TECHNICAL SPECIFICATIONS FOR THE
NUCLEAR SCIENCE CENTER REACTOR
FACILITY LICENSE NO. R-83

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TECHNICAL SPECIFICATIONS FOR THE
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Included in this document are the Technical Specifications and the "Bases" for the Technical Specifications. These bases, which provide the technical support for the individual technical specifications, are included for information purposes only. They are not part of the Technical Specifications, and they do not constitute limitations or requirements to which the licensee must adhere.

1.0 DEFINITIONS

1.1 ABNORMAL OCCURRENCE

An "Abnormal Occurrence" is defined for the purposes of the reporting requirements of Section 208 of the Energy Reorganization Act of 1974 (P.L. 93-438) as an unscheduled incident or event which the Nuclear Regulatory Commission determines is significant from the standpoint of public health or safety.

1.2 ALARA

The ALARA program (As Low As Reasonably Achievable) is a program for maintaining occupational exposures to radiation and release of radioactive effluents to the environs as low as reasonably achievable.

1.3 CHANNEL CALIBRATION

A channel calibration consists of comparing a measured value from the measuring channel with a corresponding known value of the parameter so that the measuring channel output can be adjusted to respond with acceptable accuracy to known values of the measured variable.

1.4 CHANNEL CHECK

A channel check is a qualitative verification of acceptable performance by observation of channel behavior.

1.5 CHANNEL TEST

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

1.6 COLD CRITICAL

The reactor is in the cold critical condition when it is critical with the fuel and bulk water temperatures both below 104°F (40°C).

1.7 CORE LATTICE POSITION

The core lattice position is that region in the core (approximately 3" x 3") over a grid plug hole. It may be occupied by a fuel bundle, an experiment, or a reflector element.

1.8 EXPERIMENT

Experiment shall mean (a) any apparatus, device, or material which is not a normal part of the core or experimental facilities, but which is inserted in these facilities or is in line with a beam of radiation originating from the reactor core; or (b) any operation designed to measure reactor parameters or characteristics.

1.9 EXPERIMENTAL FACILITIES

Experimental facilities shall mean beam ports, including extension tubes with shields, thermal columns with shields, vertical tubes, through tubes, in-core irradiation baskets, irradiation cell, pneumatic transfer systems and in-pool irradiation facilities.

1.10 EXPERIMENT SAFETY SYSTEMS

Experiment safety systems are those systems, including their associated input circuits, which are designed to initiate a scram for the primary purpose of protecting an experiment or to provide information which requires manual protective action to be initiated.

1.11 FLIP CORE

A FLIP core is an arrangement of TRIGA-FLIP fuel in the reactor grid plate.

1.12 FUEL BUNDLE

A fuel bundle is a cluster of three or four fuel or non-fueled elements secured in a square array by a top handle and a bottom grid plate adaptor. Non-fuel elements shall be fabricated from stainless steel, aluminum, or graphite materials.

1.13 FUEL ELEMENT

A fuel element is a single TRIGA fuel rod of either standard or FLIP type.

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1.14 INSTRUMENTED ELEMENT

An instrumented element is a special fuel element in which a sheathed chromel-alumel or equivalent thermocouple is embedded in the fuel near the horizontal center plane of the fuel element at a point approximately 0.3 inch from the center of the fuel body.

1.15 LIMITING SAFETY SYSTEM SETTING

Limiting safety system setting is setting for automatic protective devices related to those variables having significant safety functions.

1.16 MEASURING CHANNEL

A measuring channel is the combination of sensor, interconnecting cables or lines, amplifiers, and output device which are connected for the purpose of measuring the value of a variable.

1.17 MEASURED VALUE

The measured value is the magnitude of that variable as it appears on the output of a measuring channel.

1.18 MIXED CORE

A mixed core is an arrangement of standard TRIGA fuel elements with at least 35 TRIGA-FLIP fuel elements located in a central region of the core.

1.19 OPERABLE

A system, device, or component shall be considered operable when it is capable of performing its intended functions in a normal manner.

1.20 OPERATIONAL CORE

An operational core may be a standard core, mixed core, or FLIP core for which the core parameters of shutdown margin, fuel temperature, power calibration, and maximum allowable reactivity insertion have been determined to satisfy the requirements of the Technical Specifications.

1.21 PULSE MODE

Pulse mode operation shall mean any operation of the reactor with the mode selector switch in the pulse position.

1.22 REACTOR OPERATION

Reactor operation is any condition wherein the reactor is not secured.

1.23 REACTOR SAFETY SYSTEMS

Reactor safety systems are those systems, including their associated input circuits, which are designed to initiate a reactor scram for the primary purpose of protecting the reactor or to provide information which requires manual protective action to be initiated.

1.24 REACTOR SECURED

The reactor is secured when all the following conditions are satisfied:

a. The reactor is shut down,

b. The console key switch is in the "off" position and the key is removed from the console and under the control of a licensed operator or stored in a locked storage area, and

c. No work is in progress involving in-core fuel handling or refueling operations, maintenance of the reactor or its control mechanisms, or insertion or withdrawal of in-core experiments.

1.25 REACTOR SHUTDOWN

The reactor is shut down when the reactor is subcritical by at least one dollar of reactivity.

1.26 REGULATING ROD

The regulating rod is a low worth control rod that need not have scram capability and may have a fueled follower. Its position may be varied manually or by the servo-controller.

1.27 REPORTABLE OCCURRENCE

A reportable occurrence is any of the following which occurs during reactor operation:

a. Operation with any safety system setting less conservative than specified in Section 2.2, Limiting Safety System Settings:

b. Operation in violation of a Limiting Condition for Operation;

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c. Failure of a required reactor or experiment safety system component which could render the system incapable of performing its intended safety function;

d. Any unanticipated or uncontrolled change in reactivity greater than one dollar;

e. An observed inadequacy in the implementation of either administrative or procedural controls, such that the inadequacy could have caused the existence or development of a condition which could result in operation of the reactor outside the specified safety limits; and

f. Release of fission products from a fuel element.

1.28 SAFETY CHANNEL

A safety channel is a measuring channel in the reactor safety system.

1.29 SAFETY LIMIT

Safety limits are limits on important process variables which are found to be necessary to reasonably protect the integrity of certain physical barriers which guard against the uncontrolled release of radioactivity.

1.30 SHIM-SAFETY ROD

A shim-safety rod is a control rod having an electric motor drive and scram capabilities. It may have a fueled follower section.

1.31 SHUTDOWN MARGIN

Shutdown margin shall mean the minimum shutdown reactivity necessary to provide confidence that the reactor can be made subcritical by means of the control and safety systems, starting from any permissible operating conditions and that the reactor will remain subcritical without further operator action.

