applies to the information which must be available during fuel movement and during decommissioning activities.

Objective

The objective is to require that sufficient information is available to the operator to assure safe movement of fuel and decommissioning.

Specification

Reactor fuel shall not be moved and decommissioning activities shall not be conducted unless the measuring channels described in the following table are operable and the information is available in the control room:

MEASURING CHANNEL	MINIMUM NUMBER OPERABLE	ACTIVITY IN WHICH REQUIRED
wide-range log power level (startup count rate)	1	fuel movement
reactor period	1	fuel movement
area radiation monitors	2	fuel movement and decommissioning activities
particulate air radiation monitor	1	fuel movement and decommissioning activities
reactor water activity monitor	1	fuel movement

Bases

The wide range log power and reactor period channels assure that indications of subcritical reactor power level changes are available during fuel movement.

The radiation monitors provide information to operating personnel of radiation above a preset level so that there will be sufficient time to evacuate the facility or take action to prevent the release of radioactivity to the surroundings.

The reactor water activity monitor provides an early indication of possible dispersion of radioactivity into the water in case of fuel failure.

3.3 Ventilation System

Applicability

This specification applies to the operation of the reactor facility ventilation system.

Objective

The objective is to assure that the ventilation system is in operation to mitigate the consequences of the possible release of radioactive materials.

Specification

Fuel shall not be moved and decommissioning activities shall not be conducted unless the facility ventilation system is operable with a minimum air withdrawal rate of 500 cfm.

Basis

It is shown in The Safety Analysis Report that operation of the ventilation system reduces doses in the reactor facility in the event of a TRIGA fuel element failure.

4.0 SURVEILLANCE REQUIREMENTS

4.1 Fuel

Applicability

This specification applies to the surveillance requirements for the fuel elements, prior to their permanent removal from the reactor pool.

Objective

The objective is to assure that the dimensions of the fuel elements remain within acceptable limits.

Specifications

- a. All fuel elements shall be removed from their storage locations in the pool and visually inspected for evidence of deterioration of cladding, (including at least corrosion, erosion, wear, cracking, and weld integrity) at least once every five years.
- b. A fuel element indicating an elongation greater than 1/4 inch over its original length or a lateral bending greater than 1/16 inch over its original bending shall be considered to be damaged and shall be recorded as such in the fuel inventory logs.

Basis

The above limits on the allowable distortion of a fuel element correspond to strains that are considerably lower than the strain expected to cause rupture of a fuel element.

4.2 Control Rods

Applicability

This specification applies to the surveillance requirements for the control rods.

Objective

The objective is to assure the integrity of the fuel-followed control rods.

Specification

- a. The fuel-followed control rods shall be visually inspected for deterioration biennially.

Basis

The visual inspection of the fuel-followed control rods is made to determine whether the control rods are preserving the integrity of fuel.

4.3 Measuring Channels

Applicability

This specification applies to the measuring channels required by Section 3.2 of these specifications.

Objective

The objective is to assure that the wide-range log power channel and the radiation monitoring equipment is operating and to verify the appropriate alarm settings.

Specification

- a. The alarm set points for the radiation monitoring instrumentation shall be verified prior to fuel movement or conduct of decommissioning activities, on each day when those are performed.
- b. The alarm set points for the reactor period shall be verified prior to fuel movement, on each day when fuel is moved.
- c. A channel test of the wide range log power channel shall be performed prior to fuel movement, on each day when fuel is moved.
- d. A channel check of the wide range log power channel shall be performed daily whenever fuel is moved.
- e. The radiation monitoring equipment shall be calibrated annually.

Basis

Verification of the alarm set points of radiation monitoring instrumentation will assure that sufficient information to provide protection against radiation exposure is available.

Annual calibration of the radiation monitoring equipment permits any long term drifts to be corrected.

A channel test and a channel check of the wide range log power channel, including verification of the period alarm will assure that sufficient information is available to provide warning of unexpected neutron power changes. Calibration of the wide range power channel is not possible without operating the reactor, but a channel check includes comparison of the channel output with previous reading when such calibration was performed.

4.4 Maintenance

Applicability

This specification applies to the surveillance requirements following maintenance of a control or safety system.

Objective

The objective is to assure that a system is operable before being used after maintenance has been performed.

