1 Introduction

1.1 Scope

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.

1.2 Format

These specifications are formatted to NUREG-1537 and ANSI/ANS 15.1-2007

1.3 Definitions

ALARA — An acronym for "as low as reasonably achievable", ALARA means making every reasonable effort to maintain exposures to radiation as far below the dose limits in 10 CFR Part 20 as is practical, consistent with the purpose for which the licensed activity is undertaken, taking into account the state of technology, the economics of improvements in relation to state of technology, the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to utilization of nuclear energy and licensed materials in the public interest.

AUTOMATIC MODE — Automatic mode operation shall mean operation of the reactor with the mode selector switch in the automatic position.

CHANNEL — A channel is the combination of sensors, lines, amplifiers, and output devices which are connected for the purpose of measuring the value of a parameter.

CHANNEL CALIBRATION — A channel calibration is an adjustment of the 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 be deemed to include a channel test.

CHANNEL CHECK — A channel check is a qualitative verification of acceptable performance by observation of CHANNEL behavior, or by comparison of the CHANNEL with other independent CHANNELS or systems measuring the same variable.

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

CONFINEMENT — Confinement means a closure of the overall facility that controls the movement of air into it and out, thereby limiting release of effluents, through a controlled path.

CONTROL ROD — A control rod is a device fabricated from neutron-absorbing material which is used to establish neutron flux changes and to compensate for routine reactivity losses. A control rod can be coupled to its drive unit allowing it to perform a safety function when the coupling is disengaged.

CONTROL ROD GUIDE TUBE — Hollow tube in which a CONTROL ROD moves.

CORE CONFIGURATION — The core consists of TRIGA fuel elements assembled into THREE or FOUR ELEMENT FUEL BUNDLES, arranged in a close-packed array. Bundles may be displaced for the pneumatic experimental system, PuBe source, neutron detectors, and graphite reflectors.

3 Limiting Conditions for Operation

3.1 Reactor Core Parameters

Applicability

These specifications shall apply to the reactor at all times it is OPERATING.

Objective

The objective 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

1. The EXCESS REACTIVITY relative to the REFERENCE CORE CONDITION, with or without experiments in place shall not be greater than $3.50.
2. The SHUTDOWN MARGIN shall not be less than $0.50 with:
   (a) The reactor in the REFERENCE CORE CONDITION; and
   (b) Total worth of all experiments in their most reactive state; and
   (c) Most reactive CONTROL ROD fully withdrawn.
3. Core configurations:
   (a) The reactor shall only be operated with a STANDARD CORE.
   (b) No fuel shall be inserted or removed from the core unless the reactor is subcritical by more than the worth of the most reactive FOUR ELEMENT FUEL BUNDLE plus $0.50.
   (c) No control rod shall be removed from the core unless a minimum of four fuel bundles are removed from the core, having reactivity greater than the control rod.
   (d) The reactor shall only be operated with three OPERABLE control rods.
4. The reactor shall not be operated with damaged fuel except to locate such fuel. Fuel shall be considered damaged if:
   (a) A cladding defect exists as indicated by release of fission products, or
   (b) A visual inspection reveals bulges, gross pitting or corrosion.
5. The burn-up of U-235 in the UZrH fuel matrix shall not exceed 50% of the initial concentration.

Bases

1. While specification 3.1.1, in conjunction with specification 3.1.2, tends to over constrain the excess reactivity, it helps ensure that the OPERABLE core is similar to the core analyzed in the FSAR.
2. The value of the SHUTDOWN MARGIN as required by specification 3.1.2 assures that the reactor can be SHUTDOWN from any OPERATING condition even if the highest worth CONTROL ROD should remain in the fully withdrawn position.
3. Specification 3.1.3 ensures that the OPERABLE core is similar to the core analyzed in the SAR. It also ensures that accidental criticality will not occur during fuel or CONTROL ROD manipulations.

4 Surveillance Requirements

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.