1.32 STANDARD CORE

A standard core is an arrangement of standard TRIGA fuel in the reactor grid plate.

1.33 STEADY STATE MODE

Steady state mode operation shall mean operation of the reactor with the mode selector switch in the steady state position.

1.34 TRANSIENT ROD

The transient rod is a control rod with scram capabilities that can be rapidly ejected from the reactor core to produce a pulse. It may have a voided follower.

2.0 SAFETY LIMIT AND LIMITING SAFETY SYSTEM SETTING

2.1 SAFETY LIMIT-FUEL ELEMENT TEMPERATURE

Applicability

This specification applies to the temperature of the reactor fuel.

Objective

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

Specifications

a. The temperature in a TRIGA-FLIP fuel element shall not exceed 2100°F (1150°C) under any conditions of operation.

b. The temperature in a standard TRIGA fuel element shall not exceed 1830°F (1000°C) under any conditions of operation.

Bases

The important parameter for a TRIGA reactor is the fuel element temperature. This parameter is well suited as a single specification especially since it can be measured. A loss in the integrity of the fuel element cladding could arise from a build-up of excessive pressure between the fuel-moderator and the cladding if the fuel temperature exceeds the safety limit. The pressure is caused by the presence of air, fission product gases, and hydrogen from the dissociation of the hydrogen and zirconium in the fuel-moderator. The magnitude of this pressure is determined by the fuel-moderator temperature and the ratio of hydrogen to zirconium in the alloy.

The safety limit for the TRIGA-FLIP fuel element is based on data which indicate that the stress in the cladding due to the hydrogen pressure from the dissociation of zirconium hydride will remain below the ultimate stress provided the temperature of the fuel does not exceed 2100°F (1150°C) and the fuel cladding is water cooled.

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The safety limit for the standard TRIGA fuel is based on data, including the large mass of experimental evidence obtained during high performance reactor tests on this fuel. These data indicate that the stress in the cladding due to hydrogen pressure from the dissociation of zirconium hydride will remain below the ultimate stress provided that the temperature of the fuel does not exceed 1830°F (1000°C) and the fuel cladding is water cooled.

2.2 LIMITING SAFETY SYSTEM SETTING

Applicability

This specification applies to the scram setting which prevents the safety limit from being reached.

Objective

The objective is to prevent the safety limits from being reached.

Specification

The limiting safety system setting shall be 525°C (975°F) as measured in an instrumented fuel element. The instrumented element shall be located adjacent to the central bundle with the exception of the corner positions.

Basis

The limiting safety system setting is a temperature which, if exceeded, shall cause a reactor scram to be initiated preventing the safety limit from being exceeded. A setting of 525°C provides a margin of 625°C for FLIP type fuel elements and a margin of 475°C for standard TRIGA fuel elements. A part of this margin is used to account for the difference between the maximum and measured temperatures resulting from the actual location of the thermocouple. If the thermocouple element were located in the hottest position in the core, the difference between the true and measured temperatures would be only a few degrees since the thermocouple junction is at the mid-plane of the element and close to the anticipated hot spot. However, this position is normally not available due to the location of the transient rod. The location of the instrumented element is therefore restricted to the positions closest to the central element. Calculations indicate that, for this case, the true temperature at the hottest location in the core will differ from the measured temperature by no more than 40%. Thus, when the temperature in the thermocouple element reached the trip setting of 525°C, the true temperat re at the hottest location in a standard core would be no greater than 632°C and 690°C in a mixed core, providing a safety margin of at least 368°C for standard fuel elements and 460°C for FLIP type elements. These margins are ample to account

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for the remaining uncertainty in the accuracy of the fuel temperature measurement channel and any overshoot in reactor power resulting from a reactor transient during steady state mode operation.

In the pulse mode of operation, the same limiting safety system setting will apply. However, the temperature channel will have no effect on limiting the peak powers generated because of its relatively long time constant (seconds) as compared with the width of the pulse (milliseconds). In this mode, however, the temperature trip will act to reduce the amount of energy generated in the entire pulse transient by cutting the "tail" of the energy transient in the event the pulse rod remains stuck in the fully withdrawn position.

3.0 LIMITING CONDITIONS FOR OPERATION

3.1 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 will not be exceeded during steady state operation.

Specifications

The reactor power level shall not exceed 1.3 megawatts under any condition of operation. The normal steady state operating power level of the reactor shall be 1.0 megawatts. However, for purposes of testing and calibration, the reactor may be operated at higher power levels not to exceed 1.3 megawatts during the testing period.

Bases

Thermal and hydraulic calculations indicate that TRIGA fuel may be safely operated up to power levels of at least 2.0 megawatts with natural convection cooling.

3.2 REACTIVITY LIMITATIONS

Applicability

These specifications apply to the reactivity condition of the reactor and the reactivity worths of control rods and experiments. They apply for all modes of operation.

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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 will not be exceeded.

Specifications

The reactor shall not be operated unless the shutdown margin provided by control rods is greater than 0.25 dollar with:

a. the highest worth non-secured experiment in its most reactive state,

b. the highest control rod and the regulating rod (if not scrammable) fully withdrawn, and

c. the reactor in the cold condition without xenon.

Bases

The value of the shutdown margin assures that the reactor can be shut down from any operating condition even if the highest worth control rod should remain in the fully withdrawn position. If the regulating rod is not scrammable, its worth is not used in determining the shutdown reactivity.

3.3 PULSE MODE OPERATION

Applicability

This specification applies to the energy generated in the reactor as a result of a pulse insertion of reactivity.

Objective

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

Specification

The reactivity to be inserted for pulse operation shall not exceed $2.35. In the pulse mode the pulse rod will be limited by a mechanical block so that the reactivity insertion will not inadvertently exceed the value indicated.

Basis

Measurements performed on a 98 element core containing 35 FLIP elements indicated that a pulse insertion of reactivity of $2.00 results in a maximum temperature rise of approximately 300°C. A linear extrapolation, which is conservative due to heat transfer considerations and the variable heat capacity of the fuel, predicts

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that for a maximum temperature of 950°C in FLIP fuel the allowable insertion would be $2.93. Calculations indicate that this limit is reduced to $2.82 for a full FLIP core. Correcting for the changes in neutron lifetime and the temperature coefficient due to burnup results in an allowable insertion which decreases with core utilization. Calculations indicate that the allowable pulse insertion decreases to $2.48 after 8.2 Mw-yrs of operation. A maximum allowable insertion of $2.35 is well below this value for the effective lifetime of the core. The safety margin exceeds 200°C in FLIP fuel for $2.35 of pulse insertion and is considerably greater than this for standard fuel. These margins allow amply for uncertainties due to the accuracy of the measurement of extrapolation of the measured data.

