Technical Specifications
Revision 6/90

Docket 50-192

The University of Texas at Austin
TRIGA Reactor

June 1990

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1.0 DEFINITIONS

1.1 Certified Operators

An individual authorized by the U.S. Nuclear Regulatory Commission to carry out the responsibilities associated with the position requiring the certification.

1.1.1 Senior Reactor Operator

An individual who is certified to direct the activities of reactor operators. Such an individual may be referred to as a class A operator.

1.1.2 Reactor Operator

An individual who is certified to manipulate the controls of a reactor. Such an individual may be referred to as a class B operator.

1.2 Instrumentation Channel

A channel is the combination of sensor, line, amplifier, and output device which are connected for the purpose of measuring the value of a parameter.

1.2.1 Channel Test

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

1.2.2 Channel Check

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

1.2.3 Channel Calibration

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

1.3 Confinement

Confinement means an enclosure on the overall facility which controls the movement of air into it and out through a controlled path.

1.4 Experiment

Any operation, component, or target (excluding devices such as detectors, foils, etc.), which is designed to investigate non-routine reactor characteristics or which is intended for irradiation within the pool, on or in a beam tube or irradiation facility and which is not rigidly secured to a core or shield structure so as to be part of their design.

1.4.1 Experiment, Moveable

A moveable experiment is one where 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.

1.4.2 Experiment, Secured

A secured experiment is any experiment, experiment facility, or component of an experiment that is held in a stationary position relative to the reactor by mechanical means. The restraining force 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 a result of credible conditions.

1.4.3 Experimental Facilities

Experimental facilities shall mean rotary specimen rack, pneumatic transfer tube, central thimble, beam tubes and irradiation facilities in the core or in the pool.

1.5 Fuel Element, Standard

A fuel element is a single TRIGA element of standard type. Fuel is U-ZrH clad in stainless steel clad. Hydrogen to zirconium ratio is nominal 1.6.

1.6 Fuel Element, Instrumented

An instrumented fuel element is a special fuel element fabricated for temperature measurement. The element shall have at least one thermocouple embedded in the fuel near the axial and radial midpoints.

1.7 Mode: Manual, Pulse

Each mode operation shall mean operation of the reactor with the mode selection switches in the manual or pulse position.

1.8 Steady-state

Steady-state mode operation shall mean any operation of the reactor with the mode selection switch in the manual position. The pulse mode switch will define pulse operation.

1.9 Operable

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

1.10 Operating

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

1.11 Protective Action

Protective action is 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.

1.11.1 Instrument Channel Level

At the protective instrument channel level, protective action is the generation and transmission of a trip signal indicating that a reactor variable has reached the specified limit.

1.11.2 Instrument System Level

At the protective instrument system level, protective action is the generation and transmission of the command signal for the safety shutdown equipment to operate.

1.11.3 Reactor Safety System Level

At the reactor safety system level, protective action is the operation of sufficient equipment to immediately shut down the reactor.

1.12 Reactivity, Excess

Excess reactivity is that amount of reactivity that would exist if all the control rods were moved to the maximum reactive condition from the point where the reactor is exactly critical.

1.13 Reactivity Limits

The reactivity limits are those limits imposed on the reactor core excess reactivity. Quantities are referenced to a reference core condition.

1.14 Reactor Core, Standard

A standard core is an arrangement of standard TRIGA fuel in the reactor grid plate and may include installed experiments.

1.15 Reactor Core, Operational

An operational core is a standard core for which the core parameters of excess reactivity, shutdown margin, fuel temperature, power calibration, and reactivity worths of control rods and experiments have been determined to satisfy the requirements set forth in the Technical Specifications.

1.16 Reactor Operating

The reactor is operating whenever it is not secured or shutdown.

1.17 Reactor Safety Systems

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

1.18 Reactor Secure

The reactor is secure when:

1.18.1 Subcritical :

There is insufficient fissile material or moderator present in the reactor, control rods or adjacent experiments, to attain criticality under optimum available conditions of moderation and reflection, or

1.18.2 The following conditions exist :

a. The minimum number of neutron absorbing control rods are fully inserted in shutdown position, as required by technical specifications.

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 have, on movement, a reactivity worth exceeding the maximum allowed for a single experiment or one dollar which ever is smaller.

1.19 Reactor Shutdown

The reactor is shutdown if it is subcritical by at least one dollar in the reference core condition with the reactivity of all installed experiments included.

1.20 Reference Core Condition

The condition of the core when it is at ambient temperature (cold) and the reactiviity worth of xenon is negligible (<.30 dollars).

1.21 Research Reactor

A research reactor is defined as a device designed to support a self-sustaining neutron chain reaction for research, development, educational, training, or experimental purposes, and which may have provisions for the production of radioisotopes.

1.22 Rod, Control

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 loses. A control rod may be coupled to its drive unit allowing it to perform a safety function when the coupling is disengaged.

1.22.1 Shim Rod

A shim rod is a control rod having an electric motor drive and scram capabilities.

1.22.2 Regulating Rod

A regulating rod is a control rod used to maintain an intended power level and may be varied manually or by a servo-controller. The regulating rod shall have scram capability.

1.22.3 Standard Rod

The regulating and shim rods are standard control rods.

1.22.4 Transient Rod

A transient rod is a control rod used to initiate a power pulse that is operated by a motor drive and/or air pressure. The transient rod shall have scram capability.

1.23 Safety Limits

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

1.24 Scram Time

Scram time is the elapsed time between reaching a limiting safety system set point and a specified control rod movement.

