APPENDIX A

TO

FACILITY LICENSE NO. CX-22

TECHNICAL SPECIFICATIONS

AND BASES FOR THE

RENSSELAER POLYTECHNIC INSTITUTE

CRITICAL EXPERIMENTS FACILITY

SCHENECTADY, NEW YORK

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1.0 DEFINITIONS

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

A. Channel Calibration - The correlation of channel outputs to known input signals and other known parameters. Calibration shall encompass the entire channel, including equipment actuation, alarm, or trip.

B. Channel Check - Qualitative determination of acceptable operability by observation of instrument behavior during operation. This determination shall include, where possible, comparison of the instrument with other independent instruments measuring the same variable.

C. Channel Test - The injection of a simulated signal into the instrument primary sensor to verify the proper instrument response alarm and/or initiating action.

D. Control Rod Assembly - A control mechanism consisting of a top absorber section and a lower fuel follower section.

1. Control Rod Absorber Section: These may contain either enriched boron in iron, Eu_2O_3 in a stainless steel cermet, stainless steel, or an alloy of silver-cadmium-indium. All absorber sections except the one containing silver-cadmium-indium are clad in stainless steel. All are of the same dimensions, nominally 2.6 inches square, with their poisons uniformly distributed. The absorbers, when fully inserted, shall extend above the top and to within one inch of the bottom of the active core.

2. Control Rod Follower Section: An array of up to 16 stainless steel plates or stainless steel clad fuel plates containing 93 percent or less enriched fissionable oxides of uranium in a stainless steel cermet.

E. Excess Reactivity - The available reactivity above a cold, clean, critical configuration which may be added by manipulation of controls.

F. Experiment - (1) An apparatus, device, or material placed in the reactor vessel, and/or (2) any operation designed to measure reactor characteristics.

G. Measuring Channel - The combination of sensor, lines, amplifiers, and output devices which are connected for the purpose of measuring the value of a process variable.

H. Measured Value - The value of the process variable as it appears on the output of a measuring channel.

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

J. Operable - A system or component is capable of performing its intended function in its required manner.

K. Operating - A system or component is performing its intended function in its required manner.

L. Reactor Safety System - Combination of safety channels and associated circuitry which forms the automatic protective system for the reactor or provides information which requires manual protective action to be initiated.

M. Reactor Scram - A gravity drop of the control rods accompanied by the opening of the moderator dump valve. The scram can be initiated either manually or automatically by the safety system.

N. Reactor Secured - (1) The full insertion of all control rods has been verified, (2) the console key is removed, and (3) no operation is in progress which involves moving fuel elements in the reactor vessel, the insertion or removal of experiments from the reactor vessel, or control rod maintenance.

O. Reactor Shutdown - The control rod(s) are inserted and the reactor is subcritical by at least $2.86. The reactor is considered to be operating whenever this condition is not met and there are 12 or more fuel elements loaded in the core.

P. Readily Available on Call - The Licensed Senior Operator (LSO) on duty shall remain within a 15 mile radius or 30 minutes travel time of the facility, whichever is closer, and the operator-on-duty shall know the exact location and telephone number of the LSO on duty.

Q. Reportable Occurrence - The occurrence of any facility condition that:

1. Causes a Limiting Safety System Setting to exceed the setting established in Section 2 of the Technical Specifications;

2. Exceeds a Limiting Condition for Operations as established in Section 3 of the Technical Specifications;

3. Causes any uncontrolled or unplanned release of radioactive material from the restricted area of the facility;

4. Results in safety system component failures which could, or threaten to, render the system incapable of performing its intended safety function as defined in the Technical Specifications or SAR;

5. Results in abnormal degradation of one of the several boundaries which are designed to contain the radioactive materials resulting from the fission processes;

6. Results in uncontrolled or unanticipated changes in reactivity of greater than $.70;

7. Causes conditions arising from natural of offsite manmade events that affect or threten to affect safe operation of the facility, or;

8. Results in observed inadequacies in the implementation of administrative or procedural controls such that the inadequacy causes or threatens to cause the existence or development of an unsafe condition in connection with the operation of the facility.

R. Review and Approve - The reviewing group or person shall cary out a review of the matter in question and may either approve or disapprove it; before it can be implemented, the matter in question must receive approval from the reviewing group or person.

S. Safety Channel - A measuring channel in the reactor safety system.

T. Secured Experiment - Any experiment, experimental facility, or component of an experiment is deemed to be secured, or in a secured position, if it is held in a stationary position relative to the reactor. The restraining forces must be equal to or greater than those which hold the fuel elements themselves in the reactor core.

U. Source - A neutron-emitting radioactive material, other than reactor fuel, which is positioned in or near the assembly to provide an external source of neutrons.

