TECHNICAL SPECIFICATIONS

FOR THE

DOW TRIGA RESEARCH REACTOR

FACILITY LICENSE R-108

APRIL 1988

This document includes the Technical Specifications and the bases for the Technical Specifications. The bases provide the technical support for the individual Technical Specifications and are included for information purposes only. The bases are not part of the Technical Specifications and they do not constitute limitations or requirements to which the licensee must adhere.

1. DEFINITIONS

1.1. ALARA - The ALARA (As Low As Reasonably Achievable) program is a set of procedures which is intended to minimize occupational exposures to ionizing radiation and releases of radioactive materials to the environment.

1.2. Channel - A channel is a combination of sensors, electronic circuits, and output devices connected by the appropriate communications network in order to measure and display the value of a parameter.

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

1.4. Channel Check - A channel check is a qualitative verification of acceptable performance by observation of channel behavior. The verification shall include comparison of the channel with other independent channels or systems measuring the same variable, whenever possible.

1.5. Channel Test - A channel test is the introduction of a signal into a channel for verification of the operability of the channel.

1.6. Confinement - Confinement is an enclosure of the facililty which controls the movement of air into and out of the facility through a controlled path.

1.7. Excess Reactivity - Excess reactivity is that amount of reactivity that would exist if all control rods were moved to the maximum reactive position from the condition where the reactor is exactly critical.

1.8. Experiment - An experiment is any device or material, not normally part of the reactor, which is introduced into the reactor for the purpose of exposure to radiation, or any operation which is designed to investigate non-routine reactor characteristics.

1.9. Experimental Facilities include the rotary specimen rack, vertical tubes, pneumatic transfer systems, the central thimble, and the area surrounding the core.

1.10. Limiting Conditions for Operation - Limiting Conditions for Operation (LCO) are administratively established constraints on equipment and operational characteristics which shall be adhered to during operation of the reactor.

1.11. Limiting Safety System Setting (LSSS) - An LSSS is the actuating level for automatic protective devices related to those variables having significant safety functions.

1.12. Measured Value - A measured value is the value of a parameter as it appears on the output of a channel.

1.13. Modified Routine Experiments - Modified routine experiments are experiments which have not been designated as routine experiments or which have not been performed previously, but are similar to routine experiments in that the hazards are neither significantly different from nor greater than the hazards of the corresponding routine experiment.

1.14. Movable Experiment - A movable experiment is an experiment intended to be moved in or near the core or into and out of the reactor while the reactor is operating.

1.15. Operable - A component or system is operable if it is capable of performing its intended function.

1.16. Operating - A component or system is operating if it is performing its intended function.

1.17. Radiation Safety Committee (RSC) - The RSC is chartered by The Dow Chemical Company to be responsible for the license for the Dow TRIGA Research Reactor facility.

1.18. Reactivity Limits - The reactivity limits are those limits imposed on reactor core excess reactivity. Quantities are referenced to a Reference Core Condition.

1.19. Reactivity Worth of an Experiment - The reactivity worth of an experiment is the maximum absolute value of the reactivity change that would occur as a result of intended or anticipated changes or credible malfunctions that alter experiment position or configuration.

1.20. Reactor Operating - The reactor is operating whenever it is not secured or shutdown.

1.21. Reactor Safety Circuits - Reactor safety circuits are those circuits, including the associated input circuits, which are designed to initiate a reactor scram.

1.22. <u>Reactor Secured</u> - The reactor is secured whenever:

a) it contains insufficient fissile material present in the reactor, adjacent experiments or control rods, to attain criticality under optimum available conditions of moderation and reflection, or

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

sufficient control rods are inserted to assure that the reactor is subcritical by a margin greater than $1.00 cold, without xenon; and

no work is in progress involving core fuel, core structure, installed control rods or control rod drives unless those drives are physically disconnected from the control rods; and

no experiments in or near the core are being moved or serviced that have, on movement, a reactivity worth exceeding $0.75.

1.23. <u>Reactor Shutdown</u> - The reactor is shutdown if it is subcritical by at least one dollar and the reactivity worth of all experiments is accounted for.

1.24. <u>Reactor Operations Committee (ROC)</u> - The ROC is charged with direct oversight of the reactor operations, including both review and audit functions.

1.25. <u>Reactor Safety Systems</u> - Reactor Safety Systems are those systems, including associated input channels, which are designed to initiate automatic reactor protection or to provide information for initiation of manual protective action.

1.26. <u>Reference Core Condition</u> - The Reference Core Condition is that condition when the core is at ambient temperature (cold) and the reactivity worth of xenon in the fuel is negligible (less than $.30).

1.27. Research Reactor - A Research Reactor is a device designed to support a self-sustaining nuclear chain reaction for research, development, education, training, or experimental purposes, and which may have provisions for the production of radioisotopes.

1.28. Reportable Occurence - A Reportable Occurence is any of the following which occurs during reactor operation:

a) Operation with actual safety-system settings for required systems less conservative than the limiting safety-system settings specified in Technical Specification 2.2.

b) Operation in violation of limiting conditions for operation established in the Technical Specifications.

c) A reactor safety system component malfunction which renders or could render the reactor safety system incapable of performing its intended safety function unless the malfunction or condition is discovered during maintenance tests or periods of reactor shutdown.

d) Any unanticipated or uncontrolled change in reactivity greater than one dollar. Reactor trips resulting from a known cause are excluded.

e) Abnormal and significant degradation in reactor fuel, cladding, or coolant boundary which could result in exceeding prescribed radiation exposure or release limits.

f) An observed inadequacy in the implementation of either administrative or procedural controls which could result in operation of the reactor outside the limiting conditions for operation.

g) Release of radioactivity from the site above limits specified in 10CFR20.

1.29. Rod, Control - A control rod is a device containing neutron absorbing material which is used to control the nuclear fission chain reaction. The control rods are coupled to the control rod drive systems in a way that allows the control rods to perform a safety function.