3.4 CORE CONFIGURATION LIMITATION

Applicability

This specification applies to mixed cores of FLIP and standard types of fuel and to full FLIP cores.

Objective

The objective is to assure that the fuel temperature safety limit will not be exceeded due to power peaking effects in mixed cores and FLIP cores.

Specifications

a. The TRIGA core assembly may be standard, FLIP, or a combination thereof (mixed core) provided that any FLIP fuel be comprised of at least thirty-five (35) fuel elements, located in a contiguous, central region.

b. The reactor shall not be taken critical with a core lattice position vacant except for positions on the periphery of the core assembly. Water holes in the inner fuel region shall be limited to single rod positions. Vacant core positions shall contain experiments or an experimental facility to prevent accidental fuel additions to the reactor core.

c. The instrumented element shall be located adjacent to the central bundle with the exception of the corner positions (Reference: 2.2 Limiting Safety System Setting).

Bases

a. In mixed cores, it is necessary to specify the minimum number of FLIP elements and arrange them in a contiguous, central region of the core to control flux peaking and power generation values in individual elements.

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b. Vacant core positions containing experiments or an experimental facility will prevent accidental fuel additions to the reactor core. They will be permitted only on the periphery of the core or a single rod position to prevent power peaking in regions of high power density.

c. Reference: 2.2 Limiting Safety System Setting

3.5 CONTROL AND SAFETY SYSTEM

3.5.1 Scram Time

Applicability

This specification applies to the time required for the scrammable control rods to be fully inserted from the instant that a safety channel variable reaches the Safety System Setting.

Objective

The objective is to achieve prompt shutdown of the reactor to prevent fuel damage.

Specification

The scram time measured from the instant a simulated signal reaches the value of the LSSS to the instant [illegible]t the slowest scrammable control rod reaches its fully insert[illegible]osition shall not exceed 2 seconds.

Basis

This specification assures that the reactor will be promptly shut down when a scram signal is initiated. Experience and analysis have indicated that for the range of transients anticipated for a TRIGA reactor, the specified scram time is adequate to assure the safety of the reactor.

3.5.2 Reactor Control System

Applicability

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

Objective

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

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Specification

The reactor shall not be operated unless the measuring channels listed in the following table are operable.

Measuring Channel	Min. No. Operable	Effective Mode	
		S.S.	Pulse
Fuel Element Temperature	1	X	X
Linear Power Level	1	X	
Log Power Level	1	X	
Integrated Pulse Power	1		X

Bases

Fuel temperature displayed at the control console gives continuous information on this parameter which has a specified safety limit. The power level monitors assure that the reactor power level is adequately monitored for both steady state and pulsing modes of operation. The specifications on reactor power level indication are included in this section since the power level is related to the fuel temperature.

3.5.3 Reactor Safety System

Applicability

This specification applies to the reactor safety system channels.

Objective

The objective is to specify the minimum number of reactor safety system channels that must be operable for safe operation.

Specification

The reactor shall not be operated unless the safety channels described in Table 1 are operable.

Bases

The fuel temperature and power level scrams provide protection to assure that the reactor can be shut down before the safety limit on the fuel element temperature will be exceeded. The manual scram allows the operator to shut down the system if an unsafe or abnormal condition occurs. In the event of failure of the power supply for the safety chambers, operation of the reactor without adequate instrumentation is prevented. The preset timer insures that the reactor power level will reduce to a low level after pulsing.

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TABLE 1

Minimum Reactor Safety Channels

Safety Channel	Number Operable	Function	Effective Mode	
			S.S.	Pulse
Fuel Element Temperature	1	SCRAM @ LSSS	X	X
Hi Power Level	2	SCRAM @ 125%	X	
Console Scram Button	1	SCRAM	X	X
Hi Power Level Detector Power Supply	1	SCRAM on loss of supply voltage	X	
Preset Timer	1	Transient rod scram 15 seconds or less after pulse		X
Log Power	1	Prevent withdrawal of shim-safeties at $<4 \times 10^{-3}$ watts	X	
Log Power	1	Prevent pulsing above 1 kW		X
Transient Rod Position	1	Prevent application of air unless fully inserted	X	
Shim-safeties & Regulating Rod Position	1	Prevent withdrawal		X
Pool Level	1	Alarm at 90% normal operating level	X	X

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The interlock to prevent startup of the reactor at power levels less than 4×10^{-3} watts which corresponds to approximately 2 cps assures that sufficient neutrons are available for proper startup.

The interlock to prevent the initiation of a pulse above 1 kW is to assure that the magnitude of the pulse will not cause the fuel element temperature safety limits to be exceeded. The interlock to prevent application of air to the transient rod unless the cylinder is fully inserted is to prevent pulsing the reactor in the steady state mode. The interlock to prevent withdrawal of the shim-safeties or regulating rod in the pulse mode is to prevent the reactor from being pulsed while on a positive period. The pool level alarm is intended to alert the operator of any significant decrease in the pool level.

3.6 RADIATION MONITORING SYSTEM

Applicability

This specification applies to the radiation monitoring information which must be available to the reactor operator during reactor operation.

Objective

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

Specification

The reactor shall not be operated unless the radiation monitoring channels listed in the following table are operable.

Radiation Monitoring Channels*	Function	Number
Area Radiation Monitor	Monitor radiation levels in the facility	1
Continuous Air Radiation Monitor	"	1
Exhaust Gas Radiation Monitor	Monitor radiation levels in the exhaust air stack	1
Exhaust Particulate Radiation Monitor	"	1

* For periods of time for maintenance to the radiation monitoring channels, the intent of this specification will be satisfied if they are replaced with portable gamma sensitive instruments having their own alarms or which shall be kept under visual observation.

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Bases

The radiation monitors provide information to operating personnel of any impending or existing danger from radiation so that there will be sufficient time to evacuate the facility and take the necessary steps to prevent the spread of radioactivity to the surroundings.

3.7 ARGON-41 DISCHARGE LIMIT

Applicability

This specification applies to the concentration of Argon-41 that may be discharged from the TRIGA reactor facility.

Objective

To insure that the health and safety of the public is not endangered by the discharge of Argon-41 from the TRIGA reactor facility.

Specification

The concentration of Argon-41 in the effluent gas from the facility as diluted by atmospheric air in the lee of the facility due to the turbulent wake effect shall not exceed 4.8×10^{-8} μci/ml averaged over one year.

Bases

The maximum allowable concentration of Argon-41 in air in unrestricted areas as specified in Appendix B, Table II of 10 CFR 20 is 4.0×10^{-8} μci/ml. Section IX of the S.A.R. for the NSCR substantiates a 5.0×10^{-3} atmospheric dilution factor for a 2.0 mph wind speed. This dilution factor represents the conditions at the site building for a wind speed of 2 mph which occurs less than 10% of the time on an annual basis.

