TECHNICAL SPECIFICATIONS

CRITICAL EXPERIMENTS FACILITY

RENSSELAER POLYTECHNIC INSTITUTE

June 2011

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Technical Specifications

1. INTRODUCTION

1.1 Scope

The following constitute the Technical Specifications (TS) for the Rensselaer Polytechnic Institute (RPI) Critical Experiments Facility (RCF), as required by 10 CFR 50.36.

1.2 Application

Content and section numbering are in accordance with section 1.2.2 of ANS-15.1-2007.

1.3 Definitions

bottomed: A control rod is bottomed if it is resting on the carrier plate in the hydraulic buffer at the bottom of the core.

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

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

channel check: A channel check is a qualitative verification of acceptable performance by observation of channel behavior, or by comparison of the channel with other independent channels or systems measuring the same parameter.

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

control rod: A control mechanism consisting of a stainless steel basket that houses two absorber sections, one above the other. These absorber sections contain boron in iron clad in stainless steel. All are of the same dimensions, nominally 2.6 inches square, with their poisons uniformly distributed. When the control rods are bottomed the absorbers shall extend above the top and to within one inch of the bottom of the fueled portion of the core.

core configuration: The core configuration includes the number, type, and arrangement of fuel elements, and control rods occupying the core grid.

excess reactivity: Excess reactivity is that amount of reactivity that would exist if all reactivity control devices and movable experiments were moved to and moderator temperature changed to the maximum reactive condition from the point where the reactor is exactly critical ($k_{eff} = 1$) at ambient temperature.

experiment: Any operation, hardware, or target (excluding devices such as detectors, foils, etc.) that is designed to investigate reactor characteristics or that is intended for irradiation within the reactor.

fail: A component or experiment has failed if it is no longer able to perform its intended function or causes the unintentional addition or removal of reactivity.

fully inserted: A control rod is fully inserted if it is within one inch of being bottomed.

known core: A core configuration for which the power indicating instrumentation has been calibrated in accordance with surveillance procedures and the following parameters have been measured:

1. excess reactivity,
2. shutdown reactivity, all rods bottomed and one rod stuck in the full out position,
3. reactivity worth of most reactive fuel pin.

license: The written authorization, by the NRC, for an individual or organization to carry out the duties and responsibilities associated with a personnel position, material, or facility requiring licensing.

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

movable experiment: A movable 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.

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

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

protective action: The initiation of a signal or the operation of equipment within the reactor safety system in response to a parameter or condition of the reactor facility having reached a specified limit.

reactivity worth of an experiment: The reactivity worth of an experiment is the value of the reactivity change that results from the experiment being inserted into or removed from its intended position.

reactor operating: The reactor is operating whenever the reactor tank contains moderator and any fuel, and any control rod is not bottomed.

reactor operator (RO): An individual who is deemed capable and qualified by the SRO on duty to manipulate the controls of the reactor. The individual may be the SRO on duty, another SRO or someone without a Senior Reactor Operator License.

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.

reactor secured: The reactor is secured when

1. *Either* there is insufficient moderator available in the reactor to attain criticality, all control rods are bottomed, and the console keys are removed,

2. *Or* all fuel pins have been removed from the reactor.

reactor shutdown: The reactor is shutdown if all control rods are bottomed and it is subcritical by at least 1.00 $ in the reference core condition with the reactivity worth of all installed experiments included.

readily available on call: An operator is readily available on call if within 60 minutes normal travel time and 25 miles of the facility and personnel at the facility can readily contact the individual.

reference core condition: The condition of the core when it is at ambient temperature (cold) and the control rods are bottomed.

reportable occurrences:

1. Release of radioactivity from the facility above allowed limits;
2. Discovery of loose surface contamination, excluding contamination due to naturally occurring radionuclides such as radon daughters;
3. Operation with actual safety system setting less conservative than the limiting safety system settings;
4. Operation in violation of limiting conditions for operation;
5. Any reactor safety system component malfunction that could render the safety system incapable of performing its intended function;
6. An unanticipated or uncontrolled change in reactivity greater than 60 cents; or
7. 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.

review and approve: The reviewing group or persons shall carry 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 persons.

safety channel: A channel in the reactor safety system.

scram time: Scram time is the elapsed time between the initiation of a scram signal and indication that the control rod has been at least fully inserted.

secured experiment: A secured experiment is any experiment, experimental apparatus, or component of an experiment that is held in a stationary position relative to the reactor by mechanical means. The restraining forces must be substantially greater than those to which the experiment might be subjected by hydraulic, pneumatic, buoyant, or other forces that are normal to the operating environment of the experiment, or by forces that can arise because of credible malfunctions.

secured shutdown: The reactor is secured and the facility administrative requirements are met for leaving the facility with no licensed operators present.

senior reactor operator (SRO): An individual who is licensed to direct the activities of reactor operators at the RCF.

shall, should, and may: The word "shall" is used to denote a requirement; the word "should" is used to denote a recommendation; and the word "may" is used to denote permission, neither a requirement nor a recommendation.

shutdown margin: Shutdown margin is 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 the most reactive position, and that the reactor will remain subcritical without further operator action.

shutdown reactivity: The amount of reactivity the reactor is subcritical by given a specific set of conditions.

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 (2007) shall not exceed the following:

1. Annual (interval not to exceed 15 months).
2. Semiannual (interval not to exceed seven and one-half months).
3. Quarterly (interval not to exceed 4 months).
4. Monthly (interval not to exceed 6 weeks).
5. Daily prior to the first reactor startup of the day.

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.

true value: The true value is the actual value of a parameter.

unknown core: Any core configuration that is not a known core.

unscheduled shutdown: 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 that could adversely affect safe operation, not including shutdowns that occur during testing or checkout operations.

