November 19, 2007

To: U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Mail Stop O-5 C12
Washington, DC 20555-0001

Re: Docket No. 50-134; WPI Responses to NRC RAI dated October 22, 2007

Dear Sir:

The following are WPI's responses to the referenced RAI. To aid in your review, we have included NRC original questions along with our answers.

The purpose of the following question is to determine the status of your application for license renewal.

Q1. On November 25, 2002, WPI applied for renewal of Facility Operating License No. R-61 which was scheduled to expire on December 30, 2002. Because your renewal application satisfied the requirements of 10 CFR 2.109, "Effect of Timely Renewal Application," by letter dated December 13, 2002, we informed you that the license is not deemed to have expired until your application has been finally determined. With your decision to permanently shut down the reactor and terminate the license, your application for renewal no longer needs to be acted upon. Please confirm that you no longer want to pursue license renewal and that you withdraw your application for license renewal. Note that in accordance with 10 CFR 50.51(b), your license continues in effect until the Commission notifies you in writing that the license is terminated.

A1. Yes, WPI confirms that it no longer wishes to pursue license renewal and that WPI hereby withdraws its application for license renewal.

The purpose of the following question is to determine compliance with 10 CFR 50.82(b).

Q2. Your application for license amendment states that there will be no alteration or dismantling of the reactor facility that could affect the ability to monitor and contain radioactivity, or which provides a protective function. It is not clear what this means in relation to decommissioning and dismantling activities. Please confirm that no dismantling or decommissioning activities will occur before a license amendment is issued approving a decommissioning plan.

A2. WPI confirms that no dismantling or decommissioning activities will occur before a license amendment is issued approving a decommissioning plan. The only activities that are anticipated during POL status are related to routine surveillance

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and monitoring, routine maintenance and if required, repairs of the facility. Additionally, non-destructive inspections and characterization for the purposes of preparing the decommissioning plan may also occur.

The purpose of the following question is to determine compliance with requirements of your facility license.

Q3. Your application discusses changes to license condition 2.B.(2). However, the license condition you quote was amended in 1988 during conversion of the reactor to low-enriched uranium fuel. Please propose and justify changes to the current wording of license condition 2.B. (2).

A3. WPI proposes the following alternative wording of license condition 2.B. (2) for consistency with the 1988 amendment for conversion to low enriched Uranium:

> "Pursuant to the Act and 10CFR, Chapter1, Part 70, "Special Nuclear Material," to possess but not use up to a maximum of 5.2 Kilograms of contained U-235 at enrichments equal to or less than 20% and 16 grams of plutonium as Pu-Be source.

The purpose of the following questions is to determine compliance with 10 CFR 50.36.

Q4. License condition 2.D and 2.E duplicate (with minor differences in wording) the requirements of TS 5.6 and 6.7(1). Current practice is to have administrative requirements in the TSs. Please propose elimination of these license conditions or provide justification as to why these duplicate license conditions need to remain in the license.

A4. WPI proposes to eliminate license conditions 2.D and 2.E and have these administrative requirements contained in Technical Specifications 5.6 and 5.7.

Q5. Please provide replacement TS pages that reflect your proposed TS changes.

A5. Proposed replacement Technical Specifications are provided in Attachment A.

Q6. Please define the abbreviations used in your proposed definition of "Readily Available on Call." Is the expanded list of positions meeting the definition of "Readily Available on Call" consistent with the positions that can serve as emergency director per the facility emergency plan? If not, what purpose does having positions not able to serve as emergency director in the definition of readily available on call serve?

A6. The definitions of the abbreviations used for the proposed the definition of "Readily on Call" are as follows:

SRO- Senior Reactor Operator
RSO- Radiation Safety Officer
ARSO- Assistant Radiation Safety Officer

WPI confirms that the expanded list of positions meeting the definition of "Readily on Call" is consistent with the positions that can serve as emergency director per the facility emergency plan.

Q7. You have proposed the elimination of many TS requirements. While your application contains a general discussion of the justification of your proposed changes, please provide specific justification of why the eliminated TSs are no longer needed.

A7. Justification for elimination of specific Technical Specifications is provided in Attachment B.

Q8. You have proposed having the TS on water purity and surveillance of that quality only apply when fuel is in the reactor pool. Discuss the need to control water purity to control corrosion of remaining activated and contaminated components and structures after the fuel is removed but while water remains in the pool.

A8. WPI proposes to maintain the TS (2.1 Safety Limits) requirements for pool water purity and surveillance of that quality for the POL. Elimination of those requirements will be addressed in WPI's license amendment request seeking approving our decommissioning plan.

