UNIVERSITY OF CALIFORNIA, IRVINE

BERKELEY • DAVIS • IRVINE • LOS ANGELES • RIVERSIDE • SAN DIEGO • SAN FRANCISCO SANTA BARBARA • SANTA CRUZ

George E. Miller
Senior Lecturer Emeritus
Department of Chemistry and
Director, Nuclear Reactor Facility
Faculty Advisor for Science, UCI Center for Education Partnerships

IRVINE, CA 92697-2025
(949) 824-6649 or 824-6082
FAX: (949) 824-8571
email : gemiller@uci.edu

October 20, 2010

US Nuclear Regulatory Commission
Document Control Desk
Washington DC 20555
Attention: Linh Tran, Senior Project Manager
Re: Docket 50-326 - UCI Irvine License Renewal

Dear Ms Tran:
Please find attached a response regarding revisions based on the last telephone conference. Most of the items discussed related to needs to revise the proposed Technical Specifications in several regards. Revisions have been made which I hope are self explanatory. One of these related to pool level monitoring. While this revision should be clear, I have also included a further description from other documents regarding the pool water level monitoring provisions.

I am in receipt of your RAI with respect to our Operator Requalification Program and am anticipating an on-time response.
Thank you for your patience and consideration.

I declare under penalty of perjury that the foregoing and the attached is true and correct.

Executed on October20th 2010

George E. Miller

Dr. George E. Miller
Director

A020
NRR

Proposed
Technical Specifications
for the
U. C. Irvine
TRIGA Mark I Nuclear Reactor

Revision 2010-03

October 14th 2010

TABLE OF CONTENTS

1. DEFINITIONS

The following frequently used terms are defined to aid in the uniform interpretation of these specifications.

1.1 AUDIT An examination of records, logs, procedures, or other documents to ascertain that appropriate specifications and guidelines are being followed in practice. An audit report is written to detail findings and make recommendations.

1.2 CHANNEL A combination of sensor, lines, amplifier and output device which are connected for the purpose of measuring the value of a parameter.

1.3 CHANNEL CALIBRATION 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 include equipment activation, alarm or trip, and shall be deemed to include a CHANNEL TEST.

1.4 CHANNEL CHECK 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.

1.5 CHANNEL TEST An introduction of a signal into the channel to verify that it is operable.

1.6 CLOSE-PACKED ARRAY is a fuel loading pattern in which the fuel elements are arranged in the core by filling the inner rings first.

1.7 CONFINEMENT is the enclosure of the overall facility designed to limit release of effluents between the enclosure and the external environment through controlled or defined pathways.

1.8 CONTROL ROD is a device for adjustment of core reactivity through movement of neutron absorbing material or fuel, or both. A control rod may be coupled to its drive unit in a way that allows it to perform its safety function when the coupling is disengaged. Types of control rods include:

a. Regulating (REG): a rod having electromechanical drive and scram capabilities. Its position may be adjustable by manual or electronic control. It may have a fueled follower section.

b. Shim (SHIM): a rod similar to the REG rod but without the possibility of electronic adjustment of position.

c. Transient (ATR or FTR): a rod that can be moved up or down by pneumatic control. It has neutron absorbing material and may have a void follower. The length of movement of the ATR can be adjusted by an electromechanical drive system.

1.9 CORE CONFIGURATION describes a particular arrangement of fuel, control rods, graphite reflector elements, and experimental facilities inserted within the core grid plates.

1.10 CORE POSITION is defined by a series of holes in the top grid plate of the core, designed to hold a standard fuel element. It is specified by a letter, signifying the ring of holes in the grid plate, moving outwards from A through G, and a number indicating the position within the ring.

1.11 EXCESS REACTIVITY is that amount of reactivity that would exist if all reactivity control devices were moved to the maximum reactive condition from the point where the reactor is exactly critical ($k_{eff} = 1$) at reference core conditions or at a specified set of conditions.

1.12 EXPERIMENT is any operation that is designed to investigate non-routine reactor characteristics or that is intended for irradiation of items within the pool or in irradiation facilities. Hardware rigidly secured to the core or other reactor structure so as to be part of its design to carry out experiments is not normally considered an experiment. Specific experiments shall include:

a. SECURED EXPERIMENT is any apparatus, device or material held in a stationary position relative to the reactor core by mechanical means. The securing forces must be adequate to maintain a fixed position in the event of foreseen external forces on the system, or applied as the result of credible malfunctions. Secured experiments are intended to be installed only when the reactor is not operating.

b. UNSECURED EXPERIMENT is any experiment that does not meet the definition of a secured experiment.

c. MOVEABLE EXPERIMENT is any experiment in which it is intended that movement of all or a part of the experiment may be moved in or near the core or into or out of the reactor while the reactor is operating.

1.13 FUEL ELEMENT is a standard TRIGA® fuel rod with zirconium hydride/uranium fuel and stainless steel cladding. Maximum enrichment in ^{235}U is 20%, and maximum uranium is less 9% by weight.

1.14 INSTRUMENTED FUEL ELEMENT is an element in which one or more thermocouples are embedded for the purpose of measuring fuel temperature during reactor operation.

1.15 IRRADIATION FACILITIES are pneumatic transfer systems, central tube, rotary specimen rack, and the in-core facilities (including single element positions, three-element positions, and the seven element position) and any other facilities in the tank designed to provide locations for neutron or gamma ray exposure of materials.

1.16 MEASURED VALUE is the value of a parameter as it appears on the output of a channel.

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

1.18 OPERATING means a component or system is performing its intended function.

1.19 OPERATIONAL CORE means a CORE CONFIGURATION that meets all license requirements, including Technical Specifications.

1.20 PULSE MODE means any operation of the reactor with the mode switch in the PULSE position that satisfies all instrumentation and license requirements, including technical specifications, for pulse operation of the reactor.

1.21 REACTOR FACILITY is the physical area defined by rooms B64, B64A, B54, B54A, and B54B in the service level of Rowland Hall on the campus of the University of California Irvine.

1.22 REACTOR OPERATING means any time at which the reactor is not secured or shutdown.

1.23 REACTOR SAFETY SYSTEMS are those systems, including their associated input channels, that are designed to initiate automatic reactor scram or to provide information for the manual initiation of a scram for the purpose of returning the reactor to a shutdown condition.

1.24 REACTOR SECURED. The reactor is secured when
a. Either there is insufficient moderator or fissile materials to attain criticality under optimum conditions of moderation or reflection; or
b. All four CONTROL RODS are fully inserted. AND the reactor is SHUTDOWN.

1.25 REACTOR SHUTDOWN. The reactor is shutdown when it is subcritical by at least one dollar in the reference core condition with the reactivity worth of all installed experiments included and the following conditions exist:

a. No work is in progress involving core fuel, core structure, installed control rods, or control rod drives unless they are physically decoupled from the control rods;
b. No experiments are being moved or serviced that have, on movement, a reactivity worth exceeding the maximum value allowed for a single experiment, or one dollar, whichever is smaller.

1.26 REFERENCE CORE CONDITION is when the core is at ambient temperature (cold) and the reactivity worth of any xenon present is negligible (less than $0.20).

1.27 REVIEW means an examination of reports of AUDITS and other records with the purpose of establishing whether or not the facility staff is following appropriate license conditions, procedures and guidelines to operate the reactor in a safe and secure manner.

1.28 SAFETY CHANNEL means a measuring channel whose function is important to reactor and or experiment safety.

1.29 SCRAM TIME is the elapsed time between the initiation of a scram signal from a CHANNEL and a specific movement of a CONTROL ROD to its fully inserted position.

1.30 SEVEN ELEMENT POSITION is a hexagonal section which can be removed from the upper grid plate for insertion of specimens up to 4.4 in. in diameter after relocation of all six B-ring elements and removal of the central tube irradiation facility.

1.31 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.

1.32 SHUTDOWN MARGIN refers to the minimum shutdown reactivity necessary to provide confidence that the reactor can be made sub-critical by means of the control and safety systems starting from any permissible operating condition and with the most reactive rod in its most reactive position, and will remain subcritical without further operator action.