Specification

Surveillances shall be performed on a timely basis. In the event that the reactor is not in an OPERABLE condition, such as during periods of refueling, or replacement or repair of safety equipment, surveillances may be postponed, see Table 4.1, until such time that the reactor is OPERABLE. In such case that any surveillance must be postponed, a written directive signed by the Director, shall be placed in the records indicating the reason why and the expected completion date of the required surveillance. This directive shall be written before the date that the surveillance is due. Under no circumstance shall the reactor perform routine operations until such time that all surveillances are current and up to date. Any system or component that is modified, replaced, or had maintenance performed shall undergo testing to ensure that the system/component continues to meet performance requirements.

Technical Specification	Defer during shutdown?	Required prior to operations?
4.1 Reactor Core Parameters	Yes	Yes
4.2 Reactor Control and Safety Systems	Yes	Yes
4.3 Primary Coolant System	No	N/A
4.4 Confinement and Ventilation	Yes	Yes
4.5 Radiation Monitoring and Effluents	No	N/A
4.6 Experiments	Yes	Yes

Table 4.1: Surveillance Requirements

4.1 Reactor Core Parameters

Applicability

These specifications apply to the surveillance requirements for the reactor core.

Objective

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

Specifications

1. The EXCESS REACTIVITY shall be determined annually, at intervals not to exceed 15 months, and after each time the core fuel configuration is changed, these changes include any removal or replacement of CONTROL RODS.

2. The SHUTDOWN MARGIN shall be determined annually, at intervals not to exceed 15 months, and after each time the core fuel configuration is changed, these changes include any removal or replacement of CONTROL RODS.

3. CORE CONFIGURATION shall be verified prior to the first startup of the day.

4. A visual inspection of a representative group of at least 4 FOUR ELEMENT FUEL BUNDLES from rows B and C shall be performed annually at intervals not to exceed 15 months. The bundles inspected shall rotate such that in a 2-year period all accessible FOUR ELEMENT FUEL BUNDLES in rows B and C are inspected. If any are found to be damaged, an inspection of the entire MUTR core shall be performed.

5. Burnup shall be determined annually, not to exceed 15 months.

Bases

Experience has shown that the identified frequencies ensure performance and operability for each of these systems or components. For EXCESS REACTIVITY and SHUTDOWN MARGIN, long-term changes are slow to develop. For fuel inspection, visually inspecting the bundles annually will identify any developing fuel integrity issues throughout the core.

4.2 Reactor Control and Safety Systems

Applicability

These specifications apply to the surveillance requirements for reactor control and safety systems.

Objective

The objective of these specifications is to ensure that the specifications of Section 3.2 are satisfied.

Specifications

1. The reactivity worth of each CONTROL ROD shall be determined annually, at intervals not to exceed 15 months, and after each time the core fuel configuration is changed or a CONTROL ROD is inspected.

2. The CONTROL ROD withdrawal and insertion speeds shall be determined annually, at intervals not to exceed 15 months, or whenever maintenance or repairs are made that could affect rod travel times.

3. CONTROL ROD DROP TIMES shall be measured annually, at intervals not to exceed 15 months, or whenever maintenance or repairs are made that could affect their DROP TIME.

4. All scram channels listed in Table 3.1 shall have a CHANNEL TEST, including trip actions with CONTROL ROD release and specified interlocks as listed in Table 3.2 performed after each SECURED SHUTDOWN, before the first operation of the day, or prior to any operation scheduled to last more than 24 hours, or quarterly, with intervals not to exceed 4 months. Scram channels and interlocks shall be calibrated annually, at intervals not to exceed 15 months.

5. CHANNEL TESTS shall be performed on all affected safety and control systems after any maintenance is performed.

6. A CHANNEL CALIBRATION shall be made of the linear power level monitoring channels annually, at intervals not to exceed 15 months.

7. A visual inspection of one of the CONTROL ROD poison sections shall be made annually, at intervals not to exceed 15 months. In a 3 year period, all sections shall be inspected.

8. A visual inspection of the CONTROL ROD drive and scram mechanisms shall be made annually, at intervals not to exceed 15 months.