Q9. Please provide a basis for your proposed water level and water temperature TSs and why these TSs can be eliminated once fuel is removed from the facility. The TS on radiation levels is based in part on controlling radiation levels 1 m above the pool surface. If all water is removed from the reactor pool, how will radiation levels be controlled (Also see TS 3.3)? Is a TS needed for radiation levels once all water is removed from the pool? If so, please propose and justify a TS.

A9. The former 10 foot water level TS (2.1 Safety Limits) was required to assure maintenance of acceptable radiation levels above the pool and to allow adequate depth of water during fuel movement. WPI proposes to continue to control radiation levels above the pool with water shielding after removal of the fuel. WPI does not foresee draining the pool until the significant radiation sources have

been removed during decommissioning. However, after the fuel has been removed from the pool, the radiation levels emanating from within the pool are anticipated to be much lower. Therefore, strict adherence to the 10 foot water level requirement will no longer be necessary. After fuel removal, WPI proposes to monitor the radiation levels above the pool per TS 3.3 and will maintain the pool's water level as required to keep radiation levels ALARA.

WPI proposes to eliminate the applicability of the TS (2.1 Safety Limits) requirement regarding pool water temperature after fuel has been removed from the pool. At that time, temperature will no longer be a concern for fuel cooling and control of core reactivity. At that time it will only be necessary to prevent the pool water from freezing, which will be accomplished through normal heating of the building.

Q10. There does not appear to be a TS requirement for calibration of radiation area monitors in your proposed TSs. Please propose a surveillance requirement or discuss why this requirement is not needed.

A10. WPI proposes modification of TS 3.3, to require semi-annual calibration of the area radiation monitors (see attachment A)

Q11. TS 4.2 refers to 10 CFR 20.105. This regulation no longer exists. Please update this TS with reference to the current 10 CFR Part 20.

A11. WPI proposes to update TS 4.2 by replacing "10CFR20.105" with "10CFR20.1301" (see Attachment A).

Q12. TS 4.5.2, 4.5.3, and 4.5.4. Given the fact that the reactor will not operate again and that the fuel has been removed from the reactor grid plate to storage, are these TSs required for safe possession of the reactor? If not, provide justification for eliminating these TSs.

A12. WPI proposes to eliminate all of TS 4.5 The reactor fuel has been removed from the reactor grid plate and is now in their storage positions. The provisions of TS 4.5 were applicable to an operating reactor, to assure ability to control and safely shutdown of the reactor. However with the reactor permanently defueled, those functions are no longer applicable or required.

Q13. Your proposed changes to TS 5.1 and 5.2 include having the Facility Director report to the Provost and having the Provost (along with the President) appoint members of the Radiation, Health, and Safeguards Committee. Please describe the Provost's position in the Institute. Does the Provost have the same level of authority and responsibility (as related to the reactor) as the Dean of Faculty and the Vice President that the Provost is replacing? If not, explain how the level of authority and responsibility of the Provost is sufficient for the possession-only status of the reactor.

A13. Yes, the Provost has the same authority as the prior Dean of Faculty and the Vice President that the Provost replaced.

Q14. TS 5.4 refers to "unreviewed safety questions." Amendments to 10 CFR 50.59 have eliminated this terminology from the regulation. Please propose changes to this TS to be consistent with 10 CFR 50.59.

A14. We believe this question refers to TS 5.2, which refers to operation of the Radiation, Health, and Safeguards Committee. WPI proposes the following replacement wording for TS 5.2 (and as shown in Attachment A):

"A Radiation, Health, and Safeguards Committee shall review, evaluate, approve and document all changes pursuant to the definitions and requirements of 10 CFR 50.59. This committee also shall conduct, at least quarterly, reviews of operations, equipment performance, records, and procedures. The Committee shall establish written procedures regarding review methods, quorums, and subcommittees, and it shall maintain written records of its activities. The members of the Committee shall be appointed by the Provost of Worcester Polytechnic Institute (WPI) and a majority shall be WPI faculty members."

Q15. TS 5.7 refers to the Division of Reactor Projects-III/IV/V & Special Projects (DRSP). The organizational replacement for DRSP is the Division of Waste Management and Environmental Protection (DWMED) in the Office of Federal and State Materials and Environmental Management Programs. Please propose updates to your TSs to reflect the current NRC organization.

A15. WPI proposes to replace "Division of Reactor Projects-III/IV/V & Special Projects (DRSP)" with "Division of Waste Management and Environmental Protection (DWMED)", with the revised TS 5.7shown in its entirety Attachment A.

