FACILITY LICENSE R-123

TECHNICAL SPECIFICATIONS

FOR THE

UNIVERSITY OF VIRGINIA

CAVALIER REACTOR

DOCKET NO. 50-396

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1.0 Definitions

The terms Safety Limit (SL), "Limiting Safety System Setting" (LSSS), "Limiting Condition of Operation" (LCO), "Surveillance requirements," and "design features" are as defined in 10 CFR 50.36.

Channel Calibration: A channel calibration is an adjustment of the channel so that its output responds, with acceptable range and accuracy, to known values of the parameter that the channel measures. Calibration shall encompass the entire channel, including equipment actuation, alarm, or trip.

Channel Check: A channel check is a qualitative verification of acceptable performance by observation of channel behavior. This verification should include comparison of the channel with other independent channels or methods of measuring the same variable, where this capability exists.

Channel Test: A channel test is the introduction of a signal into a channel to verify that it is operable.

Experiment: An experiment is (1) any apparatus, device, or material placed in the reactor core region (in an experimental facility associated with the reactor, or inline with a beam of radiation emanating from the reactor) or (2) any incore operation designed to measure reactor characteristics.

Experimental Facility: An experimental facility is any structure or device associated with the reactor that is intended to guide, orient, position, manipulate, or otherwise facilitate a multiplicity of experiments of similar character.

Explosive Material: Explosive material is any solid or liquid that is categorized as a Severe, Dangerous, or Very Dangerous Explosion Hazard in "Dangerous Properties of Industrial Materials" by N.I. Sax, or is given an Identification of Reactivity (stability) index of 2, 3, or 4 by the National Fire Protection Association in its publication 704-M, "Identification System for Fire Hazards of Materials," also enumerated in the "Handbook for Laboratory Safety" published by the Chemical Rubber Company.

Fueled Experiment: A fueled experiment is any experiment that contains U-235 or U-233 or Pu-239. This does not include the normal reactor core fuel elements.

Measured Value: The measured value of the process variable is the value of the variable as it appears on the output of a measuring channel.

Measuring Channel: A measuring channel is the combination of sensor, lines, amplifiers, and output devices that are connected for the purpose of measuring the value of a process variable.

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

On Call: To be on call refers to an individual who (1) has been specifically designated and the designation is known to the operator on duty, (2) keeps the operator on duty informed of where he may be contacted and the phone number, and (3) is capable of getting to the reactor facility within a reasonable time under normal conditions (e.g. approximately 30 minutes).

Operable: A component or system is operable when it is capable of performing its intended function in a normal manner.

Operating: A component or system is operating when it is performing its intended function in a normal manner.

Reactivity Limits: Quantities are referenced to ambient tank water temperature with the effect of Xenon poisoning on the core activity accounted for if greater than or equal to 0.05% $\Delta k/k$. The reactivity worth of Samarium in the core will not be included in reactivity limits. The reference core condition will be known as the cold, xenon free critical condition.

Reactor Operation: The Reactor is in operation when not all of the shim rods are fully inserted and six or more fuel elements are loaded in the grid plate.

Reactor Safety System: The reactor safety system is that combination of measuring channels and associated circuitry that forms the automatic protective system of the reactor.

Reactor Secured: The reactor is secured when (1) all shim rods are fully inserted, (2) the console key is in the off position and is removed from the lock, and (3) no work is in progress in core involving fuel or experiments or maintenance of the core structure, control rods, or control rod mechanisms.

Reactor Shutdown: The reactor is in a shutdown condition when all shim rods are fully inserted.

Reportable Occurrence: A reportable occurrence is any of the conditions described in Section 6.4.2 of these specifications.

Secured Experiment: A secured experiment is any experiment, experiment facility, or component of an experiment that is held in a stationary position relative to the reactor by mechanical means. The restraining forces must be sufficient to overcome those to which the experiment might be subjected by hydraulic, pneumatic, buoyant or other forces that are normal for the operating environment of the experiment.

Shim Rod: A shim rod is a control rod fabricated from borated stainless steel, which is used to compensate for fuel burnup, temperature, and poison effects. A shim rod is magnetically coupled to its drive unit allowing it to perform the function of safety rod when the magnet is de-energized.

Surveillance Time Intervals

Annual - Interval not to exceed 15 months

Semi-annually - Interval not to exceed 7 1/2 months

Quarterly - Interval not to exceed 4 months

Monthly - Interval not to exceed 6 weeks

Weekly - Interval not to exceed 10 days

Daily - must be done during the calendar day

Tried Experiment: A tried experiment is (1) an experiment previously performed in this reactor or (2) an experiment for which the size, shape, composition, and location does not differ significantly enough from an experiment previously performed in this reactor to affect reactor safety.

True Value: The true value of a process variable is its actual value at any instant.

2.0 SAFETY LIMITS AND LIMITING SAFETY SYSTEM SETTINGS

Applicability

The concepts of Safety Limits and Limiting Safety System Settings as normally developed with regard to fuel element integrity are not strictly applicable for a low power system such as CAVALIER. The limitations on reactor power level due to radiation level and the need to handle irradiated fuel are far more restrictive than any limits based on fuel clad integrity. Therefore, limiting values are chosen rather conservatively at comparatively low levels according to the discussion provided in Section 2 of Chapter 3, SAR - CAVALIER.

2.1 Safety Limits

Objective

To assure that the reactor is operated in a manner consistent with maximizing safety for the operators and minimizing the chance for their exposure, or the exposure of the public, to ionizing radiation.