1.33 STEADY-STATE MODE is whenever the reactor is OPERATING with the mode selector switch in either of the STEADY-STATE positions.

1.34 SUBSTANTIVE CHANGES are changes in the original intent or safety significance of an action or event.

1.35 SURVEILLANCE INTERVALS that are permitted are established as follows:

a. quinquennial – every five years, not to exceed 66 months
b. biennial – every two years, not to exceed 30 months
c. annual – every year, not to exceed 18 months
d. semi-annual – not to exceed 9 months
e. quarterly – not to exceed 5 months
f. monthly, not to exceed 6 weeks
g.daily – refers to each day when the reactor is to be operated or before any operation extending more then one day

1.36 THREE ELEMENT POSITION is one of two generally triangular-shaped sections cut out of the upper grid plate, one encompassing ring holes D5, E6 and E7 and the other D14, E18 and E19. When fuel elements are placed in these locations, a special fixture provides lateral support. With the fixture and fuel removed, an experiment up to 2.4 in. in diameter may be inserted.

2. SAFETY LIMITS AND LIMITING SAFETY SYSTEM SETTINGS

2.1 Safety Limit - Fuel Element Temperature

Applicability. This specification applies to the fuel element temperature.

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

Specification. The temperature in a stainless steel clad, high hydride fuel element shall not exceed 1150°C under any conditions of operation.

Basis. The important parameter for a TRIGA® reactor is the fuel element temperature. This parameter is well suited as a single specification since it can be measured. A loss in the integrity o£ the fuel element cladding could arise from an excessive build-up of pressure between the fuel moderator and the cladding. The pressure is caused by the presence of fission product gases and hydrogen gas from the dissociation of the zirconium hydride in the fuel moderator. The magnitude of this pressure is determined by the fuel moderator temperature and the ratio of hydrogen atoms to zirconium atoms in the zirconium hydride moderator. (NUREG 1282).
The safety limit for the stainless steel clad, high hydride ($Zr/H_{1.7}$) fuel element is based on analysis (McClellan Nuclear Research Center reactor SAR 4.5.4.1.3 and Oregon State University SAR 4.5.3.1) which indicates that the stress in the cladding due to the hydrogen pressure from the dissociation of the zirconium hydride will remain below the yield stress provided the temperature of the fuel does not exceed 1150°C and the fuel cladding is water cooled so it remains well below this limit.

2.2 Limiting Safety System Settings

Applicability. This specification applies to the scram setting for the fuel element temperature channel.

Objective. The objective is to prevent the safety limit from being reached.

Specifications. For a core composed entirely of stainless steel clad, high hydride fuel elements, limiting safety system settings apply according to the location of the standard instrumented fuel element (IFE) which shall be located in the B- or C-ring as indicated in the following table:

Location	Limiting Safety System Setting
B-ring positions B3, B4, or B5	475°C
C-ring positions C6, C7, or C8	425°C

Basis. For stainless steel clad, high hydride fuel elements, fuel temperature can be measured in a system designed to initiate a reactor scram if a conservative limit is exceeded. Since the fuel element temperature is measured by a fuel element designed for this purpose (IFE), the limiting settings are given for different locations in the fuel array. With the core configuration grid used, the core is always loaded so that the maximum fuel temperature is produced in the B-ring. If the fuel element temperature is measured in the C-ring, the respective temperature is reduced appropriately. Limits are placed on IFE locations in order to assure the measured temperatures are not unduly influenced by control rod positions and represent maximum power dissipation in fuel. Maximum recorded temperatures for the UCI reactor B-ring IFE for the period since 1969 are 250°C at steady state, and 350°C for pulse operation. The limiting safety system settings are set to provide a margin between operational scram temperatures and are based on experience at this and other TRIGA® facilities as to maximum operational temperatures reached, which are considerably below the safety limit. This also allows for any reasonable uncertainties in temperature measurement. There is no evidence to support a need for reduction in fuel temperature limits as fuel ages.

3. LIMITING CONDITIONS FOR OPERATION

3.1 Reactor Core Parameters

3.1.1 Steady-state Operation

Applicability. This specification applies to the energy generated in the reactor during steady-state operation

Objective. The objective is to assure that the fuel temperature safety limit is not exceeded.

Specification. The reactor power level in steady-state operation shall not exceed 250 kilowatts.

Basis. Experience at other TRIGA® reactors and thermal and hydraulic calculations (OSU SAR 4.5.3) indicates that power levels up to 1.9 Mw can be safely used with natural convection cooling of the fuel elements, in a similar circular grid plate core configuration. Operation at less than 20% of that value will be safe.

3.1.2 Shutdown Margin

Applicability. These specifications apply to reactivity margins in shut down condition.

Objective. The objective is to assure that the reactor can be shut down at all times and to assure that the fuel temperature safety limit shall not be exceeded.

Specification. The reactor shall not be operated unless the following conditions exist

a. The shutdown margin provided by the control rods referred to the reference core condition shall be greater than $0.50 with irradiation facilities and experiments in place and the total worth of all unsecured experiments in their most reactive state; and the most reactive control rod fully withdrawn;

b. No experiment with a reactivity worth greater than $1.00 is unsecured

Basis. The value of the shutdown margin and limits on experiments assure that the reactor can be shut down and remain so even if the most reactive control rod should remain fully withdrawn and unsecured experiments are moved.

3.1.3 Core Excess Reactivity

Applicability. This specification applies to the reactivity condition of the reactor

Objective. The objective is to assure that the reactor fuel safety limit is not exceeded in any mode of operation.

Specification. The reactor shall not be operated unless the following condition exists:

The maximum available core excess reactivity based on the reference core condition shall not exceed $3.00.

Basis. Computations presented in the SAR (Chapter 13.3) establish that a sudden insertion of $3.00 results in a fuel temperature of approximately 350°C, well below the established safety limit for this fuel (TS 2.1). Such calculations are conservative, being based on a purely adiabatic model. The specifications assure that no insertion of reactivity above this value shall be possible, even under non-normal operating conditions.

3.1.4 Pulse Operation

Applicability. These specifications apply to energy generated in the reactor as a result of pulse insertion of reactivity

Objective. The objective is to assure that the fuel temperature safety limit shall not be exceeded.

Specifications. The reactor shall not be operated in the pulse mode unless, in addition to the other requirements of Section 3.1,

d. the steady-state power level of the reactor is less than 1 kilowatt; and

e. the total reactivity worth of the two transient control rods (ATR + FTR) does not exceed $3.00.

Basis. Inadvertent pulsing from a high steady-state power level or with a large reactivity change could result in a higher final peak temperature approaching the safety limit. This specification establishes a limit on pulsing from an initial high temperature or with excessive reactivity to limit temperature rise to anticipated values. TS 3.1.3 establishes the basis for the $3.00 limit.

3.1.5 This section intentionally left blank.

3.1.6 Fuel Element Inspection Parameters

Applicability. The specifications apply to all fuel elements, including fuel follower control rods.

Objective. The objective is to maintain integrity of fuel element cladding.

Specifications. The reactor shall not be operated with any fuel element identified to show damage. An exception is made for operation up to a power level at which a leak becomes detectable solely in order to be able to identify the leaking element. A fuel element shall be identified as showing damage and be removed from core if:

a. the transverse bend exceeds 1/16th inches (0.0625 in) over the length of the element; or

b. the growth in length over original measurements exceeds 1/8th inch (0.125 in); or

c. a cladding defect is suspected by a finding of release of any fission products; or

d. visual inspection identifies unusual pitting, bulging, or corrosion.

Basis. These criteria have been successfully used for hundreds of fuel inspections over many years in similar reactors to successfully identify elements that have cladding issues prior to serious failure.

3.2 Reactor Control and Safety Systems

3.2.1 Control Rods

Applicability. This specification applies to the function of all control rods.

Objective. To assure control rods are operable and that prompt reactor shut down following a scram is accomplished.