Q16. TS 5.8(1)(e) and 5.8(5). The regulations in 10 CFR 50.59 have been updated such that the reference to 10 CFR 50.59(a) is outdated. Please propose changes to the TS to reflect the current wording of 10 CFR 50.59.

A16. WPI proposes to replace 5.8 (1)(e) with "a brief summary of those changes, tests, and experiments that did not require a license amendment pursuant to 10CFR50.59 (d)(2)", and replace 5.8 (5) with "Changes, Tests, and Experiments: a brief description of the changes, tests, and experiments and a summary of the evaluation of each, pursuant to the requirements of 10CFR50.59 (d) (2)" shown in its entirety Attachment A.

Q17. Please discuss the movement of fuel from the storage racks to the shipping cask. Will movements be performed using procedures that meet the requirements of TS 5.5? Discuss how criticality safety will be maintained during fuel movement. Your proposed TS refers to the fuel movement process being overseen by the SRO and RSO. Please discuss the duties that the SRO and RSO will perform.

A17. WPI confirms that movement of the fuel from the storage racks to the shipping cask will be performed using detailed written procedures as required by TS 5.5. WPI currently does not have a procedure for this work evolution, but will prepare and approve a procedure when the recipient of the fuel becomes known (e.g. DOE or another research reactor licensee) and the specific shipping casks to be used are identified. Criticality safety will be maintained by use of administrative procedures which will limit the number of fuel elements that can be moved, at any one time, between the storage racks in the pool and the shipping cask. WPI will perform confirmatory evaluations of the shipping cask to verify that its safe configuration is applicable to WPI's fuel. The SRO will be the supervisor for the operation, and the RSO will handle radiological safety.

We certify under penalty of perjury that the foregoing is true and correct to the best of our knowledge. Executed on November 19, 2007.

Sincerely,

David S. Adams
WPI RSO

Michael J. Curley
Reactor Director
University Compliance Officer
Finance and Operations

Reviewed and approved by an officer of WPI, as indicated by the signature below:

Jeffrey Solomon
Executive Vice President

cc:
Alexander Adams Jr.
U.S. Nuclear Regulatory Commission
Mail Stop O12-D1
One White Flint North

11555 Rockville Pike
Rockville, MD 20852-2738

Enclosures:
Attachment A: Proposed Revised Technical Specifications
Attachment B: Justification for Elimination of Specific Technical Specifications

Attachment A

APPENDIX A

TO LICENSE NO. R-61

TECHNICAL SPECIFICATIONS FOR THE

WORCESTER POLYTECHNIC INSTITUTE REACTOR

(Revised November 19, 2007)

DOCKET NO. 50-134

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The actual values of dimensions, measurements, and other numerical values may differ from values given in these specifications to the extent of normal construction and manufacturing tolerances, or normal accuracy of instrumentation.

1.0 DEFINITIONS

Cold, Clean, Critical Condition: Since xenon and samarium effects are negligible for this reactor in its normal operations, the term cold, clean, critical shall refer to the condition of the reactor core when it is at the normal ambient water temperature of 70° to 75° and free of any experiments that could affect reactivity.

Critical Reactor Operation: Critical reactor operation shall refer to any situation when more than 12 fuel elements are loaded in the core and any control blade is withdrawn more than 6 in.

Experiment: An experiment shall mean any apparatus, device, or material installed in the core or in external experimental facilities that is not a normal part of those facilities.

Movable Experiment: A movable experiment is one that may be inserted, removed, or manipulated while the reactor is critical.

Operable: An instrument or channel is operable when the instrument or channel will be operational once it is energized.

Operational: An instrument or channel is operational when that instrument or channel is installed, energized, and in all other respects performing the monitoring and safety functions for which it was intended.

Reactor Operation: Reactor operation shall be any condition wherein either the reactor key is inserted into the console lock or the reactor is not in a shutdown condition.

Reactor Safety System: The reactor safety system is that combination of control channels and associated circuitry that forms the automatic protective system for the reactor or provides information that requires manual protective action to be initiated.

Reactor Scram: Reactor scram shall be the rapid insertion of the three control blades into the core by either of the following methods:

(1) Relay (slow) scram: Reactor relay scram (slow scram) shall be instigated by the relay scram circuits which control current inputs for the trip amplifier. Interruption of this current shall de-energize the scram magnets.

(2) Electronic (fast) scram: Reactor electronic scram (fast scram) shall be caused by the application of sufficient negative bias in the trip amplifier to terminate current to the scram magnets.