Specification

Maximum Reactor Power Level	100 watts
Moderator Tank Water Level	>6.25 feet from top of core

Bases

The power level values were determined by the radiation levels above the water level of the moderator tank as developed in Section 3.2 of the CAVALIER SAR. The water height of 6.25 ft would lead to a dose rate of about 60 mR/hr above the reactor tank, at a power level of 100 watts, which produces a radiation level in control room work area which is significantly less than 60 mr/hr.

2.2 Limiting Safety System Settings (LSSS)

Objective

To assure that automatic protective actions are initiated to prevent a safety limit from being exceeded.

Specification

(1) Maximum Reactor Power Level	80 watts
(2) Moderator Water Level	>7.25 feet from top of core

Bases

The reactor power value limits are slightly lower than those developed in Chapter 3, Section 2, of the CAVALIER SAR. At a power level of 80 watts with the water level at 7.25 ft above the core, radiation dose rates will be limited to <20 mr/hr above the reactor tank, and a dose rate of <1 mr/hr in the operating area and all normally accessible areas of the building. The American National Standards Institute Standard ANSI N18.9-1972 gives as a minimum requirement that the dose rates in unlimited access areas do not exceed the approved design values which are usually set at 10 to 50% of the current maximum permissible dose rate of 2.5 mrem/hr for plant personnel working a 40 hr week. The LSSS specified above will assure that the dose rates will not exceed these values.

3.0 LIMITING CONDITIONS FOR OPERATION

3.1 Power Operation

Applicability

This specification applies to the average power rating of the CAVALIER.

Objective

To assure that the reactor is operated in a manner consistent with maintenance of a low level of residual radioactivity in the fuel elements.

Specification

The Average Power Rating shall be less than 200 watt-hours/day where the averaging period shall not exceed 24 hours.

Bases

This rating will limit production of fission products to a level less than that analyzed in the Fission Product Released Section 9.4.4 of the CAVALIER SAR. This analysis indicates that the 2 hour doses at the site boundary after a very unlikely release of fission products from the fuel are within 10 CFR Part 20 averaged over a period of a year.

3.2 Reactivity

Applicability

These specifications apply to the reactivity condition of the reactor, and the reactivity worths of control rods and experiments.

Objective

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

Specifications

The following specifications apply to the reactivity conditions for reactor operation.

(1) The minimum shutdown margin provided by control rods with secured experiments in place and referred to the cold, xenon free condition with the highest worth control rod fully withdrawn, is greater than 0.4% $\Delta k/k$.

(2) Any experiment with a reactivity worth greater than 0.35% $\Delta k/k$ must be a secured experiment.

(3) The total reactivity worth of all experiments is less than 1.6% $\Delta k/k$ and the reactivity worth of a single experiment is limited to 0.5% $\Delta k/k$.

(4) The excess reactivity including experiments in the core at any time shall be less than 1.6% $\Delta k/k$.

(5) The Alternate Reactivity Insertion System is operable.

These conditions must be met at all times with the following exceptions.

(a) The reactor may be operated up to 5 watts to measure the reactivity worth of experiments and the ARIS system must be operable.

(b) The reactor may be operated up to 60 watts to calibrate control rods after a major core configuration change to determine if specifications 3.2.1 through 3.2.4 are met. The ARIS system must be operable during all operations.

Bases

The shut down margin required by Specification 3.2(1) is necessary so that the reactor can be shut down from any operating condition and that it will remain shut down without further operator action.

The reactivity limitations in Specifications 3.2 (2) and (3) are based on the guidelines given in Regulatory Guide 2.2 as developed in the CAVALIER SAR. The reactivity worth limitations of specifications 3.2 (2) for a secured experiment and 3.2 (3) for any single experiment limit reactor period to prevent exceeding the Safety Limit.

The reactivity of 1.6% $\Delta k/k$ in specification 3.2(4) corresponds to a 6.9 millisecond period. Reactor core DU-12/25 of the SPERT-I series of tests had 12 plate fuel elements containing 168 grams of U-235 substantially similar to the CAVALIER fuel elements (Reference - Thompson and Beckerly, "Technology of Nuclear Reactor Safety," Volume I, page 683 (1964). A 6.9 millisecond period was non-destructive to the SPERT reactor when shut down immediately following the excursion. See Chapter 9 of the CAVALIER SAR.

The boron addition capability of the ARIS provides additional assurance that the reactor can be shut down and maintained subcritical in the event of all four control rods failing to respond to a scram signal. See section 9.4.6 of the CAVALIER SAR.

3.3 Reactor Instrumentation

Applicability

This application applies to the instrumentation which must be operable for safe operation of the reactor.

Objective

The objective is to require that sufficient information is available to the operator to assure safe operation of the reactor.

Specification

The reactor shall not be operated unless the measuring channels described in the following table are operable and the information is displayed on the control console.

Measuring Channel	Minimum No. Operable	Operating Mode in Which Required
Startup Count Rate	2	Reactor Startup
Linear Power (Gamma-Ion Chamber)	1	All Modes
Log N and Period (CIC)	1	All Modes
Tank Top Radiation Monitor	1	All Modes
Tank Water Level	1	All Modes

Bases

The neutron detectors, and gamma monitors, provide assurance that measurements of the reactor power level are adequately covered at both low and high power ranges. The reactor tank water level indicator provides early warning of the possibility of a leak in the Moderator Tank.