V. Surveillance Frequency - Unless otherwise stated in these specifications, periodic surveillance tests, checks, calibrations, and examinations shall be performed within the specified surveillance intervals. In cases where the elapsed interval has exceeded 100% of the specified interval, the next surveillance interval shall commence at the end of the original specified interval. Allowable surveillance intervals, as defined in ANSI/ANS 15.1 (1982) shall not exceed the following:

1. Five-year (interval not to exceed six years).

2. Two-year (interval not to exceed two and one-half years).

3. Annual (interval not to exceed 15 months).

4. Seminnual (interval not to exceed seven and one-half months).

5. Quarterly (interval not to exceed four months).

6. Monthly (interval not to exceed six weeks).

7. Weekly (interval not to exceed ten days).

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

W. Surveillance Interval - The surveillance interval is the calendar time between surveillance tests, checks, calibrations, and examinations to be performed upon an instrument or component when it is required to be operable.

X. True Value - The actual value at any instant of a process variable.

Y. Unsecured Experiment - Any experiment, experimental facility, or component or an experiment is deemed to be unsecured if it is not and when it is not secured. Moving parts of experiments are deemed to be unsecured when they are in motion.

2.0 SAFETY LIMITS AND LIMITING SAFETY SYSTEM SETTINGS

2.1 Safety Limits - Reactor Power

Applicability

Applies to variables associated with reactor power.

Objective

To establish the maximum power level and annual integrated power below which fuel cladding is preserved and fission produce inventories are acceptably limited.

Specification

1. The thermal power level shall not exceed 270 watts.

2. The integrated thermal power for any 365 consecutive days shall not exceed 200 kilowatt-hours.

Bases

Since a critical experiment does not contain significant quantities of radioctivity, a definite safety limit is not required to protect the integrity of the physical barriers which guard against the uncontrolled release of radioactivity. A steady-state thermal power level of 100 watts and an integrated thermal power of 200 kW-hrs appropriately limit the quantity of radioactivity available for release and provides adequate flexibility for the performance of training and educational operations.

Administrative control of annual integrated thermal power shall be used to meet the safety limit of 200 kilowatt-hours in any consecutive 365 days.

The 270 watt limit is stipulated because at that level the change in moderator and fuel temperature will not result in damage to reactor components or compromise the integrity of the fuel clad.

Measurements have shown that during normal steady-state operation, the average moderator temperature increase is negligible and the clad and fuel temperatures remain far below their failure points. In general, the operating power level is kept as low as practicable, consistent with experimental and educational operation requirements and normally below 20 watts.

2.2 Limiting Safety System Settings - Reactor Power

Applicability

Applies to the settings to initiate protective action for instruments monitoring parameters associated with the reactor power limits.

Objective

To assure protective action before safety limits are exceeded.

Specification

The limiting safety system settings on reactor power shall be as follows:

Maximum Power Level	135 watts
Minimum Flux Level	2.0 counts/sec
Minimum Period	5 seconds

Bases

The maximum power level trip setting of 135 watts corresponds to a reading of not greater than 90% on the last scale of either linear power channel as established by activation techniques. This safety margin is sufficient to account for uncertainties in this power calibration and instrumentation. The minimum flux level has been established to prevent a source-out start up. The interlock set point on the source level channel is 2 cps. The specified minimum flux level will assure that this interlock is satisfied.

The minimum 5-second period is specified so that the automatic safety system channels have sufficient time to respond before safety limits are exceeded.

3.0 LIMITING CONDITIONS FOR OPERATION

3.1 Reactor Control and Safety Systems

Applicability

Applies to all methods of changing core reactivity available to the reactor operator.

Objective

To assure that available shutdown method is adequate and that positive reactivity insertion rates are within those analyzed in the Hazards Summary Report (hereinafter safety analysis report).

Specifications

1. The excess reactivity of the reactor core above cold, clean critical shall not be greater than $.60. The maximum reactivity worth of any clean fuel assembly shall be $5.50.

2. There shall be a minimum of three operable control rods. The reactor shall be subcritical by more than $.70 with the most reactive control rod fully withdrawn.

3. The maximum control rod reactivity rate shall be less than $.12/sec up to 10 times source level and $.05/sec at all higher levels.

4. The total control rod drop time for each control rod from its fully withdrawn position to its fully inserted position shall be less than or equal to 900 milliseconds. This time shall include a maximum magnet release time of 50 milliseconds.

5. The auxiliary reactor scram (moderator-reflector water dump) shall add negative reactivity within one minute of its activation.

6. The normal moderator-reflector water level shall be established not greater than 10 inches above the top grid of the core.

7. The minimum safety channels that shall be operating during the reactor operation are listed in Table 1.

8. After a scram, the moderator dump valve may be reclosed by a senior reactor operator if the cause of the scram is known, all control rods are verified to have scrammed and it is deemed wise to retain the moderator shielding in the reactor tank.