1.25 Shall, Should and May

The word shall is used to denote a requirement. The word should is used to denote a recommendation. The word may is used to denote permission, neither a requirement nor a recommendation.

1.26 Shutdown Margin

Shutdown margin shall mean the minimum shutdown reactivity necessary to provide confidence that the reactor can be made subcritical by means of the control and safety systems starting from any permissible operating condition and with the most reactive rod in its most reactive [illegible]tion, and that the reactor will remain subcritical without further ope[illegible]tion.

1.27 Shutdown, Unscheduled

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

1.28 Value, Measured

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

1.29 Value, True

The true value is the actual value of a parameter.

1.30 Surveillance Activities

Surveillance activities (except those specifically required for safety when the reactor is shutdown), may be deferred during reactor shutdown, however they must be completed prior to reactor startup unless reactor operation is necessary for performance of the activity. Surveillance activities scheduled to occur during an operating cycle which cannot be performed with the reactor operating may be deferred to the end of the cycle.

In general, two types of surveillance activities are specified, operability checks and calibrations. Operability checks are generally specified as monthly to quarterly. Calibrations are ge[illegible] specified as annually to biennially.

1.31 Surveillance Intervals

Maximum intervals are to provide operational flexibility and not to reduce frequency. Established frequencies shall be maintained over the long term. Allowable surveillance intervals shall not exceed the following:

1.31.1
5 years (interval not to exceed 6 years).

1.31.2
2 years (interval not to exceed 2-1/2 years).

1.31.3
Annual (interval not to exceed 15 months).

1.31.4
Semiannual (interval not to exceed 7-1/2 months).

1.31.5
Quarterly (interval not to exceed 4 months).

1.31.6
Monthly (interval not to exceed 6 weeks).

1.31.7
Weekly (interval not to exceed 10 days).

1.31.8
Daily (must be done during the calendar day).

2.0 SAFETY LIMITS AND LIMITING SAFETY SYSTEM SETTINGS

2.1 Safety Limit

Specification(s)

The maximum temperature in a standard TRIGA fuel element shall not exceed 1150°C for fuel element clad temperatures less than 500°C and shall not exceed 950°C for fuel element clad temperatures greater than 500°C. Temperatures apply to any condition of operation.

2.2 Limiting Safety System Settings

Specification(s)

Not applicable

3.0 LIMITING CONDITIONS FOR OPERATION

3.1 Reactor Core Parameters

3.1.1 Reactivity

Specification(s)

The reactor core shall have no excess reactivity and the shutdown margin with all control rods withdrawn shall be greater than 0.2% $\Delta k/k$.
The number of fuel elements in the reactor core grid shall not fill more than two of the grid structure rings.

3.1.2 Fuel Elements

Specification(s)

The reactor shall not be operable with fuel element damage. A fuel element shall be considered damaged if:

a. In measuring the elongation, the length exceeds the original length by 2.54 mm (1/10 inch).

b. In measuring the transverse bend, the bend exceeds the original bend by 1.5875 mm (1/16 inch).

c. A clad defect exists as indicated by release of fission products or visual observation.

3.2 Reactor Control and Safety System

Specification(s)

Not Applicable

3.3 Operational Support Systems

3.3.1 Water Coolant Systems

Specification(s)

Corrective action shall be taken or the reactor shut down if any of the following reactor coolant conditions are observed:

a. The bulk pool water temperature exceeds 48°C.

b. The water depth is less than 6.5 meters measured from the pool bottom to the pool water surface.

c. The water conductivity exceeds 5.0 μmho/cm for the average value during measurement periods of one month.

d. The pressure difference during heat exchanger operation is less than 7 kPa (1 psig) measured between the chilled water outlet pressure and the pool water inlet pressure to the heat exchanger.

e. Pool water data from periodic measurements shall exist for water pH and radioactivity. Radioactivity measurements will include total alpha-beta activity and gamma ray spectrum analysis.

3.3.2 Air Confinement Systems

Specification(s)

Not Applicable

3.3.3 Radiation Monitoring Systems

Specification(s)

Radiation monitoring while the reactor is operating requires the following minimum conditions :

a. A continuous air monitor (particulate) shall be operable with readout and audible alarm. The monitor shall sample reactor room air within 5 meters of the pool at the pool access level.

The particulate continuous air monitor shall be operating when the reactor is operating. A set point of the monitor will inititiate an audible warning signal.

b. Area radiation monitors (gamma) shall be operable with readout and audible alarm, one of which shall be located in the vicinity of the top of the reactor pool.

One area radiation monitor shall be operating at the pool level when the reactor is operating. Two additional area radiation monitors shall be operating at other reactor areas when the reactor is operating.

4.0 SURVEILLANCE REQUIREMENTS

4.1 Reactor Core Parameters

4.1.1 Reactivity

Specification(s)

The number of elements and physical location in the grid structure shall be verified monthly.

4.1.2 Fuel Elements

Specification(s)

The reactor fuel elements shall be examined for physical damage by a visual inspection, including a check of the dimensional measurements, made at biennial intervals, if the fuel has been in the operating core during the interval.