The radiation monitor provides information to operating personnel of a decrease in tank water level, or of high reactor power, or of any impending or existing danger from radiation, contamination, or streaming allowing ample time to take necessary precautions to initiate safety action.

3.4 Reactor Safety System

Applicability

This specification applies to the reactor safety system channels.

Objective

The objective is to stipulate the minimum number of reactor safety system channels that must be operable in order to assure that the safety limit is not exceeded during normal operation.

Specification

The reactor shall not be operated unless the safety system channels described in the following table are operable:

Measuring Channel	Minimum No. Operable	Function	Operating Mode in Which Required to be Operable
Tank Water Level Monitor	1	Scram	All Modes
Tank Top Radiation Monitor	1	Scram	All Modes
Startup Count Rate	2	To prevent control rod withdrawal when both channels read <2 CPS	Reactor Startup
Manual Switch	1	Scram	All Modes
Reactor Power Level (CIC)	1	Scram	All Modes
Reactor Power Level (Gamma)	1	Scram	All Modes
Reactor Period (CIC)	1	Scram at less than 5 second period	All Modes
Reactor Period (Gamma)	1	Scram at less than 5 second period	All Modes

Bases

The startup interlock which requires a neutron count rate of at least 2 CPS on at least one startup count rate channel before the reactor is operated, assures that sufficient neutrons are available for proper operation of the startup channel. Power level scrams are provided to assure that the reactor power is maintained within the licensed limits. The manual scram allows the operator to shut down the reactor if an unsafe or abnormal condition arises. The period scrams are provided to assure that the power level does not increase on a period less than 5 seconds. This assures that the safety limit will not be exceeded as described in the CAVALIER SAR. One period scram specified is the power level channel using the compensated ion chamber and the other period scram utilizes a gamma sensitive chamber. Specifications on the tank water level scram are included as safety functions in the event of a serious loss of moderator tank water. Reactor operations are terminated when a major leak occurs in the tank. The analysis in Section 9.2 of the SAR for CAVALIER shows the consequences resulting from loss of this water but the area could be evacuated without difficulty before significant doses are received by personnel.

The tank-top radiation monitor provides a scram and gives warning in the event of a high radiation level in the reactor room resulting from failure of an experiment, from a significant drop in tank water level, or a higher than planned power level.

3.5 Limitations on Experiments

Applicability

This specification applies to experiments installed 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

The following limits on experiments shall be met at all times.

(1) The reactivity worths of all experiments shall be in conformance with specifications in Section 3.2.

(2) Movable experiment must be worth less than 0.1% $\Delta k/k$.

(3) Experiments worth more than 0.1% $\Delta k/k$ must be inserted or removed with the reactor shutdown except as noted in item (4).

(4) Previously tried experiments with measured worth less than 0.4% $\Delta k/k$ may be inserted or removed with the reactor 2% or more subcritical.

(5) If any experiment worth more than 0.4% $\Delta k/k$ is to be inserted in the reactor, a procedure approved by the Reactor Safety Committee shall be followed.

(6) All materials to be irradiated in the reactor shall be either corrosion resistant or encapsulated within corrosion resistant containers.

(7) Irradiation containers to be used in the reactor in which a static pressure will exist or in which a pressure buildup is predicted shall be designed and tested for a pressure exceeding the maximum expected by a factor of 2.

(8) Explosive material shall not be allowed in the reactor unless specifically approved by the Reactor Safety Committee. Experiments reviewed by the Reactor Safety Committee in which the material is potentially explosive, either while contained or if it leaks from the container, shall be designed to prevent damage to the reactor core or to the control rods or instrumentation, and to prevent any changes in reactivity.

(9) Experimental apparatus, material or equipment to be inserted in the reactor, shall not be positioned so as to cause shadowing of the nuclear instrumentation, interference with the control rods, or other perturbations that may interfere with the safe operation of the reactor.

Bases

The above specified limitations on experiments are based on the guidance given in Regulatory Guide 2.2 as developed in Section 6 of the CAVALIER

SAR and concern conservative requirements for protecting the reactor from materials to be used in experiments. The reactivity of less than 0.1% $\Delta k/k$ which can be inserted or removed with the reactor in operation in specification 3.5(2) can be compensated for by manual operation of a control rod.

3.6 Operation with Fueled Experiments

Applicability

This specification applies to the operation of the reactor with any fueled experiment.

Objective

To assure that the fission product inventory in fueled experiments are within the limits used in the safety analysis.

Specification

The reactor shall not be operated with fueled experiments unless the following conditions are satisfied.

(1) The thermal power (or fission rate) generated in the experiment is less than 1 watt ($3.2x10^{10}$ fission/second).

(2) The total exposure of the experiment is not greater than the equivalent of 6 years continuous operation at 100 watts.

Basis

In the event of the failure of a fueled experiment, with the subsequent release of fission products (100% noble gas, 50% iodine, 1% solids), the 2 -hour inhalation exposures to iodine and strontium 90 isotopes at the facility exclusion distance, 70 meters, are less than the limits set by 10 CFR Part 20, using an averaging period of 1 year.

The analysis supporting this specification assumes 100% exfiltration of fission products from the reactor building in 2 hours. The safety analysis is identical with that in Section 5.4 of the UVAR Safety Analysis Report for isotopes released to the reactor building in general (other than in the UVAR reactor room). The CAVALIER is in the same building as the UVAR. The UVAR Safety Analysis Report is on record with the Commission: UVAR-18 (October, 1970), License NO. R-66, Docket No. 50-62.