1.30. Routine Experiment - A routine experiment is an experiment which involves operations under conditions which have been extensively examined in the course of the reactor test programs and which is not defined as any other kind of experiment. Experiments and classes of experiments which are to be considered as routine experiments must be so defined by the Reactor Operations Committee.

1.31. Safety Limit - A Safety Limit is a limit on an important process variable which is found to be necessary to reasonably protect the integrity of certain of the physical barriers which guard against the uncontrolled release of radiaoctivity. The principal physical barrier is the fuel element cladding.

1.32. Scram Time - Scram Time is the time required to fully insert the control rods following the actuation of a Limiting Safety System Setting.

1.33. Secured Experiment - A Secured Experiment is any experiment, experimental 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 substantially greater than those to which the experiment might be subjected by hydraulic, pneumatic, buoyant, or other forces which are normal to the operating environment of the experiment, or by forces which can arise as the result of credible malfunctions.

1.34. Shall, Should, and May - The word "shall" is used to denote a requirement, the word "should" denotes a recommendation, and the word "may" denotes permission, neither a requirement nor a recommendation.

1.35. Shutdown Margin - Shutdown Margin is the reactivity existing when the most reactive control rod is fully withdrawn from the core and the other control rods are fully inserted into the core.

1.36. Special Experiments - Special experiments are experiments which are neither routine experiments nor modified routine experiments.

1.37. TRIGA Fuel Element - A TRIGA fuel element is a sealed unit containing $(U,Zr)H_x$ fuel for the reactor. The uranium is enriched to less than 20% in 235-U and the fraction of hydrogen is in the range of 1.0-1.1 for aluminum-clad TRIGA elements and in the range of 1.6-1.7 for stainless-steel-clad TRIGA elements.

2. SAFETY LIMITS AND LIMITING SAFETY SYSTEM SETTINGS

2.1. Safety Limit (SL)

Applicability

This specification applies to the temperature of the reactor fuel.

Objective

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

Specification

The temperature in any fuel element in the Dow TRIGA Research Reactor shall not exceed 500 C under any conditions of operation.

Basis

A loss in the integrity of the fuel element cladding could arise from a buildup of excessive pressure between the fuel and the cladding if the fuel temperature exceeds the safety limit. The pressure is caused by the heating of air, fission product gases, and hydrogen from the dissociation of the fuel-moderator. The magnitude of this pressure is determined by the temperature of the fuel element and by the hydrogen content. Data indicate that the stress in the cladding due to hydrogen pressure from the dissociation of $ZrH_{1.6}$ will remain below the ultimate stress provided that the fuel temperature does not exceed 1150 C and the fuel cladding temperature does not exceed 500 C. When the cladding temperature can equal the fuel temperature the fuel temperature design limit is 950 C (M. T. Simnad, G.A. Project No. 4314, Report e-117-833, 1980).

Experience with operation of TRIGA-fueled reactors at power levels up to 1500 kW shows no damage to the fuel due to thermally-induced pressures.

The thermal characteristics of aluminum-clad TRIGA fuel elements using $ZrH_{1.1}$ moderator have been analyzed (S. C. Hawley and R. L. Kathren, NUREG/CR-2387, PNL-4028, Credible Accident Analyses for TRIGA and TRIGA-fueled Reactors, 1982) A loss-of-coolant analysis showed that in a typical graphite-reflected Mark I TRIGA reactor fueled with 60 aluminum-clad fuel elements (Reed College) the maximum fuel temperature would be less than 150 C following infinite operation at 250 kilowatts terminated by the instantaneous loss of water. These temperatures are well below the region where the $\alpha + \delta + \gamma'$ to $\alpha + \delta$ phase change occurs in $ZrH_{1.1}$ (560 C).

2.2. Limiting Safety System Settings (LSSS)

Applicability

This specification applies to the reactor scram setting which prevents the reactor fuel temperature from reaching the safety limit.

Objective

The objective of this specification is to provide a reactor scram to prevent the safety limit from being reached.

Specification

The LSSS shall not exceed 300 kW as measured by the calibrated power channels.

Basis

The LSSS which does not exceed 300 kW provides a considerable safety margin. One TRIGA reactor (General Atomics, Torrey Pines) showed a maximum fuel temperature of 350 C during operation at 1500 kilowatts, while a 250-kilowatt TRIGA reactor (Reed College) showed a maximum fuel temperature of less than 150 C (reported by S. C. Hawley, R. L. Kathren, NUREG/CR-2387, PNL-4028 (1982), Credible Accident Analyses for TRIGA and TRIGA-Fueled Reactors). A portion of the safety margin could be used to account for variations of flux level (and thus the power density) at various parts of the core. The safety margin should be ample to compensate for other uncertainties, including power transients during otherwise steady-state operation, and should be adequate to protect aluminum-clad fuel elements from cladding failure due to temperature and pressure effects.

3. LIMITING CONDITIONS FOR OPERATION (LCO)

3.1. Reactivity Limits

Applicability

These specifications shall apply to the reactor at all times that it is in operation.

Objective

The purpose of the specification is to ensure that the reactor can be controlled and shut down at all times and that the safety limit will not be exceeded.

Specifications

The reactor shall be shutdown by more than $.50 with the most reactive control rod fully withdrawn, the other two control rods fully inserted, cold, no xenon, including the reactivity worth of all experiments.

The excess reactivity measured at less than 10 watts in the reference core condition, with or without experiments in place, shall not be greater than $3.00.

Bases

The value of the minimum shutdown margin assures that the reactor can be safely shut down using only the two least reactive control rods.

The assignment of a specification to the maximum excess reactivity serves as an additional restriction on the shutdown margin and limits the maximum power excursion that could take place in the event of failure of all of the power level safety circuits and administrative controls.

3.2. Core Configuration

Applicability

This specification applies to the core configuration.

Objective

The objective of this specification is to assure that the safety limit will not be exceeded due to power peaking effects.