4.2 Reactor Control and Safety System

4.2.1 Control Assemblies

Specification(s)

Not Applicable

4.3 Operational Support Systems

4.3.1 Water Coolant Systems

Specification(s)

The following measurements shall monitor the reactor coolant conditions:

a. The pool temperature channel shall have a channel check annually.

b. The pool water depth shall have a channel check monthly.

c. The water conductivity channel shall have a channel calibration annually and pool water conductivity will be measured weekly.

d. The pressure difference channel shall have a channel test prior to each days operation, after repair or modifications, or prior to each extended period of operation of the heat exchanger and will be continuously monitored during operation.

e. Measure pool water pH with low ion test paper or equivalent quarterly. Sample pool water radioactivity quarterly for total alpha-beta activity.

4.3.2 Air Confinement Systems

Specification(s)

Not Applicable

4.3.3 Radiation Monitoring Systems

Specification(s)

The following conditions shall apply to radiation monitoring systems:

a. Calibrate particulate air monitor at semiannual intervals and check operability weekly.

b. Calibrate area radiation monitors at semiannual intervals and check operability weekly.

5.0 DESIGN FEATURES

5.1 Site and Facility Description

5.1.1 Location

Specification(s)

a. The site location is on the main campus of The University of Texas at Austin.

b. The TRIGA reactor is installed in a designated room, room 131, of a building constructed as an engineering laboratory and classroom building, Taylor Hall.

c. The reactor core is assembled in a below ground shield and pool structure with vertical access to the core.

d. License areas of the facility for reactor operation shall consist of the room enclosing the reactor shield and pool structure,(room 131 and room 131a).

5.1.2 Confinement

Specification(s)

a. The reactor room shall be designed to restrict leakage and will have a minimum enclosed air volume of 680 cubic meters.

b. Ventilation system shall circulate air within the room and shall isolate air in the reactor area upon shut off of the circulation fan.

5.1.3 Safety Related Systems

Specifications

Any modifications to the air confinement or ventilation system, the reactor shield, the pool or its penetrations, the pool coolant system, the core and its associated support structure, the rod drive mechanisms or the reactor safety system shall be made and tested in accordance with the specifications to which the systems were originally designed and fabricated. Alternate specifications may be approved by the Nuclear Reactor Committee. A system shall not be considered operable until after it is tested successfully

5.2 Reactor Coolant System

5.2.1 Natural Convection

Specification(s)

The reactor core shall be cooled by natural convection flow of water.

5.2.2 Siphon Protection

Specification(s)

Pool water level shall be protected by holes for siphon breaks in pool water system pipe lines.

5.3 Reactor Core and Fuel

5.3.1 Fuel Elements

Specification(s)

The standard TRIGA fuel element at fabrication shall have the following characteristics:

a. Uranium content: 8.5 Wt% uranium enriched to a nominal 19.7% Uranium-235.

b. Zirconium hydride atom ratio: nominal 1.6 hydrogen to zirconium, ZrH_x.

c. Cladding: 304 stainless steel, nominal .020 inches thick.

5.3.2 Control Rods

Specification(s)

The shim, regulating, and transient control rods shall have scram capability, and

a. Include stainless steel or aluminum clad and may be followed by air or aluminum, or for a standard rod may be followed by fuel with stainless steel clad.

b. Contain borated graphite, B_4C powder, or boron and its compounds in solid form as a poison.

c. The transient rod shall have an adjustable limit to allow a variation of reactivity insertions.

5.3.3 Configuration

Specification(s)

The reactor shall be an arrangement of core single grid positions occupied by fuel elements, control rods, and graphite elements. Single element positions may be occupied by voids, water or experiment facilities. Special single element positions may be occupied by approved experiments.

5.4 Reactor Fuel Element Storage

Specification(s)

a. All fuel elements shall be stored in a geometrical array where the effective multiplication is less than 0.8 for all conditions of moderation.

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 design values.

5.5 Reactor Pool Irradiator

Specification(s)

a. A 1,000 Curie gamma irradiator may be located in the reactor pool. The irradiator isotope will be cobalt-60. Pool water sample requirements will monitor pool water for source leakage.