9. The interlocks that shall be operable during reactor operations are listed in Table 2.

Table 1

Minimum Safety System Channels

Reactor Conditions and Ranges	Channels	Minimum Number	Functions
Start up 2 cps - 10^4 cps	Log Coung Rate[a]	1	Minimum flux level
Power - 10^{-4} - 150% full power	Linear Power	2	High neutron level scram
- 10^{-3} - 300% full power	Log-N Period[b]	1	Neutron level indication period scram
	Manual Scram[c]	2	Reactor scram
	Building Power	1	Loss of power
	Reactor Door Scram[d]	1	Reactor scram

(a) May be bypassed when linear power channels are reading greater than 3 X 10^{-10} amps.

(b) During steadv-state operation, this safety channel may be bypassed with the permission of the Operations Supervisor.

(c) The manual scram shall consist of a regular manual scram at the console and a manual electric switch which shall disconnect the electrical power of the facility from the reactor, causing a loss of power scram.

(d) The reactor door scram may be bypassed during maintenance checks and radiation surveys with the specific permission of the Operations Supervisor provided that no other scram channels are bypassed.

Table 2

Interlocks

Interlocks	Action if Interlock Not Satisfied
Reactor Console Keys (2) "On"	Reactor Scram
Reactor Period 15 sec[a]	Prevents Control Rod Withdrawal
Neutron Flux 2 cps	Prevents Control Rod Withdrawal
Failure of 400 Cycle Synchro Power Supply	Prevents Control Rod Withdrawal
Failure of Line Voltage to Recorders	Prevents Control Rod Withdrawal
Moderator-Reflector Water Fill On	Stops Water Fill
Water Level in Reactor Tank 10 ± 1" Above Core Top Grid	Prevents Control Rod Withdrawal

(a) These interlocks are available on only 1 of the 2 Log-N period Amplifiers and, therefore, may be bypassed with the permission of the Operations Supervisor if that one amplifier is out of service.

Bases

The minimum number of three control rods is specified to assure that there is adequate shutdown capability even for the stuck control rod condition. Normally there are more than three control rods available for shutdown capability.

The insertion time of less than 900 milliseconds for each control rod from its fully withdrawn position is specified to assure that the insertion time does not exceed that assumed when establishing the minimum period in Specification 2.2 as a limiting safety system setting.

The auxiliary reactor scram is specified to assure that there is a secondary mode of shutdown available during reactor operations. The requirement that negative reactivity be introduced in less than one minute following activation of the scram is established to minimize the consequences of any potential power transients.

The normal moderator-reflector water level of the reactor is established at not greater than 10 inches above the top grid of the core to assure than the moderator-reflector water dump, back-up scram will introduce negative reactivity within the time assumed in the safety analysis by loss of reflector at the top of the core.

The safety system channels listed in Table 1 provide a high degree of redundancy to assure that human or mechanical failures will not endanger the reactor facility or the general public.

The interlock system listed in Table 2 assures that only authorized personnel can operate the reactor and the proper sequence of operations is performed. It also limits the actions that an operator can take, and assists him in safely operating the reactor.

3.2 Reactor Parameters

Applicability

These specifications apply to core parameters and reactivity coefficients.

Objective

The purpose of these specifications is to assure that the reactor is operated within the range of parameters that have been analyzed.

Specifications

1. Above 90°F the isothermal temperature coefficient of reactivity shall be negative. The net positive reactivity insertion from the minimum operating temperature to the temperature at which the coefficient becomes negative shall be less than $.11.

2. The void coefficient of reactivity shall be negative, when the moderator temperature is above 90°F, within all standard fuel assemblies and have a minimum average negative value of $.00043/cc within the boundaries of the active fuel region.

3. The minimum operating temperature shall be 50°F.

Bases

The minimum absolute value of the temperature coefficient of reactivity is specified to assure that an adequate inherent negative reactivity effect takes place when the reactor temperature increases above 90°F. Above a moderator temperature of 90°F, the minimum average negative value of the void coefficient of reactivity is specified to assure that the negative reactivity insertion due to void formation is greater than that which was calculated to occur in the SAR. The minimum operating temperature of 50°F establishes the temperature range for which the net positive reactivity limit can be applied.

3.3 Radiation Monitoring

Applicability

These specifications apply to the minimum radiation monitoring requirements for reactor operations.

Objective

The purpose of these specifications is to assure that adequate monitoring is available to preclude undetected radiation hazards or uncontrolled releases of radioactive material.

Specifications

1. The minimum complement of radiation monitoring equipment required to be operating for reactor operation shall include:

a. A criticality detector system which monitors the main fuel storage area and also functions as an area monitor. This system shall have a visible and an audible alarm in the control room.

b. An area gamma monitoring system which shall have detectors at least in the following locations: (1) Control room; (2) Reactor room near the fuel vault; (3) Reactor room (high level monitor), and; (4) Outside the reactor room window.

c. Instruments to continuously sample and measure the particulate activity in the reactor room atmosphere shall be operating whenever the reactor is to be operated.

d. The radiation monitors required by 3.3.1 a, b, and c, may be temporarily removed from service if replaced by an equivalent portable unit.