Specification

- a. Following maintenance or modification of a control or safety system or component, it shall be verified that the system is operable prior to its return to service. A system shall not be considered operable until after it is successfully tested.
- b. Any additions, modifications, or maintenance to the ventilation system, the core and its associated support structure, the pool or its penetrations, the pool coolant system, the rod drive mechanism, or the reactor safety system shall be made and tested in accordance with the specifications to which the systems were originally designed and fabricated or to specifications approved by the Reactor Committee.
- c. A person with knowledge and experience equivalent to that of a licensed reactor operator shall be present during maintenance of the reactor control and safety system.

Basis

This specification relates to changes in reactor systems which could directly affect the safety of the reactor. Changes or replacements to these systems which meet the original design specifications are considered to meet the presently accepted operating criteria.

4.5 Pool Water

Applicability

This section applies to surveillance of pool water level and conductivity. It shall apply until all reactor fuel is permanently removed.

Objective

The objective is to assure that the depth of the pool water is maintained at an acceptable level and that its mineral content is maintained at an acceptable level, so long as reactor fuel remains in the pool.

Specifications

1. The height of the bulk coolant water above the core structure shall be measured at least monthly and verified to be not less than 14 feet
2. A device able to report a drop in pool water level to a point not less than 14 ft above the reactor core shall be continuously operable when the reactor is unattended.
3. The conductivity of the coolant water, averaged over 30 days, shall not exceed 5 micromhos/cm. The conductivity of bulk coolant water shall be verified at least monthly."

Bases

The measurement of water height at monthly intervals provides acceptable surveillance of loss by evaporation to assure that an accelerated loss rate due to leakage would be detected.

The continuous monitoring of a minimum level gives warning and ensures that the reactor fuel is always adequately shielded.

Based on experience, in which pool water conductivity changes slowly with time, observation of conductivity at monthly intervals provides acceptable surveillance of conductivity to assure that accelerated fuel clad corrosion does not occur.

5.0 DESIGN FEATURES

5.1 Reactor Fuel

Applicability

This specification applies to the fuel elements stored in the reactor pool.

Objective

The objective is to assure that the fuel elements are of such a design and fabricated in such a manner as to permit their use with a high degree of reliability with respect to their mechanical integrity.

Specifications

- a. Standard Fuel Element: The standard fuel element shall be of the TRIGA type and shall contain uranium-zirconium hydride, clad in 0.020 inch of 304 stainless steel. It shall contain a maximum of 9.0 weight percent uranium which has a maximum enrichment less than 20 percent. There shall be 1.55 to 1.80 hydrogen atoms to 1.0 zirconium atom.
- b. Loading: With the exception of one fuel-followed control element (the “regulating rod”) no fuel elements shall be placed within the B- or C- rings of the core.

Basis

This type of fuel element has a long history of successful use in TRIGA reactors.

Specification b ensures that the fuel stored within the core structure cannot attain a value of k_{eff} greater than 0.9.

5.2 Reactor Building and Decommissioning Site

Applicability

This specification applies to the facility which houses the reactor and the residual facility and site to which the Decommissioning Plan applies.

Objective

The objective is to assure that provisions are made to restrict the radioactivity released into the environment.

Specifications

- a. The reactor shall be housed in a closed room of a facility designed to restrict leakage.
- b. The free volume of the reactor room shall be at least 6,000 cubic feet.
- c. All air or other gases exhausted from the reactor room during decommissioning activities shall be released at a minimum of 12 feet above ground level.
- d. The reactor facility shall be equipped with a ventilation system capable of exhausting air or other gases from the reactor room from a stack at a minimum of 50 feet above ground level under emergency conditions.
- e. During decommissioning activities within the reactor room, openings to the room other than those designed for exhaust air and gases shall be closed except for required access and when materials prepared for shipment are being removed.
- f. During decommissioning activities outside the reactor room, components that are to be removed shall be enclosed in a manner designed to restrict leakage and to restrict access, before being dismantled.

Basis

In order that the movement of air can be controlled, the facility contains no windows that can be opened. Under emergency conditions the room air is exhausted through a filter and discharged through a stack at a minimum of 50 feet above ground to provide dilution.

Specification f applies only to equipment described in the SAR which is outside the reactor room: parts of the water purification system and the cooling system. All other decommissioning activities will be confined to the footprint described in SAR section IVa, designated as a controlled access area.

5.3 Fuel Storage

Applicability

This specification applies to the storage of reactor fuel at times when it is not in the reactor core.

Objective

The objective is to assure that fuel which is being stored will not become supercritical and will not reach unsafe temperatures.