Specifications. The reactor shall not be operated unless the control rods are operable. Control rods shall not be considered operable if:

a. damage is apparent to rods or drive assemblies that could affect operation; or

b. the scram time exceeds 2 seconds.

Basis. Experience has shown that rod movement is assured in the absence of damage and that scram times of less than 2 seconds are more than adequate to reduce reactivity to assure safety in view of known transient behavior of TRIGA® reactors.

3.2.2 Reactor Measuring Channels

Applicability. This specification applies to the information which shall be available to the reactor operator during reactor operation.

Objective. To specify that minimum number of measuring channels that shall be available to the operator to assure safe operation of the reactor.

Specifications. The reactor shall not be operated in the specified mode unless the measuring channels described in Table 1 are operable.

Table 1. Minimum Measuring Channels

Measuring Channel	Operating Mode	
	Steady-state	Pulse
Fuel Element Temperature	1	1
Linear Power Level	1	-
Log Power Level	1	-
Power Level (%)	1	1 (peak power)
Nvt circuit	-	1

Note 1. Any single power level channel may be inoperable while the reactor is operating solely for the purpose of diagnosis and/or channel tests or checks on that channel.

Note 2. Any single power level channel that is not required for safety scram purpose by TS 3.2.3 and ceases to be operable during reactor operation shall be returned to operating condition within 5 minutes or the reactor shall be shut down. For channels required by TS 3.2.3 the reactor shall be shut down immediately if the channel becomes inoperable.

Basis. The fuel temperature displayed at the control console gives continuous information on the parameter which has a specified safety limit. The power level monitors assure that measurements of the reactor power level are adequately covered at both low and high power ranges in appropriate modes. Notes 1 and 2 allow for necessary tests for brief resolving of problems or recalibration while maintaining sufficient information for safe operation.

3.2.3 Reactor Safety System

Applicability This specification applies to the reactor safety system channels.

Objective To specify the minimum number of reactor safety system channels that shall be operable in order to assure that the fuel temperature safety limit is not exceeded.

Specification. The reactor shall not be operated unless the safety system channels described in Table 2 and the interlocks described in Table 3 are operable in the appropriate operating modes.

Table 2. Minimum Reactor Safety Channels

Safety Channel	Function and trip level maximum setting	Operating Mode	
		Steady-state	Pulse
Fuel Element Temperature	Scram – 400°C (B-ring IFE) Scram – 350°C (C-ring IFE)	1	1
Reactor Power level	Scram – 110% of 250 kw	2	-
Non-Operate	Scram – loss of HV and/or signal on any required channel	1	1
Manual Bar	Scram	1	1
Preset Timer	Scram pulse rods < 15 seconds after pulse	-	1
Seismic Switch	Scram – Modified Mercalli VI	1	1

Table 3. Minimum Interlocks

Interlock	Function	Operating Mode	
		Steady-state	Pulse
Wide Range Power Level Channel (Log)	Prevent control rod withdrawal when power level is < 1 x 10^{-7} % of full power	1	-
REG, SHIM, ATR Control Rod Drives	Prevent application of air to fast transient rod when all other rods are not fully inserted	1	-
REG, SHIM, ATR Control Rod Drives	Prevent simultaneous withdrawal of more than one rod	1	-
REG, SHIM, ATR Control Rod Drives	Prevent movement of rod drives other than by air application in pulse mode	-	1
ATR Cylinder Drive	Prevent application of air to adjustable transient rod unless cylinder is fully down	1	-
Wide Range Linear Power Channel	Prevent ATR or FTR insertion unless power level < 1 kilowatt	-	1

Bases

Scrams. The fuel temperature scram provides the protection to assure that if a condition results in which the LSSS is exceeded, an immediate shutdown will occur to keep the fuel temperature well below the safety limit. The power level scrams are provided as added protection against abnormally high fuel temperature and to assure that reactor operation stays within the licensed limits. The manual scram allows the operator to shut down the system if an unsafe or abnormal condition occurs. A high voltage scram on each channel assures that detector response is operating at all times. The seismic switch will scram the reactor if major earth movement (M.M. VI or above (equal to 0.06 – 0.07 g) occurs in case the operator is prevented from operating the manual scram at the time. The preset timer scram provides pulse "clipping" to reduce energy production at the tail of a pulse.

Interlocks. The interlock to prevent startup of the reactor with less than 10^{-7} % power indication assures that indication of neutron multiplication is present as reactivity is inserted. Other interlocks on rod drives are provided to prevent inappropriate multiple simultaneous reactivity insertions by operators. The interlocks which prevent the firing of the transient rods in the steady-state mode or if the power level is greater than 1 kilowatt prevent inadvertent pulses or pulsing when fuel temperature is too high.

3.3 Coolant Systems

3.3.1 Pool Water Level

Applicability. These specifications apply to the water level in the reactor pool at all times.

Objective. To assure there is sufficient water in the reactor pool to provide cooling and shielding for radiation from the core, and to check for potential pool leakage.

Specifications.

a. The reactor shall not be operated unless the pool water level is at no more than 1 foot below the tank edge (at least 15 feet above the upper grid plate of the core and at least 24 feet above the tank floor).
b. An audible alarm, with reporting to the UCIPD dispatch desk if not locally silenced by an operator, shall operate 24/7 to alert personnel if the water level in the reactor pool falls below the above limit. Visual checking of water level may be substituted during periods when the alarm is found to be inoperable.
c. Records shall be maintained of the date, time and quantity of all water top-ups made to the pool.

Basis. Facility design calculations and subsequent measurements show that these water levels are sufficient to reduce full power operational radiation levels to acceptable levels within the facility and in any occupied areas above or surrounding the reactor. This is also true for shut down levels. The alarm will notify appropriate responders well before any increase in radiation levels to the surroundings occurs. The alarm and the operational top-up records will, if it occurs unusually frequently, alert operators to the possibility that pool leakage might be occurring, . The pool level is normally maintained at approximately 10 inches below the tank edge. Thus the alarm level is at 2 inches below and results from evaporation or leakage of only 160 gallons (640 liters).

3.3.2 Pool Water Temperature

Applicability. This specification applies to the water temperature in the reactor pool at all times.

Objective. To assure the water in the reactor pool stays within limits that provide sufficient cooling of the fuel and that minimizes stresses to the tank and reactor components.

Specification. The pool water temperature shall be maintained between 17°C and 25°C

Basis. These temperature limits are easily maintained using the available cooling system and guard against temperatures that might produce undue stresses on tank components or water purification systems.

3.3.3 Pool Water Conductivity

Applicability. This specification applies to the conductivity of water in the reactor pool at all times.

Objective. To assure the water in the reactor pool is maintained at high purity to minimize potential corrosion of reactor components.

Specification. The pool water conductivity level shall be maintained less than 3 micromhos/cm.

Basis. Experience at other reactor facilities indicates that maintaining the conductivity within 5 micromhos /cm is adequate to provide acceptable control of corrosion (NUREG 1537). An additional margin of assurance is provided by this lower specification. This also assesses possible leakage from the highly "doped" secondary cooling water system

3.3.4 Pool Water Radioactivity

Applicability. This specification applies to the radioactivity of water in the reactor pool at all times.

Objective. To assure the water in the reactor pool is maintained at high purity.

Specification. The average pool water radioactivity level shall be maintained within limits for sewer disposal as established by 10CFR Part 20, Appendix B, Table 3 for radionuclides with half-lives longer than 14 days.

Basis. Maintenance at this level will assure that any disposal of pool water, either planned or inadvertent, will be within appropriate and significant radioactivity limits. It also will provide verification of absence of fission product leakage.

3.4 Confinement

3.4.1 Operations Requiring Confinement

Applicability. This specification applies to operations where there is a need to safeguard against release of radioactive materials beyond the facility.

Objective. To assure there is confinement during certain higher risk operations that might release radioactive materials, especially gases or aerosols.