2. SAFETY LIMIT AND LIMITING SAFETY SYSTEM SETTINGS

2.1 Safety Limit – Fuel Pellet Temperature

Applicability

This specification applies to the maximum temperature reached in any in-core fuel pellet because of either normal operation or transient effects.

Objective

To identify the maximum temperature beyond which material degradation to the fuel and/or its cladding is expected and to define a safety limit below this level.

Specification

Fuel pellet temperature at any point in the core, resulting from normal operation or transient effects, shall be limited to no more than 1000 °C.

Bases

Specific determination of the melting point of the SPERT fuel has not been reported. A safety limit of 1000 °C is well below the listed melting point of UO_2 under a wide variety of conditions. The chosen value is conservative in view of variations that might result because of the presence of small quantities of impurities and the comparatively high vapor pressure of UO_2 at elevated temperatures. The safety limit specified is about 1700 °C below the measured melting point of UO_2 in a helium atmosphere.[1] Additionally, the safety limit of 1000 °C is below the melting point of Stainless Steel 304[2], the cladding material. Therefore, with the conservative assumption that the clad is at the same temperature as the fuel, the cladding integrity would not be compromised.

2.2 Limiting Safety System Settings

Applicability

This specification applies to the settings that initiate protective action for instruments monitoring parameters associated with the reactor power limits and rate of power level changes.

Objective

To ensure protective action before safety limits are exceeded.

Specification

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

1. Maximum Power Level 100 watts

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[1] W.A. Duckworth, ed., "Physical Properties of Uranium Dioxide," Uranium Dioxide: Properties and Nuclear Applications, Naval Reactors, Division of Reactor Development, Washington D.C., pp. 173-228 (1961).

[2] E.A. Avallone, T.B. Baumeister, III, ed., Mark's Standard Handbook for Mechanical Engineers, 9th Edition, pp. 6-11, McGraw-Hill, Inc., New York, (1987).

2. Minimum Period 5 seconds

Bases

The maximum power level trip setting of 100 watts on Log Power and Period Channel 2 (PP2) correlates with the operating license limit. The scram set point is used in the safety analysis with the assumption that initial power is at 100 watts indicated power.

The minimum 5-second period is specified so that the automatic safety system channels have sufficient time to respond in the event of a very rapid positive reactivity insertion. Power and maximum fuel pellet temperature increase subsequent to scram initiation are thereby limited to well below the identified safety limit. This scram is not used in the analysis of the most severe accident since the analysis assumes that the safety channel with a fast rate scram fails concurrent with the reactivity addition.

3. LIMITING CONDITIONS FOR OPERATION

3.1 Reactor Core Parameters

Applicability

These specifications apply to reactivity in the control rods plus the maximum reactivity contained in movable experiments, and reactivity coefficients.

Objective

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

Specifications

1. The excess reactivity of the reactor above cold, critical shall not be greater than 0.60 $.
2. Above 100 °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 0.15 $.
3. The void coefficient of reactivity shall be negative, when the moderator temperature is above 100 °F, within all standard fuel assemblies and have a minimum average negative value of 0.00043 $/cc within the boundaries of the active fuel region.
4. The minimum operating temperature shall be 50 °F.

Bases

Excess reactivity must be limited to ensure any reactivity addition accident is restricted to one that has been analyzed and shown to cause no core damage. The assumption in this analyzed accident is a step insertion of 0.60 $ of reactivity above critical. The minimum absolute value of the temperature coefficient of reactivity is specified to ensure that negative reactivity is inserted when reactor temperature increases above 100 °F. It is of note that even in the worst postulated accident scenarios, such as considered in Section 13 of the Safety Analysis Report (2002) (SAR), reactivity insertion because of temperature change would be negligible. The minimum average negative value of the void coefficient is specified to ensure that the negative reactivity inserted because of void formation is greater than that which was calculated in the SAR. The minimum operating temperature of 50 °F establishes the temperature range for which the net positive reactivity limit can be applied.

3.2 Reactor Control and Safety Systems

Applicability

These specifications apply to all methods of changing core reactivity available to the reactor operator.

Objective

To ensure that available shutdown reactivity is adequate and that positive reactivity insertion rates are within those analyzed in the SAR.

Specifications

1. The maximum reactivity worth of any clean fuel pin shall be 0.20 $.
2. The reactor shall not be operated unless there is a minimum of four operable control rods. The shutdown reactivity shall be greater than 0.70 $ with the most reactive control rod fully withdrawn and the remaining control rods bottomed. The minimum shutdown reactivity with all four control rods bottomed shall be greater than 1.00 $.
3. The scram 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 includes a maximum 50 millisecond magnetic clutch release time.
4. The auxiliary reactor scram (moderator-reflector water dump) shall add negative reactivity within one minute of its activation.
5. The normal moderator-reflector water level shall be established not greater than 10 inches above the top grid of the core.
6. The minimum safety channels that shall be operable during reactor operation are listed in Table 1.
7. One startup channel must be operational during facility evolutions (including but not limited to fuel movement, control rod movement, experimental apparatus insertion) and audible indication must be present in the reactor room.
8. The moderator dump may be bypassed for known cores with the permission of the SRO on duty. After a scram, the moderator dump valve may be re-closed by the SRO on duty if the cause of the scram is known, all control rods are verified to have fully inserted, and the reactor is decreasing in power.
9. The interlocks that shall be operable while the rods are not fully inserted are listed in Table 2.
10. The thermal power level shall be controlled so as not to exceed 100 W, and the

integrated thermal power for any consecutive 365 days shall not exceed 2 kW-hr.