3.8 ENGINEERED SAFETY FEATURE - VENTILATION SYSTEM

Applicability

This specification applies to the operation of the facility ventilation system.

Objective

The objective is to assure that the ventilation system is in operation to mitigate the consequences of the possible release of radioactive materials resulting from reactor operation.

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Specification

The reactor shall not be operated unless the facility ventilation system is operable except for periods of time necessary to permit repair of the system. In the event of a substantial release of airborne radioactivity, the ventilation system will be secured automatically by signals from an exhaust air radiation monitor.

Bases

During normal operation of the ventilation system, the concentration of Argon-41 in unrestricted areas is below MPC (SAR, Section IX). In the event of a substantial release of airborne radioactivity, the ventilation system will be secured automatically. Therefore, operation of the reactor with the ventilation system shut down for short periods of time to make repairs insures the same degree of control of release of radioactive materials. Moreover, radiation monitors within the building independent of those in the ventilation system will give warning of high levels of radiation that might occur during operation with the ventilation system secured.

3.9 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 reactor shall not be operated unless the following conditions governing experiments exist.

a. Non-secured experiments shall have reactivity worths less than 1 dollar.

b. The reactivity worth of any single experiment shall be less than 2 dollars.

c. Explosive materials in quantities greater than 5 pounds shall not be allowed within the reactor building. Irradiation of explosive materials shall be restricted as follows:

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(1) Explosive materials in quantities greater than 25 milligrams shall not be irradiated in the reactor pool. Explosive materials in quantities less than 25 milligrams may be irradiated provided the pressure produced upon detonation of the explosive has been calculated and/or experimentally demonstrated to be less than the design pressure of the container.

(2) Explosive materials in quantities greater than 25 milligrams shall be restricted from the upper research level, demineralizer room, cooling equipment room and the interior of the pool containment structure.

(3) Explosive materials in quantities greater than 5 pounds shall not be irradiated in experimental facilities.

(4) Cumulative exposures for explosive materials in quantities greater than 25 milligrams shall not exceed 10^{12} n/cm^2 for neutrons or 25 roentgen for gamma exposures.

d. Experiment materials, except fuel materials, which could off-gas, sublime, volatilize, or produce aerosols under (1) normal operating conditions of the experiment or reactor, (2) credible accident conditions in the reactor, or (3) possible accident conditions in the experiment shall be limited in activity such that if 100% of the gaseous activity or radioactive aerosols produced escaped to the reactor room or the atmosphere, the airborne concentration of radioactivity averaged over a year would not exceed the limit of Appendix B of 10 CFR Part 20.

e. In calculations pursuant to d. above, the following assumptions shall be used:

(1) If the effluent from an experimental facility exhausts through a holdup tank which closes automatically on high radiation level, at least 10% of the gaseous activity or aerosols produced will escape.

(2) If the effluent from an experimental facility exhausts through a filter installation designed for greater than 99% efficiency for 0.3 micron particles, at least 10% of these vapors can escape.

(3) For materials whose boiling point is above 130°F and where vapors formed by boiling this material can escape only through an undisturbed column of water above the core, at least 10% of these vapors can escape.

f. Each fueled experiment shall be controlled such that the total inventory of iodine isotopes 131 through 135 in the experiment is no greater than 1.5 curies.

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g. If a capsule fails and releases material which could damage the reactor fuel or structure by corrosion or other means, removal and physical inspection shall be performed to determine the consequences and need for corrective action. The results of the inspection and any corrective action taken shall be reviewed by the Director or his designated alternate and determined to be satisfactory before operation of the reactor is resumed.

Bases

a. This specification is intended to provide assurance that the worth of a single unfastened experiment will be limited to a value such that the safety limit will not be exceeded if the positive worth of the experiment were to be suddenly inserted

b. The maximum worth of a single experiment is limited so that its removal from the cold critical reactor will not result in the reactor achieving a power level high enough to exceed the core temperature safety limit. Since experiments of such worth must be fastened in place, its removal from the reactor operating at full power would result in a relatively slow power increase such that the reactor protective systems would act to prevent high power levels from being attained

c. This specification is intended to prevent damage to the reactor or reactor safety systems resulting from failure of an experiment involving explosive materials.

   1. This specification is intended to prevent damage to the reactor core and safety related reactor components located within the reactor pool in the event of failure of an experiment involving the irradiation of explosive materials. Limited quantities of less than 25 milligrams and proper containment of such experiment provide the required safety for in pool irradiation.

   2. This specification is intended to prevent damage to vital equipment by restricting the quantity and location of explosive materials within the reactor building. Explosives in quantities exceeding 25 milligrams are restricted from areas containing the reactor bridge, reactor console, pool water coolant and purification systems and reactor safety related equipment.

   3. The failure of an experiment involving the irradiation of up to 5 lbs of explosive material in an experimental facility located external to the reactor pool structure will not result in damage to the reactor or the reactor pool containment structure.

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4. This specification is intended to prevent any increase in the sensitivity of explosive materials due to radiation damage during exposures.

d. This specification is intended to reduce the likelihood that airborne activities in excess of the limits or Appendix B of 10 CFR Part 20 will be released to the atmosphere outside the facility boundary of the NSC.

e. The 1.5 curie limitation on iodine 131 through 135 assures that in the event of failure of a fueled experiment leading to total release of the iodine, the exposure dose at the exclusion area boundary will be less than that allowed by 10 CFR Part 20 for an unrestricted area.

f. Operation of the reactor with the reactor fuel or structure damaged is prohibited to avoid release of fission products.

4.0 SURVEILLANCE REQUIREMENTS

4.1 GENERAL

Applicability

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

Objective

The objective is to verify the proper operation of any system related to reactor safety.

Specifications

Any additions, modifications, or maintenance to the ventilation system, the core and its associated support structure, the pool or its penetrations, the pool coolant system, the rod drive mechanism, or the reactor safety system shall be made and tested in accordance with the specifications to which the systems were originally designed and fabricated or to specifications approved by the Reactor Safety Board. A system shall not be considered operable until after it is successfully tested.

Bases

This specification relates to changes in reactor systems which could directly affect the safety of the reactor. As long as changes or replacements to these systems continue to meet the original design specifications, then it can be assumed that they meet the presently accepted operating criteria.

4.2 SAFETY LIMIT - FUEL ELEMENT TEMPERATURE

Applicability

This specification applies to the surveillance requirements of the fuel element temperature measuring channel.

Objective

The objective is to assure that the fuel element temperatures are properly monitored.