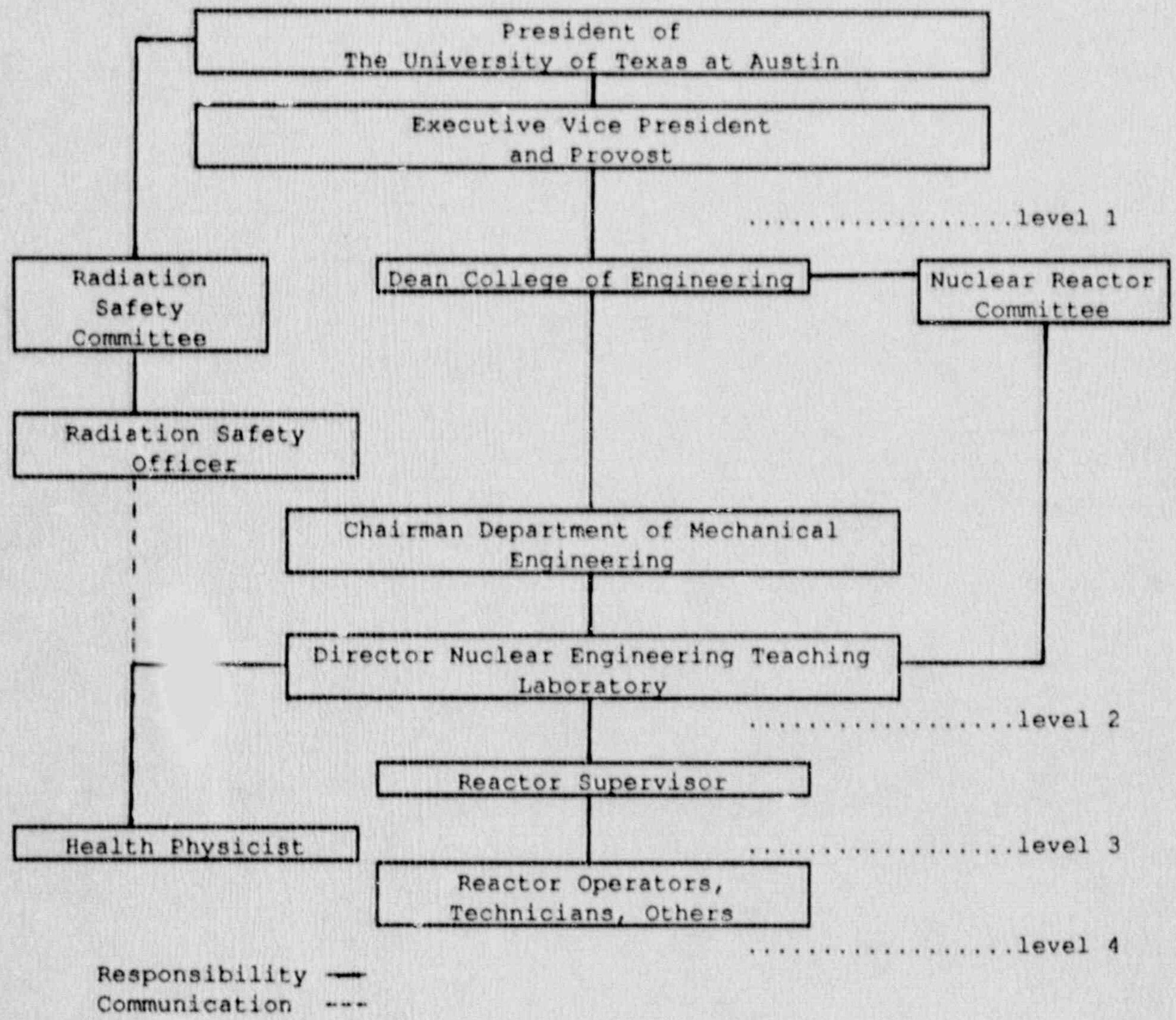
b. The irradiator assembly will be an experiment facility. Location of the assembly will be at a depth of at least 2.0 meters and at a distance of at least 0.5 meters from the reactor core structure.

6.0 ADMINISTRATIVE CONTROLS

6.1 Organization

6.1.1 Structure

The facility shall be under the control of the Director or a supervisory Senior Reactor Operator. The management for operation of the facility shall consist of the organizational structure established as follows:



6.1.2 Responsibility

The Director shall be responsible to the Dean of the College of Engineering and the Chairman of the Department of Mechanical Engineering for safe operation and maintenance of the reactor and its associated equipment. The Director or a supervisory Senior Reactor Operator shall review and approve all experiments and experimental procedures prior to their use in the reactor. Individuals of the management organization shall be responsible for the policies and operation of the facility, and shall be responsible for safeguarding the public and facility personnel from undue radiation exposures and for adhering to the operating license and technical specifications.

6.1.3 Staffing

The minimum staffing when the reactor is not shutdown shall be:

a. A certified operator in the control room.

b. A second person in the facility area that can perform prescribed written instructions. Unexpected absence for two hours shall require immediate action to obtain an alternate person.

c. A senior reactor operator readily available. The available operator should be within thirty minutes of the facility and reachable by telephone.

Events requiring the direction of a senior reactor operator shall be:

a. All fuel element or control rod relocations within the reactor core region, if the core grid structure capacity exceeds two full rings.

b. Relocation of any experiment with a reactivity worth of greater than one dollar.

A list of reactor facility personnel by name and telephone number shall be available to the operator in the control room. The list shall include:

a. Management personnel.

b. Radiation safety personnel.

c. Other operations personnel.

6.1.4 Selection and Training of Personnel

The selection, training and requlification of operators shall meet or exceed the requirements of American National Standard for Selection and Training of Personnel for Research Reactors ANSI/ANS - 15.4. Qualification and requalification of certified operators shall be subject to an approved NRC (Nuclear Regulatory Commission) program.

6.2 Review and Audit

6.2.1 Composition and Qualifications

A Nuclear Reactor Committee shall consist of at least three (3) members appointed by the Dean of the College of Engineering that are knowledgeable in fields which relate to nuclear safety. The University Radiological Safety Officer shall be a member or an ex-officio member of the Nuclear Reactor Committee. The committee will perform the functions of review and audit or designate a knowledgeable person for audit functions.

6.2.2 Charter and Rules

The operations of the Nuclear Reactor Committee shall be in accordance with an established charter, including provisions for:

a. Meeting frequency (at least once each six months).

b. Quorums (not less than one-half the membership where the operating staff does not represent a majority).

c. Dissemination, review, and approval of minutes.

d. Use of subgroups.

6.2.3 Review Function

The review function shall include facility operations related to reactor and radiological safety. The following items shall be reviewed:

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 thereto, and proposed changes in reactor facility equipment or systems having safety significance.

c. All new experiments or classes of experiments that could affect reactivity or result in the release of radioactivity.

d. Changes in technical specifications or license.

e. Violations of technical specifications or license.

f. Operating abnormalities or violations of procedures having safety significance.

g. Other reportable occurrences.

h. Audit reports.

