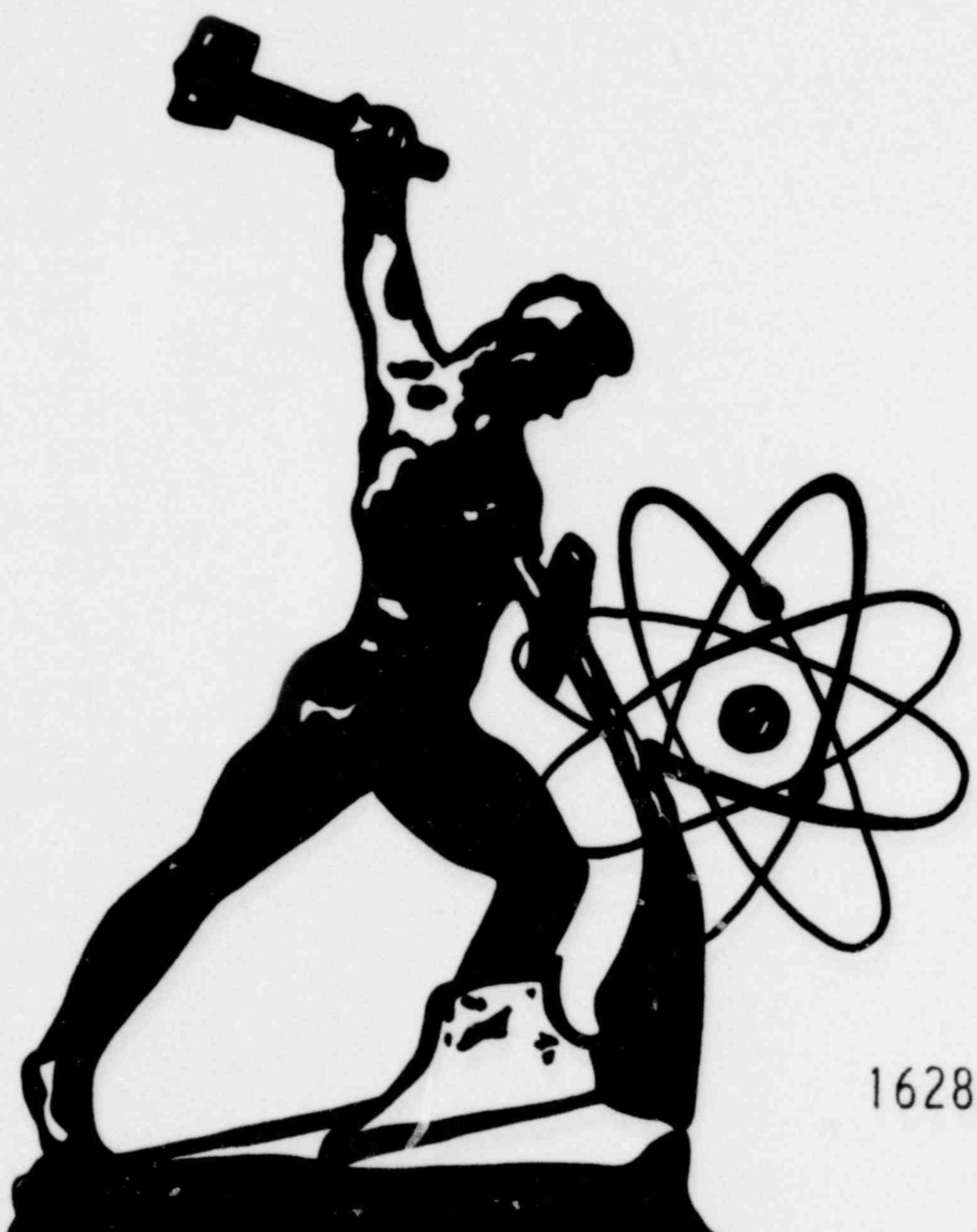
Technical Specifications
University of Missouri-Rolla Reactor



1628 227

7912200463

Technical Specifications

for

University of Missouri - Rolla
Nuclear Reactor

1628 228

Table of Contents

Technical Specifications for the UMRR

1628 229

Technical Specification for the UMRR

General

Reactor Identification

The University of Missouri - Rol.a Reactor (UMRR) is a pool type reactor, fueled with MTR type 90% enriched fuel, and/or 20% enriched Triga fuel. The reactor is housed in a building designed for a controlled release of effluents. The reactor is located on the campus of the University of Missouri - Rolla and is owned and operated by the Board of Curators.