3.7 Rod Drop Times

Applicability

This specification applies to the time from the initiation of a scram to the time a rod starts to drop (release time), and to the time it takes for a rod to drop from the fully withdrawn to the fully inserted position (free drop time).

Objective

To assure that the reactor can be shut down within a specified interval of time.

Specification

The reactor shall not be operated unless:

(1) The release time for each of the shim rods is less than 100 milliseconds, and

(2) The free drop time for each of the shim rods is less than 700 milliseconds.

Bases

Rod drop times as specified are sufficiently short to be consistent with the reactor period and neutron level scram settings to assure that the safety limits will not be exceeded in a short period transient as shown in Section 9.3 of the CAVALIER-SAR.

3.8 Alternative Reactivity Insertion System (ARIS)

Applicability

This specification applies to the boron solution in the ARIS tank and to the ARIS isolation valve.

Objective

To assure that the ARIS is capable of providing an alternative means of reactor shutdown during all reactor operations.

Specification

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

(1) The volume of solution in the ARIS tank is greater than 24 gallons.

(2) The concentration of the boron is greater than 0.129 lb/gal of solution.

(3) The ARIS valve is unlocked.

Bases

The boron solution in the ARIS tank will normally be kept at a volume of 25 gal. and a concentration of 0.144 lb of boron per gallon of solution. The combination of 24 gal. with a concentration of 0.129 lb of boron per gallon of solution will yield a total negative reactivity addition of 3.2% $\Delta k/k$ when uniformly mixed with the water in the moderator tank. The requirement that the ARIS valve be unlocked will preclude unnecessary delay in the system initiation.

4.0 SURVEILLANCE REQUIREMENTS

4.1 Shim Rods

Applicability

This specification applies to the surveillance requirements for the shim rods.

Objective

To assure that the shim rods are capable of performing their function and that no significant physical degradation in the rods has occurred.

Specification

(1) Shim rod drop times shall be measured semi-annually. Shim rod drop times shall also be measured if the control assembly is moved to a new position in the core or if maintenance is performed on the mechanism.

(2) The shim rod reactivity worths shall be measured whenever the rods are installed in a new core configuration.

Bases

The reactivity worth of the shim rods is measured to assure that the required shutdown margin is available and to provide means for determining the reactivity worths of experiments inserted in the core.

4.2 Reactor Safety System

Applicability

This specification applies to the surveillance requirements for the safety system measuring channels and associated circuits of the reactor safety system.

Objective

The objective is to assure that the safety system is operable and capable of preventing the safety limits from being exceeded.

Specification

(1) A channel test 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.

(2) A channel check of each of the reactor safety channels shall be performed daily when the reactor is in operation.

(3) A channel calibration of the reactor safety channels shall be performed semi-annually.

Bases

The daily channel tests and channel checks will assure that the safety channels are operable. The semi-annual calibration will permit any long-term drift of the channels to be corrected.

4.3 Radiation Monitoring

Applicability

This specification applies to the radiation monitor required by Section 3.3 of these specifications.

Objective

The objective is to assure that the radiation monitor is operating and to verify the appropriate alarm setting.

Specification

The operation of the radiation monitor and the position of its associated alarm set point shall be verified daily during periods when the reactor is in operation. Calibration of the radiation monitoring equipment shall be performed semi-annually.

Bases

Surveillance of the monitor equipment will provide assurance that it is operable and that sufficient warning of a potential radiation hazard is available to permit corrective action before tolerances are exceeded.

4.4 Maintenance

Applicability

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

Objective

The objective is to assure that a system is operable before being used after maintenance has been performed.

Specification

Following maintenance or modification of a control or safety system component, it shall be verified that the system is operable prior to its return to service.

Bases

The intent of the specification is to assure that work on the system or component has been properly carried out and that the system or component has been properly reinstalled or reconnected.

4.5 Alternative Reactivity Insertion System (ARIS)

Applicability

This specification applies to the alternative reactivity insertion system.

Objective

To assure that the ARIS is operable and can provide sufficient reactivity to put the reactor in a subcritical condition.

Specification

(1) Prior to each day's operation the volume of solution in the ARIS tank shall be verified, and the leak detection trap will be observed for signs of leakage.

(2) The concentration of boron in the solution shall be determined semiannually or after each make-up addition to the ARIS tank.

(3) A flow test from the ARIS tank to the flanged tee will be performed annually and the results compared to similar tests run at initial startup.

(4) The section of pipe from the flanged tee to the bottom of the moderator tank will be blown out with air annually.

Bases

The daily verification and observation will provide a means of detecting leakage form the ARIS into the moderator tank which could cause unexpected reactivity fluctuations in the system. The concentration of the boron in the solution is determined periodically to assure that the ARIS is capable of providing a negative reactivity addition of 3.2% $\Delta k/k$. The flow tests and air tests will demonstrate that the ARIS valve is operable and that the pipes are free of obstructions.

5.0 DESIGN FEATURES

5.1 Reactor Fuel

Applicability

This specification applies to the fuel elements used in the reactor core.

Objective

The objective is to assure that the fuel elements used in the CAVALIER are the same as those considered in the Safety Analysis Report.

Specification

The fuel elements shall be of the materials testing reactor (MTR) type consisting of plates containing highly enriched uranium alloy fuel, clad with aluminum. There shall be 12 fuel plates containing 165 (± 3%) grams of U-235 per element or 18 fuel plates containing 195 (± 3%), grams of U-235 per element in the standard fuel elements. There shall be six fuel plates containing 82.5 (± 3%) grams of U-235, per element or nine fuel plates containing 98 (± 3%) grams of U-235, per element in the control rod fuel elements. Partially loaded fuel elements in which some of the fuel plates do not contain uranium may be used. An experimental element in which individual fuel plates can be removed or inserted may also be used. The mass of U-235 listed above refers to the initial (zero burnup) loading.