Specification. The following operations shall not be conducted unless confinement is assured by closing doors into the facility and verifying that the facility's ventilation systems and radiation monitors for routine and emergency modes are operable:

a. reactor operation at above 1 kilowatt for more than 10 minutes; or a single pulse; or

b. movement of irradiated fuel or fueled experiments; or

c. any work on core structure, experimental facilities, control rods or control rod drives that could result in a core reactivity change greater than $0.50.

Basis. Release of gaseous or aerosol material is most likely under significant movement operations involving core components, or reactor operations at high fuel energy release. The allowance for a short period of time permits personnel access or withdrawal and movement of un-involved items, which is unlikely to coincide with accidental release.

3.4.2 Equipment to Achieve Confinement

This specification is addressed in section 3.5 below.

3.5 Ventilation Systems

3.5.1 Ventilation During Normal Operation.

Applicability. This specification applies to the facility ventilation system during reactor operations.

Objective. To assure there is adequate ventilation and flow control to assure confinement of any gaseous or aerosol radioactivity released from reactor operations, fuel leaks or from experiments.

Specification. The reactor shall not be operated unless the ventilation system is operating and maintaining a minimum of 0.10 inches of water negative pressure within the reactor room and the control room and between the reactor room and the air outside the building, except for periods of time not to exceed two hours to allow surveillance, maintenance and testing of the ventilation system. During such exception, no reactor pulses shall be fired.

Basis. Through a combination of inflow dampers and outflow exhaust, facility design establishes and exceeds these pressure differentials, which were selected on the recommendation of the reactor installer. Any negative inflow will assist in confinement of released materials. The SAR establishes that normal operation effectively dilutes ^{41}Ar levels well below 10 CFR20 limits and as detailed in facility annual reports.

3.5.2 Ventilation During Emergency Situations

Applicability. This specification applies to the ventilation system provided for emergency situations.

Objective. To assure there is confinement of radioactive releases by closing of normal ventilation and establishing a small purge flow to reduce possible exposure to personnel during the emergency.

Specification. A signal of high radiation activity alarm from a continuous particulate air monitor (CAM) measuring air from above the pool shall carry out the following functions:

a. close off inflow air by closing dampers; and

b. close off outflow air by closing dampers in exhaust ducts and removing power from relevant exhaust fans and fume hood; and

c. remove power from pneumatic transfer system so it can no longer operate to transfer air through any core region; and

d. open outflow damper in a small "purge" exhaust duct system equipped with a HEPA filter.

Basis. These actions will result in isolation of the main reactor rooms to aid in confinement, while beginning to purge contaminated air through a high grade filter. Experience at other facilities has shown that fission product release from fuel elements is most rapidly detected by a CAM operating in this manner. The SAR establishes that the emergency purge system will, in the event of a radioactive gas release, be effective in providing personnel with sufficient time to evacuate before experiencing serious exposure. It is shown in Chapter 13 of the SAR that operation of the emergency exhaust system reduces off-site doses to below 10 CFR Part 20 limits in the event of a TRIGA fuel element failure, and that operation of the normal system adequately dilutes the argon 41 released even under unusual experimental operations. The specifications governing operation of the reactor while the ventilation system is undergoing repair preclude the likelihood of fuel element failure during such times. It is shown also that, if the reactor were to be operating at full steady-state power, fuel element failure will not occur even if all the reactor tank water were to be lost immediately.

3.6 Emergency Power

Applicability. This specification applies to the availability of emergency power.

Objective. To assure certain information related to personnel safety is available in the event of main electrical power failure.

Specification. Emergency electrical power, activated rapidly upon main electrical power failure, shall be provided to facility lighting, radiation monitoring and security monitoring systems.

Basis. Provision of power to these systems will assure that personnel present at the time, or responding to an event, will have information to assist in monitoring their safety and the safety and security of the facility.

3.7 Radiation Monitoring Systems and Effluents

3.7.1 Radiation Monitoring Systems

Applicability. This specification applies to monitoring of radiation levels.

Objective. To assure information is available to provide assurance of radiological safety of personnel at the facility, and of the absence of excessive releases beyond the facility.

Specifications.

a. The reactor shall not be operated unless the following minimum radiation monitoring instruments are operating:

Radiation Area Monitors (RAM):	2
Continuous Particulate Radiation Monitor (CAM):	1

b. An environmental monitoring dosimeter pack, exchanged at least quarterly, shall be in place in the primary exhaust duct of the facility at all times, except when undergoing exchange. Additional packs shall be located in adjacent buildings, and in a more remote control for comparison.

Basis. These instruments and dosimeters will provide adequate notification of abnormal levels that could result in exposures or uncontrolled releases. The environmental dosimeters provide information that can be used to track long term trends that might need attention.

3.7.2 Effluents

Applicability. This specification applies to the release rate of ^{41}Ar.

Objective. To assure that concentration of ^{41}Ar in accessible unrestricted areas shall be below the applicable limits of 10 CFR Part 20.

Specification. The annual average concentration of ^{41}Ar released via the reactor facility exhaust duct shall not exceed 4×10^{-8} µCi/ml.

Basis. This will assure, through dilution, and the inaccessibility of the exhaust discharge above the roof that no individual will be exposed to more than the limit presented in 10 CFR 20 Appendix B, Table 2 for release to unrestricted areas.

3.8. Limitations on Experiments

3.8.1 Reactivity Limits

Applicability. This specification applies to experiments placed in the reactor and its experimental facilities.

Objective. The objective is to prevent damage to the reactor or excessive release of radioactive materials in the event of an experiment failure.

Specifications.

a. The absolute value of any unsecured experiment shall not exceed $1.00, and
b. The reactivity worth of an individual experiment shall not exceed $3.00, and
c. The sum of absolute values of all experiments shall not exceed $3.00.

Basis. The limit on an unsecured experiment is to prevent an inadvertent pulse, and to maintain shutdown margin limitations. The insertion of $3.00 pulses has been analyzed as a safe operating condition for this reactor (SAR Chapter 13) and has been exceeded safely at other reactors with similar fuel core design, so limitation of experiments such that a pulse larger than this value could not occur is prudent and well within safe limits.

3.8.2 Materials

Applicability. This specification applies to experiments placed in the reactor and its experimental facilities.

Objective. To assure minimal damage to experimental facilities or core structures as well as to minimize excessive release of radioactive materials in the event of experiment failure.

Specifications. The reactor shall not be operated unless the following conditions exist:

a. Fueled experiments are limited such that the total inventory of iodine isotopes 131 through 135 in the experiment is not greater than 0.3 curies and the Strontium 90 inventory is not greater than 1 microcurie; and

b. The quantity of known explosive materials to be irradiated is less than 25 milligrams and the pressure produced in the experiment container upon accidental detonation of the explosive has been experimentally determined to be less than half the design pressure of the container; and
c. Experiments containing materials corrosive to reactor components, compounds highly reactive with water, potentially explosive materials or liquid fissionable materials are doubly encapsulated.

d. Materials, design, and construction of experiments shall be such that assurance is given that no stress failure can occur at stresses twice those anticipated in the manipulation and conduct of the experiment or twice those that could occur as a result of unintended but credible changes of, or within, the experiment.

Basis. It is shown in the SAR, Chapter 13, that a release of 0.024 curies of iodine activity will result in a maximum dose to the thyroid of a person in an unrestricted area of less than 1/20 of the permissible dose. The limit on iodine inventory is set at 10 times this value. The limit for Strontium 90 is that which corresponds to the iodine yield of 0.3 curies for a given number of fission events and would be no hazard. Specifications b., c., and d. reduce the likelihood of damage to reactor components resulting from experiment failure.

3.8.3 Failures or Malfunctions

Applicability. This specification applies to experiments placed in the reactor and its experimental facilities.

Objective. To assure minimal damage to experimental facilities or core structures as well as to minimize excessive release of radioactive materials in the event of experiment failure.