6.2.4 Audit Function

The audit function shall be a selected examination of operating records, logs, or other documents. An audit will be by a person not directly responsible for the records and may include discussions with cognizant personnel or observation of operations. The following items shall be audited and a report made within 3 months to the Director and Nuclear Reactor Committee:

a. Conformance of facility operations with license and technical specifications at least once each calendar year.

b. Results of actions to correct deficiencies that may occur in reactor facility equipment, structures, systems, or methods of operation that affect safety at least once per calendar year.

c. Function of the retraining and requalification program for certified operators at least once every other calendar year.

d. The reactor facility emergency plan and physical security plan, and implementing procedures at least once every other year.

6.3 Operating Procedures

Written operating procedures shall be prepared reviewed and approved by the Director or a supervisory Senior Reactor Operator and the Nuclear Reactor Committee prior to initiation of the following activities:

a Startup, operation, and shutdown of the reactor.

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

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

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

e. Administrative controls for operation maintenance, and the conduct of experiments or irradiations that could have an effect on reactor safety.

f. Personnel radiation protection consistent with applicable regulations or guidelines shall include a management commitment and programs to maintain exposures and releases as low as reasonably achievable.

g. Implementation of required plans such as the emergency plan or physical security plan.

Substantive changes to the above procedures shall be made effective after approval by the Director or a supervisory Senior Reactor Operator and the Nuclear Reactor Committee. Minor modifications to the original procedures which do not change the original intent may be made by a senior reactor operator but the modifications must be approved by the Director or a supervisory Senior Reactor Operator. Temporary deviations from the procedures may be made by a senior reactor operator in order to deal with special or unusual circumstances or conditions. Such deviations shall be documented and reported to the Director or a supervisory Senior Reactor Operator.

6.4 Experiment Review and Approval

Not Applicable

6.5 Required Actions

6.5.1 Action to be Taken in Case of a Safety Limit Violation

In the event of a safety limit violation, the following action shall be taken:

a. The reactor shall be shut down and reactor operation shall not be resumed until a report of the violation is prepared and authorization by the Nuclear Regulatory Commission (NRC) is issued.

b. The safety limit violation shall be promptly reported to the Director of the facility or a designated alternate.

c. The safety limit violation shall be subsequently reported to the NRC.

d. A safety limit violation report shall be prepared and submitted to the Nuclear Reactor Committee. The report shall describe: (1) Applicable circumstances leading to the violation including, when known, the cause and contributing factors, (2) Effect of the violation on reactor facility components, systems, or structures and on the health and safety of the public, (3) Corrective actions taken to prevent recurrence.

6.5.2 Action to be Taken in the Event of an Occurrence that is Reportable.

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

a. Reactor conditions shall be returned to normal or the reactor shutdown. If it is necessary to shut down the reactor to correct the occurrence, operations shall not be resumed unless authorized by the Director or his designated alternate.

b. Occurrence shall be reported to the Director or his designated alternate and to the Nuclear Regulatory Commission as required.

c. Occurrence shall be reviewed by the Nuclear Reactor Committee at the next regularly scheduled meeting.

6.6 Reports

All written reports shall be sent within the prescribed interval to the NRC, Washington D.C. 20555, Atten: Document Control Desk, with a copy to the Regional Administrator, Region IV.

6.6.1 Operating Reports

Routine annual reports covering the activities of the reactor facility during the previous calendar year shall be submitted within three 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 the energy produced by the reactor or the hours the reactor was critical, or both.

b. The unscheduled shutdowns including, where applicable, corrective action taken to preclude recurrence.

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

d. Tabulation of major changes in the reactor facility and procedures, and tabulation of new tests or experiments, or both, that are significantly different from those performed previously, including conclusions that no unreviewed safety questions were involved.

e. A summary of the nature and amount of radioactive effluents released or discharged to the environs beyond the effective control of the university as determined at or before the point of such release or discharge. The summary shall include to the extent practicable an estimate of individual radionuclides present in the effluent. If the estimated average release after dilution or diffusion is less than 25% of the concentration allowed or recommended, a statement to this effect is sufficient.

f. A summary of exposures received by facility personnel and visitors where such exposures are greater than 25% of that allowed or recommended.

g. A summarized result of environmental surveys performed outside the facility.

6.6.2 Special Reports

A written report within 30 days to the NRC of:

a. Permanent changes in the facility organization involving Director or Supervisor.

b. Significant changes in transient or accident analysis as described in the Safety Analysis Report.

A report to NRC Operation Center and Region IV by telephone not later than the following working day and confirmed in writing by telegraph or similar conveyance to be followed by a written report within 14 days that describes the circumstances of the event of any of the following:

a. Violation of fuel element temperature safety limit.

b. Release of radioactivity above allowable limits.

c. Other reportable occurrences.

Other events that will be considered reportable events are listed in this section. A return to normal operation or curtailed operation until authorized by management will occur. (Note: Where components or systems are provided in addition to those required by the technical specifications, the failure of 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.)

a. Operation with actual safety-system settings for required systems less conservative than the limiting safety system settings specified in the technical specifications.

b. Operation in violation of limiting conditions for operation established in technical specifications unless prompt remedial action is taken.

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 shutdowns.

d. An unanticipated or uncontrolled change in reactivity greater than one dollar. Reactor trips resulting from a known cause are excluded.

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

f. An observed inadequacy in the implementation of administrative or procedural controls such that the inadequacy causes or could have caused the existence or development of an unsafe condition with regard to reactor operations.