Various core configurations consisting of any combination of the above fuel elements may be used to accommodate experiments, but the loadings shall always be such that the minimum shutdown margin and excess reactivity as specified in Section 3.2 of these specifications are not exceeded.

Bases

These same type fuel elements have been run in the UVAR reactor at 2MW for many years and would create no safety problems for the CAVALIER.

5.2 Fuel Storage

Applicability

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

Objective

The objective is to assure that fuel which is being stored will not become supercritical and will not reach unsafe temperatures.

Specification

(1) All reactor fuel elements not in the reactor core shall be stored in a geometric array where k_{eff} is less than 0.9 for all conditions of moderation.

(2) Irradiated fuel elements and fueled 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 surface temperature will not exceed the boiling point of water.

Bases

Within these specifications, the fuel can be stored safely under all conditions. The UVAR storage facility was constructed to meet these specifications and will be used to store the CAVALIER elements.

6.0 ADMINISTRATIVE CONTROLS

6.1 Organization

6.1.1 Structure

The reactor facility shall be an integral part of the School of Engineering and Applied Science of the University of Virginia. The organizational structure of UVA relating to the reactor facility is shown in Figure 6.1. The Chairman, Department of Nuclear Engineering will have overall responsibility for management of the facility (Level 1).

6.1.2 Responsibility

The Reactor Facility Director shall be responsible for the overall facility operation (Level 2). During periods when the Reactor Facility Director is absent, his responsibilities are delegated to the Reactor Supervisor (Level 3).

The Reactor Facility Director shall have at least a Bachelor of Science or Engineering degree and have a minimum of 5 years of nuclear experience. A graduate degree may fulfill 4 years of experience on a one-for-one time basis.

The Reactor Supervisor shall be responsible for the day-to-day operation of the UVAR and CAVALIER and for ensuring that all operations are conducted in a safe manner and within the limits prescribed by the facility license and the provisions of the Reactor Safety Committee. During periods when the Reactor Supervisor is absent, his responsibilities are delegated to a person holding a Senior Reactor Operator license (Level 4).

The Reactor Supervisor shall have the equivalent of a Bachelor of Science or Engineering degree and have at least 2 years of experience in

Reactor Operations at this facility, or an equivalent facility, or at least 6 years of experience in Reactor Operations. Equivalent education or experience may be substituted for a degree. Within nine months after being assigned to the position, the Reactor Supervisor shall obtain and maintain an NRC Senior Operator license.

6.1.3 Staffing

When the reactor is operating the following conditions will be met:

(1) A licensed Senior Reactor Operator or a licensed Reactor Operator shall be present at the reactor controls.

(2) A licensed Senior Reactor Operator shall be on call, but not necessarily at the facility.

(3) At least one other person, not necessarily licensed to operate the reactor, shall be present at the facility.

(4) rearrangements of the core or other nonroutine actions shall be supervised by a licensed Senior Reactor Operator.

(5) A health physicist who is organizationally independent of the Reactor Facility Operations groups, as shown in Figure 6.1, shall be responsible for radiological safety at the facility.

6.2 <u>Review and Audit</u>

There shall be a Reactor Safety Committee that shall review and audit reactor operations to ensure that the facility is operated in a manner consistent with public safety and within the terms of the facility license. The Reactor Safety Committee shall report to the President of the University and advise the Chairman, Department of Nuclear Engineering, and the Reactor Facility Director on those areas of responsibility specified below.