Table 1: Minimum Safety System Channels

Reactor Conditions – Ranges		Channels	Minimum Number	Functions
Startup:	2 cps - 10^4 cps	Log Count Rate	1	Minimum Flux Level Interlock (see Table 2)
Power:	10^{-11} – 10^{-3}amps	Linear Power	2	High Neutron Level Scram
	10^{-14} - 10^{-3} amps +999 – -999 seconds	Log-N; Period	1	High Neutron Level and Period Scram
		Manual Scram[a]	2	Reactor Scram
		Control Panel 1 Power	1	Reactor Scram
		Reactor Door Scram[b]	1	Reactor Scram

(a) 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 scram circuit rectifier, causing a loss of power scram.

(b) The reactor door scram may be bypassed during maintenance checks and radiation surveys with the specific permission of the Operations Supervisor.

Table 2: Interlocks

Interlocks	Action if Interlock Not Satisfied
Reactor Console Keys (2) "On"	Reactor Scram
Reactor Period > 15 sec	Prevents Control Rod Withdrawal
Neutron Flux > 2 cps	Prevents Control Rod Withdrawal
Line Voltage to Recorders > 100 V	Prevents Control Rod Withdrawal
Moderator-Reflector Water Fill “Off”	Prevents Control Rod Withdrawal

Bases

The worth of a single fuel pin varies considerably depending upon where the pin is located. Removal of a pin near the center will increase reactivity for under-moderated configurations while removal of a pin on the periphery will reduce reactivity. A maximum worth is specified to provide additional margin to the limit of 0.60 $ excess reactivity in any experiment that removes a fuel pin. Limiting worth to 0.20 $ also ensures that the operator will not have difficulty controlling power during the normal operation of measuring reactivity changes by pulling control rods to the top stop and measuring reactor period.

The minimum number of four control rods is specified to ensure that there is adequate shutdown capability even for the stuck control rod condition.

The scram time of less than 900 milliseconds from the fully withdrawn position is specified to ensure that the insertion time does not exceed that assumed when analyzing the consequence of the most severe credible accident.

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 maximum water height of 10" above the top of the core ensures that the water dump will insert negative reactivity within one minute of activation, provides a large upper reflector to allow consistency between critical position measurements and experiments, and prevents instrument tube flooding that could disable a safety system channel.

If the shielding provided by the moderator is desired (or for any other reason) the moderator may be retained after a scram. Before the auxiliary scram may be terminated by reclosing the moderator dump valve, the rods should be verified to have been fully inserted and the reactor must be decreasing in power. During operation of known cores, the auxiliary scram valve may be bypassed with approval from the SRO on duty to prevent the loss of shielding (or for any other reason) as this core has been proven to meet all other shutdown criteria with the activation of only the primary scram.

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 ensures 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 the operator in safely operating the reactor. The minimum flux level has been established at 2 cps to prevent a source-out startup and provide a positive indication of proper instrument function before any reactor startup. Not requiring the interlocks while the rods are fully inserted but not bottomed allows for approximately one inch of rod travel to verify the operability of these interlocks. Experience has shown that rod worth in the first inch is small.

The annual limit for integrated power is set at 2 kWh to ensure that the maximum dose in any unrestricted area will not exceed 100 mrem per year and the maximum dose in any restricted area (not including the reactor room itself, which should not normally be occupied during operation) will not exceed 5 rem per year.

3.3 Coolant systems – None required

No system is needed specifically to cool the fuel, because the reactor is operated at such low power levels. The roughly 2000 gallons of water used as the moderator is in direct contact with the fuel and provides enough thermal inertia that no noticeable increase in temperature can be achieved using only energy released through fission.

3.4 Containment or confinement – None required

3.5 Ventilation Systems – None required

3.6 Emergency Power – None required

No emergency power exists at the facility. If building power is lost a passive scram is initiated, bottoming all control rods and draining the moderator regardless of the water dump bypass condition.

3.7 Radiation Monitoring

Applicability

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

Objective

The purpose of these specifications is to ensure that adequate monitoring is available to preclude undetected radiation hazards to facility personnel and the public.

Specifications

1. The minimum complement of radiation monitoring equipment required to be operating for reactor operation shall include:
    a. An area gamma monitoring system that 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.
    b. The radiation monitors required by 3.7.1a may be temporarily removed from service if replaced by an equivalent portable unit.
    c. A calibrated and operational portable survey meter capable of measuring ambient radiation exposure shall be available.
2. During fuel loading or unloading, or during any experiments involving the addition or removal of material from the core (activation foils, etc.) a thin-window GM detector shall be available to check for personnel or area contamination.
3. A criticality detector system that monitors the main fuel storage area is required at all times except while the fuel vault is locked and maintenance on this system is being performed. This system shall have a visible and an audible alarm in the control room. This system may be the same as the area gamma monitor required by 3.7.1a (2).

4. A continuous air monitor (CAM) that draws air from near the surface of the reactor tank shall be operating while the reactor is operating.

Bases

The continuous monitoring of radiation levels in the reactor room and other stations ensures the warning of the existence of any abnormally high radiation levels. The availability of required portable monitors provides 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 reactor minimizes the probable existence of high radiation levels.

A CAM will be able to detect large levels of Ar-41 or radioactive airborne particulate, which may indicate accidental activation of the reactor room air or release of radioactive material from a fuel rupture or experimental equipment failure.

The criticality monitor may be inoperable temporarily due to maintenance, during which access to the fuel vault is prohibited to minimize the possibility of a criticality accident.

3.8 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 ensure the safety of the reactor and personnel.

Specifications

1. No new experiment shall be performed until a written procedure that has been developed to permit good understanding of the safety aspects is reviewed and approved by the Nuclear Safety Review Board (NSRB) and approved by the Operations Supervisor. Experiments that fall in the general category, but with minor deviations from those previously approved, 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 channels.
3. No credible experiment failure shall interfere with another experiment, experimental apparatus or affect fuel cladding.
4. No power transients shall possibly cause an experiment to fail.
5. For movable experiments with an absolute worth greater than 0.35 $, the maximum reactivity change for withdrawal and insertion shall be 0.20 $/sec. Moving parts worth less than 0.35 $ may be oscillated at higher frequencies in the core.
6. The maximum positive step insertion of reactivity that can be caused by an experimental accident or experimental equipment failure of a movable or unsecured experiment shall not exceed 0.60 $.