Specifications

a. Whenever a reactor scram caused by high fuel element temperature occurs, an evaluation shall be conducted to determine whether the fuel element temperature safety limit was exceeded.

b. A calibration of the temperature measuring channels shall be performed semi-annually but at intervals not to exceed 8 months.

c. A Channel Check of the fuel element temperature measuring channel shall be made daily whenever the reactor is operated by recording a measured value of a meaningful temperature indication.

Bases

Operational experience with the TRIGA system gives assurance that the thermocouple measurements of fuel element temperatures have been sufficiently reliable to assure accurate indication of this parameter.

4.3 LIMITING CONDITIONS FOR OPERATION

4.3.1 Reactivity Requirements

Applicability

These specifications apply to the surveillance requirements for reactivity control of experiments and systems.

Objective

The objective is to measure and verify the worth, performance, and operability of those systems affecting the reactivity of the reactor.

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Specificat...

a. The reac... ity worth of each control rod and the shutdown margin shall be determined annually but at intervals not to exceed 14 months.

b. The reactivity worth of an experiment shall be estimated or measured, as appropriate, before reactor operation with said experiment.

c. The control rods shall be visually inspected for deterioration at intervals not to exceed 2 years.

d. The transient rod drive cylinder and associated air supply system shall be inspected, cleaned, and lubricated as necessary semiannually at intervals not to exceed 8 months.

e. The reactor shall be pulsed semiannually to compare fuel temperature measurements and peak power levels with those of previous pulses of the same reactivity value r the reactor shall not be pulsed until such comparative pulse measurements are performed.

Bases

The reactivity worth of the control rods is measured to assure that the required shutdown margin is available and to provide an accurate means for determining the reactivity worths of experiments inserted in the core. Past experience with TRIGA reactors gives assurance that measurement of the reactivity worth on an annual basis is adequate to insure no significant changes in the shutdown margin. The visual inspection of the control rods is made to evaluate corrosion and wear characteristics caused by operation in the reactor. The reactor is pulsed at suitable intervals and a comparison made with previous similar pulses to determine if changes in fuel or core characteristics are taking place.

4.3.2 Control and afety Systems

Applicability

These specifications apply to the surveillance requirements for measurements, tests, and calibrations of the control and safety systems.

Objective

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

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Specifications

a. The scram time shall be measured annually but at intervals not to exceed 14 months.

b. A Channel Test of each of the reactor safety system channels for the intended mode of operation shall be performed prior to each day's operation or prior to each operation extending more than one day, except for the pool level channel which shall be tested weekly.

c. A Channel Calibration shall be made of the power level monitoring channels by the calorimetric method annually but at intervals not to exceed 14 months.

Bases

Measurement of the scram time on an annual basis is a check not only of the scram system electronics, but also is an indication of the capability of the control rods to perform properly. The channel tests will assure that the safety system channels are operable on a daily basis or prior to an extended run. The power level channel calibration will assure that the reactor will be operated at the proper power levels. Transient control rod checks and semiannual maintenance insure proper operation of this control rod.

4.3.3 Radiation Monitoring System

Applicability

This specification applies to the surveillance requirements for the area radiation monitoring equipment and the continuous air monitoring system.

Objective

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

Specification

The area radiation monitoring system and the continuous air monitoring system shall be calibrated annually but at intervals not to exceed 14 months and shall be verified to be operable at weekly intervals.

Bases

Experience has shown that weekly verification of area radiation and air monitoring system set points in conjunction with annual calibration is adequate to correct for any variation in the system due to a change of operating characteristics over a long time span.

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4.3.4 Ventilation System

Applicability

This specification applies to the building confinement ventilation system.

Objective

The objective is to assure the proper operation of the ventilation system in controlling releases of radioactive material to the uncontrolled environment.

Specification

It shall be verified weekly that the ventilation system is operable.

Bases

Experience accumulated over several years of operation has demonstrated that the tests of the ventilation system on a weekly basis are sufficient to assure the proper operation of the system and control of the release of radioactive material.

4.3.5 Experiment and Irradiation Limits

Applicability

This specification applies to the surveillance requirements for experiments installed in the reactor and its experimental facilities and for irradiations performed in the irradiation facilities.

Objective

The objective is to prevent the conduct of experiments or irradiations which may damage the reactor or release excessive amounts of radioactive materials as a result of failure.

Specifications

a. A new experiment shall not be installed in the reactor or its experimental facilities until a hazards analysis has been performed and reviewed for compliance with the Limitations on Experiments, Section 3.9 by the Reactor Safety Board. Minor modifications to a reviewed and approved experiment may be made at the discretion of the senior reactor operator responsible for the operation provided that the hazards associated with the modifications have been reviewed and a determination made and documented that the modifications do not create a significantly different, a new, or a greater safety risk than the original approved experiment.

324 297

b. The performance of an experiment classified as an approved experiment shall not be performed until it has been reviewed for compliance by a licensed senior operator and a person qualified in health physics.

Bases

It has been demonstrated over a number of years of experience that experiments and irradiations reviewed by the Reactor Staff and the Reactor Safety Board as appropriate can be conducted without endangering the safety of the reactor or exceeding the limits in the Technical Specifications.

4.3.6 ALARA PROGRAM

Applicability

This specification applies to the operating philosophy for maintaining occupational exposures to radiation and release of radioactive effluents to the environs as low as reasonably achievable.

Objective

The objective is to reduce occupational exposures to radiation and release of radioactive effluents to the environs to as low as reasonably achievable through radiation protection planning and practices.

Specification

Management will provide an environment requiring personnel to be continually vigilant for ways and means to reduce radiation exposures and release.

Bases

The Nuclear Science Center has made a conscientious effort to maintain a reasonable and valid ALARA program. Experience accumulated over several years of operating under an established program demonstrates that an ALARA program is a valid method for maintaining occupational exposures to radiation and release of effluents to the environs to an effective minimum.

4.4 REACTOR FUEL ELEMENTS

Applicability

This specification applies to the surveillance requirements for the fuel elements.

324 298

Objective

The objective is to verify the continuing integrity of the fuel element cladding.

Specifications

All fuel elements shall be inspected visually for damage or deterioration and measured for length and bend at intervals not to exceed the sum of 3,500 dollars in pulse reactivity. The reactor shall not be operated with damaged fuel. A fuel element shall be considered damaged and must be removed from the core if:

a. In measuring the transverse bend, the bend exceeds 0.125 inch over the length of the cladding,

b. In measuring the elongation, its length exceeds its original length by 0.125 inch, or

c. A clad defect exists as indicated by release of fission products.