2. Portable detection and survey instruments shall be provided.

Bases

The continuous monitoring of radiation levels in the reactor room and other stations assures the warning of the existence of any abnormally high radiation levels. The availability of instruments to measure the amount of particulate activity in the reactor room air assures continued compliance with the requirements of 10 CFR Part 20. The availability of required protable monitors provide assurance that personnel will be able to monitor potential radiation fields before an area is entered.

In all cases, the low power levels encountered in operation of the critical assembly minimizes the probable existence of high radiation levels.

3.4 Experiments

Applicability

These specifications apply to all experiments placed in the reactor tank.

Objective

The objective of these specifications is to define a set of criteria for experiments to assure the safety of the reactor and personnel.

Specifications

1. No new experiment shall be performed until a written procedure which has been developed to permit good understanding of the safety aspects is reviewed and approved by the Nuclear Safety Review Board and approved by the Operations Supervisor. Experiments that fall in the general category, but with minor deviations from those previously performed, may be approved directly by the Operations Supervisor.

2. No experiment shall be conducted if the associated experimental equipment could interfere with the control rod functions or with the safety functions of the nuclear instrumentation.

3. For movable experiments with an absolute worth greater than $.35, the maximum reactivity change for withdrawal and insertion shall be $.20/sec. Moving parts worth less than $.35 may be oscillated at higher frequencies in the core.

4. The maximum positive step insertion of reactivity which can be caused by an experimental accident or experimental equipment failure of a moveable experiment shall not exceed $.60.

5. Experiments shall not contain a material which may produce a violent chemical reaction and/or significant airborne radioactivity.

6. Experiments containing known explosives or highly flammable materials shall not be installed in the reactor.

7. All experiments which corrode easily and are in contact with the reactor coolant shall be encapsulated within corrosion resistant containers.

8. The radioactive material content of any singly encapsulated experiment shall be limited such that the complete release of all gaseous, particulate or volatile components directly to the reactor room will not result in exposures in excess of 10% of the equivalent annual exposures stated in 10 CFR 20 for persons remaining in unrestricted areas for two hours or in restricted areas during the length of time required to evacuate the restricted area.

9. The radioactive material content of any doubly encapsulated experiment shall be limited such that the postulated complete release from the encapsulation or confining boundary of the experiment could not result in exposure in excess of applicable limits in 10 CFR 20 of any person occupying an unrestricted area continuously for a period of two hours from the time of release, or an exposure in excess of applicable limits in 10 CFR 20 for persons located within the restricted area during the length of time required to evacuate the restricted area.

Bases

The basic experiments to be performed in the reactor programs are described in the Safety Analysis Report (SAR). The present programs are oriented toward reactor operator training, the instruction of students, and with such research and development as is permitted under the terms of the facility license. To assure that all experiments are well planned and evaluated prior to being performed, detailed written procedures for all new experiments must be reviewed by the NSRB and approved by the Operations Supervisor.

Since the control rods enter the core by gravity and are required by other technical specifications to be operable, no equipment should be allowed to interfere with their functions. To assure that specified power limits are not exceeded, the nuclear instrumentation must be capable of accurately monitoring core parameters.

All new reactor experiments are reviewed and approved prior to their performance to assure that the experimental techniques and procedures are safe and proper and that the hazards from possible accidents are minimal. A maximum reactivity change is established for the remote positioning of experimental samples and devices during reactor operations to assure that the reactor controls are readily capable of controlling the reactor.

All experimental apparatus placed in the reactor must be properly secured. In consideration of potential accidents, the reactivity effect of movable apparatus must be limited to the maximum accidental step reactivity insertion analyzed in the SAR section. This corresponds to a $.60 positive step while operating at full power followed by one failure in the reactor safety system.

Restrictions on irradiations of explosives and highly flammable materials are imposed to minimize the possibility of explosion or fires in the vicinity of the reactor.

To minimize the possibility of exposing facility personnel or the public to radioactive materials, no experiment will be performed with materials that could result in a violent chemical reaction, produce airborne activity, or cause a corrosive attack on the fuel cladding or primary coolant system.

Specifications 8 and 9 will assure that the quantities of radioactive materials contained in experiments will be limited such that their failure will not result in exposures to individuals in restricted or unrestricted areas to exceed the maximum allowable exposures stated in 10 CFR part 20. The restricted area maximum is defined in 10 CFR 20.101 and 10 CFR 20.103. The unrestricted area maximum is defined in 10 CFR 105(1) and 10 CFR 106.