Readily Available on Call: Readily available on call shall mean the Senior Reactor Operator (SRO), Radiation Safety Officer (RSO), Assistant Radiation Safety Officer (ARSO), or member of the Radiation, Health, and Safeguards Committee (RHSC) on duty that is within a reasonable driving time (1/2 hr) from the reactor building, that can be contacted in the event of an emergency.

Reportable Occurrence: A reportable occurrence is any of the following conditions:

(1) a safety system setting less conservative than the limiting setting established in the Technical Specifications

(2) operation in violation of a limiting condition for operation established in the Technical Specifications

(3) a safety system component malfunction or other component or system malfunction that during operation could, or threatens to, make the safety system incapable of performing its intended safety functions

(4) release of fission products from a failed fuel element

(5) an uncontrolled or unplanned release of radioactive material from the restricted area of the facility

(6) an uncontrolled or unplanned release of radioactive material that results in concentrations of radioactive materials within the restricted area in excess of the limits specified in Appendix B, Table 1 of 10 CFR 20

(7) an uncontrolled or unanticipated change in reactivity in excess of 0.5% $\Delta k/k$

(8) conditions arising from natural or man-made events that affect or threaten to affect the safe operation of the facility

(9) an observed inadequacy 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

Shutdown Condition:

The reactor shall be deemed to be in the shutdown condition if no control or regulating blade is withdrawn form its fully inserted position or if there are less than 12 fuel elements loaded on the grid plate.

2.0 SAFETY LIMITS AND OPERATING RESTRICTIONS

2.1 Safety Limits

Radiation Alarms: Upon indication of radiation levels in excess of 50 mrems/hr (20 mrems/hr for fuel storage) area monitors shall actuate audible evacuation alarms in the reactor room and in the second and third floor areas above the reactor pool.

Radiation Levels: The maximum radiation levels 1 m above the pool surface and at the surface of the concrete shield, when the beam port and thermal column are closed, shall be less than 50 mrems/hr.

Water Level: The minimum depth of water above the top of the end box of the core fuel elements in the reactor pool shall be 10 ft., when fuel is present in the pool. When fuel is not in the pool, the water level shall be maintained to keep radiation levels as low as reasonably achievable (ALARA). The pool water level detector and alarm will be operational when fuel is present in the pool, with the alarm set-point being a water level drop of less than or equal to 1 foot. The pool water level detector and alarm my be by-passed provided a license senior reactor operator is present in the facility.

Water Purity: Corrective action shall be taken promptly if the following limits for the pool water are not met.

(1) pH less than 8.0 and greater than 6.0
(2) resistivity greater than 5×10^{-5} ohm-cm
(3) pool water activity less than 10^{-5} uCi/ml

Water Temperature: The maximum bulk water temperature of the reactor pool shall be 110°F and the minimum shall be 40°F, when fuel is in the pool.

3.0 SURVEILLANCE REQUIREMENTS

3.1 Frequency of Surveillance

Quarterly: The area radiation monitoring systems and the pool water level switch shall be checked and ensured to be operational quarterly.

Semiannually: At least semiannually, the pool water pH shall be measured and conductivity and pH devices shall be calibrated, as long as fuel is present in the pool.

3.2 Action to be Taken

If maintenance or recalibration is required for any of the items, it shall be performed and the instrument shall be rechecked before reactor startup proceeds.

3.3 Radiation Detection

Area Monitors: Area radiation sensors capable of detecting gamma radiation in the range of 0.1 to 100 mrems/hr shall be installed near the beam port, demineralizer, thermal column door, fuel storage area, and less than 1 m above the core pool surface. Upon indication of radiation levels in excess of 50 mrems/hr (20 mrems/hr for fuel storage) these monitors shall actuate audible alarms in the reactor room and in the second and third floor areas above the reactor pool. Area Monitors shall be calibrated on a semi-annual basis.

Portable area monitors capable of detecting gamma radiation in the range of 0.10 to 50 mRems/hr may temporarily replace fixed area monitors described above provided that the required alarms are operational.

Portable Monitors: During fuel handling or other operations involving or potentially involving sources of radiation, , operable portable survey instruments shall be readily available to the reactor operator for measuring beta-gamma exposure rates with ranges designated 1.0 mR/hr or less to over 50 R/hr, and fast plus thermal neutron dose rates from 0.04 to 1,000 mrems/hr. One or more portable survey instruments for measuring beta-gamma exposure rates with a minimum range of 10 mR/hr to 50 R/hr will be kept available to the reactor staff in an external location (normally the security office) to facilitate obtaining radiation readings if a reactor radiation alarm should be activated

4.0 SITE AND DESIGN FEATURES

4.1 Site

The reactor and associated equipment is housed in the Washburn Laboratories located between West Street and Boynton Street on the campus of Worcester Polytechnic Institute in Worcester, Massachusetts.