7. Experiments shall not contain materials that can cause a violent chemical reaction. Unencapsulated experiments shall not contain a material that may produce significant airborne radioactivity. Encapsulated experiments may contain materials that can cause a minor release of airborne radioactivity, subject to the limits in TS 3.8.10.
8. Experiments containing known explosives or highly flammable materials shall not be installed in the reactor.
9. All experiments that corrode easily and are in contact with the moderator shall be encapsulated within corrosion resistant containers.
10. All experiments containing radioactive material shall be evaluated for their potential release of airborne radioactivity. Limits shall be established for the permissible quantity of radioisotopes in the experiments such that a complete release of all gaseous, volatile, or particulate constituents instantaneously and uniformly distributed in the reactor room air would not exceed twice the associated value of Table 2, Column 1 in Appendix B to 10 CFR Part 20 for that radioisotope and inhalation class.

Bases

The basic experiments to be performed in the reactor programs are described in the 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 ensure 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 ensure 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 ensure 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 and for oscillation of experimental samples and devices during reactor operations to ensure 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. This corresponds to a 0.60 $ 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, or cause a corrosive attack on the fuel cladding.

The limitation in TS 3.8.10 is designed to simultaneously ensure that dose limits in restricted and unrestricted areas are not exceeded in the event of a release of radioactive material contained in an experiment to the surrounding air. Values in Appendix B, Table 2, Column 1 represent the concentration inhaled on a continuous basis resulting in one-half the annual limit of dose to members of the public (50 mrem), with no credit taken for dilution between the point of discharge and the receptor location. The bounding condition occurs when the discharge rate equals the standard persons breathing rate, at 1.2 m^3/hour. When the air is discharged from the reactor room at this rate, the annual average effluent concentration will be no greater than one-fifth the concentrations in Appendix B, Table 2, Column 1, and therefore limits members of the public in unrestricted areas to less than one-tenth the annual dose limit due to this discharge. As no credit is taken for dilution between restricted and unrestricted areas, this limitation will necessarily provide adequate protection to radiation workers in restricted areas as well.

3.9 Facility-specific Limiting Conditions for Operations

Applicability

The limiting conditions for operations presented in this section are applicable at any time the reactor is not secured.

Objective

To prevent inadvertent addition of reactivity to the core and radiation exposure to facility personnel.

Specification

All fuel transfers shall be conducted under the direction of a SRO.

Operating personnel shall be familiar with health physics procedures and monitoring techniques, and shall monitor all operations and evolutions with appropriate radiation instrumentation.

For a completely unknown or untested core, fuel loading shall follow the inverse multiplication approach to criticality and, thereafter, meet TS 4.1.

For a known core, up to a quadrant of fuel pins may be removed from the core or a single fuel pin may be replaced with another pin 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 0.20 $;
2. The reactor is subcritical by at least 1.00 $ in reactivity;
3. There is initially only one vacant position within the active fuel lattice;
4. The nuclear instrumentation is operable;
5. The dump valve is not bypassed; and

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

Bases

The Basis for fuel transfers being monitored by a SRO is to ensure that the fuel transfers are performed in accordance with facility specifications. During movement of fuel, the basis for radiation monitoring is to provide indication of the level of radioactivity in the vicinity of the fuel and core. The basis for limiting the re-arrangement of fuel is to prevent inadvertent insertion of excess reactivity above the 0.60 $ limit and to ensure adequate shutdown reactivity exists with all rods bottomed.

4. SURVEILLANCE REQUIREMENTS

4.1 Reactor Core Parameters

Applicability

These specifications apply to the verification of shutdown reactivity, reactivity worth of fuel, and reactor power levels that pertain to reactor control.

Objective

The purpose of these specifications is to ensure 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:

1. excess reactivity;
2. worth of most reactive fuel pin;
3. reactor power instrument calibration; and
4. shutdown reactivity, all rods bottomed.

Bases

Measurements of the above parameters are made when a new reactor configuration is assembled. Whenever the core configuration is altered to result in an unknown or untested configuration, the core parameters are evaluated to ensure that they are within the limits of these specifications and the values analyzed in the SAR. During this test period of the reactor, measurements are performed using the approved experimental procedures.

The excess reactivity measurement is made to verify that this configuration is not subject to a reactivity addition accident more severe that that analyzed and described in the SAR, Section 13.2.

This same accident assumes a scram signal at a maximum power level of 100 watts indicated so it is necessary to measure reactor power and make any necessary adjustments to the instrumentation that indicates reactor power. The scram signals are based in detector current while the visual display is in watts. The high current scram must be verified to not exceed an indicated 100 watts.

Lastly, the accident analysis assumes the reactor is shutdown by at least 1.00 $ of reactivity after the high current scram occurs. Shutdown reactivity is also measured to ensure the reactor meets the definition of shutdown when all control rods are bottomed.

4.2 Reactor Control and Safety Systems

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 ensure that the safety and control equipment is operable and will function as required in TS 3.2.