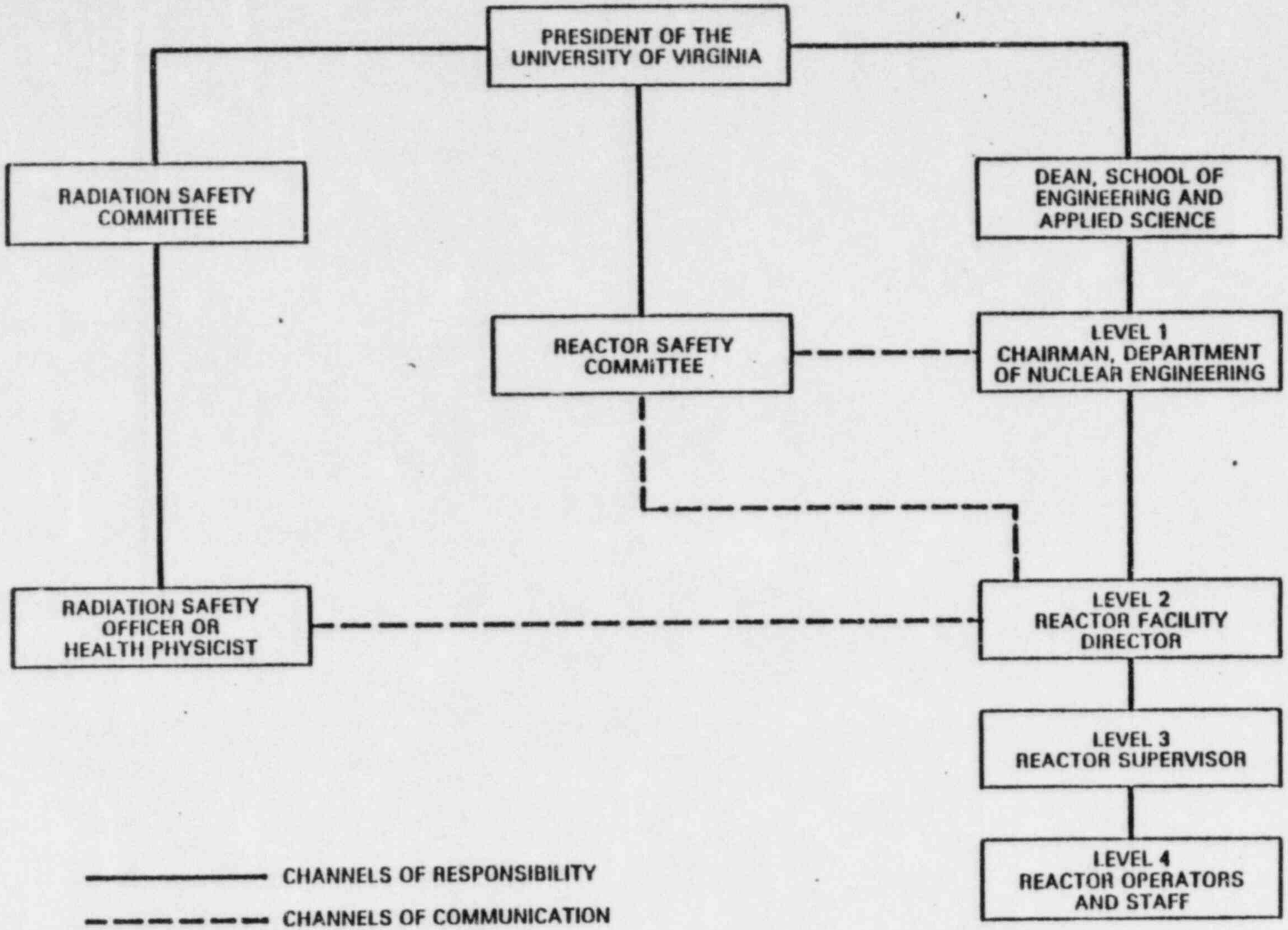

Figure 6.1 Organizational structure of UVA relating to reactor facility

6.2.1 Composition and Qualification

The Committee shall be composed of at least five members, one of whom shall be the Radiation Safety Officer of the University. No more than two members will be from the organization responsible for Reactor Operations. The membership of the Committee shall be such as to maintain a degree of technical proficiency in areas relating to reactor operation and reactor safety.

6.2.2 Charter and Rules

(1) A quorum of the Committee shall consist of not less than a majority of the full committee and shall include the Chairman or his designee.

(2) The Committee shall meet at least semiannually and shall be on call by the Chairman. Minutes of all meetings shall be disseminated to responsible personnel as designated by the Committee Chairman.

(3) The Committee shall have a written statement defining such matters as the authority of the Committee, the subjects within its purview, and other such administrative provisions as are required for effective functioning of the Committee.

6.2.3 Review Function

As a minimum the responsibilities of the Reactor Safety Committee include:

(1) review and approval of untried experiments and tests that are significantly different from those previously used or tested in the reactor, as determined by the Facility Director.

(2) review and approval of changes to the reactor core, reactor systems or design feature that may affect the safety of the reactor.

(3) review and approve all proposed amendments to the facility license, Technical Specifications, and changes to the standard operating procedures (discussed in Section 6.3 of these specifications).

(4) review reportable occurrences and the actions taken to identify and correct the cause of the occurrences.

(5) review significant operating abnormalities or deviations from normal performance of facility equipment that affect reactor safety.

(6) review reactor operation and audit the operational records for compliance with reactor procedures, Technical Specifications, and license provisions.

6.3 Operating Procedures

Written procedures, reviewed and approved by the Reactor Safety Committee shall be in effect and followed for the items listed below. These procedures shall be adequate to ensure the safe operation 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) actions to be taken to correct specific and foreseen potential malfunctions of systems or components, including responses to alarms, suspected system leaks and abnormal reactivity changes.

(4) emergency conditions involving potential or actual release of radioactivity, including provisions for evacuation, re-entry, recovery, and medical support.

(5) preventive and corrective maintenance operations that could have an effect on reactor safety.

(6) periodic surveillance (including test and calibration) of reactor instrumentation and safety systems.

Radiation control procedures shall be maintained and made available to all operations personnel.

Substantive changes to the approved procedures shall be made only with the approval of the Reactor Safety Committee. Changes that do not change the original intent of the procedures may be made with the approval of the Facility Director. All such minor changes to procedures shall be documented and subsequently reviewed by the Reactor Safety Committee.

6.4 Required Actions

6.4.1 Action To Be Taken in the Event a Safety Limit is Exceeded

In the event a safety limit is violated, the following actions shall be taken;

(1) The reactor shall be shut down and reactor operations shall not be resumed until authorized by the Commission.

(2) The occurrence shall be reported to the Reactor Facility Director and the Chairman of the Reactor Safety Committee, or their designee, as soon as possible, but not later than the next work day. Reports shall be made to the Commission in accordance with Section 6.6 of these specifications.

(3) A written safety limit violation report shall be made that shall include an analysis of the causes of the violation and extent of resulting damage to facility components, systems, or structures; corrective actions taken; and recommendations for measures to preclude reoccurrence. This report shall be submitted to the Reactor Safety Committee for review.