4.2 Restricted Area and Exclusion Area

The reactor room shall constitute a restricted area as defined in 10 CFR 20 and shall be controlled by partitions and normally locked doors. In addition, two small areas, one each on the second and third floors of Washburn Laboratories, directly above the reactor control drives, shall become restricted areas whenever the radiation levels in any of the rooms exceed those specified in 10 CFR 20.1301. The exclusion areas, as defined in 10 CFR 100, shall consist of the reactor room and the areas above the reactors.

4.3 Reactor Building and Ventilation System

The reactor shall be housed in a closed room that is designed to restrict leakage. The ventilation system shall provide at least two changes of air per hour in the reactor room whenever the reactor is operating.

4.4 Reactor Core

Fuel Elements: Standard fuel elements shall be flat plate type consisting of uranium-aluminum alloy clad with aluminum. The width and depth of each fuel element shall be 3 in. x 3 in. Each element shall have an active length of 24 in. There shall be a maximum of 10 g of U-235 in each fuel plate and not more than 170 g of U-235 in any fuel element. The fuel shall be enriched to less than 20% U-235. Standard fuel elements have 18 fuel plates, each plate 1.52 mm thick with a clad thickness of 0.381 mm on each side. No fuel elements may be installed in the core.

5.0 ADMINISTRATIVE AND PROCEDURAL REQUIREMENTS

5.1 Facility Administrator

The Director of the Nuclear Reactor Facilities shall have full responsibility for maintaining the facility in a safe configuration. The Director shall report to the Provost and shall be responsible to the Radiation, Health, and Safeguards Committee for conformance to the facility license provisions and all local and NRC safety regulations. The Director also shall be responsible for proper maintenance of such records and operating practices as the Committee may deem necessary for the safe storage of the facility.

5.2 Radiation, Health, and Safeguards Committee

A Radiation, Health, and Safeguards Committee shall review, evaluate, approve and document all changes pursuant to 10 CFR 50.59. This committee also shall conduct, at least quarterly, reviews of operations, equipment performance, records, and procedures. The Committee shall establish written procedures regarding review methods, quorums, and subcommittees, and it shall maintain written records of its activities. The members of the Committee shall be appointed by the President or Provost of Worcester Polytechnic Institute (WPI) and a majority shall be WPI faculty members.

5.3 Radiological Safety Officer

A Radiological Safety Officer shall be appointed to serve on the Radiation, Health, and Safeguards Committee and to review and approve all proposed procedures and experiments concerning radiological safety. The Radiological Safety Officer shall advise the Director of the Nuclear Reactor Facilities of rules, regulations, and procedures relating to radiological safety and shall routinely conduct radiation surveys.

5.4 Fire Protection

The licensee shall provide heat or ionization-type smoke detectors, which will alarm when there is a fire in the reactor room. At least two such detectors shall be operable at all times.

5.5 Procedures

Detailed written procedures shall be provided for all normal operations of the reactor, supporting facilities, maintenance operations, radiation protection, experiments, and emergency plans and operations. These procedures shall be approved by the Radiation, Health, and Safeguards Committee before they are implemented.

Temporary procedures that do not change the intent of the initial approval procedures may be authorized by two members of the facility staff at least one of whom shall be a licensed senior operator. Such procedures shall be subsequently reviewed by the Radiation, Health, and Safeguards Committee.

5.6 Operating Records

In addition to records required elsewhere in the license application, the following records shall be kept of

(1) maximum radioactivity released or discharged into the air or water beyond the effective control of the licensee as measured at or before the point of such release or discharge

(2) maintenance operations involving substitution or replacement of reactor equipment or components

(3) tests and measurements performed pursuant to the Technical Specifications

5.7 Reports

In addition to reports otherwise required under this license and applicable regulations

(1) The licensee shall inform the Commission of any incident or condition relating to the safe storage of the facility that prevented or could have prevented a safety system from performing its safety function as described in the Technical Specifications. For each such occurrence, WPI shall promptly notify, by telephone or telegraph, the Administrator or the appropriate NRC Regional Office listed in Appendix D of 10 CFR 20 and shall submit within 10 days a report in writing to the Director, Division of Waste Management and Environmental Protection (DWMED), with a copy to the Regional Office.