Specifications

The critical core shall be an assembly of standard NRC-approved stainless-steel-clad or aluminum-clad TRIGA fuel elements in light water.

The fuel shall be arranged in a close-packed array for operation at full licensed power except for (1) replacement of single individual fuel elements with in-core irradiation facilities or control rod guide tubes and (2) the start-up neutron source.

The aluminum-clad fuel element shall be placed in the E or F ring of the core.

Bases

Operation with standard NRC-approved TRIGA fuel in the standard configuration ensures a conservative limitation with respect to the Safety Limit.

Placement of the aluminum-clad fuel element in the outer rings of the reactor core will help ensure that this element is not exposed to higher than average power levels, thus providing a greater degree of conservatism with respect to the Safety Limit for this one element.

3.3. Reactor Control and Safety Systems

Applicability

These specificatio apply to the reactor control and safety systems and .afety-related instrumentation that must be operating when the reactor is in operation.

Objective

The objective of these specifications is to assure that all reactor control and safety systems and safety-related instrumentation are operable to minimum acceptable standards during operation of the reactor.

Specifications

There shall be a minimum of three operable control rods in the reactor core.

Each of the three control rods shall drop from the fully withdrawn position to the fully inserted position in a time not to exceed one second.

The reactor safety channels and the interlocks s 1 be operable in accordance with table 3.3A.

The reactor shall not be operated unless the measuring channels listed in Table 3.3B are operable.

Positive reactivity insertion rate by control rod motion shall not exceed $.20 per second.

Bases

The requirement for three operable control rods ensures that the reactor can meet the shutdown specifications.

The control rod drop time specification assures that the reactor can be shutdown promptly when a scram signal is initiated. The value of the control rod drop time is adequate to assure safety of the reactor.

Use of the specified reactor safety channels, set points, and interlocks given in table 3.3A assures protection against operation of the reactor outside the safety limits.

The requirement for the specified measurement circuits provides assurance that important reactor operation parameters can be monitored during operation.

The specification of maximum positive reactivity insertion rate helps assure that the Safety Limit is not exceeded.

TABLE 3.3A.

MINIMUM REACTOR SAFETY CIRCUITS,
INTERLOCKS, AND SET POINTS

Scram Channels

Scram Channel	Minimum Operable	Scram Setpoint
Reactor Power Level	2	Not to exceed maximum licensed power
Reactor Period	1	Not less than 7 seconds
Wide-Range Linear Channel Detector Power Supply	1	Failure of the detector high-voltage power supply
Wide-Range Log Channel	1	Failure of the detector high-voltage power supply
Manual Scram	1	Not applicable

Interlocks

Interlock/Channel	Function
Startup Countrate	Prevent control rod withdrawal when the neutron count rate is less than 2 cps
Rod Drive Control	Prevent simultaneous manual withdrawal of two control elements by the control rod drive motors

TABLE 3.3A

BASES FOR REACTOR SAFETY CHANNELS AND INTERLOCKS

Scram Channels

Scram Channel	Bases
Reactor Power Level	Provides assurance that the reactor will be shut down automatically before the safety limit can be exceeded
Reactor Period	Prevents operation in a regime in which transients could cause the safety limit to be exceeded
Reactor Power Channel Detector Power Supplies	Provides assurance that the reactor cannot be operated without power to the neutron detectors which provide input to the wide-range linear power channel and the wide-range log power channel
Manual Scram	Allows the operator to shut the reactor down at any indication of unsafe or abnormal conditions

Interlocks

Interlock/Channel	Bases
Startup Countrate	Provides assurance that the signal in the log power channel is adequate to allow reliable indication of the state of the neutron chain reaction
Rod Drive Control	Limits the maximum positive reactivity insertion rate

TABLE 3.3B

MEASURING CHANNELS

Measuring channel	Minimum Number Operable
Wide-range Log N and Period Channel	1
Power-Level Channel (Linear)	1
Power-Level Channel (Percent Power)	1
Water Radioactivity Monitor	1
Water Temperature Monitor	1

TABLE 3.3B

BASES FOR MEASURING CHANNELS

Measuring Channel	Basis
Wide-Range Log N and Period Channel	Provides assurance that the reactor power level and period can be adequately monitored.
Power-level Channel (Linear)	Provides assurance that the reactor power level can be adequately monitored.
Power-level Channel (Percent Power)	Provides assurance that the reactor power level can be adequately monitored.
Water Radioactivity Monitor	Provides assurance that the water radioactivity level can be adequately monitored.
Water Temperature Monitor	Provides assurance that the water temperature can be adequately monitored.

3.4. Coolant System

Applicability

These specifications apply to the quality of the coolant in contact with the fuel cladding, to the level of the coolant in the pool, and to the bulk temperature of the coolant.

Objectives

The objectives of this specification are:

to minimize corrosion of the cladding of the fuel elements and minimize neutron activation of dissolved materials,

to detect releases of radioactive materials to the coolant before such releases become significant,

to ensure the presence of an adequate quantity of cooling and shielding water in the pool, and

to prevent thermal degradation of the ion exchange resin in the purification system.

Specifications

The conductivity of the pool water shall not exceed 5 μmhos/cm averaged over one month.

The pool water pH shall be in the range of 4 to 7.5.

The amount of radioactivity in the pool water shall not exceed 0.1 μCi/mL.

The water must cover the core of the reactor to a minimum depth of 15 feet during operation of the reactor.

The bulk temperature of the coolant shall not exceed 60 C during operation of the reactor.

Bases

Increased levels of conductivity in aqueous systems indicate the presence of corrosion products and promote more corrosion. Experience with water quality control at many reactor facilities, including the past 19 years of operation of the Dow TRIGA Research Reactor, has shown that maintenance within the specified limit provides acceptable control. Maintaining low levels of dissolved electrolytes in the pool water also reduces the amount of induced radioactivity, in turn decreasing the exposure of personnel to ionizing radiation during operation and maintenance. Both of these results are in accordance with the ALARA program.