6.4.2 Action To Be Taken in the Event of a Reportable Occurrence

A reportable occurrence is any of the following conditions:

(1) any safety system setting less conservative than specified in Section 2.2 of these specifications.

(2) operating in violation of an LCO established in these specifications, unless prompt remedial action is taken.

(3) safety system component malfunctions or other component or system malfunctions during reactor operation that could, or threaten to, render the safety system incapable of performing its intended safety function, unless immediate shutdown of the reactor is initiated.

(4) an uncontrolled or unanticipated increase in reactivity in excess of 0.5% $\Delta k/k$.

(5) an observed inadequacy in the implementation of either administrative or procedural controls, such that the inadequacy could have caused the existence or development of an unsafe condition in connection with the operation of the reactor.

(6) abnormal and significant degradation in reactor fuel, and/or cladding, coolant boundary, or containment boundary (excluding minor leaks) where applicable that could result in exceeding prescribed radiation-exposure limits of personnel and/or environment.

In the event of a reportable occurrence, the following action shall be taken:

(1) The Director of the Reactor Facility shall be notified as soon as possible and corrective action shall be taken before resuming the operation involved.

(2) A written report of the occurrence shall be made which shall include an analysis of the cause of the occurrence, the corrective action taken, and recommendations for measures to preclude or reduce the

probability of reoccurrence. This report shall be submitted to the Director and the Reactor Safety Committee for review.

(3) A report shall be submitted to the Nuclear Regulatory Commission in accordance with Section 6.6 of these specifications.

6.5 Plant Operating Records In addition to the requirements of applicable regulations, records (or logs) of the items listed below shall be kept in a manner convenient for review and shall be retained as indicated.

6.5.1 Records To Be Retained for a Period of at Least Five Years

(1) normal plant operation

(2) principal maintenance activities

(3) experiments performed with the reactor

(4) reportable occurrences

(5) equipment and component surveillance activity

(6) facility radiation and contamination surveys

(7) transfer of radioactive material

(8) changes to operating procedures

6.5.2 Records To Be Retained for the Life of the Facility

(1) gaseous and liquid radioactive effluents released to the environs

(2) offsite environmental monitoring surveys

(3) fuel inventories and transfers

(4) radiation exposures for all personnel

(5) changes to reactor systems, components, or equipment that may affect reactor safety

(6) updated and corrected drawings of the facility

(7) minutes of Reactor Safety Committee meetings

6.6 Reporting Requirements

In addition to the requirements of applicable regulations, reports should be made to the U.S. Nuclear Regulatory Commission as follows:

6.6.1 Special Reports

(1) A report as soon as possible, but no later than the next working day, to the NRC Region II, Office of Inspection and Enforcement of

(a) any accidental offsite release of radioactivity above permissible limits, whether or not the release resulted n property damage, personal injury, or exposure

(b) Any reportable occurrences as defined in Section 6.4.2 of these specifications

(c) any violation of a safety limit

(2) A report within 14 days in writing to the Director, Division of Reactor Licensing, US NRC, Washington, D.C. 20555 with a copy to the NRC Region II, Office of Inspection and Enforcement of

(a) any accidental offsite release of radioactivity above permissible limits, whether or not the release resulted in property damage, personal injury, or exposure

(b) any reportable occurrence as defined in Section 6.4.2 of these specifications

(c) any violation of a safety limit

(3) A report within 30 days in writing to the Director, Division of Reactor Licensing, US NRC, Washington, D.C. 20555, with a copy to the Commission Region II, Office of Inspection and Enforcement of

(a) any substantial variance from performance specifications contained in these specifications or in the SAR

(b) any significant change in the transient or accident analyses as described in the SAR

(c) changes in personnel serving as Chairman of the Department of Nuclear Engineering, Reactor Facility Director, or Reactor Supervisor

(4) A report within nine months after initial criticality of the reactor or within 90 days of completion of the startup test programs, whichever is earlier, to the Director, Division of Reactor Licensing, US NRC, Washington, D.C. 20555 upon receipt of a new facility license, an amendment to the license authorizing an increase in power level or the installation of a new core of a different design than previously used. The report will include the measured values of the operating conditions or characteristics of the reactor under the new conditions, including

(a) total control rod reactivity worth

(b) reactivity worth of the single control rod of highest reactivity worth

(c) minimum shutdown margin both at ambient and operating temperatures

6.6.2 Routine Reports

A routine report will be made by March 31 of each year to the Director, Division of Reactor Licensing, US NRC, Washington, D.C. 20555, with a copy to the Commission Region II Office of Inspection and Enforcement, providing the following information:

(1) A narrative summary will be prepared of operating experience (including experiments performed) and of changes in facility design, performance characteristics, and operating procedures related to the reactor safety occurring during the reporting period.

(2) A tabulation will be prepared showing the energy generated by the reactor (in watt hours) and the number of hours the reactor was critical each quarter during the year.

(3) A report will be made of the results of the safety-related maintenance and inspections. The reasons for corrective maintenance of safety-related items will be included.

(4) A report shall be prepared of the number of emergency shutdowns and inadvertent scrams, including their reasons and the corrective actions taken.

(5) A summary will be prepared to changes to the facility or procedures, which affect reactor safety, and performance of tests or experiments carried out under the conditions of Section 50.59 of 10 CFR 50.

(6) A summary will be prepared of the nature and amount of radioactive gaseous, liquid and solid effluents released or dischanged to the environs beyond the effective control of the licensee as measured or calculated at or prior to the point of such release or discharge.