(2) The licensee shall report to the Director, DWMED, in writing within 30 days, any observed occurrence of substantial variance of conditions from performance specifications contained in the Safety Analysis Report or the Technical Specifications.

(3) The licensee report to the Director, DWMED, in writing within 30 days, any occurrence of significant changes in the accident analysis as described in the SAR.

5.8 Annual Operating Reports

A report covering the previous year shall be submitted to the Administrator of the appropriate Regional Office not later than March 31 of each year. It shall include

(1) Operations Summary: a summary of issues having safety significance occurring during the reporting period, 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) any abnormal results of surveillance tests and inspections required by these Technical Specifications
(e) a brief summary of those changes, tests, and experiments that did not require a license amendment pursuant to 10CFR50.59 (d) (2)
(f) changes in the plant staff serving in the positions of Reactor Facility Director, SRO, RSO or ARSO, or Radiation, Health, and Safety Committee members

(4) Maintenance: a discussion of corrective maintenance (excluding preventative maintenance) performed during the reporting period on safety related systems and components

(5) Changes, Tests, and Experiments: a brief description of the changes, tests, and experiments and summary of the evaluation of each, pursuant to the requirements of 10CFR50.59 (d) (2)

(6) Radioactive Effluents Releases: a statement of the quantities of radioactive effluents released from the plant

5.9 Fuel Storage

Two fuel storage racks are located on opposite sides of the reactor pool. Each rack shall be designed to contain not more than 18 fuel elements. When the reactor contains a critical mass, all additional fuel elements not in the core shall be locked in place except as authorized by the licensed senior operator in charge.

A fuel element shall not be stored outside of the reactor pool unless it produces radiation dose levels of less than 100 mrems/hr at the storage container surface. Storage containers of fuel elements shall be locked closed when unattended.

All fuel element transfer to or from the reactor core shall be conducted by a staff of not less than three persons, which shall include a licensed senior operator in charge and a RSO. Staff members will continuously monitor the operations using appropriate radiation monitoring and core nuclear instrumentation.

Attachment B: Justification for Eliminated Technical Specifications During POL Status

2.0 SAFETY LIMITS AND OPERATING RESTRICTIONS

2.1 Safety Limits (Eliminated Items)

The following safety limits only apply to a functional reactor, as the reactor core has been permanently de-fueled, they are no longer necessary.

Criticality: The reactor shall be subcritical when the three control blades are at their fully withdrawn positions and the regulating blade is in its fully inserted position.

Shutdown Margin: The minimum shutdown margin under any condition with the highest worth control blade fully withdrawn shall be no less than 1%Δk/k.

Magnet Release and Blade Drop Times: The interval between the occurrence of cutoff voltage (scram) and the separation of each control blade from its magnet shall not exceed 100 msec. Total time of insertion of the first 24 in. of the control blades following initiation of a scram signal shall be less than 600 msec, including the magnet release time.

Maximum Excess Reactivity: The maximum excess reactivity above cold, clean, critical shall be 0.5%Δk/k.

Control Blade Withdrawal: The maximum withdrawal rate for a control blade shall be 7.5 in./min. The maximum reactivity addition rate through movement of the regulating blade shall be 0.006%Δk/k•sec. Interlocks shall prevent simultaneous withdrawal of more than one control blade and shall prevent withdrawal of any control blade unless the regulating blade is fully inserted.

Startup Source Requirement: During reactor startup, a neutron source producing at least 10^6 neutrons/sec shall be located adjacent to the fuel region. When readings on the log count rate meter are below 50 counts/sec, an interlock shall prevent withdrawal of any control blade.

Temperature and Void Coefficients: The temperature and void coefficients of reactivity shall be more negative than -2×10^{-5} Δk/k•°F and -2×10^{-3} Δk/k•% void, respectively, at 80°F, and shall not be positive at any average core water temperature above 80°F.

2.2 General Operating Limitations (Eliminated Items)

The following operating limits only apply to a functional and operating reactor, as the reactor core has been permanently de-fueled, they are no longer necessary.

(1) Personnel Requirement – Reactor operation shall be permitted only when two or more persons are in the reactor facility, at least one of whom is a licensed operator at the controls. A senior operator shall be readily available on call during reactor critical operation.

(2) System Integrity – The reactor shall not be operated when there are significant defects in fuel elements, control blades, or the reactor safety and control systems.

(3) Abnormal Conditions – When abnormal operation of the reactor occurs, including its controls, safety systems, and auxiliary systems, action shall be taken immediately to scram the reactor and determine the cause of the abnormal behavior. The operator at the controls

shall have authority to scram the reactor whenever he/she believes that a question of adequate safety exists.