A written report within 90 days after the initial criticality or 9 months after license issuance, which ever is earlier, of the startup test program, to the NRC of:

Characteristics upon receipt of a new facility license, of the reactor under the new conditions, describing the measured values of the operating conditions including:

a. Total control reactivity worth and reactivity of the rod of highest reactivity worth.

b. Minimum shutdown margin of the reactor both at ambient and operating temperatures.

c. An evaluation of facility performance to date in comparison with design conditions and measured operating characteristics, and a reassessment of the safety analysis when measurements indicate that there may be substantial variance from prior analysis submitted with the license application.

6.7 Records

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.

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

(Note: Applicable annual reports, if they contain all of the required information, may be used as records in this section.)

a. Gaseous and liquid radioactive effluents released to the environs.
b. Offsite environmental monitoring surveys required by technical specifications.
c. Events that impact or effect decommissiong of the facility
d. Radiation exposure for all personnel monitored.
e. Updated drawings of the reactor facility.

6.7.2 Records to be Retained for a Period of at Least Five Years or for the Life of the Component Involved Whichever is Shorter:

a. Normal reactor facility operation (supporting documents such as checklists, log sheets, etc. shall be maintained for a period of at least one year).
b. Principal maintenance operations.
c. Reportable occurrences.
d. Surveillance activities required by technical specifications.
e. Reactor facility radiation and contamination surveys where required by applicable regulations.
f. Experiments performed with the reactor.
g. Fuel inventories, receipts, and shipments.
h. Approved changes in operating procedures.
i. Records of meeting and audit reports of the review and audit group.

6.7.3 Records to be Retained for at Least One Licensing Cycle:

Retraining and requalifications of licensed operations personnel. Records of the most recent complete cycle shall be maintained at all times the individual is employed.

APPENDIX

A.1.0 DOCKET 50-602 INFORMATION

The Technical Specifications of this document depend on the analysis and conclusions of the Safety Analysis Report. Descriptive information important to each specification is presented in the form of the applicability, objective and bases. This information defines the conditions effective for each technical specification, except administrative conditions, for the Docket 50-602 facilty.

A.1.1 Applicability

The applicability defines the conditions, parameters, or equipment to which the specification applies.

A.1.2 Objective

The objective defines the goals of the specification in terms of limits, frequency, or other controllable item.

A.1.3 Bases

The bases presents information important to the specification, including such things as justification, logical constraints and development methodology.

A.2.0 SAFETY LIMITS & LIMITING SAFETY SYSTEM SETTINGS APPLICABILITY, OBJECTIVES AND BASES

A.2.1 Safety Limit

Applicability

This specification applies to the temperature of the reactor fuel in a standard TRIGA fuel element.

Objective

The objective is to define the maximum temperature that can be permitted with confidence that no damage to the fuel element cladding will result.

Bases

The important parameter for a TRIGA reactor is the fuel element temperature. This parameter is well suited as a single specification since it can be measured directly. A loss in the integrity of the fuel element cladding could arise from a build-up of excessive pressure between the fuel-moderator and the cladding if the fuel temperature exceeds the safety limit. The pressure is caused by the presence of air, fission product gases, and hydrogen from the dissociation of the hydrogen and zirconium in the fuel-moderator. Hydrogen pressure is the most significant component. The magnitude of this pressure is determined by the fuel-moderator temperature and the ratio of hydrogen to zirconium in the alloy.

The safety limit for the standard TRIGA fuel is based on calculations and experimental evidence. The results indicate that the stress in the cladding due to hydrogen pressure from the dissociation of zirconium hydride will remain below the ultimate stress provided that the temperature of the fuel does not exceed 1150°C and the fuel cladding does not exceed 500°C. For conditions that might cause the clad temperatures to exceed 500°C the safety limit of the fuel should be set at 950°C.

A.2.2 Limiting Safety System Setting

A.2.2.1 Fuel Temperature

Applicability

This specification applies to the protective action for the reactor fuel element temperature.

Objective

The objective is to prevent the fuel element temperature safety limit from being reached.

Bases

For non pulse operation of the reactor, the limiting safety system setting is a temperature which, if exceeded, shall cause a reactor scram to be initiated preventing the safety limit from being exceeded. A setting of 550°C provides a safety margin at the point of measurement of at least 400°C for standard TRIGA fuel elements in any condition of operation. A part of the safety margin is used to account for the difference between the true and measured temperatures resulting from the actual location of the thermocouple. If the thermocouple element is located in the hottest position in the core, the difference between the true and measured temperatures will be only a few degrees since the thermocouple junction is near the center and the mid-plane of the fuel element. For pulse operation of the reactor, the same limiting safety system setting will apply. However, the temperature channel will have no effect on limiting the peak powers generated because of its relatively long time constant (seconds) as compared with the width of the pulse (milliseconds).

In this mode, however, the temperature trip will act to limit the energy release after the pulse if the transient rod should not reinsert and the fuel temperature continues to increase.

A critical core configuration will not be present in the reactor grid structure. Without the capability to generate power in the fuel elements, a safety limit on temperature, power level or reactivity is not necessary. Instead, a limit on the number of elements in the reactor grid structure will assure that a critical configuration does not exist. Filling any two rings of the grid structure sill not create a configuartion with K > or 8.

A.3.0 LIMITING CONDITIONS FOR OPERATION
APPLICABILITY, OBJECTIVES & BASES

A.3.1 Reactor Core Parameters

A.3.1.1 Reactivity

Applicability

This specification applies to the reactivity condition of the reactor core in terms of the available excess above the cold xenon free, critical condition.