(7) A report will be prepared with a description of any environmental surveys performed outside the facility.

(8) A summary will be prepared of radiation exposures received by facility personnel and visitors, including the dates and time of significant exposures (greater than 500 mrem for adults and 50 mrem for persons under 18 years of age) and a summary of the results of radiation and contamination surveys performed within the facility.

OPERATOR REQUALIFICATION PROGRAM

FOR THE UNIVERSITY OF VIRGINIA REACTOR FACILITY

A. General

1. This requalification program applies to licensed individuals of both the University of Virginia Research Reactor (UVAR) and the low power training reactor (CAVALIER), located at the Reactor Facility of the University of Virginia.

2. The operations manager of the reactor facility shall be responsible for administering the re-qualification program.

B. Program

1. Each licensed individual will be required to complete all check lists and perform a start-up of the reactor at least once every three months and at least 10 times during the period of his license. All individuals who are licensed for both the UVAR and the CAVALIER will be required to complete at least five start-ups on each facility during the period of his license. If a licensed individual fails to perform these functions for a period of four months or longer he will be removed from licensing activities and be required to take either a written or oral examination similar in scope to the N.R.C. exam and an operating test under the direction of a qualified Senior Operator before being reinstated as a qualified licensed operator. A grade of 70% or greater will be considered passing. The results of these exams shall be documented.

2. Each licensed individual will be required to attend a series of lectures at least once each year. The lectures will cover various aspects of the reactor operation including theory and principles of operation, plant operating characteristics, plant instrumentation and control systems,

plant protection systems, safety systems, normal, abnormal and emergency operating procedures, radiation control and safety , and technical specifications.

Once a year a written exam will be given to each licensed individual to determine his continuing knowledge of the facilities operations. If the results of these exams disclose deficiencies in certain areas, additional lectures may be given to cover the subject in more detail. A grade of 70% or better will be considered passing. The individual administering and grading these exams will be exempt from taking the exam.

3. Standard operating procedures and abnormal emergency procedures will be reviewed annually with licensed individuals as part of a lecture series.

All licensed individuals will be informed of system changes or procedural changes by a memo issued by the operations manager. An up-to-date copy of the standard operating procedures will be kept in the control room of each reactor at all times.

4. A personal file shall be kept on each licensed individual. The file shall contain records on check-lists and start-ups performed by the individual, his attendance at lectures and the content and results of written exams.

The operations manager will make periodic independent evaluations of each individual by observing the completion of check lists and start-ups and control manipulations by each operator. Comments on these observations will be noted in the individual's file. If an operator is found to be deficient in some area of operation this will be documented and the appropriate action taken to correct the deficiency will be noted.

PROCEDURES FOR IMPLEMENTING

THE REQUALIFICATION PROGRAM FOR

OPERATORS AND SENIOR OPERATORS LICENSED

ON THE UVAR AND CAVALIER REACTORS

To comply with 10 CFR Part 55 Appendix A, the following program will be inacted and maintained to insure that the operators and senior operators sustain an adequate knowledge and performance levels sufficient to operate the UVAR and CAVALIER reactors in a safe manner.

The program will cycle on a yearly schedule, running from 1 July to 30 June, with the yearly program terminating with the requalification examination.

I. Lectures and Drills

The reactor operator and senior operator will attend a series of lectures covering the following topics:

a) Normal Operating Procedures

b) Abnormal and Emergency Procedures

c) Technical Specification

d) Plant Instrumentation

e) Reactor Protective and Safety System

f) Radiation Control and Safety

g) Reactor Theory and Plant Operating Characteristics

h) Any Changes to Procedures or Equipment

If a lecture is missed, a make-up written or oral examination will be given and noted. The written examinations will be kept for the qualification period.

Drills will be conducted during the requalification period to insure that the operators and senior operators are familiar with the procedures necessary to prevent the endangerment of the personn in the reactor building and aid an injured and/or contaminated perso or persons. The drills to be held are:

a) Evacuation - once in fall and spring semester.

b) Injured and/or contaminated person - once a year.

II. Evaluation of Performance

An annual evaluation will be made of each operator or senior operator while he or she performs a daily checklist and a reactor startup. The evaluation will be made by a senior operator or the operations manager and will be based on compliance with written procedures and good engineering practices. If an operator or senior operator is licensed on both the UVAR and CAVALIER reactors, he or she need only to be evaluated on one of the reactors. Any deficiencies in the operator or senior operator performances will be noted and appropriate corrective action will be taken and noted. As a part of the evaluation, the operator or senior operator will discuss with the evaluator or simulate on the console, the procedures to be taken for emergency and/or abnormal conditions.

III. Requalification Examination

The reactor operator examination will consist of a seven part test covering the following:

a) Principles of Reactor Operation

b) Feature of Facility Design

c) General Operating Characteristics

d) Instrumentation

e) Safety System

f) Operating Procedures

g) Health Physics

The senior operator examination will consist of the same areas listed for the operators test plus an additional section covering administrative controls.

Each question of each section on the examination will be rated as to its total worth and the operator or senior operator must pass each section of the test with a grade of 70% or better. A 70% overall grade will be considered passing.

If an operator or senior operator receives less than 70% on one or more areas but pass the test overall, he or she will re-study the area(s) and will demonstrate his or her knowledge by taking a make-up written examination. If an operator or senior operator scores less than 70% overall on the examination, he or she will retake the entire examination after a period of reviewing the material covered in the requalification lectures.

The individual administering the examination will be exempt from taking it.