Monitoring the pH of the pool water provides early detection of extreme values of pH which could enhance corrosion.

Monitoring the radioactivity in the pool water serves to provide early detection of possible cladding failures. Limitation of the radioactivity according to this specification decreases the exposure of personnel to ionizing radiation during operation and maintenance in accordance with the ALARA program.

Maintaining the specified depth of water in the pool provides shielding of the radioactive core which reduces the exposure of personnel to ionizing radiation in accordance with the ALARA program.

Maintaining the bulk temperature of the coolant below the specified limit assures minimal thermal degradation of the ion exchange resin.

3.5. Confinement

Applicability

This specification applies to the reactor room confinement.

Objective

The objective of this specification is to mitigate the consequences of possible release of radioactive materials to unrestricted areas.

Specification

The ventilation system shall be operable and the external door shall be closed whenever the reactor is operated, fuel is manipulated, or radioactive materials with the potential of airborne releases are handled in the reactor room.

Basis

This specification ensures that the confinement is configured to control any releases of radioactive material during fuel handling, reactor operation, or the handling of possible airborne radioactive material in the reactor room.

3.6. Radiation Monitoring Systems

Applicability

These specifications apply to the radiation monitoring information available to the reactor operator during operation of the reactor.

Objective

The objective of these specifications is to ensure that the reactor operator has adequate information to assure safe operation of the reactor.

Specifications

A Continuous Air Monitor (CAM) (with readout meter and audible alarm) in the reactor room must be operating during operation of the reactor.

The Area Monitor (AM) (with readout meter and audible alarm) in the reactor room must be operating during operation of the reactor or when work is being done on or around the reactor core or experimental facilities. During short periods of repair to this monitor, not to exceed thirty days, reactor operations or work on or around the core or experimental facilities may continue while a portable gamma-sensitive ion chamber is utilized as a temporary substitute, provided that the substitute can be monitored by the reactor operator.

Bases

The radiation monitors provide information of existing levels of radiation and air-borne radioactive materials which could endanger operating personnel or which could warn of possible malfunctions of the reactor or the experiments in the reactor.

3.7. Experiments

Applicability

These specifications apply to experiments installed in the reactor and its experimental facilities.

Objective

The objective of these specifications is to prevent damage to the reactor or excessive release of radioactive materials in case of failure of an experiment.

Specifications

1. Operation of the reactor for any purpose shall require the review and approval of the appropriate persons or groups of persons, except that operation of the reactor for the purpose of performing routine checkouts, where written procedures exist for those operations, shall be authorized by the written procedures. An operation shall not be approved unless the evaluation allows the conclusion that the failure of an experiment will not lead to the direct failure of a fuel element or of any other experiment.

2. The total absolute reactivity worth of in core experiments shall not exceed $1.00. This includes the potential reactivity which might result from experimental malfunction, experiment flooding or voiding, or the removal or insertion of experiments.

3. Experiments having reactivity worths of greater than $0.75 shall be securely located or fastened to prevent inadvertent movement during reactor operation.

4. Experiments containing materials corrosive to reactor components, compounds highly reactive with water, potentially explosive materials or liquid fissionable materials shall be doubly encapsulated.

5. Materials which could react in a way which could damage the components of the reactor (such as gunpowder, dynamite, TNT, nitroglycerin, or PETN) shall not be irradiated in quantities greater than 25 milligrams in the reactor or experimental facilities without out-of-core tests which shall indicate that, with the containment provided, no damage to the reactor or its components shall occur upon reaction. Such materials in quantities less than 25 milligrams may be irradiated provided that the pressure produced in the experiment container upon reaction shall be calculated and/or experimentally demonstrated to be less than the design pressure of the container. Such materials must be packaged in the appropriate containers before being brought into the reactor room or must be in the custody of duly authorized local, state, or federal officers.

6. Experiment materials, except fuel materials, which could off-gas, sublime, volatilize or produce aerosols under (a) normal operating conditions of the experiment or the reactor, (b) credible accident conditions in the reactor or (c) 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 would not exceed the limits of Appendix B of 10 CFR Part 20.

   The following assumptions should be used in calculations regarding experiments:

   a. If the effluent from an experimental facility exhausts through a holdup tank which closes automatically on high radiation levels, the assumption shall be used that 10% of the gaseous activity or aerosols produced will escape.

   b. If the effluent from an experimental facility exhausts through a filter installation designed for greater than 99% efficiency for 0.3 micron particles, the assumption shall be used that 10% of the aerosols produced escape.

c. For materials whose boiling point is above 55 C and where vapors formed by boiling this material could escape only through an undisturbed column of water above the core, the assumption shall be used that 10% of these vapors escape.

7. 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 and the maximum strontium-90 inventory is no greater than 5 millicuries.

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

9. Experiments shall not occupy adjacent fuel-element positions in the B- and C-rings.

Bases

1. This specification is intended to provide at least one level of review of any proposed operation of the reactor in order to minimize the possibility of operations of the reactor which could be dangerous or in violation of administrative procedures or the technical specifications. The exception is made in the case of those few very well characterized operations which are necessary for routine checkout of the reactor and its systems, provided that those operations have been defined by written procedures which have been reviewed and approved by the Reactor Supervisor and the Reactor Operations Committee.

2. This specification is intended to limit the reactivity of the system so that the Safety Limit would not be exceeded even if the contribution to the total reactivity by the experiment reactivity should be suddenly removed.

3. This specification is intended to limit the power excursions which might be induced by the changes in reactivity due to inadvertent motion of an unsecured experiment. Such excursions could lead to an inability to control the reactor within the limits imposed by the license.

4. This specification is intended to reduce the possibility of damage to the reactor or the experiments due to release of the listed materials.

5. This specification is intended to reduce the possibility of damage to the reactor in case of accidental detonation of the listed materials.

6. This specification is intended to reduce the severity of the results of accidental release of airborne radioactive materials to the reactor room or the atmosphere.

7. This specification is intended to reduce the severity of any possible release of these fission products which pose the greatest hazard to workers and the general public.