Objective

The objective is to prevent the fuel element temperature safety limit from being reached by limiting the potential reactivity available in the reactor for any condition of operation.

Bases

The reactor core is no longer available for operation. By limiting the number and location of elements in the grid structure the shutdown margin and excess reactivity are no longer functional constraints. Excess reactivity is zero and the shutdown margin exceeds those applicable to any operable configuration.

A.3.1.2 Fuel Elements

Applicability

This specification applies to the measurement parameters for the fuel elements.

Objective

The objective is to verify the physical condition of the fuel element cladding.

Bases

The elongation limit has been specified to assure that the cladding material will not be subjected to stresses that could cause a loss of integrity in the fuel containment and to assure adequate coolant flow. The limit of transverse bend has been shown to result in no difficulty in disassembling the reactor core. Analysis of the removal of heat from touching fuel elements shows that there will be no hot spots resulting in damage to the fuel caused by this touching. Experience with TRIGA reactors has shown that fuel element bowing that could result in touching has occurred without deleterious effects. Measurement of element physical dimensions are requirments for elements subject the heat load conditions as a result if operation at power. If no power is being produced by an element physical inspections for indiations of corrosion are more significant than dimensional checks. Dimensional checks are to be done prior to operation of the element in an operable core.

A.3.2 Reactor Control and Safety System

Not Applicable.

A.3.2.3 Reactor Safety System

Not Applicable

A.3.2.4 Reactor Instrument System

Not Applicable

A.3.3 Operational Support System

A.3.3.1 Water Coolant Systems

Applicability

This specification applies to the operating conditions for the reactor pool and coolant water systems.

Objective

The objective is to assure that adequate conditions are maintained to provide shielding of the reactor radiation, protection against corrosion of the reactor components, cooling of the reactor fuel, and prevent leakage from the primary coolant.

Bases

The specifications for conditions of the pool water coolant system provide controls that are to control the radiation exposures and radioactive releases associated with the reactor fission product inventory.

a. The bulk water temperature constraint assures that sufficient core cooling exists under all anticipated operating conditions and protects the resin of the water purification system from deterioration.

b. A pool water depth of 6.5 meters is sufficient to provide more than 5.25 meters of water above the reactor core so that radiation levels above the reactor pool are at reasonable levels.

c. Average measurements of pool coolant water conductivity of 5.0 µmho/cm assure that water purity is maintained to control the effects of corrosion and activation of coolant water impurities.

d. A pressure difference at the heat exchanger chilled water outlet and the pool water inlet of 7 kPa will be sufficient to prevent loss of pool water from the primary reactor coolant system to the secondary chilling water system in the event of a leak in the heat exchanger.

e. Periodic sampling of pool water pH and radioactivity are supplemental measurements that assist evaluation of the overall conditions of the reactor pool. Protection of aluminum components requires a pH range of 5 to 8.5. Measurements of radioactivity in the pool water provide information to evaluate working hazards for personnel, leakage indications for radioactive sources in the pool, and monitoring for activation of unknown components in the water.

A.3.3.2 Air Confinement Systems

Not Applicable

A.3.3.3 Radiation Monitoring Systems

Applicability

This specification applies to the radiation monitoring conditions in the reactor area during reactor operation.

Objective

The objective is to monitor the radiation and radioactivity conditions in the reactor area to control exposures or releases.

Bases

The radiation monitors provide information to operating personnel of impending or existing hazards from radiation so that there will be sufficient time to take the necessary steps to control the exposure of personnel and release of radioactivity or evacuate the facility. Alarm setpoints do not include measurement uncertainty. These setpoints are measured values are not true values

a. Air particulate radioactivity accumulates on the filter of a continuous monitor that records the radiation levels. An alert and alarm set point including remote readouts at the reactor control console inform the operator of the monitor status and activity levels.

Air flow rates provide detection capability of one maximum permissible concentration at one hour by accumulation of particulates by the filter.

b. Several area radiation monitors (six) are part of the permanent installation. Some locations are experiment areas in which shield configurations determine the levels of radiation during reactor operation. At the pool access area radiation levels substantial enough to be a high radiation level may occur.

Alarm levels at 100 mr/hr will monitor radiation areas if the limit of 2 or 5 mr/hr is not reasonable.

A.3.4 Limitations on Experiments

A.3.4.1 Reactivity

Not Applicable

A.4.0 SURVEILLANCE REQUIREMENTS
OBJECTIVES & BASES

A.4.1 Reactor Core Parameters

A.4.1.1 Reactivity

Applicability

This specification applies to the measurement of reactor excess reactivity.

Objective

The objective is to periodically determine that no core excess reactivity exists.

Bases

Monthly checks of the placement of elements in the grid structure will periodically verify the shutdown condition of the reactor core.

A.4.1.2 Fuel Elements

Applicability

This specification applies to the inspection requirements for the fuel elements.

Objective

The objective is to inspect the physical condition of the fuel element cladding.

Bases

The frequency of inspection and measurement schedule is based on the parameters most likely to affect the fuel cladding of a pulsing reactor operated at moderate pulsing levels and utilizing fuel elements whose characteristics are well known. No use of the fuel to produce power or heat energy does not introduce any condition that would cause damage to the fuel unless physical movement or chemical conditions of the storage environment change.

A.4.2 Reactor Control and Safety System

Not Applicable

A.4.2.3 Reactor Safety System

Not Applicable

A.4.3 Operational Support Systems

A.4.3.1 Water Coolant Systems

Applicability

This specification applies to surveillance conditions for the reactor pool and coolant water systems.