Bases

The frequency of inspection and measurement schedule is based on the parameters most likely to affect the fuel cladding of a pulsing reactor operated at moderate pulsing levels and utilizing fuel elements whose characteristics are well known.

The limit of transverse bend has been shown to result in no difficulty in disassembling the core. Analysis of the removal of heat from touching fuel elements shows that there will be no hot spots resulting in damage to the fuel caused by this touching. Experience with TRIGA reactors has shown that fuel element bowing that could result in touching has occurred without deleterious effects. The elongation limit has been specified to assure that the cladding material will not be subjected to stresses that could cause a loss of integrity in the fuel containment and to assure adequate coolant flow.

5.0 DESIGN FEATURES

5.1 REACTOR FUEL

Applicability

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

324 299

Objective

The objective is to assure that the fuel elements are of such a design and fabricated in such a manner as to permit their use with a high degree of reliability with respect to their physical and nuclear characteristics.

Specifications

a. TRIGA-FLIP Fuel

The individual unirradiated FLIP fuel elements shall have the following characteristics:

(1) Uranium content: maximum of 9 Wt-% enriched to nominal 70% Uranium 235.

(2) Hydrogen-to-zirconium atom ratio (in the ZrH_x): nominal 1.6 H atoms to 1.0 Zr atoms.

(3) Natural erbium content (homogeneously distributed): nominal 1.5 Wt-%.

(4) Cladding: 304 stainless steel, nominal 0.020 inch thick.

(5) Identification: Top pieces of FLIP elements will have characteristic markings to allow visual identification of FLIP elements employed in mixed cores.

b. Standard TRIGA fuel

The individual unirradiated standard TRIGA fuel elements shall have the following characteristics:

(1) Uranium content: maximum of 9.0 Wt-% enriched to a nominal 20% Uranium 235.

(2) Hydrogen-to-zirconium atom ratio (in the ZrH_x): nominal 1.7 H atoms to 1.0 Zr atoms.

(3) Cladding: 304 stainless steel, nominal 0.020 inch thick.

Bases

a. A maximum uranium content of 9 Wt-% in a TRIGA-FLIP element is about 6% greater than the design value of 8.5 Wt-%. Such an increase in loading would result in an increase in power density of about 2%. Similarly, a minimum erbium content of 1.1% in an element is about 30% less than the design value. This variation would result in an increase in power

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density of only about 6% An increase in local power density of 6% reduces the safety margin by at most ten percent. The maximum hydrogen-to-zirconium ratio of 1.65 could result in a maximum stress under accident conditions in the fuel element clad about a factor of two greater than the value resulting from a hydrogen-to-zirconium ratio of 1.60. However, this increase in the clad stress during an accident would not exceed the rupture strength of the clad.

When standard and FLIP fuel elements are used in mixed cores, visual identification of types of elements is necessary to verify correct fuel loadings. The accidental rotation of fuel bundles containing standard and FLIP elements can be detected by visual inspection. Should this occur, however, studies of a single FLIP element accidently rotated into a standard fuel region indicate an insubstantial increase in power generation in the FLIP element.

b. A maximum uranium content of 9 Wt-% in a standard TRIGA element is about 6% greater than the design value of 8.5 Wt.%. Such an increase in loading would result in an increase in power density of less than 6%. An increase in local power density of 6% reduces the safety margin by at most 10%. The maximum hydrogen-to-zirconium ratio of 1.8 will produce a maximum pressure within the clad during an accident well below the rupture strength of the clad.

5.2 REACTOR CORE

Applicability

This specification applies to the configuration of fuel and and in-core experiments.

Objective

The objective is to assure that provisions are made to restrict the arrangement of fuel elements and experiments so as to provide assurance that excessive power densities will not be produced.

Specifications

a. The core shall be an arrangement of TRIGA uranium-zirconium hydride fuel-moderator bundles positioned in the reactor grid plate.

b. The reflector, excluding experiments and experimental facilities, shall be water or a combination of graphite and water.

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Bases

a. Standard TRIGA cores have been in use for years and their characteristics are well documented. FLIP cores have been operated at General Atomics and the Puerto Rico Nuclear Center and their operational characteristics are available. General Atomics has also performed a series of experiments using standard and FLIP fuel in mixed cores. In addition, studies performed at Texas A&M for a variety of mixed core arrangements and operational experience with mixed cores indicate that such loadings would safely satisfy all operational requirements.

b. The core will be assembled in the reactor grid plate which is located in a pool of light water. Water in combination with graphite reflectors can be used for neutron economy and the enhancement of experimental facility radiation requirements.

5.3 CONTROL RODS

Applicability

This specification applies to the control rods used in the reactor core.

Objective

The objective is to assure that the control rods are of such a design as to permit their use with a high degree of reliability with respect to their physical and nuclear characteristics.

Specification

a. The shim-safety control rods shall have scram capability and contain borated graphite, B_4C powder or boron and its compounds in solid form as a poison in aluminum or stainless steel cladding. These rods may incorporate fueled followers which have the same characteristics as the fuel region in which they are used.

b. The regulating control rod need not have scram capability and shall be a stainless rod or contain the materials as specified for shim-safety control rods. This rod may incorporate a fueled follower.

c. The transient control rod shall have scram capability and contain borated graphite or boron and its compounds in a solid form as a poison in an aluminum or stainless steel clad. The transient rod shall have an adjustable upper limit to allow a variation of reactivity insertions. This rod may incorporate an aluminum or air follower.

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Bases

The poison requirements for the control rods are satisfied by using neutron absorbing borated graphite, B_4c powder or boron and its compounds. Since the regulating rod normally is a low worth rod, its function could be satisfied by using a solid stainless steel rod. These materials must be contained in a suitable clad material, such as aluminum or stainless steel, to insure mechanical stability during movement and to isolate the poison from the pool water environment. Control rods that are fuel followed provide additional reactivity to the core and increase the worth of the control rod. The use of fueled followers in the FLIP region has the additional advantage of reducing flux peaking in the water filled regions vacated by the withdrawal of the control rods. Scram capabilities are provided for rapid insertion of the control rods which is the primary safety feature of the reactor. The transient control rod is designed for a reactor pulse. The nuclear behavior of the air or aluminum follower which may be incorporated into the transient rod is similar to a void. A voided follower may be required in certain core loadings to reduce flux peaking values.

5.4 RADIATION MONITORING SYSTEM

Applicability

This specification describes the functions and essential components of the area radiation monitoring equipment and the system for continuously monitoring airborne radioactivity.

Objective

The objective is to describe the radiation monitoring equipment that is available to the operator to assure safe operation of the reactor.

Specification

The radiation monitoring equipment listed in the following table will be available for reactor operation.