Specifications

1. The scram time, shall be measured semiannually to verify that the requirements of TS 3.2.3, are met.
2. The moderator-reflector water dump time shall be measured semiannually to verify that the requirement of TS 3.2.4, is met.
3. The startup and power safety channels shall be calibrated annually.
4. A channel test of the safety system channels and a visual inspection of the reactor shall be performed daily prior to reactor startup. A channel test of the interlock system shall be performed daily prior to reactor startup to satisfy rod drive permit. A channel test shall be performed following a secured shutdown.
5. The moderator-reflector water height shall be checked visually prior to reactor startup to verify that the requirements of TS 3.2.5, are met.
6. In addition to the scheduled surveillances, any system shall be tested to prove operability after all modification, maintenance, or repairs have been made to that system.
7. Integral power shall be tallied quarterly as long as the three previous consecutive quarters do not exceed 1.5 kW-hr. If three consecutive quarters exceed a total of 1.5 kW-hr, the surveillance shall be monthly.
8. Requirements 1 thru 6 may be waived when the instrument, component, or system is not required to be operable, but a channel test shall be performed on the instrument, component or system 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 ensure compliance with TS 3.2.3 and 3.2.4.

Manual scram, CP1 power, and reactor door scrams are exempt from annual calibration because these signals are “on” or “off.” A channel test is satisfactory to determine the operability of these safety systems.

Visual inspection of the reactor components, including the control rods, prior to each day's operation, is to ensure that the components have not been damaged and that the core is in the proper condition. Redundant safety channels are provided by having three independent channels provide high current scrams if necessary and by requiring all three channels be operable. The analysis of the most severe accident shows no fuel damage even if one channel fails. 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 ensure 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 procedures are enumerated in the daily startup checklist.

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

If components are not needed, such as during prolonged secured periods, components are not used and are not required to be operable. Before reactor operations may resume all requirements must be met including all safety system channels are verified as operable.

4.3 Coolant Systems

No coolant system exists.

4.4 Containment or Confinement – None required

4.5 Ventilation Systems – None required

No surveillances are required for the ventilation system.

4.6 Emergency Power – None required

No emergency power system exists.

4.7 Radiation Monitoring

Applicability

These specifications apply to the surveillance of the area radiation monitoring equipment and all portable radiation monitoring instruments. These specifications also apply to moderator in the storage tank or reactor tank.

Objective

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

Specification

The criticality detector system, CAM and area gamma monitors shall be tested with a radiation source at least monthly and daily if the reactor is operated and calibrated semiannually.

Portable survey meters shall be calibrated at the manufacturer's recommended frequency.

Prior to discharge to the environment the moderator shall be monitored for radioactivity to prove that gross activity levels are lower that maximum levels permitted by 10 CFR 20 Appendix B Table 2.

Bases

Experience has demonstrated that calibration of the criticality detectors, CAM and gamma monitors semiannually is adequate to ensure that significant deterioration in accuracy does not occur. Furthermore, the operability of these radiation monitors is included in the daily pre-startup checklist. If the reactor is not operated for more than a month, the instruments are required to be checked to ensure operability. Portable instruments are calibrated at the manufacturer recommended frequency.

Experience has demonstrated that the moderator does not accumulate radioactive material due to the low operating neutron fluence. Therefore, periodic monitoring is not necessary. Verification is necessary, however, prior to discharge to the environment.

4.8 Experiments – None required

Since experiments may vary drastically no general surveillances are defined. However, approved experimental procedures may contain experiment specific surveillances.

4.9 Facility-specific Surveillance Requirements – None required

No facility specific surveillances are required.

5. DESIGN FEATURES

5.1 Site and Facility Description

Applicability

These specifications apply to the design of the RCF and the surrounding site.

Objective

The purpose of these specifications is to provide a layout of the site and the structures that contain the reactor in a means to protect personnel.

Specification

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 riverbank of greater than 50 feet radius defines the exclusion area.

The reactor 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.

The reactor room is a 12-inch reinforced concrete enclosure with approximate floor dimensions of 40x30 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 lightweight concrete, five plies of felt and asphalt, with a gravel surface. Access to the reactor room is through a sliding fireproof steel door that 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.

Bases

The inner and outer fences provide for the security of the facility. The sliding steel access door provides a means to move equipment into and out of the reactor room. The smaller personnel door permits personnel access without sliding the door out of position. The 3500-gallon water storage tank allows for the storage of approximately 2000 gallons needed to fill the reactor tank for operations with an additional volume to maintain net positive suction head for the reactor fill pump.

5.2 Reactor Coolant System

Applicability

These specifications apply to design of the reactor tank and the methods by which the tank can be dumped or filled.

Objective

The purpose of these specifications is to demonstrate the size of the reactor tank, its connection to the water tank and how the water is to be introduced into or removed from the reactor tank.

Specification

The reactor core is installed in a stainless steel reactor tank that 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. The water handling system allows remote filling and emptying of the reactor tank. It provides for a water dump by means of a failsafe 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. 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.

Bases

The capacity of the reactor tank is adequate to contain the core support structure, lattice plates, detectors, control rods, immersion heaters, and agitator, while still providing adequate moderation and reflector savings for the core. The 6-inch dump line and fail-safe butterfly valve provide for rapidly draining the moderator from the reactor tank to the storage tank in the event of a scram. The fill rate of approximately 50 gpm allows for completing the reactor tank fill in a reasonable amount of time. The sequential interlock system prevents the simultaneous addition of moderator with control rod withdrawal.

5.3 Reactor Core and Fuel

Applicability

These specifications apply to the makeup of the fuel pellets and the support structure that contains the fuel.

Objective

The purpose of these specifications is to provide a detailed makeup of the fuel composition and to give the fuel pin design and configuration with support structures.

Specification

The reactor core shall consist of uranium fuel in the form of 4.8 weight percent or less enriched UO_2 pellets in metal cladding, arranged in roughly a cylindrical fashion with four control rods placed symmetrically about the core periphery. The total core configuration and the arrangement of individual fuel pins, including any experiment, shall comply with the requirements of TS 3.1 and 3.2. Core fuel pins to be utilized are 4.8 weight percent enriched SPERT (F-1) fuel rods. Each fuel rod is made up of sintered UO_2 pellets, encased in a stainless steel tube, capped on both ends with a stainless steel cap and held in place with a chromium nickel spring. Gas gaps to accommodate fuel expansion are also provided at both the upper end and around the fuel pellets. NUREG-1281 describes these fuel pins in additional detail.