Accuracy

The numerical values given in these specifications may vary from measured values due to the normal accuracy of the instrumentation and or measuring devices.

Definitions

Reactor Shutdown

Reactor shutdown shall mean that sufficient control rods are inserted so as to assure the reactor is subcritical by at least 1%.

Reactor Secured

Reactor secured shall mean that conditions exist wherein:

1. The reactor is shut down.
2. The magnet power is off and the key removed from the console.
3. The shut down check list is complete.

Operable

A system or device will be construed to be operable when it is capable of performing its intended function in a normal manner.

Cold Clean Critical

1628 230

Cold Clean Critical shall mean the critical condition that exists when the temperatures of the reactor fuel and pool water is at ambient temperature and that no appreciable amount of fission products are present in the core.

Experiment

Any apparatus, device, or material placed in the neutron flux of the reactor. An untried experiment shall mean an experiment which has not been previously run in the UMRR.

Experimental Facility

An experimented facility shall mean the thermal column, pneumatic tubes, reactor core, sample rotor or other devices designed to hold, position or expose samples for irradiation purposes.

Reactor Safety Circuits

Reactor safety circuits shall mean those circuits, including their associated equipment, which are designed to initate a reactor scram.

Steady State Operation

Steady state operation shall mean that operation of the reactor in which the power is held constant and the reactor is on automatic control.

Direct Supervision

Direct Supervision is defined as the supervisory personnel being in audible and visual contact with the person or persons being supervised.

Safety Limits

Applicability

This specification applies to the power level and the rate of change of power.

Objective

To insure the integrity of the fuel and to prevent the release of fission products from the fuel.

Specifications

The reactor power shall not exceed 200 K.W. + the normal accuracy of the instrumentation as indicated by the Intermediate Range Linear Nuclear Instrument Channel.

The rate of the reactor power increase shall never be faster than a 15 second period.

Conditions for operation

Reactivity Limits

Excess reactivity above Cold Clean Critical shall never exceed 3.5%, and this maximum shall never be used except for control rod calibration. The excess reactivity at an other time shall not exceed 1.5%. The reactivity worth of any single independent experiment shall not exceed 0.7%. The reactivity worth of all experiments in the core that are designed to be moveable shall not exceed 0.4%.

Reactor operation by student personnel will not be permitted when the excess reactivity of the core is greater than 0.7%, excepting those students who are in operator training courses and then the excess reactivity shall not exceed 1.5%.

Bases

The reactivity limits have been designed to give adequate excess reactivity to overide the negative temperature coefficient and to permit irradiation of experiments. Limits on experimented worths provide an adequate shut down margin in the event an experiment is accidently expelled from the reactor, and to avoid reactor excursions greater than would be expected from normal operation. The shut down margin assures that the reactor can be shut down should any one of the trippable control rods become stuck in the fully withdrawn position.

Instrumentation

Applicability

This specification applies to the devices which provide information on power level, rate of change of power, rate of change of subcritical neutron flux and pool temperature.

Objective

The objective is to assure the information available to the operator concerning reactor operations within permissible limits.

Specifications

1. There shall be at least one thermocouple positioned to read the core inlet temperature, and at least one thermocouple positioned to read the core outlet temperature.

2. There shall be at least five neutron measuring chambers located adjacent to the core. These will present neutron level information to the console.

Bases

Since the pool water temperature has an effect on the core reactivity it is important that the information be available at all times. Neutron flux is an important parameter for a reac r since it is directly proportional to the power level. The start up channel covers the source range while the other channels will provide reliable information after criticality through full power.

Control

Applicability

This specification applies to the control system including the control rods, control rod drives, and the control console.

Objective

The objective is to provide a system that will insure control by the operator or control within the prescribed limits should the operator fail to function correctly.

Specifications

1. The control system shall include a minimum of four control rods, one of which is designated as a regulating rod which shall have a worth of no more than 0.7%. The gang worth of the three other rods shall be greater than 7%. The maximum drop time shall not exceed 600 milliseconds from scram initation to full insertion.

The regulating rod shall be connected to a control device that will allow automatic control for steady state operation.