Specifications

- a. All fuel elements shall be stored in a geometrical array where the value of k_{eff} is less than 0.9 for all conditions of moderation and reflection using light water.
- b. Irradiated fuel elements and fueled devices shall be stored in an array which will permit sufficient natural convection cooling by water or air such that the fuel element or fueled device temperature will not exceed 800°C.

Basis

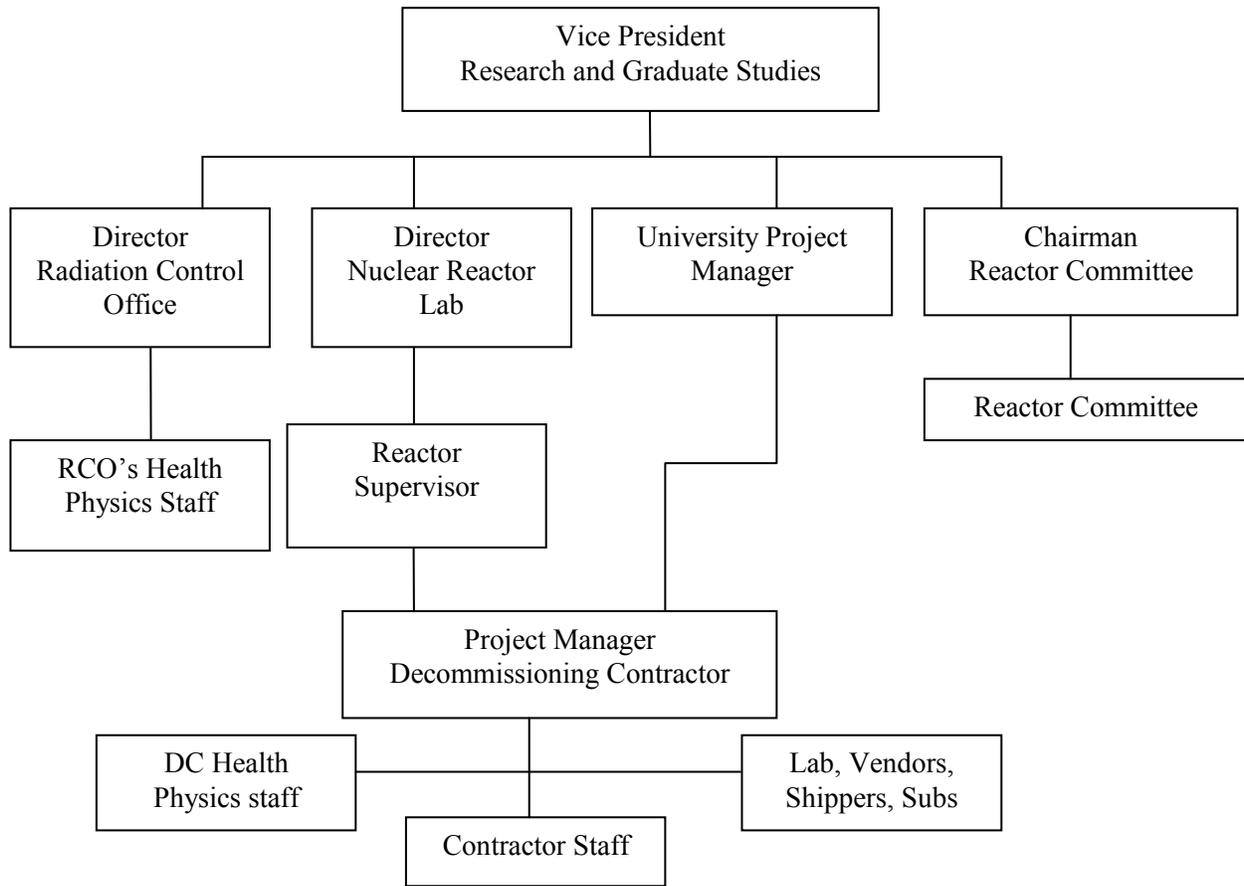
Specification 5.3a assures that unplanned criticality will not occur in fuel storage racks.