4.0 SURVEILLANCE REQUIREMENTS

4.1 Reactor Control and Safety

Applicability

These specifications apply to the surveillance of the safety and control apparatus and instrumentation of the facility.

Objective

The purpose of these specifications is to assure that the safety and control equipment is operable and will function as required in Specification 3.1.

Specifications

1. The total control rod drop time and magnet release time shall be measured semiannually to verify that the requirements of Specification 3.1, Item 3, are met.

2. The moderator-reflector water dumpt ime shall be measured semiannually to verify that ther equirement of Specification 3.1, Item 4, is met.

3. All instrument channels, including safety system channels, shall be calibrated annually.

4. A channel test of the safety system channels (intermediate, and power range instruments) and a visual inspection of the reactor shall be performed daily prior to reactor start up. The interlock system shall be checked to satisfy rod drive permit. These systems shall be rechecked following a shutdown in excess of 8 hours.

5. The moderator-reflector water height shall be checked visually before reactor start up to verify that the requirements of Specification 3.1, Item 5, are met.

6. These tests may be waived when the instrument, component, or system is not required to be operable, but the instrument, component or system shall be tested prior to being declared operable.

Bases

Past performance of control rods and control rod drives and the moderator-reflector water fill and dump valve system have demonstrated that testing semiannually is adequate to assure compliance with Specification 3.1, Items 3, 4 and 5.

Visual inspection of the reactor components, including the control rods, prior to each day's operation, is to assure that the components have not been damaged and that the core is in the proper condition. Since redundancy of all safety channels is provided, random failures should not jeopardize the ability of the overall system to perform its required functions. The interlock system for the reactor is designed so that its failure places the system in a safe or non-operating condition. However, to assure that failures in the safety channels and interlock system are detected as soon as possible, frequent surveillance is desirable and thus specified. All of the above procedurs are enumerated in the daily start up check list.

Past experience has indicated that, in conjunction with the daily check, calibration of the safety channels annually assures the proper accuracy is maintained.

4.2 Reactor Parameters

Applicability

These specifications apply to the verification of control rod reactivity worths, temperature and void coefficients of reactivity, and reactor power levels which pertinent to the reactor control.

Objective

The purpose of these specifications is to assure that the analytical bases are and remain valid and that the reactor is safely operated.

Specifications

The following parameters shall be determined during the initial testing of an unknown or previously untested core configuration:

a. control rod bank reactivity worth;

b. temperature and void coefficients of reactivity;

c. reactor power measurement;

d. shutdown margin.

Bases

Measurements of the above are parameters made when a new reactor configuration is assembled. Whenever the core configuration is altered considerable to an unknown or untested configuration, the core parameters are evaluated to assure that thay are within the limits of these specifications and the values analyzed in the SAR. During the initial test period of the reactor, measurements and calculations of core parameters will be for standard assemblies which are to be utilized in the reactor's operational program.

4.3 Radiation Monitoring

Applicability

These specifications apply to the surveillance of the area and air radiation monitoring equipment.

Objective

The purpose of these specifications is to assure the continued validity of radiation protection standards in the facility.

Specification

The criticality detector system, area gamma monitors, and the mobile particulate air monitor shall be checked daily if the reactor is operated, tested monthly, and calibrated semiannually.

Bases

Experience has demonstrated that calibration of the criticality detectors, air gamma monitors, and the mobile air monitoring instrument semiannually is adequate to assure that significant deterioration in accuracy does not occur. Furthermore, the operability of these radiation monitors is included in the daily pre-start up check list.

5.0 DESIGN FEATURES

5.1 Site

The facility is located on a site situated on the south bank of the Mohawk River in the City of Schenectady. An inner fence of greater than 30 feet radius defines the restricted area. An outer fence and river bank of greater than 50 feet radius defines the exclusion area.

5.2 Facility

The facility is housed in the reactor building. The security of the facility is maintained by the use of two fences; one at the site boundary and the other defining the restricted area around the reactor building itself.

5.3 Reactor Room

The reactor room is a 12 inch reinforced concrete enclosure with approximate floor dimensions of 40 X 30 feet. The height from the ground floor to the ceiling shall be about 30 feet. The roof is a steel deck covered by 2 inches of light weight concrete, five plies of felt and asphalt, with a gravel surface. Access to the reactor room is through a sliding fireproof steel door which also contains a smaller personnel door. Near the center of the room is a pit 14.5 X 19.5 feet wide and 12 feet deep with a floor of 18 inch concrete. This part contains the 3500 gallon water storage tank and other piping and auxiliary equipment.

5.4 Reactor

5.4.1 Reactor Tank

The stainless steel lined reactor tank has a capacity of approximately 2000 gallons of water. The tank nominal dimensions are 7 feet in diameter and 7 feet high. The tank is supported at floor level above the reactor room by 8 inch steel I beams. There are no side penetrations in the reactor tank.