Safety and Control Instrumentation

TABLE I

SAFETY AND CONTROL INSTURMENTATION

Situation	Detector	Unit Initiating Action	Resulting Action	Setpoint
Manual Scram	Operator	Scram Button	Scram	operator
Period 5 seconds or less	Compensated Ion Chamber	Log N & Period Amplifier	Scram	>5sec
150% Full Power or more	(2) Uncompensated Ion Chamber	Safety Amplifier	Scram	<150%
Bridge Motion	Motion Switch	Motion Switch	Scram	<1/4 inch
Log N & Period Amplifier NOT Operative	Log N Period Amplifier	Relay	Scram	N/A
120% Demand or more	Compensated Ion Chamber	Linear Recorder	Rundown	<120%

Table I (continued)

Situation	Detector	Unit Initiating Action	Resulting Action	Setpoint
Period 15 seconds or less	Compensated Ion Chamber	Period Recorder	Rundown	>15 sec
Regulating Rod Insert Limit on Auto.	Micro-Switch	Micro-Switch	Rundown	>0.0
Low CIC Voltage	DC Realy	DC Realy	Rundown	>400v
120% Full Power or more	Compensated Ion Chamber	Log N Recorder	Rundown	<120%
High Radiation at RAM Points (1,2,3)	GM Tubes	Remote Area Monitoring (RAM) System	Rundown	<15 mr/Hr
Period 30 seconds or less (2)	Compensated Ion Chamber	Period Recorder	Rod Prohibit	>30 sec
Any Recorder Off (4)	Realy	Relay	Rod Prohibit	N/A
Log Count Rate 2 CPS or less (2)	Fission Chamber	Log Count Rate System	Rod Prohibit	>2 cps
Safety Rods Below Shim Range or Regulating Rod Above Insert Limit (2)	Micro-Switch	Relay	Rod Prohibit	N/A
Reactor Power Deviation More than ± 5% of Selected Power Level	Compensated Ion Chamber	Linear Channel Recorder	Servo-Prohibit	N/A
Core Inlet Water Temperature 135°F or more	Thermocouple	Relay	Rod Prohibit	<135°F
Interlock Bypassed	Key Switch	Key Switch	-----	N/A
Effluent Pool Demineralizer Conductivity 0.5 Meg Ohms	Conductivity Bridge	Relay	-----	<0.5 megohms per cm

Table I (continued

Situation	Detector	Unit Initiating Action	Resulting Action	Setpoint
High Neutron Flux in Beam Room (3)	BF_3 Neutron Detector	Relay	-----	<10,000 cpm

(1) Radiation detector on the reactor bridge causes building alram.

(2) Indicates that the situation may be key bypassed around safety circuitry.

(3) These will be set by measurement during initial increase in power level. The set-points will be less than 30 mrem/hr.

(4) The drive motor on startup channel recorder may be off.

Scram Circuits

The scram circuits are designed to shut down the reactor quickly in the event of a power excursion, a rapid increase in period, failure of the period detection equipment and the manual scram provides an overide of the automatic circuits. The bridge motion scram is designed to scram the reactor in the event of motion of the reactor core.

Rundown Circuits

Rundowns are designed to shut down the reactor automatically due to higher than normal levels. Faster flux change than normal, loss of power to the neutron detectors and to preclude the use of the automatic control when the regulating rod is not in a position to provide the needed reactivity for control. Also included in the rundowns are high radiation levels in several areas of the reactor building.

Rod Prohibits

The rod prohibits precludes the possibility of withdrawing rods due to the lack of source neutrons, operation with any recorder off, excessive period or excessive pool water temperature.

Radiological Monitoring

Applicability

This specification shall apply to the radiation monitoring system of the facility.

Objective

The objective is to provide information about the radiation levels in the building and to provide the necessary alarms in the event the set limits are exceeded.

Specifications

There shall be a minimum of three radiation monitors one on each level of the facility indicating the general radiation levels around the building. At least one of the three monitors shall shut down the reactor automatically in the event the prescribed radiation level is exceeded. All three of these monitors will have readouts in the control room.

Bases

It is important to be constantly aware of the radiation levels in the facility. An adequate alarm system must be provided to warn personnel of any impending or existing danger from radiation, and that will allow sufficient time to evacuate the building.

Reactor Water

Applicability

This specification pertains to the reactor pool water.

Objective

The objective is to ensure that the temperature of the pool water does not exceed the recommended operating temperature of the demineralizer resins.

Specifications

The reactor shall not be operated when the bulk pool water temperature exceeds 57°C.