Specifications. Where the possibility exists that the failure of an experiment under normal operating conditions of the experiment or reactor, credible accident conditions in the reactor, or possible accident conditions in the experiment could release radioactive gases or aerosols to the reactor room or any unrestricted area, the quantity and type of material in the experiment shall be limited such that the airborne radioactivity in the reactor facility or the unrestricted area will not exceed the applicable dose limits in 10CFR 20, assuming that:

a. 100% of the gases or aerosols escape from the experiment.

b. If the effluent from an experiment exhausts through a filter system designed for greater than 99% efficiency for 0.3 micron particles, at least 10% of the gases or aerosols will escape.

c. For a material whose boiling point is above 55°C and where vapors formed by boiling this material could escape only through a column of water above the core, at least 10% of those vapors will escape.

Basis. This specification is intended to assist experiment review and design in meeting the goals of 10CFR20 by reducing the likelihood of excessive facility personnel or public exposure by gases or aerosols as a result of experiment failure.

3.9. This section deliberately left blank.

4. SURVEILLANCE REQUIREMENTS

4.0 General

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

Objective. To assure the proper operation of any system related to reactor safety.

Specifications.

a. Surveillance requirements may be deferred during prolonged reactor shutdown, however they shall be completed prior to any reactor start-up unless reactor operation is required for performance of the surveillance when it may be deferred until the reactor next shuts down.

b. All replacements, modifications, and changes to systems having a safety related function shall meet or exceed the requirements of the original system or component. A safety system shall not be considered operable until it has been properly tested to meet expected specifications.

Basis. Changes or maintenance can affect reactor operation parameters. This specification will assure that safety systems function according to established criteria before any reactor operation.

4.1 Reactor Core Parameters

Applicability. This specification applies to the surveillance requirements for reactor core parameters

Objective. To verify that the reactor does not exceed authorized limits for power, shutdown margin, core excess reactivity, specifications for fuel element condition, and verification of total reactivity worth of each control rod.

Specifications.

a. A channel calibration shall be made of the power level monitoring channels by the calorimetric method annually.

b. The total reactivity worth of each control rod shall be measured annually or following any significant change (>$0.25) in core configuration.

c. The core excess reactivity shall be measured using control rod position data prior to each day's operation, or prior to each operation extending more than one day, or following any significant change (>$0.25) in core configuration.

d. The shutdown margin shall be calculated at each day's shutdown, or at the end of any operation exceeding one day, or following any significant change (>$0.25) in core configuration.

e. All core fuel elements shall be visually inspected (under water) and measured for length and bend quinquennially, but at intervals separated by not more than 500 pulses of magnitude greater than $1.00 of reactivity. Fuel follower control rods shall be measured for bend at the same time interval. Such surveillance shall also be performed for elements in the B and C rings in the event that there is indication that fuel temperatures greater than the limiting safety system setting on temperature may have been exceeded.

Basis. Experience has shown that the identified frequencies are more than adequate to ensure performance and operability for this reactor. The value of significant change is measureable and will assure sufficient shutdown margin even taking into account decay of poison.
For fuel elements, the most severe stresses induced in the fuel elements result from pulse operation of the reactor, during which differential expansion between the fuel and the cladding occurs and the pressure of the gases within the elements increases sharply. The surveillance interval is selected based on the past history of more frequent, uneventful, inspections for over 40 years at this facility and experience at other TRIGA facilities with similar power levels, fuel type, and operational modes. It is also designed to reduce the possibilities of mechanical failures as a result of handling elements, and to minimize potential radiation exposures to personnel.

4.2 Reactor Control and Safety Systems

Applicability. This specification applies to the surveillance requirements for the reactor control and safety systems.

Objective. The objective is to verify performance and operability of those systems and components which are directly related to reactor safety.

Specifications.

a. Control rod drop (scram) times for all four control rods shall be determined annually.

b. Transient (non fuel-follower) control rods and fuel follower control rods shall be visually inspected for deterioration quinquennially.

c. The transient (pulse) rod drive cylinders and the associated air supply systems shall be inspected, cleaned, and lubricated if necessary, annually.

d. On each day that pulse mode operation of the reactor is planned, a functional performance check of the transient (pulse) rod system shall be performed.

e. A channel check of each of the reactor safety system channels shall be performed prior to each day's operation or prior to each operation extending more than one day.

f. A channel test of each item in Tables 2 and 3 in section 3.2.3, shall be performed semi-annually.

g. A calibration of the temperature measuring channel shall be performed annually.

Basis. The control rods are inspected and drop times checked to assure safe operations. The surveillance intervals for those and the channel surveillances are selected based on the past history for over 40 years at this facility and are adequate to correct for long term drifts and other instrument problems.

4.3 Reactor Pool Water

Applicability. This specification applies to the surveillance requirements for the reactor pool water.

Objective. The objective is to assure that the reactor pool water level channel is operable, that alarm settings are verified and alarm reporting is functional. In addition, that the water purity is being maintained within acceptable limits.

Specifications.

a. A channel check of the pool water level measuring channel shall be performed monthly to include verification of the alarm reporting system.

b. A channel calibration of the pool water level measuring channel shall be performed annually to include verification of the alarm set point.

c. The pool water conductivity shall be measured at the end of each operating day, or at shutdown for a period of operation extending more than one day. When the reactor has not been operated for prolonged periods, the conductivity shall be measured at least quarterly.

d. The pool water radioactivity shall be measured quarterly in comparison to former data, a tap water sample, and a sample from a pit representing water accumulated in the ground surrounding the reactor tank unless there is evidence either of fuel element leakage of fission products, or of pool water leakage, in which event, the pool water radioactivity shall be measured immediately.

Basis. These verifications will assure that a continued warning system for a rapid loss of pool water incident is maintained, and any sudden perturbation of pool water quality is noted quickly to allow for corrective action to minimize corrosion, or build-up of radioactivity in the water. The check on conductivity monitors possible leakage into the pool from the secondary water system. Radioactivity measurements will enable assessments of impacts of pool leaks and/or fission product leaks from a fuel element.

4.4 This section deliberately left blank.

4.5 Ventilation Systems

Applicability. This specification applies to the surveillance requirements for the reactor room ventilation system.

Objective. To verify performance is adequate to provide for normal and emergency mode ventilation for the facility to control and confine releases of airborne radioactive materials.

Specifications.

a. A channel check of the existence of negative air pressure between the reactor room and the control room, and the reactor room and the outside air shall be performed daily.

b. A channel test of the function of the particulate high radiation (CAM) alarm to properly set the ventilation system into "emergency" mode shall be performed daily.

Basis. These checks will assure that any reactor operation that results in release of airborne radioactivity will result in appropriate confinement of that activity to the reactor room.

4.6 Emergency Power

Applicability. This specification applies to the provision of emergency electrical power to room lighting, radiological safety, and security instrumentation.

Objective. To assure proper connection and function of the emergency electrical power so that personnel are provided lighting and information relating to radiological safety in the event of main electrical power failure.

Specification. A verification check that the instruments relating to radiological safety are attached to the correct circuit for emergency electric power provision shall be performed annually. Verification shall also be sought from the campus Facilities Management operation, that the emergency power generator has been successfully tested for operation and "switch-over" during the previous year.

Basis. It is important for safety that verification of emergency power functions be carried out. Past experience has shown that this frequency is adequate to assure continuity of this service.

4.7 Radiation Monitoring System

Applicability. This specification applies to the surveillance requirements for the radiation monitoring instrumentation required by Section 3.7.1.a of these specifications.

Objective. The objective is to assure that the radiation monitoring system is operating properly and to verify the appropriate alarm settings.

Specifications.

a. A channel test of the radiation monitoring systems required by Section 3.7.1.a. shall be performed daily. This shall include verification of the alarm set points.

b. A channel calibration of the radiation monitoring systems required by Section 3.7.1.a. shall be performed annually.

Basis. Surveillance of the equipment will assure that sufficient protection against radiation is available. Past experience has shown that these frequencies are adequate to assure proper operation.