Objective

The objective is to maintain the reactor coolant conditions within acceptable specifications.

Bases

Conditions for the reactor coolant are monitored by visual observation of measurements or automatic action of sensors. Periodic checks and tests of measurement devices for the reactor coolant system parameters assure that the coolant system will perform its intended function. Measurement frequencies of pool parameters relate to the time periods appropriate to detection of abnormal conditions. Pool temperature, depth, and heat exchanger pressure differences have an immediate effect on system operation. Water conductivity, pH as a supplemental indicator, and pool radioactive concentrations are conditions that develop at rates detectable at monthly to annual intervals.

A.4.3.2 Air Confinement Systems

Not Applicable

A.4.3.3 Radiation Monitoring Systems

Applicability

This specification applies to the surveillance conditions of the radiation monitoring channels.

Objective

The objective is to assure the radiation monitors are functional.

Bases

Periodic calibrations and frequent checks are specified to maintain reliable performance of the radiation monitoring instruments. Calibration and check frequencies follow the general recommendations of guidance documents.

A.4.4 Limitations on Experiments

Not Applicable

A.5.0 DESIGN FEATURES
OBJECTIVES & BASES

A.5.1 Site and Facility Descriptions

A.5.1.1 Location

Applicability

This specification applies to the TRIGA reactor site location and specific facility design features.

Objective

The objective is to specify those features related to the Safety Analysis evaluation.

Bases

a. The TRIGA facility site is located in an area controlled by The University of Texas at Austin.

b. The room enclosing the reactor has been designed with characteristics related to the safe operation of the facility.

c. The shield and pool structure have been designed to contain the reactor structure in a below ground level pool.

d. The resticted access to specific facility areas assure that proper controls are established for the safety of the public and for the security of special nuclear materials.

A.5.1.2 Confinement

Applicability

This specification applies to the boundary for control of air in the area of the reactor.

Objective

The objective is to assure that provisions are made to control or restrict the amount of release of radioactivity into the environment.

Bases

a. Calculations of the concentrations of released radionuclides within the reactor area depend on the available enclosed air volume to limit the concentrations to acceptable levels.

b. Control of the reactor area air exchange to adjacent areas is by leakage at doors and building joints. Control of the ventilation fan stops the air flow within the room.

A.5.1.3 Safety Related Systems

Applicability

This specification applies to the requirements of any system related to reactor safety.

Objective

The objective is to assure the proper function of any system related to reactor safety.

Bases

This specification relates to changes in reactor systems which could affect the safety of the reactor operation. Changes or substitutions to these systems that meet or exceed the original design specifications are assumed to meet the presently accepted operating criteria. Questions that may include an unreviewed safety question are referred to the reactor operation committee.

A.5.2 <u>Reactor Coolant System</u>

Applicability

This specification applies to the reactor coolant system composed of deionized water.

Objective

The objective is to assure that adequate water is available for cooling and shielding during reactor operation.

Bases

a. This specification is based on thermal and hydraulic calculations which show that a standard TRIGA core can operate in a safe manner at power levels exceeding 1500 kW with natural convection flow of the coolant water and a departure from nucleate boiling ratio of 2.0.

b. Siphon breaks set the subsequent pool water level for loss of coolant without an associated water return caused by inadvertant pumping or accidental siphon of water from the pool.

A.5.3 Reactor Core and Fuel

A.5.3.1 Fuel Elements

Applicability

This specification applies to the fuel elements used in the reactor core.

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 physical and nuclear characteristics.

Bases

The design basis of the standard TRIGA core demonstrates that 1.5 megawatt steady or 36 megawatt-sec pulse operation presents a conservative limitation with respect to safety limits for the maximum temperature generated in the fuel. No significant fuel temperature greater than 101°C can occur without an operable core.

A.5.3.2 Control Rods

Applicability

This specification applies to the control rods used in the reactor core.

Objective

The objective is to assure that the control rods are of such a design as to permit their use with a high degree of reliability with respect to their physical and nuclear characteristics.

Bases

The poison requirements for the control rods are satisfied by using neutron absorbing borated graphite, B4C powder, or boron and its compounds. These materials must be contained in a suitable clad material, such as aluminum or stainless steel, to insure mechanical stability during movement and to isolate the poison from the pool water environment. Scram capabilities are provided for rapid insertion of the control rods which is the primary safety feature of the reactor. The transient control rod is designed for a reactor pulse.

A.5.3.3 Configuration

Applicability

This specification applies to the configuration of fuel elements, control rods, experiments and other reactor grid plate components.

Objective

The objective is to assure that provisions are made to restrict the arrangement of fuel elements and experiments to provide assurance that excessive power densities will not be produced.

Bases

Standard TRIGA cores have been in use for years and their characteristics are well documented.

A.5.4 Reactor Fuel Element 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 storage will not achieve criticality and will not exceed design temperatures.

Bases

The limits imposed by these specifications are considered sufficient to provide conservative fuel storage and assure safe storage.

A.5.5 Gamma Pool Irradiator

Applicability

This specification applies to the gamma irradiator experiment facility in the reactor pool.

Objective

The objective is to assure that the use of the irradiator does not cause any threat to the reactor or safety question.

Bases

Location of the irradiator is at a distance from the reactor sufficient to avoid interference with reactor operation. Depth of the pool water for adequate shielding of the irradiator is also a constraint of the location

A.6.0 NOTES

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