2.3 Experiments (Eliminated in entirety)

The reactor is no longer functional, as the reactor core has been permanently de-fueled. As such experiments using the reactor are no longer possible. Therefore, these requirements are no longer necessary.

(1) The graphite thermal column and the beam port shall be vented to the facility ventilation exhaust system.

(2) No experiments with moving components shall be irradiated with the reactor unless the reactivity worth of the moving component is less than 0.25$.

(3) Experiments shall be designed so that they do not significantly block natural circulation flow within the reactor core.

(4) The total worth of all experiments with positive reactivity contributions shall be limited so that summed with the cold, clean, core excess reactivity the total is not greater than 0.5% $\Delta k/k$.

(5) All samples or experiments shall be doubly encapsulated and ensured leak tight if release of the contained materials could cause corrosive attack to the facility or excessive contamination of the pool water.

(6) No experiment shall be installed in such a manner that

(a) it could significantly shadow the nuclear instrumentation system monitors
(b) failure of the experiment could interfere with the insertion of a control blade
(c) failure of the experiment could damage the reactor
(d) failure of the experiment could release excessive airborne contamination

(7) No explosive or other materials that could combine violently shall be irradiated in the reactor or in external experiment facilities, in quantities greater than the equivalent of 25 mg of TNT. In addition, the stress that would be produced in the experiment container upon detonation of the explosive shall be calculated and/or experimentally determined to be less than the yield stress of the container.

(8) If a container fails and releases material that could damage the reactor fuel or structure by corrosion or other means, physical inspection shall be performed to determine the consequences and need for corrective action.

3.0 SURVEILLANCE REQUIREMENTS

3.1 Frequency of Surveillance (Eliminated items)

The following surveillance requirements can only be performed with a functional reactor, as the reactor core has been permanently de-fueled, they are no longer necessary or possible .

Daily: Before each day's critical operation (with the exception of those experiments that require the reactor to be operated continuously for more than one full day, the two safety channels, the log-N period channel, and the console annunciator system shall be checked and ensured to be operational.

Semiannually: At least semiannually, a reactor inspection shall be performed consisting of

(1) The excess reactivity of the core above cold, clean, critical shall be measured.
(2) The console instrumentation shall be calibrated by a foil activation measurement of reactor power where applicable, or calibrated by other means, and checked for proper conditions.
(4) The minimum shutdown margin with the highest worth control blade fully withdrawn shall be verified to be no less than 1% $\Delta k/k$.
(5) The reactivity worth of the regulating blade shall be measured.

Annually: At least once each year, all fuel elements shall be removed from the core to the storage racks. While the fuel elements are thus stored, the control blades shall be brought to the surface and visually inspected and the blades drives lubricated. Blade drop times and magnet release times shall be measured for each control blade, and a plot of blade drop times versus distance shall be obtained for each safety blade and compared with data of previous years. Abnormal deviation from previous data will be investigated and reviewed by the Radiation, Health, and Safeguards Committee.

4.0 SITE AND DESIGN FEATURES (Eliminated items)

The following design features only apply to a functional reactor, as the reactor core has been permanently de-fueled, they are no longer necessary .

4.5 Reactor Safety and Control Systems

The safety system shall be designed so that no single electrical fault that partially or completely disables the automatic scram function can, in any manner, impair or disable the manual scram function, and vice versa. The safety system shall be fail safe with respect to loss of voltage.

4.5.1 Nuclear Instrumentation

The channels of nuclear instrumentation (listed below with their minimum operating ranges) shall during all reactor critical operations be operational and shall be connected to the safety system, except as noted in Table 4.1.

(1) startup channel; background to 10^{-2} % full power, i.e., background to 1 W

(2) log-N period channel; 2 x 10^{-3} % to 150% full power, i.e., 0.2 W to 15 kW

(3) linear safety channels 1 and 2, 2 x 10^{-3} % to 150 full power, i.e., 0.2 W to 15 kW

4.5.2 Control Blades

There shall be three control blades, intersecting the core, each consisting of vertical blades 10.5 in. wide x 40.5 in. long with a poison section composed of boron carbide and aluminum 0.375 in. thick sandwiched between aluminum side plates.

4.5.3 Regulating Blade

There shall be one regulating blade consisting of a vertical stainless-steel blade 10.65 in. wide x 40.5 in. long x 0.125 in. thick. It shall have a reactivity worth of less than 0.7% $\Delta k/k$.