5.0 DESIGN FEATURES

5.1 Site and Facility Description

Specifications

a. The reactor facility is housed in a closed five room suite on a single level in the basement of Rowland Hall, on the University of California Irvine campus. The minimum free air volume of the reactor room shall be 10,000 cubic feet.

b. A ventilation system shall be capable of exhausting air or other gases from the reactor room at a minimum of 70 feet above ground level.

c. Emergency shutdown of the specific reactor area exhaust and air input ducts shall be controlled by a high radioactive particulate count rate alarm signal originating in the reactor room.

Basis. The extent of the facility is specified to define the controlled area so as to establish ventilation and other controls needed to assure minimal radiation exposure to facility personnel and the community.

5.2. Reactor Coolant System

Specifications.

a. The reactor core is cooled by natural convection water flow.

b. All piping and other equipment for pool cooling systems is above pool level and inlet and outlet pipes to the heat exchanger and demineralizer are equipped with siphon breaks not less than 14 feet above the upper core grid plate.

c. A pool water level indication is provided at the control console.

d. A pool water temperature indication is provided at the control console.

e. A pool water conductivity measurement instrument is provided in the reactor room.

f. Gamma and beta radiation spectrometry equipment is provided for water sample radioactivity assay.

Basis. Pool water quantity and quality is controlled so as to limit radiation and/or radioactivity release, corrosion of components. Information is necessary to provide staff with indications of change in pool water characteristics.

5.3. Reactor Core and Fuel

5.3.1 Reactor Core.

Specifications.

a. The core assembly consists of TRIGA® fuel elements.

b. The core fuel shall be kept in a close-packed array except for control rods, single- or three-element or seven-element positions occupied by in-core experiments, irradiation facilities (including transfer system termini), graphite dummy elements, and a central dry tube.

c. Reflection of neutrons is provided by combinations of graphite and water, with the graphite in sealed containment with aluminum cladding, either in the form of rods occupying grid positions, or in a larger reflector structure surrounding the core.

d. An Am-Be neutron source is provided in a specific location in the upper grid plate to provide start-up neutrons. It may be removed for maintenance purposes.

Basis. TRIGA® fuel and reactor design has a long and successful history of use when used under specific conditions. The Am-Be source is in a sealed capsule and has a long useful life.

5.3.2. Control Rods.

Specifications.

a. The SHIM and REG rods are motor driven with scram capability and solid boron compounds in a poison section, with fuel followers of standard TRIGA® fuel meeting the same specifications as in Section 5.3.3.

b. The transient rods (ATR and FTR) are pneumatically driven, have scram capability and contain solid boron compounds in a poison section. They incorporate air filled followers. The ATR has an adjustable upper limit to provide variable pulse insertion capability.

Basis. These control rods have a long successful history of use.

5.3.3. Reactor Fuel.

Specifications. Standard unirradiated TRIGA® fuel elements have the following characteristics:

a. The total uranium content shall be nominally 8.5 % by weight, enriched to less than 20% ^{235}U.

b. The hydrogen to zirconium atom ratio in the zirconium hydride shall be a nominal 1.65 hydrogen atoms to 1.0 zirconium atom.

c. The cladding shall be 304 stainless steel, nominally 0.020 inches thick.

d. An upper fitting designed to fit a latching tool for fuel movement, with engraved unique serial numbers.

Basis. TRIGA® fuel elements meeting these manufacturer's specifications have a long history of successful use with minimal failures. Minor deviations about these levels due to manufacturing variations are not to be considered violations of this specification.

5.4. Fuel Storage

Specifications.

a. All fuel elements shall be stored in a geometrical array where the k_{eff} is less than 0.90 for all conditions of moderation and reflection.

b. Irradiated fuel elements and fuel devices shall be stored in an array which will permit sufficient natural convection cooling by water or air such that the fuel element or fueled device temperature will not exceed 80°C.

c. Fuel showing evidence of damage (see TS 3.1.6) shall be stored separately from fuel not suspected to be damaged, and shall be checked thoroughly for fission product leakage.

Basis. These specifications establish a sufficient reactivity margin to guard against accidental criticality of elements in storage, and that heat dissipation does not create excess corrosion or other problems. Damaged fuel is more likely to have or develop fission product leakage and so must be monitored and kept separately.

6 0 ADMINISTRATIVE CONTROLS

6.1 Organization

The UCI Nuclear Reactor operations involve no shift work and mostly short operating schedules, only a few times a week at most. This necessitates only a small staff, not necessarily full-time.

6.1.1 Structure.

The reactor facility is housed in the School of Physical Sciences of the University of California, Irvine. The official licensee of the reactor is the Board of Regents of the University of California, who has delegated authority for license matters to the Executive Vice Chancellor and Provost of the University of California, Irvine. The reactor is related to the University structure of positions shown in the organization chart, Figure 1.

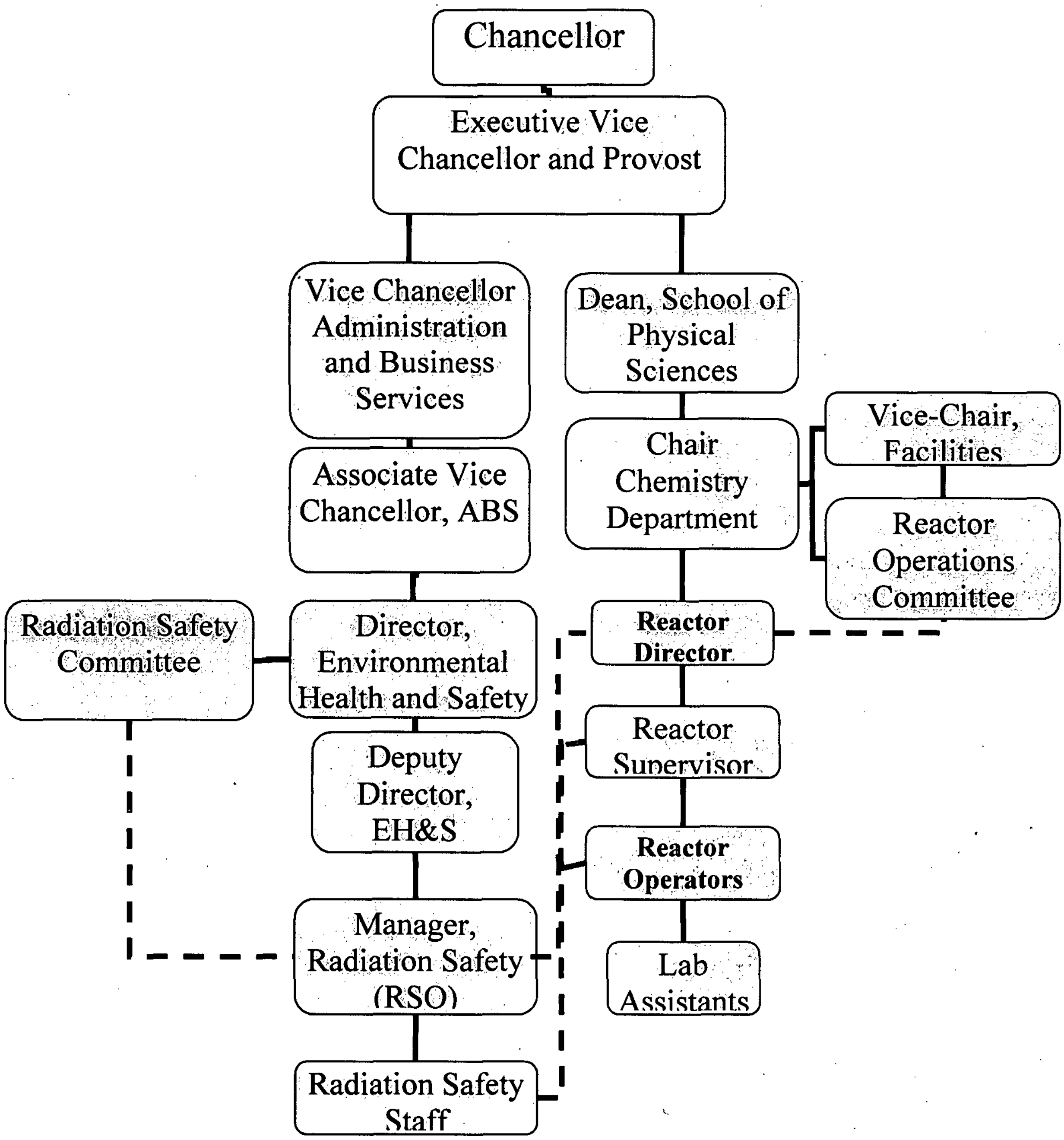
6.1.2 Responsibilities.