8. This specification requires specific actions to determine the extent of damage following releases of materials. No theoretical calculations or evaluations are allowed.

9. This specification prevents serious modification of the neutron distribution which could affect the ability of the control rods to perform their intended function of maintaining safe control of the reactor.

4. SURVEILLANCE REQUIREMENTS

Allowable surveillance intervals shall not exceed the following:

biennially - not to exceed 30 months
annually - not to exceed 15 months
semi-annually - not to exceed seven and one-half months
monthly - not to exceed six weeks
weekly - not to exceed 10 days
daily - must be done before the commencement of operation each day of operation

Established frequencies shall be maintained over the long term, so, for example, any monthly surveillance shall be performed at least 12 times during a calendar year of normal operation. If the reactor is not operated for a period of time exceeding any required surveillance interval, that surveillance task shall be performed before the next operation of the reactor. Any surveillance tasks which are missed more than once during such a shut-down interval need be performed only once before operation of the reactor. Surveillance tasks scheduled daily or weekly which cannot be performed while the reactor is operating may be postponed during continuous operation of the reactor over extended times. Such postponed tasks shall be performed following shutdown after the extended period of continuous operation before any further operation, where each task shall be performed only once no matter how many times that task has been postponed.

4.1. Reactor Core Parameters

Applicability

These specifications apply to surveillance requirements for reactor core parameters.

Objective

The objective of these specifications is to ensure that the specifications of section 3.1 are satisfied.

Specification

The reactivity worth of each control rod, the reactor core excess, and the reactor shutdown margin shall be measured at least annually and after each time the core fuel is moved.

Basis

Movement of the core fuel could change the reactivity of the core and thus affect both the core excess reactivity and the shutdown margin, as well as affecting the worth of the individual control rods. Evaluation of these parameters is therefore required after any such movement. Without any such movement the changes of these parameters over an extended period of time and operation of the reactor have been shown to be very small so that an annual measurement is sufficient to ensure compliance with the specifications of section 3.1.

4.2. Reactor Control and Safety Systems

Applicability

These specifications apply to the surveillance requirements of the reactor safety systems.

Objective

The objective of these specifications is to ensure the operability of the reactor safety systems as described in section 3.3.

Specifications

1. Control rod drive withdrawal speeds and control rod drop times shall be measured at least annually and whenever maintenance is performed or repairs are made that could affect the rods or control rod drives.

2. A channel calibration shall be performed for the wide-range linear power channel by thermal power calibration at least annually.

3. A channel test shall be performed at least daily and after any maintenance or repair for each of the six scram channels and each of the two interlocks listed in table 3.3A, and the log power channel.

4. The control rods shall be visually inspected at least biennially.

Bases

1. Measurement of the control rod drop time and compliance with the specification indicates that the control rods can perform the safety function properly. Measurement of the control rod withdrawal speed ensures that the maximum reactivity addition rate specification will not be exceeded.

2. Variations of the indicated power level due to minor variations of any one of the three neutron detectors would be readily evident during day-to-day operation. The specification for thermal calibration of the wide-range linear channel provides assurance that long-term drift of all three neutron detectors would be detected and that the reactor will be operated within the authorized power range.

3. The channel tests performed daily before operation and after any repair or maintenance provide timely assurance that the systems will operate properly during operation of the reactor.

4. Visual inspection of the control rods provides opportunity to evaluate any corrosion, distortion, or damage that might occur in time to avoid malfunction of the control rods. Experience at the Dow TRIGA Reactor Facility over the past 19 years indicates that the surveillance specification is adequate to assure proper operation of the control rods. This surveillance complements the rod drop time measurements.

4.3. Coolant System

Applicability

These specifications shall apply to the surveillance requirements for the reactor coolant system.

Objective

The objective of these specifications is to ensure that the specifications of section 3.4 are satisfied.

Specifications

1. The conductivity, pH, and the radioactivity of the pool water shall be measured at least monthly.

2. The level of the water in the pool shall be determined to be adequate on a weekly basis.

3. The temperature of the coolant shall be monitored during operation of the reactor.

Bases

1. Experience at the Dow TRIGA Research Reactor shows that this specification is adequate to detect the onset of degradation of the quality of the pool water in a timely fashion. Evaluation of the radioactivity in the pool water allows the detection of fission product releases from damaged fuel elements or damaged experiments.

2. Experience indicates that this specification is adequate to detect losses of pool water by evaporation.

3. This specification will enable operators to take appropriate action when the coolant temperature approaches the specified limit.

4.4. Radiation Monitoring Systems

Applicability

These specifications apply to the surveillance requirements for the Continuous Air Monitor (CAM) and the Area Monitor (AM), both located in the reactor room.

Objective

The objective of these specifications is to ensure the quality of the data presented by these two instruments.

Specifications

1. A channel calibration shall be made for the CAM and the AM at least annually.

2. A channel test shall be made for the CAM and the AM at least weekly.

Bases

These specifications ensure that the named equipment can perform the required functions when the reactor is operating and that deterioration of the instruments will be detected in a timely manner. Experience with these instruments has shown that the surveillance intervals are adequate to provide the required assurance.

4.5. Facility Specific Surveillance

Applicability

This specification shall apply to the fuel elements of the Dow TRIGA Research Reactor.

Objective

The objective of this specification is to ensure that the reactor is not operated with damaged fuel elements.

Specification

Each fuel element shall be visually examined annually.

The reactor shall not be operated with damaged fuel except to detect and identify damaged fuel for removal. A TRIGA fuel element shall be removed from the core if:

a) The transverse bend exceeds 0.125 inch over the length of the cladding.

b) The length exceeds the original length by 0.125 inch.

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

Basis

Visual examination of the fuel elements allows early detection of signs of deterioration of the fuel elements, indicated by signs of changes of corrosion patterns or of swelling, bending, or elongation.