The fuel pins are supported and positioned on a fuel pin support plate, drilled with holes to accept tips on the end of each pin. The support plate rests on a carrier plate, which forms the base of a three-tiered overall core support structure. An upper fuel lattice plate rests on the top plate, and both are drilled through with holes with the prescribed arrangement to accommodate the upper ends of the fuel pins. The lower fuel pin support plate, a middle plate, and the upper fuel pin lattice plate are secured with tie rods and bolts. The entire core structure is supported vertically and anchored by four posts set in the floor of the reactor tank.

Four control rod assemblies are installed, spaced 90 degrees apart at the core periphery. Each rod consists of a 6.99-cm square stainless steel tube, which passes through the core and rests on a hydraulic buffer on the bottom carrier plate of the support structure.

Housed in each of these "baskets" are two neutron-absorber sections, one positioned above the other.

Bases

The basis for the fuel pin specifications comes from the SPERT fuel pin description in NUREG-1281. The support structure and lattice plates are designed to support a nominal core load of fuel pins and the four perimeter control rods. The control rod absorber sections are arranged such that the combination of the four rods satisfy the requirements, with regard to reactivity with one stuck rod and shutdown reactivity.

The total core configuration and the arrangement of individual fuel pins, including any experiment, shall comply with the requirements of TS 3.1 and 3.2. The core shall consist of all SPERT (F-1) fuel. All core components are composed of stainless steel, eliminating the risk of corrosion. Fuel pins have been qualified by the DOE and NRC in accordance with their standards details of compositions. The design criteria of the fuel pins was set to minimize the risk of fission product release. The enriched boron absorber sections are strategically positioned one above the other. In the end, each of the four rods has approximately the same reactivity effect.

5.4 Fissionable Material Storage

Applicability

These specifications apply to the storage of fuel not loaded in the reactor core.

Objective

The purpose of these specifications is to define the storage of fuel when it is not needed in the reactor core and what precautions are taken to keep the stored fuel from becoming critical.

Specification

When not in use, the SPERT (F-1) fuel 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 a minimum center-to-center separation of 8.5 inches and with no more than 15 SPERT (F-1) fuel pins per tube mounted on a steel wall rack. The center-to-center spacing of the storage tubes, together with the cadmium clad steel tubes, ensures that the infinite multiplication factor is less than 0.9 when the vault is fully flooded with water.

Bases

Fuel not loaded in the reactor is stored in the fuel vault for security and for criticality safety. The spacing of the tubes, the limit of 15 pins per storage tube, and the cadmium sheet wrapped on the storage tube ensure conditions in the vault remain subcritical in the event of a complete flood of the vault. The criticality monitor provides for indication of an inadvertent criticality in the fuel vault.

6. ADMINISTRATIVE CONTROLS

6.1 Organization

Structure

The organization for the management and operation of the reactor facility shall include the structure indicated in Figure 1.

Level 1: Dean, School of Engineering

Level 2: Facility Director

Chair, Nuclear Safety and Review Board (NSRB)

Level 3: Operations Supervisor

Level 4: RO's and SRO's

Responsibility

The Dean, School of Engineering, is responsible for the facility license and appoints the Chair, NSRB. The Facility Director is responsible for facility administration and safety. The NSRB serves as an independent review and auditing body. This board is described in further detail in TS 6.2. The Operations Supervisor is responsible for day-to-day safety and operation of the facility, as well as coordinating the training of new RO's and SRO's. The Operations Supervisor has the primary responsibility to ensure surveillances and maintenance are performed when necessary and operator proficiency is maintained. The RO's and SRO's are responsible for conducting day-to-day operations and maintenance in accordance with facility procedures.

The RPI Radiation Safety Officer (RSO) who is organizationally independent of the reactor operations group shall provide advice as required by the Facility Director and the Operations Supervisor in matters concerning radiological safety. The RSO also has interdiction responsibility and authority.

Personnel at the various management levels, in addition to the duties and responsibilities outlined above, shall be responsible for safeguarding the public and facility personnel from undue radiation exposures and for adhering to all requirements of the operating license and technical specifications.

Staffing

1. The minimal staffing when the reactor is not shutdown as described in these specifications shall be:
    a. A RO licensed pursuant to 10 CFR 55 or SRO licensed pursuant to 10 CFR 55 present at the controls.
    b. One other person in the control room certified by the SRO on duty as qualified to activate the manual scram and initiate emergency procedures.
    c. A SRO shall be present or readily available on call. The identity of and method for rapidly contacting the SRO on call shall be known to the operator.

2. The minimal staffing when the reactor is shutdown, but not secured is a SRO on duty in the control room and a second SRO present or readily available on call.
3. 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:
    a. Management personnel.
    b. Radiation safety personnel.
    c. Other operations personnel.
4. Events requiring the direction of the Operations Supervisor:
    a. All fuel or control rod relocations within the reactor core unless the activity is part of an approved experiment.
    b. Recovery from unplanned or unscheduled shutdown.
5. Responsibility of any level may be delegated to either a designated alternate or a member of a higher administrative level, conditional on all appropriate qualifications are met by the alternate.

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-15.4-1988, 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 Reactor Operator License for the RPI Critical Facility. Years spent in baccalaureate or graduate study in a nuclear engineering discipline or in the US Navy Nuclear Power School may be substituted for operating experience on a one-for-one basis up to a maximum of two years.

Level 1 and 2 personnel are not required to have operating licenses and will be appointed by the appropriate bodies at RPI. The Facility Director shall have a minimum of six years of nuclear experience. The individual shall have a recognized baccalaureate or higher degree in an engineering or scientific field. The degree may fulfill up to four of the six years of nuclear experience required.