Specification 5.3b is based on a fuel temperature limit of 950°C to assure fuel clad integrity when the clad temperatures can equal the fuel temperature (Simnad, G. A. Report E-117-833, February 1980, p.4-1)

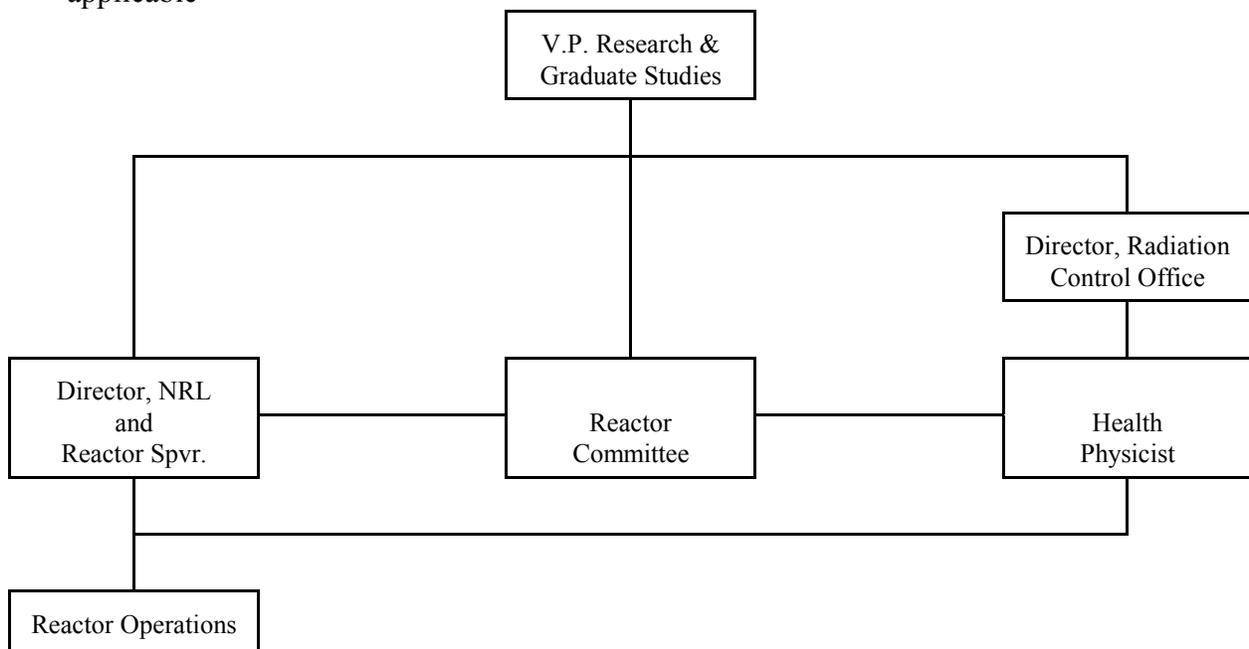
6.0 ADMINISTRATIVE CONTROLS

6.1 Organization

- a. The reactor facility shall be maintained by the Nuclear Reactor Laboratory (NRL) at the University of Arizona. The Nuclear Reactor Laboratory Director shall report to the Vice President for Research and Graduate Studies at the University of Arizona as shown in the organization charts below.
- b. The reactor facility shall be under the supervision of a person with qualifications and knowledge equivalent to that of a licensed senior operator for the reactor. He shall be responsible for assuring that all activities are conducted in a safe manner and within the limits prescribed by applicable federal regulations, by the facility license, and by the provisions of the Reactor Committee.
- c. There shall be a Health Physicist responsible for assuring the safety of the reactor from the standpoint of radiation protection.
- d. A person with qualifications and knowledge equivalent to that of an NRC-licensed operator must be present in the control room when the key switch is on. The reactor shall remain shut down.



The above organizational chart from our Decommissioning Plan replaces the organizational chart below when decommissioning activities commence. Until then, the following chart is applicable



6.2 Review

- a. There shall be a Reactor Committee which shall review reactor operations and decommissioning activities to assure that the facility is maintained in a manner consistent with public safety and within the terms of the facility license.
- b. The responsibility of the Committee includes, but is not limited to, the following:
 1. Review and approval of all proposed changes to the facility, procedures, and Technical Specifications;
 2. Determination of whether a proposed change, or test, would constitute a license amendment pursuant to 10 CFR 50.59(c)(2) as outlined in UARR 165;
 3. Review and approval of all proposed changes to the Decommissioning Plan;
 4. Review of the operation and operational records of the facility;
 5. Review of abnormal performance of plant equipment and operating anomalies;
 6. Review of unusual or abnormal occurrences and incidents which are reportable under 10 CFR 20 and 10 CFR 50;
 7. Review and audit of the retraining and requalification program for the operating staff; and
 8. Biennial audit of the Emergency Plan.
- c. The Committee shall be composed of at least five members, and shall include a health physicist and members competent in the field of reactor operations, radiation science, or reactor engineering. The membership of the Committee shall be such as to maintain a high level degree of technical proficiency.
- d. The Committee shall establish a written charter defining such matters as the authority of the Committee, review and audit functions, and other such administrative provisions as are required for effective functioning of the Committee. Minutes of all meetings of the Committee shall be kept and submitted to committee members and to the Vice President for Research and Graduate Studies in a timely manner.
- e. A quorum of the Committee shall consist of not less than three members of the Committee and shall include the chairman or his designee.
- f. The Committee shall meet at least quarterly.