Radiation Monitoring Channel and Function

Area Radiation Monitor (gamma sensitive instruments)
Function - Monitor radiation fields in key locations, alarm and readout at control console and readout in reception room.

Continuous Air Radiation Monitor (beta, gamma sensitive detector with air collection capability)
Function - Monitor concentration of radioactive particulate activity in building, alarm and readout at control console and readout in reception room.

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Gas and Particulate Stack Radiation Monitor (gamma sensitive detector with air collection capability)

Function - Monitor concentration of radioactive particulate activity and radioactive gases in building exhaust, alarm and readout at control console and readout in reception room.

Basis

The radiation monitoring system is intended to provide information to operating personnel of any impending or existing danger from radiation so that there will be sufficient time to evacuate the facility and take the necessary steps to prevent the spread of radioactivity to the surroundings.

5.5 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 critical and will not reach an unsafe temperature.

Specifications

a. All fuel elements shall be stored in a geometrical array where the k-effective is less than 0.8 for all conditions of moderation.

b. 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 temperature will not exceed design values.

Basis

The limits imposed by Specifications 5.5.a and 5.5.b are conservative and assure safe storage.

5.6 REACTOR BUILDING AND VENTILATION SYSTEM

Applicability

This specification applies to the building which houses the reactor.

324 304

Objective

The objective is to assure that provisions are made to restrict the amount of release of radioactivity into the environment.

Specifications

a. The reactor shall be housed in a facility designed to restrict leakage. The minimum free volume in the facility shall be 180,000 cubic feet.

b. The reactor building shall be equipped with a ventilation system designed to filter and exhaust air or other gases from the reactor building and release them from a stack at a minimum of 85 feet from ground level.

c. Emergency shutdown controls for the ventilation system shall be located in the reception room and the system shall be designed to shut down in the event of a substantial release of fission products.

Bases

The facility is designed such that the ventilation system will normally maintain a negative pressure with respect to the atmosphere so that there will be no uncontrolled leakage to the environment. The free air volume within the reactor building is confined when there is an emergency shutdown of the ventilation system. Controls for startup, emergency filtering, and normal operation of the ventilation system are located in the reception room. Proper handling of airborne radioactive materials (in emergency situations) can be conducted from the reception room with a minimum of exposure to operating personnel

5.7 REACTOR POOL WATER SYSTEMS

Applicability

This specification applies to the pool containing the reactor and to the cooling of the core by the pool water.

Objective

The objective is to assure that coolant water shall be available to provide adequate cooling of the reactor core and adequate radiation shielding.

Specifications

a. The reactor core shall be cooled by natural convective water flow.

b. The pool water inlet and outlet pipe to the demineralizer shall not extend more than 15 feet below the top of the reactor pool when fuel is in the core.

c. Diffuser and skimmer pumps shall be located no more than 15 feet below the top of the reactor pool.

d. Pool water inlet and outlet pipe to the heat exchanger shall have emergency covers within the reactor pool for manual shut off in case of pool water loss due to external pipe system failure.

e. A pool level alarm shall indicate loss of coolant if the pool level drops approximately 10% below operating level.

Bases

a. This specification is based on thermal and hydraulic calculations which show that the TRIGA-FLIP core can operate in a safe manner at power levels up to 2,700 kW with natural convection flow of the coolant water. A comparison of operation of the TRIGA-FLIP and standard TRIGA Mark III has shown to be safe for the above power level. Thermal and hydraulic characteristics of mixed cores are essentially the same as that for TRIGA-FLIP and standard cores.

b. In the event of accidental siphoning of pool water through inlet and outlet pipes of the demineralizer system, the pool water level will drop no more than 15 feet from the top of the pool.

c. In the event of pipe failure and siphoning of pool water through the skimmer and diffuser water systems, the pool water level will drop no more than 15 feet from the top of the pool.

d. Inlet and outlet coolant lines to the pool heat exchanger terminate at the bottom of the pool. In the event of pipe failure, these lines must be manually sealed from within the reactor pool. Covers for these lines will be stored in the reactor pool. Time required to uncover the reactor core due to failure of a single pool coolant pipe system is 17 minutes.

e. Loss of coolant alarm after 10% loss requires corrective action. This alarm is observed in the reactor control room and the reception room.

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6.0 ADMINISTRATIVE CONTROLS

6.1 ORGANIZATION

a. The facility shall be under the direct control of the Director (NSC) or a licensed senior operator designated by him to be in direct control. The Director shall be responsible to the Vice President for Engineering and Director of the Texas Engineering Experiment Station for safe operation and maintenance of the reactor and its associated equipment. The Director (NSC) or his appointee shall review and approve all experiments and experimental procedures prior to their use in the reactor. He shall enforce rules for the protection of personnel against radiation.

b. The safety of operation of the Nuclear Science Center Reactor shall be related to the University Administration as shown in the following chart.

Office, President
Texas A&M University

Radiological Safety Office	Vice President for Engineering and Director, TEES	Reactor Safety Board

Director
Nuclear Science Center

Reactor
Operations

6.2 REVIEW AND AUDIT

a. A Reactor Safety Board (RSB) or at least three (3) members knowledgeable in fields which relate to Nuclear Safety shall review, evaluate, and approve safety standards associated with the operation and use of the facility. The University Radiological Safety Officer shall be an ex-officio member of the Reactor Safety Board. The jurisdiction of the RSB shall include all nuclear operations in the facility and general safety standards.

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b. The operations of the Reactor Safety Board shall be in accordance with a written charter, including provisions for:

   (1) Meeting frequency,

   (2) Voting rules,

   (3) Quorums,

   (4) Method of submission and content of presentation to the Committee,

   (5) Use of subcommittees, and

   (6) Review, approval, and dissemination of minutes.

c. The RSB or a Subcommittee thereof shall audit reactor operations at least quarterly, but at intervals not to exceed four months.

d. The responsibilities of the Board or designated Subcommittee thereof include, but are not limited to, the following:

   (1) Review and approval of experiments utilizing the reactor facilities,

   (2) Review and approval of all proposed changes to the facility, procedures, and Technical Specifications,

   (3) Review of the operation and operational records of the facility,

   (4) Review of unusual or abnormal occurrences and incidents which are reportable under 10 CFR Part 20 and 10 CFR Part 50,

   (5) Determination of whether a proposed change, test, or experiment would constitute an unreviewed safety question or a change in the Technical Specifications, and

   (6) Review of abnormal performance of facility equipment and operating anomalies.