a. The reactor facility is under the direction of a Reactor Director who shall be a tenure member of the Chemistry Department faculty. Operations are supervised by the Reactor Supervisor who shall hold a valid senior operator's license for the facility. This position shall be responsible for assuring that all operations are conducted in a safe manner and within the limits prescribed by the facility license, the provisions of the Reactor Operations Committee and the provisions of the UCI Radiation Safety Committee. The Reactor Director and Reactor Supervisor positions may be occupied by the same individual.

b. There is a UCI Radiation Safety Officer responsible for the safety of operations from the standpoint of radiation protection. This position reports to the Office of Environmental Health and Safety which is an organization independent of the reactor operations organization as shown in Figure 1. An independent campus-wide Radiation Safety Committee (RSC) is responsible for establishment and review of all policies involving radiation and radioactivity.

c. In the event of absence, or during filling of appointments to specific positions, temporary duties and responsibilities may be carried out by the person next higher or lower in line in the organization chart.

Figure 1. UCI Reactor Organization Chart



6.1.3 Staffing.

a. The minimum staffing when the reactor is operating shall include:
1. A licensed operator with direct access to the reactor controls;
2. A second designated individual present within Rowland Hall with the ability to check on the safety of the licensed operator and to act in the event of emergency; and
3. A licensed Senior Operator (SRO) on call and expected to be available at the facility within 30 minutes, if called.

b. A list of reactor facility personnel, and other persons responsible for radiological safety and security on campus shall be kept in the reactor control room for use by an operator. The list shall include telephone numbers of the Reactor Director, the Reactor Supervisor, the Radiation Safety Officer and other back-up radiological safety personnel, senior or other licensed operators, and personnel with responsibilities for maintenance in Rowland Hall.

c. The following events require the presence in the facility of a licensed Senior Reactor Operator:
1. initial start-up and approach to power of the day;
2. fuel or control-rod relocations within the core region;
3. insertion, removal, or relocation of any experiment worth more than $1.00; and
4. restart following any unplanned or unscheduled shutdown, or significant power reduction.

6.1.4 Selection and Training of Personnel.

The selection, training, and requalification of operations personnel should, where applicable, meet the requirements of ANSI/ANS-15.4, latest revision.

6.2 Review and audit

A Reactor Operations Committee (ROC) shall review reactor operations to assure that the facility is operated in a manner consistent with public safety and within the terms of the facility license. Review and audit of radiological safety at the facility is also carried out by the UCI Radiation Safety Committee (RSC).

6.2.1 ROC Composition and Qualifications

The ROC shall have at least five members, at least one of whom shall be a health physicist designated by the Office of Environmental Health and Safety of the University. The Committee as a whole shall be knowledgeable in nuclear science and issues related to reactor and/or radiological safety. The membership shall include at least two members who are not associated with the Department of Chemistry. Approved alternates may serve in the absence of regular members. Members and alternates and a chairperson for the committee shall be appointed by the Chair of the UC Irvine Department of Chemistry or higher authority.

6.2.2 ROC Charter and rules

The following responsibilities constitute the charter of the ROC.

1. Meeting semi-annually, with provision for additional meetings when circumstances warrant to assure safety at the facility.

2. A quorum shall consist of not less than a majority of the members and shall include the chairperson or his/her designee. Votes shall not be taken where a majority of those voting would be directly associated with facility operations.

3. Review and audit of facility staff and operations as indicated further below.

4. Designation of individuals to perform audits of facility operations and records.

5. Preparation, approval, and dissemination of minutes of meetings.

6. Preparation and dissemination of findings and other reports as needed to assure safe operations of the reactor.

7. Approval of individuals for the supervision and operation of the reactor.

6.2.3 <u>ROC Review function</u>

The following review functions shall be the responsibility of the ROC.

1. Review and approval of all proposed changes to the facility, its license, procedures, ROC charter, and Technical Specifications, including those made under provisions of 10 CFR 50.59, and the determinations leading to decisions relating to 50.59 approvals;

2. Review and approval of new or changed procedures, experiments, components, or instrumentation having safety significance;

3. Review of the quality assurance program implementation applicable to the reactor components;

4. Review of new experiments or changes in experiments that could have reactivity or safety significance;

5. Review of violations of technical specifications, license, or violations of procedures or instructions having safety significance;

6. Review of operating abnormalities that have safety significance;

7. Review of reportable occurrences listed in Sections 6.6.1 or 6.7.2;

7. Review of audit reports.

6.2.4 <u>ROC Audit function</u>

The ROC shall audit or review audits performed by designated individuals on its behalf at least annually. The audit shall include, but not be limited to:

1. Facility operations for conformance to the technical specifications and applicable license or other conditions;

2. Retraining and requalification of operators according to the Requalification Plan;

3. The result of action taken to correct those deficiencies that may occur in the reactor facility equipment, systems, structures, procedures or methods of operation that affect reactor safety; and

4. The facility Emergency Plan (EP) and implementing procedures including written reports of any drills or exercises carried out. A full audit of the EP should be conducted biennially by the ROC and/or RSC.

6.3 Radiation Safety

As delineated in section 6.1.2.b, the UCI Radiation Safety Officer (RSO) is responsible for implementation of the radiological safety program at the reactor facility in accordance with applicable federal and state of California standards and regulations. The program should use the guidelines of ANSI/ANS 15.11.

6.4 Operating Procedures

Written procedures, reviewed and approved by the ROC, shall be in effect and implemented for the following items. The procedures shall be adequate to assure the safety of the reactor but should not preclude the use of independent judgment and action should the situation require such.

1. Startup, operation, and shutdown of the reactor.

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

3. Maintenance of major components of systems that could have an effect on reactor safety.

4. Surveillance checks, calibrations and inspections required by the technical specifications or that could have an effect on reactor safety;

5. Personnel radiation protection, including provisions to maintain personnel exposures as low as reasonably achievable (ALARA);

6. Administrative controls for operations and maintenance, and for the conduct of irradiations or experiments that could affect reactor safety;

7. Implementation of required plans including Emergency (EP) and Physical Security (PSP) plans;

8. Shipping and/or transfer of radioactive materials.

Substantive changes to the above procedures shall be made only with the approval of the ROC. Temporary changes to the procedures that do not change their original intent may be made by the Reactor Supervisor. All such temporary changes to procedures shall be documented and subsequently reviewed by the Reactor Director and the ROC. Substantive changes affecting radiological safety should be made only with the approval of the RSO. Temporary, minor, changes in radiological safety procedures may be made by the Reactor Supervisor, but should be reported to the RSO as soon as possible.

6.5 Experiment Review and Approval

Approved experiments shall be carried out in accordance with established and approved procedures. Procedures for experiment review and approval shall include:

1. All new experiments or class of experiment shall be reviewed and approved by the ROC and approved in writing by the Reactor Director. The review shall include analysis by the RSO or other designated radiation safety personnel.

2. Substantive changes to existing experiments or classes shall be made only after review by the ROC and RSO or their designees. Minor changes that do not significantly alter the experiment may be approved by a senior reactor operator (SRO).

6.6 Required Actions

6.6.1 Actions To Be Taken In Case of a Safety Limit Violation.

In the event the safety limit on fuel temperature is exceeded:

1. The reactor shall be shut down and reactor operation shall not be resumed until authorized by the NRC.

2. The event shall be reported immediately to the Reactor Director, the ROC chairperson, and the RSO.

3. The event shall be reported to the NRC Operations Center within 24 hours;

4. A report, and any applicable follow-up report, shall be prepared and reviewed by the ROC, for submission to NRC, describing:

    a. applicable circumstances leading to the violation including, where known, the cause and contributing factors;
    b. effects of the violation upon reactor facility components, systems, or structures, and on the health and safety of personnel and the public; and
    c. corrective action to prevent occurrence.