4.6. ALARA

Applicability

This specification applies to the surveillance of all reactor operations that could result in occupational exposures to ionizing radiation or the release of radioactive materials to the environment.

Objective

The objective of this specification is to provide surveillance of all operations that could lead to occupational exposures to ionizing radiation or the release of radioactive materials to the environs.

Specification

The review of all operations shall include consideration of reasonable alternate operational modes which might reduce exposures to ionizing radiation or releases of radioactive materials.

Basis

Experience has shown that experiments and operational requirements, in many cases, may be satisfied with a variety of combinations of facility options, power levels, time delays, and effluent or staff radiation exposures. The ALARA (As Low As Reasonably Achievable) principle shall be a part of overall reactor operation and detailed experiment planning.

5. DESIGN FEATURES

5.1. Reactor Site and Building

Applicability

These specifications shall apply to the Dow TRIGA Research Reactor.

Objectives

The objectives of these specifications are to define the exclusion area and characteristics of the confinement.

Specifications

The minimum distance from the center of the reactor pool to the boundary of the exclusion area shall be 75 feet.

The reactor shall be housed in a room of about 6000 cubic feet volume designed to restrict leakage.

All air or other gas exhausted from the reactor room and from associated experimental facilities during reactor operation shall be released to the environment at a minimum of 8 feet above ground level.

Bases

The minimum distance from the pool to the boundary provides for dilution of effluents and for control of access to the reactor area.

Restriction of leakage, in the event of a release of radioactive materials, can contain the materials and reduce exposure of the public.

Release of gases at a minimum height of 8 feet reduces the possibility of exposure of personnel to such gases.

5.2. Reactor Coolant System

Applicability

This specification applies to the Dow TRIGA Research Reactor.

Objective

The objective of this specification is to define the characteristics of the cooling system of this reactor.

Specification

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

Basis

Experience has shown that TRIGA reactors operating at power levels up to 1000 kilowatts can be cooled by natural convective water flow without damage of the fuel elements.

5.3. Reactor Core and Fuel

Applicability

These specifications shall be applicable to the Dow TRIGA Research Reactor.

Objective

The objective of these specifications is to define certain characteristics of the reactor in order to assure that the design and accident analyses will be correct.

Specification

The fuel will be standard NRC-approved TRIGA fuel.

The control elements shall have scram capability and shall contain borated graphite, boron carbide powder, or boron and its components in solid form as a poison in an aluminum or stainless steel cladding.

The reflector (excluding experiments and experimental facilities) shall be a combination of graphite and water.

Bases

The entire design and accident analysis is based upon the characteristics of TRIGA fuel. Any other material would invalidate the findings of these analyses.

The control elements perform their function through the absorption of neutrons, thus affecting the reactivity of the system. Boron has been found to be a stable and effective material for this control.

The reflector serves to conserve neutrons and to reduce the amount of fuel that must be in the core to maintain the chain reaction.

5.4. Fuel Storage

Applicability

This specification applies to the Dow TRIGA Research Reactor fuel storage facilities.

Objective

The objective of this specification is the safe storage of fuel.

Specification

All fuel and fueled devices not in the core of the reactor shall be stored in such a way that k_{eff} shall be less than 0.8 under all conditions of moderation, and that will permit sufficient cooling by natural convection of water or air that temperatures shall not exceed the Safety Limit.

Basis

A value of k_{eff} of less than 0.8 precludes any possibility of inadvertent establishment of a self-sustaining nuclear chain reaction. Cooling which maintains temperatures lower than the Safety Limit prevents possible damage to the devices with subsequent release of radioactive materials.

6. ADMINISTRATIVE CONTROLS

6.1. Organization

The Dow TRIGA Research Reactor is owned and operated by The Dow Chemical Company. The reactor is administered and operated through the Analytical Laboratory of the Michigan Division of Dow Chemical USA and is located in 1602 Building of the Analytical Laboratory at the Midland, Michigan location of the Michigan Division.