6.3 <u>ACTION TO BE TAKEN IN THE EVENT A SAFETY LIMIT IS EXCEEDED</u>

In the event a safety limit is exceeded:

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

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b. An immediate report of the occurrence shall be made to the Chairman, Reactor Safety Board, and reports shall be made to the NRC in accordance with Section 6.7 of these specifications, and

c. A report shall be prepared which shall include an analysis of the causes and extent of possible resultant damage, efficacy of corrective action, and recommendations for measures to prevent or reduce the probability of recurrence. This report shall be submitted to the Reactor Safety Board for review and then submitted to the NRC when authorization is sought to resume operation of the reactor.

6.4 ACTION TO BE TAKEN IN THE EVENT OF A REPORTABLE OCCURRENCE

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

a. The Director (NSC) or his designated alternate shall be notified and corrective action taken with respect to the operations involved,

b. The Director (NSC) or his designated alternate shall notify the Chairman of the Reactor Safety Board,

c. A report shall be made to the Reactor Safety Board which shall include an analysis of the cause of the occurrence, efficacy of corrective action, and recommendations for measures to prevent or reduce the probability of recurrence, and

d. A report shall be made to the NRC in accordance with Section 6.7 of these specifications.

6.5 OPERATING PROCEDURES

Written operating procedures shall be adequate to assure the safety of operation of the reactor, but shall not preclude the use of independent judgement and action should the situation require such. Operating procedures shall be in effect for the following items:

a. Testing and calibration of reactor operating instrumentation and controls, control rod drives, area radiation monitors, and air particulate monitors;

b. Reactor startup, operation, and shutdown;

c. Emergency and abnormal conditions, including provisions for evacuation, reentry, recovery, and medical support;

d. Fuel element and experiment loading or unloading;

e. Control rod removal or replacement,

f. Routine maintenance of the control rod drives and reactor safety and interlock systems or other routine maintenance that could have an effect on reactor safety;

g. Actions to be taken to correct specific and foreseen potential malfunctions of systems or components, including responses to alarms and abnormal reactivity changes, and

h. Civil disturbances on or near the facility site.

Substantive changes to the above procedures shall be made only with the approval of the Reactor Safety Board. Temporary changes to the procedures that do not change their original intent may be made by the Director (NSC) or his designated alternate. All such temporary changes shall be documented and subsequently reviewed by the Reactor Safety Board.

6.6 FACILITY OPERATING RECORDS

In addition to the requirements of applicable regulations, and in no way substituting therefor, records and logs shall be prepared of at least the following items and retained for a period of at least five years for items a through e and indefinitely for items f through k.

a. Normal reactor operation,

b. Principal maintenance activities,

c. Abnormal occurrences,

d. Equipment and component surveillance activities required by the Technical Specifications,

e. Experiments performed with the reactor,

f. Gaseous and liquid radioactive effluents released to the environs,

g. Offsite environmental monitoring surveys,

h. Fuel inventories and transfers,

i. Facility radiation and contamination surveys,

j. Radiation exposures for all personnel, and

k. Updated, corrected, and as-built drawings of the facility.

6.7 REPORTING REQUIREMENTS

In addition to the requirements of applicable regulations, and in no way substituting therefor, reports shall be made to the NRC Region IV, Office of Inspection and Enforcement as follows:

a. A report within 24 hours by telephone and telegraph.

   (1) Any accidental release of radioactivity above permissible limits in unrestricted areas whether or not the release resulted in property damage, personal injury, or exposure;

   (2) Any violation of the safety limit; and

   (3) Any reportable occurrences as defined in Section 1.11 of these specifications.

b. A report within 10 days in writing of:

   (1) Any accidental release of radioactivity above permissible limits in unrestricted areas whether or not the release resulted in property damage, personal injury, or exposure. The written report (and, to the extent possible, the preliminary telephone or telegraph report) shall describe, analyze, and evaluate safety implications, and outline the corrective measures taken or planned to prevent reoccurrence of the event;

   (2) Any violation of a safety limit; and

   (3) Any reportable occurrence as defined in Section 1.11 of these specifications.

c. A report within 30 days in writing of:

   (1) Any significant variation of measured values from a corresponding predicted or previously measured value of safety-connected operating characteristics occurring during operation of the reactor;

   (2) Any significant change in the transient or accident analysis as described in the Safety Analysis Report;

   (3) Any changes in facility organization; and

   (4) Any observed inadequacies in the implementation of administrative or procedural controls.

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d. A report within 90 days after completion of startup testing of the reactor upon receipt of a new facility license or an amendment to the license authorizing an increase in reactor power level describing the measured values of the operating conditions or characteristics of the reactor under the new conditions including:

(1) An evaluation of facility performance to date in comparison with design predictions and specifications, and

(2) A reassessment of the safety analysis submitted with the license application in light of measured operating characteristics when such measurements indicate that there may be substantial variance from prior analysis.

e. An annual report covering the operation of the unit during the previous calendar year submitted prior to March 31 of each year providing the following information:

(1) A brief narrative summary of (1) operating experience (including experiments performed), (2) changes in facility design, performance characteristics, and operating procedures related to reactor safety and occurring during the reporting period, and (3) results of surveillance tests and inspections;

(2) Tabulation of the energy output (in megawatt days) of the reactor, hours reactor was critical, and the cumulative total energy output since initial criticality;

(3) The number of emergency shutdowns and inadvertent scrams, including reasons therefor;

(4) Discussion of the major maintenance operations performed during the period, including the effect, if any, on the safety of the operation of the reactor and the reasons for any corrective maintenance required;

(5) A brief description, including a summary of the safety evaluations of changes in the facility or in procedures and of tests and experiments carried out pursuant to Section 50.59 of 10 CFR Part 50;

(6) A summary of the nature and amount of radioactive effluents released or discharged to the environs beyond the effective control of the licensee as measured at or prior to the point of such release or discharge.

Liquid Waste (summarized on a monthly basis)

(a) Radioactivity discharged during the reporting period.

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[1] Total radioactivity released (in curies).

[2] The MPC used and the isotopic composition if greater than 1×10^{-7} microcuries/cc for fission and activation products.

[3] Total radioactivity (in curies), released by nuclide, during the reporting period based on representative isotopic analysis.

[4] Average concentration at point of release (in microcuries/cc) during the reporting period.

(b) Total volume (in gallons) of effluent water (including dilutent) during periods of release.

Gaseous Waste (summarized on a monthly basis)

Radioactivity discharged during the reporting period (in curies) for:

(a) Argon-41

(b) Particulates with half lives greater than eight-days.

Solid Waste

(a) The total amount of solid waste packaged (in cubic feet).

(b) The total activity involved (in curies).

(c) The dates of shipment and disposition (if shipped off site).

(7) A summary of radiation exposures received by facility personnel and visitors, including dates and time of significant exposures and a summary of the results of radiation and contamination surveys performed within the facility; and

(8) A description of any environmental surveys performed outside the facility.

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