6.3 Operations

a. Operating Procedures

Written procedures, reviewed and approved by the Reactor Committee, shall be in effect and followed for the following items. The procedures shall be adequate to assure the safety of the reactor, but should not preclude the use of independent judgment and action should the situation require such.

1. Installation or removal of fuel elements, control rods, experiments, and experimental facilities.
2. Actions to be taken to correct specific and foreseen potential malfunctions of systems or components, including responses to alarms, suspected primary coolant system leaks, and abnormal reactivity changes.
3. Emergency conditions involving potential or actual release of radioactivity, including provisions for evacuation, re-entry, recovery, and medical support.
4. Maintenance procedures which could have an effect on reactor safety.
5. Periodic surveillance of reactor instrumentation and safety system, area monitors and continuous air monitors.
6. Decommissioning activities

Substantive changes to the above procedures shall be made only with the approval of the Reactor Committee. Temporary changes to the procedures that do not change their original intent may be made with the approval of the Reactor Laboratory Director. All such temporary changes to procedures shall be documented and subsequently reviewed by the Reactor Committee.

b. ALARA Program

A program shall be established to assure that radiation exposures and releases are kept as low as reasonably achievable.

6.4 Action to be Taken in the Event a Safety Limit is Exceeded

In the event a safety limit is exceeded, or thought to have been exceeded:

- a. The reactor shall be shut down and reactor operation shall not be resumed until authorized by the NRC.
- b. An immediate report of the occurrence shall be made to the Chairman of the Reactor Committee and reports shall be made to the NRC in accordance with Section 6.7 of these specifications.
- c. A report shall be made which shall include an analysis of the causes and extent of possible resultant damage, efficiency of corrective action, and recommendations for measures to prevent or reduce the probability of recurrence. This report shall be submitted to the Reactor Committee for review, and a similar report submitted to the NRC when authorization to resume operation of the reactor is requested.

6.5 Action to be Taken in the Event of a Reportable Occurrence

In the event of a Reportable Occurrence, the following action shall be taken:

- a. The Reactor Laboratory Director shall be notified and corrective action taken prior to resumption of the operation involved.
- b. A report shall be made which shall include an analysis of the cause of the occurrence, efficacy of corrective action and recommendations for measures to prevent or reduce the probability of reoccurrence. This report shall be submitted to the Reactor Committee for review.
- c. A report shall be submitted to the NRC in accordance with Section 6.7 of these specifications.

6.6 Plant Operating Records

In addition to the requirements of applicable regulations, and in no way substituting for them, records and logs of the following items shall be prepared and retained for a period of at least 5 years (except as otherwise specified in the Commission's regulations);

- a. Normal plant operation (but not including supporting documents such as checklists, and recorder charts, which shall be maintained for a period of at least one year);
- b. Principal maintenance activities;
- c. Reportable Occurrences;
- d. Equipment and component surveillance activities required by the Technical Specification;
- e. Experiments performed with the reactor;

Logs and records of the following items shall be prepared and retained for the life of the facility.

- f. Gaseous and liquid radioactive effluents released to the environs;
- g. Off-site environmental monitoring surveys;
- h. Fuel inventories and transfers;
- i. Facility radiation and contamination surveys;
- j. Radiation exposures for all personnel;
- k. Updated, corrected, and as-built drawings of the facility; and
- l. Decommissioning activities

6.7 Reporting Requirements

In addition to the requirements of applicable regulations, and in no way substituting for them, reports shall be made to the NRC as follows:

- a. A report within 24 hours by telephone and telegraph or telefax (FAX) to the responsible NRC organization as listed in the Emergency Kit and posted as deemed necessary by the Reactor Committee of:
 1. Any accidental off-site release of radioactivity above limits permitted by 10 CFR 20, whether or not the release resulted in property damage, personal injury, or exposure;
 2. Any violation of a Safety Limit; and
 3. Any reportable occurrences as defined in Section 1.0 (Reportable Occurrence) of these specifications in writing.