Bases

It is desirable to operate the reactor with a temperature that will not harm the demineralizer resins. Water purity is an unnecessary technical specification for reactor safety. Although impure water will accelerate corrosion it will not produce an unsafe condition, merely an inconvient one.

Surveillance

Control Rods

Applicability

This surveillance specification shall apply to the control rod system for the reactor.

Objective

The objective is to insure the integrity of the three trippable control rods.

Specifications

The measurement of the control rod worth shall be made semiannually but at intervals not to exceed eight months.

The control rod drop times shall be made semiannually but at intervals not to exceed eight months. A visual inspection of the control rods shall be at intervals not to exceed two years.

Bases

In order to determine the reactivity worth of experiments and the reactivity worth of various cores the control rods should be calibrated periodically.

Radioactive Releases

In order to comply with ALARA a water retention system shall be used to retain the liquid effluents from the water purification system. The waste water is held until well below 10-CFR-20 Appendix B, Table 1 Column 2 limits for unrestricted release.

Gaseous effluents are constantly monitored and total releases are calculated monthly. Liquid effluents are calculated each time a release to the sanitary sewer is made. While operating at full power gaseous effluents are well below the level for unrestricted release.

The detailed methodology for measuring and calculating the effluents is given in the operating procedure and is approved by the Health Physicist.

1628 239

The rod drop times must be measured in order to determine the emergency shut down time. The visual inspection of the control rods are necessary to detect any metallurgical problems.

Console

Applicability

This specification applies to the reactor control system, its safety circuits and start up instrumentation.

Objective

The objective is to insure the realibility of the reactor control and safety system.

Specifications

The reactor safety circuits and start up instrumentation shall be checked as operable prior to each days operation, and/or before each start up after the reactor has been secured.

The calibration of power level will be made semiannually but at periods not to exceed eight months. The alignment of all console instruments shall be made semiannually but at periods not to exceed eight months.

Bases

This requirement assures the reactor operator that the information presented to the consolers correct, allowing the operator to make correct judgements concerning the operation.

The power calibration will assure the maximum power limits will be met.

Radiation Monitoring Equipment

Applicability

This surveillance specification shall apply to the radiation monitoring equipment in the reactor building.

Objective

The objective is to insure that the radiation monitoring equipment is functioning and that the alram settings are reasonable.

Specifications

The alarm set points for the radiation monitoring instrumentation on the console shall be checked prior to starting up the reactor for each days operation. Other monitoring equipment shall be checked on a weekly basis during normal operating periods.

Bases

The procedures for emergency evaluation involve signals from the radiation monitoring equipment checking of that system is needed for both radiation control and emergency procedures.

Maintenance

Applicability

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

Objective

The objective is to insure that the control or safety system is operable and calibrated before being used after maintenance.

Specifications

Following maintenance or modification of the control or safety system, an operational and/or alignment of the associated system shall be performed before the affected system is to be considered operable.

Bases

Any time that maintenance or modification of a system is required, it is necessary to know if the system has been returned to a normal operating status before the reactor is brought to power.

Design Features

Reactor Fuel

Applicability

This specification shall apply to the fuel elements in the reactor core.

Objective

The objective is to insure 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

MTR Fuel Element

The standard MTR fuel element contains 10 plates. The overall demensions of each element is approximately 3 X 3 X 36 inches. There is approximately 17 grams of U^{235} per plate. Each plate is 24 inches long and clad in 20 mils of aluminum.

The entire assembly is joined at the bottom to a cylindrical nose piece that is machined to fit into the bottom grid plate. Two identical elements which contain only five plates with fuel are designated as half elements.

MTR Control Rod Element

The standard MTR Control rod elements are identical to the fuel element with the exception that the center four plates have been removed and have been replaced with a guide for the control rod. In addition the fuel plate spacing is slightly closer than in a standard element.

Standard Triga Fuel Element

The Triga fuel elements consist of a cluster of four rods mechanically joined together to form a fuel element of the same demension of a MTR fuel element. Each fuel rod is 30 inches long with an overall outside diameter of 1.41 inches. The fuel length is 15 inches and the entire rod which is clad is 20 mils of stainless steel. Each rod contains approximately 35 grams of U^{235} with a 20% enrichment. The fuel composition is Uranium-Zirconium hydride.

Loading

The fuel elements shall be placed in a closely packed array except for positions occupied by control rods and a neutron start up source.

Bases

Both the MTR and Triga type fuel has a long history of successful use. Operation with a mixed core will yield necessary data on different enrichments.