Bases

1. The reactivity worth of the CONTROL RODS, specification 4.2.1, is measured to assure that the required SHUTDOWN MARGIN is available and to provide a means to measure the REACTIVITY WORTH OF EXPERIMENTS. Long term effects of TRIGA reactor operation are such that measurements of the reactivity worths on an annual basis are adequate to insure that no significant changes in SHUTDOWN MARGIN have occurred.
2. The CONTROL ROD withdrawal and insertion rates, specification 4.2.2, are measured to insure that the limits on maximum reactivity insertion rates are not exceeded.
3. Measurement of the CONTROL ROD DROP TIME, specification 4.2.3, ensures that the rods can perform their safety function properly.
4. The surveillance requirement specified in specification 4.2.4 for the reactor safety scram channels ensures that the CHANNELS are OPERABLE.
5. The surveillance test performed after maintenance or repairs to the REACTOR SAFETY SYSTEM as required by specification 4.2.5 to ensure that the affected CHANNEL will be OPERABLE.
6. The linear power level CHANNEL CALIBRATION specified in specification 4.2.6 will assure that the reactor will be operated at the licensed power levels.
7. Specification 4.2.7 assures that a visual inspection of CONTROL ROD poison sections is made to evaluate corrosion and wear characteristics and any damage caused by operation in the reactor.
8. Specification 4.2.8 assures that a visual inspection of control drive mechanisms is made to evaluate corrosion and wear characteristics and any damage caused by operation in the reactor.

4.3 Primary Coolant System

Applicability

These specifications apply to the surveillance requirements of the reactor primary coolant system.

Objective

The objective of these specifications is to ensure the reactor primary coolant system is OPERABLE as described in Section 3.3.

Specifications

1. The primary coolant level shall be verified before each reactor startup or daily during operations exceeding 24 hours.
2. Pool water conductivity shall be determined prior to the first startup of the day.
3. Pool water gross gamma activity shall be determined monthly, at intervals not to exceed six weeks. If gross gamma activity is high (greater than twice historical data), gamma spectroscopy shall be performed. Gamma spectroscopy shall be performed quarterly, not to exceed 4 months.
4. Pool water temperature shall be measured prior to the reactor startup and shall be monitored during reactor operation.

2. Specification 5.2.2 ensures that the pool water level can normally decrease only by 50.8 cm (20 in) if the coolant piping were to rupture and syphon water from the reactor tank. Thus, the core will be covered by at least 4.57 m (15 ft.) of water.

5.3 Reactor Core and Fuel

Applicability

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

Objective

The objective is to ensure that the CORE CONFIGURATION is as specified in the license.

Specifications

1. The core shall consist of TRIGA fuel elements assembled into THREE or FOUR ELEMENT FUEL BUNDLES.
2. The fuel bundles shall be arranged in a rectangular close-packed array, with bundles displaced for the pneumatic experimental system, PuBe source, neutron detectors, and graphite reflectors.
3. The reactor shall not be operated at power levels exceeding 250 kW.
4. The reflector shall be a combination of two graphite reflectors.

5.3.1 Reactor Fuel

Applicability

This specification applies to the FUEL ELEMENTS used in the reactor core.

Objective

The objective is to assure that the FUEL ELEMENTS are of such 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, and that the fuel used in the reactor has characteristics consistent with the fuel assumed in the SAR and the license.

Specifications

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

1. Uranium content: a maximum of 9.0% weight uranium enriched to less than 20% ^{235}U.
2. Zirconium hydride atom ratio: nominal 1.5 - 1.7 hydrogen-to-zirconium, ZrHx.
3. Cladding: 304 stainless steel, nominal thickness of 0.508 mm (.020 in).
4. The overall length of a FUEL ELEMENT shall be 30 inches, and the fueled length shall be 15 inches.

Basis

The design basis of the standard TRIGA FUEL ELEMENT demonstrates that 250 kW steady state operation presents a conservative limitation with respect to SAFETY LIMITS for the maximum temperature generated in the fuel.