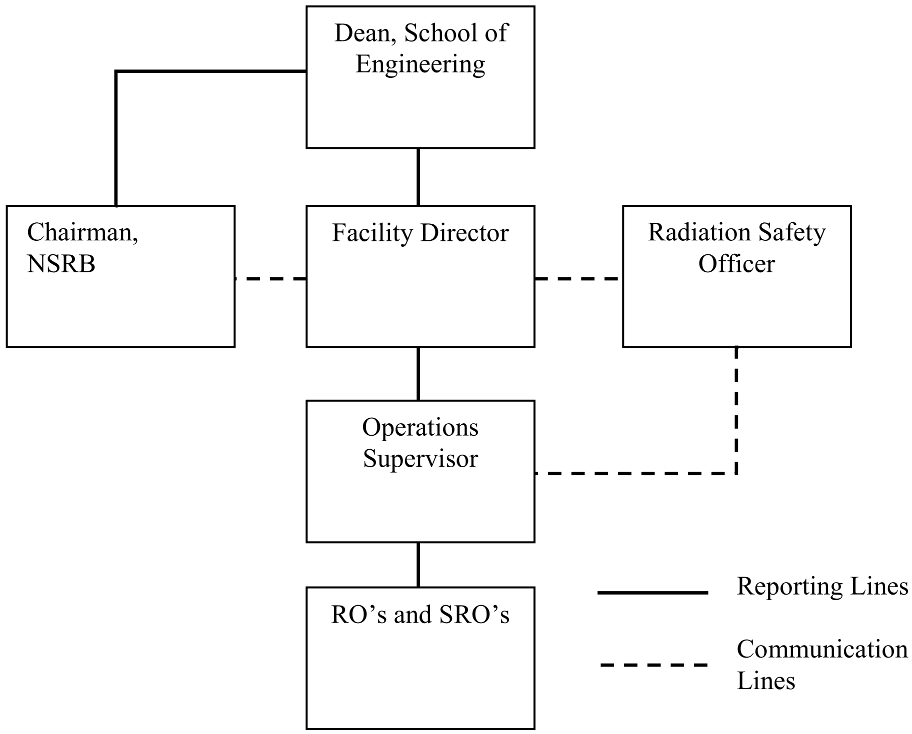

Figure 1: RCF Management Organization

6.2 Review and Audit

A 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.

Composition and Qualifications

The NSRB shall be appointed by the Dean, School of Engineering, in accordance with the NSRB Charter. The NSRB shall consist of a minimum of 3 persons. The Chair will be appointed by the Dean.

Charter and Rules

The NSRB Charter shall describe the composition of the board. The NSRB shall function under the following rules:

1. The NSRB shall meet at least semiannually.
2. The quorum shall consist of not less than a majority of the full NSRB and shall include the Chairman or his designated alternate. In addition, the majority of the quorum shall not be composed of operating staff (i.e., the Level 2 facility director or administrator and anyone who reports to that person).
3. Minutes of each NSRB meeting shall be distributed, reviewed, and approved by the Chairman and NSRB members, and such others as the Chairman may designate.

Review Function

The following items shall be reviewed and approved by the NSRB before implementation:

1. Proposed experiments and tests utilizing the reactor facility that are significantly different from tests and experiments previously performed at the facility;
2. Determinations that proposed changes in equipment, systems, tests, experiments, or procedures do not require a license amendment, as described in 10 CFR 50.59;
3. Proposed changes in reactor facility equipment or systems having safety significance;
4. Reportable occurrences;
5. Proposed changes to the TS and proposed amendments to the facility license;
6. Operating, Emergency and Surveillance procedures;
7. Audit reports.

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 at least annually.

1. Reactor operations and reactor operational records for compliance with internal rules, regulations, procedures, and with license provisions;
2. Existing operating procedures for adequacy and to ensure that they achieve their intended purpose in light of any changes since their implementation;
3. Plant equipment performance with particular attention to operating anomalies, abnormal occurrences, and the steps taken to identify and correct their use;
4. Facility emergency plan and implementing procedures.

In the case that any deficiency is identified during the audit, the auditing group shall report, in writing, directly to the Dean, School of Engineering.

6.3 Radiation Safety

The Radiation and Nuclear Safety Committee and the Radiation Safety Officer shall be responsible for the implementation of the Radiation Safety Program for the RCF. The primary purpose of the program is to assure radiological safety for all University personnel and the surrounding community.

AS LOW AS IS REASONABLY ACHIEVABLE (ALARA) PROGRAM

Control of ionizing radiation exposure is based on the assumption that any exposure involves some risk. However, occupational exposure within accepted limits represents a very small risk compared to the other risks voluntarily encountered in other work environments.

The policy of RPI is to maintain occupational exposures of individuals to be well within allowable limits as are defined in the appropriate regulations. The individual and collective dose to workers is maintained as low as reasonably achievable (ALARA).

ALARA is a part of the normal work process where people are working with ionizing radiation. Management at all levels, as well as each individual worker, must take an active role in minimizing this radiation exposure.

Exposures at the facility are routinely reviewed by the Radiation Safety Officer and Radiation and Nuclear Safety Committee to ensure that proper radiation safety procedures are in place and ALARA is maintained.

6.4 Procedures

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

1. Startup, operation and shut down of the reactor.
2. Installation and removal of fuel pins, control rods, experiments, and experimental facilities.
3. Corrective actions to be taken to correct specific and foreseen malfunctions such as for power failures, reactor scrams, radiation emergency, responses to alarms, moderator leaks and abnormal reactivity changes.
4. Periodic surveillance of reactor instrumentation and safety systems, area monitors, and continuous air monitors.
5. Procedures for implementing the approved facility emergency plan and facility security plan.
6. Maintenance procedures that could have an effect on reactor safety.
7. Use, receipt, and transfer of byproduct material.