The reactor tank is connected to the water storage tank via a six inch quick dump line. Therefore, it is required that the storage tank be vented to the atmosphere such that its freeboard volume can always contain all water in the primary system.

5.4.2 Reactor Core

The stainless steel reactor core structure is comprised of upper, center, and lower grid plates. The active core is situated between the upper and center grid plates and is about 22 inches in height and 22 inches in equivalent diameter. The core normally contains 38 stationary fuel assemblies and 4 control rod assemblies with fuel followers. The entire support structure is mounted on four posts set in the floor of the reactor tank.

5.4.3 Standard Fuel Assemblies

A stationary fuel assembly shall be composed of a maximum of 18 fuel plates of stainless steel clad 93% or less than 93% enriched UO_2 - SS cermet. The box-type fuel assemblies are 2.9 X 2.9 X 22 inches in dimensions. The center-to-center spacing of the fuel plates is maintained by grooved polystyrene inserts at 0.163 inch. A control rod fuel follower will be of similar fuel enrichment, but limited to a maximum of 16 plates per assembly. For reduced loadings, plates may be omitted or dummy plates used.

5.4.4 Control Rod Assemblies

The control rod assembly shall consist of a control rod absorber section and a control rod follower. The length of the control rod poison section is 22 inches and is nominally 2.619 inches square. The poison and fuel follower are inserted in a stainless steel square tube, 2.75 inches square, which passes through the core and rests in a hydraulic buffer on the bottom grid plate of the support structure.

The drive mechanism is a motor and gear box coupled by a magnetic clutch to a rack and pinion attached to the top of the rod from an overhead cantilever mount.

5.5 Water Handling System

The water handling system allows remote filling and emptying of the reactor tank. It provides for a water dump by means of a fail safe butterfly-type gate valve when a reactor scram is initiated. The filling system shall be controlled by the operator who must satisfy the sequential interlock system before adding water to the tank. A pump is provided to add the moderator-reflector water from the storage dump tank into the reactor tank. Slow and fast fill rates of about 10 gpm and 50 gpm, respectively, are provided. A nominal six inch valve is installed in the dump line and has the capability of emptying the reactor tank on demand of the operator or when a reactor scram is initiated, unless bypassed with the approval of the

licensed senior operator on duty. A valve is installed in the bottom drain line of the reactor tank to provide for completely emptying the reactor tank.

5.6 Fuel Storage and Transfer

When not in use, the fuel plates shall be stored within the storage vault located in the reactor room. The vault shall be closed by a locked door and shall be provided with a criticality monitor near the vault door. The fuel shall be stored in cadmium clad steel tubes with no more than 1 kg fuel per tube mounted on a steel wall rack. The center-to-center spacing of the storage tubes together with the cadmium clad steel tubes assures that the infinite multiplication factor is less than 0.9 when flooded with water.

All fuel transfers shall be conducted under the direction of a licensed senior operator.

Operating personnel shall be familiar with health physics procedures and monitoring techniques and shall monitor the operation with appropriate radiation instrumentation.

For a completely unknown or untested system, fuel loading shall follow the inverse multiplication approach to criticality and, thereafter, meet Specification 4.2. Should any interruption of the loading occur (more than four days), all fuel elements except the initial loading step shall be removed from the core in reverse sequence and the operation repeated.

For a known system, up to a quadrant of elements may be removed from the core or a single stationary fuel assembly be replaced with another stationary assembly only under the following conditions:

1. The net change in reactivity has been previously determined by measurement or calculation to be negative or less than $.72.

2. The reactor is subcritical by at least $2.86 in reactivity.

3. There is initially only one vacant position within the active fuel lattice.

4. The nuclear instrumentation is on scale and the dump valve is not bypassed.

5. The critical rod bank position is checked after the operation is complete.

6.0 ADMINISTRATIVE CONTROLS

6.1 Organization

6.1.1 Structure

The organization for the management and operation of the reactor facility shall include the structure indicated in Figure 6.1.

Level 1: The Facility Director is responsible for the facility license and site administration.

Level 2: The Operations Supervisor is responsible for the reactor facility operation and management.

Level 3: Licensed senior operators are responsible for daily reactor operations.

Level 4: Licensed operators are the operating staff.

A health physicist who is organizationally independent of RPI operations group shall provide advise as required by the RPI Operations Supervisor in matters concerning radiological safety. The healthy physicist also has interdiction responsibility and authority.

6.1.2 Responsibility

The Operations Supervisor of the Rensselaer Polytechnic Institute Critical Experiment Facility shall be responsible for the safe operation of the facility. He shall be responsible for assuring that all operations are conducted in a safe manner and within the limits prescribed by the facility license, including these technical specifications.

In all matters pertaining to the operation of the reactor and these technical specifications, the Operations Supervisor shall report to and be directly respnsible to the Facility Director.