- b. A written report within ten days to the U. S. Nuclear Regulatory Commission, Attn: Document Control Desk, Washington D.C. 20555, with a copy to the responsible NRC facility inspector of:
 1. Any significant variation of measured values from a corresponding predicted value of previously measured value of safety-connected operating characteristics occurring during operation of the reactor;
 2. Incidents or conditions relating to operation of the facility which prevented or could have prevented the performance of engineered safety features as described in these specifications;
 3. Any reportable occurrences as defined in Section 1.0 of these specifications;
 4. Any violation of a Safety Limit; and
 5. Any accidental off-site release of radioactivity above limits permitted by 10 CFR 20, whether or not the release resulted in property damage, personal injury, or exposure.

- c. A written report within 30 days to the U.S. Nuclear Regulatory Commission, Attn: Document Control Desk, Washington D.C. 20555, with a copy to the responsible NRC facility inspector of:
 1. Any substantial variance from performance specifications contained in these specifications or in the Safety Analysis Report;
 2. Any significant change in the transient or accident analysis as described in the Safety Analysis Report;

3. Any changes in facility organization; and
 4. Any observed inadequacies in the implementation of administrative or procedural controls.
- d. A written report within 60 days after completion of startup testing of the reactor to the U. S. Nuclear Regulatory Commission, Attn: Document Control Desk, Washington D.C. 20555, with a copy to the responsible NRC facility inspector of:
1. An evaluation of facility performance to date in comparison with design predictions and specifications; and
 2. A reassessment of the safety analysis submitted with the license application in light of measured operating characteristics when such measurements indicate that there may be substantial variance from prior analysis.
- e. A written annual report within 60 days following the 30th of June each year to the U.S. Nuclear Regulatory Commission, Attn: Document Control Desk, Washington D. C. 20555, with a copy to the responsible NRC facility inspector of:
1. A brief narrative summary of (1) operating experience (including experiments performed), (2) changes in facility design, performance characteristics, and operating procedures related to reactor safety and occurring during the reporting period, and (3) results of surveillance tests and inspections;
 2. Tabulation of the energy output (in megawatt days) of the reactor, amount of pulse operation, hours reactor was critical, and the cumulative total energy output since initial criticality;
 3. The number of emergency shutdowns and inadvertent scrams, including reasons therefore;
 4. Discussion of the major maintenance operations performed during the period, including the effect, if any, on the safety of the operation of the reactor, and the reasons for any corrective maintenance required;
 5. A brief description including a summary of the safety evaluations of changes in the facility or in procedures and of tests and experiments carried out pursuant to Section 50.59 of 10 CFR Part 50;
 6. A summary of the nature and amount of radioactive effluents released or discharged to the environs beyond the effective control of the licensee as measured at or prior to the point of such release or discharge;

Liquid Waste (summarized on a monthly basis)

- (a) Radioactivity discharged during the reporting period.
 - (1) Total radioactivity released (in curies).
 - (2) The limiting concentrations (10CFR20, Appendix B) used and the isotopic composition if greater than 1×10^{-7} microcuries/cc for fission and activation products.
 - (3) Total radioactivity (in curies), released by nuclide, during the reporting period, based on representative isotopic analysis.
 - (4) Average concentration at point of release (in microcuries /cc) during the reporting period.
- (b) Total volume (in gallons) of effluent water (including diluent) during periods of release.

Gaseous Waste (summarized on a monthly basis)

- (a) Radioactivity discharged during the reporting period (in curies) for:
 - (1) Gases.
 - (2) Particulates with half lives greater than eight days.
- (b) The limiting concentrations (10CFR20, Appendix B) used and the estimated activity (in curies) discharged during the reporting period, by nuclide, for all gases and particulates based on representative isotopic analysis.

Solid Waste

- (a) The total amount of solid waste packaged (in cubic feet).
 - (b) The total activity involved (in curies).
 - (c) The dates of transfer or shipment and disposition
- 7. A summary of radiation exposures received by facility personnel and visitors, including dates and time of significant exposures, and a summary of the results of radiation and contamination surveys performed within the facility; and
 - 8. A description of any environmental surveys performed outside the facility.

6.8 Review of Experiments

- a. There shall be no experiments or irradiations utilizing the reactor.