6.6.2 Actions to be taken in the event of an occurrence of the type identified in Section 6.7.2, other than a safety limit violation.

1. The reactor shall be secured and the Reactor Director and/or Supervisor notified.

2. Operation shall not be resumed until authorized by the Reactor Director and/or Supervisor.

3. The occurrence shall be reported to NRC as required in Section 6.7.2 of these specifications, and reviewed by the ROC at their next meeting.

6.7 Reports

In addition to the requirements of applicable regulations, and in no way substituting for them, reports shall be made to the NRC as listed below. All written reports shall be directed to the Document Control Desk, USNRC, Washington, D. C. 20555

6.7.1. Annual Operating Report.

A routine annual report shall be submitted by the Reactor Director to NRC at the end of each 12-month period for operations for the preceding year's activities between July 1st through June 30th. The report shall include:

1. a brief narrative summary of operating experience (including experiments performed) and a tabulation showing the energy generated by the reactor (in megawatt hours), the amount of pulse operation, and the number of hours the reactor was critical;

2. the number of unplanned shutdowns and inadvertent scrams, including the reasons therefore, and corrective actions taken (if any) to reduce recurrence;

3. a tabulation of major preventive and corrective maintenance operations having safety significance;

4. a tabulation of major changes in the reactor facility and procedures, and tabulations of new experiments that are significantly different from those performed previously, including a summary of safety evaluations performed to assess that they do not require prior NRC approval and are authorized by 10CFR 50.59;

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

6. a summarized result of environmental surveys performed outside the facility; and

7. a summary of radiation exposures received by facility personnel and visitors, where such exposures are greater than 25% of that allowed.

6.7.2 Special Reports.

1. A report not later than the following working day by telephone to the NRC Operations Center, and confirmed in writing, to be followed by a written report that describes the circumstances of the event within 14 days, of any of the following:

a. violation of a safety limit (fuel temperature);

b. release of radioactivity from the site above allowed limits;

c. operation with actual safety system settings for required systems less conservative than the limiting safety system settings in these specifications;

d. operation in violation of limiting conditions for operation unless prompt remedial action is taken as permitted in section 3;

e. a required reactor safety system component malfunction that renders or could render the safety system incapable of performing its intended safety function. If the malfunction or condition is caused by maintenance, then no report is required;

f. an unanticipated or uncontrolled change in reactivity greater than one dollar. Reactor trips resulting from known cause are excluded;

g. abnormal or significant degradation in reactor fuel or cladding, or both, coolant boundary, or confinement boundary (excluding minor leaks) where applicable; or

h. an observed inadequacy in 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.

2. A report within 30 days (in writing) of:

   a. permanent significant changes in facility organization; and

   b. significant changes in the transient or accident analyses as described in the SAR.

6.8 <u>Records</u>

In addition to the requirements of applicable regulations, and in no way substituting therefore, records and logs shall be prepared and retained for periods as described here. Records may be in a variety of formats.

6.8.1 <u>Records to be retained for a period of at least 5 years or for the life of the component involved if less than 5 years</u>.

1. Normal reactor facility operation, but not including supporting documentation such as checklists, log sheets, etc., which shall be retained for one year.

2. principal maintenance activities;

3. reportable occurrences;

4. surveillance activities required by the Technical Specifications;

5. reactor facility radiation and contamination surveys;

6. experiments performed with the reactor;

7. fuel inventories, receipts and shipments;

8. approved changes in operating procedures; and

9. ROC records of meetings and audit reports.

6.8.2 Records to be retained for at least one certification cycle.

Records of retraining and requalification of licensed operators (and SRO's) shall be retained at all times the individual has duties as an operator or his or her license is renewed.

6.8.3 Records to be retained for the lifetime of the reactor facility.

Applicable annual reports containing this information may also be used as records for the following:

1. gaseous and liquid radioactive effluents released to the environs;
2. off-site environmental monitoring surveys;
3. radiation exposures for all personnel monitored; and
4. drawings of the reactor facility and safety related components.

Revision October 2010 SAR 13.4.3.1

13.4.3.1 Pool Water Quantity Monitoring.

Provision is made for recording any make-up water quantity and/or water level changes within the reactor tank. No automatic make-up is provided, so procedures require recording approximate make up quantity and new level. This is done on the daily start-up checklist assisted by a float level monitor installed in the pool with a read-out at the control console. This latter reports the level in approximately 12 mm increments. For this pool, 25 mm (1 inch) corresponds to 80 gallons of water. Records are examined annually so as to detect any deviation from normal evaporation rates. To enable reasonable comparisons, the pool water temperature is operationally required to be maintained between 18 $^{\circ}$C and 24 $^{\circ}$C. Average values for atmospheric humidity, which affects evaporation rate, are relatively low in this area, though excursions do occur during certain seasons. Measurements of water level and additions over a two year period have been made from 2008 through 2010. On the assumption that there is currently no pool leakage (which is fully believed to be correct) so that all change is due to evaporation, the average loss rate was found to be 5.4 gallons/day (gpd), with a seasonal variation (presumably owing to humidity changes) from a low of 3.2 gpd to a high of 6.4 gpd. The water level is normally maintained between 20 and 30 cm (a range of 4 inches) below the upper tank lip. Any unusual drop rate – i.e., exceeding 1 inch (80 gallons) per two weeks is procedurally required to be reported and understood. Any operation of the low water alarm which implies a drop below 30 cm (1 foot) or by 4 inches (320 gallons) below maximum operational height, will be responded to and investigated no matter when it occurs.

The "new" level monitor is physically described below (extract from UCI training manual).

5.6.3. Pool Water Level

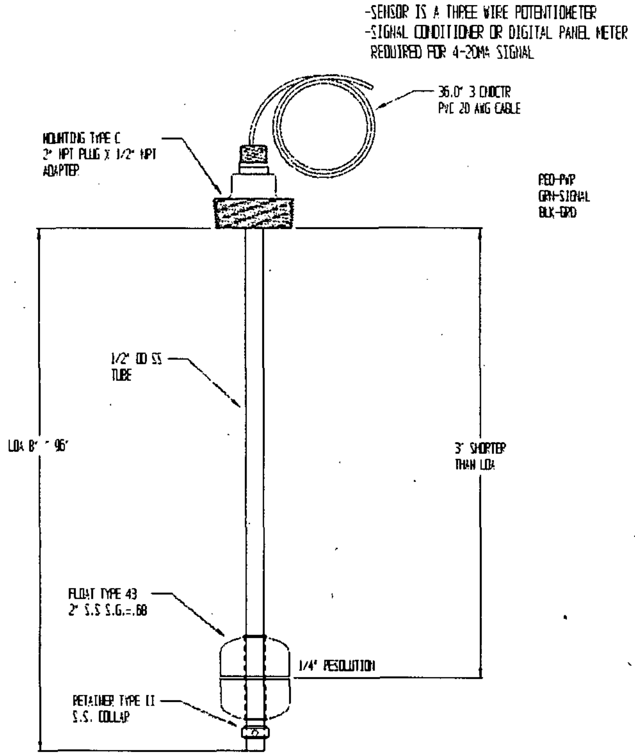


Fig 5-23 Pool Level Monitor

An all stainless steel float continuous level monitor (Innovative Components, Model CLM 2000-SS), (Fig 5-23) is installed in the pool that provides a read-out and alarms at the control console (Model DPM 5714B) with additional alarm at the security dispatch point. The level monitor reports the level in adjustable units but with approximately 12.5 mm increments. For this pool, 25 mm corresponds to 80 gallons of water.

An alarm indicates a level more than 12 inches below the pool rim has been reached and operates 24/7. A low level alert is given the operator well before additional make-up water is required to maintain the dash-pot action on the fuel follower control rod barrels (see section 5.3.2.)