6.1.3 Staffing

a) The minimal staffing when the reactor is not shutdown as described in these specifications shall be:

   1) An operator or senior operator licensed pursuant to 10 CFR 55 be present at the controls.

   2) A licensed senior operator shall be present or readily available on call.

3) The identity of and method for rapidly contacting the licensed senior operator on duty shall be known to the operator.

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

1) Management personnel.

2) Radiation safety personnel.

3) Other operations personnel.

c) Events requiring the direction of the Operations Supervisor:

1) All fuel or control rod relocations within the reactor core.

2) Recovery from unplanned or unscheduled shutdown.

6.1.4 Selection and Training of Personnel

The selection, training and requalification of operations personnel shall meet or exceed the requirements of American National Standard for Selection and Training of Personnel for Research Reactors, ANSI/ANS-15.4-1977, Sections 4-6.

Additionally, the minimum requirements for the Operations Supervisor are at least four years of reactor operating experience and possession of a Senior Operator License for the RPI Critical Facility. Years spent in baccalaureate or graduate study may be substituted for operating experience on a one-for-one basis up to a maximum of two years.

6.1.5 Review and Audit

A Nuclear Safety Review Board (NSRB) shall review and audit reactor operations and advise the Facility Director in matters relating to the health and safety of the public and the safety of facility operations.

6.1.5.1 Composition and Qualification

The NSRB shall have at least four members of whom no more than the minority shall be from the line organization shown in Figure 6.1. The board shall be made up of senior personnel who shall collectively provide a broad spectrum of expertise in reactor

technology. Qualified and approved alternates may serve in the absence of regular members.

6.1.5.2 Charter and Rules

The Review Board shall function under the following rules:

a) The Chairman of the NSRB shall be approved by the Facility Director.

b) The Board shall meet at least semiannually.

c) The quorum shall consist of not less than a majority of the full Board and shall include the Chairman or his designated alternate.

d) Minutes of each Board meeting shall be distributed to the Director, NSRB members, and such others as the Chairman may designate.

6.1.5.3 Review and Approval Function

The following items shall be reviewed and approved before implementation.

a) Proposed experiments and tests utilizing the reactor facility which are significantly different from tests and experiments previously performed at the facility.

b) Reportable occurrences.

c) Proposed changes to the Technical Specifications and proposed amendments to facility license.

6.1.5.4 Audit Function

The audit function shall include selective (but comprehensive) examination of operating records, logs, and other documents. Where necessary, discussions with cognizant personnel shall take place. In no case shall the individual immediately responsible for the area audit in the area. The following areas shall be audited:

a) Reactor operations and reactor operational records for compliance with internal rules, regulations, procedures, and with licensed provisions;

b) Existing operating procedures for adequacy and to assure that they achieve their intended purpose in light of any changes since their implementation;

c) Plant equipment performance with particular attention to operating anomalies, abnormal occurrences, and the steps taken to identify and correct their use.

6.2 Procedures

Written procedures shall be prepared, reviewed and approved prior to initiating any of the activities listed in this section. The procedures, including applicable check lists, shall be reviewed by the NSRB and followed for the following operations:

1) Start up, operation and shutdown of the reactor.

2) Installation and removal of fuel elements, control rods, experiments and experimental facilities.

3) Corrective actions to be taken to correct specific and forseen malfunctions such as for power failures, reactor scrams, radiation emergency, responses to alarms, moderator leaks and abnormal reactivity changes.

4) Periodical surveillance of reactor instrumentation and safety systems, area monitors, and continuous air monitors.

5) Implementation of the facility security plan.

6) Implementation of facility emergency plan in accordance with 10 CFR 50, Appendix E.

7) Maintenance procedures which could have an effect on reactor safety.

Substantive changes to the above procedures shall be made only with the prior approval of the NSRB. Temporary changes to the procedures that do not change their original intent may be made with the approval of the Operations Supervisor. All such temporary changes to the procedures shall be documented and subsequently reviewed by the Nuclear Safety Review Board.

6.3 Experiment Review and Approval

1) All new experiments or classes of experiments that might involve an unreviewed safety question shall be reviewed by the Nuclear Safety Review Board. NSRB approval shall assure that compliance

to the requirements of the license technical specifications shall be documented.

b) Substantive changes to previously approved experiments shall be made only after review and approval in writing by NSRB. Minor changes that do not significantly alter the experiment may be approved by the Operations Supervisor.

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

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

e) Review comments of the NSRB setting forth any conditions and/or limitations shall be documented in committee minutes and submitted to the Facility Director.

6.4 Required Actions

6.4.1 Action to be taken in Case of Safety Limit Violations

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

b) The safety limit violation shall be promptly reported to the level one authority or designated alternates and to the NSRB.

c) The safety limit violation shall be reported to the Nuclear Regulatory Commission in accordance with Section 6.5.3.