Fuel Storage

Applicability

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

Objective

The objective is to insure that fuel which is being stored will not become supercritical.

Specifications

All stored fuel elements shall be stored in a geometrical array where the K_{eff} is less than 0.6 for all conditions of moderation.

Bases

The fuel elements must be stored in such a fashion to preclude any possibility of criticality.

Administrative and Procedural Safeguards

Isotopes and Safety Committee

This committee is directly responsible for the safe operation of the Nuclear Reactor Facility. It reviews and approves all projects utilizing the facility and reviews and approves all proposed changes to the facility. The committee is also responsible for determining whet er a proposed change, test, or experiment would constitute an unreviewed safety question or a change in technical specifications. The membership of the committee shall be such as to maintain a high degree of technical expertise, and shall meet at least at quarterly intervals.

Operation and Written Procedures

The following operations shall be done only in accordance with written instructions.

1. Checkout and calibration of reactor operating instrumentation.
2. Reactor start up and sh wn.
3. Control rod removal for inspection.
4. The loading and unloading of fuel, except for the removal of loading of a single element.

Record Retention

The following records shall be retained for at least five years:

Records and logs of principal maintenance activities, inspections, repair and replacement of principal items of equipment related to nuclear safety.

ALL REPORTABLE OCCURRENCES submitted to the Commission.

Records of surveillance activities, inspections and calibrations required by these Technical Specifications.

Records of reactor tests and experiments. 1628 244

Records of radioactive shipments

Records of sealed source leak tests and results.

The following records shall be retained for the duration of the Facility Operating License:

Records and drawing changes reflecting facility design modifications made to systems and equipment described in the Hazard Analysis Report.

Records and logs of facility operation covering time interval at each power level on the Log N recorder only.

Records of new and irradiated fuel inventory, fuel transfers and assembly burnup histories.

Records of facility radiation and contamination surveys.

Records of radiation exposure for all individuals entering radiation control areas.

Records of gaseous and liquid radioactive material released to the environs.

Records of training and qualification for current members of the plant staff.

Records of meetings of the Radiation Safety Committee.

1628 245

Modifications and Maintenance

Any additions, modifications or maintenance to the core, its supporting structure, rod drive mechanisms or the reactor safety system shall be made in accordance with the specifications not to exceed the original design of the systems, or the specifications approved by the Safety Committee as suitable and not involving an unreviewed safety question. A system shall not be considered.

Experiments

Any proposed project utilizing the neutron flux of the reactor shall be evaluated by the experimenter. The evaluation then shall be reviewed by a licensed Senior Operator and the Reactor Health Physicist to assure compliance with the provisions of the utilization license, tech specs, and 10 CFR 20. If in their judgement it meets with the above provision and does not constitute a threat it to the Safety Committee for final approval. When pertinent the evaluation shall include:

The reactivity worth of the experiment, including the effects of changes of temperature, pressure, or chemical composition, and any radiation hazard that may result from its interaction with the neutron flux. After a project request has been given final approval by the safety committee, each individual experiment in the project shall be approved by at least two persons, one of which is a member of the health physics staff, the other a licensed Senior Operator of the facility.

For the approval of an experiment the experimenter must submit an "Irradiation Request Form" to the Reactor Manager or the Health Physicist. The request shall contain information to the target material, amount, chemical form, and packaging. For routine irradiation which do not contain nuclear fuel or explosive materials and which do not constitute a threat to the intergrity or safety of the reactor or personnel: approval for the irradiation shall be made by a licensed Senior Operator and the Reactor Health Physicist or his designee. Samples must be doubly encapsulated when the release of the contained material could cause corrosion of the experimental facility.

1628 247

Core Loading Patterns

Applicability

This specification shall apply to studies of core loading patterns using mixed Triga and MTR fuel.

Objective

To insure safe operations with a mixed core.

Specifications

1. All movements of fuel shall follow written procedures and will be done under the direct supervision of a licensed Senior Operator.
2. The loading of fuel elements into any position shall be done with the safety rods halfway withdrawn (Shim Range).
3. The maximum excess above cold clean critical shall not exceed 1.5%.
4. The maximum steady state operation during the study shall not exceed 100 kilowatts. Previous to any operation above 100 watts during these studies the critical rod heights shall be determined by operating the reactor at low power for a period long enough to determine cold clean critical excess reactivity.

1628 248