4.5.4 Blade Position Indicators

The blade position indicator on the console shall provide an indication of the blade position to within ±.02 in. Signal lights shall be provided for each control blade drive and for the regulating blade to indicate the upper and lower limits of travel and, in the case of control blades, an armature engaged by a magnet.

Table 4.1 Safety system functions

Condition*	Detector	Set point range	Action	Comment

Neutron count rate ≤ set point	B-10 chamber in startup channel	≥ 50 counts/ sec	Interlock prevents safety blade withdrawal	May be bypassed only when k_{eff} ≤ 0.9
Reactor period ≤ set point	Compensated ion chamber in log-N period channel	≥ + 5 sec	Relay scram and alarm	
Reactor period ≤ set point	Compensated ion chamber in log-N period channel	≥ + 3 sec	Electronic scram/ alarm	
Reactor period ≥ set point	2 compensated ion chambers in level safety channels 1 and 2	≤ 150% full power	Electronic scram/ alarm	
	1 compensated ion chamber in log-N period channel	≤ 150% full scale reading of log-N recorder	Relay scram/alarm	
Reactor period ≥ set point	Compensated ion chamber in linear level channels 1 and 2	≤ 115% full scale reading of linear level recorder	Alarm	
Actuation of manual scram switch	Contacts within switch	_____	Relay scram/alarm	
Pool water level ≤ set point *(Pool level requirement moved to TS 2.1)*	Level switch	≤ 1 foot drop in pool water level	Building evacuation alarm	May be bypassed provided a licensed senior operator is present in the facility

* Except as noted above none of the conditions listed may be bypassed during critical operation of the reactor. When any of the nuclear detection systems listed above are disabled or undergoing maintenance, the reactor must be maintained in the shutdown condition.

5.0 ADMINISTRATIVE AND PROCEDURAL REQUIREMENTS

The following administrative and procedural requirements only apply to a functional reactor, as the reactor core has been permanently de-fueled, they are no longer possible or necessary.

5.6 Operating Records (Eliminated items)

In addition to records required elsewhere in the license application, the following records shall be kept of

(1) reactor operation, including power levels and periods of operation at each power level

(3) emergency shutdowns and inadvertent scrams, including reasons for emergency shutdowns

(5) experiments installed including description, reactivity worths, locations, exposure time, total irradiation and any unusual events involved in their performance and in their handling

(7) incore irradiations

5.8 Annual Operating Reports (Eliminated Items)

(2) Power Generation: the most current summary of the thermal output of the facility available together with a summary of the total thermal power generated over the life of the reactor

(3) Shutdowns: a listing of unscheduled shutdowns which have occurred during the reporting period, tabulated according to cause, and a brief discussion of the actions taken to prevent recurrence

5.10 Initial Startup of Altered Core Configuration

(1) During a critical experiment of a new (not previously used) core configuration, subcritical multiplication plots shall be obtained from a least two instrumentation channels.

(2) When a change of core configuration involving a single grid position is being made, two control blades shall be cocked at the half withdrawn position and the third shall be fully inserted during the fuel transfer. For a previously untried configuration, the removable plate element shall be used first in the new position with only two plates present. Thereafter not more than two plates shall be loaded in any step and core excess reactivity measurements shall be made after each step to ensure that the total excess reactivity after fuel insertion will be below the maximum permissible value of 0.5% $\Delta k/k$.

(3) When more than one grid position is involved in a loading change, the core shall be unloaded to less than one-half the estimated critical mass and all incore experiments shall

be removed. Multiplication information with all blades fully withdrawn shall be incorporated in a reciprocal multiplication curve and a new value of critical mass extrapolated. The fuel mass in each loading step shall not be more than one-half the difference between loaded and extrapolated critical fuel mass until such difference in less than a single standard element. Blades shall not be more than 50% withdrawn during the actual loading of the fuel into the core.

After the completion of the core loading, tests shall be performed to ascertain that the excess reactivity limits set forth in these specifications are not exceeded. For a core geometry which hs been previously loaded and for which an excess reactivity measurement has previously been made, criticality checks shall be made in loading the last 3 elements in lieu of the preceding loading step requirements of this paragraph.

All standard fuel elements shall be unloaded before a control blade may be manually removed.

Procedures for reloading the last half of the core shall prescribe the loading of fuel nearest the grid box center first with fuel loading thereafter proceeding outward. The reactor shall not be brought critical nor shall more than two control blades be fully withdrawn when any vacant grid box position is surrounded by four fuel elements. The control blades shall be positioned to intersect the completed core.