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

1) Applicable circumstances leading to the violation including, when known, the cause and contribution factors.

2) Effect of the violation upon reactor facility components, systems, or structures on the health and safety of personnel and the public.

3) Corrective action to be taken to prevent recurrence.

The report shall be reviewed by the NSRB and any follow-up report shall be submitted to the Commission when authorization is sought to resume operation of the reactor.

6.4.2 Action to be Taken in the Event of an Occurrence of the Type Identified in Section 1.0 R (Reportable Occurrence)

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

b) Occurrence shall be reported to the Facility Director or designated alternates and to the commission as required.

c) All such conditions, including action taken to prevent or reduce the probability of a recurrence, shall be reviewed by the NSRB.

6.5 Reports

In addition to the applicable reporting requirements of Title 10, Code of Federal Regulations, the following identified reports shall be submitted to the director of the appropriate Regional Office of Inspection and Enforcement unless otherwise noted.

6.5.1 Operating Reports

A report covering the previous year shall be submitted by March 1 of each year. It shall include the following:

a) Operations Summary. A summary of operating experience occurring during the reporting period that relate to the safe operation of the facility, including:

1) Changes in facility design;

2) Performance characteristics (e.g., equipment and fuel performance);

3) Changes in operating procedures which relate to the safety of facility operations.

4) Results of surveillance tests and inspections required by these Technical Specifications;

5) A brief summary of those changes, tests, and experiments which require authorization from the commission pursuant to 10 CFR 50.59(a), and;

6) Changes in the plant operating staff serving in the following positions:

a) Facility Director;

b) Operations Supervisor;

c) Health Physicist;

d) Nuclear Safety Review Board Members.

b) Power Generation. A tabulation of the integrated thermal power during the reporting period.

c) Shutdowns. A listing of unscheduled shutdowns which have occurred during the reporting period, tabulated according to cause, and a brief discussion of the preventive action taken to prevent recurrence.

d) Maintenance. A tabulation of corrective maintenance (excluding preventative maintenance) performed during the reporting period on safety related systems and components.

e) Changes, Tests and Experiments. A brief description and a summary of the safety evaluation for all changes, tests, and experiments which were carried out without prior Commission approval pursuant to the requirements of 10 CFR Part 50.59(b).

f) A summary of the nature, amount and maximum concentrations 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.

g) Radioactive Monitoring. A summary of the TLD dose rates taken at the exclusion area boundary and the site boundary during the reporting period.

h) Occupational Personnel Radiation Exposure. A summary of radiation exposures greater than 25% of the values allowed by 10 CFR 20 received during the reporting period by facility personnel (faculty, students or experimenters).

6.5.2 Non-Routine Reports

a) Reportable Operational Occurrence Reports. Notification shall be made within 24 hours by telephone and telegraph to the Director of the appropriate Regional Office followed by a written report within 10 days to the Director of the Regional Office in the event of a reportable operational occurrence as defined in Section 1.0. The written report on these reportable operational occur-

rences, and to the extent possible, the preliminary telephone and telegraph* notification shall: (a) describe, analyze, and evaluate safety implications; (b) outline the measures taken to assure that the cause of the condition is determined; (c) indicate the corrective action (including any changes made to the procedures and to the quality assurance program) taken to prevent repetition of the occurrence and of similar occurrences involving similar components or systems; and (d) evaluate the safety implications of the incident in light of the cumulative experience obtained from the record of previous failures and malfunctions of similar systems and components.

b) Unusual Events. A written report shall be forwarded within 30 days to the director of the appropriate Regional Office in the event of: 1) Discovery of any substantial errors in the transient or accident analyses or in the methods used for such analyses, as described in the Safety Analysis Report or in the bases for the Technical Specifications.

6.6 Operationg Records

6.6.1 The following records and logs shall be maintained at the Facility or at Rensselar for at least five years.

a) Normal facility operation and maintenance.

b) Reportable operational occurrences.

c) Tests, check, and measurements documenting compliance with surveillance requirements.

d) Records of experiments performed.

e) Records of radioactive shipments.

6.6.2 The following records and logs shall be maintained at the Facility or at Rensselaer for the life of the Facility.

a) Gaseous and liquid radioactive releases from the facility.

b) TLD environmental monitoring systems.

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*Telegraph notification may be sent on the next working day in the event of a reportable operational occurrence during a weekend or holiday period.

c) Radiation exposures for all RPI Critical Facility personnel (students, experimenters.)

d) Fuel inventories, offsite transfers and inhouse transfers if they are not returned to their original core or vault location during the experimental program in which the original transfer was made.

e) Facility radiation and contamination surveys.

f) The present as-built facility drawings and new updated or corrected versions.

g) Minutes of Nuclear Safety Review Board meetings.