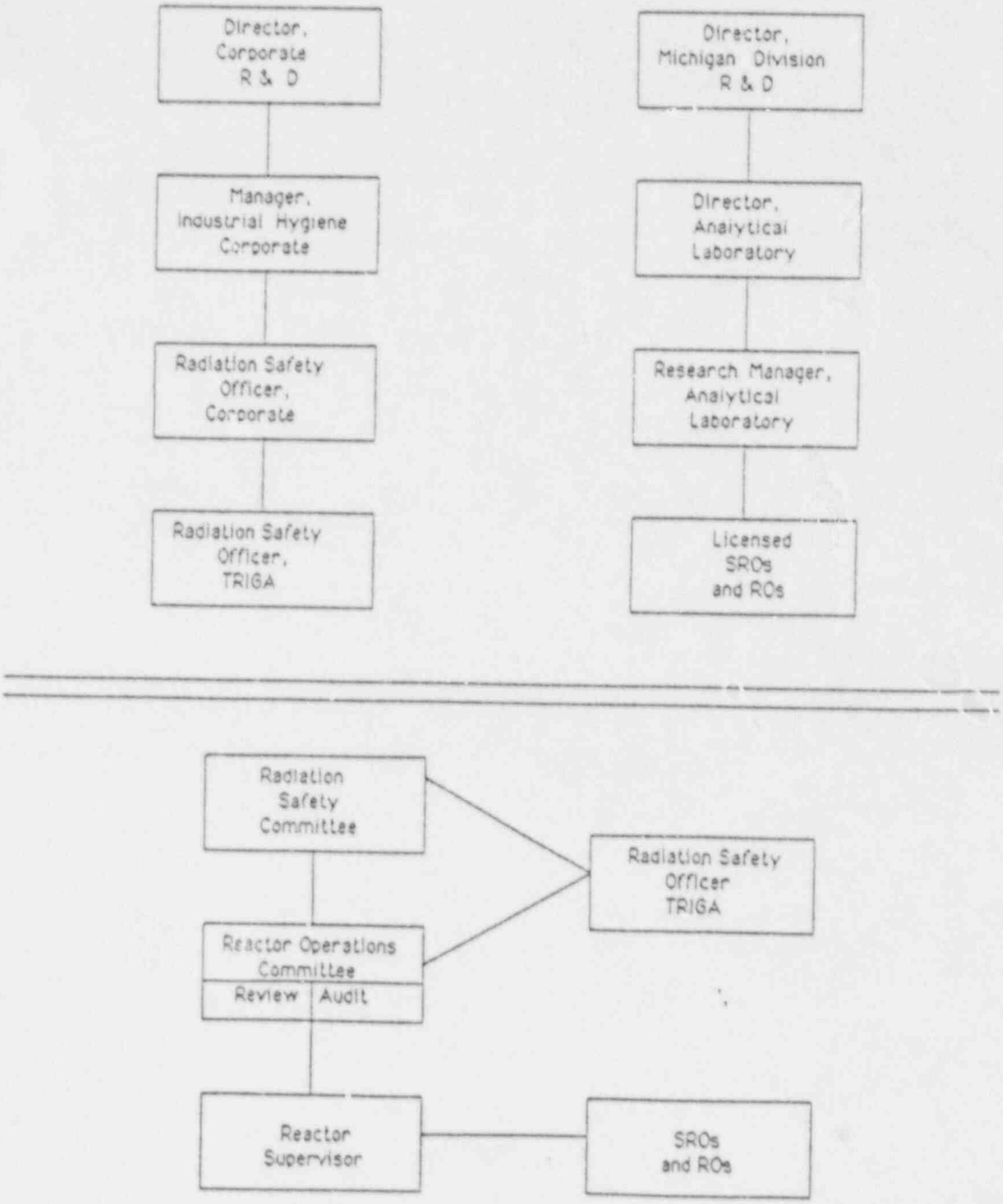
6.1.1. Structure

The structure of the administration of the reactor is shown in figure 6.1. This structure cuts across the lines of management of The Dow Chemical Company. The individual responsible for radiation safety is the Radiation Safety Officer for the reactor who reports on matters of radiation safety to the Radiation Safety Committee and to the Reactor Operations Committee. The review and audit functions are performed by the Reactor Operations Committee which is composed of at least four persons including the Analytical Laboratory Research Manager, the Radiation Safety Officer, and the Reactor Supervisor.

6.1.2. Responsibility

The day-to-day responsibility for the safe operation of the reactor rests with the Reactor Supervisor who is a licensed Senior Reactor Operator appointed by the Facility Director. The Reactor Supervisor may appoint equally-qualified individuals, upon notification of the Facility Director and the Reactor Operations Committee, to assume the responsibilities of the Reactor Supervisor. The Reactor Supervisor reports in a management sense to the Facility Director and within the reactor organization to the Reactor Operations Committee.

Figure 6.1. Administration



6.1.3. Staffing

The minimum staffing when the reactor is not secured shall be:

a. a licensed Reactor Operator or Senior Reactor Operator in the control room, and

b. a second person present at the facility able to carry out prescribed written instructions, and

c. a licensed Senior Reactor Operator in the facility or readily available on call and able to be at the facility within 30 minutes.

The following operations require the presence of the Reactor Supervisor or a designated alternate:

a. manipulations of fuel in the core;

b. manual removal of control rods;

c. maintenance performed on the core or the control rods;

d. recovery from unexplained scrams, and

e. movement of any in-core experiment having an estimated reactivity value greater than $0.75.

A list of reactor facility personnel by name and telephone number shall be readily available in the control room for use by the operator, including management, radiation safety, and other operations personnel.

6.1.4. Selection and Training of Personnel

The Reactor Supervisor is responsible for the training and requalification of the facility Reactor Operators and Senior Reactor Operators. The selection, training, and requalification of operations personnel shall be consistent with all current regulations.

Day-to-day changes in equipment, procedures, and specifications shall be communicated to the facility staff as the changes occur.

6.2. Review and Audit

The review and audit functions shall be the responsibility of the Reactor Operations Committee (ROC).

6.2.1. Charter and Rules

a. This Committee shall consist of the Facility Director, who shall be designated the chair of this committee; the Radiation Safety Officer; the Reactor Supervisor; and one or more persons who are competent in the field of reactor operations, radiation science, or reactor/radiation engineering.

b. A quorum shall consist of a majority of the members of the ROC. No more than one-half of the voting members present shall be members of the day-to-day reactor operating staff.

c. The Committee shall meet quarterly and as often as required to transact business.

d. Minutes of the meetings shall be kept as records for the facility.

e. In cases where quick action is necessary members of the ROC may be polled by telephone for guidance and approvals.

f. The ROC shall report at least twice per year to the Radiation Safety Committee.

6.2.2. Review Functions

The ROC shall review and approve:

a. every experiment involving fissionable material;

b. experiments or operations which would require a change of core configuration, or a change in the equipment or apparatus associated with the reactor core or its irradiation facilities, or a new piece of apparatus being mounted in the reactor well; except that movement of the neutron source for the purpose of routinely checking the instrumentation, or the movement of the neutron detectors to establish the proper calibration of the associated channels shall not require review by the ROC;

c. any other experiment or operation which is of a type not previously approved by the Committee;

d. proposed changes in operating procedures, technical specifications, license, or charter;

e. violations of technical specifications, of the license, of internal procedures, and of instructions having safety significance;

f. operating abnormalities having safety significance;

g. reportable occurrences;

h. proposed changes in equipment, systems, tests, or experiments with respect to unreviewed safety questions; and

i. audit reports.

6.2.3. Audit Function

a. The ROC shall direct an annual audit of the facility operations for conformance to the technical specifications, license, and operating procedures, and for the results of actions taken to correct those deficiencies which may occur in the reactor facility equipment, systems, structures, or methods of operations that affect reactor safety.

This audit may consist of examinations of any facility records, review of procedures, and interviews of licensed Reactor Operators and Senior Reactor Operators.