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, reported to the Facility Director within 24 hours and subsequently reviewed by the NSRB.

6.5 Experiment Review and Approval

1. All new experiments or classes of experiments shall be reviewed by the NSRB. NSRB approval shall ensure compliance with the requirements of the license, TS and 10 CFR 50.59, and shall be documented. This includes NSRB review of determinations that proposed changes in tests and experiments do

not require a license amendment, as described in 10 CFR 50.59.

2. Substantive changes to previously approved experiments shall be made only after review and approval in writing by NSRB and the Facility Director. Minor changes that do not significantly alter the experiment may be approved by the Operations Supervisor.
3. Approved experiments shall be carried out in accordance with established approved procedures.
4. Prior to review, an experiment plan or proposal shall be prepared describing the experiment, including any safety considerations.
5. Review comments of the NSRB setting forth any conditions and/or limitations shall be documented in committee minutes and submitted to the Facility Director.

6.6 Required Actions in the Event of a Safety Limit Violation

1. The reactor shall be shutdown and reactor operations shall not be resumed until authorized by the NRC.
2. The safety limit violation shall be promptly reported to Facility Director or designated alternates and to the NSRB.
3. The safety limit violation shall be reported to the NRC in accordance with TS 6.8 Special Reports Item 1.
4. A safety limit violation report shall be prepared. The report shall describe the following:
    a. Applicable circumstances leading to the violation including, when known, the cause and contributing factors.
    b. Effect of the violation upon reactor facility components, systems, or structures and on the health and safety of personnel and the public.
    c. Corrective action to be taken to prevent reoccurrence.

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

6.7 Required Actions in the Event of a Reportable Occurrence

1. The reactor shall be shut down. Operations shall not be resumed unless authorized by the Chair, NSRB.
2. Occurrence shall be reported to the Facility Director or designated alternate, the NSRB and to the NRC not later than the following working day by telephone and confirmed in writing to the NRC, to be followed by a written report that describes the circumstances of the event within 14 days of the event.
3. All such conditions, including action taken to prevent or reduce the

probability of a recurrence, shall be reviewed by the NSRB. The NSRB shall concur with corrective actions.

6.8 Reports

In addition to the requirements of applicable regulations, and in no way substituting therefore, all written reports shall be sent to the U.S. Nuclear Regulatory Commission, Attn: Document Control Desk, Washington, D.C. 20555, with a copy to the Region I Administrator.

Operating Reports

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

1. Operations Summary. A summary of operating experience occurring during the reporting period that relates to the safe operation of the facility, including:
    a. Changes in facility design;
    b. Performance characteristics (e.g., equipment and fuel performance);
    c. Changes in operating procedures that relate to the safety of facility operations;
    d. Results of surveillance tests and inspections required by these Technical Specifications;
    e. A brief summary of those changes, tests, and experiments that require authorization from the NRC pursuant to 10 CFR 50.59, and;
    f. Changes in the plant operating staff serving in the following positions:
        i. Facility Director;
        ii. Operations Supervisor;
        iii. RSO;
        iv. NSRB Members.
2. Power Generation. A tabulation of the integrated thermal power during the reporting period.
3. Shutdowns. A listing of unscheduled shutdowns that have occurred during the reporting period, tabulated according to cause, and a brief description of the preventive action taken to prevent recurrence.
4. Maintenance. A tabulation of corrective maintenance (including major preventative maintenance) performed during the reporting period on safety related systems and components.
5. Changes, Tests and Experiments. A brief description and a summary of the safety evaluation for all changes, tests, and experiments that were carried out without prior NRC approval pursuant to the requirements of 10 CFR 50.59.
6. 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.

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

Special Reports

1. Reportable Operational Occurrence Reports. Notification shall be made within 24 hours by telephone in accordance with 10 CFR 50.36(c)(7) followed by a written report in accordance with 10 CFR 50.36(c)(5) within 10 days in the event of a reportable operational occurrence as defined in Section 1.3. The written report on these reportable operational occurrences, and to the extent possible, the preliminary telephone and e-mail notification shall: (1) describe, analyze, and evaluate safety implications; (2) outline the measures taken to ensure that the cause of the condition is determined; (3) 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 (4) 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.
2. Unusual events. A written report in accordance with 10 CFR 50.36(c)(5) shall be submitted as specified in 10 CFR 50.4 within 30 days in the event of discovery of any substantial errors in the transient or accident analyses or in the methods used for such analyses, as described in the SAR or in the bases for the TS.
3. Key changes in Organization. A written report in accordance with 10 CFR 50.36(c)(5) submitted as specified in 10 CFR 50.4 shall be provided for any change in Level 1 or Level 2 personnel.

6.9 Operating Records

The following records and logs shall be maintained at the RCF or at RPI for at least five years:

1. Normal facility operation (except retain checklists for one year) and principal maintenance operations;
2. reportable occurrences;
3. tests, checks, and measurements documenting compliance with surveillance requirements;
4. experiments performed with the reactor;

5. fuel shipments, inventories, and receipts;
6. reactor facility radiation and contamination surveys;
7. approved changes to operating procedures;
8. records of NSRB meetings and audits.

Records to be retained for at least one certification cycle:

> Records of training or retraining of certified operations personnel shall be maintained at all times the individual is employed or until the certification is renewed.

The following records and logs shall be maintained at the RCF or at RPI for the life of the RCF:

1. gaseous and liquid radioactive releases from the facility;
2. TLD environmental monitoring systems;
3. radiation exposures for all RPI Critical Facility personnel (students and experimenters) and visitors;
4. records of the results of each review of exceeding the safety limit, the automatic safety system not functioning as required by the limiting safety system settings, or any limiting condition for operation not being met;
5. the present as-built facility drawings and new updated or corrected versions.