The audit shall be performed by one or more persons appointed by the ROC. At least one of the auditors shall be familiar with reactor operations. No person directly responsible for any portion of the operation of the facility shall audit that operation.

A written report of the audit shall be submitted to the ROC within three months of the audit.

Deficiencies that affect reactor safety shall be reported to the Facility Director immediately.

b. The ROC shall direct an annual audit of the facility emergency plan, security plan, and the reactor operator requalification program. This audit may consist of the annual review of these plans for the requalification program.

6.3. Procedures

Written procedures shall be reviewed and approved by the ROC for:

a. reactor startup, routine operation, and shutdown;

b. emergency and abnormal operating events, including shutdown;

c. fuel loading or unloading;

d. control rod removal or installation;

e. checkout, calibration and determination of operability of reactor operating instrumentation and controls, control rod drives and area radiation and air particulate monitors; and

f. preventive maintenance procedures.

Temporary deviations from the procedures may be made by the responsible Senior Reactor Operator or higher individual in order to deal with special or unusual circumstances. Such deviations shall be documented and reported immediately to the Reactor Operations Committee.

6.4. Experiment Review and Approval

a. Routine Experiments (as reviewed and defined by the ROC) shall have the written approval of the Reactor Supervisor or a designated Assistant Reactor Supervisor.

b. Modified Routine Experiments shall have the written approval of the Reactor Supervisor or a designated Assistant Reactor Supervisor. The written approval shall include documentation that the hazards have been considered by the reviewer and been found appropriate for this form of experiment.

c. Special Experiments, those experiments that are neither Routine Experiments nor Modified Routine Experiments, shall have the approval of both the Reactor Supervisor (or designated Assistant Reactor Supervisor) and the ROC. Experiments which require the approval of the ROC through sections 6.2.2.a., 6.2.2.b., or 6.2.2.c. of the Technical Specifications are always Special Experiments.

6.5. Required Actions

6.5.1. In case of Safety Limit violation:

a. the reactor shall be shut down until resumed operations are authorized by the US NRC;

b. the Safety Limit violation shall be immediately reported to the Facility Director or to a higher level;

c. The Safety Limit violation shall be reported to the US NRC in accordance with section 6.6.2.; and

d. a report shall be prepared for the ROC describing the applicable circumstances leading to the violation including, when known, the cause and contributing factors, describing the effect of the violation upon reactor facility components, systems, or structures and on the health and safety of personnel and the public, and describing corrective action taken to prevent recurrence of the violation.

6.5.2. In case of a Reportable Occurrence of the type identified in section 1.28:

a. reactor conditions shall be returned to normal or the reactor shall be shut down; if the reactor is shut down operation shall not be resumed unless authorized by the Facility Director or designated alternate;

b. the occurrence shall be reported to the Facility Director and to the US NRC as required per section 6.6.2.; and

c. the occurrence shall be reviewed by the ROC at the next scheduled meeting.

6.6. Reports

6.6.1. Operating Reports

A report shall be submitted annually, within 90 days of the anniversary of the license, to the Radiation Safety Committee and to the Director, Office of Nuclear Reactor Regulation, US NRC, Washington, DC, with a copy to the Regional Administrator, US NRC Region III, which shall include the following:

a) status of the facility staff, licenses, and training;

b) a narrative summary of reactor operating experience, including the total megawatt-days of operation;

c) tabulation of major changes in the reactor facility and procedures, and tabulation of new tests and experiments that are significantly different from those performed previously and are not described in the Safety Analysis Report, including a summary of the analyses leading to the conclusions that no unreviewed safety questions were involved and that 10 CFR 50.59 (a) was applicable;

d) the unscheduled shutdowns and reasons for them including, where applicable, corrective action taken to preclude recurrence;

e) tabulation of major preventive and corrective maintenance operations having safety significance;

f) a summary of the nature and amount of radioactive effluents released or discharged to environs beyond the effective control of the owner-operator as determined at or before the point of such release or discharge (the summary shall include to the extent practicable an estimate of individual radionuclides present in the effluent; if the estimated average release after dilution or diffusion is less than 25% of the concentration allowed or recommended, only a statement to this effect is needed); and

g) a summary of the radiation exposures received by facility personnel and visitors where such exposures are greater than 25 % of those allowed or recommended in 10 CFR 20.

6.6.2. Special Reports

a. There shall be a report to US NRC Region III not later than the following working day by telephone and confirmed in writing by telegraph or similar conveyance to the Director of Nuclear Reactor Regulation, US NRC, with copy to the Regional Administrator, Region III, US NRC to be followed by a written report that describes the event within 14 days of:

a violation of the Safety Limit; or

a reportable occurence (section 1.28).

b. There shall be a written report presented within 30 days to the Director of Nuclear Reactor Regulation, US NRC, with copy to the Regional Administrator, Region III, US NRC, of:

permanent changes in the facility involving level 1 or level 2 personnel; or

significant changes in the transient or accident analysis report as described in the Safety Analysis Report.

c. A written report shall be submitted to the Director of the Office of Nuclear Reactor Regulation, US NRC, with copy to the Regional Administrator, Region III, US NRC, within 60 days after criticality of the reactor under conditions of a new facility 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.

6.7. Records

6.7.1. The following records shall be kept for a minimum period of five years:

a. reactor operating logs;

b. irradiation request sheets;

c. checkout sheets;

d. maintenance records;

e. calibration records;

f. records of reportable occurrences;

g. fuel inventories, receipts, and shipments;

h. minutes of ROC meetings;

i. records of audits;

j. facility radiation and contamination surveys; and

k. surveillance activities as required by the Technical Specifications.

6.7.2 Records of the retraining and requalification of Reactor Operators and Senior Reactor Operators shall be retained for at least one complete requalification schedule.

6.7.3. The following records shall be retained for the lifetime of the reactor:

a. records of gaseous and liquid radioactive effluents released to the environment;

b. records of the radiation exposure of all individuals monitored; and

c. drawings of the reactor facility.